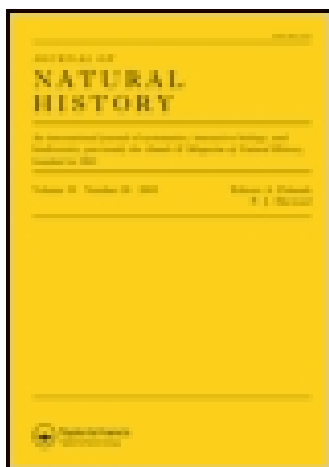


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Bombus rubriventris: type locality, different histories of bumblebees in the New World, and a likely invertebrate extinction

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***Bombus rubriventris*: type locality, different histories of bumblebees in the New World, and a likely invertebrate extinction**

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The bumblebee *Bombus rubriventris* Lepeletier is known only from the holotype. This specimen was collected at least 180 years ago and possibly more than 200 years ago. Given the high level of survey effort applied to bumblebees in general and the knowledge that there is only one other bumblebee species (among c. 250 species) known from a single specimen, it seems reasonable to infer from available information that *B. rubriventris* is likely to be extinct. However, the location of the type locality remains uncertain. Although there is no reason to challenge the original description placing the type locality in Brazil, there are reasons to doubt whether a label “St. Domingue.” (interpreted by later authors as placing the type locality either in Goiás or in the Dominican Republic) originally belonged to the specimen. Indirect evidence from morphology and from the historical biogeography of bumblebees supports a South American type locality, with the Brazilian Atlantic Forest as a likely candidate.

Keywords: Atlantic Forest; biogeography; bumble bee; extinction; IUCN Red List

Introduction

Although large numbers of invertebrate extinctions since AD 1500 are suspected, relatively few have been documented ([cmsdocs.s3.amazonaws.com/summarystats/2013_2_RL_Stats_Table4a.pdf](https://s3.amazonaws.com/cmsdocs.s3.amazonaws.com/summarystats/2013_2_RL_Stats_Table4a.pdf); endangeredspeciesinternational.org/extinct_list.htm; both accessed 2014). Small organisms such as insects are less well known (Reed and Boback 2002), it may be especially difficult to demonstrate when they are definitely no longer persisting somewhere (Gerlach et al. 2012), and there has been less documentation (McKinney 1999; Dunn 2005) and concern (Collen et al. 2012) for their extinctions. One candidate for a recently extinct invertebrate is the colourful red-and-black bumblebee, *Bombus rubriventris* Lepeletier.

The IUCN Bumblebee Specialist Group was formed to assess the threat status of bumblebees worldwide using the IUCN Red List categories and criteria (Williams and Jepsen 2013; iucn.org/bumblebees, accessed 2014). This project is driven in part by the high value given to bumblebees generally for their ecosystem service of pollination (Velthuis and van Doorn 2006; Goulson 2010). Fortunately for these Red List assessments, bumblebees are relatively well sampled among invertebrates, because of their large size and attractive appearance (Williams 1998). In the case of *B. rubriventris*, identifying the type locality could potentially have profound consequences for our understanding of the date of arrival of

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bumblebees in Central and South America and of their subsequent history of spread and speciation. Here I seek to elucidate what is known of *B. rubriventris* and where it is likely to have occurred.

Original description

Bombus rubriventris was described originally as species number 23 on page 472 of Lepeletier de Saint-Fargeau's (1835) *Histoire Naturelle des Insectes*:

"Hirsutus, ater; thorace undique griseo hirtio, pilis brevibus. Abdominis supra segmento primo nigro, secundo, tertio quartoque rubris, quinto anoque nigris; tibiis tarsisque fusce rufis, supra nigro villosis, subtus rufo hirtis. Alis fuscis, violaceo nitentibus.

Nigra si fuisset hirsuties thoracis, pro Bombo Carolino habuissem."

[Hairy, dull black; with the thorax covered everywhere with grey bristly hair, the hairs shorter. With the first segment of the abdomen dorsally glossy black, the second, third and fourth red, the fifth and the anus glossy black; with the tibiae and tarsi dark reddish, black-haired above, with reddish bristly hairs below. With the wings dark, shining violet./Were the hair of the thorax glossy black, I would have taken it for *Bombus Carolinus*.] (M.A. Alonso-Zarazaga, *in litt.*)

The description is then repeated with slight elaboration in French, specifying that the specimen was a "*Femelle*. Long. 11 lig." The statement *pro Bombo Carolino habuissem* is a reference to a species now known as *Bombus excellens* Smith (Milliron 1962) not the *Apis carolina* of Linnaeus. It is known from high elevations of the northern Andes (Milliron 1973) and has a colour pattern of the pubescence similar to *B. rubriventris*. The last line of the description for *B. rubriventris* reads: "Brésil. Musée de M. le compte Dejean".

The date of Lepeletier's publication is given on the title page as 1836, but a note inserted into the copy in the Natural History Museum (NHM, London) library reads "This volume was published in the week ending 26 Dec. 1835/(Bibl. France) Ioanis Sherborn." D. Baker (*in litt.*) confirmed this earlier date from the *Bibliographie de la France*.

Subsequent treatments

Smith (1854) on page 401 referred to a specimen in the J.O. Westwood collection as the type specimen ("*type sp. in Coll. Westw.*"). The collection worked on by Westwood is in the Oxford University Museum of Natural History (OUMNH).

Greene (1862) compared the colour pattern of the pubescence of *B. rubriventris* when discussing *Bombus huntii* (page 173) and then redescribed (page 174) *B. rubriventris* under the name "12. *Bombus Carolinus*. Auct. (St. Fargeau.)", without using the name *rubriventris* or having seen a specimen, but referring to [Lepeletier de] "St. Fargeau. See his work, Vol. I. p. 472, *et seq.*".

Franklin (1913) on page 181 wrote that he believed that the type was "probably lost" and that: "I have seen no *Bombus* specimen which I could consider as representing this species. *B. carolinus* [of authors, = *B. excellens*] comes nearest to it and

[Lepeletier de] St. Fargeau probably made his description from a freak specimen of that species” (my insertions in brackets).

Cockerell (1921) on page 364 described a specimen of *B. rubriventris* labelled “St. Domingue.” in the Hope collection (OUMNH) and stated that he regarded it as “probably the type”.

Frison (1925) on page 154 referred to the note by Cockerell (1921). Frison concluded: “Cockerell says that the malar space is moderate in length, ‘rather shorter than in *brasiliensis*’, and if it were not for this statement I would be inclined to consider *rubriventris* as a synonym of *carolinus*...” [of authors, = *B. excellens*].

Milliron (1960) described a specimen in the Westwood Collection, Hope Department (OUMNH), to be “in good condition” and wrote that it was “Labelled as type by me”. He gave the type locality as “St. Domingue [Santo Domingo]” (his brackets).

Milliron (1973) on page 137 gave the type locality as “Brazil (‘St. Dominique’, [São Domingos, Goiás]” (his brackets), but on the next page (page 138) he reported what must have been the same label locality as “St. Domingue.” (as in his earlier paper) and then discussed the specimen’s likely origins at length (see below). He suggested that the species is “either very rare and localized in highland areas or it is entirely extinct”.

Williams (1998) on page 112 reported the interpretations of Milliron (1973), adding comments on the condition of the specimen and diagnostic characters that separate it from other similar species.

Other references mention the species but without adding further information (Dalla Torre 1896; Moure and Sakagami 1962; Abrahamovich and Diaz 2002; Cameron and Williams 2003; Abrahamovich et al. 2004; Moure and Melo 2012).

Provenance and status of the OUMNH specimen

There is a specimen in the Westwood Collection, Hope Department (OUMNH), a large female, almost 20 mm in length (Figure 1), that appears to be a queen in the morphological sense. Although substantially smaller than as described by Lepeletier (11 French lines is 24.7 mm in length), it agrees in the colour pattern of the pubescence with the original description, and is the only specimen known so to do. Milliron (1973, 138) believed that “It is very unlikely that Lepeletier had before him more than this single specimen, which he indicated was from the Dejean collection (intensive search did not, however, disclose any *rubriventris* (Lep.) among the few remaining recognizable specimens of the Dejean collection).” Milliron had examined F.W. Hope’s copy of Lepeletier de Saint-Fargeau (1835) and found notes by Westwood in the margin beside the description of *B. rubriventris* to the effect that the label “*Bombus*”/“*Rubriventris*.”, reverse side “*Carolinus*”, was attached by Lepeletier.

The labels on the OUMNH specimen are currently: (1) [female]; (2) “*Bombus*”/“*Rubriventris*.”, reverse side “*Carolinus*”; (3) “St. Domingue.” or possibly “st. domingue.”; (4) “TYPE HYM: 63”/“*rubriventris*”/“Lep.”/“HOPE DEPT. OXFORD”; (5) “TYPE [female]”/“*Bombus*”/“*rubriventris*”/“Lep.”/“H. E. Milliron 1960”. The second label matches the label described by Westwood and Milliron, while the third label matches the label described by Cockerell and Milliron. The pin appears to be of



Figure 1. Dorsal aspect of the holotype female of *Bombus rubriventris* showing the ‘St. Domingue.’ label (photo: NHM photo unit). Scale divisions in mm.

an early nineteenth century design, with a silver shaft and a head wrought from coiled brass wire (R. Thompson, NHM, pers. comm.).

Milliron (1973, 138) believed that P.A. Latreille had acquired the specimen now in the OUMNH possibly as early as 1800, although he does not record why he believed this. D. Baker (*in litt.*) believed that it could have been acquired by Latreille at any time before his death in 1833. However, it was probably acquired by Latreille before 1826, when at least the bulk of Latreille’s collection was purchased by P.F.M.A. Dejean (Horn et al. 1990), because it was while it was in the Dejean collection that the specimen came to the attention of Lepeletier. Papavero (1971) gives an account of early collectors in Brazil, but there is no mention of an obvious direct connection with Latreille or Paris collections.

Baker (1994) documents that at some date after 1841 the Dejean collection passed in part to Westwood at Oxford via J.G. Audinet-Serville. Therefore it had neither originally belonged to the Hope Department and then “passed through the hands of Lepeletier” as stated by Cockerell (1921, 364), nor had it been acquired by Westwood from Lepeletier as stated by Milliron (1973, 138).

As reported previously (Williams 1998), the specimen is not now “in good condition” (Milliron 1960) but has had the metasoma glued back into place at the

waist (tarsi on all legs and the terminal joints of the right antenna are incomplete). Nonetheless, the characters of both the head and the metasoma appear to be distinctive from other known bumblebee species (Williams 1998), so there is no reason to believe that the specimen is a composite and not genuine. It is possible that damage and repair to the specimen have contributed to the discrepancy in measured body length.

I regard the female specimen (Figure 1) in the Westwood Collection as the holotype by monotypy (the only specimen examined by Lepeletier when writing his description) of *B. rubriventris* (ICZN 1999: Article 73.1.2), because: (1) only a single specimen is implied in the original description by the use of the singular “*Femelle*. Long. 11 lig.”; (2) the Westwood Collection female is the unique specimen to agree in colour pattern of the pubescence with the original description; and (3) this is the only specimen known to bear Lepeletier’s label “*Bombus*”/“*Rubriventris*.”.

Type locality

The original description gives the type locality as “Brésil”, whereas the third label on the type specimen apparently gives its origin as “St. Domingue.”.

Milliron (1973, 138) had examined a copy of Lepeletier de Saint-Fargeau (1835), originally owned by Hope and later used by Westwood, and found notes by Westwood in the margin beside the description of *B. rubriventris* to the effect that Westwood believed that the “St. Domingo.” label (Westwood’s spelling) was written by Latreille. From a recent examination of this copy (OUMNH), Westwood’s notes are written in pencil, which is now difficult to read. Milliron interpreted the label information in combination with the original description as referring to a São Domingos in the state of Goiás, Brazil (one of many similar place names in South America, see below).

I have examined a copy of a letter written by Latreille and the examples of his handwriting reproduced by Baker (1994). Intriguingly, although the handwritten characters of the locality label “St. Domingue.” are mostly simple (e.g. the cross-like “t”), there is a distinctive “S” elongated below the line and a complex flourish on the upper part of the “D” (Figure 1). There is a similar “S” and “D” in Latreille’s handwriting in Baker’s figs 1a (“*signatum fem.*”) and 1d (“*dentipes. mas.*”). The latter is quite distinct from the formation of the letter “D” by Lepeletier (Baker’s fig. 1g). The handwriting sample on the locality label is too small to be conclusive and a person’s handwriting can change during their life, but it is quite possible that the locality label was written by Latreille. However, this does not prove that the label was added to this specimen by Latreille, or that it was added by anyone before the description of *B. rubriventris* by Lepeletier, so it could be a later addition.

D. Baker (*in litt.*) believed that the published type locality, Brésil, and the specimen label, “St. Domingue.”, are in conflict to such a degree that “it is unlikely to be the specimen on which Lepeletier based his description”. He argued that Saint-Domingue (“Dominican Republic, not necessarily the town of S. Domingo”) and Le Cap Français à Saint-Domingue (now Cabo Francés

Viejo, Dominican Republic) were localities well known to contemporary French entomologists. Indeed, Baker considered it unthinkable that Lepeletier would describe a bee that he knew to be labelled “St. Domingue.” as coming from “Brésil” (although, of 26 Lepeletier bee species’ names listed by Baker in his 1994 paper, three names apparently have published type localities in countries outside the distribution of the species as they are currently understood). Baker concluded that either the specimen is not the type, or the label does not belong to it. In fact there is another example in Baker’s paper on the Lepeletier and Latreille types in the OUMNH (Baker 1994, 1192) for which Baker concluded that the type locality published for *Anthophora domingensis* Lepeletier (a synonym of *Amegilla garrula* (Rossi)?), the only bee listed in this publication as described from a specific Central or South American locality, of Le Cap Français à Saint-Domingue, is in this case a “false locality”. Baker believed that it may have resulted either from a misreading of the label by Lepeletier (the label may have been read as “capf”) or from Lepeletier having been misinformed by Dejean. Baker goes on to write that this “*Amegilla* does not occur in the West Indies” (*Amegilla garrula* is a European species). It seems to me likely that in the case of *Anthophora domingensis*, the label referring to Saint-Domingue was added to the specimen in error before its description by Lepeletier in 1841. A similar fate could have befallen the type of *B. rubriventris*, but perhaps after its description in 1835.

Exploring this avenue further, the Muséum National d’Histoire Naturelle (MNHN, Paris) has multiple type specimens of fish taxa with the type locality “St. domingue.”. These are regarded as referring to what is now the Dominican Republic, all collected by Dr Alexandre Ricord (1798–1876). Ricord was employed as a naval doctor, but was also a correspondent with the Paris museum. Another possibility for the “St. Domingue.” label of *B. rubriventris* is that in the seventeenth, eighteenth and early nineteenth centuries, it was common practice for specimens from continental interiors to be labelled with the name of the port of export from which they were bought or shipped, with little interest in their precise origin (Vane-Wright, *in litt.*). So it is even possible that Ricord purchased the specimen in what is now the Dominican Republic, whatever its origin.

Intriguingly, there are similar flourishes for the letter “D” in Ricord’s handwritten correspondence (e.g. letter to R. Pearle, 10 February 1822, Smithsonian archives, unit 7054 box 1 folder 14) to those noted above for the “St. Domingue.” label of *B. rubriventris*. However, Ricord’s “S” is usually much extended above rather than below the line. This appears to weaken the support for the “St. Domingue.” label having been written by Ricord. The possibility that the specimen was nonetheless collected by Ricord in the Dominican Republic and then passed to Latreille could remain, even if it is less likely. For the fish taxa described from the Ricord material by G. Cuvier in 1830, 1831 and 1832, the date of collection of these specimens is given as 1827 (see Fishbase, MNHN), but this is after most of Latreille’s collection was purchased by Dejean.

If we were nonetheless to take the specimen label “St. Domingue.” at face value, then a Dominican origin should at least be considered. Bumblebees are hitherto unknown from and have been presumed absent from the Caribbean islands. But if

searches had not been made, then they might have been overlooked. If bumblebees were to occur there, then the most likely place would be on the highest mountain, which is Pico Duarte (3175 m) in the Cordillera Central, behind the town of Santo Domingo. However, repeated expeditions to the Cordillera Central to collect bees since 1988 (approximately 500 collector hours: J. Rawlins, *in litt.*) and in 1999 (M. Ivie, *in litt.*) have found no bumblebees.

Alternatively, if we take the published type locality “Brésil” at face value, and if we accept Baker’s view that Lepeletier would not have written this if the specimen had borne a label “St. Domingue.” at the time of description, then the “St. Domingue.” label should be discounted from giving the true type locality. Consequently, Baker (*in litt.*) wrote that [any] “attempts to identify the supposed type locality of *rubriventris* among the numerous S. Domingos on the American mainland were doomed to failure” and there are indeed many similar names (e.g. Table 1; see others in Paynter and Traylor 1991).

In summary, the “St. Domingue” label may have been written by Latreille, but it may also have been added to the specimen by a third party, and perhaps after the description of *B. rubriventris*. This leaves the type locality “Brésil” in the original description as probably the most reliable evidence of its origin available at present. Any further resolution of the type locality within Brazil would have to rely on indirect or external evidence.

Colour pattern and length of the pubescence

There could be other clues to the origin of the OUMNH specimen in the colour pattern and length of the pubescence. Bumblebee colour patterns often show close convergences in particular regions among unrelated but co-occurring species (Williams 2007). The black thorax and extensively red metasoma are characteristic of several species of the high Andes mountains, including *Bombus excellens* (subgenus *Thoracobombus*, like *B. rubriventris*), *Bombus baeri* Vachal and *Bombus coccineus* Friese (both subgenus *Cullumanobombus*). Some individuals with this colour pattern have been recorded from nearer to the northern coast of the continent in Colombia and Venezuela (Milliron 1973). But neither the Andes (in a broad sense) nor the distribution ranges of any of these Andean bumblebee species fall within the boundaries of modern Brazil. Even in the 1820s, the larger Empire of Brazil at its greatest

Table 1. A selection of example places with names similar to ‘St. Domingue.’, especially in Brazil, among candidates for the type locality of *Bombus rubriventris* (coordinates for WGS84 datum).

Place	Province/States	Country	Elevation (m)	Latitude	Longitude
Santo Domingo	Santo Domingo	Dominican Republic	50	+18.49980	−69.98171
São Domingos	Goiás	Brazil	672	−13.39822	−46.32126
São Domingues	São Paulo	Brazil	776	−23.55654	−46.44947
São Domingos	Rio de Janeiro	Brazil	37	−22.88948	−43.30304

extent never included parts of the Andes. Nonetheless, no specimens resembling *B. rubriventris* in morphology have been collected from the Andes (in a broad sense).

Bumblebees of high elevations in the Andes (in a broad sense) often have long pubescence (e.g. *B. excellens*, *B. baeri* and *B. coccineus*). They contrast with *B. rubriventris*, which has short pubescence, similar to the relatively low-elevation species from eastern Brazil, such as *B. (Th.) brevivillus* Franklin, *B. (Th.) brasiliensis* Lepeletier and *B. (Th.) atratus* Franklin (NHM collection). Hence, the indirect evidence from colour pattern and from hair length is inconsistent.

Relationships to other taxa

Bombus rubriventris is superficially similar to queens of the Chinese *Bombus pyr-osoma* Morawitz, for example in the length and colour pattern of the pubescence, and in some aspects of morphology (including the shape of the oculo-malar area, sculpturing of the ocello-ocular area, and sculpturing of metasomal tergum 6). Some of the more obvious differences are that *B. rubriventris* has the pubescence of metasomal terga 5–6 black rather than red, the wings are slightly darker, and the distal posterior corner of the mid basitarsus is produced as a sharp spine, rather than forming nearly a right angle.

From its morphology, *B. rubriventris* belongs almost certainly to the former subgenus *Fervidobombus* Skorikov, most species of which are Neotropical (Williams 1998). *Fervidobombus* has been revised more recently as part of the broader subgenus *Thoracobombus* Dalla Torre (Williams et al. 2008). Cameron and Williams (2003) and Cameron et al. (2007) used several genes to estimate the phylogenetic relationships among nearly all of the New World species of *Thoracobombus*. Unfortunately, these analyses did not include *B. rubriventris*, because neither DNA nor morphological characters of the male genitalia were available for study. The female *B. rubriventris* can be distinguished from females of *B. (Th.) excellens* (which have a similar colour pattern of the pubescence) because *B. rubriventris* has the pubescence much shorter and more even; the oculo-malar area is nearly square rather than nearly twice as long as the basal breadth of the mandible; and metasomal tergum 6 is weakly raised in a medial bump posteriorly, just before the apex (Williams 1998). Milliron (1973) considered the female morphological characters of *B. rubriventris* to be “very much like those of *B. bellicosus*” Smith, distinguishing *B. rubriventris* by its more evenly curved posterior edge of the hind basitarsus. He distinguished *B. rubriventris* from *B. (Th.) opifex* Smith by the shorter oculo-malar area of *B. rubriventris*. Williams (1998) suggested that *B. rubriventris* can be distinguished from *B. (Th.) bellicosus* because *B. rubriventris* has finer and more uniform punctures on the central area of the clypeus, and a distinct medial groove subapically on tergum 6. It was considered that *B. rubriventris* is slightly more similar in these characters to *B. opifex*, although the difference between *B. opifex* and *B. bellicosus* is subtle. *Bombus rubriventris* can also be distinguished from *B. opifex* and *B. bellicosus* by the band of fine punctures in the outer lateral part of the ocello-ocular area, which for *B. rubriventris* is narrower (extending just less than half of the distance from the eye to the lateral ocellus), less dense (most of the punctures are spaced by more than their own breadths) so that it is shining, and where it extends anteriorly of the lateral ocellus it has a shallow but distinct longitudinal broad depression or groove. *Bombus rubriventris* has the corbicular fringes of the hind tibia short, the outer corbicular

surface on the proximal two-thirds with many short very fine branched hairs, more like *B. bellicosus* than *B. opifex*. Hence a particularly close relationship to *B. bellicosus* seems likely. In the future more information might be gleaned from a morphometric study of wing venation (cf. Wappler et al. 2012) and this option is being pursued.

Biogeography of New World bumblebees

A preliminary estimate of bumblebee phylogeny using male morphology concluded that bumblebees are likely to have reached South America after the northern and southern continents last re-connected, as part of the great “faunal interchange”, within the last 4 million years (Williams 1985). Re-analysis of the same distribution data but using molecular evidence from Cameron et al. (2007) in a study by Hines (2008) suggested a date for this colonization of South America having started before 15–7.5 million years ago. If the type locality of *B. rubriventris* were in Brazil, then this could be consistent with either of these phylogenetic and biogeographic estimates.

Alternatively, if the type locality were in the Dominican Republic, then that would have dramatic consequences for reconstructions of the historical biogeography of bumblebees. Bumblebees are thought to be very poor at dispersing over sea and arriving in a fit state and in sufficient numbers to establish viable populations (Ito and Sakagami 1980; Ito 1987; Macfarlane and Gurr 1995; Estoup et al. 1996). Although queen bumblebees are sometimes able to fly long distances across sea (Haeseler 1974), it is unclear whether they arrive in a fit physiological state to found colonies. Furthermore, because sex determination in bumblebees depends on heterozygosity at a single locus so that sibling matings will result in the rearing of many diploid males (Duchateau et al. 1994), unless many different queens arrive in a new area together, then severe inbreeding depression is likely to result. Therefore if bumblebees were to have reached the area of the present Dominican Republic, then they are more likely to have had to have spread in larger numbers through suitable habitat across land when it was still part of the mainland of Central America. That would require bumblebees to have reached the Caribbean region before the end of the Cretaceous period (Donnelly 1988; Iturralde-Vinent and MacPhee 1999), long before what is currently accepted for the arrival of bumblebees in the New World (Williams 1985; Hines 2008). Consequently, a Dominican type locality would require a major revision of our understanding of the entire historical biogeography of bumblebees, which makes the Dominican interpretation less likely.

There have been documented losses of some bee species (including *B. bellicosus*) from some parts of Brazil (Freitas et al. 2009; Martins et al. 2013). We have now no admissible direct information on where within Brazil *B. rubriventris* may have been collected. But one of the most famous concentrations of high species endemism in South America is in the Atlantic Forest region of Brazil, which has suffered extensive habitat degradation (Fonseca 1985; Bibby et al. 1992). When seeking an area of Brazil with exceptionally high levels of endemism where extinction of a short-haired bumblebee is likely to have occurred in the last 200 years, this would have to be a strong candidate. Any material from the Atlantic Forest being shipped to Europe in the eighteenth or early nineteenth centuries is very likely to have been exported via Rio de Janeiro, so “Brésil” would be a likely given locality. The Atlantic Forest ecoregion is also adjacent in its southern part

(wwf.panda.org/what_we_do/where_we_work/atlantic_forests, accessed 2014) to the distributions of those bumblebee species that are likely to be most closely related to *B. rubriventris* (*B. bellicosus* and *B. opifex*; see maps in Milliron 1973). However, the bumblebee fauna of southeastern Brazil is relatively well known (Silveira and Cure 1993), and *B. rubriventris* has so far remained undetected.

Conclusions

Bombus rubriventris is known only from the holotype queen. The type locality is uncertain. While there is no particular reason to challenge the original description in placing the type locality in Brazil, there are reasons to doubt whether a label “St. Domingue.” originally belonged to the type. Indirect evidence from morphology and the historical biogeography of bumblebees supports a South American type locality, with the Brazilian Atlantic Forest as a likely candidate.

IUCN criteria (IUCN 2001) for assessing a species as extinct are:

“when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon’s life cycle and life form.”

As far as is known, there is only a single specimen of the bumblebee species *B. rubriventris*. The single specimen was collected at least 180 years ago and possibly more than 200 years ago. Therefore, given the high level of survey effort applied to bumblebees in general and the knowledge that there is only one other bumblebee species (out of *c.* 250 species) known from a single specimen (*B. melanopoda* Cockerell; Williams 1998), it seems reasonable from available information to assess *B. rubriventris* as likely to be extinct.

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