

The Tropical Andean Bee Fauna (Insecta: Hymenoptera: Apoidea), with Examples from Colombia

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Abstract. Using reports from the literature and data from collections, we provide the first checklist of the tropical Andean bee species found above 2500 m, with a particular emphasis on those in Colombia, where the data are strongest. This listing consists of 65 species in 26 genera from 5 families for Colombia and 90 species in 27 genera for Venezuela, Ecuador, and Peru. For Colombia, the Apidae and Halictidae are the most speciose taxa of those families found at high elevations and contain a similar numbers of species; however, unlike Apidae, Halictidae is not well understood taxonomically and appears to be the most diverse apoid lineage in the tropical Andes. Most bee species occur in cloud forest and only a few in Páramo. Too little data is available for general conclusions on the bee faunas for the remaining countries at this time. We also present an overview of the biogeography, distribution, and biology of this little-known fauna and suggest future directions for research on these bees.

Key words. Apoidea, Andes, biodiversity, biogeography, checklist, Colombia.

1. Introduction

Bees (Apoidea) are found in all biogeographic regions of the Earth outside of the extreme arctics, although their greatest abundance and diversity is in warm-temperate and xeric areas. Approximately 17,000 species of bees are presently known, although estimates range as high as 20,000–25,000 species worldwide (MICHENER 2000b), segregated into six families, five extant and one extinct (ENGEL 2000, 2001). MICHENER (2000a, 2000b) recently pointed out that among the least known bee faunas in the world is that of the higher tropical Andes, from Bolivia to Venezuela. Indeed, while the apifaunas of other South American countries are relatively well, albeit still quite limitedly, understood (e.g., SILVEIRA et al. 2002 for Brazil; TORO 1986 for Chile), those of the Andean countries are quite poorly investigated. Remarkably, while the bee fauna of Colombia is in need of exploration, it is more comprehensively studied than any of the other Andean countries, with preliminary checklists for the fauna (e.g., SMITH-PARDO 2003). Comprehensive checklists for Bolivia, Peru, Ecuador, and Venezuela are entirely lacking. Thus, Colombia serves as an ideal region for focusing a broader discussion on the Andean bee fauna, highlighting examples from this area and drawing the attention of melittologists to expand our knowledge in all of the Andean countries.

In Colombia, the Andes are divided into three cordilleras (mountain ranges) which traverse the country from the southwest to northeast: the Cordillera Occidental with elevations of up to 3900 m; the Cordillera Central, with the highest peaks at 5432 m, has its origins in the Cordillera Oriental in Ecuador; and the Cordillera Oriental, the longest and widest range, with elevations reaching 5400 m (RANGEL & AGUILAR 1995). In Colombia, high altitudes are characterized mainly by two vegetation types: (1) Cloud Forest, usually occurring between ~2400 m and 3300 m, and (2) Páramo, high mountain grasslands dominated by giant rosettes of members of the family Asteraceae, occurring between 3500 m and 4100 m. Isolated patches of xeric areas also occur above 2000 m (CUATRECASAS 1989; STURM & RANGEL 1985). The Andes appear to be one of the areas of highest endemism and species richness in Colombia,

probably owing to their structural complexity, altitudinal gradient, and variable topography. Although these montane ecosystems are considered priority areas for the conservation of biodiversity, few studies have been conducted here. The Andes are also threatened by agriculture and human population growth.

In an attempt to summarize our currently scattered knowledge of the South American Andean bee fauna, herein we provide the first preliminary checklist of the species found at altitudes above 2500 m in Colombia, with available notes on species from other Andean countries. We have added comments regarding the altitudinal distribution patterns that bees exhibit and reviewed the importance of these results in the context of information that is currently available. We hope to draw more attention to and encourage future studies on this unique bee fauna.

2. Material and methods

Data were gathered from a survey of bibliographic reports to construct a preliminary list of all bee species that have been found in the Andes at elevations higher than 2500 m from Peru to Venezuela. The list was complemented by examination of specimens deposited in the Natural History Museum, University of Kansas (KU), the American Museum of Natural History (AMNH), and the following Colombian insect collections: Instituto Alexander von Humboldt, Villa de Leyva, Boyacá; Instituto de Ciencias Naturales, Museo de Historia Natural de la Universidad Nacional de Colombia, Bogotá; Laboratorio de Investigaciones en Abejas del Departamento de Biología de la Universidad Nacional de Colombia (LABUN), Bogotá; Universidad Nacional de Colombia, Palmira; Museo Francisco Luis Gallego, Universidad Nacional de Colombia, Medellín; Colección Entomológica de la Universidad del Valle, Cali; Universidad de la Salle, Bogotá; Universidad Javeriana, Bogotá; and personal insect collections of Fernando Fernández and Carlos Sarmiento.

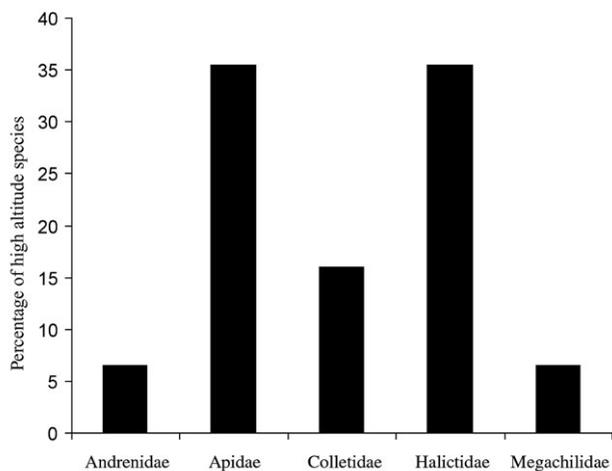


Fig. 1. Percentage of bee species found in each family above 2500 m of altitude in Colombia.

For Colombia, information regarding the vegetation type of the collection site was extracted from the literature or from specimen labels. Based on their altitudinal distribution records, species were coded as 'restricted' when found only at high altitudes (e.g., above 1400 m), 'widespread' when collected from lowlands to highlands, and 'transient' for those taxa that do not belong to Andean ecosystems but eventually were collected in high elevations. For those taxa recorded for the first time here, the number of different locality records is given in order to provide an indication of the accuracy of their assignment in terms of these three categories

3. Results

This preliminary survey reports approximately 131 species in 33 genera, representing all 5 extant families of bees, from Venezuela to Peru. For Colombia 65 species in 26 genera (also from all 5 families) of bees were found (Tab. 1) and 90 species in 27 genera for all other countries (Tab. 3). Not all specimens were identified to species level due to lack of taxonomic treatment, and some undetermined specimens may represent new species. Therefore, the total number of species is provisional and the list can be strongly biased toward those families better known taxonomically like Apidae.

The total number of bee species occurring in the higher Andes of Colombia represents about 12% of the total bee species listed for the country (SMITH-PARDO 2003). Our data show that there is a distinctive and interesting fauna from the higher Andes of Colombia. This result was expected since high altitude ecosystems are suspected to have unique biota due to special climatic conditions such as broad diurnal thermal variation, high ultraviolet radiation, and strong winds (RANGEL & AGUILAR 1995).

Owing to the scarcity of information from Andean countries other than Colombia, these lists will certainly be expanded as more thorough sampling and new revisions are undertaken. For example, the most extensive survey of stingless bees in Ecuador (COLOMA-ROMAN 1986) sampled relatively few sites above 2500 m, although a few were near

2300 m. Thus, available data is scarce for truly high elevation taxa and further sampling is required throughout Peru, Ecuador, and Venezuela.

Two general altitudinal distribution patterns can be recognized from the data. The first pattern is that of some species occurring from lowlands to high altitudes (e.g., *Bombus atratus*, *B. pullatus*, *Trigona fulviventris* s.str.). The introduced *Apis mellifera* also fits into this group. The second pattern is a distribution restricted to high elevations. Approximately 70% of the species listed in Tab. 1 fit in this group. Apidae and Halictidae are the families with the highest proportion of species occurring in high elevations (Fig. 1). However, unlike Apidae, the Andean halictids are not well studied taxonomically and most specimens remain unidentified. Without including those in the calculations, the present data underestimate the true diversity of this family. Halictids thus seem to be the most diverse family and are probably one of the more important components in these ecosystems. For example, the genera *Caenohalictus* Cameron and *Neocorynura* Schrottky are represented by only a few species in the present list even though they are well represented in museums, and may contain the majority of undescribed species.

Most Andean bee species occur in cloud forest and only a few in Páramo. About 26% of Andean species reach the latter ecosystem and to date, the bumble bee *Bombus funebris* is the only well known species restricted to it. This species has been collected at 4750 m in Nevados National Park in the Cordillera Central, the highest elevation recorded for bees in Colombia. Several taxa of stingless bees (Meliponini) also have adapted to high altitudes like *Parapartamona* Schwarz. Although they do not properly belong to this fauna, larger bees typical of the lowlands, with a broad flight range, such as *Eulaema* Lepageletier and *Xylocopa* Latreille, also have been collected at elevations near 2500 m (Tabs. 1, 3).

4. Discussion

4.1. Distribution patterns

Widespread bees, occurring from lowlands to high altitudes, suggest the ability to adapt to different environmental conditions and use diverse pollen sources. Pollen-generalist social species like *Bombus atratus*, *B. pullatus*, *Trigona fulviventris* s.str., and *T. amalthea* are the best examples of this pattern.

Some stingless bee taxa (Meliponini) are well-adapted to high altitudes (BRAVO 1992; ROUBIK et al. 1997; GONZALEZ & NATES-PARRA 1999). *Parapartamona* occurs from Peru to Colombia (GONZALEZ & NATES-PARRA 1999; GONZALEZ & SMITH-PARDO 2003), and along with *Meliwillea* Roubik, Segura & Camargo, from the highlands of Costa Rica and Panama, is the only multi-species highly social taxon endemic to the Andes reaching up to 3500 m of altitude. *Melipona nigrescens* is a single highly social species occurring in the Colombian highlands, unlike most species of this genus, which are typically found in the lowlands.

Probably only the larger bees of the genera *Eulaema* and *Xylocopa* fall in the category of transient bees. Because of their size and long distance flights, we speculate they can move from lower elevations searching for food. Previous reports of the orchid bee (Euglossini) genera *Eulaema* and

Eufriesea Cockerell crossing lakes while carrying pollinia of orchids found at least 45–50 km away from the collection place (DRESSLER 1982) support the idea that larger bees can fly long distances and reach upper elevations in the Andes. However, *Xylocopa* species that nest in tree trunks used for lumber also could be transported by humans from lowland sites where they are abundant.

In addition to bees listed in this work, other species are restricted to the Andes at altitudes of 1800 m to ~2400 m, but have not yet been found above 2500 m: e.g., *Centris* (*Ptilocentris*) *festiva* Smith, 1854, *Eufriesea nigrescens* (Friese, 1923), *Paratetrapedia* sp., *Bombus melaleucus* Handlirsch, 1888, *B. excellens* Smith, 1879, and the augochlorine genera *Chlerogella* Michener, *Chlerogas* Vachal, and *Ischnomelissa* Engel. Perhaps the presently known distribution of these groups is simply an artifact of sampling and they may be found above 2500 m in further surveys; however, vegetation cover and other ecological factors not directly related to altitude also play important roles in the definition of the various local species assemblages. Actually, in general no sharp altitudinal delimitation can be defined to separate lowland and highland faunas as discussed by SILVEIRA & CURE (1993) for the mountain bee fauna of Brazil. Although low temperatures could be the most restrictive factor for bees, comparatively warmer temperatures in the highlands of Colombia and Ecuador – due to their proximity to the equator – might allow them to reach high elevations (BAUMGARTNER & ROUBIK 1989), such as those known for stingless bees and bumble bees.

The geographic distribution data for the species listed in the present work must be taken as provisional, and for some of them, such as *Geotrigona subgrisea* and *Paratrigona eutae-niata*, as tentative (see NATES-PARRA et al. 1999). Considering their wide range and distribution, other species such as some *Augochlora* Smith (e.g., *Augochlora repandirostris*) listed by MOURE & HURD (1987), ranging from lowlands in Brazil to highlands in Santa Fe de Bogotá (~2600 m), Colombia, may represent more than one species. Indeed, recently a species closely allied to *A. repandirostris* has been described from Colombian lowlands (WCISLO et al. 2003).

Locality names given on old specimen labels are partly problematic due to homonyms. For instance, in the past, many places in the lowlands between the Andes in Colombia were known by the name “Bogotá”, thus some old specimens labeled “Bogotá” may not actually be from near the Colombian capital Bogotá. This problem has also been noted for other hymenopterans such as vespid wasps (*C. Sarmiento* pers. comm.) and is likely also true for several localities on older labels from other countries (e.g., “Guayaquil” in Ecuador; GONZALEZ & MICHENER in press). At present, there exist no intensive and systematic surveys of the bee fauna in the Andes. In Colombia only occasional collections, made mainly in the central region of the Cordillera Oriental, between the departments of Cundinamarca and Boyacá, are known. This would explain the bias in the distribution data of most of the species towards the Cordillera Oriental (Tab. 1). A similar bias exists for the distribution data of bees in cloud forests versus Páramo. Accurate distribution records and a better understanding of the phylogenetic relationships for many taxa are needed to draw strong conclusions about the biogeography of the Andean bees.

4.2. Origins of the Andean bee fauna

Based on its composition, the three most obvious origins of this Andean bee fauna are: (1) a southward migration by Nearctic or Holarctic elements that entered via the Central American land bridge, such as *Bombus* Latreille, (2) a northward migration of groups that evolved in southern South America and speciated in these new Andean ecosystems during the migration periods, and (3) an upward migration of lowland South American groups which differentiated and potentially diversified at high altitudes. Undoubtedly, climatic changes during the Quaternary played a significant role in shaping the evolution of Andean bees during and after uplifting to high altitudes. The Pleistocene climatic events modified the vegetation belts and opportunities for migrations. Glacial climates allowed high altitude organisms to migrate and disperse from mountain to mountain along the Andes when vegetation zones were lowered, whereas warm climates restricted migrations. These phenomena of migration and isolation gave an opportunity for speciation in successive periods of isolation (reviewed by SIMPSON 1971). The majority of Andean bees appear to have southern lowland tropical origins (e.g., Augochlorini: ENGEL 2000), or perhaps even Gondwanaland origins. Meliponini is a supposed best unlikely example of the latter origin (CAMARGO et al. 1988), and contains endemic taxa that evolved from lowland ancestors. Examples include *Parapartamona*, which is probably derived from lowland tropical *Partamona* Schwarz (ROUBIK et al. 1997), and at least the Andean *Chilicola* Spinola, subgenus *Hylaeosoma* Ashmead (Colletidae), whose origins from lowland tropical antecedents is suggested by its current distribution and fossil evidence (MICHENER 2002). The Andes also acted as a strong geographical barrier to migrations of lowland taxa, yielding complex populations in Meliponini, along the pre-Andean region and in the valleys between the cordilleras in northern South America (CAMARGO 1984). Some Andean taxa, facilitated by glacial climates, also reached Central American mountains (e.g., *Andinaugochlora* Eickwort and *Chlerogella*, which also occur in the highlands of Costa Rica and Panama: ENGEL & SMITH-PARDO 2004).

4.3. Taxonomic novelties and problems

From his monumental work on Augochlorini (Halictidae), including a few specimens from the Andes, EICKWORT (1969) predicted a high diversity of these bees in the Andean region, and speculated that new genera and new radiations of previously known genera might be found. Recently, the augochlorine genera *Ischnomelissa* and *Neocorynurella* Engel have been described from the Andes of Colombia, Ecuador, and Venezuela, and some new species of these genera remain undescribed (ENGEL 1997; ENGEL & KLEIN 1997; Engel unpubl. observations). Interesting new high-altitude taxa have also been found in Andrenidae, a very rare group of bees in Colombia presently known from only two lowland species in Colombia (Engel & Gonzalez unpubl. observations). In addition, an undescribed species of the cosmopolitan genus *Anthophora* Latreille (Apidae) has been found in restricted xeric areas above 2200 m (GONZALEZ & CHAVEZ in press). MICHENER (2000a, 2002) described a new subgenus of *Hylaeus* Fabricius and a new subgenus of *Chilicola* (both Colletidae) from the Andes, showing again the distinctiveness of this

fauna. Despite the morphological distinctiveness of these taxa, among all of these, however, only the augochlorines and *Chilicola* have been placed into cladistic frameworks. Thus, many supposed Andean 'endemic' subgenera and genera may merely be strongly modified members of taxa otherwise restricted to lowlands. The need for phylogenetic studies is critical; these will not only provide robust classifications, but will elucidate evolutionary patterns and phenomena. Resolving the phylogenetic placement of Andean taxa relative to other lineages will provide a more accurate picture of radiations in the Andean region, and knowledge of the biology of some Andean taxa might be critical to understand and clarify the evolution of higher categories in some groups of bees. For example, in a recent cladistic analysis of Augochlorini, the phylogenetic position of *Andinaugochlora* is enigmatic, despite its close phenetic similarity to *Neocorynurella* (ENGEL 2000). Indeed, both *Andinaugochlora* and *Neocorynurella* may be phylogenetic derivatives of the larger, more widespread genus *Neocorynura*, itself having reached the high Andes (e.g., ENGEL 1999). Cladistic work on *Neocorynura* and its relatives (presently in progress by A.H. Smith-Pardo) will hopefully resolve the placement of these genera, and may indicate that *Neocorynura* has extended to high altitudes multiple times independently. Already it appears that *Andinaugochlora*, *Neocorynurella*, and at least one lineage of *Neocorynura* (i.e., *Neocorynura papallactensis*, but likely others as well) have independently extended into the Andes (Smith-Pardo pers. comm.). Similar examples could be mentioned for *Bombus*, in which several infrageneric categories show intergradation and certain discordances in some characters (MICHENER 2000b). Analogously, the high-altitude Mesoamerican species *B. macgregori* Labougle & Ayala, 1985 perhaps renders related groups paraphyletic and is ecologically not understood. Behavioral and ecological data have proven to be robust in phylogenetic studies of bees (e.g., ENGEL & SCHULTZ 1997; ENGEL 2000). Thus, comparative studies on behavior, nest architecture, host plants, etc. for Andean bee taxa would help us to gain a better understanding of the generic relationships and taxonomic placement of these bees (e.g., *Parapartamona* may render *Partamona* paraphyletic as the latter is principally defined on the absence of the former's autapomorphies: but see PEDRO & CAMARGO 2003).

4.4. Andean bee biology

Currently, biological information is available for only a few species (Tab. 2). For instance, endemic South American subgenera of *Bombus*, such as *Rubicundobombus* Skorikov and *Funebribombus* Skorikov, each apparently with a single species (CHAVARRÍA 1996; WILLIAMS 1998), remain ecologically unknown.

Interesting bee relationships with native plants and other organisms remain to be discovered or studied in finer detail. For example, at least three augochlorine genera (*Ischnomelissa*, *Chlerogas*, and *Chlerogella*), and two species of Colletidae (*Cadegualina andina* and *C. sericata*) exhibit elongate heads, which has been hypothesized as an adaptation for tubular flowers (e.g., BROOKS & ENGEL 1999; ENGEL 1998, 2000); however, only anecdotal records and no fine behavioral observations are available to test this hypothesis. Indeed, the only floral record for *Chlerogella* is that of *Clidemia crenulata* Gleason, 1945 (Melastomataceae) for *Chlerogella clidemiae* (ENGEL 2003). *Clidemia* is buzz-pollinated by a variety of bees and does not support

the notion of specialization. However, it is very likely that *C. clidemiae*, as well as other *Chlerogella*, visits other flowers for which its peculiar adaptations are necessary.

Recently, natural enemies not previously known were documented as associated organisms for two species of *Neocorynura*: a new species of phorid fly (genus *Megaselia* Rondani, 1856) attacking the brood provisions (GONZALEZ et al. 2002) and an undescribed parasitic mutillid wasp of the genus *Lophomutilla* Mickel, 1952. To date, this new *Lophomutilla* species and *Lophomutilla halicta* (Mickel, 1973) are the only species of this genus known to parasitize augochlorine bees (ROUBIK 1989). Similarly, while poorly understood or documented, bees (particularly Halictidae) are frequently associated with phoretic mites (e.g., EICKWORT 1979, 1994; OCONNOR 1988; FAIN et al. 1999). Although mites are frequently seen on museum specimens, to date studies have not investigated further the association between high altitude bees and their mites. It would be interesting to discover whether there has been specialization in both the bees and the mites (perhaps even co-cladogenesis) for their lofty life-histories.

Tropical high altitudes also represent an opportunity to understand how differences in seasonality can influence social behavior. In several species of primitively social sweat bees (Halictinae), there is a marked geographic variation in the expression of eusociality (EICKWORT et al. 1996; WCISLO 1997). In high altitudes of temperate latitudes and in extreme cold temperate areas they are solitary because the favorable season is too short for females to produce a generation of workers prior to new reproductive. In contrast, at tropical latitudes or low altitudes these bees produce more than one brood per season and are social (examples in WCISLO 1997). Thus, since highland tropical environments lack a strong winter, these areas could be expected to contain proportionally more social taxa. Furthermore, the strong diurnal fluctuations of temperature in tropical high altitudes might also yield smaller colonies, a low brood survivorship, and a more dominant queen, promoting a more eusocial behavior in those 'social species' as noted in temperate populations of *Halictus ligatus* (Say 1837) under extreme weather conditions (RICHARDS & PACKER 1995, 1996). There are no data from the Andes about this phenomenon and it would be an interesting biological aspect for further research.

4.5. Role of bees as pollinators in tropical Andes greater than expected?

In temperate montane environments hymenopteran abundance, diversity, and importance as pollinators all usually decrease with increasing altitude, where they are replaced by Diptera and Lepidoptera pollinators, although data are scarce (WARREN et al. 1988; NEFF & SIMPSON 1993). Community pollination studies in the Chilean Andes show that the importance of bees as pollinators decreases from 50% to 13% in the altitudinal gradient between 2200 and 3600 m (ARROYO et al. 1982). In the high-altitude areas of Australia, flies were the predominant pollinators (INOUE & PYKE 1988). However, in the Rocky Mountains of Colorado between 2900 and 4100 m, bees were the main pollinators at all sites (MOLDENKE & LINCOLN 1979).

The tropical Andes experience large daily changes in weather conditions, which influence diurnal bee flight activity. Anecdotal observations in tropical Andes at ~2800 m indicate that diurnal temperatures can change quickly from near zero to ~20°C, and when fog and low clouds cover the sky,

bees often remain in their nests for days, foraging only for the few minutes to one hour or so of sunlight each day (MICHENER et al. 1979). Bees also exhibit this behavior at mid-elevations in Costa Rica during the rainy season (WCISLO et al. 1993).

Pollen analyses from nests of two species of *Neocorynura* show that they are polylectic (typical for the tribe Augochlorini), even though they have rarely been collected on flowers (Gonzalez et al. unpubl. data), and were previously known only from Malaise traps. Thus, bees may play a more important pollinating role in the Andes than floral observations initially suggest.

Flower longevity of plants in Andean highlands is longer than in lowlands due to the strong and unpredictable diurnal changes of temperature in this environment. This has been hypothesized as a strategy to increase the chances of pollination by visitors, which are scarce under such conditions (PRIMACK 1985). However, there are no studies on community-level pollination or the importance of particular bee taxa within tropical Andean ecosystems.

4.6. Parasitic versus non-parasitic bees

Parasitic bee taxa are more diverse in temperate areas than in the tropics owing to seasonality. Based on an extensive survey of published reports, WCISLO (1987) showed that there are proportionally more clepto- and socially-parasitic species of bees, wasps, and ants in temperate regions than near the equator. This is presumably owing to the high synchronization between parasite and host imposed by the seasons, in contrast to less seasonal lowland tropical environments. WCISLO (1987) hypothesized that high altitudes in temperate regions would contain more parasites than tropical high altitudes because highland tropical environments are relatively cooler year-round, and generally less seasonal than lower tropical altitudes. Socially-parasitic bee species are not known from the Andes; cleptoparasitic bee species reported in the present study are: one species each of *Coelioxys* Latreille (Megachilinae) and *Doeringiella* Holmberg (Apinae) and at least three species of *Sphcodes* Latreille (Halictinae), corresponding to less than 5% of the total known Andean bee fauna contrasting with 36% parasitic species recorded from the Alps (BEAUMONT 1960). Although most specimens were not identified to the species level and many areas in the Andes remain to be sampled, this preliminary survey tentatively supports Weislo's hypothesis.

4.7. Conclusions and future directions

The relatively recent origin of the Andes (about 25 million years ago) and their complex biota due to the historical geological changes and the position of northern South America make this an area of special interest to biologists. There is a diverse and interesting Andean bee fauna that is little known taxonomically and ecologically. The present data do not allow us to draw any strong conclusions about the biogeography of the Andean bees, since the phylogenetic relationships for many taxa are unclear and there is a lack of accurate distribution records. However, in general, the composition of the tropical Andean bee fauna parallels that of the Andean flora. Andean bees are a complex mix of: (1) endemic taxa evolved from lowland ancestors, (2) groups having a northern origin that entered South America via the Central America land bridge, and (3) taxa from the lowlands with sufficient plasticity to reach at least part of these

Andean ecosystems. A cladistic biogeographic analysis of some taxa could help explain the historical biogeographic patterns and factors involved in the evolution of this fauna. Furthermore, cladistic analyses can further refine the presently artificial taxonomy of many groups of bees, whereby the expected monophyletic Andean radiations will possibly render lowland taxa of equivalent taxonomic rank paraphyletic. Such artificial taxonomic edifices obscure interesting evolutionary patterns or inflate the diversity of higher clades making comparisons with other faunas meaningless. The few examples given above show how important the Andean bee fauna is in contrast to an evident lack of available knowledge. To date, there has not been any systematic sampling in the higher tropical Andes; for Colombia, most of the material deposited in museums comes from the central part of the Cordillera Oriental, and for other countries, the sampling is sparse or limited to a few visits to particular parks. Future studies should center on areas and ecosystems such as the high altitudes of the Sierra Nevada de Santa Marta in Colombia, which has been biogeographically isolated and is virtually unsampled. Bees from xeric areas also are interesting because such areas represent 'biogeographic islands' separated from one another by expanses of cloud forests. They are likely to contain a diverse fauna, according to MICHENER'S (1979) hypothesis on high bee diversity in warm-temperate and xeric regions of the world. We need to obtain basic data on seasonality, biology, and natural history of Andean bees, and their association with the flora, in order to obtain a better understanding of their diversity and to promote the conservation of Andean areas. Finally, given that moderate elevations of the Andes are a center of agriculture in all Andean countries, studies emphasizing the use of native bee species as potential crop pollinators should be a focus in the future.

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Tab. 1. Preliminary checklist of the bees from high altitudes (above 2500 m) in Colombia. Sociality (Soc.): SC = eusocial; C = communal; S = solitary; P = cleptoparasitic. Vegetation type (Veg. type): CF = cloud forest; P = Páramo; X = Xeric Vegetation. Geographic distribution (Geogr. distr.): O = Cordillera Oriental; C = Cordillera Central; W = Cordillera Occidental (when recorded for the first time herein, the number of different sites within the same cordillera where species have been collected is indicated as arabic numerals). Altitudinal distribution pattern (Alt. distr. patt., explained in Material and Methods): R = restricted to high altitudes; W = widespread; T = transient; ? = insufficient information available. Note: Depository collections for those taxa recorded for the first time in this work are indicated as follows: * = LABUN and ** = KU (see Material and Methods). Those genera known only from high altitudes but lacking specific altitudinal data in Colombia are treated as restricted (e.g., *Andinaugochlora*). Additionally, species only recorded from high altitudes in Colombia but occurring at lower altitudes in other regions are classified as widespread (e.g., *Augochlora esox*).

Taxa	Soc.	Altitude [m]	Veg. type	Geogr. distr.	Alt. distr. patt.	References
ANDRENIDAE						
<i>Protandrena</i> sp.n. 1 **	S	2600–2800	CF	O(2)	R	Engel & Gonzalez (unpubl. data)
<i>Protandrena</i> sp.n. 2 **	S	2800–3100	CF	O(2)	R	Engel & Gonzalez (unpubl. data)
APIDAE						
Anthophorini						
<i>Anthophora</i> (<i>Mystacanthophora</i>) sp.n.	S	2200–2700	X	O(3)	R	GONZALEZ & CHAVEZ (in press)
Apini						
<i>Apis mellifera</i> Linnaeus, 1758	SC	0–3400	CF, P, X	O, C, W	W	herein
Bombini						
<i>Bombus atratus</i> Franklin, 1913	SC	150–3500	CF, P	O, C, W	W	LIÉVANO & OSPINA (1984)
<i>Bombus funebris</i> Smith, 1854	SC	2850–4750	P	O, C	R	LIÉVANO & OSPINA (1984)
<i>Bombus hortulanus</i> Friese, 1904	SC	2100–3100	CF, P	O, C	R	LIÉVANO & OSPINA (1984)
<i>Bombus pullatus</i> Franklin, 1913	SC	18–3500	CF, P	O, C, W	W	LIÉVANO & OSPINA (1984)
<i>Bombus robustus</i> Smith, 1854	SC	2320–3600	CF, P	O, C	R	LIÉVANO & OSPINA (1984)
<i>Bombus rohweri</i> (Frison, 1925)	SC	2300–3300	CF, P	O, C, W	R	CHAVARRÍA (1996)
<i>Bombus rubicundus</i> Smith, 1854	SC	2550–3690	CF, P	O, C	R	LIÉVANO & OSPINA (1984)
<i>Bombus volucelloides</i> Gribodo, 1892	SC	1000–3000	CF, P	O, C, W	W	CHAVARRÍA (1996)
Eucerini						
<i>Thygater aethiops</i> (Smith, 1854) *	S	~1400–3400	CF, P, X	O	R	URBAN (1967), herein
Euglossini						
<i>Eulaema bombiformis</i> (Packard, 1869)	C	2–2560	CF	O	T	BONILLA (1990)
<i>Eulaema cingulata</i> (Fabricius, 1804)	C	100–2560	CF	O	T	BONILLA (1990)
<i>Eulaema nigrita</i> Lapeletier de Saint Fargeau, 1841	C	20–2560	CF	O	T	BONILLA (1990)
<i>Eulaema polychroma</i> (Mocsáry, 1899)	C	960–3000	CF	O	T	BONILLA (1990)
<i>Eulaema polyzona</i> (Mocsáry, 1897)	C	2560	CF	O	T	BONILLA (1990)
Meliponini						
<i>Geotrigona</i> aff. <i>subgrisea</i> (Cockerell, 1919) s.str.	SC	~1320–3450	CF	O(1)	R	herein
<i>Melipona nigrescens</i> Friese, 1900 *	SC	1200–3400	CF	O, C, W	W	NATES-PARRA (1995), herein
<i>Parapartamona brevipilosa</i> (Schwarz, 1948)	SC	1500–3400	CF	O, C	R	GONZALEZ & NATES-PARRA (1999)
<i>Parapartamona caliensis</i> (Schwarz, 1948)	SC	1800–2600	CF	C, W	R	GONZALEZ & NATES-PARRA (1999)
<i>Parapartamona imberbis</i> Moure, 1992	SC	1400–2400	CF	O	R	GONZALEZ & NATES-PARRA (1999)
<i>Parapartamona zonata</i> (Smith, 1854)	SC	1460–3400	CF	O	R	GONZALEZ & NATES-PARRA (1999)
<i>Paratrigona eutaeniata</i> Camargo & Moure, 1994	SC	1320–3450	CF	O	?	NATES-PARRA et al. (1999)
<i>Partamona peckolti</i> Friese, 1901 *	SC	1200–2850	CF	O(2)	W	PEDRO & CAMARGO (2003), herein
<i>Scaptotrigona</i> cf. <i>limae</i> Brèthes, 1920 *	SC	1400–2600	CF	C(1), W	R?	herein
<i>Trigona amalthea</i> (Olivier, 1798) s.str. *	SC	0–2640	CF	O(1), C, W	W	herein
<i>Trigona fulviventris fulviventris</i> Guerin-Meneville, 1845 *	SC	0–3450	CF	O, C(1)	W	herein
Xylocopini						
<i>Xylocopa fimbriata</i> Fabricius, 1804	S	5–2650	CF	O	T	CRUZ (1996)
<i>Xylocopa frontalis</i> (Oliver, 1789)	S	0–2500	CF	O	T	CRUZ (1996)
<i>Xylocopa lachnea</i> Moure, 1951	S	4–2560	CF	O	T	CRUZ (1996)
COLLETIDAE						
Colletinae						
<i>Colletes</i> sp. 1 **	S	2500	CF	C(1)	R?	herein
<i>Colletes</i> sp. 2 **	S	2650–3650	CF, P	O(1)	R?	herein
<i>Colletes</i> spp.	S	~2800	CF	O	R?	herein
Diphaglossinae						
<i>Cadegualina andina</i> (Friese, 1925) *	S	2900	CF	C	R	GONZALEZ & MICHENER (in press)
<i>Cadegualina sericata</i> (Friese, 1925) *	S	2800–2950	CF, P	O(2)	R	GONZALEZ & MICHENER (in press)
Xeromelissinae						
<i>Chilicola aequatoriensis</i> Benoist, 1942 **	S	2400–2700	CF	O(1)	R?	MICHENER (2002), herein
<i>Chilicola colombiana</i> Michener, 2002	S	1630–2972	CF	?	R?	MICHENER (2002)
<i>Chilicola gibbosa</i> Michener, 2002	S	~2500	CF	?	R?	MICHENER (2002)
<i>Chilicola paramo</i> Gonzalez & Michener, 2004	S	3400–3600	P	O(1)	R	GONZALEZ & MICHENER (2004)

Taxa	Soc.	Altitude [m]	Veg. type	Geogr. distr.	Alt. distr. patt.	References
HALICTIDAE						
Augochlorini						
<i>Andinaugochlora</i> sp. *	?	2800	CF	O(1)	R	herein
<i>Andinaugochlora joannisi</i> (Vachal, 1904)	?	?	?	?	R?	ENGEL (1996)
<i>Augochlora bogotensis</i> (Vachal, 1911)	?	2600	?	O	R?	MOURE & HURD (1987)
<i>Augochlora dorsualis</i> (Vachal, 1911)	?	2600	?	O	R	MOURE & HURD (1987)
<i>Augochlora ectasis</i> (Vachal, 1911)	?	2600	?	O	R	MOURE & HURD (1987)
<i>Augochlora esox</i> (Vachal, 1911)	?	2600	?	O	W	MOURE & HURD (1987)
<i>Augochlora foxiana</i> Cockerell, 1900	?	815–2600	?	O	W	MOURE & HURD (1987)
<i>Augochlora laenifrons</i> (Vachal, 1911)	?	2600	?	O	R	MOURE & HURD (1987)
<i>Augochlora myrrhites</i> (Vachal, 1911)	?	2600	?	O	R	MOURE & HURD (1987)
<i>Augochlora repandirostris</i> (Vachal, 1911)	S?	815–2600(?)	?	O	?	MOURE & HURD (1987)
<i>Neocorynura</i> sp. 1 **	?	2800	CF	O(1)	R	Gonzalez et al. (unpubl. data)
<i>Neocorynura</i> sp. 2 **	?	2800	CF	O(1)	R	Gonzalez et al. (unpubl. data)
<i>Neocorynura</i> spp. *	?					herein
<i>Neocorynurella seeleyi</i> Engel & Klein, 1997 **	?	2800–3230	CF, P	O(2)	R	ENGEL & KLEIN (1997), herein
<i>Neocorynurella cosmetor</i> (Vachal, 1911)	?	2600(?)	?	O	R	MOURE & HURD (1987), ENGEL (2000)
Caenohalictini						
<i>Caenohalictus columbus</i> (Vachal, 1903)	?	2600(?)	?	O	?	MOURE & HURD (1987)
<i>Caenohalictus eberhardorum</i> Michener, 1979	?	~1800–2900	CF	O(1), W(1)	R	MICHENER et al. (1979), MOURE & HURD (1987)
<i>Caenohalictus lindigi</i> (Vachal, 1911)	?	2600(?)	?	O	?	MOURE & HURD (1987)
<i>Caenohalictus</i> spp.	?	?	CF, P		?	herein
Gastrohalictini						
<i>Lastioglossum (Dialictus)</i> sp.	?	2500	X	O(1)	?	herein
Halictini						
<i>Sphcodes (Austrosphcodes) bogotensis</i> Meyer, 1922	P	2600(?)	?	O	?	MOURE & HURD (1987)
<i>Sphcodes</i> spp. *	P	2600–2800	CF, X	O	?	herein
MEGACHILIDAE						
Megachilini						
<i>Megachile</i> sp. *	S	2600–3000	CF	O(2)	R?	herein
<i>Coelioxys</i> sp. *	P	2700	CF	O(1)	R?	herein

Tab. 2. Andean bee species occurring in Colombia with biological information available. Locality of study: located in Colombia unless otherwise indicated. Type of information: N = nest architecture; B = social behavior; F = floral sources (* without any specification of whether floral visit is for pollen or nectar); E = natural enemies; S = seasonality; D = developmental cycle; O = other.

Species	Locality of Study	Information	References
<i>Anthophora (Mistacanthophora)</i> sp.	Mondoñedo, Cundinamarca	N, F, S	GONZALEZ & CHAVEZ (in press)
<i>Bombus atratus</i>	Facatativa and La Calera, Cundinamarca	N, B, D, O	MEJÍA (1999)
<i>Bombus funebris</i>	Iguaque, Boyacá	F*	SARMIENTO (1993)
<i>Bombus hortulanus</i>	Iguaque, Boyacá	F*	SARMIENTO (1993)
<i>Bombus rubicundus</i>	Iguaque, Boyacá	F*	SARMIENTO (1993)
<i>Parapartamona brevipilosa</i>	Iguaque, Boyacá (also Cosanga [Ecuador])	N, F*	BRAVO (1993), SARMIENTO (1993)
<i>Parapartamona zonata</i>	Cosanga [Ecuador]	N	BRAVO (1993)
<i>Neocorynura</i> sp. 1	Iguaque, Boyacá	N, F, E	Gonzalez et al. (unpubl. data)
<i>Neocorynura</i> sp. 2	Iguaque, Boyacá	N, F, E	Gonzalez et al. (unpubl. data)
<i>Caenohalictus eberhardorum</i>	West of Cali, Valle	N, B, S, O	MICHENER et al. (1979)

Tab. 3. Preliminary checklist of the bees from high altitudes (above 2500 m) in Andean regions. Sociality (Soc.): SC = eusocial; C = communal; S = solitary; P = cleptoparasitic. Geographic distribution (Geogr. distr.): Venezuela (Ve), Ecuador (Ec), Peru (Pe); occurrence in Colombia (Co) is additionally indicated (see Tab. 1). Altitudinal distribution pattern (Alt. distr. patt.): R = restricted to high altitudes; W = widespread; ? = insufficient information available. * Owing to the distribution records of this taxon in Colombia and older records of it from Ecuador and Venezuela (but locality data not very precise) it is likely to occur at similar altitudes in all countries. ** Note that most localities in COLOMA-ROMAN (1986) are not at high elevations and those that apparently are do not have reliable data (thus, these records should be reconfirmed with new sampling above 2500 m in Ecuador). For widespread genera where most well-known species occur at a diversity of altitudes yet only one or two records exist for rare species, these are considered questionably restricted to high altitudes given the paucity of data. Species only recorded from high altitudes in Andean countries but occurring at lower altitudes in other regions are classified as widespread (e.g., *Eulaema boliviensis*).

Taxa	Soc.	Altitude [m]	Geogr. distr.	Alt. distr. patt.	References
APIDAE					
Anthophorini					
<i>Anthophora (Mystacanthophora) andicola</i> Schrottky, 1911	S	2500–4000	Pe	R	SCHROTTKY (1911)
<i>Anthophora (Mystacanthophora) arequipensis</i> Brèthes, 1920	S	2400–3300	Ec, Pe	R	herein
<i>Anthophora (Mystacanthophora) paranensis</i> Holmberg, 1903	S	590–2500	Pe	W	herein
<i>Anthophora (Mystacanthophora) pilifrons</i> Packard, 1869	S	1800–3300	Ec, Pe	R	herein
<i>Anthophora (Mystacanthophora) versicolor</i> Friese, 1925	S	2400–3000	Pe	R	herein
Apini					
<i>Apis mellifera</i> Linnaeus, 1758	SC	0–3400	Ve, Ec, Pe	W	herein
Bombini					
<i>Bombus baeri</i> Vachal, 1904	SC	1900–4200	Pe	R	CHAVARRÍA (1996)
<i>Bombus coccineus</i> Friese, 1903	SC	2000–4200	Ec, Pe	R	CHAVARRÍA (1996)
<i>Bombus opifex</i> Smith, 1879	SC	0–3900	Ec, Pe	W	CHAVARRÍA (1996)
<i>Bombus funebris</i> Smith, 1854	SC	2000–3500	Ec, Pe	R	CHAVARRÍA (1996)
<i>Bombus rohweri</i> (Frison, 1925)	SC	2300–3300	Co, Ve	R	CHAVARRÍA (1996)
<i>Bombus butteli</i> Friese, 1903	SC	1370–3200	Ec, Pe	R	CHAVARRÍA (1996)
<i>Bombus ecuadorius</i> Meunier, 1890	SC	1300–3500	Ec, Pe	R	CHAVARRÍA (1996)
<i>Bombus robustus</i> Smith, 1854	SC	750–3700	Ve, Co, Ec, Pe	W	CHAVARRÍA (1996)
<i>Bombus volucelloides</i> Gribodo, 1892	SC	1000–3000	Ve, Co, Ec, Pe	W	CHAVARRÍA (1996)
<i>Bombus rubicundus</i> Smith, 1854	SC	2000–3600	Ve, Co, Ec, Pe	R	CHAVARRÍA (1996)
<i>Bombus handlirschi</i> Friese, 1903	SC	2000–3480	Pe	R	CHAVARRÍA (1996)
Epeolini					
<i>Doeringiella hebes</i> Roig-Alsina, 1989	P	2800	Pe	R?	ROIG-ALSINA (1989)
Eucerini					
<i>Alloscirtetica oliveirae</i> Urban, 1977	S	3700–3800	Pe	R	URBAN (1977)
<i>Alloscirtetica weyrauchi</i> Michener, LaBerge & Moure, 1955	S	3100	Pe	R	URBAN (1971)
<i>Thygater dispar</i> (Smith, 1854) *	S	1900–3460	Ec, Pe	R?	URBAN (1967)
<i>Thygater melanotrichia</i> Urban, 1967	S	2800	Pe	R	URBAN (1967)
Euglossini					
<i>Eulaema boliviensis</i> (Friese, 1898)	C	3900	Ve	W	herein
<i>Eulaema polychroma</i> (Mocsáry, 1899)	C	450–3400	Co, Ec, Pe, Ve	W	OLIVEIRA (2000), herein
Meliponini					
<i>Parapartamona zonata</i> (Smith, 1854)	SC	2500 **	Ec	R	COLOMA-ROMAN (1986)
<i>Trigona amalthea</i> (Olivier, 1789)	SC	2500 **	Ec	W	COLOMA-ROMAN (1986)
<i>Trigona silvestriana</i> Vachal, 1908	SC	2500 **	Ec	W	COLOMA-ROMAN (1986)
Tapinotaspidini					
<i>Chalepogenus rasmusseni</i> Roig-Alsina, 1999	S	2770	Pe	R	ROIG-ALSINA (1999)
Xylocopini					
<i>Xylocopa fimbriata</i> Fabricius, 1804	S	4–2600	Co, Ec, Pe	W	HURD (1978), herein
<i>Xylocopa frontalis</i> (Olivier, 1789)	S	0–2500	Co, Ec, Pe	W	HURD (1978), herein
<i>Xylocopa lachnea</i> Moure, 1951	S	4–2600	Co, Ec, Pe	W	HURD (1978), herein
<i>Xylocopa viridigastra</i> Lepelletier de Saint Fargeau, 1841	S	10–4000	Ec, Pe	W	HURD (1978)
COLLETIDAE					
Colletinae					
<i>Colletes mimicus</i> Cockerell, 1913	S	2801	Pe	R?	MOURE & URBAN (2002)
<i>Colletes rubicola</i> Benoist, 1942	S	2600–2760	Ec	R	MOURE & URBAN (2002)
Diphaglossinae					
<i>Cadegualina andina</i> (Friese, 1925) *	S	>2000	Co, Ec, Ve	R	URBAN & MOURE (2001)
<i>Caupolicana egregia</i> Friese, 1906	S	2500	Pe	R	URBAN & MOURE (2001)
<i>Caupolicana niveofasciata</i> Friese, 1898	S	2430–3155	Ec	R?	URBAN & MOURE (2001)
Hylaeinae					
<i>Hylaeus benoisti</i> Michener, 2000	S	2850	Ec	R	MICHENER (2000a)
<i>Hylaeus expansus</i> (Vachal, 1909)	S	3300	Pe	R?	URBAN & MOURE (2002)
Xeromelissinae					
<i>Chilicola aequatoriensis</i> Benoist, 1942	S	1900–2700	Ec, Pe, Ve	R?	MICHENER (2002)
<i>Chilicola involuta</i> Michener, 2002	S	3150–3200	Ec	R	MICHENER (2002)
<i>Chilicola espeleticola</i> Michener, 2002	S	3710–4300	Ve	R	MICHENER (2002)
<i>Chilicola quitensis</i> Benoist, 1942	S	2850	Ec	R	MICHENER (2002)
<i>Chilicola bigibbosa</i> Michener, 2002	S	3460	Pe	R	MICHENER (2002)
<i>Chilicola styliventris</i> (Friese, 1908)	S	2300–3800	Ec, Pe	R	MICHENER (2002)
<i>Chilicola brzoskai</i> Michener, 2002	S	2500	Ec	R	MICHENER (2002)
<i>Chilicola simplex</i> Michener, 2002	S	2907	Ec	R	MICHENER (2002)

Taxa	Soc.	Altitude [m]	Geogr. distr.	Alt. distr. patt.	References
HALICTIDAE					
Augochlorini					
<i>Andinaugochlora micheneri</i> Eickwort, 1969	?	3050	Ec	R	MOURE & HURD (1987)
<i>Andinaugochlora joannisi</i> (Vachal, 1904)	?	2800	Pe	R	ENGEL (1996)
<i>Augochlora atricreus</i> (Vachal, 1911)	?	3000	Pe	R?	MOURE & HURD (1987)
<i>Augochlora cylix</i> (Vachal, 1911)	?	~3000	Pe	R?	MOURE & HURD (1987)
<i>Augochlora jugalis</i> (Vachal, 1911)	?	3000	Pe	R?	MOURE & HURD (1987)
<i>Augochlora leptis</i> (Vachal, 1911)	?	900–3000	Ec, Pe	W	MOURE & HURD (1987)
<i>Augochlora pachytes</i> (Vachal, 1911)	?	~500–3000	Pe	W	MOURE & HURD (1987)
<i>Augochlora patruelis</i> (Vachal, 1911)	?	~3000	Pe	R?	MOURE & HURD (1987)
<i>Augochlora phoenicis</i> (Vachal, 1904)	?	~2000–3300	Pe	R?	MOURE & HURD (1987)
<i>Augochlora punctibasis</i> (Vachal, 1911)	?	~3000	Pe	R?	MOURE & HURD (1987)
<i>Augochlora repandirostris</i> (Vachal, 1911)	?	815–2600(?)	Bolivia to Co	W	MOURE & HURD (1987)
<i>Augochloropsis cyclis</i> (Vachal, 1903)	?	~3000	Pe	R?	MOURE & HURD (1987)
<i>Augochloropsis holmbergi</i> (Schrottky, 1910)	?	~3000	Pe	R?	MOURE & HURD (1987)
<i>Augochloropsis varians</i> (Vachal, 1903)	?	500–3000	Pe	W	MOURE & HURD (1987)
<i>Ischnomelissa rhina</i> Brooks & Engel, 1998	?	2300–2600	Ec	R	BROOKS & ENGEL (1998)
<i>Neocorynura cicur</i> (Vachal, 1904)	?	3300	Pe	R?	MOURE & HURD (1987)
<i>Neocorynura lasipion</i> (Vachal, 1904)	?	3300	Pe	R?	MOURE & HURD (1987)
<i>Neocorynura marginans</i> (Vachal, 1904)	?	~2000–3300	Pe	R?	MOURE & HURD (1987)
<i>Neocorynura nossax</i> (Vachal, 1904)	?	~2000–3300	Pe	R?	MOURE & HURD (1987)
<i>Neocorynura notoplex</i> (Vachal, 1904)	?	3300	Pe	R?	MOURE & HURD (1987)
<i>Neocorynura papallactensis</i> Engel, 1999	?	3200	Ec	R	ENGEL (1999)
<i>Neocorynura pseudobaccha</i> (Cockerell, 1901)	?	500–3000	Pe	W	MOURE & HURD (1987)
<i>Neocorynura riverai</i> (Vachal, 1904)	?	3300	Pe	R?	MOURE & HURD (1987)
<i>Neocorynura sequax</i> (Vachal, 1904)	?	3300	Pe	R?	MOURE & HURD (1987)
<i>Neocorynura stilborhin</i> (Vachal, 1904)	?	500–3000	Pe	W	MOURE & HURD (1987)
<i>Neocorynura triacontas</i> (Vachal, 1904)	?	~2000–3300	Pe	R?	MOURE & HURD (1987)
<i>Neocorynurella seeleyi</i> Engel & Klein, 1997	?	2800–4300	Co, Ve	R	ENGEL & KLEIN (1997), herein
<i>Neocorynurella cosmetor</i> (Vachal, 1911)	?	~2500–2600	Ve	R	MOURE & HURD (1987), ENGEL (2000)
<i>Pseudaugochlora crawfordi</i> (Vachal, 1904)	?	~3000	Pe	R?	MOURE & HURD (1987)
<i>Pseudaugochlora praepotens</i> (Vachal, 1904)	?	~3000	Pe	R?	MOURE & HURD (1987)
Caenohalictini					
<i>Caenohalictus cuprellus</i> (Vachal, 1903)	?	~2000–3300	Pe	R?	MOURE & HURD (1987)
<i>Caenohalictus ecuadorensis</i> (Cameron, 1903)	?	2740	Ec	R?	MOURE & HURD (1987)
<i>Caenohalictus notares</i> (Vachal, 1904)	?	~2700	Ec	R?	MOURE & HURD (1987)
<i>Caenohalictus obnuptus</i> (Vachal, 1903)	?	~2000–3300	Pe	R?	MOURE & HURD (1987)
<i>Caenohalictus riveti</i> (Vachal, 1904)	?	~2700	Ec	R?	MOURE & HURD (1987)
<i>Caenohalictus robertsi</i> Packer, 1993	?	4000	Ec	R	PACKER (1993)
Gastrohalictini					
<i>Lasioglossum (Dialictus) spp.</i>	?	~2500–2600	Ec, Pe	?	herein
Halictini					
<i>Sphecodes spp.</i>	P	~2500–2600	Ec, Pe	?	herein
MEGACHILIDAE					
Anthidiini					
<i>Anthidium cuzcoense</i> Schrottky, 1910	S	3500	Pe	R?	URBAN (2001)
<i>Anthidium nigerrimum</i> Schrottky, 1910	S	3500	Pe	R?	URBAN (2001)
<i>Anthidium peruvianum</i> Schrottky, 1910	S	3000–4000	Pe	R	herein
Megachilini					
<i>Megachile eumelanotricha</i> Moure, 1956	S	3900–4700	Pe	R	MOURE (1956)
<i>Megachile (Chrysosaurus) remigata</i> Vachal, 1908	S	3000	Pe	R	RAW (2002)
<i>Megachile spp.</i>	S	2500–3000	Ec, Pe	R?	herein