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TRABAJOS ORIGINALES

Vascular flora and phytogeographical links of the Carabaya Mountains, Peru

Flora vascular y conexiones fitogeográficas de las montañas Carabaya, Perú

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Abstract

Studies of floristic composition and plant species richness in tropical mountains support their recognition as areas of high biological diversity, and therefore of their importance for plant conservation. Here, we present data on the flora of the high Andes of eight sites centered in the Carabaya mountains, and also provide a floristic comparison with nine other floras within Peru and northern Bolivia. The study area includes 506 species of vascular plants, grouped in 203 genera and 66 families. The highest species richness was found in two families: Asteraceae and Poaceae, which collectively encompass 37% of all species. Other important families were Caryophyllaceae, Fabaceae, Malvaceae, Brassicaceae, Caprifoliaceae, Gentianaceae, Plantaginaceae and Cyperaceae. The most diverse genera were *Senecio*, *Calamagrostis*, *Poa* and *Nototriche*. Perennial herbs were the dominant growth form. The vascular flora of the Carabaya Mountains is closely related to those of other regions of southern Peru. Also, more than half of all vascular plants registered for the Carabaya Mountain occur in the Andean region of Bolivia, which shows the undoubted geophysical and phytogeographical connection of the Carabaya and the Bolivian Apolobamba Mountains. This study also shows that there is still a need for more extensive plant collecting and future exploration, since the Carabaya, as other parts of Peru's high Andes are subject of dramatic change that may threaten these plant populations.

Keywords: High Andean flora; Peru; floristic composition; taxonomy.

Resumen

Los estudios sobre la composición florística y riqueza de especies en montañas tropicales apoyan su reconocimiento como áreas de alta diversidad biológica, y, por tanto, de su importancia para la conservación. En este trabajo presentamos datos sobre la flora altoandina de ocho sitios localizados en la Cordillera de Carabaya, proveemos también una comparación florística con otros nueve lugares tanto en Perú como en el norte de Bolivia. El área de estudio incluye 506 especies de plantas vasculares, reconocidas en 203 géneros y 66 familias. Las tasas más altas de riqueza de especies se hallan en dos familias: Asteraceae y Poaceae, que colectivamente abarcan el 37% de todas las especies. Otras familias importantes fueron Caryophyllaceae, Fabaceae, Malvaceae, Brassicaceae, Caprifoliaceae, Gentianaceae, Plantaginaceae y Cyperaceae. Los géneros más diversos fueron *Senecio*, *Calamagrostis*, *Poa* y *Nototriche*. La forma de crecimiento predominante fueron las hierbas perennes. La flora vascular de la Cordillera Carabaya está muy relacionada con otras regiones del sur de Perú. Además, más de la mitad de todas las plantas vasculares registradas para la Cordillera Carabaya se encuentran en la región andina de Bolivia, lo que demuestra la indudable conexión geofísica y fitogeográfica entre las cordilleras Carabaya y Apolobamba de Bolivia. Este estudio también demuestra la necesidad de una extensa colección botánica y futura exploración, desde que Carabaya, como otras partes de los altos Andes del Perú, están sujetos a cambios dramáticos que amenazan las poblaciones de esas plantas.

Palabras clave: flora altoandina; Perú; composición florística; taxonomía.

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Declaration of authorship

The authors state that all participated in the development of the work. PG, BL, AC and PJ: did sampling, drafting of the manuscript, and data analysis. PG and BL: did interpretation and preparation of the final version.

The authors declare that they have no conflict of interest.

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Introduction

The high Andes are places of concern due to the foreseeable effects of climate change (Markham et al. 1993, Beniston 1994, Thompson et al. 2006, Conde & Saldaña 2007, Pauli et al. 2003, 2007, Young 2014). In Peru, high Andean sites cover close to 16% of the total country area, and they are highly vulnerable to landscape changes that may affect its vegetation and components (Rodriguez & Young 2000, Young 2011). The urgency for the development of conservation strategies for sites and plant species is widely recognized; however, it faces challenges in relation to the dynamism and complexity of environmental changes and their interactions with human influences (Markham et al. 1993, Fort 2015, Kohler et al. 2014).

The Peruvian high Andes (above 3500 m) includes an interesting native vascular flora estimated to consist of more than 2000 plant species (see Jørgensen et al. 2011), of which nearly 32% of them are endemic to Peru. This region has recently seen an increase in taxonomical and ecological studies, accompanied by plant recording and exploration (e.g. Ballard and Iltis 2012, Al-Shehbaz et al. 2013, 2015a, 2015b, Gonzáles et al. 2015, Gonzáles & Cano 2016, Montesinos-Tubée et al. 2015, Linares et al. 2015, Ospina et al. 2016, Sylvester et al. 2016a, 2016b). The completion of the Bolivian catalog (Jørgensen et al. 2014) also provides needed data for a floristic comparison to understand plant richness in the Andes, and floristic connections. Here, we present a compilation of the vascular plant flora of a mountain range in southern Peru: the Carabaya Mountains. We asked how taxonomic richness of our study area compares to other parts of the Andes, particularly to neighboring sites in Peru, and northern Bolivia. The Carabaya is geographically linked to Bolivia through the Apolobamba Mountains, and so we asked if richness and composition at high elevations are similar. We also explore the potential implications of our findings for plant conservation based on the state of knowledge of the high Andean flora.

Material and methods

Study area.- The study area encompasses the high Andes between 4000–5300 m of the Carabaya Cordillera, along the eastern Andes in Puno, between 13°50'–15°05' S and 69°58'–70°58' W, crossing the provinces of Carabaya, Sandia and San Antonio de Putina (Fig. 1). The Carabaya also includes the largest tropical glacier system: Quelccaya, an area that has contributed to our understanding of climate change (Thompson et al. 2003, 2006, 2013). The Carabaya Mountains extends into Bolivian territory, and in the Department of La Paz, the northeastern Andes are known as the Apolobamba Mountains (Argollo et al. 1987, Argollo & Iriondo 2008). We obtained field data from eight sites (Fig. 1).

In the Carabaya we recognize four vegetation formations: puna grasslands; rock vegetation dominated by chasmophytes; high Andean wetlands; river shores and lakes, and periglacial areas including cryoturbated soils and subnival pumices (Weberbauer 1945, Galán de Mera et al. 2014, Montesinos–Tubée et al. 2015a).

Collection and species identification.- We compiled all species names, habitats, and distribution information initially based on specimens collected by the authors for the study area. For each species from the Carabaya, we gathered information on collectors and collection number. However, for a small group of species that had only been recorded by photo or by authors' field notes, and lack a herbarium voucher, we cited other collections made in neighboring areas. All collections from the study area were identified using taxonomical keys and descriptions available from the botanical literature (Macbride 1936, Tovar 1993, and others). A few reported species were excluded, for example a photo of *Stangea rhizantha* did not match the species (Linares et al. 2012), and *Valeriana globularis* (Linares et al. 2012) was replaced by it's correct spelling, *Valeriana globularioides* Graebn.

We also compiled all records for eight floras at high elevations, three sites (Parinacochas, Juli and Tambo Ichuna) were located above 3100 m elevation on the Pacific Basin, and the remaining five sites (from north to south: Cordillera Blanca, Concepcion, Bofedales, Apacheta and Vilcanota) were located above 4000 m. Species considered as national endemics were recorded from León et al. (2007), Al-Shehbaz et al. (2013, 2015a, 2015b), Gonzáles et al. (2015), Montesinos-Tubée et al. (2015b), and Gonzáles and Cano (2016).

For the flora of the Department of La Paz in northern Bolivia, we downloaded the species records from the Bolivia Catalog database (http://www.tropicos.org/ProjectAdvSearch.aspx?projectid=13&langid=66).

Specimen data were also obtained from online sources of several institutions (e.g., Field Museum Neotropical specimens [http://fm1.fieldmuseum.org/vrrc/], the Tropicos® database of Missouri Botanical Garden [http://www.tropicos.org/], New York Botanical Garden digital herbarium [http://sciweb.

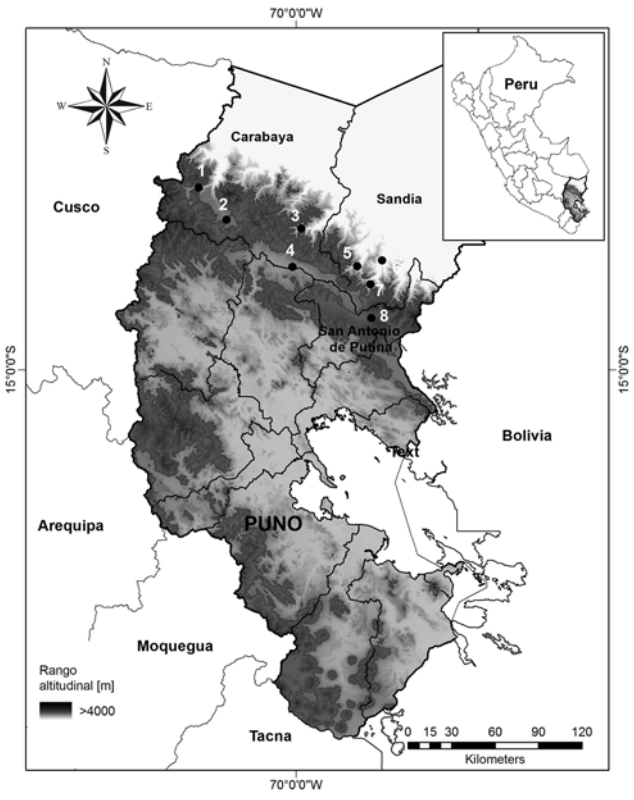

Figure 1. Map of the study area. (Puno, Peru). Locality (1) Corani, (2) Macusani, (3) Ajoyani, (4) Cruzero, (5) Patambuco, (6) Sandia, (7) Cuyocuyo, (8) Ananea.

nybg.org/Science2/vii2.asp]), the digital herbarium portion of Atrium [http://atrium.andesamazon.org/digital_herbarium.php], JSTOR [https://plants.jstor.org/). We also included or reviewed collections of the following herbaria B, BM, CUZ, F, G, GH, HUSA, HUT, K, LIL, LP, MO, MOL, NY, S, US and USM (Index Herbariorum). The Angiosperm Phylogeny Group IV (2016) classification system was used for the management of the angiosperm taxa.

Floristic comparison.- Our database of all taxa was compared with checklists of nine studies in the high Andes. These nine sites encompass about seven degrees of latitude (8°50' – 17°26' S), and represent both Pacific and Amazon basins. Within these sites there are a variety of habitats from open grasslands, rocky places, shrublands and wetlands. Four floras represent mostly wetlands and surrounding areas (Flores et al. 2005, Arteta et al. 2006, Roque & Ramírez 2008, Valencia et al. 2013), two floras represent sites located in periglacial areas with processes of cryoturbation (Cano et al. 2010, 2011), and four floras represent large or detailed surveys in the puna ecosystem (Tupayachi 2005, Montesinos-Tubée 2011, 2012, Jørgensen et al. 2014).

Results

We recorded over 10000 plant collections for all nine sites in the Peruvian Andes. This sampling effort still represents a low collection density index with a CDI (specimens/100 km^2) of nearly 5. For southern Peru, and particulary for Puno (up to 4000 m), the largest plant collections were made by Augusto Weberbauer, César Vargas, Hugh Weddell, Franz Meyen, Jaroslav Soukup, Francis Pennell, Werner Rauh, Wilibald Lechler, Alfredo Tupayachi, Oscar Tovar and Dora Stafford, all of them made during the 19th and 20th centuries.

The highest elevations (above 4000 m) of the Carabaya Mountains harbors 506 species of vascular plants (pteridophytes, Gymnospems, Eudicots and Monocots) grouped in 203 genera and 66 families (Table 1; Fig. 2 and Appendix 1). Eudicots were the largest group (with 68.2% of the total registered), and including 69.5% of genera and 71.9% of all species; followed by Monocots with 16.7%, 22.7% and 23.7% respectively for all three main taxonomic categories. Ferns and lycophytes were scarcely represented with only nine families (13.6%), fifteen genera (7.4%) and twenty-one species (4.2%). For these elevations, we found only one species of gymnosperm (*Ephedra rupestris*).

Asteraceae was the most diverse family, with 38 genera and 110 species, followed by Poaceae (21/78), Caryophyllaceae (10/24), Fabaceae (6/23), Malvaceae (3/21), Brassicaceae (11/21), Caprifoliaceae (3/17), Gentianaceae (3/16), Plantaginaceae (4/13) and Cyperaceae (7/12). These ten families include 52% of all genera and 66% of all species registered for Carabaya. Asteraceae and Poaceae together account for 29.1% of the total genera and 37.2% of all species (Table 2). Another 10 families have six to ten species, containing 16.2% of the total taxa registered. Sixty-six percent of the remaining families include five or less number of species: 24 families have between two and five species, containing 13.2% of total taxa, while 22 families are represented by a single species.

The most diverse genera were *Senecio* (28 species), *Calamagrostis* (21), *Poa* (21), *Nototriche* (19), *Gentianella* (13), *Valeriana* (13), *Werneria* (10), *Lupinus* and *Astragalus* with nine species each, *Festuca* and *Plantago* with eight species each, *Mniodes* and *Ranunculus* with seven each; *Geranium*, *Neobartsia, Oxalis, Perezia, Pycnophyllum,* and *Xenophyllum* with six each; *Cerastium, Hypochaeris, Sisyrinchium* and *Viola* with five each (Table 3). The remaining, 62 genera (30.5%), include between two and four species, while 117 genera (57.6%) only have one species.

Perennial herbs are the dominant life form with 467 (92.3%) species, these include aquatics, palustrine and terrestrial forms. While woody life forms include 20 species (4%) of subshrubs, 15 (3%) shrubs, three (0.6%) cactus, and one tree (0.2%). (Appendix 1).

Comparison of Carabaya flora with nines sites, including

Table 1. Number of families, genera and species by taxa recorded in the study area.

Taxa	Families	Genera	Species
Eudicots	45	141	364
Monocots	11	46	120
Gymnospems	1	1	1
Pteridophytes	9	15	21
Total	66	203	506

Table 2. Families with more genera and species in the Cordillera Carabaya.

Families	Genera	Species
Asteraceae	38	110
Poaceae	21	78
Caryophyllaceae	10	24
Fabaceae	6	23
Malvaceae	3	21
Brassicaceae	11	21
Caprifoliaceae	3	17
Gentianaceae	3	16
Plantaginaceae	4	13
Cyperaceae	7	12

Table 3. Genera with more species in the Cordillera Carabaya.

Genera	Species	Genera	Species
Senecio	28	*Mniodes*	7
Calamagrostis	21	*Pycnophyllum*	6
Nototriche	19	*Bartsia*	6
Poa	19	*Perezia*	6
Gentianella	13	*Geranium*	6
Valeriana	13	*Oxalis*	6
Werneria	10	*Lachemilla*	6
Lupinus	9	*Xenophyllum*	6
Astragalus	9	*Cerastium*	5
Plantago	8	*Hypochaeris*	5
Festuca	8	*Sisyrinchium*	5
Ranunculus	7	*Viola*	5

Figure 2. a) *Hypochaeris echegarayi* (Asteraceae); b) *Werneria heteroloba* (Asteraceae); c) *Stangea paulae* (Caprifoliaceae); d) *Gentiana sedifolia* (Gentianaceae); e) *Nototriche staffordiae* (Malvaceae); f) *Myrosmodes paludosa* (Orchidaceae); g) *Poa apiculata* (Poaceae); h) *Salpichroa amoena* (Solanaceae).

northern Bolivia reveals that Asteraceae and Poaceae remain the most species-rich families. All sites, except Parinacochas, have most of its genera and species (over 50%) included in the same ten families identified in Table 4. Other sites representing specific habitats (periglacial areas, and wetlands), also have the same species-rich families as those found in Carabaya (see also Table 2). The richness of all eight sites of Carabaya is as high as those found in northern Bolivia and Moquegua in southwestern Peru.

Over 91 % of species recorded for Carabaya have an altitudinal range above 4000 m (Append. 1). Plant endemism in the Department of Puno reaches 185 species, and most species are found at the upper limits of our study area (Append. 1).

Discussion

The high Andes is an important biogeographical region, distributed as an archipelago along the mountain range. Its plant species richness is high compared to other mountain ranges, and where past geological changes has allowed expansion and contraction, which may explain current plant composition, diversity and endemism (Sklenář et al. 2013, Hughes & Atchison 2015). Most recent studies have shown the northern Andes, particularly the paramo, as a place of high plant species richness (Sklenář & Balslev 2005, 2007, Cuesta et al. 2017). Our data also demonstrates that other parts of the upper tropical central Andes are as important in terms of plant composition and diversity.

Over 50% of floristic records for the study area are new, particularly for the department of Puno (Brako & Zarucchi 1993, Ulloa Ulloa et al. 2004, Linares et al. 2012). For the flora at high elevations (≥4000 m) of Puno, our results have tripled (20 more species) the known number of endemic species. It is worth noting that this department has the highest percentage of rarity (65%) compared to other departments (León et al. 2007). The value of the CDI is lower than the national value of 34 recorded almost 30 years ago (see Toledo & Sosa 1993), and it demonstrates the need for further botanizing. This need is further complicated by pressures of global changes, creating important challenges for plant conservation (Young 2014).

The flora of the Carabaya, at the family level, includes two families (Asteraceae and Poaceae) that contribute significantly to its composition with over a third of species. The predominance of both families is a common pattern in the High Andean flora (Gentry 1993, Cuesta et al. 2017), where these two families can include 30 to 60% of all species in an area (Table 4). In addition, this trend of family oligarchy extends in our study to 18 other families, among them Fabaceae, Caryophyllaceae, Brassicaceae and Malvaceae, which has been shown to be species rich throughout the Puna (Cuesta et al. 2017). Most families, however, are species poor, and they usually represent taxa that originated in temperate areas. Probable explanations of species richness of those few families may include geological history, altitudinal range and different evolutionary paths of mountain ranges within the Andes.

A total of 506 species of vascular plants growing above 4000 m in the Carabaya shows that our floristic results are consistent with those found for other equivalent areas in the tropical high Andes. Species richness in our study area is like those found for Peru's jalca (Sánchez 1996). For the Andean highlands of northern Bolivia (Department of La Paz) reported by Jørgensen (2014), total species (737) number is larger than for our study area, which can be explained by representing a flora of a bigger

Table 4. Comparing the number of species (E) and genera (G) of the principal families in different Andean localities ([1]Flores *et al.* 2005, [2]Arteta et al. 2006, [3]Roque & Ramírez 2008, [4]Valencia et al. 2013, [5]Tupayachi 2005, [6]Cano et al. 2011, [7]Cano *et al*. 2010, [8]Montesinos–Tubée 2011, 2012, [9]Jørgensen et al. 2014), with respect to what was found in the study area.

	Concepción[1] 4350–4550 m		Bahía de Juli[2] 3830–4200 m		Parinacochas[3] 3100–3500 m		Bofedales[4] 4200–4800 m		Vilcanota[5] >4000		Apacheta[6] >4500 m		Cordillera Blanca[7] >4500 m		Tambo–Ichuña[8] 3400–4850 m		Carabaya >4000 m		Bolivia[9] >4000 m	
Familias	G	E	G	E	G	E	G	E	G	E	G	E	G	E	G	E	G	E	G	E
Asteraceae	15	24	27	39	30	43	15	22	15	40	20	51	15	40	52	127	38	110	50	189
Poaceae	10	25	12	18	16	26	7	23	9	25	6	26	11	31	28	46	21	78	30	129
Brassicaceae	1	1	5	7	3	4	1	1	2	2	5	11	6	15	13	24	11	21	14	35
Caryophyllaceae	4	4	5	5	3	3	4	5	3	3	4	8	5	7	10	18	10	24	12	50
Fabaceae	1	3	5	8	8	14	2	2	0	0	2	4	1	1	9	18	6	23	13	63
Malvaceae	1	2	2	3	2	2	2	2	2	5	1	7	1	4	4	19	3	21	4	28
Plantaginaceae	1	3	1	3	1	1	2	3	3	3	0	0	0	0	2	12	4	13	5	13
Apiaceae	1	1	4	5	4	4	5	7	1	2	3	4	3	3	8	11	6	9	9	18
Cyperaceae	2	2	2	5	5	5	8	10	1	2	0	0	0	0	8	8	7	12	10	28
Caprifoliaceae	0	0	0	0	1	1	1	1	1	8	3	6	3	7	3	9	3	17	5	13
Others familias	28	35	74	92	106	122	28	50	32	34	16	17	20	28	134	215	94	178	120	271
% species by 10 families	56	65	46	50	41	46	63	60	54	73	73	87	69	79	51	58	54	65	56	68
Total	64	100	137	185	179	225	75	126	69	124	60	134	65	136	271	507	203	506	272	837

area with more extensive botanizing.

As proposed by Sklenář et al. (2013), floristic similarities in the Andes are higher in areas of geographical proximity. The undoubted geophysical connection of the Carabaya and the Bolivian Apolobamba Mountains, may suggest a close floristic relationship with Bolivia's high Andean flora. We found nearly half of all vascular plants (262 species) registered for the Carabaya Mountain also occur in the Andean region of Bolivia. At the family level, eight families Asteraceae, Poaceae, Fabaceae, Caryophyllaceae, Brassicaceae, Malvaceae, Cyperaceae and Apiaceae are part of the most diverse families in both study areas (Tabla 4). However, there are thirteen families (Araceae, Araliaceae, Basellaceae, Bromeliaceae, Calyceraceae, Ericaceae, Dennstaedtiaceae, Frankeniaceae, Polygalaceae, Portulacaceae, Ruppiaceae, Schoepfiaceae and Selaginellaceae) that have not yet been collected in the Carabaya. While another four families (Asparagaceae, Escalloniaceae, Convolvulaceae and Berberidaceae) have not yet been recorded for the Bolivian flora at similar altitudes

There are also 35 genera and 244 species in Carabaya not registered for Bolivia, the largest of these differences are present in genera such as *Senecio* (with 15 species), *Nototriche* (13), *Valeriana, Calamagrostis* and *Gentianella* (with 9 species each), *Poa* (7), *Xenophyllum* (6*), Lupinus, Neobartsia* and *Pycnophyllum* (with 5 species each). Most of these species (186) are endemic to Peru, and they occupy the highest part of the study area.

A comparison with the species composition of Cordillera Vilcanota, located to the north of our study area, reveals that 46% of the species registered there have not yet been found in Carabaya. Studies in Vilconata have emphasized areas covered by *Polylepis* forest that were not included for Carabaya. Still, excluding those species of *Polylepis* forests, a third of species of the flora of Vilcanota have not been recorded in Carabaya.

At a more local scale, we found that Carabaya has similar number of taxa as those reported for an upper basin in Moquegua (Montesinos-Tubée 2011, 2012; Table 4) on the Pacific Basin. Seven plant families: Asteraceae, Poaceae, Brassicaceae, Caryophyllaceae, Fabaceae, Malvaceae and Plantaginaceae are part of the most diverse families in both study areas (Tabla 4). Two families Asteraceae and Poaceae have also equal representation for both sites, with 22%, and 15% for Carabaya, and 25% and 9% for Tambo–Ichuña respectively. However, some differences at the family level are present due to the altitudinal extent of our study (4000—5300 m) vs. those of Montesinos-Tubée (3400–4850 m). For example Cyperaceae and Caprifoliaceae are among the top ten most diverse families in the Carabaya, while Solanaceae and Cactaceae are for Moquegua (Montesinos-Tubée 2011, 2012). These differences may also reflect floristic differences between western and southern ranges.

The top ten most diverse families have also been reported by Cano et al. (2010, 2011) for periglacial sites with cryoturbated soils in Ancash (Cordillera Blanca) and Ayacucho-Huancavelica (Apacheta), reaching 79 and 87% respectively (Table 4). However, these families decrease their diversity at lower elevation (Flores et al. 2005, Arteta et al. 2006, Roque & Ramírez 2008), or when the richness is restricted to specific vegetation formations such as wetlands (Ruthsatz 2012, Valencia et al. 2013).

For the flora of Carabaya, the most abundant genera in terms of species richness were *Senecio*, *Calamagrostis*, *Nototriche* and *Poa;* this taxonomic composition towards a few highly diverse genera has been explained due to the high degree of a recent local speciation driven by geographic isolation between high alpine 'continental islands' or complexes (Sklenář & Balslev 2005, Sklenář et al. 2013). In addition, these same genera are the most abundant in terms of vegetation cover (Cuesta et al. 2017).

A perennial life form is obviously the dominant plant type in the high Andes. This life form includes most species in plant lineages with rapid diversification and radiation in the Andes, such as *Lupinus*, *Nototriche, Pycnophyllum*, *Senecio* and others. Hughes and Atchison (2015) suggest "that perenniality could have played a general role as a key adaptation, enabling lineages to take advantage of ecological opportunities associated with the recent availability of alpine habitats to rapidly diversify" as was observed in *Lupinus* (Drummond et al. 2012). In this study, half of the Carabaya flora has longer life cycles as "Perennials" represented by herbaceous forms. However, a more detailed exam might allow recognition of other types such as rosettes, mats, and cushions.

Because of the availability of data from local, regional and country floras further comparisons are now feasible. The similarities in floristic composition and richness confirm the importance of the tropical Andes as global hotspot of plant diversity. Differences in flora sizes, especially between Carabaya and its closest neighboring sites, demonstrate the need of extending botanical exploration in Peru, and for the detailed recording in different types of habitats. Plant collections are still needed in many areas to fully understand the patterns of species diversity, and characteristics of their populations. As it can be found in the results of this study, several species have not been found since their discovery (e.g., *Alsine rupestris* Muschl., *Nototriche cupuliforme* Krapov. and *Nototriche erinacea* A.W. Hill). The high number of species (>91%) with its lower limits above 4000 m underscores the importance of the high Andes for conservation. This is even more important today in the Peruvian high Andes, where climatic conditions and human induced changes play an important role for impacting them (see Young 2014). Threats originate directly by overlapping competing human activities such as mining, fire, agriculture, landslides, erosion and other land uses. In addition, climate change associated to these anthropic influences are leading to the fragmentation of habitats and therefore, the loss of species survival and diversity, and possible mountaintop extinctions. Finally, it should be mentioned that many taxonomic studies are still pending to fully understand the biodiversity of the fascinating Andean highlands.

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Appendix 1. Checklist of vascular flora of the Cordillera Carabaya, indicating growth form (F) (h: herb, s: subshrub, a: shrub, ab: tree, c: cactoide), endemic species (E) (x: reported in León et al. (2007); x* no collections in other countries but not previously reported as endemic to Peru), Elev.: elevational record of these collection(s); Voucher: PG (Paúl Gonzáles), FP (Francis Pennell), JS (Jaroslav Soukup), CV (César Vargas), OT (Oscar Tovar), AW (Augusto Weberbauer), MW (Maximilian Weigend), f!: not registered herbarium specimen, known only as photograph from study area; [ ]: collections within brackets come from neighboring areas.

family	Species	F	E	Elev.	Voucher
Pteridophytes					
Aspleniaceae	*Asplenium gilliesii* Hook.	h	–	>4000	f!
	Asplenium monanthes L.	h	–	>4000	Boeke JD. 2972
	Asplenium triphyllum C. Presl	h	–	4499	PG 3816
Dryopteridaceae	*Elaphoglossum mathewsii* (Fée) T. Moore	h	–	>4000	PG 3025
	Polystichum cochleatum (Klotzsch) Hieron.	h	–	>4000	f!
Isoetaceae	*Isoetes andina* Hook.	h		>4000	León 5316
	Isoetes lechleri Mett.	h		>4000	Lechler 1937
Lycopodiaceae	*Phlegmariurus crassus* (Humb. & Bonpl. ex Willd.) B. Øllg.	h	–	>4000	f!
Ophioglossaceae	*Ophioglossum crotalophoroides* Walter	h	–	>4000	f!
Polypodiaceae	*Campyloneurum amphostenon* (Kunze ex Klotzsch) Fée	h	–	>4000	f!
	Campyloneurum asplundii (C. Chr.) Ching	h	–	>4000	f!
	Melpomene peruviana (Desv.) A.R. Sm. & R.C. Moran	h	–	>4000	f!
	Pleopeltis pycnocarpa (C. Chr.) A.R. Sm.	h	–	3935	PG 3047
Pteridaceae	*Argyrochosma nivea* (Poir.) Windham	h	–	>4000	f!
	Cheilanthes pilosa Goldm.	h	–	>4000	f!
	Cheilanthes pruinata Kaulf.	h	–	>4000	f!
	Cheilanthes scariosa (Sw.) C. Presl	h	–	>4000	f!
	Pellaea ovata (Desv.) Weath.	h	–	>4000	f!
Salviniaceae	*Azolla filiculoides* Lam.	h	–	>4000	f!
Woodsiaceae	*Cystopteris fragilis* (L.) Bernh.	h	–	>4000	f!
	Woodsia montevidensis (Spreng.) Hieron.	h	–	>4000	f!
Gymnospems					
Ephedraceae	*Ephedra rupestris* Benth.	s	–	>4000	f!
Monocots					
Alstroemeriaceae	*Alstroemeria pygmaea* Herb.	h	–	3500–4400	MW 2000/68, CV 6840
	Bomarea dulcis (Hook.) Beauverd	h	–	4499	Hill 3819, Raimondi A. 10229
	Bomarea involucrosa (Herb.) Baker	h	–	>4000	f!
Amaryllidaceae	*Nothoscordum gramineum* (Sims) P. Beauv.	h	–	3800	CV 15181
Asparagaceae	*Oziroe acaulis* (Baker) Speta	h	–	4000	CV 7146
Cyperaceae	*Carex boliviensis* Van Heurck & Müll. Arg.	h	–	>4000	f!
	Carex bonplandii Kunth	h	–	>4000	f!
	Carex brachycalama Griseb.	h	–	4499	f!
	Carex pichinchensis Kunth	h	–	>4000	Lechler 2519, PG 3817
	Cyperus andinus Palla ex Kük.	h	–	>4000	f!
	Eleocharis albibracteata Nees & Meyen ex Kunth	h	–	4381	f! [Meyen s.n.]
	Oreobolus venezuelensis Steyerm.	h	–	>4000	PG 3083
	Phylloscirpus acaulis (Phil.) Goetgh. & D.A. Simpson	h	–	>4000	f! [PG 1604]
	Phylloscirpus deserticola (Phil.) Dhooge & Goetgh.	h	–	>4000	León 5315
	Trichophorum rigidum (Boeckeler) Goetgh., Muasya & D.A. Simpson	h	–	>4000	f!

(...)

family	Species	F	E	Elev.	Voucher
	Zameioscirpus atacamensis (Phil.) Dhooge & Goetgh.	h	–	>4000	f!
	Zameioscirpus muticus Dhooge & Goetgh.	h	–	4285	f! [PG1603]
Hydrocharitaceae	*Elodea potamogeton* (Bertero) Espinosa	h	–	>4000	f!
Iridaceae	*Cardenanthus vargasii* R.C. Foster	h	x*	4399	PG 3450
	Olsynium acaule (Klatt) Goldblatt	h	–	4301	PG 3421
	Olsynium junceum (E. Mey. ex C. Presl) Goldblatt	h	–	>4000	f!
	Sisyrinchium brevipes Baker	h	–	>4000	f!
	Sisyrinchium caespitificum Kraenzl.	h	–	>4000	f!
	Sisyrinchium chilense Hook.	h	–	>4000	f!
	Sisyrinchium palustre Diels	h	–	>4000	f!
	Sisyrinchium porphyreum Kraenzl.	h	–	4301	PG 3418
Juncaceae	*Distichia muscoides* Nees & Meyen	h	–	>4000	f!
	Juncus arcticus Willd.	h	–	>4000	f!
	Juncus bufonius L.	h	–	>4000	f!
	Juncus ebracteatus E. Mey.	h	–	>4000	f!
	Juncus stipulatus Nees & Meyen	h	–	4381	PG 3086
	Luzula ecuadoriensis Balslev	h	–	4335	PG 3002
	Luzula racemosa Desv.	h	–	>4000	f!
	Oxychloe andina Phil.	h	–	4700	PG 3452
	Patosia clandestina (Phil.) Buchenau	h	–	4424	PG 3447
Juncaginaceae	*Lilaea scilloides* (Poir.) Hauman	h	–	>4000	f!
Orchidaceae	*Aa rosei* Ames	h	–	4100	CV 6846
	Myrosmodes chiogena (Schltr.) C.A. Vargas	h	–	4897	PG 3057b
	Myrosmodes gymnandra (Rchb. f.) C.A. Vargas	h	–	4458	PG 2996
	Myrosmodes paludosa (Rchb. f.) P. Ortiz	h	–	4285–4897	PG 3022, PG 3057a
Poaceae	*Aciachne acicularis* Lægaard	h	–	>4000	f!
	Aciachne pulvinata Benth.	h	–	3250–3630	Bennett B. 2004, 2099, Lechler 3238
	Aegopogon cenchroides Humb. & Bonpl. ex Willd.	h	–	>4000	f!
	Agrostis breviculmis Hitchc.	h	–	3790–4600	Anonimo 7158, Bennett B. 2283
	Agrostis tolucensis Kunth	h	–	>4000	f!
	Alopecurus hitchcockii Parodi	h	–	>4000	f!
	Anatherostipa hans–meyeri (Pilg.) Peñail.	h	–	3940–4335	AW 940, Bennett B. 2759, Lechler 1978, PG 3017
	Anatherostipa obtusa (Nees & Meyen) Peñail.	h	–	>4000	f! [Monheim 160, 10, OT 5175, 5259, Weddell 4488]
	Avena sativa L.	h	–	>4000	f! [OT s.n.]
	Bromus catharticus Vahl	h	–	>4000	f! [Monheim 19]
	Bromus lanatus Kunth	h	–	>4000	f! [CV 16233]
	Bromus pitensis Kunth	h	–	>4000	f!
	Bromus villosissimus Hitchc.	h	–	>4000	CV 7894
	Calamagrostis antoniana (Griseb.) Hack. ex Dusén	h	–	4600	CV 7184
	Calamagrostis breviaristata (Wedd.) Pilg.	h	–	4897	PG 3067
	Calamagrostis brevifolia (J. Presl) Steud.	h	–	>4000	f!
	Calamagrostis chrysantha (J. Presl) Steud.	h	–	>4000	CV 7167, León 5321
	Calamagrostis eminens (J. Presl) Steud.	h	–	>4000	f!
	Calamagrostis heterophylla (Wedd.) Pilg.	h	–	3790	Bennett B. 2287

(...)

family	Species	F	E	Elev.	Voucher
	Calamagrostis intermedia (J. Presl) Steud.	h	–	3550	Metcalf R. 30433
	Calamagrostis jamesonii Steud.	h	–	>4000	f! [Pearson 75]
	Calamagrostis macrophylla (Pilg.) Pilg.	h	–	>4000	Metcalf R. 30433
	Calamagrostis minima (Pilg.) Tovar	h	–	>4000	AW 953
	Calamagrostis nitidula Pilg.	h	–	4400	AW 960, León 5319
	Calamagrostis ovata (J. Presl) Steud.	h	–	>4000	CV 7892, Lechler 2057
	Calamagrostis recta (Kunth) Trin. ex Steud.	h	–	3470	Bennett B. 2264
	Calamagrostis rigescens (J. Presl) Scribn.	h	–	>4000	f! [JS 113]
	Calamagrostis rigida (Kunth) Trin. ex Steud.	h	–	>4000	f!
	Calamagrostis rupestris Trin.	h	–	4400	CV 8131
	Calamagrostis setiflora (Wedd.) Pilg.	h	–	>4000	f!
	Calamagrostis spiciformis Hack.	h	–	3300	Bennett B. 2494
	Calamagrostis tarmensis Pilg.	h	–	4288–3470	Bennett B. 2263, PG 3034, 3018
	Calamagrostis trichophylla Pilg.	h	–	>4000	f! [Stordy s.n., Harlam s.n.]
	Calamagrostis vicunarum (Wedd.) Pilg.	h	–	4381	PG 3085
	Dielsiochloa floribunda (Pilg.) Pilg.	h	–	>4000	AW 1028, León 5320, 5342
	Festuca breviaristata Pilg.	h	–	>4000	f!
	Festuca divergens Tovar	h	x*	4559	PG 2998
	Festuca dolichophylla J. Presl	h	–	>4000	f! [JS 447, OT 5243, 5159]
	Festuca humilior Nees & Meyen	h	–	>4000	CV 7897
	Festuca lasiorrhachis Pilg.	h	–	>4000	Ferreyra R. 16741
	Festuca orthophylla Pilg.	h	–	>4000	f! [Pearson 46, OT 5102, AW 4087]
	Festuca rigescens (J. Presl) Kunth	h	–	4897	PG 3049
	Festuca setifolia Steud. ex Griseb.	h	x*	3500–4700	Lechler 1826
	Festuca tenuiculmis Tovar	h	x*	>4000	f!
	Hordeum muticum J. Presl	h	–	>4000	f! [JS 115]
	Jarava ichu Ruiz & Pav.	h	–	>4000	f! [Pearsson 10, Stafford D. 63, Rauh 1490, 642]
	Muhlenbergia angustata (J. Presl) Kunth	h	–	>4000	Boeke JD. 2974
	Muhlenbergia ligularis (Hack.) Hitchc.	h	–	3790	Bennett B. 2284
	Muhlenbergia peruviana (P. Beauv.) Steud.	h	–	4100	Bennett B. 2738
	Nassella brachyphylla (Hitchc.) Barkworth	h	–	>4000	CV 7901
	Nassella inconspicua (J. Presl) Barkworth	h	–	>4000	f! [OT 5187, 5333, Harlam s.n.]
	Nassella pubiflora (Trin. & Rupr.) E. Desv.	h	–	>4000	f! [Lechler 1736, Ellenberg 421]
	Paspalum pygmaeum Hack.	h	–	3630	Bennett B. 2010
	Pennisetum clandestinum Hochst. ex Chiov.	h	–	>4000	f!
	Piptochaetium panicoides (Lam.) E. Desv.	h	–	4285	CV 7163, PG 3020
	Poa aequigluma Tovar	h	–	>4000	f!
	Poa annua L.	h	–	2790	Bennett B. 2289
	Poa apiculata Refulio	h	x	4999	PG 2985
	Poa ayacuchensis Tovar	h	x	4335	PG 3019
	Poa calycina (J. Presl) Kunth	h	–	>4000	CV 7891
	Poa dentigluma Tovar	h	–	>4000	f!
	Poa gilgiana Pilg.	h	–	>4000	CV 7902
	Poa glaberrima Tovar	h	–	4288	PG 3035

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family	Species	F	E	Elev.	Voucher
	Poa gymnantha Pilg.	h	–	>4000	CV 7174
	Poa horridula Pilg.	h	–	>4000	Lechler 2682, Bennett B. 2323
	Poa humillima Pilg.	h	–	>4000	f!
	Poa lepidula (Nees & Meyen) Soreng & L.J. Gillespie	h	–	4600–5300	CV 8136, León 5323
	Poa macusaniensis (E.H.L. Krause) Refulio	h	–	4381	Lechler 1836, PG 3091
	Poa marshallii Tovar	h	–	>4000	f!
	Poa perligulata Pilg.	h	–	>4000	f!
	Poa peruviana Jacq.	h	–	>4000	f!
	Poa pseudoaequigluma Tovar	h	–	>4000	f!
	Poa serpaiana Refulio	h	–	4381	PG 3084
	Poa spicigera Tovar	h	–	>4000	f!
	Polypogon interruptus Kunth	h	–	>4000	f!
	Trisetum spicatum (L.) K. Richt.	h	–	4285	PG 3024
	Vulpia dertonensis (All.) Gola	h	–	>4000	f!
	Vulpia myuros (L.) C.C. Gmel.	h	–	3690	Bennett B. 2660
Potamogetonaceae	*Stuckenia punensis* (A. Galán) A. Galán	h	–	>4000	f! [Iltis 1441]
	Stuckenia pectinata (L.) Börner	h	–	4360	CV 7132
Eudicots					
Amaranthaceae	*Gomphrena meyeniana* Walp.	h	–	4360	CV 7121
Apiaceae	*Azorella biloba* (Schltdl.) Wedd.	h	–	4150–4399	CV 6838, CV 6848, Lechler s.n., PG 3448
	Azorella diapensioides A. Gray	h	–	>4000	f! [CV 13010, JS 210; 214, Stordy 32]
	Azorella multifida (Ruiz & Pav.) Pers.	h	–	4300	CV 6841
	Bowlesia palmata Ruiz & Pav.	h	–	3935	PG 3043
	Bowlesia tropaeolifolia Gillies & Hook.	h	–	3900	Hoogte L. 2402
	Chaerophyllum andicola (Kunth) K.F. Chung	h	–	4300	CV 1308, Hoogte L. 850
	Daucus montanus Humb. & Bonpl. ex Spreng.	h	–	>4000	f!
	Lilaeopsis macloviana (Gand.) A.W. Hill	h	–	>4000	f! [Aguilar 135]
	Niphogeton scabra (H. Wolff) J.F. Macbr.	h	–	>4000	f!
Apocynaceae	*Philibertia lysimachioides* (Wedd.) T. Mey.	s	–	>4000	f!
Asteraceae	*Achyrocline alata* (Kunth) DC.	h	–	>4000	f!
	Achyrocline ramosissima Britton ex Rusby	h	–	>4000	f! [Aguilar 441, FP 13484, JS 93]
	Ageratina glechonophylla (Less.) R.M. King & H. Rob.	s	–	>4000	f!
	Aldama helianthoides (Rich.) E.E. Schill. & Panero	h	–	3935	PG 3040
	Baccharis caespitosa (Ruiz & Pav.) Pers.	s	–	4000–5300	León 5338
	Baccharis genistelloides (Lam.) Pers.	s	–	>4000	Boeke JD. 3105
	Baccharis tola Phil.	a	–	>4000	f!
	Baccharis tricuneata (L. f.) Pers.	a	–	>4000	Boeke JD. 3168
	Bidens andicola Kunth	h	–	>4000	f!
	Chersodoma antennaria (Wedd.) Cabrera	h	–	4522	PG 3432
	Chersodoma jodopappa (Sch. Bip.) Cabrera	s	–	>4000	f! [PG 3311]
	Chuquiraga jussieui J.F. Gmel.	s	–	>4000	Stafford D. 1111, 420
	Conyza artemisioides Meyen & Walp.	h	–	>4000	PG 3072
	Conyza bonariensis (L.) Cronquist	h	–	>4000	f!
	Conyza coronopifolia Kunth	h	–	3935	PG 3038

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family	Species	F	E	Elev.	Voucher
	Conyza deserticola Phil.	h	–	3935	PG 3039
	Cotula mexicana (DC.) Cabrera	h	–	>4000	f!
	Cuatrecasasiella isernii (Cuatrec.) H. Rob.	h	–	>4000	f!
	Diplostephium carabayense Wedd.	s	x	>4000	f!
	Erigeron lanceolatus Wedd.	h	–	>4000	f!
	Erigeron rosulatus Wedd.	h	–	>4000	León 5327
	Facelis plumosa (Wedd.) Sch. Bip.	h	–	>4000	f! [FP 13459]
	Galinsoga mandonii Sch.Bip. ex Baker	h	–	3935	PG 3046
	Gamochaeta americana (Mill.) Wedd.	h	–	>4000	Boeke JD. 3053
	Gamochaeta humilis Wedd.	h	–	4400	CV 17630
	Gamochaeta purpurea (L.) Cabrera	h	–	>4000	f! [Aguilar, 418, CV s.n, 16254, Rauh P650]
	Gnaphalium dombeyanum DC.	h	–	>4000	Boeke JD. 3163
	Gnaphalium lacteum Meyen & Walp.	h	–	>4000	f! [FP 13444]
	Gnaphalium polium Wedd.	h	–	>4000	f! [Aguilar, 417, FP 13444, 13470, 13470a]
	Hieracium leptocephalium Benth.	h	–	>4000	f!
	Hieracium neoherrerae Zahn	h	–	4288	PG 3030
	Hypochaeris chillensis (Kunth) Britton	h	–	4288	PG 3029
	Hypochaeris echegarayi Hieron.	h	–	>4000	f!
	Hypochaeris meyeniana (Walp.) Benth. & Hook. f. ex Griseb.	h	–	>4000	f!
	Hypochaeris sessiliflora Kunth	h	–	>4000	f!
	Hypochaeris taraxacoides Ball	h	–	>4000	f!
	Jalcophila ecuadorensis M.O. Dillon & Sagást.	h	–	4516	PG 3102
	Laennecia gnaphalioides (Kunth) Cass.	h	–	>4000	f!
	Leucheria daucifolia (D. Don) Crisci	h	–	>4000	JS J. 474
	Misbrookea strigosissima (A. Gray) V.A. Funk	h	–	>4000	f!
	Mniodes aretioides (Wedd.) Cuatrec.	s	–	4500	Dillon M. 1083
	Mniodes conoidea (Wedd.) S. E. Freire	h	–	4500	Dillon M. 1082
	Mniodes kunthiana (DC.) S. E. Freire	h	–	>4000	León 5326
	Mniodes longifolia (Cuatrec. & Aristeg.) S. E. Freire	h	–	>4000	f!
	Mniodes piptolepis (Wedd.) S. E. Freire	h	–	>4000	f! [Aguilar s.n., 427, Mexia 4262, FP13368, 13437]
	Mniodes schultzii (Wedd.) S. E. Freire	h	–	>4000	f! [Stafford D. 746]
	Mniodes subspicata (Wedd.) S.E. Freire	h	–	>4000	f! [Dillon M., 1070, FP 13369, 13471]
	Noticastrum marginatum (Kunth) Cuatrec.	h	–	>4000	f!
	Novenia acaulis (Benth. & Hook. f. ex B.D. Jacks.) S.E. Freire & F.H. Hellw.	h	–	4300	Martín 2092
	Oriastrum stuebelii (Hieron.) A.M.R. Davies	h	–	>4000	f!
	Oritrophium hieracioides (Wedd.) Cuatrec.	h	–	4285	PG 3026
	Oritrophium limnophilum (Sch. Bip.) Cuatrec.	h	–	>4000	f!
	Paranephelius ovatus A. Gray ex Wedd.	h	–	>4000	f!
	Perezia ciliosa (Phil.) Reiche	h	–	>4000	f!
	Perezia coerulescens Wedd.	h	–		CV 7169, 9626, Dillon M. 1089
	Perezia multiflora (Bonpl.) Less.	h	–	>4000	f! [Zuniga 33, FP 13429]
	Perezia pungens (Bonpl.) Less.	h	–	>4000	Diaz s.n.
	Perezia pygmaea Wedd.	h	–	4381	PG 3090, Monheim 55
	Perezia sublyrata Domke	h	–	>4000	f!

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family	Species	F	E	Elev.	Voucher
	Senecio adenophylloides Sch. Bip.	a	–	4520	PG 3070, 3071
	Senecio adenophyllus Meyen & Walp.	a	–	>4000	f!
	Senecio algens Wedd.	h	–	4335–5024	PG 3010, PG 3825
	Senecio breviscapus DC.	h	–	>4000	f!
	Senecio candollei Wedd.	h	–	4335	PG 3005
	Senecio canescens (Bonpl.) Cuatrec.	h	–	4500	Dillon M. 1080
	Senecio canoi P. Gonzáles, Montesinos & Ed. Navarro	h	x	4520–4742	PG 3429, 3428, 3441
	Senecio chavanilloensis Cuatrec.	h	–	>4000	Boeke JD. 3000
	Senecio collinus DC.	a	x	>4000	f!
	Senecio condimentarius Cabrera	h	–	>4000	f!
	Senecio evacoides Sch. Bip.	h	–	>4000	f!
	Senecio ferreyrae Cabrera	s	x	>4000	f!
	Senecio gamolepis Cabrera	s	–	4857	Linares E. 2733
	Senecio humillimus Sch. Bip.	s	–	4762	PG 3442, 3443
	Senecio hyoseridifolius Wedd.	h	–	>4000	f!
	Senecio jarae Phil.	h	–	4346	Linares E. 2712
	Senecio macrorrhizus Wedd.	h	x	>4000	f!
	Senecio modestus Wedd.	h	–	4499	PG 3814
	Senecio moqueguensis Montesinos	h	x	4496	PG 3422
	Senecio nivalis (Kunth) Cuatrec.	h	–	4520–4897	PG 3822, 3056
	Senecio nutans Sch. Bip.	a	–	>4000	f!
	Senecio pinnatilobatus Sch. Bip.	a	–	4499	PG 3821
	Senecio rhizomatus Rusby	h	–	>4000	f!
	Senecio rudbeckiifolius Meyen & Walp.	a	–	>4000	f!
	Senecio rufescens DC.	a	–	>4000	f!
	Senecio serratifolius (Meyen & Walp.) Cuatrec.	h	–	4897	PG 3053
	Senecio tassaensis Montesinos	h	x	4762	PG 3444, 3445
	Senecio Vulgaris L.	h	–	>4000	f!
	Soliva neglecta Cabrera	h	–	>4000	f!
	Sonchus asper (L.) Hill	h	–	>4000	f!
	Stevia macbridei B.L. Rob.	h	–	3935	PG 3045
	Stevia mandonii Sch. Bip.	h	–	>4000	f!
	Stuckertiella capitata (Wedd.) Beauverd	h	–	>4000	f! [Iltis 1426, JS 504]
	Tagetes multiflora Kunth	h	–	>4000	f!
	Taraxacum fernandezianum Dahlst. ex Skottsb.	h	–	>4000	f!
	Werneria apiculata Sch. Bip.	h	–	>4000	f!
	Werneria glaberrima Phil.	h	–	>4000	f!
	Werneria heteroloba Wedd.	h	–	4939	PG 2995
	Werneria nubigena Kunth	h	–	>4000	f!
	Werneria obtusiloba S.F. Blake	h	–	4939	PG 2994
	Werneria orbignyana Wedd.	h	–	4335–4499	PG 3004, 3820
	Werneria pectinata Lingelsh.	h	–	>4000	f!
	Werneria pumila Kunth	h	–	>4000	f!
	Werneria pygmaea Gillies ex Hook. & Arn.	h	–	4381	PG 3088, 3089

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family	Species	F	E	Elev.	Voucher
	Werneria solivifolia Sch. Bip.	h	–	4412	PG 3094
	Xenophyllum ciliolatum (A. Gray) V.A. Funk	h	–	4897–5230	PG 3061, 3837, 3104
	Xenophyllum dactylophyllum (Sch. Bip.) V.A. Funk	s	–	5024	PG 3829
	Xenophyllum digitatum (Wedd.) V.A. Funk	h	–	4897–5230	PG 3048, 2978, 3103
	Xenophyllum marcidum (S.F. Blake) V.A. Funk	h	–	5072–5230	PG 3832, 3106
	Xenophyllum pseudodigitatum (Rockh.) V.A. Funk	s	–	5024–5072	PG 3828, 3833
	Xenophyllum staffordiae (Sandwith) V.A. Funk	s	x	4897	PG 3055
Begoniaceae	*Begonia veitchii* Hook. f.	h	–	>4000	f!
Berberidaceae	*Berberis agapatensis* Lechl.	a	–	>4000	Lechler 2646
	Berberis carinata Lechl.	a	–	>4000	Lechler 2644
	Berberis rectinervia Rusby	a	–	3850	CV 6853
Boraginaceae	*Hackelia revoluta* (Ruiz & Pav.) I.M. Johnst.	h	–	4335	PG 3003
	Phacelia secunda J.F. Gmel.	h	–	4000–4150	CV 12534, 7003, Metcalf R. 30708
	Plagiobothrys humilis (Ruiz & Pav.) I.M. Johnst.	h	–	4520	PG 3079
Brassicaceae	*Brassica rapa* subsp. *campestris* (L.) Clapham	h	–	>4000	f!
	Brayopsis alpaminae Gilg & Muschl.	h	–	4520	PG 3075
	Brayopsis monimocalyx O.E. Schulz	h	–	4400–4999	CV 17627, PG 2991
	Capsella bursa–pastoris (L.) Medik.	h	–	>4000	f!
	Cardamine bonariensis Pers.	h	–	>4000	f! [Lecher 1811]
	Descurainia athrocarpa (A. Gray) O.E. Schulz	h	–	4330–4897	CV 7008, PG 3051
	Descurainia myriophylla (Willd. ex DC.) R.E. Fr.	h	–	3935	PG 3042
	Draba brackenridgei A. Gray	h	–	4897	PG 3064
	Draba cuzcoensis O.E. Schulz	h	–	4762	PG 3438
	Draba loayzana Al–Shehbaz	h	–	4736	Navarro E. 1092
	Draba punoensis Al–Shehbaz, Ed. Navarro, H. Trinidad & A. Cano	h	x	4658–4762	Navarro E. 1087, PG 3437
	Englerocharis blanca–leoniae A–Shehbaz, P. Gonzáles & A. Cano	h	x	4897	PG 3059
	Englerocharis peruviana Muschl.	h	–	4644	Linares E. 2708
	Lepidium bipinnatifidum Desv.	h	–	4999–4520	PG 2992, 3080
	Lepidium chichicara Desv.	h	–	>4000	f! [Meyen s.n. CV 18541, PG 3307, 3308]
	Lepidium meyenii Walp.	h	–	4300–4762	CV 7134, 7011, PG 3439
	Mancoa hispida Wedd.	h	–	4520	PG 3077
	Rorippa nana (Schltdl.) J.F. Macbr.	h	–	>4000	Lechler 2583
	Weberbauera insisa A–Shehbaz, P. Gonzáles & A. Cano	h	–	4522–5000	PG 3430, 3107
	Weberbauera peruviana (DC.) Al–Shehbaz	h	–	>4000	MW 2000/120
	Weberbauera spathulifolia (A. Gray) O.E. Schulz	h	–	4320–4892	CV 6837, 6837, PG 3060
Cactaceae	*Austrocylindropuntia floccosa* (Salm–Dyck) F. Ritter	c	–	>4000	f!
	Austrocylindropuntia lagopus (K. Schum.) I. Crook, J. Arnold & M. Lowry	c	–	4360–4400	CV 7136, 22550
	Echinopsis maximiliana Heyder ex A. Dietr.	c	–	>4000	f!
Calceolariaceae	*Calceolaria plectranthifolia* Walp.	h	–	4288	PG 3028
	Calceolaria scapiflora (Ruiz & Pav.) Benth.	h	–	>4000	f!
Campanulaceae	*Hypsela reniformis* (Kunth) C. Presl	h	–	>4000	f! [JS 100, Mandon 489]
	Lysipomia acaulis Kunth	h	–	>4000	f!
	Lysipomia glandulifera (Schltdl. ex Wedd.) Schltdl. ex E. Wimm.	h	–	>4000	Lechler 2076
	Lysipomia laciniata A. DC.	h	–	3595–4424	Lechler 1956, Raimondi A. 11597, Sharpe 109, CV 1290, 10724, PG 3446

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family	Species	F	E	Elev.	Voucher
	Lysipomia sphagnophila Griseb. ex Wedd.	h	–	>4000	Lechler 2641
	Wahlenbergia peruviana A. Gray	h	–	>4000	f!
	Wahlenbergia urcosensis E. Wimm.	h	x	>4000	f!
Caprifoliaceae	*Belonanthus spathulatus* (Ruiz & Pav.) Schmale	h	–	>4000	f!
	Stangea paulae Graebn.	h	x	5024–084	PG 3826, 2979
	Stangea rhizantha (A. Gray) Killip	h	x	4450–4897	CV 7012, PG 3050
	Stangea wandae Graebn.	h	–	>4000	f! [Stafford D. 737, 1268]
	Valeriana andina Britton	h	–	4335	PG 3015
	Valeriana baltana Graebn.	h	x	>4000	Ferreyra 531
	Valeriana cephalantha Schltdl.	h	x	>4000	Lechler 2044
	Valeriana coarctata Ruiz & Pav.	h	–	4644	Linares E. 2690
	Valeriana globularioides Graebn.	h	–	4897	PG 3054
	Valeriana herrerae Killip	h	x	4000	CV 7145
	Valeriana johannae Weberl.	h	x	>4000	Bernardi L. 16774
	Valeriana micropterina Wedd.	h	–	4288–4496	PG 3032, 3001, 3016, 3425, Lechler 1962
	Valeriana niphobia Briq.	h	–	>4000	Hohenacker R. 1962
	Valeriana nivalis Wedd.	h	–	4496	PG 3427
	Valeriana pennellii Killip	h	–	>4000	f! [CV 31]
	Valeriana plectritoides Graebn.	h	x	3800	CV 6863, AW 928a
	Valeriana pycnantha A. Gray	h	–	4600	CV 7180
Caryophyllaceae	*Alsine rupestris* Muschl.	h	x	>4000	AW 1042
	Arenaria digyna Willd. ex D.F.K. Schltdl.	h	–	4999	PG 2990
	Arenaria lanuginosa (Michx.) Rohrb.	h	–	4000	CV 7148
	Cardionema ramosissimum (Weinm.) A. Nelson & J.F. Macbr.	h	–	4000	CV 7154
	Cerastium danguyi J.F. Macbr.	h	–	>4000	f!
	Cerastium glomeratum Thuill.	h	–	>4000	f!
	Cerastium mucronatum Wedd.	h	–	>4000	f!
	Cerastium peruvianum Muschl.	h	–	4400	CV 7036
	Cerastium subspicatum Wedd.	h	–	>4000	Weddell H. 4653
	Drymaria divaricata var. *stricta* (Rusby) J.A. Duke	h	–	>4000	Lechler 1947
	Paronychia andina A. Gray	h	–	4450	CV 7015
	Paronychia mandoniana Rohrb.	h	–	>4000	f! [Lecher 1760]
	Pycnophyllum aschersonianum Muschl.	h	x	>4000	f!
	Pycnophyllum bryoides (Phil.) Rohrb.	h	–	4400	AW 501b
	Pycnophyllum glomeratum Mattf.	h	–	4400–5024	AW 501a, 952, PG 3081, 3827
	Pycnophyllum lechlerianum Rohrb.	h	x	4999	PG 2988
	Pycnophyllum molle Remy	h	–	4335–4400	PG 3009, AW 946, 950
	Pycnophyllum weberbaueri Muschl.	h	–	4399–5024	PG 3451, 3823
	Silene mandonii (Rohrb.) Bocquet	h	–	>4000	f!
	Silene thysanodes Fenzl	h	–	>4000	f!
	Spergularia fasciculata Phil.	h	–	>4000	f! [Lecher 1772]
	Stellaria cuspidata D.F.K. Schltdl.	h	–	3800	AW 925
	Stellaria media (L.) Vill.	h	–	>4000	f!
	Stellaria weddellii Pedersen	h	–	>4000	f!

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family	Species	F	E	Elev.	Voucher
Convolvulaceae	*Dichondra microcalyx* (Hallier f.) Fabris	h	–	>4000	f!
Crassulaceae	*Crassula closiana* (Gay) Reiche	h	–	>4000	f!
	Crassula connata (Ruiz & Pav.) A. Berger	h	–	>4000	f! [FP 13043]
Elatinaceae	*Elatine triandra* Schkuhr	h	–	>4000	Lechler 2687
Escalloniaceae	*Escallonia myrtilloides* L. f.	a	–	>4000	Boeke JD. 3020
Euphorbiaceae	*Euphorbia huanchahana* (Klotzsch & Garcke) Boiss.	h	–	>4000	f!
Fabaceae	*Adesmia schickendantzii* Griseb.	s	–	4192	Galán 3896
	Astragalus arequipensis Vogel	h	–	>4000	JS J. 966
	Astragalus dielsii J.F. Macbr.	h	–	4897	PG 3058
	Astragalus dillinghamii J.F. Macbr.	h	x	4412–4999	PG 3100, 2983
	Astragalus diminutivus (Phil.) Gómez–Sosa	h	–	4200	CV 15179
	Astragalus garbancillo Cav.	h	–	>4000	f! [JS 85]
	Astragalus minimus Vogel	h	–	>4000	f! [Meyen 67]
	Astragalus pilgeri J.F. Macbr.	h	–	4450	CV 7026
	Astragalus uniflorus DC.	h	–	>4000	f!
	Astragalus weddellianus (Kuntze) I.M. Johnst.	h	–	3750–4400	JS J. 549; 424, CV 7026, 7030
	Lupinus ananeanus Ulbr.	h	–	>4000	f!
	Lupinus aridulus C.P. Sm.	h	–	4335	PG 3006
	Lupinus breviscapus Ulbr.	h	–	>4000	f!
	Lupinus eriocladus Ulbr.	h	–	4000	CV 7153
	Lupinus gibertianus C.P. Sm.	h	–	3500–4600	CV 6852, 7170, Lechler 1842
	Lupinus microphyllus Desr.	h	–	>4000	f!
	Lupinus peruvianus Ulbr.	h	–	4335	PG 3008, 3012, Antezana F. 16
	Lupinus pulvinaris Ulbr.	h	–	4500	AW 985
	Lupinus ulbrichianus C.P. Sm.	h	–	>4000	AW 870
	Medicago polymorpha L.	h	–	>4000	f!
	Trifolium amabile Kunth	h	–	>4000	f! [CV 21253]
	Trifolium repens L.	h	–	>4000	f!
	Vicia graminea Sm.	h	–	>4000	f! [CV 12499, 18540, 20915]
Gentianaceae	*Gentiana sedifolia* Kunth	h	–	>4000	f! [FP 13418; 13426, JS 98]
	Gentianella armerioides (Griseb. ex Gilg) J.S. Pringle	h	–	>4000	Lechler 2000a
	Gentianella bridgesii (Gilg) Fabris ex T.N. Ho & S.W. Liu	h	–	4000	AW 1048
	Gentianella campanuliformis (Reimers) Fabris	h	x	4999	PG 2986
	Gentianella centamalensis (Gilg) Zarucchi	h	x	>4000	f!
	Gentianella dolichopoda (Gilg) J.S. Pringle	h	x*	4381	PG 3092
	Gentianella lobelioides (Gilg) Zarucchi	h	x	4600	AW 955
	Gentianella persquarrosa (Reimers) J.S. Pringle	h	x	4939	PG 2993
	Gentianella potamophila (Gilg) Zarucchi	h	x	>4000	f!
	Gentianella primuloides (Gilg) J.S. Pringle	h	–	>4000	Lechler 2002
	Gentianella punicea (Wedd.) Holub	h	–	4000	Weddell H. s.n.
	Gentianella sandiensis (Gilg) J.S. Pringle	h	–	3600	AW 917a
	Gentianella scarlatiflora (Gilg) J.S. Pringle	h	x*	4300	CV 15180
	Gentianella scarlatina (Gilg) Zarucchi	h	–	>4000	AW 1047
	Halenia caespitosa Gilg	h	–	14500 ft	Stafford D. 1117

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family	Species	F	E	Elev.	Voucher
	Halenia umbellata (Ruiz & Pav.) Gilg	h	–	3600–4288	MW 2000/123, Hoogte L. 2399, PG 3031
Geraniaceae	*Erodium cicutarium* (L.) L'Hér. ex Aiton	h	–	>4000	f! [FP 13401]
	Erodium moschatum (L.) L'Hér. ex Aiton	h	–	>4000	f!
	Geranium core–core Steud.	h	–	3935	PG 3037, 3041
	Geranium crassipes Hook. ex A. Gray	h	–	>4000	Lechler 1985
	Geranium dielsianum R. Knuth	h	–	>4000	f!
	Geranium fallax Steud.	h	–	>4000	Lechler 1907
	Geranium sessiliflorum Cav.	h	–	>4000	f! [AW 1003a, FP 13439]
	Geranium weddellii Briq.	h	–	4336	JS J. 537
Grossulariaceae	*Ribes bolivianum* Jancz.	a	–	3850	CV 6864
	Ribes brachybotrys (Wedd.) Jancz.	a	–	4800	Hoogte L. 2212
Haloragaceae	*Myriophyllum quitense* Kunth	h	–	>4000	f! [FP 13425, JS 835]
Hypericaceae	*Hypericum silenoides* Juss.	h	–	>4000	f!
Lamiaceae	*Hedeoma mandoniana* Wedd.	h	–	>4000	f!
	Lamium amplexicaule L.	h	–	>4000	f!
	Lepechinia meyenii (Walp.) Epling	h	–	>4000	f!
	Stachys pusilla (Wedd.) Briq.	h	–	>4000	f!
Loasaceae	*Caiophora contorta* (Desr.) C. Presl	h	–	4330	CV 7009
	Caiophora horrida (Britton) Urb. & Gilg	h	–	>4000	f! [CV 6830, 13009, 20880]
	Caiophora rosulata (Wedd.) Urb. & Gilg	h	–	>4000	f!
Malvaceae	*Acaulimalva steinbachii* Krapov.	h	–	>4000	f!
	Nototriche anthemidifolia (J. Rémy) A.W. Hill	h	–	4412	PG 3099
	Nototriche armeriifolia A.W. Hill	h	x	>4000	f!
	Nototriche azorella A.W. Hill	h	x*	4600	AW 957
	Nototriche carabayensis P. Gonzáles, M. Chanco & Ed. Navarro	h	x	5072	PG 3835
	Nototriche condensata (Baker f.) A.W. Hill	h	–	>4000	Lechler 1972
	Nototriche congesta A.W. Hill	h	x*	4500	AW 1018
	Nototriche cupuliforme Krapov.	h	x	4360	CV 7119
	Nototriche digitulifolia A.W. Hill	h	x	4897	PG 3052
	Nototriche erinacea Hill ex Burtt	h	x	4897	PG 3062
	Nototriche flabellata (Wedd.) A.W. Hill	h	–	4400–4897	Lechler 1972, AW 961, PG 3066
	Nototriche longirostris (Wedd.) A.W. Hill	h	–	4360	CV 7118
	Nototriche longituba Burtt & Hill	h	x	>4000	f! [Howell Williams s.n.]
	Nototriche obcuneata (Baker f.) A.W. Hill	h	–	4500–5084	AW 983, 1023, PG 3834, 2976
	Nototriche pedicullariifolia (Meyen) A.W. Hill	h	–	4500–4700	AW 1023, CV 7896, 7185
	Nototriche pellicea A.W. Hill	h	x	4412	PG 3098
	Nototriche purpurascens A.W. Hill	h	–	4897	PG 3065
	Nototriche sepaliloba Hochr.	h	x*	4885	Linares E. 2722
	Nototriche staffordiae Burtt & Hill	h	x	>4000	f! [Stafford D. 1263]
	Nototriche sulphurea A.W. Hill	h	–	4700	AW 219, 963
	Tarasa urbaniana (Ulbr.) Krapov.	h	–	3600–4520	AW 927, CV 1312, PG 3076
Montiaceae	*Calandrinia acaulis* Kunth	h	–	4300	AW 956, CV 6839
	Montia fontana L.	h	–	>4000	f!
Onagraceae	*Epilobium denticulatum* Ruiz & Pav.	h	–	4335	AW 357, PG 3014

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	Oenothera multicaulis Ruiz & Pav.	h	–	>4000	f! [JS 104]
Orobanchaceae	*Neobartsia bartsioides* (Hook.) Edwin	h	–	>4000	JS J. 970
	Neobartsia diffusa (Benth.) Uribe-Convers & Tank	h	–	>4000	León 5343, Linares 2742
	Neobartsia elongata (Wedd.) Uribe-Convers & Tank	h	–	4335–4499	PG 3013, 3426, 3818
	Neobartsia fiebrigii (Diels) Uribe-Convers & Tank	h	–	>4000	f!
	Neobartsia inaequalis (Benth.) Uribe-Convers & Tank	h	–	>4000	f! [AW 510, 919]
	Neobartsia pedicularoides (Benth.) Uribe-Convers & Tank	h	–	>4000	f!
	Castilleja pumila (Benth.) Wedd.	h	–	>4000	f! [FP 13428, JS 938, Rauh 47]
	Castilleja virgatoides Edwin	h	–	>4000	f!
Oxalidaceae	*Oxalis calachaccensis* R. Knuth	h	–	>4000	f! [CV 6825]
	Oxalis cuzcensis R. Knuth	h	–	4520	PG 3073
	Oxalis nubigena Walp.	h	–	>4000	f! [FP 13394, Meyen s.n.]
	Oxalis oreocharis Diels	h	–	4450	CV 7012
	Oxalis pinguiculacea R. Knuth	h	–	3800–4450	CV 6844, CV 7024
	Oxalis tuberosa Molina	h	–	>4000	AW 295
Phrymaceae	*Mimulus glabratus* Kunth	h	–	>4000	f!
Piperaceae	*Peperomia peruviana* Dahlst.	h	–	4644	Linares E. 2692
	Peperomia verruculosa Dahlst. ex A.W. Hill	h	–	4450	CV 7013
Plantaginaceae	*Callitriche heteropoda* Engelm. ex Hegelm.	h	–	>4000	f!
	Callitriche nubigena Fassett	h	–	>4000	f!
	Ourisia biflora Wedd.	h	–	14500 ft	Stafford D. 1112
	Ourisia muscosa Wedd.	h	–	4762	PG 3435
	Plantago australis Lam.	h	–	>4000	f! [CV 21263]
	Plantago lamprophylla Pilg.	h	–	4520	PG 3082
	Plantago linearis Kunth	h	–	4516	PG 3101
	Plantago nubicola (Decne.) Rahn	h	–	4335–4522	Hoogte L. 2997, PG 3011, 3449, 3434, CV 17621, AW 994
	Plantago orbignyana Steinh. ex Decne.	h	–	>4000	f! [Meyen s.n.]
	Plantago rigida Kunth	h	–	4000–4381	AW 1050, Weddell H. s.n., PG 3087
	Plantago sericea Ruiz & Pav.	h	–	>4000	f! [CV 20887, 20923, 21259]
	Plantago tubulosa Decne.	h	–	>4000	f!
	Veronica serpyllifolia L.	h	–	3000	CV 1283, 9637
Polemoniaceae	*Gilia laciniata* Ruiz & Pav.	h	–	>4000	f! [Stafford D. 517, FP 13410]
	Phlox gracilis (Douglas ex Hook.) Greene	h	–	>4000	Hill s.n.
Polygonaceae	*Muehlenbeckia volcanica* (Benth.) Endl.	h	–	>4000	AW 849
Ranunculaceae	*Caltha sagittata* Cav.	h	–	>4000	Lechler 1953, Weddell H. s.n., Linares 2680
	Krapfia haemantha (Ulbr.) Tamura	h	–	4335–4897	Raimondi A. s.n., PG 3000, 3068
	Oreithales integrifolia (DC.) Schltdl.	h	–	4500	Lechler 2706, CV 22556
	Ranunculus breviscapus DC.	h	–	>4000	f!
	Ranunculus filamentosus Wedd.	h	–	4400–4999	CV 7033, PG 3431, 2984
	Ranunculus flagellifolius Nakai	h	–	>4000	f!
	Ranunculus limoselloides Turcz.	h	–	>4000	f!
	Ranunculus praemorsus Kunth ex DC.	h	–	2500	AW 597, Lechler 2709, Raimondi A. s.n.
	Ranunculus trichophyllus Chaix ex Vill.	h	–	>4000	f!
	Ranunculus uniflorus Phil. ex Reiche	h	–	4381	PG 3093

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Rosaceae	*Aphanes andicola* Rothm.	h	–	4520	PG 3078
	Lachemilla barbata (C. Presl) Rothm.	h	–	>4000	f!
	Lachemilla diplophylla (Diels) Rothm.	h	–	>4000	f!
	Lachemilla frigida (Wedd.) Rothm.	h	–	4285	PG 3023
	Lachemilla pinnata (Ruiz & Pav.) Rothm.	h	–	4400	CV 17623
	Lachemilla sandiensis Rothm.	h	x	>4000	AW 945
	Lachemilla vulcanica (Schltdl. & Cham.) Rydb.	h	–	3600	AW 926
	Polylepis besseri Hieron.	ab	–	3800–4100	CV 12528, 7139
	Tetraglochin cristatum (Britton) Rothm.	s	–	>4000	f! [Tupayachi A. 1570, CV 1, 20927, 22545]
Rubiaceae	*Galium aparine* L.	h	–	3935	PG 3044
	Galium corymbosum Ruiz & Pav.	h	–	>4000	f! [FP 13407]
Saxifragaceae	*Saxifraga magellanica* Poir.	h	–	3500–4400	CV 6859, 6857, 7172, AW 183
Scrophulariaceae	*Limosella subulata* E. Ives	h	–	>4000	f!
Solanaceae	*Nicotiana pavonii* Dunal	h	–	>4000	Metcalf R. 30712
	Nicotiana undulata Ruiz & Pav.	h	–	>4000	f! [CV 9627, JS 902, 632]
	Salpichroa amoena Benoist	s	–	3800–4260	MW 2000/119, Särkinen T. 4056, PG 3036
	Salpichroa glandulosa (Hook.) Miers	s	–	4260	PG 3036
	Salpichroa lehmannii Dammer	s	–	4200–4496	MW 2000/53, Särkinen T. 4039, PG 3424
	Solanum acaule Bitter	h	–	4335–4450	PG 3007, 3095, CV 7023
	Solanum grandidentatum Phil.	h	–	4200–4596	Beltrán H. 6453, MW 2000/54
	Solanum weddellii Phil.	h	–	4200–4200	Särkinen T. 4038
Urticaceae	*Urtica echinata* Benth.	h	–	>4000	f! [Tupayachi A. 28663]
	Urtica flabellata Kunth	h	–	4600–4700	AW 969
	Urtica urens L.	h	–	>4000	f!
Verbenaceae	*Verbena litoralis* Kunth	h	–	>4000	f!
Violaceae	*Viola enmae* P. Gonzáles	h	x	4300–4400	PG 3420, 3096
	Viola ferreyrae P. Gonzáles	h	x	4300–4400	PG 3419, 3097
	Viola micranthella Wedd.	h	–	4335	PG 2999
	Viola pusillima Wedd.	h	–	>4000	f! [PG 1605]
	Viola pygmaea Juss. ex Poir.	h	–	4300–4360	MW 2000/63, CV 7125