BOTANICAL INVENTORY AND CONSERVATION ASSESSMENT OF SIEMPRE VERDE RESERVE, IMBABURA PROVINCE, ECUADOR

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ABSTRACT

Siempre Verde Reserve is located in Imbabura Province, Ecuador, in the northwestern Andes within the "Chocó-Andean Corridor" and occupies an area of 504 ha, ranging in elevation from about 2300 to 3500 m. It is privately owned by the Lovett School, originally purchased in 1992 to construct a research center and to protect one of the few remaining tracts of undisturbed cloud forest in the region. It was legally established as a "bosque protector" by the Ecuadorian government in 1994. A study was initiated in April, 2016, to inventory the flora and assess the conservation value of the site by collecting botanical specimens and by evaluating prior and on-going studies on the flora and fauna of the site. The resulting study documents 408 taxa of vascular plants, including 42 pteridophytes, 1 gymnosperm, and 365 angiosperms. Of the angiosperms, 47 are Monocots, 24 are Magnoliids and Chloranthales, and 294 are Eudicots. Included in the list are 40 taxa endemic to Ecuador and 97 taxa on the IUCN Red List of Threatened Species. Previous and on-going studies indicate a high diversity of orchids, epiphytes, and a rich fauna, including many plant-animal associations involving bats, birds, and insects. Some of Ecuador's most charismatic and threatened animals are known from Siempre Verde, including the spectacled bear, the puma, the olinguito, and at least nine species of bats. Much of the lower elevations along the river and around the building sites have been highly disturbed, but the higher elevations are still occupied by mature forest, with "elfin" forest at the higher sites. In comparisons with the tree and shrub species of other selected cloud forest studies in the region it was found that Siempre Verde shares 41% to 68% of the genera and 14% to 28% of the species for the lower montane zone, and 73% to 87% of the genera and 22% to 42% of the species for the upper montane zone. Notably, there are 30 genera and 144 species at Siempre Verde not found at any other of the 14 sites selected. Several non-native plant species were found, but none were particularly invasive. These results suggest that a rich flora exists at Siempre Verde, and that the Reserve harbors a unique combination of species unlike other similar cloud forest sites, providing evidence of the high conservation value of the site. Already a part of Ecuador's private forest reserve system, Siempre Verde Reserve is located in a region facing increasing threats from mining activities and climate change, and like other cloud forest sites in the region, faces a precarious future. This study summarizes the biological richness at the site, highlights the uniqueness of the Siempre Verde Reserve, and provides an important tool for decision-making and conservation policy.

RESUMEN

La Reserva Siempre Verde está ubicada en la provincia de Imbabura, Ecuador, en los Andes noroccidentales dentro del "Corredor Chocó-Andino" y abarca un área de 504 ha entre 2300 a 3500 m de elevación. La reserva es propiedad privada de Lovett School, originalmente adquirida en 1992 para construir un centro de investigación y proteger una de las pocas extensiones remanentes de bosque nublado intacto en la región. El gobierno ecuatoriano lo reconoció legalmente como un "bosque y vegetación protectora" (BVP) en 1994. En abril de 2016 se inició un estudio para evaluar el valor de conservación del sitio mediante la recolección de especímenes botánicos y la evaluación de estudios previos y en curso sobre su flora y fauna. El presente estudio documentó 408 taxones de plantas vasculares, entre ellos 42 pteridofitos, 1 gimnosperma y 365 angiospermas. Entre las angiospermas, 47 son monocotiledóneas, 24 son Magnolidae y Chloranthales, 294 son Eudicotiledóneas. En la lista se incluyen 40 taxones endémicos de Ecuador y 97 taxones catalogados en la Lista Roja de Especies Amenazadas de la UICN. Estos resultados indican una alta diversidad de orquídeas, epífitas y una rica fauna, que incluye muchas

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asociaciones entre plantas y animales como murciélagos, aves e insectos. Algunos de los animales más carismáticos y amenazados de Ecuador se han registrado en Siempre Verde, como son el oso de anteojos, el puma, el olinguito y al menos nueve especies de murciélagos. Gran parte de las elevaciones más bajas a lo largo del río y alrededor de las facilidades logísticas han sido perturbadas, pero las elevaciones más altas están ocupadas por bosques primarios no perturbados, y con bosques "enanos" en el punto más alto. Comparaciones entre las especies arbóreas y arbustivas de otras localidades con bosque nublado seleccionadas de la región, se encontró que Siempre Verde comparte del 41% al 68% de los géneros y del 14% al 28% de las especies para la zona montana baja, y del 73% al 87% de los géneros. y 22% a 42% de las especies para la zona montana alta. Es de destacar que, 30 géneros y 144 especies de Siempre Verde no se encontraron en ninguno de los otros 14 sitios seleccionados. Se encontraron varias especies de plantas no nativas, pero ninguna fue particularmente invasiva. Estos resultados sugieren que existe una flora muy rica en Siempre Verde y que la reserva a berga una combinación única de especies a diferencia de los otros sitios de bosque nublado similares, lo que proporciona una evidencia del alto valor de conservación del sitio. A pesar de ser parte del sistema de reservas forestales privadas del Ecuador, la Reserva Siempre Verde está situada en una región que enfrenta amenazas crecientes por las actividades mineras y el cambio climático y, al igual que los otros bosque nublados en la región, enfrenta un futuro incierto. Este estudio resume la riqueza biológica y resalta las características únicas de la Reserva Siempre Verde; además, provee una importante herramienta para la toma de decisiones y políticas de conservación.

INTRODUCTION

The Siempre Verde Reserve (SVR, hereafter) is a 504-hectare private nature reserve near the community of Santa Rosa, Imbabura Province, Ecuador, about 23 km northwest of Otavalo. The property is owned by the Lovett School, an educational institution in Atlanta, Georgia, U.S.A. The first lands were purchased in 1992 to create a protected reserve and establish a research center for the Lovett School, and additional property was added later. SVR was legally established in Ecuador in 1994 as a "bosque protector," dedicated to the conservation of Ecuadorian biodiversity and the sustainable use of natural resources in perpetuity. SVR encompassed 330 ha until 2019, when the Ecuadorian government annexed an additional 174 ha for the reserve, including higher elevations to the southeast. The unique location and high biological richness offer national and international students many opportunities for research and cultural experiences. SVR regularly hosts groups of students from the United States, mainly during June, July, and October, and also offers programs for students from nearby towns during the remainder of the year.

SVR is located within the "Chocó-Andean Corridor," an internationally recognized "hot spot" of biodiversity and endemism. In this region much of the habitats and original vegetation have been lost due to agriculture, urbanization, and other human activities (Roy et al. 2018). These "hot spots" are especially significant for preserving biodiversity, and the few remaining intact forests in these regions provide valuable study sites for baseline investigations of the flora and fauna (Marchese 2015; Myers et al. 2000).

There has been no comprehensive floristic study of the vascular plants at SVR, although some studies of the vegetation and particular plant groups have been carried out in recent years (Bucalo 2016; Jiménez-Paz 2016; Jiménez-Paz et al. 2021; Reynolds 2022; Worthy 2016; Worthy et al. 2019, 2022; Zapata-Blanco 2019), as well as collecting of herbarium specimens by Grady L. Webster and associates, Lorena Endara, Nathan Muchhala, Álvaro J. Pérez and associates, and Rosa Jiménez-Paz (see Appendix 1 for details). In addition, since 2019, almost 1,000 plant observations have been uploaded to iNaturalist (www.inaturalist.org), as a method of systematic documentation of photographic evidence across all taxa at SVR.

Study Area

SVR is located on the western slopes of the Andes Mountains, about 4.5 hours northwest of Quito, at elevations of about 2300 to 3500 m (Fig. 1). At the time of this 2016 field study, the reserve encompassed 330 ha at elevations of 2300 to 3300 m, and it is this portion of the site on which the study was focused. The site is south of the Toabunchi River and west of the Cotacachi Volcano. The river forms the northern and western boundaries of the property, and boundaries to the southwest and east are formed by smaller unnamed tributaries. A waterfall of approximately 15 m in height is formed by the Quebrada Honda in the northern portion of the property. The northernmost point on the property is along the river at 0.37658° and 78.4254° at 2400 m, and the southernmost point is along the edge of the recently annexed property at around 0.3536° and 78.3961°, at about 3500 m. The former high point of the property was near the overlook, El Mirador, at 0.3597° and 78.4108°, at about 3300 m. The Robert and Connie Braddy Research Center (Fig. 2) built on the property is at

Fig. 1. Map of Siempre Verde Reserve, Imbabura Province, Ecuador. Map projection: WGS84, UTM 17S; Source material: Cartotecnia, JAXA, ESRI, Google, GPS tracking; GIS Work by Dean Hardy; adapted from Google Earth by Alex Reynolds.

Fig. 2. Robert and Connie Braddy Research Center at Siempre Verde Reserve. Photo by Alex Reynolds, 2022.

2470 m, coordinates 0.37168° and 78.42168°. The bordering properties include several private protected forests, such as the Altochoco and Árbol Lindo reserves. SVR is contiguous to the Cotacachi-Cayapas Ecological Reserve, one of the largest reserves in Ecuador's SNAP (Sistema Nacional de Áreas Protegidas).

The plant communities include lower montane rain forest and upper montane rain forest, as described by Harling (1979) (see Discussion), with the lower elevations having been previously disturbed by agricultural activities, and including riverside vegetation, fields, and open areas with buildings and bamboo thickets. The upper montane elevations at the site show little evidence of disturbance, and approximately 95% of SVR is covered by mature forest. The uppermost sites can be characterized as "elfin" forest, with trees of low heights and thickly covered by a high abundance of epiphytes (Fig. 3). There are two main hiking trails: 1) the Waterfall Trail, from the station to an unnamed waterfall at about 2700 m, and 2) the Arriba Trail, which extends from the lodge to the overlook, "El Mirador." at about 3300 m (Fig. 4). In addition, there are three shorter trails, the Crossroads Trail which connects the Waterfall Trail to the Arriba Trail, the River Trail, which connects the Waterfall Trail to the river, and the River Loop Trail which connects the River Trail to the entry road leading to the staff cabin. There is also a recently opened trail, the Sendero al Paramo, extending along newly acquired property to the southeast of El Mirador to the highest point on the reserve at 3520 m. In total, the established trail network covers approximately 8.7 km (5.4 mi).

The soils are classified as Inceptisols, suborder Andepts, described as of volcanic ash origin, with appreciable content of amorphous clays and high amounts of pyroclastic material, and these develop, with weathering, into loam to silty loam, rich in organic material, with acidic pH and low fertility (PRONAREG 1984).

Meteorological data from SVR has been gathered for several years from weather stations near the lodge and near El Mirador (Reynolds 2011). The rainy season usually extends from October to May, and the dry season from June to September. Yearly rainfall varies from 2500 mm to 2700 mm, with highest rainfall in December and lowest in August. The average daytime temperature is 19°C (66°F) and the average nighttime temperature is 10°C (50°F) at the lower elevations. At the highest elevations the temperatures vary from 4.5°C (40°F) at night to 18°C (64°F) during the day, and the precipitation is similar to that of lower elevations.

Several surveys of the animal populations at SVR indicate that a rich assemblage of fauna exists at the site (Reynolds 2011). Over 200 species of birds have been recorded for the site, including the plate-billed mountain toucan (*Andigena laminirostris*), toucan barbet (*Semnornis ramphastinus*), and over 15 species of hummingbirds, such as the Collared Inca (*Coeligena torquata*). Mammals include the spectacled bear, the puma, the recently described olinguito (*Bassaricyon neblina*), and at least nine species of bats. No formal entomological surveys have been performed; however, a diverse assemblage of moths and butterflies has been documented, including significant pollinator species (A. Reynolds, pers. comm.).

The goals of this study were: 1) conduct a floristic inventory of SVR, focused primarily on woody plants, including trees, shrubs, woody vines, and epiphytes; 2) survey and evaluate herbarium specimens previously collected from the site and review all previous botanically-related studies at SVR; 3) compare the similarities and differences of SVR with other representative sites; and 4) assess the conservation value of SVR. Pteridophytes, orchids, bromeliads, and herbaceous species were not particularly targeted during the 2016 study, although some collections were made of more conspicuous or notable species, and previous collections from SVR of species in these groups and housed at the herbarium at Pontificia Universidad Católica del Ecuador (QCA hereafter) were included in the final species listing.

METHODS

Specimens were collected by RLJ between April 7 and August 31, 2016 using standard herbarium techniques for the preparation of botanical vouchers. Numerous photographs were taken in the field, and additional photographs were taken during the pressing process. A total of 436 sets of specimens were transported to the QCA herbarium, with a complete primary set deposited at QCA, and one set of Melastomataceae specimens deposited at the National Herbarium of Ecuador (QCNE). Two complete sets of specimens were shipped to the United States, but these sets were lost after arriving in Miami in December 2016, between the U.S. Parcel Service and

Fig. 3. Elfin forest at Siempre Verde Reserve, elevation 3270 m. Photo by Ronald Jones.

U.S. Customs. Despite numerous attempts over several months, the shipment of over 800 specimens was never recovered. Only the primary set of RLJ collections deposited at QCA and QCNE remain in existence.

Identification work involved the use of available keys, especially the 97 volumes of Flora of Ecuador (Harling et al. 1973–2020). Gentry (1993) and Keller (2004) were also invaluable resources. Comparisons with available specimens at QCA and QCNE were conducted, and searches for similar specimens at QCA were greatly facilitated by the use of the herbarium database, https://bioweb.bio/portal/, which includes images in many cases. The websites for neotropical herbarium specimens (https://collections-botany.fieldmuseum.org/) at the Chicago Field Museum and for Tropicos (https://www.tropicos.org/home) at Missouri Botanical Garden were also very helpful. Questions concerning the correct binomial nomenclature were resolved by consulting with authorities or by referring to POWO (2022). Family names follow the Angiosperm Phylogeny Group (Stevens 2001 onwards) and the Pteridophyte Phylogeny Group (PPG 2016).

In addition, all SVR collections prior to 2016 at QCA were pulled to check for additions to the flora. These studies began in 2016 but identification work was not completed. RLJ returned to Quito in summer, 2022, and continued the work on identification of SVR specimens at QCA, including about 130 specimens collected by Grady Webster and associates in 2004 that had never been processed. Specimens from the epiphytic study by Zapata-Blanco (2019), focusing chiefly on ferns, Araceae, and Orchidaceae, were not processed and labeled in time for inclusion in this study.

To determine similarities and differences, the flora of SVR was compared with that of 14 other cloud forest studies in the region. Two studies were chosen for overall comparisons, and 12 for comparing the woody plants at two elevational zones.

Fig. 4. RLJ collecting amongst *Puya* on steep slope below El Mirador at 3300 m. Photo by Nelson Ruiz.

RESULTS

Appendix 1 provides a complete list of all 408 taxa documented from SVR, and each listing includes collectors, collection numbers, habit, habitat, and endemic status, as well as an indication of their presence at other similar sites. All but 29 taxa are identified to species. Included are 105 families and 233 genera. The totals for the groupings are as follows: 42 pteridophytes, one gymnosperm, and 365 angiosperms. Of the 42 pteridophytes, eight were tree ferns and three were climbing ferns. Of the angiosperm taxa, there are 47 in the monocot families, 24 in the early diverging angiosperm lineages, and 294 in the eudicot families. Among the monocots there was one species each for the Arecaceae, Cyclanthaceae, Dioscoreaceae, and Zingiberaceae. Of the remaining monocots, there were five tall/woody grasses, four vines/lianas, six terrestrial or epiphytic bromeliads, and 28 terrestrial or epiphytic orchids. Of the remaining angiosperms, there were 90 trees, 131 small trees or shrubs, 77 lianas, vines, or epiphytes, 19 non-climbing herbs, and one holoparasite.

The most speciose families are Asteraceae (29), Orchidaceae (28), Rubiaceae (26), Melastomataceae (23), Ericaceae (22), Solanaceae (18), Gesneriaceae (13), Piperaceae (12), Urticaceae (10), and Clusiaceae (8). Genera with five or more taxa are *Miconia* (10), *Solanum* (9), *Palicourea* (7), *Piper* (7), *Weinmannia* (7), *Lepanthes* (6), *Psammisia* (6), *Begonia* (5), *Centropogon* (5), *Cyathea* (5), *Mikania* (5), *Passiflora* (5), and *Peperomia* (5).

The fern flora provided a number of notable collections. Several species of Cyathaceae grew in the immediate vicinity of the station, including: *Cyathea conjugata*, *C. cystolepis*, *C. planadae*, and *Sphaeropteris quindiuensis*. *Cyathea caracasana* was only found at the higher elevations. Only one site was found for *Alsophila erinacea*, on the path recently cut above the waterfall. *Dicksonia karsteniana* grew in several places in the lower sections of the Arriba Trail. Other large and notable ferns included *Pteridium arachnoideum* and *Eupodium* *pittieri*, both occurring near the beginning of the Waterfall Trail. Both species of *Equisetum* were found growing in close proximity, among boulders and gravel islands in the river bed.

Gymnosperms, Arecaceae, Cyclanthaceae, and Zingiberaceae were represented by only one species for each of these groups on the property. *Podocarpus oleifolius* was found on the path above the waterfall, and this was the only known tree on the property (N. Ruiz, pers. comm.). Several immature specimens of Andean wax palm, *Ceroxylon* cf. *parvifrons*, were observed along the upper section of the Arriba Trail and more mature specimens could be seen in the distance from the highest point on the property at El Mirador. Several sites were found along the lower elevation trails for *Sphaeradenia horrida* and *Renealmia fragilis*.

The common bamboo that dominates much of the open, disturbed areas and occurs as undergrowth at the lower elevations of the property was identified as *Chusquea scandens*, but some plants may represent a yet undescribed species (see Novelties). The tall bamboo near the stream at the junction of the river trail with the main road to SVR is *Chusquea macclurei*, an endemic species listed as vulnerable in Ecuador. The largest bamboo, found in the middle section of the Arriba Trail is *Chusquea* cf. *lehmannii*, and is commonly used for building materials (N. Ruiz, pers. comm.).

Only a few bromeliads were documented, including *Guzmania gloriosa*, *G. multiflora*, and *Gregbrownia lyman-smithii*, all growing along the path between the staff cabin and the lodge. Two species of *Pitcairnia* occurred at lower to mid elevations, and *Puya glomerifera* was found only at the highest elevations near El Mirador. Many additional epiphytic species of Bromeliaceae occur on the property, and these were the subject of the recent study by Zapata-Blanco (2019).

Twenty-eight species of orchids are listed in Appendix 1; these are the only ones from SVR that are identified to species and deposited at QCA; there are twelve additional orchid specimens from SVR deposited at QCA that are not fully identified. Many other collections have been made in conjunction with several research projects (noted above) but these specimens have not been labeled, databased, and deposited in the herbarium. There are 146 orchid specimens from SVR and environs listed and imaged on the BOLD website, https://www.boldsystems.org/index.php/; ninety-five of these specimens are identified to species and 51 to genus. Over 200 orchid species have been observed at SVR, many of which are illustrated with color photographs in Reynolds (2022).

A literature review on the status of plant-animal associations at SVR is presented below in Discussion.

Rare and Endemic Species, and Species Underrepresented in QCA

About 24% of the 408 listed species for SVR, a total of 97 taxa, are listed in IUCN (2022). There is 1 Data Deficient, 14 Near Threatened, 17 Vulnerable, 62 Least Concern, 2 Endangered (*Axinaea sodiroi* and *Hoffmannia ecuatoriana*), and 1 listed as Extinct (*Casearia quinduensis*), and these categories are so indicated in Appendix 1). Forty species are endemic to Ecuador (León-Yánez et al. 2011), and are so indicated in Appendix 1. Four of the 28 species of Orchidaceae are listed as threatened in Ecuador and seven are endemic. SVR collections have provided the following additional records for species with limited collections at QCA (four or fewer records): first records for *Cayaponia simplicifolia, Clusia salvinii, Cranichis diphylla, Cyathea planadae, Lepanthes columbar, L. stupenda, L. urotepala, Mikania discifera, M. multinervia, Ocotea* cf. *ceronii, Piper serrulatum, Pleurothallis carduela,* and *P. ripleyi;* second records for *Critoniopsis palaciosii, Glossoloma subglabrum, Lepanthes tachirensis, Piper cornifolium, Restrepiopsis viridula, Solanum fallax*, and *Telipogon williamsii*; third records for *Axinaea sodiroi, Casearia quinduensis, Mikania iodotricha, Pleurothallis dunstervillei, Prescottii stachyodes*, and *Xylobium pallidiflorum*; fourth records for *Cyathea delgadii, C. mettenii, Impatiens sodenii, Lepanthes magnifica, Meriania peltata, Pilea obetiifolia, Piper lunulibracteatum, Smilax tomentosa, Specklinia grobyi*, and *Zanthoxylum quinduense*, fourth and fifth records of *Myrcia* cf. *crassimarginata/fallax*, and the fifth records for *Pilea* cf. *fallax*, *Piper ecuadorense* and *Pseudogynoxys sodiroi*. The only record for *Fernandezia sanguinea* prior to these collections from SVR was from elsewhere in Imbabura Province in 1980. The collection of *Mikania discifera* is the second collection for Ecuador, known previously only from a 1996 collection in Carchi Province at 2740 m. These recent collections provide valuable information for future reassessments of the conservation status of these species.

Only a few plant species identified at SVR are not native to Ecuador, these species listed as such by Jørgensen & León-Yánez (1999): *Cynoglossum amabile*, an herb growing along the path at the entrance near the creek; *Nasturtium officinale*, an herb of wet sites, and *Phaseolus coccineus*, an escape from cultivation. The *Impatiens* species growing around the lodge and on the roofs of buildings was initially misidentified in 2016. Further comparisons in 2022 to specimens at QCA and QCNE confirmed that it was actually *I. sodinii*, an African species, somewhat succulent and shrublike, to 1.5 m, with whorled leaves; there were only a few specimens of this species at QCA and QCNE. None of these non-native species appeared to be particularly problematic; the most invasive species of the property are native: *Anredera baselloides*, an herbaceous vine growing in the field along the river path, *Chusquea scandens* and related species, covering many hectares of the property, and *Pteridium arachnoideum*, spreading from a site at the beginning of the Waterfall Trail.

DISCUSSION

Novelties (recently described, undescribed, and problematic species at SVR)

The SVR flora includes species of *Podandrogyne* and *Ocotea* that have been only recently described. Collections of specimens in the genus *Podandrogyne* in 2016 were identified as *P. brevipedunculata* Cochrane, but later consultations with T. Cochrane and X. Cornejo confirmed that two different taxa were present, and these specimens should be included in their two newly described species, *P. flammula* and *P. websteri* (Cochrane & Cornejo 2020). Two collections from 2016 of *Ocotea* were originally identified as *O. sericea* Kunth, these specimens characterized by dense red pubescence on the foliage, terminal leaves were folded lengthwise, and the leaf bases downwardly revolute at the base and nearly sessile. After further studies in 2022 and consultation with H. van der Werff, it was concluded that the most likely name to be associated with these specimens was his recently described *O. ceronii* (van der Werff 2020). The cited specimens in this paper were all from Pichincha Province, 1500 to 1800 m, including one at QCA (*Á.J. Pérez # 4996*), so these SVR records are the first from Imbabura Province, and from a higher elevation.

The SVR flora also includes specimens of *Chusquea*, *Clusia*, *Faramea*, and *Piper* that may represent undescribed species. The mountain bamboo grasses on the property, *Chusquea* sp., include plants that are typical of *C. scandens*, but collections from some populations likely represent an undescribed species (L. Clark, pers. comm.). The specimens of *Clusia* also presented identification problems. An attempt was made to match up these *Clusia* collections with known species, but some are likely undescribed species (M. Gustafsson, pers. comm.). The sap in these plants varied from cream to bright yellow, the stigma numbers were 4, 6, or 8, and the fruits from spherical to elliptic. In addition, some specimens of *Faramea* collected in 2016 may be from an undescribed species related to *F. calyptrata* (C. Taylor, pers. comm.), and a specimen of *Piper* collected along the river may represent an undescribed species (R. Callejas Posada, pers. comm.)

Four other trees, one a member of the Myrtaceae, one a member of the Salicaceae, one the only known species of Arecaceae on site, and one from an undetermined family, have presented particularly problematic questions. The "chuagola" tree (this same common name was reported from two different geographic areas in the region) with orangish-scaly bark and clearly in the Myrtaceae, was identified as *Myrcianthes rhopaloides* in the first tree surveys at SVR (Jiménez-Paz 2016), and was the prevalent species in the lower elevation transects. Later studies and consultation with authorities (L. Kawasaki, B. Holst) have determined that it was a *Myrcia*, but the species remains uncertain. In addition to the collections of this taxon from SVR (see Appendix 1), there are several other collections at QCA of this taxon from the region, including specimens collected by Á.J. Pérez (*# 10943* and *# 11013*), from Imbabura Province, and one by M. Buenaño and associates. (*# 262*), from Carchi Province. These collections from outside SVR are all from elevations below 1700 m. Additional studies in 2022 and further advice from authorities suggested that this taxon was closely related to *M. crassimarginata*, a species of the Amazon basin, or *M. fallax*, an Andean species. It will key to *M. fallax* in Kawasaki et al. (2019), but with notable differences in the fruit, which are more elliptic and strongly ribbed, and much larger, to 3 cm long, and the foliage is very similar to that of the red-listed *M. crassimarginata* (Fig. 5). These taxa are in one of the largest and most difficult group of species in Myrtaceae, often without clear differences to separate taxa

(L. Kawasaki, pers. comm.). It is herein listed as *Myrcia* cf. *crassimarginata/fallax*, but the matter remains unresolved.

An unusually large-fruited specimen of *Casearia* was collected at the lower elevations, on the River Trail (Fig. 6). The fruit was up to 3 cm thick, yellowish and pulpy, and the local name for this small tree was "huzabillo" (N. Ruiz, pers. comm.). Photos of foliage and fruit were sent to two authorities (M. Alford, R. Liesner), and both suggested that *C. quinduensis* was a good possibility, but neither was 100% certain. This species is listed as Extinct in the IUCN Red List (2022). Additional investigation is certainly warranted with the possibility of the rediscovery of an extinct species at SVR.

The *Ceroxylon* species encountered in the upper montane zone could not be positively identified. The only collection was of a juvenile specimen, as a mature specimen with flowers and fruits was not accessible. By referencing the monograph of the genus (Sanín & Galeano 2011), and by consulting with M.J. Sanín, it was determined that the mostly likely species at these high elevation sites at SVR was *C. parvifrons*.

Another puzzling collection was from a tree with opposite, palmately compound leaves with three to five leaflets, located near the staff cabin at about 2400 m. It could not be placed with any of the usual suspects—Bignoniaceae, Sapindaceae, or Verbenaceae. The leaves were most similar to *Billia,* but species in this genus are not known to have five leaflets, and the petiolules were not elongate as in most of the Bignoniaceae (Fig. 7). Some *Vitex* are generally similar in leaflet morphology, but other foliage features were notably different. RLJ planned to visit the site again in summer 2022, for more observations and collections of this and other species, but these plans were thwarted by the political uprisings in which roads to the north of Quito were blocked. No flowers or fruits have been observed, and it is hoped that monitoring of the tree by the SVR staff will uncover more information on the identity of this species.

Elevational Comparisons at SVR

The elevational changes in plant communities at SVR have been the subject of several investigations prior to this current study. Jiménez-Paz (2016) and Jiménez-Paz et al. (2021) reported the results of transect analyses of tree species at three elevational ranges, concluding that basal area decreased with elevation, that alpha diversity peaked at mid-elevation, and that beta diversity increased with distance between plots along elevation. Worthy (2016) and Worthy et al. (2019) analyzed selected gene regions from 70 species from these elevational ranges and found that species diversity decreases with elevation but that there was a stronger phylogenetic clustering at higher elevations, indicating more closely related angiosperms at the higher elevations.

In these previous studies it was reported that the prevalent tree at the lower elevations (2400–2700 m) was *Myrcianthes rhopaloides*, later identified as a species of *Myrcia* (see Novelties, above), followed by other taxa of more of similar importance: *Faramea calyptrata, Ficus dulciaria, Guarea kunthiana*, and *Blakea* cf. *acuminata*, as well as species of *Clusia*, *Cyathea*, *Ocotea*. Other tree species documented from this elevation as part of the current study included: *Brunellia acostae*, *Cecropia* (3 spp.), *Cinchona pubescens*, *Dendrophorbium lloense*, *Myrsine coriacea*, *Saurauia* (2 spp.), and *Weinmannia* (2 spp.). Smaller trees and shrubs at the lower SVR elevations included *Blakea* (2 spp.), *Vasconcellea pubescens*, *Cavendishia bracteata, Coriaria ruscifolia, Drymonia teuscheri, Fuchsia* (3 spp.), *Hedyosmum scabrum, Palicourea* (6 spp.), *Piper* (6 spp.), *Podandrogyne* (2 spp.), *Psychotria* (3 spp.), and *Solanum* (8 spp.). Lianas, vines, and epiphytes were abundant, especially species of *Begonia*, *Bomarea*, *Centropogon*, *Lepanthes* and other species of Orchidaceae, *Mikania* and other Asteraceae, *Passiflora*, *Psammisia* and other species of Ericaceae.

The river corridor and open fields at SVR have not been subjected to previous collecting studies. During the current study the following species were collected along the river at about 2400 m: trees included *Clusia* cf. *multiflora*, *Escallonia paniculata, Freziera tomentosa, Hedyosmum scabrum, Morella pubescens, Rhamnus granulosa*, and *Weinmannia polyphylla*; shrubs, lianas, and epiphytes included *Begonia segregata*, *Calceolaria pedunculata*, *Colignonia ovalifolia, Heppiella ulmifolia, Munnozia senecionidis, Piper* (3 spp.), *and Psammisia* (3 spp.). In the open fields along the River Loop Trail at about 2450 m the following species were documented: *Baccharis latifolia, Castilleja arvensis, Delostoma integrifolia, Gunnera brephogea, Inga insignis, Lepechinia vesciculosa,*

Fig. 5. *Myrcia* specimen, (RLJ # 11153) of unresolved identity. Photo by Ronald Jones.

Monnina (2 spp.), *Monochaetum* (2 spp.), *Pseudogynoxys sodiroi, Rubus* (2 spp.), *Sida poeppigiana, Solanum* (2 spp.), *Tropaeolum adpressum,* and *Cissus* (2 spp.).

At middle elevations (2700–3100 m) the prevalent tree species according to Jiménez-Paz et al. (2021) was *Gordonia fruticosa*, with several other species of similar importance, including *Hedyosmum cuatrecazanum*, *Ternstroemia lehmannii*, *Blakea* cf. *acuminata*, and *Weinmannia lenticifolia*. Other species documented in this current study included: *Alsophila erinacea*, *Brunellia tomentosa, Chusquea* cf. *lehmannii*, *Citharexylum montanum*, *Clusia* cf. *ducu, Cyathea delgadii, Daphnopsis equatorialis, Fuchsia dependens, Meliosma frondosa, Meriania* (2 spp.), *Podocarpus oleifolius, Siparuna piloso-lepidota,* and *Styrax cordatus*.

At higher elevations (3100–3300 m), corresponding to the elfin forest and adjacent forested areas, the prevalent tree species according to Jiménez-Paz et al. (2021) was *Weinmannia rollottii*, followed by *Freziera verrucosa*, *Cyathea* sp., *Weinmannia pinnata*, *Ilex hualgayoca*, *Prunus huantensis*, *Geissanthus andinus*, *Weinmannia auriculata*, and *Escallonia myrtilloides*. Other canopy species documented during the current study from this highest elevation included: *Freziera canescens, Gordonia fruticosa, Hedyosmum strigosum, Miconia corymbiformis, Oreopanax floribundus, Ruagea pubescens, Sciodaphyllum sodiroi, and Viburnum pichinchense.* Ferns included *Blechnum fragile and Cyathea caracasana* and notable vines were *Hydrocotyle hexagona* and *Viola scandens*.

In the shrub-dominated areas around El Mirador at about 3300 m the following species were collected: *Arcyctophyllum* cf. *capitatum, Baccharis genistelloides, Brachyotum lindenii, Clethra ovalifolia, Columellia oblonga, Dendrophthora chrysostachya, Diplostephium floribundum, D. hartwegii, Eriosorus flexuosus, Gaultheria* (3 spp.), *Gynoxys acostae, Macleania* (2 spp.), *Mikania discifera, Sphyrospermum* cf. *boekii*, and *Sticherus revolutus*. Below the overlook *Achyrocline alata* and *Puya glomerifera* occurred on the steep unforested slope, and mature

Fig. 6. *Casearia specimen*, (RLJ 11016), identified as *C. quinduensis*, declared extinct in IUCN (2022). Photo by Ronald Jones.

Ceroxylon palms could be observed on the distant ridges. Higher elevations to the southeast of El Mirador were only recently acquired, and were not included in this study.

Regional Comparisons

Various terms have been presented for montane forests or cloud forests. Harling (1979) classified the vegetation on the western Andean slopes of Ecuador between 700 and 2500 m as "lower montane rain forest" and the vegetation from 2500 m to the upper limit of closed forest (3400 to 3600 m) as "upper montane rain forest." The term "cloud forest" (local names include *bosque nublado* or *ceja andina*), can also be applied to both vegetation regions, but more consistently relates to the upper elevations (Neill 1999). Webster (1995) also used Harling's terms for lower and upper montane rain forest, with similar elevational limits, but noted that the elevational dividing line between upper and lower vegetation types may vary based on rainfall and other factors. In a more recent vegetation classification for the country (MAE 2013), the lower elevation region is classified as "*Bosque siempreverde montano de Cordillera Occidental de los Andes*" and the upper region as "*Bosque siempreverde montano alto de Cordillera Occidental de los Andes*." Neill (1999) listed several SVR species as important components of the lower montane rain forest of the w. Andes, including *Ruagea pubescens*, *Meriania tomentosa*, and *Cinchona pubescens*, and for the upper montane rain forest throughout the Andes, the following SVR species were mentioned: *Sciodaphyllum sodiroi*, *Weinmannia pinnata*, *Clusia flaviflora*, *Gynoxys acostae*, and *Escallonia myrtilloides*.

Ulloa Ulloa and Jørgensen (1993) provided an overall treatment for the genera of trees and shrubs in the Andes. They observed that the level of 2300–2500 m of altitude is the "natural" limit of maximum

Fig. 7. Tree (RLJ 11375) of unknown family. Photo by Ronald Jones.

distribution of several families, genera and species that disappear upwards, and used this range of elevation to delimit, in a broad sense, two types of vegetation: sub-Andean and Andean. They noted that these boundaries are obviously very variable and depend on numerous topographic, climatic, soil, and human factors. In the transition zone from 2300–2500, a number of genera can be found that are more typical of lower elevations, such as the SVR genera *Alsophila*, *Beilschmiedia*, *Cecropia*, *Erythrina*, *Tetrorchidium*, and *Tovaria*. The forests of higher elevation from 2500 to 3000 m are characterized by medium-sized trees of about 15 m tall with the trunks often covered by epiphytic vegetation. SVR genera mentioned for these sites included *Aegiphila*, *Brunellia*, *Ceroxylon*, *Chusquea*, *Cinchona*, *Cyathea*, *Dicksonia*, *Freziera*, *Hedyosmum*, *Ilex*, *Meliosma*, *Miconia*, *Ocotea*, *Palicourea*, *Saurauia*, *Tournefortia,* and *Weinmannia*. At the highest elevations of forest cover, between 3000 and 3400 m, the trees are even smaller, only 6–9 m high, with twisted or multiple trunks, these nearly completely covered by epiphytes. Characteristic SVR woody genera for this elevation are *Clethra*, *Columellia*, *Escallonia*, *Gordonia*, *Gynoxys*, *Hesperomeles*, *Styrax*, *Symplocos*, and *Weinmannia*. Above 3400 m in the Andes the forests become more fragmented, often with *Polylepis* spp., or transitions to paramo vegetation. These community types are absent from SVR, although several species more associated with paramo have been observed along recently acquired property to the southeast of El Mirador.

The discussion that follows provides a more detailed account of the similarities and differences between SVR and other cloud forest sites in the region (see Tables 1 and 2 for citations and locations). Because trees and shrubs were the most frequently studied groups at these sites, and were the main focus of this SVR study, it is these groups that are used for more detailed analyses of the floras (Tables 1 and 2). In these tables the species at SVR are divided into those below 2700 m (Table 1) and above 2700 m (Table 2) for a more accurate

Table 1. A comparison of tree and shrub species below 2700 m at Siempre Verde Reserve with other similar sites.

Site	Distance from SVR	Area < 2700 m	Elevation (m)	Annual Rainfall	No. tree and shrub species < 2700 m	No. tree and shrub species shared with SVR	% tree and shrub species shared with SVR	No. tree and shrub genera < 2700 m	No. woody genera plant shared with SVR	% tree and shrub genera shared with SVR
SVR	0	144 ha	2300–2700	2500–2800 mm	131	–		85	–	–
MAQU (Webster & Rhode 2001)	38 km SW	4500 ha	1150–2750	ca. 3000 mm	534	88	16.5%	202	83	41.1%
INTAG (Wilson & Rhemtulla 2018)	40– 45 km SW	730 ha	1960–2060	1500–3300 mm	76	14	18.4%	50	32	64%
JUNIN (Wilson & Rhemtulla 2018)	40–45 km SW	1500 ha	2040–2150	1500–3300 mm	110	15	13.6%	82	44	53.7%
LOS CEDROS (Wilson &Rhemtulla 2018)	40–45 km SW	6880 ha	1950–2100	1500–3300 mm	94	22	23.4%	61	33	54.1%
SANTA LUCIA (Wilson &Rhemtulla 2018)	40–45 km SW	780 ha	2000–2150	1500–3000 mm	54	15	27.8%	47	32	68.1%

Table 2. A comparison of tree and shrub species above 2700 m at Siempre Verde Reserve with other similar sites.

Site	Distance from SVR	Area > 2700 m (ha)	Elevation (m)	Rainfall in mm/year	No. tree and shrub species > 2700 m	No. tree and shrub species shared with SVR	% tree and shrub species shared with SVR	No. tree and shrub genera	No. tree and shrub genera shared with SVR	% tree and shrub genera shared shared with SVR
SVR	0	360 ha	2700–3300 m	2500–2700 mm	100	–	–	69	–	–
ALTO (Garzón & Aguirre. 2002)	adjacent	2500 ha	2700–2950 m	2500–2700 mm	26	11	42%	25	–	80%
APAQ (Cerón et al. 2006)	ca. 65 km NE	Area not specified	3000 & 3180 m (two separate sites)	500–1000 mm	64	21 (13 at one site, 6 at another, and 2 at both sites)	33%	46	–	80%
COTA (Peñafiel et al. 2006	12 km SE	Area not specified	2800–3400 m	1800–2800 mm	54	12	22%	46	–	70%
COTA (Young & Keating 2001)	10 km SE	270 ha	3330–3630 m	1000–1500 mm	28	7	25%	26	–	73.1%
CUIC (Peñafiel 2003)	10.5 km SE	827 ha	3100–3400 m	1255 mm	77	17	22%	51	–	72.9%
PASO (Cerón 2013)	ca. 90 km S	200 ha	3000–3400 m	1200 mm	68	25	37%	52	–	87%
PASO (Valencia & Jørgensen 1992)	ca. 90 km S	Area not specified	3260–3310 m		32	7	21.9%	29	–	76%

comparison with the other sites of similar elevation ranges. In each table, the distance from SVR, the size of the area, the elevation range, and the rainfall are given, in addition to species and generic comparisons. Two additional regions, the Pululahua volcano area (Cerón 2004), and a region of three sites in n. Ecuador, (Cuamacás and Tipaz 1995) are discussed in relation to an overall comparison of all species. All SVR species (trees, shrubs, and others) shared with these sites are indicated in Appendix 1.

Lower Montane Cloud Forest Sites

Table 1 provides a comparison of the tree and shrub floras of SVR, the Maquipucuna Reserve (Webster & Rhode 2001), and four sites in the Intag region (Wilson & Rhemtulla 2018). The flora of the Maquipucuna Reserve, (MAQU hereafter), is the most thoroughly studied flora of a lower montane rainforest on the western slopes of the Ecuadorian Andes. This 4,500 ha reserve includes elevations from 1100 to 2800 m and over 1600 taxa were documented, including expansive listings of groups that were not targeted at SVR (herbs, ferns, and the epiphytic arums, bromeliads, and orchids). With only about 3% of the land area of MAQU, the lower elevations of SVR have about 25% of the total tree and shrub species at MAQU and share about 17% of these species. In addition, the lower elevations of SVR have 41% of the genera of trees and shrubs at MAQU, and all the lower elevation SVR genera except two, *Morella* and *Rhamnus*, can be found at MAQU. The "dominant and abundant" tree and shrub species listed for MAQU between 1700 and 2750 m included the following species documented from low montane SVR: *Baccharis latifolia, Coriaria ruscifolia, Cornus peruviana, Dendrophorbium lloense, Fuchsia macrostigma, F. sessilifolia, Guarea kunthiana, Heppiella ulmifolia, Palicourea calothyrsus, Sapium stylare, Siparuna aspera*, and *S. echinata*. Genera common to both sites, but with different species present at MAQU, included *Casearia, Clethra, Hedyosmum, Miconia, Myrcianthes, Ocotea*, and *Nectandra*. Several tree genera at MAQU were not located at SVR, such as *Citronella*, *Stylogyne*, and *Eugenia*.

The riparian vegetation at MAQU occurred at a lower elevation (< 2000 m) than at SVR, and shared only a few species in common with riparian and lowest elevations at SVR. There were several common woody genera present at MAQU, but with different species present, such as species of *Blakea*, *Piper*, *Cecropia*, *Clusia*, *Ficus*, *Hoffmannia*, and *Siparuna*. Shared species included both species of *Equisetum*, *Erato polymnoides*, *Hydrangea peruviana*, *Pteris podophylla*, and *Rubus bolivianus*. Notable riverside species at MAQU such as *Alnus acuminata* and the tall grasses *Guadua angustifolia* and *Gynerium sagittatum* were not located at SVR.

The overall lower montane flora at SVR shows many similarities to the MAQU flora, as well as notable differences. About 41% (169/408) of the SVR species were also documented at MAQU (see Appendix 1). All of the top ten families listed above for SVR are among the top ten families for MAQU except the Clusiaceae, Ericaceae, and Urticaceae, and these three all have 20+ taxa at MAQU (when *Cecropia* is included in Urticaceae). Of chiefly woody plant families with at least six species at MAQU, only three, Bombacaceae (or Malvaceae/Bombacoideae), Lecythidaceae, and Marcgraviaceae were absent from SVR. Numerous families (30+), mostly herb-dominated or lower elevation groups) at MAQU were not documented at SVR, but only three SVR families were not documented at MAQU: Basellaceae, Myricaceae, and Podocarpaceae.

Many species and generic differences among the sites can be attributed to variation in disturbance history or to climate or elevational patterns. For example the more disturbed lower elevations of SVR share many of the second-growth species of MAQU, but MAQU monocot genera often associated with lower elevations, such as *Calathea*, *Costus*, *Furcraea*, and *Heliconia*, were not observed at SVR. Also, there were 11 species of Arecaceae at MAQU, and none at low montane elevations at SVR (one at the higher SVR elevation). Fewer than a dozen of the SVR species associated with the higher elevations and elfin forest were also found at MAQU, such as species of *Escallonia*, *Freziera*, *Gaultheria*, *Oreopanax*, *Prunus*, and *Viburnum*.

Wilson and Rhemtulla (2018) presented data from transect studies of woody plants at five sites in the Intag region (INTA, hereafter), these 40–45 km southwest of SVR. Four of these were selected for comparison with SVR because of similarities in area size and vegetation type, but all had elevation ranges from 150–400 m below the lowest elevations at SVR (Table 1). For the four listed INTA sites, the range in shared species with SVR was from 14%–23% and the range in shared genera was from 54%–68%. There were very few low montane SVR species listed among the top 30 most frequent species at these sites, but other SVR species occurred at lower frequencies. All shared species are indicated in Appendix 1. These INTA studies listed several chiefly woody families more associated with lowland rain forest floras, such as the Anacardiaceae, Annonaceae, Apocynaceae, Arecaceae, Dichapetalaceae, Lecythidaceae, and Myristicaceae, which were not represented at SVR except for one species of *Ceroxylon*, and there was a total of about 35 genera of trees and shrubs from these four sites that were not documented for SVR. Webster (1995) noted that only two woody leguminous genera were commonly found in cloud forests, *Erythrina* and *Inga*, and this was found to be true for these lower montane sites in INTA, MAQU, and SVR. Wilson and Rhemtulla (2018) concluded that even relatively small and closely located cloud forest sites can harbor quite different floras, possibly due to slight differences in geographic barriers and climatic variations, providing additional justification for preserving these sites.

Many SVR species were found to be present at the INTA sites and MAQU, especially at the latter site, but there were also many SVR species not found at the other sites. The following lower montane species are among those listed for SVR, MAQU and at least one of the INTA sites: *Blakea rotundifolia, Brunellia acostae, Cecropia maxima, Cestrum megalophyllum, Chrysochlamys colombiana, Escallonia myrtilloides, Faramea calyptrata, Guarea kunthiana, Myrcia* cf. *fallax* (or *M.* cf. *crassimarginata/fallax), Oreopanax palamophyllus, Siparuna piloso-lepidota*, and *Turpinia occidentalis*. There were also a number of upper montane SVR species listed for lower montane INTA and MAQU, some listed as dominant or abundant, including *Alsophila erinacea, Cyathea caracasana, Freziera canescens, Gaultheria foliolosa, G. insipida, G. myrsinoides, Geissanthus andinus, Gordonia fruticosa, Hedyosmum cuatrecazanum, Hieronyma macrocarpa, Meriania tomentosa, Oreopanax floribundus, Palicourea amethystina, Siparuna piloso-lepidota, Weinmannia auriculifera, W. lentiscifolia* and *Viburnum pichinchense*. It is quite possible that these species may also exist at lower montane SVR sites, just not yet detected. Wilson and Rhemtulla (2018) reported the number of unique species at each site varied from 43%–68%. For SVR, the number of unique tree and shrub species below 2700 m, when compared to these INTA sites and to MAQU, was 35% (45/130).

Upper Montane Cloud Forest Sites

For tree and shrub species composition above 2700 m, studies from the following sites were chosen for comparison with SVR: Alto Choco (Garzón & Aguirre 2002), Apaqui River/Carchi (Cerón et al. 2006), Cotacachi Volcano (Peñafiel et al. 2006; Young & Keating 2001), Cuichocha Lake (Peñafiel 2003), and Pasochoa Volcano (Valencia & Jørgensen 1992; Cerón 2013), as shown in Table 2 and Appendix 1. All of these sites were similar in elevation range to upper montane SVR, but some had less rain and most studies were more limited in scope.

The Altochoco Reserve (ALTO, hereafter) is the closest site to SVR, located just across the Toabunchi River. Sampling at 2700 m and 2950 m by Garzón and Aguirre (2002) produced a list of 26 taxa very comparable to higher elevations at SVR, with 42% of the species and 80% of the genera. The following SVR species were listed as among those with highest importance values at ALTO: *Gordonia fruticosa, Citharexylum montanum, Weinmannia pinnata, Miconia corymbiformis, Hedyosmum cuatrecazanum*, and *Rugaea pubescens*.

Cerón et al. (2006) sampled three sites in Apaqui River region of Carchi Province, about 65 km northeast, producing an overall species list of 149 species. This region has similar elevation to the highest sites at SVR, but less rainfall; two of the sites with more similar vegetation were chosen for comparison with SVR, those at Pisan and La Delicia, with a total of 64 species of trees and shrubs. These sites shared 33% of the SVR species and 80% of the genera. Among the most frequent taxa at these sites were these high elevation SVR species: *Chusquea* cf. *lehmannii, Diplostephium floribundum, Hesperomeles obtusifolius, Macleania rupestris, Weinmannia pinnata*; and these SVR genera: *Baccharis, Gynoxys, Hedyosmum, Meliosma, Miconia*, and *Viburnum*. *Podocarpus oleifolius* and two SVR liana species, *Jungia coarctata* and *Smilax domingensis*, were also present.

The Cotacachi-Cayapas sites are about 12 km southeast of SVR and 5 km northeast of Lake Cuicocha. For trees and shrubs SVR shared about 22% of the species and 70% of the genera in the study by Peñafiel et al. (2006), and a similar number, 25% and 73%, respectively, with the more limited study by Young and Keating (2001). These sites corresponded to the uppermost elevations at SVR and beyond, to about 3600 m. SVR species listed as most frequent or dominant at these sites included *Columellia oblonga, Escallonia myrtilloides*, and *Weinmannia pinnata*, and other species of SVR genera *Gynoxys*, *Myrsine*, *Oreopanax*, and *Tournefortia*. Additional SVR tree and shrub species listed for these sites included *Dendrophthora chrysostachya*, *Gaultheria myrsinoides*, *Hesperomeles obtusifolia*, and *Morella pubescens*. Other than trees and shrubs, the only other SVR species listed in these studies were *Oncidium pentadactylon*, *Oxalis lotoides*, and *Passiflora alnifolia*.

The Cuicocha Lake region (hereafter CUIC), is only 10.5 km southeast from SVR. The study by Peñafiel (2003) took place at elevations from 3100–3400 m, but the site differs from SVR in having lake shore and island vegetation and less varied terrain. For trees and shrubs, SVR shares 22% of the species with CUIC, with most being in the shrub category, but with a total of 73% of the genera in the tree and shrub categories being shared. For trees or shrubs at CUIC, the following were shared with SVR: *Achyrocline alata, Baccharis genistelloides, Columellia oblonga, Escallonia myrtilloides, Gaultheria myrsinoides, Hesperomeles obtusifolia, Llerasia hypoleuca, Morella pubescens*, and *Weinmannia pinnata*. Many of the same SVR genera were present at CUIC but with different or undetermined species, including *Dendrophorbium*, *Diplostephium*, *Geissanthus*, and *Oreopanax*. This study also included ferns and monocots, and there were only a few of the same shared species, as in these genera: *Bomarea, Diphasiastrum, Epidendrum, Equisetum, Lycopodium, Maxillaria, Niphidium, Oncidium, Pitcairnia*, and *Puya*. There were several shared genera in the Orchidaceae and Poaceae, including undetermined species of *Chusquea* growing 6 m high on the islands. In an overall comparison of all groups of species from CUIC (see Appendix 1), only 36 species were shared with SVR.

Two other studies of upper montane cloud forest sites were selected from the Pasochoa Volcano region, about 90 km S of SVR, one by Valencia and Jørgensen (1992) and one by Cerón (2013), for comparison with SVR. The earlier study involved a transect on the Pasochoa Volcano at about 3300 m, while the later study analyzed sites at 3000–3400 m adjacent to Pasochoa Wildlife Refuge in Pichincha Province. These studies produced lists of 32 and 63 tree and shrub species, respectively, and sharing about 22% of the species and 76% of the genera in the earlier study, and 37% of the species and 87% of the genera in the later study. The prevalent species at these sites included many SVR species, including: *Axinaea macrophylla, Boehmeria celtidifolia, Cornus peruviana, Miconia corymbiformis, Oreopanax palamophyllus*, and *Podocarpus oleifolius*, as well as species of *Geissanthus*, *Hedyosmum*, *Miconia*, and *Myrcianthes*. Additional SVR tree and shrub species present at these sites included *Baccharis genistelloides, Ceroxylon parvifrons, Disterigma acuminata, Escallonia myrtilloides, Gynoxys acostae, Ilex myricoides, Prunus huantensis,* and *Weinmannia rollotii*. Shared species other than trees or shrubs included *Galium hypocarpium*, *Mikania multiflora*, and *Pleurothallis bivalvis*.

In an overall comparison of upper montane sites in Table 2, the most commonly listed tree and shrub species at SVR and the other sites were the following: *Achyrocline alata, Axinaea macrophylla, Baccharis genistelloides, Columellia oblonga, Cyathea caracasana, Dendrophothora chrysostachya, Escallonia myrtilloides, Gaultheria myrsinoides., Gordonia fruticosa, Gynoxys acostae, Hedyosmum cuatrecazanum, Miconia corymbiformis, Morella pubescens, Palicourea amethystina, Prunus huantensis*, and *Weinmannia pinnata*. Twenty-four of the 100 tree and shrub species of upper montane SVR were not documented at any of the other sites. Additional species from lower montane SVR were also listed for some of the other upper montane sites in Table 2, such as *Baccharis latifolia, Bocconia integrifolia, Cavendishia bracteata, Chusquea scandens, Cleome anomala, Coriaria ruscifolia, Phytolacca bogotensis*, and *Verbesina arborea*.

There were a number of tree and shrub genera present at more than one of the other seven sites in Table 2 that were not documented at SVR, including the following: *Acalypha, Alchornea, Ardisia, Badilloa, Barnadesia, Buddleja, Byttneria, Cedrela, Chuquiraga, Dalea, Duranta, Gaiadendron, Grosvenoria, Hypericum, Lasiocephalus, Lophosoria, Otholobium, Polylepis, Siphocampylus, Tovomitopsis*, and *Vallea*. Many of these genera are associated with drier sites or higher elevations than can be found at SVR.

Overall Comparison of SVR with sites of similar elevation range

For an overall comparison of SVR species with another site of similar elevation range, and rainfall, the study of the Pululahua Geobotanical Reserve (Cerón 2004) was selected, although it is a much larger reserve, > 3000 ha, about 35 km south of SVR, with an elevation range of about 1800–3300 m, and with greater diversity of habitat, including more open and drier sites than at SVR. When comparing only the tree and shrub flora at Pululahua Reserve (PULU, hereafter), it was found that the number of species and genera were remarkably similar, although SVR has only about 15% of the land area, 225–230 species for each, and 135–145 genera for each. For trees and shrubs, SVR shared 23% of the species, and 53% of the genera. Overall, SVR shared 106 of the 905 species listed for PULU, which included many species of arums, orchids, and other groups not targeted at SVR. Fern genera with shared species included *Diphasiastrum, Equisetum, Huperzia* (*Phlegmariurus*), *Pteridium, Diplopterygium, Niphidium*, and *Thelypteris* (*Amauropelta*), and monocot genera with shared species included *Bomarea, Ceroxylon parvifrons, Chusquea, Guzmania, Mezobromelia, Pitcairnia, Elleanthus, Epidendrum, Maxillaria,* and *Oncidium*. Other examples of shared species between PULU and SVR included species of *Cecropia, Dendrophorbium, Dendrophthora, Escallonia, Freziera, Gunnera, Myrsine, Ocotea,* and *Rhamnus*. PULU genera absent from SVR were numerous, including many of the woody genera listed above in the previous section, as well as species of non-native genera, these often escaping from cultivation, such as species of *Cupressus* and *Pinus*.

One final comparison can be made, that to a species list published by Cuamacás and Tipaz (1995) for three sites in northern Ecuador. In this book the authors provided a list of 101 species from these three sites: Guandera Biological Station, 3090–3680 m in Carchi Province and 84 km northeast from SVR, and two sites in Imbabura Province, the Tablachupa Forest, 2200–3200 m and about 3 km east of SVR, and the Cushnirumi Forest, 2800–3700 m and about 20 km southeast of SVR. These sites therefore account for the entire elevation range at SVR, but also include higher elevation paramo sites. About 40% (40/101) of the trees and shrubs described for these sites have also been documented for SVR, and 76% of the genera (45/59) were shared with SVR. Each of the 101 species is provided with a description of its vegetative and reproductive features, habitat and distribution, and a full-page drawing. Included are six SVR species not found in any of the sites from Tables 1 and 2 or from PULU: *Brunellia tomentosa, Cinchona pitayensis*, *Delostoma integrifolium*, *Hedyosmum strigosum*, *Inga insignis*, and *Weinmannia auriculifera*. These comparisons again illustrate how many of these species are widely distributed in these cloud forests of northern Ecuador, but some less so, and often occur in unique formations of different combinations of species.

Plant-Animal Associations at SVR

As is typical of most relatively undisturbed cloud forests, SVR harbors many plants that support a variety of animal life. This is particularly evident in the case of pollinators and seed dispersers, such as birds, bats, and insects. A study by Santander et al. (2021) documented the plant-hummingbird associations at a upper montane site in northwest Andes, and listed species in the following SVR genera: *Bomarea, Brachyotum, Centropogon, Disterigma, Fuchsia, Gaultheria, Heppiella, Macleania, Miconia, Palicourea, Passiflora*, and *Rubus*. Luteyn (2021) notes that while the brightly colored corolla tubes of many genera in the Ericaceae (*Cavendishia*, *Macleania*, and *Thibaudia*) are hummingbird pollinated, several important high elevation genera (*Disterigma*, *Gaultheria*, and *Pernettya*) have small white flowers that are likely bee pollinated, possibly benefitting from a mixed pollinator strategy due to reduced pollinator visitation. Another unusual bird pollination relationship that has been observed at the higher elevations at SVR, includes the "puff pollination" system of *Axinaea* spp. in which the anthers provide a food reward, but dust their passerine pollinator through a unique bellows system (Dellinger et al. 2014).

Nathan Muchhala and associates studied bat-pollinated flowers in Ecuador for about 20 years, including a visit to SVR in 2009, and published a series of articles on their studies, beginning with Muchhala and Jarrín (2002) and most recently in Gamba and Muchhala (2022). They also collected about 125 specimens for deposit at QCA, and these specimens include species of SVR genera *Burmeistera, Centropogon, Cobaea, Cleome, Passiflora, Pitcairnia, Meriania,* and *Trianaea*. The latest study by Gamba and Muchalla (2022) documented in two out of three species pairs that insect-pollinated species had greater population level genetic differention than hummingbird-pollinated species. These and other studies have also found a notable shift in pollinator interactions from hummingbird pollinated flowers at lower elevations to bat pollinated at higher elevations, including *Centropogon* and *Burmeistera* (Lagomarsino et al. 2017), *Guzmania*, *Tillandsia*, and *Puya* (Aguilar-Rodriguez et al. 2019), and *Passiflora* spp. along elevational transects similar to the study area at SVR

(Abrahamczyk et al. 2014). Many of these are conspicuous understory and/or epiphytic plants and their nectar-feeding pollinators (i.e. *Anoura geoffroyi* and *Anoura caudifera*) have been observed at SVR.

While no formal studies of insect pollination have been conducted at SVR, observations of pollinator insects indicate a wide diversity of insect-plant interactions are present. Several of these relationships, such as the coevolution of *Ficus* spp. & fig wasps (Machado et al. 2005), nocturnal pollination by sphinx moths (Sphingidae), and nectar robbing of Ericaceae flowers by native bees, moths, and even birds are widely reported elsewhere (Luteyn 2021). Other conspicuous flora from SVR, such as the Orchidaceae, are known for their complex pollinator interactions, such as *Lepanthes* orchids' pseudocopulation with their fungus gnat pollinators (Blanco & Barboza 2005). *Epidendrum*, *Maxillaria*, and *Oncidium* species at lower elevations are indicative of hummingbird and bee pollinators, while at higher elevations an obvious shift toward smaller insect pollinators (flies and gnats) is evident in the increased diversity of *Pleurothallis*, *Lepanthes*, and *Stelis* species.

Finally, it is worth noting the assemblages of fruit-eating and seed dispersing animals are also indicative of strong biodiversity networks at SVR. Many of the conspicuous birds, such as the plate-billed mountain toucan, colorful tanagers, and toucan barbet, are voracious consumers of native fig and cecropia (guarumos) fruits. In addition, the olinguito is frequently observed visiting cecropias and other fruit-bearing trees near the lodge at SVR (A. Reynolds, pers. comm.). Muchhala and Proaño (2009) reported several fruit eating bat species from SVR including *Sturnira* and *Platyrhinus*, which also commonly eat the fleshy fruits of figs and cecropias, as well as *Piper* and *Solanum* spp. (Giannini 1999). An altitudinal transition has also been documented among high elevation bats, with a trend to higher consumption of epiphytic blueberries (*Cavendishia* and *Psammisia*) above 2000 m (Castaño et al. 2018). The occasional remains of a shredded *Puya* at SVR provide evidence of feeding by the spectacled bear (*Tremarctos ornatus*), and these bears also consume the foliage of other species in the Bromeliaceae (such as *Guzmania* spp.), the foliage and fruit of *Ceroxylon* spp , and the fleshy fruits of several genera in the Ericaceae that are present at SVR (Aguilar-Rodríguez et al. 2019; Chavez et al. 2018).

SUMMARY AND CONCLUSIONS

SVR encompasses a variety of habitats and plant communities, including river corridors, small streams, roadsides, open fields, bamboo thickets, developed sites with several facilities, hiking trails, low elevation cloud forest, high elevation cloud forest, and elfin forest transitioning into a shrub zone. Close to 95% is covered by primary forest, with about 144 ha below 2700 m, and 360 ha above 2700 m. Species groupings at three elevation ranges, 2300–2700, 2700–3100, and 3100–3300, are described for SVR. The lowest elevation range is compared with other sites classified as lower montane rain forest, and the higher two elevation ranges are grouped together as upper montane rain forest for regional comparisons. These comparisons with other sites show that SVR provides an excellent example of the typical floras of lower and higher montane vegetation types in the northwestern Andes, in that most of the representative families and genera are present, and many of the species, whereas families, genera, and species associated with more lowland rain forest were mostly absent. The comparisons of tree and shrub genera and species illustrate the uniqueness of the SVR flora, in that the range of shared genera varied from about 41%–68% for lower montane sites, and from about 73%–87% for upper montane sites, and the range of shared species varied from about 14%–28% for lower montane sites, and from about 22%–42% for upper montane sites. For both genera and species, it is apparent that the upper montane taxa display a higher fidelity to their particular habitat at different sites. Most species associated with drier sites or higher elevations at the other locations were absent from SVR. More significantly, SVR included 30 genera and 144 species that were not found at any of the other lower or upper montane sites in Tables 1 and 2 or at PULU or at GUAN. Even with sites only a few km away, substantial differences in flora are shown to exist. When the entire species list is compared to that of PULU it was found in spite of dissimilar habitats at the two sites, there were still many instances of shared species and an overall similarity in the woody flora, but with many differences when the overall floras are compared.

This study has increased our knowledge of the Ecuadorian flora by providing one of the few available comprehensive studies on the flora of a cloud forest in this northwestern portion of the Andes, and including comparisons with other similar sites. High biodiversity of plant and animal species is evident at SVR. As noted above, preliminary animal surveys at SVR suggest that the site harbors a rich assemblage of animals and their associated plants, especially mammals, birds, and pollinator insects. By combining the results of a floristic study in 2016 with previous collections dating back to 2004, a comprehensive list of 408 species has been produced. Included in this list are 40 species endemic to Ecuador and 97 of the species are listed in IUCN (2022). Additional herbarium records of 41 species have been deposited at QCA for underrepresented taxa. Several recently named species, and several other possibly undescribed species were found to be present. Specimen documentation of the epiphytic flora in general, and the orchid flora in particular, is incomplete, but is likely to be found to be extremely rich, based on preliminary studies. Exotic invasive species were few and currently not problematic. Portions of the lower elevations are much disturbed, but the plant communities of upper elevations are covered by primary forest, and the upper montane "elfin" forest is the most pristine site within SVR, and this high elevation community as well as the less explored sites on the property, especially those in the recently acquired property to the southeast, are much in need of additional studies.

SVR is a protected site and under no direct threats at the present, and the bordering properties are mostly dedicated forest reserves, providing additional protection to the site. However, there is a current threat to the general Intag region and Imbabura Province from widespread illegal mining of gold and copper involving thousands of miners, as well as proposed mining concessions that include almost the entirety of the adjacent communities (Vandegriff et al. 2018). In 2016 Ecuador opened up about 13% of the country to mining exploration, many in previously protected forests, and Roy et al. (2018) provided a study of potential biodiversity losses that mining could cause in the northwestern Andes. They focused on the threats to mammals, amphibians, reptiles, birds, and orchids from several cloud forest sites, noting the presence of hundreds of imperiled species, ranging from critically endangered to less threatened, that each Reserve protected a unique subset of taxa in this region, with many highly localized endemics, and that the reserves often generate sustainable income for many local people. They concluded that "short-term national profits from mining will not compensate for the permanent biodiversity losses, and the long-term ecosystem service and economic losses at the local and regional level."

A longer-term impending threat is climate change. Due to their elevation, neotropical montane cloud forests are extremely vulnerable to changes in overall temperature and precipitation, as well as any shifts in seasonality. A recent study (Helmer et al. 2019) projects that up to 86% of neotropical montane cloud forests will shrink or dry within 45 to 65 years, primarily due to decline of cloud immersion, if greenhouse gas emissions continue to rise through the 21st century, leading, no doubt to rapid acceleration of extinctions of many kinds of species.

This study also highlights the value of private reserves in protecting the diminishing biodiversity of Ecuador. In regards to orchids, Meisel and Woodward (2005) stated that "… with 75% of montane forests destroyed, and only 15% of species protected within existing reserves, fully a third of Ecuador's endemic orchid species are at risk of extinction. Private reserves in the Andes can play a major role in the conservation of orchids." It is hoped that this study will help the owners and staff of Siempre Verde Reserve to better understand the types of plants and communities that occur on their property, to implement more long range management and conservation plans, and to improve the educational experiences of visitors. It is also hoped that this study will lead to an increased interest in the region from researchers. This study comes at a critical time, when the general region is facing numerous threats from agricultural development, deforestation, mining activities, and climate change. Actions need to be taken on many fronts to avoid the potentially catastrophic changes that are predicted.

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These authorities agreed to assist in the study although there were no duplicates to share (as these had all been lost during shipping). Photographs, either via email or Flickr, were submitted in lieu of specimens. In many cases these photographs were sufficient to allow accurate species identifications, in other cases it was not possible, and only suggestions or recommendations could be offered by the cited authorities. In all cases the final decisions concerning species to list in the Appendix rest with the authors, but the willingness of all involved to spend time, often considerable time, to assist in species identifications using only photographs is most gratefully acknowledged.

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†Grady L Webster, renowned American botanist, long-time professor at the University of California, Davis, and specialist in the Euphorbiaceae, passed away in 2005. He and his associates worked for about 10 years on the flora of the Maquipucuna Reserve in the Western Andes in Ecuador, the results published in 2001. I contacted Grady shortly before his unexpected death for suggestions about Andean sites in need of floristic work, and he recommended the Siempre Verde Reserve, which he had visited on a collecting trip in 2004, leaving a bundle of about 130 unprocessed specimens at QCA along with an excel file of collection data. In 2014, I applied for a Fulbright Grant with the flora of Siempre Verde Reserve as the focus of the study, and the application was successful. I was very appreciative of the advice that Grady Webster had given me, and felt privileged to complete the identifications and prepare the labels for his Siempre Verde collections, the last specimens that he collected in Ecuador.—RLJ

APPENDIX 1

List of vascular plant species documented for Siempre Verde Reserve (SVR).

Abbreviations:

SVR	trail system
RIV	plants collected along the Toabunchi River, 2380–2420 meters
FIE	Plants collected in the open field on the River Trail, 2425–2450 meters
EL1	plants collected at forested elevations, 2400–2700 meters
EL2	plants collected at forested elevations, 2700–3100 meters
EL3	plants collected at forested elevations, 3100–3300 meters
EL3/SHR	plants collected in shrub zone near El Mirador, 3300 meters

* Non-native species listed in Jørgensen & León-Yánez (1999)
! Species listed in IUCN Red List of Threatened Species (www.iucnredlist.org/)
Endemic- species listed in León-Yánez et al. (2011).

Other sites:

ALTO	Altochoco Reserve
APAQ	Apaqui River region
COTA	Cotacachi Volcano
CUIC	Cuichocha Lake
GUAN	Guandera and associated sites
INTA	Intag Valley region
MAQU	Maquipucuna Reserve
PASO	Pasochoa Volcano
PULU	Pululahua Volcano

Collectors:

Voucher collections (collectors, dates, abbreviations): Grady L. Webster and associates, 2004, SV numbers (GW) Nathan Muchhala, 2009 (NM); Lorena Endara, 2010, (LE); Álvaro J. Pérez and associates, 2011 to 2013, (AJP); Rosa Jiménez-Paz in 2014 and 2015, (RJP); and Ronald L. Jones, 2016, collection numbers 11000 to 11436. Images of many of these specimens are available on the website for QCA, https://bioweb.bio/portal/.

PTERIDOPHYTES

Aspleniaceae

Asplenium cuspidatum Lam.—SV17 (GW); epiphytic or terrestrial fern; EL1. MAQU

Asplenium miradorense Lieb.—SV108 (GW); terrestrial fern; EL1.

Asplenium serra Langsd. & Fisch.—11167; epiphytic fern; EL1. MAQU.

Asplenium uniseriale Raddi—SV16 (GW); terrestrial fern; EL1.

Blechnaceae

Blechnum fragile (Liebm.) C.V. Morton & Lell.—11267; AJP 5179, 5438; terrestrial fern; EL3.

Cyatheaceae

Alsophila erinacea (H. Karst.) D.S. Conant—11366; tree fern; EL2. INTA, MAQU.

Cyathea conjugata (Spruce ex Hook.) Domin—11087, 11088; tree fern; EL1.

!*Cyathea cystolepis* Sodiro—11086, 11276, 11281; tree fern; EL1, EL3. Data Deficient.

Cyathea delgadii Pohl ex Sternb.—11057; tree fern; EL2.

Cyathea caracasana (Klotzsch) Domin—11266; tree fern; EL3. ALTO.

Cyathea planadae Arens & Smith—11084; tree fern; EL1.

Sphaeropteris quindiuensis (H. Karst.) R. Tryon—11085; tree fern; EL1. MAQU.

Dennstaedtiaceae

Hypolepis bogotensis H. Karst—11333; terrestrial fern; EL1.

Pteridium arachnoideum (Kaulf.) Maxon—11340; terrestrial fern; EL1. PULU.

Dicksoniaceae

Dicksonia karsteniana (Kotzsch) T.Moore—11345; tree fern; EL2. MAQU.

Dryopteridaceae

Elaphoglossum lloense (Hook.) T. Hook.—AJP 5168; epiphytic fern; EL3.

Elaphoglossum tabanense Andre ex H. Christ.—SV70 (GW); AJP 5469; epiphytic fern; EL2.

Elaphoglossum sp. "A"—SV109; epiphytic fern. Unknown elev.

Equisetaceae

Equisetum bogotense HBK—11320; AJP 5481; terrestrial horsetail fern; RIV. CUIC, MAQU, PULU.

!*Equisetum giganteum* L.—11319; SV124 (GW); AJP 5506; terrestrial horsetail fern; RIV. Least Concern. MAQU, PULU.

Gleicheniaceae

Diplopterygium bancroftii (Hook.) A.R. Sm.—11111; climbing fern; EL1. MAQU, PULU.

Sticherus revolutus (Kunth) Ching—11177; SV83 (GW); climbing fern; EL3/SHR.

Sticherus tomentosus (Cav. ex Sw.) A.R. Sm.—11109; climbing fern; EL1. MAQU.

Hymenophyllaceae

!*Hymenophyllum* cf. *cristatum* Hook. & Grev.—AJP 5473; epiphytic fern; EL2. Endemic. Near Threatened.

Lycopodiaceae

Diphasiastrum thyoides (Humb. & Bonpl.) Holub.—SV49 (GW); terrestrial clubmoss; EL1. CUIC, MAQU, PULU.

Lycopodium clavatum L.—SV54 (GW); terrestrial clubmoss; EL1. CUIC, MAQU, PULU.

Phlegmariurus hippurideus (Christ) B. Øllg.—11290; SV71 (GW); terrestrial clubmoss; EL3.

Phlegmariurus phylicifolius (Desv. Ex Poir) Holub.—AJP 5446; epiphytic clubmoss; EL2. PULU.

Phlegmariurus reflexus (Lam.) B.Øllg.—AJP 5497; terrestrial clubmoss; EL1.

Phlegmariurus rosenstockianus (Herter) B. Øllg.—SV72 (GW); epiphytic clubmoss; EL2.

Mariattiaceae

Eupodium pittieri (Maxon) Christenh.—11224, 11306; terrestrial fern; EL1.

Polypodiaceae

Campyloneurum fuscosquamatum Lellinger—11156; epiphytic fern; EL1.

Campyloneuron sp. "A"—SV112 (GW); AJP 5392; epiphytic fern; EL1.

Niphidium crassifolium (L.) Lellinger—11331; epiphytic fern; EL1. CUIC, MAQU, PULU.

Serpocaulon fraxinifolium (Jacq.) AR Sm.—11332; epiphytic fern; EL1. MAQU, PULU.

Unknown genus—SV113 (GW); epiphytic fern; EL1.

Pteridaceae

Eriosorus flexuosus (Kunth) Copel—11259; sprawling terrestrial fern; EL3/SHR.

Pteris podophylla Sw.—11342; terrestrial fern; EL1. MAQU.

Vittaria sp.—SV110 (GW); AJP 5389; epiphytic fern; EL1.

Selaginellaceae

Selaginella cf. *silvestris* Aspl.—11303; terrestrial spikemoss; EL1.

Thelypteridaceae

Amauropelta cheilanthoides (Kunze) A. & D. Löve—11213, 11386; terrestrial fern; EL1. MAQU, PULU.

Amauropelta pachyrhachis (Kunze) A. & D. Löve—11327; terrestrial fern; EL1. MAQU, PULU.

GYMNOSPERMS

Podocarpaceae

!*Podocarpus oleifolius* D. Don ex Lamb—11365; tree; EL2. Least Concern. APAQ, GUAN, PASO.

ANGIOSPERM: MONOCOTS

Alstroemeriaceae

Bomarea multiflora (L.f) Mirb.—11066, 11205, 11236, 11394; SV43, 118 (GW); AJP 5170, 5433; vine; EL1. CUIC, MAQU, PULU.

Bomarea pardina Herb.—11146, 11393; AJP 5384; vine; EL1. MAQU.

Arecaceae

!*Ceroxylon* cf. *parvifrons* (Engel) H. Wendl.—11271; palm tree; EL3. Vulnerable. PASO, PULU

Bromeliaceae

Gregbrownia lyman-smithii (Rauh & Barthlott) W. Till & Barfuss—11388; epiphytic or terrestrial bromeliad; EL1. MAQU, PULU.

Guzmania gloriosa (André) André ex Mez.—11436; terrestrial bromeliad; EL1. MAQU, PULU.

Guzmania multiflora (André) André ex Mez.—11389; terrestrial bromeliad; EL1. PULU.

!*Pitcairnia pungens* Kunth—SV2 (GW); epiphytic or terrestrial bromeliad; EL1. Endemic. Least Concern. CUIC, PULU.

!*Pitcairnia sodiroi* Mez—SV1 (GW); AJP 5181, 5493; epiphytic or terrestrial bromeliad; EL1/EL2. Endemic. Near Threatened. MAQU, PULU.

!*Puya glomerifera* Mez & Sodiro—11248; terrestrial bromeliad; EL3/SHR. Endemic. Least Concern. CUIC.

Cyclanthaceae

Sphaeradenia horrida (Harling) Harling—11039, 11311; terrestrial cyclanth; EL1. MAQU.

Dioscoreaceae

Dioscorea sp.—AJP 5399, 5484, 6118; vine; EL1.

Orchidaceae—All orchids listed below are deposited at QCA and identified to species by one of the following collectors: L. Endara, F. Tobar, A. Reynolds, W. Forster, E. Hágsater & E. Santiago). Synonyms (in parenthesis) are listed for those specimens filed under a different name at QCA.

Andinia pensilis (Schltr) Luer—AJP 5382; epiphyte; EL1. Endemic.

Cranichis diphylla Sw.—LE 1578; terrestrial; EL1.

Elleanthus aurantiacus (Lindl.) Rchb.f.—11121; terrestrial canelike; EL1. MAQU, PULU.

Elleanthus petrogeiton Schltr.—11046; terrestrial canelike; EL1. Endemic.

Epidendrum bractiacuminatum Hágsater & Dodson—AJP 5203; epiphytic. EL2. Endemic.

Epidendrum cochlidium Lindl.—11392; epiphytic; EL1. MAQU, PULU.

Epidendrum gastropodium Rchb.f.—AJP 5193; epiphytic; EL2. CUIC.

Epidendrum oxycalyx Hágstater & Dodson—LE 1587; epiphytic or terrestrial; EL2.

Fernandezia pastii (Rchb.f) M.W.Chase—LE 1589; epiphytic or terrestrial; EL1. (*Pachyphyllum pastii* Rchb.f.).

Fernandezia sanguinea (Lindl.) Garay & Dunst.—11194; AJP 5447; LE 1590; epiphytic or terrestrial; EL2/EL3.

Lepanthes columbar Luer—LE 1579; epiphytic; EL1. Endemic.

Lepanthes magnifica Luer—LE 1575; epiphytic; EL1.

!*Lepanthes mucronata* Lindl.—LE 1584; epiphytic; EL1. Least Concern. MAQU.

Lepanthes stupenda Luer—LE 1582; epiphytic; EL1.

Lepanthes tachirensis Foldats—LE 1574, 1588; epiphytic; EL2.

Lepanthes urotepala Rchb.f.—LE 1583; epiphytic; EL1. Endemic.

Maxillaria grandiflora (Kunth) Lindl.—AJP 5177; epiphytic; EL2. CUIC, MAQU, PULU.

Oncidium pentadactylon Lindl.—AJP 5424; epiphytic; EL2. CUIC, MAQU, PULU.

Platystele alucitae Luer—LE 1580; epiphytic; EL1.

Pleurothallis bivalvis Lindl.—LE 1570, 1576; epiphytic; EL1. PASO.

Pleurothallis carduela (Luer) J.M.H. Shaw—LE 1585; epiphytic; EL1. Endemic. (*Acronia carduela* Luer).

Pleurothallis dunstervillei Foldats—AJP 6150; hemiepiphytic; EL1.

Pleurothallis ripleyi Luer—LE 1586; epiphytic; EL1. Endemic (likely). (*Acronia ripleyi* Luer).

Prescottia stachyoides (Sw.) Lindl.—LE 1591; terrestrial; EL2. MAQU.

Restrepiopsis viridula (Lindl.) Luer (OR *Pleurothallopsis tubulosa* (Lindl.) Pridgeon & M.W. Chase)—LE 1573; epiphytic; EL1.

Specklinia grobyi (Bateman ex Lindl.) F. Barros—LE 1581b; epiphytic; EL1. (*Pleurothallis grobyi* Bateman ex Lindl.).

Telipogon williamsii P. Ortiz—LE 1581a; epiphytic; EL1. MAQU. (*Stellilabium andinum* (L.O.Williams) Garay & Dunst.).

Xylobium pallidiflorum (Hook.) G. Nicholson. AJP 5420; epiphytic; EL2. MAQU,

Poaceae

Cenchrus bambusiformis (E. Fourn.) Morrone—11390; tall grass; RIV.

!*Chusquea macclurei* L.G. Clark—11399; giant mountain bamboo grass; EL1. Endemic. Vulnerable.

Chusquea cf. *lehmannii* Pilg.—11435; giant mountain bamboo grass; EL2. APAQ, PULU.

Chusquea scandens Kunth—SV111 (GW); AJP 5434; mountain bamboo grass; EL1. MAQU, PASO, PULU.

Chusquea sp. nov.—11067, 11079, 11310; mountain bamboo grass; EL1.

Smilacaceae

Smilax domingensis Willd.—11346; liana; EL1. APAQ.

Smilax tomentosa Kunth—AJP 5423; liana; EL2.

Zingerberaceae

Renealmia fragilis Maas—11029, 11330; terrestrial ginger lily; EL1. MAQU.

ANGIOSPERM: Chloranthales and Magnoliids

Chloranthaceae

!*Hedyosmum cuatrecazanum* Occhioni—AJP 6109; small tree; EL2. Least Concern. ALTO, GUAN, MAQU, PULU.

Hedyosmum scabrum (Ruiz & Pav.) Solms—11137, 11221, 11234; AJP 5435, 5478, 5489; small tree; EL1/RIV.

Hedyosmum strigosum Todzia—11265, 11268; SV67 (GW); AJP 5200, 5453; small tree; EL3. GUAN.

Lauraceae

!*Beilschmiedia tovarensis* (Meisn.) Sach.Nishida—11338; tree; EL1. Least Concern. MAQU.

!*Nectandra* cf. *laurel* Klotzsch—AJP 6107; tree; EL2. Least Concern. GUAN, MAQU.

Nectandra sp. A—11368; tree; EL1.

Ocotea cf. *ceronii* van der Werff—11357, 11376; tree; EL1.

Ocotea cf. *floribunda* (Sw.) Mez—11148; tree; EL1. GUAN, MAQU, PULU.

Ocotea sp. A—11068; tree; EL1.

Piperaceae

Peperomia acuminata Ruiz & Pav.—11430; SV75 (GW); shrub or small tree; EL2. MAQU.

Peperomia ternata C. DC.—SV90 (GW); succulent herb; EL1.

Peperomia sp. A.—SV15 (GW); herb; Unknown elev.

Peperomia sp. B.—SV50, 100 (GW); terrestrial, herb; Unknown elev.

Peperomia sp. C.—SV92 (GW); terrestrial, herb; Unknown elev.

Piper sp. nov.—11098; shrub or small tree; RIV.

Piper cornifolium Kunth—11233; shrub or small tree; RIV/EL1.

Piper ecuadorense Sodiro—11231; shrub or small tree; RIV. MAQU.

!*Piper lacunosum* Kunth—11324; shrub or small tree; EL1. Least Concern.

Piper lanceifolium Kunth—11050; AJP 5505; shrub or small tree; EL1. MAQU, PULU.

Piper lunulibracteatum C. DC.—11323, 11377; shrub or small tree; EL1.

Piper serrulatum Yuncker—11282; shrub or small tree; EL1.

Siparunaceae

Siparuna echinata (Kunth) A. DC—11208; shrub; EL1. MAQU, PULU.

!*Siparuna pilosa-lepidota* Heilborn—11082, 11263; shrub; EL2/EL3. Endemic. Near Threatened. INTA, MAQU.

!*Siparuna aspera* (Ruiz & Pav.) A. DC—AJP 5502; small tree; EL1. Least Concern. MAQU.

ANGIOSPERM: EUDICOTS

Acanthaceae

Aphelandra acanthus Nees—11044; shrub; EL1.

Stenostephanus jamesonii (Wassh.) Wassh.—11034; SV21 (GW); shrub; EL1. Endemic.

Actinidaceae

!*Saurauia lehmannii* Hieron.—11043; tree; EL1. Endemic. Near Threatened. MAQU.

!*Saurauia pseudostrigillosa* Buscal—11138, 11339; AJP 5173, 5425; tree; EL1/EL2. Endemic. Least Concern. GUAN, INTA, PULU.

Amaranthaceae

Alternanthera mexicana (Schltdl.) Hieron.—11169, 11326; SV29 (GW); sprawling herb; EL1. MAQU.

Iresene diffusa Humb. & Bonpl.—11120; SV120 (GW); high-climbing subshrub; EL1. CUICH, MAQU, PULU.

Apiaceae

!*Hydrocotyle hexagona* Mathias—11180; SV78 (GW); viney herb; EL3. Endemic. Vulnerable.

Aquifoliaceae

Ilex hualgayoca Loizeau & Spichiger—11255, 11406; tree; EL3.

Ilex myricoides Kunth—RJP 503; tree; EL3. PASO.

Araliaceae

Oreopanax floribundus (Kunth) Decne. & Planch—11272; tree; EL3. MAQU.

Oreopanax palamophyllus Harms—11042, 11202; tree; EL1. GUAN, MAQU, PASO, PULU.

Sciodaphyllum sodiroi Harms—11196, 11269; tree; EL3. Endemic. APAQ, GUAN.

Asteraceae

Achyrocline alata (Kunth) DC.—11403; subshrub; EL3. COTA, CUIC, PULU.

Acmella oppositifolia (Lam.) R.K. Jansen—11372; trailing ground cover herb; EL1.

Ageratina pichinchensis (Kunth) R.M. King & H. Rob.—SV38 (GW); shrub; EL1. CUIC.

Baccharis genistelloides (Lam.) Pers.—11400; shrub; EL3/SHR. COTA, CUIC, PASO, PULU.

Baccharis latifolia (Ruiz & Pav.) Pers.—11049, 11134, 11297; shrub; FIE. APAQ, CUIC, MAQU, PASO, PULU.

Chromolaena leptocephala (DC) R.M. King & H. Rob.—11217; shrub; EL1.

!*Critoniopsis palaciosii* H. Rob.—11298; small tree; EL1. Endemic. Vulnerable.

Dendrophorbium lloense (Hieron. ex Sodiro) C. Jeffrey—11315, 11334; tree; EL1. MAQU, PASO, PULU.

Diplostephium floribundum (Benth.) Wedd.—11172; AJP 5455; shrub; EL3/SHR. APAQ.

Diplostephium hartwegii Hieron.—11242; AJP 5458; shrub; EL3/SHR.

Erato polymnioides DC.—11161; SV119 (GW); shrub; EL1. MAQU, PULU.

!*Gynoxys acostae* Cuatrec.—11408; shrub; EL3/SHR. Endemic. Least Concern. PASO.

!*Hebeclinium obtusisquamosum* (Hieron.) R.M. King & H. Rob.—11308; shrub; EL1. Endemic. Vulnerable. MAQU.

Jaegeria hirta (Lag.) Less—11373; trailing ground cover herb; EL1. MAQU, PULU.

Jungia coarctata Hieron.—11158, 11292, 11422; liana; EL1. APAQ, PULU.

Liabum stipulatum Rusby—11240; shrub; EL1. MAQU.

Llerasia hypoleuca (Turcz) Cuatrec.—11286; shrub or small tree; EL3. CUIC, PASO, PULU.

Mikania banisteriae DC.—11378; vine; EL1. MAQU.

Mikania discifera W.C. Holmes & H. Rob.—11183; vine; EL3. Endemic.

!*Mikania iodotricha* S.F. Blake—SV65 (GW); vine; EL3. Endemic. Near Threatened..

Mikania leiostachya Benth.—11358; SV40 (GW); vine; EL1.

Mikania multinervia Turz.—11184; vine; EL3. CUIC, PASO.

Munnozia jussieui (Cass.) H. Rob. & Brettell—11275; SV39 (GW); shrub or liana; EL3. APAQ, PASO.

Munnozia senecionidis Benth.—11102, 11195, 11317 shrub or liana; RIV, EL3. APAQ, MAQU, PULU.
Pentacalia theifolia (Benth.) Cuatrec.—11411; liana; EL3.
!*Pseudogynoxys sodiroi* (Hieron.) Cuatrec.—11091; liana; FIE. Endemic. Vulnerable.
Verbesina arborea Kunth—11296; tree; EL1. CUIC, COTA, MAQU, PASO, PULU.
Unknown genus—11116; tree with opposite leaves and double-pappus; EL1.
Unknown genus—11077; liana; EL2.

Balanophoraceae
Langsdorffia hypogaea Mart.—11040; AJP 5166; holoparasite; EL1. MAQU.

Balsaminaceae
**Impatiens sodenii* Engl. & Warb.—11170; succulent subshrub, native of Africa; EL1.

Basellaceae
Anredera baselloides (Kunth) Baill.—11092; vine; FIE.

Begoniaceae
!*Begonia exalata* C. DC.—11343; SV45 (GW); subshrub; EL1. Endemic. Vulnerable. MAQU.
Begonia longirostris Benth.—11155; AJP 5485; subshrub; EL1. MAQU.
Begonia maurandiae A.DC.—AJP 5520, 6110; succulent epiphyte; EL1. MAQU, PULU.
Begonia pululahuana C. DC.—11147; AJP 5407; liana or epiphyte; EL1. MAQU, PULU.
Begonia segregata L.B.Smith & B.G.Schub.—11229; SV25 (GW); liana; RIV.

Berberidaceae
Berberis grandiflora Turcz.—11407; shrub; EL3.

Bignoniaceae
Delostoma integrifolia D. Don—11143; small tree; FIE. GUAN.
Tourrettia lappacea (L'Hér.) Willd.—11004, 11136; AJP 5503; vine; EL1.

Boraginaceae
**Cynoglossum amabile* Stapf. & J.R. Drumm.—11328; herb, native to Asia; EL1. CUIC, MAQU.
Tournefortia gigantifolia Killip ex J.S. Mill. SV31 (GW); shrub; EL3. MAQU.

Brassicaceae
**Nasturtium officinale* R. Br.–SV37 (GW); herb, native to Europe and Asia; EL1.

Brunelliaceae
!*Brunellia acostae* Cuatrec.—11110; AJP 5188; tree; EL1. Vulnerable. ALTO, GUAN, INTA, MAQU.
Brunellia tomentosa Humb. & Bonpl.—11412, 11418, 11431, tree; EL2/EL3. GUAN.

Calceolariaceae
Calceolaria mexicana Benth.—SV32 (GW); AJP 5413; sprawling herb; EL1.
!*Calceolaria pedunculata* Molau—11318; SV126 (GW); AJP 5487; shrub; RIV. Endemic. Vulnerable.

Campanulaceae
!*Burmeistera sodiroana* Zahlbr.—11118, 11230; SV20 (GW); AJP 5405; liana or epiphyte; EL1. Endemic. Vulnerable.
Burmeistera glabrata (Kunth) Benth. & Hook. f.—11192; liana; EL1.
Centropogon cornutus (L.) Druce—AJP 5431; shrub; EL2.
!*Centropogon dissectus* E. Wimm.—AJP 5430; shrub or epiphyte; EL2. Endemic. Near Threatened.
!*Centropogon llanganatensis* Jeppesen—11113, 11130, 11329; SV33 (GW); AJP 5418; shrub or epiphyte; EL1. Endemic. Near Threatened.
Centropogon nigricans Zahlbr.—NM 402; 11151; shrub; EL1. MAQU,
Centropogon solanifolius Benth.—11053, 11304; SV9 (GW); 5186, AJP 5397; liana; EL1. MAQU.

Caprifoliaceae
Valeriana clematitis Kunth—11129; vine; EL1. MAQU, PULU.

Caricaceae
Vasconcellea pubescens A.DC.—11106; shrub; EL1. MAQU, PULU.

Cleomaceae
Cleome anomala Kunth—11027; SV18 (GW); 400, NM 415; shrub; EL1. CUIC, MAQU, PASO.
Podandrogyne flammea Cochrane & Cornejo—11002, 11141; shrub; EL1.
Podandrogyne websteri Cochrane & Cornejo—11335; SV4 (GW); shrub; EL1. Endemic. MAQU (so indicated in Cochrane and Cornejo (2020).

Clethraceae
!*Clethra ovalifolia* Turcz—11176, 11258; AJP 5197, 5452; tree; EL3/SHR. Least Concern. GUAN, MAQU.
!*Clethra revoluta* (Ruiz & Pav.) Spreng—AJP 6122; RJP 822; tree; EL1/EL2. Least Concern. MAQU.

Clusiaceae
Chrysochlamys columbiana (Cuatrec.) Cuatrec.—11166; tree; EL1. ALTO, MAQU.
!*Clusia* cf. *ducu* Benth.—11429; epiphyte; EL2. Least Concern.
!*Clusia* cf. *flaviflora* Engl.—11410; small tree; EL3. Least Concern. GUAN, INTA.
!*Clusia* cf. *multiflora* Kunth—11100, 11005, 11379, 11380; AJP 5450; tree; RIV/EL1. Least Concern. ALTO, GUAN, MAQU, PULU.
!*Clusia* cf. *salvinii* Donn.Sm.—11360; tree; EL1. Least Concern.
Tovomita weddelliana Planch. & Triana—11055; tree; EL1.
Tovomita sp. "A"—11336; epiphyte at top of dead Cecropia; EL2.
Tovomita sp. "B"—11052; tree; EL1.

Columelliaceae
Columellia oblonga Ruiz & Pav.—11244; AJP 5449; shrub; EL3/SHR. COTA, CUIC, PULU.

Coriariaceae
Coriaria ruscifolia L.—11097, 11108; SV122 (GW); shrub; EL1. COTA, CUIC, MAQU, PULU.

Cornaceae
!*Cornus peruviana* Macbr.—11045; AJP 5480; tree; EL1. Least Concern. GUAN, MAQU, PASO.

Cucurbitaceae
Cayaponia simplicifolia (Naud.) Cogn.—11028; vine; EL1. MAQU.
Cyclanthera brachybotrys (Poepp. & Endl.) Cogn.—11162; vine; EL1.
Melothria dulcis Wunderlin—11302; vine; EL1.

Cunoniacae
Weinmannia auriculifera Hieron.—RJP 537; tree; EL3. GUAN.
!*Weinmannia lentiscifolia* C. Presl—RJP 198; tree; EL2. Least Concern. MAQU.
Weinmannia mariquitae Szyszył.—RJP 595; tree; EL3. PULU.
!*Weinmannia multijuga* Killip & Smith—11159; tree; EL1. Least Concern.
!*Weinmannia pinnata* L.—11031, 11188, 11420; tree; EL1/EL3. Least Concern. ALTO, APAQ, COTA, CUIC, GUAN, INTA, PULU.

Weinmannia polyphylla Moric. Ex Seringe—11103, 11232; SV19 (GW); AJP 5482; tree; RIV, EL1.

!*Weinmannia rollottii* Killip—11245; AJP 5466; tree; EL3. Least Concern. GUAN, PASO.

Ericaceae

!*Cavendishia bracteata* (Ruiz & Pav. ex J.St.Hil.) Hoerold—11023, 11051, 11062; shrub; EL1. Least Concern. COTA, CUIC, INTA, MAQU, PULU.

Disterigma acuminatum (Kunth) Nied.—11179; woody epiphyte; EL3/SHR. PASO, PULU.

!*Disterigma alaternoides* (Kunth) Nied.—11235; woody epiphyte; RIV. Least Concern. MAQU.

Gaultheria erecta Vent—11409; shrub; EL3/SHR.

Gaultheria foliolosa Benth.—11173, 11174; AJP 5192; shrub; EL3/SHR. COTA, MAQU.

Gaultheria insipida Benth.—11251; AJP 5204; shrub; EL3/SHR. MAQU, PULU.

!*Gaultheria myrsinoides* Kunth—AJP 5462; shrub; EL3/SHR. Least Concern. COTA, CUIC, PULU.

!*Macleania ericae* Sleumer—11064; AJP 5175; shrub or epiphyte; EL1. Endemic. Vulnerable. MAQU.

Macleania macrantha Benth.—11171, 11246; SV69 (GW); AJP 5465; woody epiphyte; EL3/SHR. PULU.

!*Macleania rupestris* (Kunth) A.C. Sm.—11193; shrub; EL3. Least Concern. APAQ, PULU.

Macleania stricta A.C. Sm.—11226; shrub or epiphyte; EL1.

Psammisia coarctata (Ruiz & Pav.) A.C. Sm.—11020, 11096; shrub or epiphyte or liana; RIV/EL1.

Psammisia debilis Sleumer—11019, 11032, 11164; shrub or epiphyte; RIV/EL1. MAQU.

Psammisia graebneriana Hoerold.—11069; shrub or epiphyte; EL2. PULU.

Psammisia cf. *guianensis* Klotzsch—AJP 5385; shrub or epiphyte; EL1.

Psammisia sodiroi Hoer.—11078, 11182; SV74 (GW); shrub or epiphyte; EL2. MAQU, PULU.

Psammisia cf. *ulbrichiana* Hoer—11314; shrub or epiphyte; RIV. MAQU.

Sphyrospermum cf. *boekii* Luteyn—11401; shrub; EL3/SHR.

Sphyrospermum buxifolium Poepp. & Endl.—11150, 11348; AJP 5437; shrub or epiphyte; EL1. MAQU.

!*Sphyrospermum grandifolium* (Hoerold) A.C. Sm.—AJP 5189; shrub or epiphyte; EL3. Least Concern. MAQU.

!*Sphyrospermum sodiroi* (Hoerold) A.C. Sm.—11076; AJP 5504; epiphyte; EL2. Endemic. Vulnerable.

!*Thibaudia floribunda* Kunth—11261; shrub or epiphyte; EL3. Least Concern. MAQ, PULU.

Escalloniaceae

Escallonia myrtilloides L.f.—AJP 5459, 5519; shrub; EL3. COTA, CUIC, GUAN, MAQU, PASO, PULU.

!*Escallonia paniculata* (Ruiz & Pav.) Schult.—11099, 11228, 11316; tree; RIV. Least Concern. GUAN, MAQU, PULU.

Euphorbiaceae

!*Euphorbia laurifolia* Juss.—11396; tree; EL1. Native to Ecuador but cultivated at SVR. Least Concern. COTA, MAQU, PULU.

Sapium stylare Mull. Arg.—11356; AJP 6105; tree; EL1. MAQU.

!*Tetrorchidium rubrivenium* Poepp.—RJP 704; tree; EL2. Least Concern.

Fabaceae

!*Erythrina edulis* Micheli—11200; AJP 5500; tree; EL1. Least Concern. GUAN, INTA, MAQU.

!*Inga insignis* Kunth—11322; tree; FIE. Least Concern. GUAN.

Inga lallensis Spruce ex Benth.—11037; AJP 6144; tree; EL1. INTA.

**Phaseolus coccineus* L.—SV46 (GW); herb, native of Central America; EL1. MAQU, PULU.

Gesneriaceae

Alloplectus peruvianus (Zahlbr.) Kvist & Skog—SV3 (GW); AJP 5172; shrub; EL2.

!*Besleria modica* C.V. Morton—11015; SV60 (GW); AJP 5410; shrub or small tree; EL1. Endemic. Near Threatened.

Besleria reticulata Fritsch—11074, 11181; SV73 (GW); AJP 5441; shrub; EL2.

!*Besleria solanoides* Kunth—SV8 (GW); shrub; EL1. Least Concern. MAQU.

Columnea medicinalis (Wiehler) L.E. Skog & L.P. Kvist—11095; shrub; EL1. MAQU, PULU.

Drymonia teuscheri (Raymond) J.L. Clark—11011, 11350, 11427; SV57, SV56, SV58 (GW); NM 405; AJP 5185; shrub; EL1/EL2. MAQU.

Gasteranthus columbiana (C.V.Morton) Wiehler—11352, 11370; SV6 (GW); AJP 6101; shrub; EL1.

Gasteranthus pansamalanus (Donn.Sm.) Wiehler—11312; shrub; SV59 (GW); EL1.

Glossoloma cf. *ichthyoderma* (Hanst.) J.L. Clark—11083; shrub; EL2. PULU.

Glossoloma oblongicalyx (J.L. Clark & L.E. Skog) J.L. Clark—11209; shrub; EL1.

Glossoloma subglabrum J.L. Clark—NM 407; shrub; EL1.

Glossoloma tetragonoides (Mansf.) J.L.Clark—11142, 11154; NM 406; AJP 5404; shrub; EL1. MAQU, PULU.

Heppiella repens Hanst.—SV68 (GW); small subshrub; EL2.

Heppiella ulmifolia (Kunth) Hanst.—11090; SV121 (GW); shrub; RIV. CUIC, PASO, PULU.

Gunneraceae

Gunnera brephogea Linden & Andre—11112, 11299, 11321; giant herb; EL1/FIE. MAQU, PULU.

Hydrangeaceae

!*Hydrangea peruviana* Moric.—11382; liana; EL1. Least Concern. MAQU, PULU.

Lamiaceae

!*Aegiphila bogotensis* (Spreng) Moldenke—RJP 337; shrub; EL2. Least Concern. APAQ.

Lepechinia vesiculosa (Benth.) Epling—11135; shrub or small tree; FIE.

Minthostachys mollis (Kunth) Griseb.—SV42 (GW); herb; EL1. CUIC, PULU.

Salvia pauciserrata Benth.—11071, 111197; SV22 (GW); shrub; EL1/EL3.

Stachys lamioides Benth.—11212; SV41 (GW); trailing vine; EL1. MAQU.

Loasaceae

Klaprothia mentzelioides Kunth—11325; SV53 (GW); sprawling herb; EL1. MAQU.

Nasa peltiphylla (Weigend) Weigend—11395; SV115 (GW); shrub with stinging hairs; EL1.

Lythraceae

Cuphea racemosa (l.f.) Spreng—SV47 (GW); subshrub; EL1. MAQU.

Malvaceae

Bastardiopsis myrianthus (Planch. & Linden) Fuertes & Fryxell—11206; AJP 6147; small tree; EL1. MAQU.

Sida poeppigiana (Schumann) Fryxell—11107, 11139; shrub; FIE. MAQU, PULU.

Melastomataceae

Andesanthus gleasonianus (Wurdack) P.J.F. Guim. & Michelang.—11022; AJP 5176; tree; EL1. Vulnerable.

!*Axinaea quitensis* Benoist—11125, 11178, 11264; SV76 (GW); AJP 5496; tree; EL1/EL3. Endemic. Near Threatened.

!*Axinaea macrophylla* (Naudin) Triana—AJP 5457, 5467; tree; EL2. Least Concern. INTA, PASO.

!*Axinaea sodiroi* Wurdack—AJP 5439; tree; EL2. Endemic. Endangered.

Blakea cf. *acuminata* (Wurdack) Penneys & Judd–11369; tree; EL2.

Blakea punctulata (Triana) Wurdack—AJP 5491, 6102; liana or shrub; EL2.

Blakea quadriflora Gleason—11199; tree; EL1. MAQU.

!*Blakea rotundifolia* D. Don—11355, 11391; AJP 5499; tree; EL1. Endemic. Vulnerable. MAQU, PULU.

Brachyotum lindenii Cogn.—11404; shrub; EL3/SHR.

Meriania peltata L. Uribe—11163; tree; EL2. MAQU.

Meriania tomentosa (Cogn.) Wurdack—11081, 11280; NM 403; tree; EL2/EL3. APAQ, GUAN, INTA, MAQU, PULU.

Miconia cf. *aggregata* Gleason—11114, 11293, 11295, 11363, 11384; SV7, 96 (GW); AJP 5387; tree; EL1.

Miconia corymbiformis Cogn.—11260; tree; EL3. ALTO, APAQ, GUAN, INTA, PASO.

Miconia sp. A—11070, 11186; small tree; EL2/EL3.

Miconia sp. B—11140, 11115; SV127 (GW); liana or shrub; EL1.

Miconia sp. C—11364; tree; EL1.

Miconia sp. D—11253; small tree; EL3.

Miconia sp. E—11239; liana; EL1.

Miconia sp. F—11279; 11423; tree; EL3.

Miconia sp. G—11421; tree; EL3.

Miconia sp. H—SV61; tree; EL2.

Monochaetum hartwegianum Naud.—11089, 11126; SV128 (GW); shrub; FIE. MAQU, PULU.

Monochaetum lineatum (D. Don) Naudin—11093; shrub; FIE. MAQU, PULU.

Meliaceae

Guarea kunthiana A. Juss.—11056, 11065, 11383; AJP 5174; tree; EL1. GUAN INTA, MAQU.

!*Ruagea pubescens* H. Karst—11256, 11361, 11416, 11424; tree; EL1/EL3. Least Concern. ALTO, GUAN, PULU.

Moraceae

Ficus dulciaria Dugand—11041, 11168, 11385; AJP 5401; tree; EL1. GUAN, MAQU.

!*Ficus gigantosyce* Dugand—11337; AJP 6104; tree; EL1. Least Concern.

!*Morus insignis* Bureau—RJP 898; tree; EL1. Least Concern. INTA, MAQU, PULU.

Myricaceae

!*Morella pubescens* (Humb. & Bonpl. ex Willd.) Wilbur—11104, 11241; AJP 5475; tree; RIV/EL3. Least Concern. COTA, CUIC, GUAN, PASO.

Myrtaceae

!*Myrcia* cf. *crassimarginata* McVaugh/*fallax* (Rich.) DC—11153; RJP 989; AJP 5402; "Chuagola" tree; EL1. Least Concern.

!*Myrcianthes orthostemon* (O. Berg) Grifo—11014, 11211, 11381; RJP 878; small tree; EL1. Least Concern. MAQU.

Nyctaginaceae

!*Colignonia ovalifolia* Heimrl.—11313; SV93 (GW); liana; RIV. Least Concern.

Colignonia rufopilosa Kuntze—11277; liana; EL3. MAQU.

Onagraceae

Fuchsia dependens Hook.—11036, 11073; SV102 (GW); liana; EL1/EL2.

Fuchsia macrostigmata Benth.—11033, 11054; SV10 (GW); shrub; EL1. INTA, MAQU.

Fuchsia sessilifolia Benth.—11000; SV36 (GW); shrub; EL1. MAQU, PULU.

Orobanchaceae

Castilleja arvensis Schltdl. & Cham.—11127; herb; FIE. CUIC, PULU.

Oxalidaceae

Oxalis lotoides HBK—11191, 11414; vine; EL3. CUIC, MAQU, PULU.

Papaveraceae

Bocconia integrifolia Humb. & Bonpl.—11300; shrub; EL1. MAQU PULU.

Passifloraceae

Passiflora alnifolia Kunth—11214; SV48 (GW); liana; EL1. CUIC, MAQU, PULU.

Passiflora cumbalensis (H. Karst.) Harms—11220, 11419; liana; EL1/EL3.

Passiflora edulis Sims—11160; liana; EL1.

Passiflora gracillima Killip—AJP 5426; liana; EL2.

Passiflora ursina Killip & Cuatrec.—11198, 11349; AJP 5488; liana; EL1. PULU.

Pentaphylacaceae

Frezieria canescens Bonpl.—11254; AJP 5198; tree; EL3. APAQ, GUAN, MAQU, PULU.

Freziera reticulata Bonpl.—RJP 651; tree; EL2/EL3. MAQU.

!*Freziera tomentosa* Ruiz & Pav.—11101; AJP 5479; tree; RIV. Near Threatened. PULU.

!*Freziera verrucosa* (Hieron.) Kobuski—11262; AJP 5187, 5196; tree; EL3. Least Concern. MAQU, PULU.

Ternstroemia lehmannii (Hieron.) Urb.—RJP 249; AJP 5398; tree; EL2. INTA,

Phyllanthaceae

Hieronyma macrocarpa Müll.-Arg.—11149; tree; EL2. GUAN, INTA, MAQU, PULU.

Phytolaccaceae

Phytolacca bogotensis HBK—11305; SV11 (GW); shrub; EL1. COTA, CUIC, MAQU, PASO, PULU.

Polemoniaceae

Cobaea trianae Hensl.—11301; SV95 (GW); AJP 5180; NM 401; liana; EL1. MAQU.

Polygalaceae

Monnina hirta (Bonpl.) B. Eriksen—11061, 11131; shrub or small tree; FIE. PULU.

Monnina denticulata Chodat—11289; shrub or small tree; EL3.

Monnina pichinchensis B. Eriksen—11021, 11047; SV35 (GW); shrub or small tree; FIE/EL1. Endemic.

Primulaceae

Ardisia foetida Willd. ex Roem. & Schult.—11018, 11024; tree; EL1.

Geissanthus andinus Mez—11187, 11257; SV85 (GW); AJP 5195; shrub or small tree; EL3/SHR. APAQ.

Myrsine coriacea (Sw.) R. Br. ex Roem. & Schult.—11059, 11397; AJP 5507; tree; EL1. GUAN, MAQU, PULU.

!*Myrsine dependens* (Ruiz & Pav.) Spreng.—AJP 5199; small tree; EL3. Least Concern.

Rhamnaceae

Gouania sp.—11237; liana; EL1.

Rhamnus granulosa (R. & P.) M.C. Johnston—11105, 11157; AJP 5476; tree; RIV/EL1. GUAN, PULU.

Rosaceae

Hespermeles obtusifolia (Pers.) Lindl.—11247, 11402; shrub or small tree; EL3/SHR. APAQ, COTA, CUIC, PULU.

Prunus huantensis Pilg.—11415; tree; EL3. APAQ, INTA, MAQU, PASO

Rubus bogotensis Kunth—11387; trailing shrub; EL1. PULU.

Rubus boliviensis Focke—11145, 11398; shrub; FIE. MAQU, PULU.

Rubus glaucus Benth.—11003, 11144; shrub; FIE. MAQU.

Rubus roseus Poir.—11278; shrub; EL3.

Rubiaceae

Arcyctophyllum cf. *capitatum* (Benth) K. Schum.—11175, 11250; SV66 (GW); AJP 5190; shrub; EL3/SHR.

Cinchona pitayensis (Wedd.) Wedd.—AJP 6115; tree; EL1/EL3. GUAN.

!*Cinchona pubescens* Vahl—11063, 11218; tree; EL1. Least Concern. ALTO, INTA, MAQU, PULU.

Faramea cf. *calyptrata* C.M. Taylor—11012, 11362; AJP 5411; small tree; EL1. INTA, MAQU.

Faramea cf. *flavicans* (Roem. & Schult.) Standl.—AJP 6121; small tree; EL2.

Galium hypocarpium (L.) Endl. & Griseb.—11001; sprawling subshrub; EL1. CUIC, MAQU, PASO, PULU.

Gonzalagunia sororia Standl.—11048; SV34 (GW); shrub; EL1.

!*Guettarda crispiflora* Vahl—RJP 1028; small tree. EL1. Least Concern. PULU.

!*Guettarda hirsuta* (Ruiz & Pav) Pers.—RJP 50; small tree; EL1. Least Concern.

!*Hoffmannia ecuatoriana* Standl.—11008, 11165; SV101 (GW); shrub; EL1. Endemic. Endangered.

Manettia peruviana Standl.—11294; trailing shrub. EL1. MAQU.

Manettia recurva Sprague—11119; SV44 (GW); AJP 5432, 5442; vine; EL1. MAQU.

Nertera granadensis (Mutis ex L.f.) Druce—SV123 (GW); sprawling herb; EL1. PULU.

Notopleura sp.—11432; SV24 (GW); shrub; EL3.

!*Palicourea amethystina* (Ruiz & Pav.) DC.—11405, 11417; SV24 (GW); small tree; EL3. Least Concern. GUAN, INTA, MAQU.

!*Palicourea angustifolia* Kunth—11006, 11010, 11017, 11222; small tree; EL1. Least Concern. APAQ, INTA.

!*Palicourea calothyrsus* K. Schum. & K. Krause—11030, 11287; 11367; small tree; EL1. Vulnerable. MAQU, PULU.

Palicourea caprifoliacea Wernham—11038; small tree; EL1.

Palicourea lugoana C.M. Taylor—11152; SV14 (GW); small tree; EL1.

!*Palicourea lyristipula* Wernham—11013; AJP 5381; small tree; EL1. Least Concern.

!*Palicourea stipularis* Benth.—11288, 11124, 11190; small tree; EL1/EL3. Least Concern.

Psychotria cf. *convergens* C.M. Taylor—11009; small tree; EL1.

Psychotria sp. A—11207; small tree; EL1.

Psychotria sp. B—SV89 (GW); small tree; EL1.

Psychotria sp. C.—AJP 5395; shrub, fruits green; small tree; EL2.

Unknown genus—11354; small tree; EL1.

Rutaceae

Zanthoxylum quinduense Tul.—RJP 278; tree; EL2. GUAN, MAQU.

Zanthoxylum sp. "A"—11351; tree; EL1.

Sabiaceae

!*Meliosma frondosa* Cuatrec. & Idrobo—11274, 11347; AJP 6113; tree; EL1/EL3. Least Concern.

Salicaceae

Casearia javitensis Kunth—11359, 11201, 11309; AJP 5443; small tree; EL1.

!*Casearia quinduensis* Tul.—11016; tree; EL1. Extinct. MAQU.

Santalaceae

Dendrophthora chrysostachya (J. Presl) Urb.—11252; parasitic shrub; EL3/SHR. COTA, PULU.

Dendrophthora dodsonii Kuijt—AJP 6148; parasitic shrub; EL1.

Sapindaceae

Allophylus excelsus (Triana & Planch.) Radlk.—RJP 746; tree; EL2. GUAN, INTA.

Solanaceae

Capsicum lycianthoides Bitter—11123; SV91, 104 (GW); AJP 5182, 5386; shrub; EL1. MAQU.

Cestrum megalophyllum Dunal—AJP 5390; shrub; EL1. INTA, MAQU.

Cestrum petiolare Kunth—11270; AJP 5440; shrub; EL3.

!*Cuatresia harlingiana* Hunz.—11094; shrub; RIV. Endemic. Near Threatened. INTA, MAQU, PULU.

Deprea glabra (Standl.) Hunz.—11189, 11285; shrub; EL3. MAQU.

Deprea sachapapa (Hunz.) S. Leiva & Deanna—11203; shrub; EL1.

Iochroma calycinum Benth.—11060; SV116 (GW); shrub; EL1. MAQU.

!*Lycianthes radiata* (Sendtn.) Bitter—11007, 11204; SV105 (GW); AJP 6153; shrub; EL1. Least Concern. MAQU.

!*Solanum asperolanatum* Ruiz & Pav.—11025, 11132, 11341; small tree; EL1/FIE. Least Concern. MAQU, PASO, PULU.

!*Solanum cajanumense* Kunth—11035; shrub; EL1. Near Threatened.

Solanum colombianum Dun.—11216; AJP 6152; trailing vine; EL1.

!*Solanum fallax* Bohs—SV5 (GW); shrub; EL2. Near Threatened.

!*Solanum juglandifolium* Dun.—11122, 11215; SV87 (GW); AJP 5183; trailing vine; EL1/FIE. Least Concern.MAQU.

Solanum macrotonum Bitter—AJP 5477; herb; RIV. MAQU.

!*Solanum nutans* Ruiz & Pav.—11284, 11374, 11428; SV103 (GW); shrub or small tree; EL1. Least Concern. GUAN, MAQU.

Solanum sp. "A"—11353; shrub; EL1.

Solanum sp. "B"—SV106, SV27; shrub; EL1.

Trianaea nobilis Planch. & Linden—NM 404, AJP 6111; liana; EL1/EL2. MAQU.

Staphyleaceae

!*Turpinia occidentalis* (Sw.) G. Don—AJP 6100; tree; EL1. Least Concern. GUAN, INTA, MAQU.

Styracaceae

Styrax cordatus (Ruiz & Pav.) A. DC—11434; RJP 225; AJP 6119; tree; EL2.

Symplocaceae

!*Symplocos subandina* B.Stahl—RJP 784; tree; AJP 6112; EL2/EL3. Endemic. Vulnerable.

Theaceae

Gordonia fruticosa (Schrad.) H.Keng—11072, 11243; AJP 5463, 6114; tree; EL2/EL3. ALTO, APAQ, GUAN, INTA.

Thymelaeaceae

!*Daphnopsis equatorialis* Nevling—11433; AJP 5171, 5383; tree; EL2. Near Threatened.

Tovariaceae

Tovaria pendula Ruiz & Pav.—11291; sprawling subshrub; EL1. MAQU.

Tropaeolaceae

Tropaeolum adpressum D.K. Hughes—11128; AJP 5483; vine; FIE. MAQU.

Tropaeolum pubescens HBK—11425; vine; EL3. MAQU.

Urticaceae

!*Boehmeria celtidifolia* Kunth—RJP 686; small tree; EL2. Least Concern, PASO, PULU.

!*Boehmeria ramiflora* Jacq.—11344; shrub; EL1. Least Concern.

Cecropia angustifolia Trécul—11227; tree; EL1. INTA.

Cecropia gabrielis Cuatrec.—11223, 11225, 11238; RJP 44; tree; EL1. MAQU.

!*Cecropia maxima* Snethl.—11058; AJP 6145, 6146; tree; EL1. Vulnerable. INTA, MAQU, PULU.

Phenax hirtus (Sw.) Wedd.—11026; SV98 (GW); liana; EL1. MAQU.

Pilea arguta Wedd.—11117; succulent vine; EL1.

Pilea cf. *fallax* Wedd.—11185; succulent vine; EL3.

Pilea obetiifolia Killip—SV88 (GW); AJP 5416, 5417; epiphytic succulent herb, EL2.

Urtica leptophylla Kunth—11371; SV107 (GW); trailing vine; EL1. PULU.

Verbenaceae

Citharexylum montanum Moldenke—11426; AJP 6149; tree; EL2. GUAN, ALTO.

Viburnaceae

Viburnum pichinchense Benth.—11273; RJP 375; tree; EL3. MAQU.

Violaceae

Viola scandens Humb. & Bonpl. ex Roem. & Schult.—11413; vine; EL3. MAQU.

Vitaceae

Cissus erosa Rich.—11133; AJP 5436; liana; FIE.

Cissus obliqua Ruiz & Pav.—11080, 11210, 11219; liana; FIE/EL1. CUIC, MAQU.

Unknown family—11375; tree with opposite and palmately compound leaves and expanded petiole apex, leaflets to 17 × 6 cm, tapering to a short petiolule to 1.5 cm, not Bignoniaceae, Sapindaceae subfamily Hippocastanoideae, or Verbenaceae, filed as a *Billia* in Hippocastanceae but leaflets 5; EL1.

REFERENCES

Abrahamczyk, S., D. Souto-Vilarós, & S.S. Renner. 2014. Escape from extreme specialization: Passionflowers, bats and the sword-billed hummingbird. Proc. Biol. Sci. 281(1795):20140888. doi: 10.1098/rspb.2014.0888. PMID: 25274372; PMCID: PMC4213610.

Aguilar-Rodríguez, P., T.E. Krömer, M. Tschapka, J. García-Franco, J. Escobedo-Sartie, & M. Gonzales. 2019. Bat pollination in Bromeliaceae. Pl. Ecol. Diversity 12(1):1–19.

Blanco, M. & G. Barboza. 2005. Pseudocopulatory pollination in *Lepanthes* (Orchidaceae: Pleurothallidinae) by fungus gnats. Ann. Bot. 95(5):763–772.

Bucalo, K. 2016. Evaluating the evolutionary and genetic relationships of the Andean orchids of Northwestern Ecuador. M.S. thesis, Columbus State University, Columbus, GA, U.S.A.

Castaño, J., J. Carranza, & J. Pérez-Torres. 2018. Diet and trophic structure in assemblages of montane frugivorous phyllostomid bats. Acta Oecol. 91:81–90.

Cerón, C.E., C.I. Reyes & V. Nelson Gallo. 2006. Remanentes de bosque Altoandino en la cuenca del río Apaqui, Carchi-Ecuador. Cinchonia 7(1):28–39. Video at: https://issuu.com/jpintoz/docs/2006_cer_n_et_rembqaandcurapaquicar. Accessed July 2022.

Cerón, C.E. 2004. Reserva Geobotánica del Pululahua, formaciones vegetales, diversidad, endemismo, y vegetación. Cinchonia 5(1):1–108.

Cerón, J.C. 2013. Estructura y composición florística en un gradiente altitudinal de un remanente de bosque montano alto en el cantón Mejía, provincia de Pichincha. Tesis, Centro Universitario Quito, Eucador.

Chávez, A., C. Díaz, & J. Amanzo. 2018. Plants in the diet of Spectacled Bear (*Tremarctos ornatus*) in Corosha, Peru. https://fieldguides.fieldmuseum.org/sites/default/files/rapid-color-guides-pdfs/. Accessed September 2022.

Cochrane, T. & X. Cornejo. 2020. New species of *Podandrogyne* (Cleomaceae) IV. Two species from Western Ecuador and Western Colombia. Harvard Pap. Bot. 25:221–230.

Cuamacás, S.B. and G.A. Tipaz. 1995. Arboles de los Bosques Interandinos del Norte del Ecuador. Monografia No. 4, Museo Ecuatoriano de Ciencias Naturales.

Dellinger, A., D. Penneys, Y. Staedler, L. Fragner, W. Weckwerth, & J. Schönenberg. 2014. A specialized bird pollination system with a bellows mechanism for pollen transfer and staminal food body rewards. Curr. Biol. 24:1–5. 10.1016/j.cub.2014.05.056.

Gamba, D. & N. Muchhala. 2022. Pollinator type strongly impacts gene flow within and among plant populations for six Neotropical species. Ecology. 2023 Jan;104(1):e3845. doi: 10.1002/ecy.3845. Epub 2022 Oct 12. PMID: 36224746

Garzón, C. & K. Aguirre. 2002. Diagonostico preliminar biotico en Loma Redonda y La Primavera, Reserva Alto Choco, Fundacion Zoobreviven, Sector Intag., Quito, Ecuador.

Gentry, A. 1993. A field guide to the families and genera of woody plants of Northwest South America (Colombia, Ecuador, Peru). The University of Chicago Press, IL, U.S.A. and Conservation International.

Giannini, N. 1999. Selection of diet and elevation by sympatric species of *Sturnira* in an Andean rainforest. J. Mammalogy 80:1186–1195.

Harling, G. 1979. The vegetation types of Ecuador—a brief survey. In: K. Larsen & L. Holm-Nielsen, eds. Tropical Botany. Academic Press, London, UK.

Harling, G., B. Sparre, L. Andersson, C. Persson, R. Eriksson, B. Ståhl, & K. Romoleroux. 1973–2020. Flora of Ecuador. University of Gothenburg, Sweden, 97 vol.

Helmer E.H, E.A. Gerson, L.S. Baggett, B.J. Bird, T.S. Ruzycki, & S.M. Voggesser. 2019. Neotropical cloud forests and paramo to contract and dry from declines in cloud immersion and frost. PLoS ONE 14(4): e0213155. https://doi.org/10.1371/journal. pone.0213155. Accessed Sep 2022.

IUCN 2022. The IUCN Red List of Threatened Species. Version 2022-1. http://www.iucnredlist.org. Downloaded on October 1, 2022.

Kawasaki, M.L., B.K. Holst, & Á.J. Pérez. 2019. Myrtaceae. IN: Flora of Ecuador, vol. 95. University of Gothenburg, Sweden.

Keller, R. 2004. Identification of tropical woody plants in the absence of flowers, a field guide, 2nd edition. Birkhäuser Verlag, Switzerland.

Jiménez-Paz, R. 2016. Floristic composition, structure and diversity along an elevational gradient in an Andean forest of Northern Ecuador. Disertación previa a la obtención del título de Licenciado en Ciencias Biológicas, Pontificia Universidad de Católica del Ecuador, Quito, Ecuador.

Jiménez-Paz R., S.J. Worthy, R. Valencia, A.J. Pérez, A. Reynolds, J. Barone, & K. Burgess. 2021. Tree community composition, structure and diversity along an elevational gradient in an Andean forest of Northern Ecuador. J. Mountain Sci. 18(9):2315–2327. https://doi.org/10.1007/s11629-020-6479-3. Accessed July 2022.

Jørgensen, P. & S. León-Yánez, eds. 1999. Catalogue of the vascular plants of Ecuador. Monogr. Syst. Missouri Bot. Gard. 75:1–1181

Lagomarsino, L., E. Forrestel, N. Muchhala, & C. Davis. 2017. Repeated evolution of vertebrate pollination syndromes in a recently diverged Andean plant clade. Evolution 71(8):1970–1985. 10.1111/evo.13297.

León-Yánez, S., R. Valencia, N. Pitman, L. Endara, C. Ulloa Ulloa, & H. Navarrete, eds. 2011. Libro rojo de las plantas endémicas del Ecuador, 2nd ed. Publicaciones del Herbario QCA, Pontificia Universidad Catolica del Ecuador, Quito, Ecuador.

Luteyn, J. 2021. The plant family Ericaceae (“blueberries”) in Ecuador: Ecology, diversity, economic importance, and conservation. Revista Ecuatoriana de Medicina Ci. Biol. 42(2):79–98.

Machado, C., N. Robbins, M.T.P. Gilbert, & E.A. Herre. 2005. Critical review of host specificity and its coevolutionary implications in the fig/fig-wasp mutualism. Proc. Natl. Acad. Sci. U.S.A. 102:6558–6565.

(MAE) Ministerio del Ambiente Ecuador (Galeas, R., J, Guevara, B. Medina-Torres, M. Chinchero, & X. Herrera, eds.). 2013. Sistema de Clasificación de Ecosistemas del Ecuador Continental. Quito, Ecuador.

Marchese, C. 2015. Biodiversity hotspots: A shortcut for a more complicated concept, Global Ecol. Conservation 3:297–309.

Meisel, J.E. & C.L. Woodward. 2005. Andean orchid conservation and the role of private lands: A case study from Ecuador. Selbyana 26:49–57.

Muchhala, N. & P. Jarrin. 2002. Flower visitation by bats in cloud forests of western Ecuador. Biotropica 34(3):387–395.

Muchhala, N. & D. Proaño. 2009. Unpublished data from field surveys at Siempre Verde, Oct. 9–13, 2009. Ecuador.

Myers, N., R.A. Mittermeir, C.G. Mittermeir, G.A.B. da Fonseca, & J. Kent. 2000. Biodiversity hotspots for conservation priorities. Nature 403: 853–858.

Neill, N. 1999. Vegetation. In: Jørgensen, P. & S. León-Yánez, eds. Catalogue of the vascular plants of Ecuador. Missouri Botanical Garden Press, St. Louis, U.S.A.

Peñafiel, M. 2003. Flora y vegetación de Cuicocha. Ediciones Abya - Yala. 58 pág. https://digitalrepository.unm.edu/cgi/viewcontent.cgi?article=1280&context=abya_yala. Accessed March 2022.

Peñafiel, M., M. Tipán, L. Nolivos, & K. Vásquez. 2006. Biological diversity in Cotachachi's Andean forests. In: Development with Identity: Community, Culture and Sustainability in the Andes. Ed. R. Rhoades. CAB Books.

POWO. 2022. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew, UK. http://www.plantsoftheworldonline.org/. Retrieved 18 October 2022.

(PPG) Pteridophyte Phylogeny Group (Eric Scheuttpelz & 93 others). 2016. A community-derived classification for extant lycophytes and ferns. J. Syst. Evol. 54(6):563–603.

(PRONAREG) Programa Nacional de Regionalizacion Agraria. 1984. Soil map. 1:50,000. Instituto Geografico Militar, Quito, Ecuador

Reynolds, A. 2011. Protected forest reserve, Siempre Verde, land management plan. Report submitted to the Ministry of Environment, Ecuador.

Reynolds, A. 2022. Guide to the orchids of SVR, Imbabura, Ecuador. Blurb, Inc.

Roy, B. A., M. Zorrilla, L. Endara, D.C. Thomas, R. Vandegrift, J.M. Rubenstein, T. Policha, B. Ríos-Touma, & M. Read. 2018. New mining concessions could severely decrease biodiversity and ecosystem services in Ecuador. Trop. Conservation Sci. 11:1–20.

Sanín, M.J. & G. Galeano. 2011. A revision of the Andean wax palms, *Ceroxylon* (Arecaceae). Phytotaxa 34:1--64.

Santander, T. + 13 others. 2021. Ecology of plant-hummingbird interactions in Yanacocha, Ecuador. National Geographic Society. https://docslib.org/doc/11654921/ecology-of-plant-hummingbird-interactions-in-yanacocha-ecuador. Accessed August 2022.

Stevens, P.F. (2001 onwards). Angiosperm Phylogeny Website. Version 14, July 2017 [and more or less continuously updated since]." http://www.mobot.org/MOBOT/research/APweb/. Accessed March 2022.

Ulloa Ulloa, C. & P.M. Jørgensen. 1993. Arboles y arbustos de los Andes del Ecuador. AAU Rep. 30:1–264.

Valencia, R. & P.M. Jørgensen. 1992. Composition and structure of a humid montane forest on the Pasochoa volcano, Ecuador. Nord. J. Bot. 12:239–247. Copenhagen.

Vandegrift, R., D. Thomas, B. Roy, & M. Levy. 2018. The extent of recent mining concessions in Ecuador. Rainforest Information Center, Nimbin, New South Wales, Australia

van der Werff, H. 2020. Studies in Andean *Ocotea* (Lauraceae) V. Species with unisexual flowers and sparsely appressed-pubescent or glabrous leaves without domatia occurring above 1000 m in altitude. Novon 28(3):192–230. https://doi.org/10.3417/2020450 Accessed April 2022.

Webster, G.L. 1995. The panorama of neotropical cloud forest. In: S. Churchill, H. Balslev, E. Forero, & J.Luteyn, eds. Biodiversity and Conservation of Neotropial Montane Forests. New York Botanical Garden, New York, U.S.A.

Webster, G.L. & R.M. Rhode. 2001. Plant diversity of an Andean cloud forest: Checklist of the vascular flora of Maquipucuna, Ecuador. University of California Press, Berkeley and Los Angeles, U.S.A. Updates at https://maqui.ucdavis.edu/. Accessed September 2022.

Wilson, S.J. & J.M. Rhemtulla. 2018. Small montane cloud forest fragments are important for conserving tree diversity in the Ecuadorian Andes. Biotropica 50(4):586–597.

Worthy, S.J. 2016. Phylogenetic analyses of Andean and Amazonian tree communities in Ecuador. M.S. thesis, Columbus State University, Columbus, GA, U.S.A.

Worthy, S.J., R.A. Jiménez-Paz, Á.J. Pérez, A. Reynolds, J. Cruse-Sanders, R. Valencia, J.A. Barone, & K.S. Burgess. 2019. Distribution and community assembly of trees along an Andean elevational gradient. Plants, MDPI. 18 pp. https://www.mdpi.com/2223-7747/8/9/326/htm. Accessed March 2022.

Worthy, S.J., K. Bucalo, E. Perry, A. Reynolds, J. Cruse-Sanders, A.J. Pérez, & K.S. Burgess. 2022. Ability of *rbc*L and *mat*K DNA barcodes to discriminate between montane forest orchids. Pl. Syst. Evol. 308:19. https://doi.org/10.1007/s00606-022-01809-z. Accessed March 2022.

Young K.R. & P.L. Keating. 2001. Remnant forests of Volcán Cotacachi, Northern Ecuador. Arctic, Antarctic, & Alpine Res. 33(2):165–172

Zapata-Blanco, J. 2019. Composición y estructura de epífitas vasculares en un gradiente altitudinal en un Bosque Montano Alto, Imbabura, Ecuador. Disertación previa a la obtención del título de Licenciado en Ciencias Biológicas, Pontificia Universidad de Católica del Ecuador, Quito, Ecuador.