







## Describing and diffusing the ethnobotanical knowledge of Bogotá D.C. (Colombia) through an online tool focused on common names of plants

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Received: September 30, 2018

Accepted: March 28, 2019

### ABSTRACT

Although ethnobotanical knowledge is considered potentially valuable information for several human disciplines, it is currently declining due to a decrease in the transmission of cultural knowledge and the depletion of natural resources. Consequently, focused efforts are required to compile such information and ultimately facilitate its diffusion. Bogotá D.C. consists of a large territory of rural and urban zones which has become a place of diverse cultural dynamics due to complex processes of historical evolution, making it an important target to conserve ethnobotanical knowledge. Here, we made a thorough compilation of ethnobotanical data for Bogotá focusing on plant common names and developed a freely available online tool (Platform of Plant Common Names of Bogotá) with the aim of preserving and promoting the transmission of biocultural heritage. The compiled dataset consists of over 2,226 combinations between scientific and common names which may be queried using the online tool, leading to specific pages that display several additional features. Since its launch, the online tool has been visited over 6200 times, mainly by Colombian users under the age of 34, which is conveniently in line with our goal of improving the intergenerational transmission of biocultural heritage.

**Keywords:** common names, ethnobotanical knowledge, online tools, biocultural heritage, Bogotá D.C.

## Introduction

Ethnobotanical knowledge holds great potential value for several aspects of human disciplines and activities, such as medicine and conservation biology. However, the ongoing loss of cultural heritage due to the overall deprivation of natural resources, the adoption of modern lifestyles and the decline of traditional spaces for vertical and horizontal means transmission entails a greater risk of loss of this knowledge (Edwards & Heinrich 2006; Pilgrim *et al.* 2008; Vandebroek & Balick 2012). Consequently, the need to promote the dissemination of ethnobotanical knowledge among different sectors of society is becoming increasingly evident.

In the last decades, efforts to disseminate and regulate the conservation of this knowledge has been carried out by different entities and research groups. The Convention for the Safeguarding of Intangible Cultural Heritage by the UNESCO, whose participant states have agreed to identify, research, protect, conserve, transmit and restore several features of this cultural heritage (UNESCO 2003), is the main regulatory framework for many endeavors regarding heritage conservation, which encompasses a fraction of the practices and knowledge of biological resources and often referred in some contexts as biocultural heritage (SOLAE 2016) or intangible cultural heritage (UNESCO 2003).

Even though preserving cultural heritage is essential, it is not enough for its long-term conservation if not combined

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with efforts for an efficient transmission of knowledge. In this context, some recent works (Thomas 2003; Parra *et al.* 2010; Subires 2012; Tamayo & Leite 2015; Monge 2017; Torres & Delgado 2017) have shown the importance of implementing information technologies (ITs) for the diffusion of tangible and intangible cultural heritage. They all conclude that ITs effectively extend the reach of transmission of this knowledge to a wider and more diverse public in comparison to traditional media, also hinting that, if properly executed, the digitalization of cultural heritage is an efficient strategy for its conservation, allowing the public not only to receive the content that is being transmitted but also to interact, produce and share their own knowledge.

Finding solutions to close the gaps between scientific and popular knowledge, promote methodological approaches to study plants from different disciplines, enable intergenerational rapprochement and recognize the value of regional biocultural heritages are great challenges that require the synthesis of high quality and openly available information transmitted in an adequate language. In spite of this, botanical studies are in most cases unknown to the non-scientific public, and in the case of ethnobotany, results and research outcomes are usually not socialized with the local communities in which the research was conducted. Fortunately, the current trend of moving toward open science and open data has led to a narrowing of the gap between science and the non-scientific community (Dai *et al.* 2018), as well as opening up an opportunity to incorporate ITs for the diffusion of knowledge. Those who support open science argue that knowledge should be freely available, helping scientists to cooperate with open data and networks, as well as creating openly available platforms and ultimately making science more accessible for citizens (Fecher & Friesike 2014).

In this work, we opted to use common names as a key element for communicating ethnobotanical knowledge. It is well known that although plants are known by their scientific names in academic environments, they are most widely known by their common (also regarded as vernacular, popular and vulgar) names (Gledhill 2002), which are technically called phytonyms. Common names are popular distinctions that do not obey to strict scientific rules, since the same name can be applied to different plants in the same place, so the same plant species might have several common names depending on the area (Pérez 1978; Magaña 2006). In addition to being used for practical purposes by local non-scientific communities, common names can also be regarded as a tool for appropriation and biocultural identity (Álvarez 2006; Fajardo *et al.* 2013).

There are numerous approaches to ethnolinguistics and ethnotaxonomy that have made important contributions worldwide. Works focused on common names in Spanish-speaking countries carried out in the Iberian Peninsula (Álvarez 2006; Fajardo *et al.* 2013; García 2016) have provided information on common names applied to plants

by Spanish settlers; other works carried out in Latin America (Baeza 1920; Hernández *et al.* 1994; Galeote 1997; Magaña 2006; Moraes *et al.* 2006; Muiño *et al.* 2006; Torre *et al.* 2008; López 2012; Martínez 2012) provide data about the loanwords of Indo-European and Amerindian languages. In South America, the work of Bernal *et al.* (2017) stands out as a national level compilation of data for Colombia, in which resolution is given at department level (first-level administrative subdivisions of the country). However, considering the vast cultural and biological diversity of this country, further studies at more local levels are required.

Here, we use Bogotá D.C., the capital city of Colombia, as our focal study area to examine and compile ethnobotanical data. Located at an altitude of 2,640 m in the eastern cordillera of the Andes, Bogotá has suffered a complex process of historical evolution and cultural admixture that led to different relationships between the population and its territory, along with ecological and cultural dynamics around the plants by urban and rural inhabitants from all regions of the country. Bogotá became the destination of massive migrations of people fleeing from civil (Mejía 1997; Arenas 2009) and independence wars (Jaramillo 1989), which along with the industrialization of agricultural activities and the expansion of the urban frontier (Cardeno 2007), led to an accentuated phenomenon of miscegenation and cultural loss (Jarro 2005). The *Bogotazo* marked the beginning of a period of bipartisan violence that spread throughout the country until a few decades ago and produced population displacements throughout the country and a consequent population growth in the city (Jaramillo 1989; Arias 1998). In the 1950's, some neighbouring municipalities occupied by people displaced from the departments of Boyacá and Cundinamarca due to the armed conflict, were annexed to Bogotá (Cardeno 2007; Jarro 2005). With these events, the population of Bogotá exponentially increased in the last fifty years from 1,697,311 inhabitants in 1962 (Cardeno 2007) to approximately 8,181,047 inhabitants in 2017 (DANE 2018). All of this has drawn our interest to understanding how the inhabitants of the city and its surrounding areas relate to the vegetal cover in terms of applied names and uses.

Despite the growing bibliographical production on ethnobotany, especially about plant use (Pérez 1934; Gutiérrez *et al.* 2011; Mahecha *et al.* 2011; Sierra & Amarillo 2014; Ortiz *et al.* 2015; Mahecha 2015; Pérez & Matiz 2017) and etymological data (Montes 1963; 1978; 1997; Acuña 1983; Torres 1998; Giraldo 2014; 2016; Gómez 2017; Portilla 2015), research in Bogotá has been focused on very specific localities or limited by particular approaches and directed only at the academic public. Moreover, the available information is currently scattered over multiple sources of consultation; therefore the general public cannot easily access information about the wide diversity of common names and reported uses for the plants growing in Bogotá.

This study represents a combined effort from academia and public institutions to promote the appropriation of



natural and cultural heritage, facilitate the communication of this knowledge between different corners of society and also to provide valuable insights to conserve, recover and apply these resources. The outcome was the development of an online, free access tool designed for citizens: the Platform of Plant Common Names of Bogotá (in Spanish: Plataforma de Nombres Comunes de las Plantas de Bogotá), in which users are able to query information about plants occurring in Bogotá D.C. by their common names.

## Materials and methods

### Study Area

Data compilation was restricted to The Capital District (D.C.) of Bogotá, which is located on the Cordillera Oriental of the Colombian Andes 4°42'N, 74°4'W, 2,640 m a.s.l. (Fig. 1). It has an area of 163,635.88 Ha, in which 25 % of it corresponds to the urban territory while the remaining



**Figure 1.** Location of Bogotá D.C.

75 % is rural land. In the latter, the predominant land cover towards the south and east of the area is paramo, followed by pastures and crops, especially in its peripheries, with relictual high Andean forest located mainly in the south and in mountainous areas, in addition to a relictual coverage of scrubland and subxerophytic grasslands concentrated towards the south and southwest of the region. All of these covers have different levels of anthropic intervention (Isaacs & Jaimes 2014). The city has an approximate area of 2,944 Ha (5041 zones in total) of green urban coverage, composed mainly by parks and sports venues (Secretaría de Cultura, Recreación y Deporte 2017).

### Data Compilation

The common names of the vascular plants occurring in Bogotá were compiled from secondary information (specimens from the JBB, UDBC and COL herbaria, catalogs of useful species, trees and gardening guides, floristic inventories, technical reports, historical or literary documents, among others) and complementary field work mainly carried out between 2015 and 2016 by conducting 83 semi-structured interviews with subjects (hereafter called informants), in both urban and rural areas in Bogotá D.C. Informants were mostly owners, inhabitants or managers of the properties where collected plants were growing. They were selected following the “snowball sampling” approach as described by Bryman (2012).

The interviews revolved around four main inquiries about the plants growing on the informants’ gardens or orchards: (1) whether they know of the existence of a plant’s common name, (2) what was the associated common name, (3) why are they called that way, and (4) what (and how) is the plant used for. When possible, a photographic or video record of the species and their uses was taken, and botanical specimens were collected, identified and stored in the Herbarium of the Botanical Garden of Bogotá (JBB).

### Data cleansing and annotation of complementary information

Once the information was consolidated, the nomenclatural and taxonomic validation was carried out against botanical collections at JBB Herbarium (Jardín Botánico de Bogotá José Celestino Mutis 2018), the Catalog of plants and lichens of Colombia (Bernal *et al.* 2015) and Common names of plants in Colombia (Bernal *et al.* 2017) for native plants, and the Taxonomic Name Resolution Service (Boyle *et al.* 2013) for non-native plants. In addition, attributes of (i) origin, (ii) habitat, (iii) growth form, (iv) use category and (v) etymology were also annotated by some of the criteria described below.

(i) Information of origin was assigned using an adaptation of the World Geographical Scheme for Recording Plant Distributions employing the regional scheme (Brummitt 2001).

(ii) A classification of the identified species according to their growth form was made and ten categories were adapted from botanical dictionaries, as listed and described in Table S1 in supplementary material (Font Quer 1953; Moreno 1984).

(iii) Each taxon was assigned to the type of habitat in which it is located (urban, rural and/or conserved). Such information was obtained directly from the secondary source (scientific literature, floristic inventories, or metadata of herbarium specimens).

(iv) For the use category, we adapted the classification of Pérez & Matiz (2017), which is presented in Table S2 in supplementary material.

(v) We obtained some of the etymological data of the registered common names from the explanations of the informants, although most of the data were acquired from bibliographic resources, especially in the etymology of American, Colombian and Bogotan Spanish. A detailed approach to the linguistic aspects of common names in the data set is currently being constructed (A Pachón & A Rodríguez unpubl. res.). However, we preliminarily made a categorization into three groups according to their origin: scientific (those that come directly or indirectly from scientific names such as *Anturio*, *Begonia*, *Dalia* or *Eucalipto*), genetic (those that come from languages other than Spanish, such as Indo-European or indigenous such as *Arrayán* and *Chilco*, respectively), and popular (those that come from metaphors or analogical routes that were assigned by different motivations such as *Corono* or *Ojo de poeta*). We also used a fourth category under the term “unknown” for those common names in which we were unable to find etymological data. For names derived directly from the scientific nomenclature, sources dedicated to the etymology of scientific names were used and, in some cases, we refer to the original descriptions of the species or protologues containing this information.

In addition to the aforementioned complementary information for each taxa, we also included hyperlinks to illustrations of the *Digitalization project of the drawings of the Royal Botanical Expedition to the New Kingdom of Granada* in The Real Jardín Botánico-CSIC webpage (Real Jardín Botánico-CSIC 2017).

### Availability, functionality and monitoring of the online tool

The development and design of a website within the domain of the Botanical Garden of Bogotá (Platform of Plant Common Names of Bogotá: <http://coleccion.jbb.gov.co/nombrescomuneshogota/>) was conducted to enable the citizens to perform simple queries on the compiled database (Fig. 2). In the home page, users may perform queries by either common names or scientific names. Each query may lead to two types of information pages: one

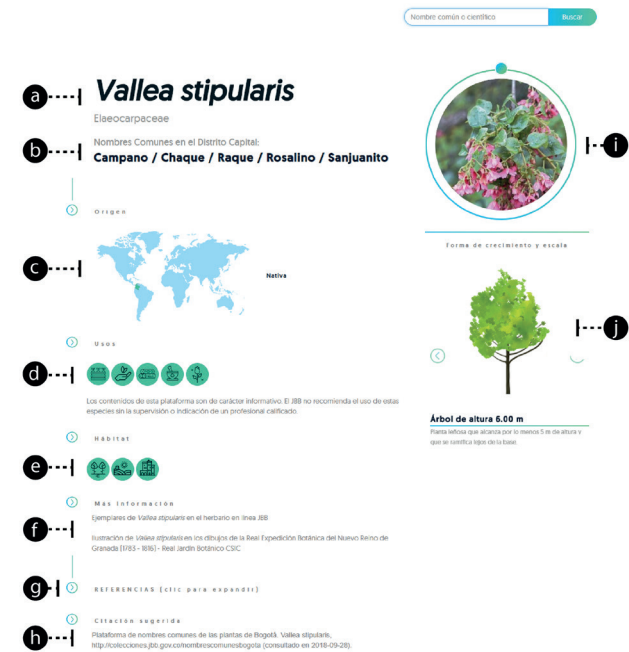


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focused on species attributes (common names, pictures of living specimens, origin, uses) (Fig. 3) and another one focused in the matching between scientific and common names (etymological data and lexicography, common name pronunciation, multimedia and references) (Fig. 4). Given that this resource was primarily designed for the local population of the study area, the entirety of its contents are in Spanish.



**Figure 2.** Homepage of the Platform of Plant Common Names of Bogotá website



**Figure 3.** Search result for scientific name. **A.** Scientific name and botanical family, **B.** Common names of plant reported in Bogotá D.C., **C.** Origin of taxa, **D.** Plant uses reported in Bogotá D.C. **E.** Type of hábitat, **F.** Link to other information sources of the specie, **G.** Sources, **H.** How to cite this record, **I.** Pictures of living specimens, **J.** Habit growth form and height.

Since its launch, website traffic was tracked monthly using the Google Analytics web service to monitor the preferences of visitors, focusing on traffic statistics such as *users* (number of people visiting the website at least once within a selected timeframe), *new users* (number of people

that have visited the website for the first time within a selected timeframe), and *sessions* (total number of visits). We also obtained demographic data such as the geographical origin of the visits by country and region.



**Figure 4.** **A.** Audio file with common name pronunciation; **B.** Transcription of common name to International Phonetic Alphabet (IPA); **C.** Common name; **D.** Scientific name and botanical family; **E-F.** Etymological data of common name; **G.** Sources; **H.** How to cite this record; **I.** Pictures of living specimens; **J.** Additional multimedia material of specie (texts, video, hyperlinks).

## Results

### Compiled data set

We obtained a data set of 4,140 records represented by 1,133 taxa associated with 1,566 common names. In this context, we regard a record as a unique combination of a common name with a plant species (scientific name) and a source. Moreover, the unique combination of a common name with a plant species (scientific name) regardless of the source, which were denominated in this work as *combinations*, reached a total of 2,226 (Table S3 in supplementary material).

One hundred and thirty (130) sources were consulted for obtaining *combination* records and were classified into articles (197), informative materials (35), herbarium specimens (351), technical reports or unpublished report by professionals of the entities (808), books (579), literary works (47), web resources (470) and informants (1653).

Regarding complementary information, 193 sources were used to investigate the origin of taxa, 58 sources for habitat, 105 for use category and 87 for etymological data (Table S4 in supplementary material).

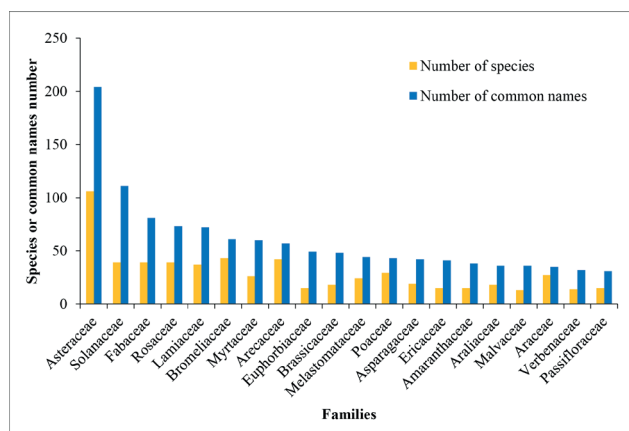
### Description of botanical data

Out of a total of 1,133 taxa, 960 were identified at the species level, 168 at the genus level and five up to family level. Taxa included in our dataset represent a total of 595 genera in 150 families. Native and non-native species



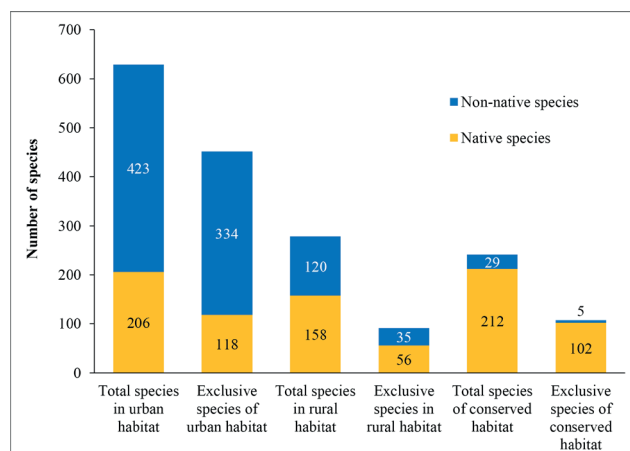
correspond to 491 and 468 of taxa, respectively. For the 2050 native and 684 non-native plant species reported for Bogotá D.C. (Línea Flora de Bogotá y Colecciones de Referencia unpubl. res.), we found common names for 16.8% and 69.7% of them, respectively.

Asteraceae was the family with the highest number of reported common names, followed by Solanaceae, Fabaceae, Rosaceae and Lamiaceae (Fig. 5). Note that the number of common names is always higher than the number of species per family, due to the association of more than one common name for a given species. This set represents 53% of the taxa of the entire data group and 54% of the common names.



**Figure 5.** Families with the highest number of associated common names.

Regarding the type of habitat, plants growing on urban areas had the greatest contribution of species with associated common names (Fig. 6). Among growth forms, terrestrial herbs contributed with most of the common names (36%), followed by trees (25%) and shrubs (19%), with the remaining 20% being vines, epiphyte herbs, subshrubs, palms, ferns, aquatic herbs and arborescent ferns.



**Figure 6.** Native and non-native species according to habitat.

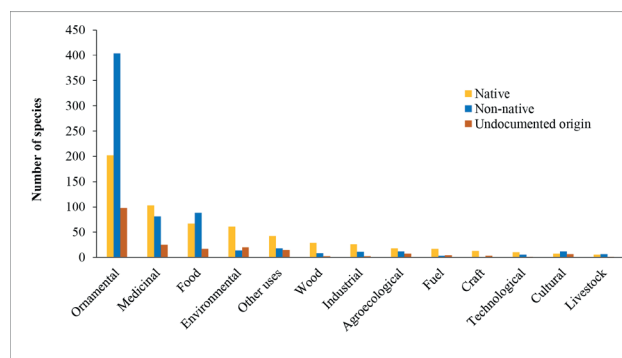
The geographic origin of taxa identified at species level is shown in Table 1, in which most of the introduced species come from Asia, followed by Africa, Europe and, to a lesser extent, those from other regions of the American continent.

**Table 1.** Number of plant species with common names in Bogotá according to the place of origin.

| Place of origin                               | Number of species |
|-----------------------------------------------|-------------------|
| Asia                                          | 92                |
| Africa                                        | 70                |
| South America                                 | 69                |
| Europe                                        | 51                |
| Central America                               | 43                |
| Oceania                                       | 36                |
| Europe, Africa, Asia                          | 34                |
| Europe, Asia                                  | 29                |
| North America                                 | 14                |
| Central America, South America                | 10                |
| Africa, Asia                                  | 5                 |
| Asia, Oceania                                 | 5                 |
| North America, Central America                | 3                 |
| Europe, Asia, North America                   | 2                 |
| Europe, Africa                                | 2                 |
| Central America, The Caribbean                | 1                 |
| Central America, The Caribbean, South America | 1                 |
| The Caribbean                                 | 1                 |
| Uncertain origin                              | 1                 |

### Plant use data

As shown in Table 2, *Macleania rupestris* and *Myrcianthes rhopaloides* (both of them being abundant species in high Andean forests) were the ones with the highest number of reported uses. Most of the widely used species are native, with the most frequent use category being ornamental (34%), medicinal (17%) and environmental (10%). Moreover, the number of native and non-native species reported for each use category is shown in Figure 7, in which white bars represent taxa that are not identified at the species level, so the origin cannot be associated with certainty and were thus excluded from Table 2, but were included here since they contribute to the total taxa for each use category.



**Figure 7.** Number of taxa that were reported for each of the use categories.

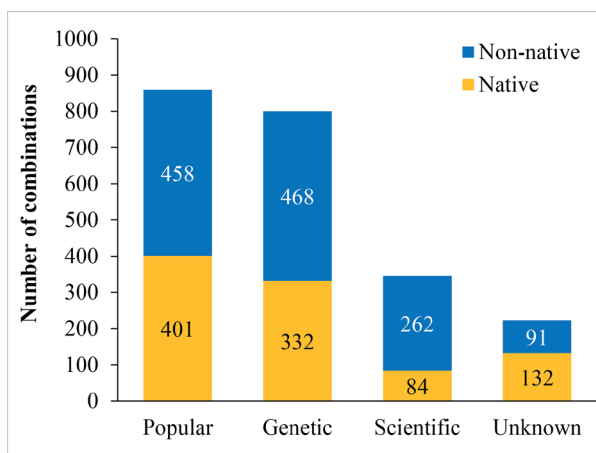
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**Table 2.** Species with the largest number of registered uses. N: native, E: non-native, Ag: agroecological, Te: technological, Or: ornamental, Me: medicinal, Wo: wood, In: industrial, Cu: cultural, Fu: fuel, Fo: food, En: environmental, Cr: craft, Li: livestock, O: other.

| Species                        | Origin | Number of uses | Use category                   |
|--------------------------------|--------|----------------|--------------------------------|
| <i>Macleania rupestris</i>     | N      | 8              | Ag, Or, Me, Wo, In, Fu, Fo, En |
| <i>Myrcianthes rhopaloides</i> | N      | 8              | Or, Me, Wo, In, Fu, Fo, En, O  |
| <i>Alnus acuminata</i>         | N      | 7              | Ag, Te, Or, Me, Wo, In, En     |
| <i>Myrcianthes leucoxyla</i>   | N      | 7              | Or, Me, In, Cu, Fo, En, O      |
| <i>Prunus serótina</i>         | E      | 7              | Ag, Or, Me, Wo, Fo, En, O      |
| <i>Hesperomeles goudotiana</i> | N      | 6              | Or, Me, Wo, In, Fo, En         |
| <i>Phytolacca bogotensis</i>   | N      | 6              | Ag, Te, Or, Me, En, Cr         |
| <i>Vaccinium meridionale</i>   | N      | 6              | Ag, Or, Me, In, Fo, En         |
| <i>Weinmannia tomentosa</i>    | N      | 6              | Ag, Me, Wo, Fu, En, O          |
| <i>Baccharis latifolia</i>     | N      | 5              | Or, Me, Fu, En, O              |
| <i>Bucquetia glutinosa</i>     | N      | 5              | Or, Wo, Fu, En, O              |
| <i>Chenopodium quinoa</i>      | E      | 5              | Or, In, Cu, Fu, Fo             |
| <i>Lafoensia acuminata</i>     | N      | 5              | Te, Or, Wo, En, Cr             |
| <i>Malva sylvestris</i>        | E      | 5              | Te, Li, Or, Me, O              |
| <i>Morella parvifolia</i>      | N      | 5              | Or, Me, Cu, Fo, En             |
| <i>Morella pubescens</i>       | N      | 5              | Or, Me, Wo, En, Cr             |
| <i>Opuntia ficus-indica</i>    | E      | 5              | Or, Me, In, Fo, En             |
| <i>Pinus patula</i>            | E      | 5              | Te, Or, Me, Fu, O              |
| <i>Salix humboldtiana</i>      | N      | 5              | Or, Me, In, En, Cr             |
| <i>Sambucus nigra</i>          | E      | 5              | Or, Me, Wo, Cu, O              |
| <i>Vallea stipularis</i>       | N      | 5              | Or, Me, Wo, Fu, En             |

### Description of etymological data

To visualize proportions among categories of etymological origins, we used combinations rather than common names as units, given that a same common name applied to different species (or scientific names) may have a different motivation or etymological root. Figure 8 shows the number of combinations for each category, also indicating whether the species in the combination is native or non-native. Proportions between native and non-native species within each category are also shown.



**Figure 8.** Number of combinations in each category of etymological origin.

Common names of uncertain etymological origin or no available information (unknown category) represent 14.5 % of all the taxa in our dataset.

As shown in Table 3, plants with up to 19 common names were detected, with an overall average of 1.4 common names per species along our entire data set. Out of the 10 species that have eight or more common names, *Solanum tuberosum* stands out first since it has numerous cultivated varieties and is an important component in the diet of the inhabitants of the region, followed by *Macleania rupestris*, which as stated earlier, is the species the highest number of reported uses.

**Table 3.** Plant species with the highest number of common names in Bogotá.

| Species                        | Number of common names |
|--------------------------------|------------------------|
| <i>Solanum tuberosum</i>       | 19                     |
| <i>Macleania rupestris</i>     | 12                     |
| <i>Tropaeolum tuberosum</i>    | 12                     |
| <i>Euphorbia pulcherrima</i>   | 9                      |
| <i>Oxalis tuberosa</i>         | 9                      |
| <i>Canna indica</i>            | 8                      |
| <i>Cedrela montana</i>         | 8                      |
| <i>Gomphrena globosa</i>       | 8                      |
| <i>Myrcianthes rhopaloides</i> | 8                      |
| <i>Ullucus tuberosus</i>       | 8                      |

The top ten common names assigned to the highest number of different plant species are presented in Table 4. Those names are usually associated with a group of species belonging to higher ranked taxa such as *orquídea* (family Orchidaceae), *helecho* (Division Polypodiophyta), *pino* (family Pinaceae), and others that correspond to smaller groups as genera or even infrageneric groups of closely related species (i.e. *Quiche*, *Salvia*, *Curuba*, *Encenillo*).

**Table 4.** Common names applied to the largest number of species in Bogotá.

| Common name | Number of species |
|-------------|-------------------|
| Quiche      | 10                |
| Tinto       | 10                |
| Cortadera   | 9                 |
| Curuba      | 9                 |
| Tillandsia  | 9                 |
| Tuno        | 9                 |
| Chite       | 8                 |
| Palo blanco | 8                 |
| Zarcillejo  | 8                 |
| Chilco      | 7                 |

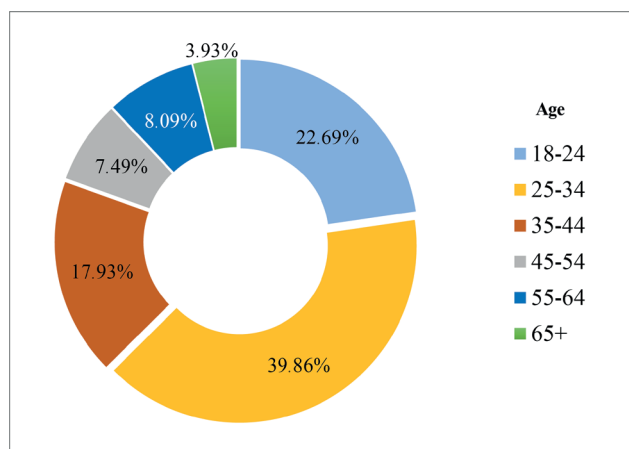
Of the total common names documented in this study, 78% apply to a single species, 53% of the species receive a single common name and 27% of the combinations consist in species that receive only one common name.



## Online dataset and web traffic data

After its launch in October 2017, the Platform of Plant Common Names of Bogotá counts with the dataset described in the previous sections to enable users' queries. It also contains a number of other features such as 1209 pictures of living plants representing 418 taxa (representing a 37 % of all taxa in the database), 218 text fragments associated with 294 combinations, 285 video clips associated with 452 combinations and 45 hyperlinks to illustrations of the *Digitalization project of the drawings of the Royal Botanical Expedition to the New Kingdom of Granada* (Real Jardín Botánico-CSIC 2017).

Up to September 2018, there have been 6261 sessions, and since the trend stabilized after a peak in November 2017 (briefly after its launch date), there has been an average of 450 sessions per month. The reported number of users in 11 months is 3785, with 94 % of them being from Colombia (Fig. S1 in supplementary material). Because 34 % of users had registered Google accounts during their visits, we could also obtain age range information from Google Analytics, as shown in Figure 9.



**Figure 9.** Percentage of user age ranges according to their registered Google accounts.

## Discussion

The main achievement of this study was enabling the community to get access to our thoroughly compiled ethnobotanical data set through the Platforms of Plant Common Names of Bogotá, representing the most comprehensive synthesis of information at a local scale for this particular location. For a comparison, a very similar project was conducted at the entire national level for Colombia (Bernal *et al.* 2015: <http://www.biovirtual.unal.edu.co/nombrescomunes>). Such database holds a number of records for the department of Cundinamarca (a first-level administrative division) that is approximately close to the ones reported here for Bogotá D.C., considering that the

latter is spatially embedded in the former and corresponds only to a 6.5 % of its total area.

Other analogous studies and projects have been carried out in several locations around the world which also incorporate virtual tools, such as the Hawaiian Ethnobotany Online Database (<http://data.bishopmuseum.org/ethnobotanydb/ethnobotany.php?b=list&o=1>), the Native American Ethnobotany database de Dan Moerman (<http://naeb.brit.org/>) or Bangladesh Ethnobotany online database (<http://www.ebbd.info/about-us.html>) to name a few. Nonetheless, the potential for knowledge transmission of virtual media has not been fully exploited. Until 2005, out of 40 worldwide level studies aimed at preserving and restoring biocultural diversity, only four of them mention the use of databases to promote transmission of knowledge to the communities, with three of them being in Australia (Edwards & Heinrich 2006).

## Insights from the ethnobotanical dataset

We found that about 27 % of the plants that grow in Bogotá, (including both native and non-native) have at least one common name. In other words they are recognized and/or used in some way by citizens, which assign vernacular names as an important element for the successful communication of knowledge, acting as a bridge to the scientific community and political decision-makers to enhance the appropriation and perpetuation of the biocultural heritage of the Capital District.

Local institutions are constantly interacting with the community, leading to several resulting technical reports that contribute a high number of combinations (see Technical reports in Tab. S5 in supplementary material). However, a large fraction of this sources of information has not been formally published, and because they are not easily accessible, we suspect most of them remain largely unreviewed. This lead us to believe that the ethnobotanical work of the region may be underestimated. For this reason it is necessary to promote ethnobiological research and train scientists to produce high-quality studies on the subject, as recommended by some authors (Albuquerque *et al.* 2013).

We also highlight the information recorded on the labels of herbarium specimens (contributing 16 % of the combinations in the dataset). This underscores the valuable potential of specimen labels for interdisciplinary research, so the correct appropriation of ethnobotanical information in biological collections must be as rigorous as the rest of the information they contain in order to be able to make accurate and useful analyzes.

Of all the 3132 vascular-plant species reported for Bogotá D.C. (Línea Flora de Bogotá y Colecciones de Referencia unpubl. res.), 27 % of them had at least one associated common name. This percentage is similar to the 29 % of plants with common names reported for Colombia (Bernal *et al.* 2015; Bernal *et al.* 2017). Although Asteraceae was



## Describing and diffusing the ethnobotanical knowledge of Bogotá D.C. (Colombia) through an online tool focused on common names of plants

remarkably the most represented family in our common name dataset with 106 (9.5%) taxa (Fig. 2), this number is not surprising given that it is the second most speciose plant family in Colombia and also in America (Ulloa *et al.* 2017). Members of this family are also abundant in all zones and ecosystems with different degrees of human intervention, also presenting several use categories such as food, medicinal, and ornamental among others. Other families worth mentioning are Bromeliaceae and Arecaceae, which mainly comprise species of ornamental use, and families such as Fabaceae, Rosaceae, Solanaceae and Lamiaceae which have more representation due to their nutritional and medicinal use.

Regarding the type of habitat, the fact that the majority of combinations came from the urban zone was expected given the higher population density, and also because it was a more thoroughly sampled zone during our fieldwork studies (Tab. S5 in supplementary material). Other reasons will be further explained later when variables such as origin and use category are integrated. Urban habitats usually have a high number of exclusive non-native species in their gardens or orchards. Nevertheless, the high number of native species reported with common names exclusively in urban areas is striking (Fig. 3). This underlines the importance of densely populated areas as socioecological memory reservoirs (Barthel *et al.* 2010), and biocultural mosaics (Cuvi 2017). In contrast, the relatively high proportion of native species in conserved habitats ratifies them as important sites for the conservation of not only biodiversity but also its associated traditional knowledge, which is particularly vulnerable to stressors of anthropic origin. Despite the fact that rural areas did not present a high number of exclusive species, their importance as a connector of urban and conserved areas is evident.

The number of exclusive species in the different environments also show a dissociation between natural and urban environments, not only as a result of the involuntary changes in coverage due to anthropic intervention, but also because of the intentional incorporation of non-native or transplanted species in gardening and urban trees, which is not always done to promote functionality and connectivity but to respond to landscape or purely aesthetic perspectives that favor the transnationalization of species, as evidenced by the highly invasive *Thunbergia alata*, a species introduced from eastern Africa (Vélez & Herrera 2015).

Our results reiterate the calls of several other authors to direct the ethnobiological studies towards the most populated areas, which are the ones that have the greatest environmental impact (Barthel *et al.* 2010; Hurrell 2014; Emery & Hurley 2016). Knowing how to configure urban spaces and having an idea of the popular knowledge associated with the plants that citizens are growing can improve communication and undertake research, conservation and working plans on functional and sustainable green areas with communities as suggested

by recent works (Caicedo *et al.* 2016; Emery & Hurley 2016; Sierra & Amarillo 2017).

On the other hand, with two-thirds of the area of Bogotá D.C. being non-urban, our results show the need to increase the sampling in rural and conserved areas, in order to detect key species for conservation strategies that might be ecologically vulnerable and whose loss may also have consequences in their associated cultural heritage, as shown by the low number of native species exclusive to rural areas (Fig. 3), and by the exclusive use of native species for handicraft.

The origin of most of the non-native plant species is usually from geographically distant continents (Asia, Africa and Europe), while those from neighboring regions paradoxically contribute to a lesser extent in species richness. It is also worth noting that the contribution of non-native species from other areas of South America is close to that of Central America, North America and the Caribbean (Tab. 1), hinting a strong influence of horticulture and domestication of plants for human consumption.

Plant species with the highest frequency of use categories are herbs (35.9%), in which the ornamental, medicinal and food uses stand out. Paradoxically, herbs also include most of the plants whose presence are considered undesirable and have motivated the implementation of management plans for control or eradication, such as weeds that grow in crops or other areas with high anthropic intervention.

Ornamental use is the dominant in the global data group. As explained above, this is expected due to the urban habitat being the most densely populated one and the one that receives most of the contributions from foreign species, which is in accordance with previous studies (Freire *et al.* 2014; Cuvi 2017; Sierra & Amarillo 2017). On the other hand, the importance of ornamental plants decreases in rural areas, since basic needs such as health and food make the plants with those respective use categories acquire greater relevance and therefore represent greater diversity and species richness, as supported by data from other studies (Castellanos 2011; Ortiz *et al.* 2015; Pérez & Matiz 2017).

Medicinal use occupies the second place in terms of number of species. Within this category, 39 % of the species are non-native, 49 % are native and the rest are species of which we do not have taxonomic resolution to associate information of origin. Even though native plants represent a majority in this use category, we consider that the proportion of non-native plants is unexpectedly high, likely because of massive human migration events in the last decades. However, further studies are required to reveal the motivations behind the preference of non-native plants over their native counterparts. Whether the inclusion of non-native plants expands the repertoire of natural medicines for treating poorly known ailments, or the knowledge has been lost for native species (Medeiros *et al.* 2017) is something that remain to be answered. On the other hand, this information contains data of potential medicinal use



that may be of pharmacological interest and that have not been approved yet (Fonnegra & Jiménez 1999) nor have been the subject of research.

Similarly, our results also show that plant species with food and cultural use are also dominated by non-native species (Fig. 4). This is interesting since probably some of the introduced plants have conserved the associated knowledge from their place of origin or have been appropriated to such a level that they are part of the cultural practices of the region. In this sense, it is noteworthy that the plants used for handicraft are exclusively native, so it is advisable to inquire about this knowledge to promote its conservation as biocultural knowledge associated with native species.

As evidenced by their dominance, non-native species are an important component of Bogotá's flora, both because of the diversity and richness they represent in taxonomic terms, as well as the wealth of knowledge that they bring from their places of origin or that they bring out in the citizens who appropriate them. For these reasons, these plants, as well as the native ones, must be studied in detail to determine their positive and negative contributions to the configuration of the landscape and ecosystem services.

The species with the highest number of reported uses was the highly abundant *Macleania rupestris*, which is also second in having the highest number of associated common names with 12. This might raise inquiries regarding the use of number of common names per species as indirect indicators for prioritization conservation management plans, identification of important species in socio-economic matters, or even potential alert of invasion (e.g. *Canna indica* is reported as potential invasive species in urban wetlands, Camelo *et al.* 2012).

Our preliminary analysis on the etymological origin of the documented common names shows that popular motivations are the most frequent drivers of name assignment, being applied indistinctly to both native and non-native plants. Genetic influence was found in the second instance, that is, the one that comes from the linguistic Pre-Columbian routes (e.g. *Chicalá* a Muisca voice for trees with colorful flowers (Giraldo 2014), *Paico* a Quechua voice for *Dysphania ambrosioides* [Montes 1997]) or other external languages that have influenced the Spanish language in Bogotá and that have prevailed (e.g. *Sábila* from Hispanic Arabic for *Aloe vera* and *Perejil* derived from Latin [Corominas 2008]). Despite their difficult pronunciation by Spanish speakers, we found a strong influence of the scientific names perpetuated or modified by commercial and horticultural processes, as they have been integrated into the local flora (e.g. *Epidendro*, derived from *Epidendrum*, and *Eucalipto*, derived from *Eucalyptus*). The wealth of social processes that Bogotá D.C. has suffered since its inception, being the destination of displacements and migrations from all over the country, has turned it into a biocultural mosaic where numerous influences converge and that are evident in the local plant names employed by its inhabitants, and also can

be an explanation to the high percentages of non-native plant species that we find in this study.

### *Insights from the online tool*

Besides the plethora of advantages of using online tools to bring together the citizenship with valuable knowledge, current web analytic tools bring the additional benefit (in this case for researchers) of monitoring several trends and features of the visiting users that might eventually be insightful for the purpose of ethnobotanical research. In our case, a relevant finding besides the sheer number of users is that the online tool is being employed by people under the age of 34. This is in line with one of our goals of serving as an intergenerational bridge for the transmission of biocultural heritage knowledge, which was obtained from historical sources and informants of over an age of 50, who are not regular users of ITs.

Although our online tool is relatively new and is initially intended for local use in Bogotá D.C., it poses as a relevant contribution to the proper use of common names and associated ethnobotanical that may serve as a basis for assigning and implementing conservation plans for endangered species, restoration of ecosystems, bioprospecting and control of invasive plants, among others. We hope that the Platform of Plant Common Names of Bogotá, being a free access and intuitive tool, accomplishes its purpose in diffusing the essential ethnobotanical information compiled here and to promote citizens participation spaces to narrow the existing information gaps.

This overview reveals an important field of action for interdisciplinary work, requiring the cooperation of different entities and the contribution of technical and financial resources for the development of further open access virtual tools not only to achieve the goals mentioned so far in this study but also for their implementation as educational and research resources.

## Acknowledgements

We thank the professionals of the Botanical Garden of Bogotá, as well as other external people who contributed with information associated with the plants of Bogotá D.C. We also thank Anyi Pachón for the contributions in the etymological categorization, Néstor García for his aid in the establishment of use categories, the intern students for their assistance in the project, Andrés Del Risco for the review and translation of this document along with Scott Bridges.

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