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Floristic study and conservation value analysis of the Jordán river middle basin forest (Jujuy, Argentina)

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Abstract. The floristic study and the conservation value analysis of forest from the Jordan river middle basin are addressed in this research. This vegetation forms part of the subtropical mountain forests or Yungas, one of the most diverse ecosystems on Earth. Present forest species were surveyed, and the vegetation Interest Conservation index (INCON) was determined based on a series of conservation value criteria (Phytocenotic, Territorial, Mesological, Ethnobotanical, Perceptual and Didactics) recorded in the field. Available data on socio-cultural aspects of the area was also included in the study. All plants were identified up to genera and/or species. INCON was calculated from the sum of scoring assigned to each analyzed criterion. As a result, 42 forest species were identified; for each one, its conservation status was performed, including the altitudinal vegetation belt, biogeographical origin (at least for the genus), and their ethnobotanical value. The INCON obtained (135 points) showed the high natural, ethnocultural, landscape, and educational value of these forest vegetation according to the criteria analyzed. This information provides a useful tool to have a more precise knowledge of the diversity conservation status of Las Yungas. It also serves to recognize the biological and environmental relevance of this area, whose usefulness can be used for conservation purposes or decision making on protection plans.
Keywords: Yungas; Subtropical forest; floristic composition; vegetation assessment; conservation; Serranía de Calilegua; East of Jujuy.

Estudio florístico y análisis valorativo de la vegetación arbórea de los bosques subtropicales de montaña o "Yungas" de la cuenca media del río Jordán (Jujuy, Argentina).

Resumen. En este trabajo se aborda el estudio florístico y el análisis valorativo de la vegetación de los bosques subtropicales de montaña o "Yungas" de la cuenca media del río Jordán (Jujuy, Argentina). Para ello, se muestrearon las especies arbóreas presentes y se determinó el índice de Interés de Conservación (INCON) de la vegetación en base a criterios valorativos (Fitocenóticos, Territoriales, Mesológicos, Etnobotánicos, Percepcionales y Didácticos) registrados en el campo y extraídos de la información disponible sobre los aspectos socioculturales del área. Se determinó la riqueza específica, de géneros y familias botánicas. INCON se calculó a partir de la suma de los valores de cada uno de los criterios analizados. Como resultado, se identificaron 42 especies arbóreas, para cada especie se estableció su status, piso altitudinal de vegetación y origen biogeográfico del género y se consignó su valor etnobotánico. El valor máximo de INCON obtenido (135 puntos) refleja el elevado valor natural, etnocultural, paisajístico y didáctico de la vegetación de estos bosques en relación a los criterios analizados. La información resultante constituye una herramienta para la valoración de la diversidad, así como de la importancia biológica y ambiental del área de estudio que puede ser utilizada para fines de conservación y protección.
Palabras clave: Yungas; bosque subtropical; composición florística; estudio de la vegetación; conservación; Serranía de Calilegua; Este de Jujuy.

Introduction

The floristic studies and vegetation assessment allow for updating the species list of a region, but also to know the diversity and to evaluate the conservation status of the existing vegetation formations. Faced with the degradation and loss of biodiversity of many natural ecosystems, the work of surveying, describing and monitoring the floristic richness and vegetation conservation analysis becomes of fundamental importance. They provide a diagnosis jointly on the plant resources of territory and contribute to implement strategies for their conservation and sustainable management (Meaza, 2000; Anon., 2005; Lepetz *et al.,* 2009; Schmeller *et al.*, 2009; Giorgis *et al*., 2011).

The biological diversity of tropical and subtropical forests of Latin America is one of the highest on the planet, despite the significant exploitation perpetrated on its natural resources and its ecosystems transformation, many of them unique in the world. Particularly in the far north of Argentina, there is a remarkable formation of subtropical mountain forests or "Yungas" that is very well represented in the Provinces of Jujuy and Salta. These forests are identified as the essential biodiversity hotspot in Argentina (Burkart, 2005). However, they are a

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critical ecosystem threatened by the agricultural frontier expansion, indiscriminate felling, extensive livestock farming, fires and the development of urbanizations in inaccessible areas. These activities are transforming, degrading, and causing the loss of their biodiversity, which historically has been mainly a source of timber, medicinal, and food resources. Yungas deforestation has been taking place for more than a century, it dates back to the colonial era and has increased in the last forty years, from 18% of transformed forests in 1970 to 31% based on data from the year 2010 (Arambarri *et al*., 2009; Malizia *et al*., 2012).

The northern Yungas of Argentina constitutes a dense pluviseasonal formation that develops along a marked altitudinal (400–3500 m asl), bioclimatic, topographic, and geomorphological gradient. Such environmental complexity determines the great biological diversity and the high number of endemisms that exhibit its flora and vegetation adapted to climatic conditions specified by alternating warm-humid and temperate-dry seasons, with frosts and winter snowfalls in the summit areas.

The Argentine Yungas represent less than 2% of the surface of the country (about 5,2 million hectares); however, this small area lodge approximately 40-50% of the biodiversity of Argentina. For this reason, in 2002, the Las Yungas Biosphere Reserve (RBYungas) was created within the framework of the UNESCO Man and Biosphere Program, to implement actions focused on its conservation and sustainable management. The RBYungas is the second largest one in Argentina, it occupies 1,350.000 hectares distributed in the Provinces of Jujuy and Salta and stretches along a 300 and 3500 m asl altitudinal gradient (Pacheco & Brown, 2006; Malizia *et al*., 2012).

The floristic and vegetation studies of northern Argentina Yungas are still insufficient, and the quantitative data on their biodiversity are incomplete. It is mainly due to the high floristic richness of this forest formation and the diversity and complexity of its plant communities. In this sense, and to contribute to the knowledge of these forests, the study of the forest flora of Jordan river middle basin, an emblematic area from the biological, environmental, and landscape point of view, located within the RBYungas, was carried out. As a particular objective, the conservation value analysis of the forest vegetation was addressed preliminarily to determine the Interest of Conservation of the area index (INCON) and, with this, merit its inclusion within Calilegua National Park Core Zone, a protected area adjacent to the study area.

Materials and Methods

Study Area

The study area covers the Jordan river middle basin (23° 39’ S / 64° 56’W, 1400−1550 m asl) located in Serranía de Calilegua, a sub-Andean mountain range that extends from Perú to the extreme north of Argentina in the Valle Grande Department (Province of Jujuy, Argentina) (Figure 1). This orographic system constitutes the first barrier where the humid winds coming from the Atlantic Ocean condense and contribute to the regulation of the water networks (Bermejo river high basin). The regional climate, especially of the rainfall regime and amount, which are responsible for the dense forest cover that typifies this territory. The basin runs through geological faults that make up a very narrow channel with a marked slope (over 35%) in a strongly steep environment, difficult to access and transit, delimited by stunning outcrops and vertical ravines (Figure 2, Appendix 2). Throughout the area, there is a dense formation of subtropical mountain forests or Yungas that belong to the classic Tucumano-Bolivian Rainforest (Hauman, 1931) and represent the transition between the upper belt of the *Montane Rainforest* and the *Montane Forest* of the Yungas Phytogeographic Province (Cabrera, 1994) (Figure 3, Appendix 2). These forests are assimilated to the Sub-Andean and Montane Boliviano-Tucumano semideciduous and seasonal evergreen vegetation of the Bolivian-Tucumanan Biogeographic Province (Tropical South Andean Region) (Navarro, 2011; Navarro & Maldonado, 2002; Rivas-Martínez *et al*., 2011). The bioclimate of the area is Mesotropical Pluviseasonal upper subhumid, with lower humid places (Entrocassi *et al*., 2014). In its lower section, the Jordan River flows into hot springs visited by its scenic beauty and therapeutic properties (for healing rheumatic and skin diseases). This site is also considered a magical place and a spiritual retreat.

The basin located in the buffer zone of the Las Yungas Biosphere Reserve is adjacent to the Calilegua National Park Core Zone. According to the Territorial Ordination Plan of Native Forests in Jujuy Province, it has the Red category for Forest protection that defines it as an area of high conservation value that should not be transformed.

Figure 1. Location of Jordan river basin in the province of Jujuy (black triangle).

Figure 2. View of the Jordan river middle basin.

Figure 3. Panoramic view of the middle basin of the Jordan river located in the Serranía de Calilegua.

Floristic study

Three sampling campaigns were carried out during the fall and spring of 2016 and the summer of 2017. The survey and collection of the tree species were done on open hillsides with different slopes, in low or medium height ravines, and riparian environments associated with the basin (terraces and fluvial beaches). On each collection site, the following data were recorded: height above sea level, geographic coordinates, hillside

exposure, topography, and edaphic characteristics. The studied surface covered approximately 5 km^2.

The taxonomic determination of the species collected were developed at the Centre for Research and Studies on Plant Diversity (Cie.Di.Ve.) of the Agricultural Sciences Faculty, National University of Jujuy. Specific literature was consulted (Boelcke, 1992; Burkart, 1952; Cabrera, 1978, 1983, 1993; Digilio & Legname, 1966; Font Quer, 1953; Hunziker, 1984, 1995/2007; Hutchinson, 1982; Job, 1953; Legname, 1982; Novara, 1994, 2012; Orsi, 1976; Parodi, 1972; Romeo & Sánchez, 2005; Romeo & Cruz, 2008; Zapater *et al*., 2004; Zuloaga & Morrone, 1996, 1999a, 1999b; Zuloaga *et al*., 1999, 2008; Zuloaga, 2014).

The scientific nomenclature updating, the assignment of the status of each species (endemic, restricted or with wide distribution) and the species distribution in the altitudinal vegetation belts (*Montane Rainforest* and the *Montane Forest*) was carried out according to the Catalogue of Vascular Plants of the Southern Cone (Zuloaga, 2014) and the list of the trees of the Yungas of Argentina (Brown & Malizia, 2007). The list of species that make up the forest flora of the study area was made with this information (Table 1). Subsequently, the specific wealth was established, and the most diverse families were identified. The percentage of identified species was also calculated with respect to the total number of forest species of the Yungas of Argentina (Brown & Malizia, 2007), as well as their conservation status according to the IUCN Red List (www.iucnredlist.org). The biogeographical origin of each genus was indicated, taking as a reference to Quiroga's study (2010).

Table 1. List of tree species of the study area. S (Status): E, endemic; R, restricted; A, broad distribution. BOG (Biogeographic origin of the genus): N, Neotropical; P, Pantropical; H, Holarctic; Au, Austral. AVB (Altitudinal vegetation belt): MR, Montane Rainforest; MF, Montane Forest; Pmf, Pre-Montane Forest. * Species with ethnobotanical value.

Species	Family	S	BOG	AVB
Allophylus edulis *	Sapindaceae	A	P	MR
Alnus acuminata *	Betulaceae	R	H	MF
Berberis jujuyensis	Berberidaceae	E	C	MR
Blepharocalyx salicifolius *	Myrtaceae	A	N	MR
Bocconia integrifolia *	Papaveraceae	R	N	MR
Bougainvillea stipitata *	Nyctaginaceae	A	N	MR
Carica quercifolia *	Caricaceae	A	N	MR
Cedrela angustifolia *	Meliaceae	R	N	MR
Celtis iguanaea *	Celtidaceae	A	H	MR
Crinodendron tucumanum	Elaeocarpaceae	R	Au	MF
Croton piluliferus	Euphorbiaceae	E	P	MR
Cupania vernalis *	Sapindaceae	A	N	MR
Duranta serratifolia	Verbenaceae	R	N	MR
Erythrina falcata *	Fabaceae	A	P	MR
Ilex argentina *	Aquifoliaceae	R	C	MF
Juglans australis *	Juglandaceae	R	H	MR
Kaunia lasiophtalma	Asteraceae	R	P	MR
Kaunia saltensis	Asteraceae	E	P	MR
Maytenus verticillata *	Celastraceae	E	P	MF
Myrcianthes mato *	Myrtaceae	R	N	MR
Myrcianthes pseudomato *	Myrtaceae	R	N	MR
Myriocarpa stipitata	Urticaceae	A	N	MR
Myrsine coriacea	Primulaceae	A	N	MR
Myrsine laetevirens *	Primulaceae	A	N	MR
Nectandra angusta *	Lauraceae	A	N	MR
Ocotea porphyria *	Lauraceae	R	N	MR
Oreopanax kuntzei *	Araliaceae	E	N	MR
Parapiptadenia excelsa *	Fabaceae	R	N	MR
Pisonia zapallo *	Nyctaginaceae	A	N	MR
Podocarpus parlatorei *	Podocarpaceae	R	Au	MF
Prunus tucumanensis *	Rosaceae	R	H	MF
Ruprechtia apetala	Polygonaceae	A	N	MR-Pmf

Species	Family	S	BOG	AVB
Sambucus nigra subsp. *peruviana* *	Adoxaceae	R	H	MF
Sapium haematospermum	Euphorbiaceae	A	P	MR
Sebastiania brasiliensis *	Euphorbiaceae	A	P	MR
Senna spectabilis	Fabaceae	E	P	MR
Solanum riparium	Solanaceae	R	C	MR
*Styrax subargenteus**	Styracaceae	R	H	MR
*Tecoma stans**	Bignoniaceae	A	N	MR
Tipuana tipu *	Fabaceae	R	N	MR
Vassobia breviflora *	Solanaceae	A	N	MR
Zanthoxylum coco *	Rutaceae	A	P	MR

Conservation status analysis of vegetation

The Interest Conservation (INCON) of the basin forest vegetation was determined following Meaza (2000) methodology. It suggests the use of 16 criteria to analyze the role played by vegetation on ecosystem stability and balance. It scores ranging from 0 to 20 applied to each criterion, being 200 the maximum total score to be assigned to a plant group. In this study 11, vegetation conservation status criteria were analyzed: of the natural order (Phytocenotic, Territorial and Mesological) and cultural order (Ethnobotanical, Perceptual and Educational) (Table 2), the criteria of Representativeness, Spontaneous regenerability, Rarity, Relictism and Finicole feature of the vegetation were not applied for not having sufficient and reliable information, this impacted on the final score of INCON since it discounted 60 points to the conservation status analysis carried out. Biological and environmental information recorded in the field and documented using other studies that expanded and adjusted the information on the ecological and socio-cultural characteristics of the area (Government of the Province of Jujuy, 2010; Lomáscolo *et al*., 2010; Malizia *et al*., 2012) was considered for the assignment of the score to the criteria used. Particularly, the ethnobotanical evaluation was designated from the traditional uses of tree species as Non-Wood Forest Products (NWFP) (medicinal, food, dyer, forage, ornamental, fuel, tanning, rituals, stimulants, fibers, handicrafts, construction, tools, and instruments making) that were reported by other authors for the northern Argentine Yungas (Brown & Malizia, 2007; Hilgert, 2007; Arambarri *et al*., 2009; Novara, 2012). The INCON of the studied area was obtained from the summation of the scores assigned to the 11 evaluation criteria analyzed (Appendix 1).

The Bioclimatic typology of the province of Jujuy maps (Entrocassi *et al*., 2014), based on the Worldwide bioclimatic classification system (Rivas-Martínez, 2008; Rivas-Martinez *et al*., 1999, 2011) were used for the bioclimatic characterization of the study area.

Results and Discussion

In this study, 42 trees species belonging to 39 genera, and 29 families were recorded (Table 1). More than half of the identified species (57%) are endemic and restricted to the Argentine Yungas: 6 species (14%) are endemically unique to the northern Yungas (Jujuy and Salta), and 18 species (43%) have a restricted distribution throughout the Yungas (Jujuy, Salta, Tucumán and Catamarca). The remaining 18 species (43 %) have a wide distribution (they are distributed in the Yungas and other biogeographic units) (Table 1).

Table 2. Criteria used in the conservation status analysis of the Jordan river middle basin forest vegetation, based on Meaza (2000). * A very relevant criterion due to its diagnostic value.

Conservation status criteria	Description	Score range
Phytocenotic	**1- Diversity** (specific richness): the number of species that make up the vegetation studied is considered.	1 to 10
	2- Maturity: the structural and dynamic state of the vegetation is considered.	2 to 20 *
Territorial	**3- Endemicity**: the presence of endemic taxa and endemic plant groups are considered.	0 to 10
Mesological	**4- Geomorphological Function:** qualifies the protective role of the vegetation cover against gravitational and morphogenetic processes.	2 to 20 *
	5- Climatic Function: qualifies the regulatory role of vegetation cover over local climate and especially the topo-microclimatic one.	1 to 10
	6- Hydrological Function: describes the protective role of the vegetation cover on the regulation and hydric characteristics.	1 to 10
	7- Edaphic Function: describes the protective role of the vegetation cover on the generation, evolution, and characteristics of the soil.	1 to 10
	8- Faunistic Function: describes the protective role of the vegetation cover as a refuge, support, and trophic reservoir for fauna.	1 to 10

Conservation status criteria	Description	Score range
Cultural	**9- Ethnobotanical Value:** evaluates the ethnocultural interest of plants and vegetation (mainly the traditional uses of tree species and historical, archaeological, religious, mythological, symbolic, recreational, etc. aspects).	2 to 20 *
	10- Perceptual Value: assesses the perceptive relationship of man versus vegetation (scenic, aesthetic, and experiential).	1 to 10
	11- Didactic Value: assesses the academic interest of vegetation natural and cultural aspects.	1 to 10

Of the 29 families identified, the most diverse ones were Fabaceae (4 species) and Euphorbiaceae and Myrtaceae (3 species each); 6 families presented two species (Asteraceae, Lauraceae, Nyctaginaceae, Primulaceae, Sapindaceae, and Solanaceae) and 20 families were represented by one single species (Figure 4). These results coincide with other studies that include Fabaceae, Euphorbiaceae, and Myrtaceae among the most diverse and ecologically important families of the *Montane Rainforest* of Argentinian Yungas (Malizia *et al*., 2012; Martín, 2014; Haagen Entrocassi, 2014; Entrocassi, 2016; Entrocassi *et al*., 2019).

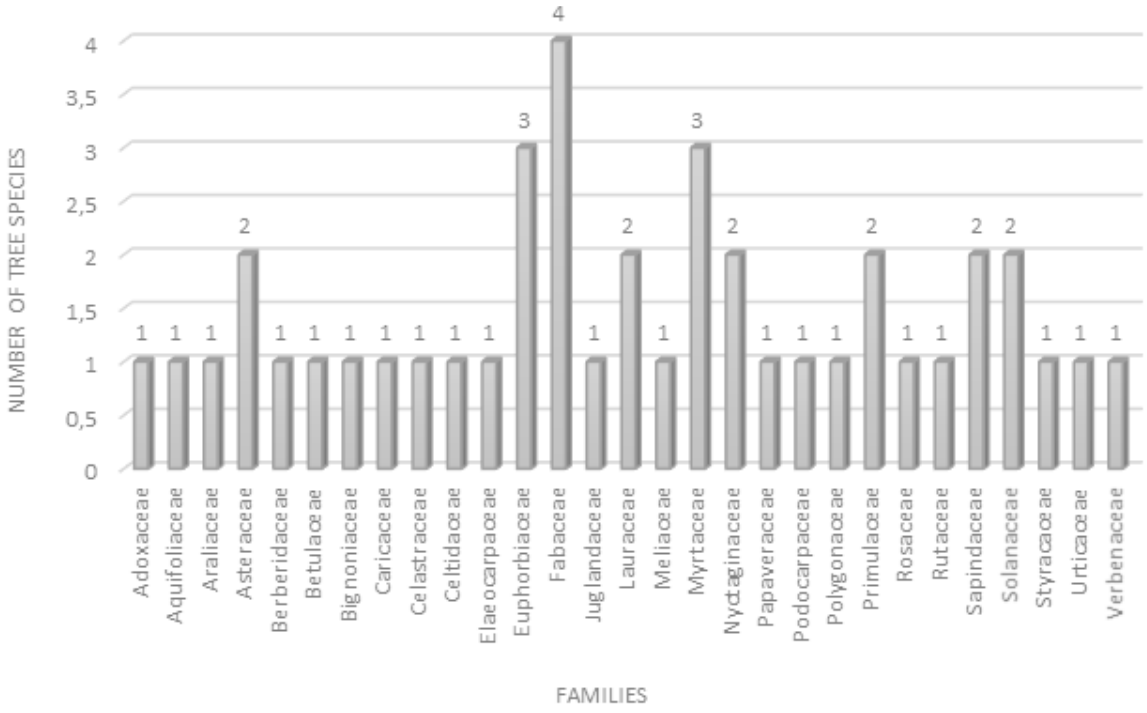

Figure 4. Tree species richness by botanical family.

The 42 species identified represent 21% of the total tree species registered for the Argentine Yungas (more than 200) according to the list provided by Brown & Malizia (2007). Regarding its conservation status, two species are on the IUCN Red List: *Cedrela angustifolia* ("cedro coya") within the "Endangered" category and *Juglans australis* ("nogal criollo") within the "Near Threatened" category (these species have been heavily exploited due to their wood value), the rest of the identified species is not included in the list. The number of tree species with ethnobotanical value was high (30 species, 71%) (Table 1).

The forest flora surveyed in the Jordan river middle basin is represented mainly by species that have their optimum distribution in the *Montane Rainforest,* where they are more abundant and frequent (34 species: 81%): *Allophylus edulis*, *Berberis jujuyensis*, *Blepharocalyx salicifolius*, *Bocconia integrifolia*, *Boungainvillea stipitata*, *Carica quercifolia*, *Cedrela angustifolia*, *Celtis iguanaea*, *Croton piluliferus*, *Cupania vernalis*, *Duranta serratifolia*, *Erythrina falcata*, *Kaunia lasiophtalma*, *K. saltensis*, *Myrcianthes mato*, *M. pseudomato*, *Myriocarpa stipitata*, *Myrsine coriacea*, *M. laetevirens*, *Nectandra angusta*, *Ocotea porphyria*, *Oreopanax kuntzei*, *Parapiptadenia excelsa*, *Pisonia zapallo*, *Sapium haematospermum*, *Sebastiania brasiliensis*, *Senna spectabilis*, *Solanum riparium*, *Styrax subargenteus*, *Tecoma stans*, *Tipuana tipu*, *Vassobia breviflora* y *Zanthoxylum coco*; while the number of characteristics belonging to the *Montane Forest* is much

lower (7 species, 19%) (*Alnus acuminata*, *Crinodendron tucumanum*, *Ilex argentina*, *Maytenus verticillata*, *Podocarpus parlatorei*, *Prunus tucumanensis* and *Sambucus nigra* subsp. *peruviana*) (Figure 5, Table 1).

These results show that the *Montane Rainforest* provides greater species richness in the rainforest-forest transition of the basin, probably because it is the vegetation belt with the greatest diversity within the Argentine Yungas. Only one species *Ruprechtia apetala* has an optimum distribution range in the lower belt of the Yungas (Pre-Montane Forest). In Chaco dry and warm forests, their presence in the higher, humid, and temperate basin environments would mark the upper limit of its altitudinal distribution. The montane rainforest is much richer than the montane forest in all categories (see Table 2). In contrast, the Montane forest is represented by few restricted species and only an endemic one (*Maytenus verticillata*).

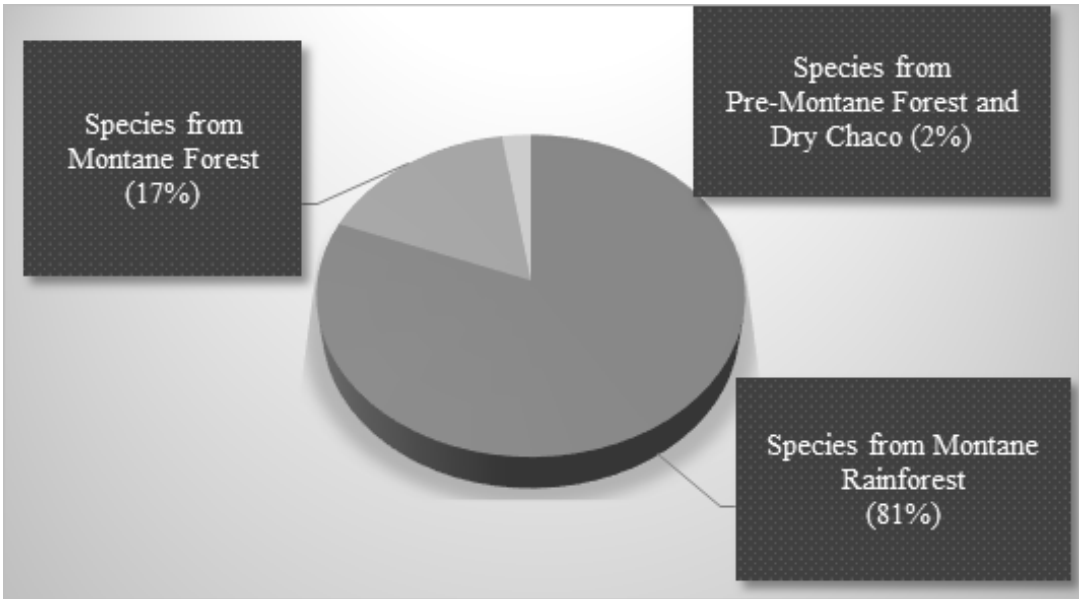

Figure 5. Percentage of characteristic species from the study area in the different Las Yungas bioclimatic belts.

Table 2. Number of species found in Montane Forest and rainforest.

	Characteristic	Endemic	Restricted	Wide distribution	Ethnobotanical value
Montane rainforest	34	5	12	18	24
Montane forest	7	1	6	0	6

Regarding the biogeographic origin of the genera, 21 are of Neotropical origin (54%), ten Pantropical (26%), six Holarctic (15%), and only two genera are of austral origin (5%), while no Andean genera were recorded (Table 1). These results show that different biogeographical origin species converge in the basin, but the Neotropical and Pantropical genera that are characteristic of the *Montane Rainforest* predominate, while Holarctic genera and austral characteristics of the *Montane Forest* appear in a smaller proportion.

The tree species richness (42) is consistent with those recorded in other studies for the same altitudinal vegetation belt of the Argentine Yungas (20−60 species approx. depending on the latitude) (Morales *et al*., 1995; Brown *et al*., 2001; Malizia, 2004; Malizia *et al*., 2006; Martín, 2014; Entrocassi, 2016; Entrocassi *et al*., 2019). However, this number is likely to increase depending on new collections scheduled for the future in the study area. The specific richness observed could be due to the ecotone development between the upper belt of the *Montane Rainforest* and the *Montane Forest*. Above 1600 m asl, the number of species decreases with the increase in altitude, as indicated by the lower richness observed in the Calilegua National Park vegetation adjacent to the basin, where 29 tree species were reported per hectare (at 1700 m asl) (Malizia, 2004). This pattern of specific richness decrease with altitude increase is a widely observed phenomenon in numerous studies of Andean subtropical forests. As noted, the altitudinal vegetation belt of the *Montane Rainforest* has the highest tree species diversity in the Yungas, whereas, at higher altitudes in the *Montane Forest*, the richness of species, genera, and families decreases and changes the composition of the forest stratum and forest structure (Grau & Brown, 1993; Lieberman *et al*., 1996; Gentry, 1998; Vásquez & Givnish, 1998; Brown *et al*., 2001; Brown & Malizia, 2004).

The high percentage of species with restricted and endemic distribution (24 species, 57%) is added to the observed richness data; this reflects the relevance of the basin forest flora, the uniqueness of the environment and its biological importance (Figure 4).

The conservation status analysis of the forest vegetation gave a total score equal to 135 (Appendix 1), showing that Jordan River middle basin vegetation has a high Interest Conservation (INCON), in accordance with the criteria analyzed (Phytocenotic, Territorial and Mesological). The dominant vegetation is composed of mature, pluristratified,

semideciduous, and seasonal evergreen mesoforests, with high coverage, diversity, and great landscape value. Vegetation plays a fundamental role within the basin, as it constitutes a protective cover that reduces the erosive process produced by an unstable water environment with a marked slope. It receives enormous precipitation in summer, creating an extraordinary increase of Jordan river volume and the dragging of sediment great amounts (stones and mud). The vegetation of these forests also contributes to the basin water yield, for it takes water from clouds and mists that settle on the mountain slopes and provides to its supply as an ecosystem service.

The role of those forest on the local climate of the basin is also important, they regulate light intensity, precipitation or the speed of the wind; they also contribute to the ground regulation (geomorphological and hydrological features) producing abundant organic matter and reducing erosion caused by the dragging of sediments, landslides, collapses, etc. In addition, these forests have a high faunistic value because they provide shelter and food to various species of resident and migratory animals, many of which are in a state of vulnerability, such as big mammals (jaguar, *Panthera onca* and tapir, *Tapirus terrestris*).

From the ethnobotanical, perceptual, and educational point of view (Table 3), the forest vegetation is part of the communities worldview that inhabit the basin's environment (man, nature, culture, territory, and spirituality). Said communities, mostly "Kollas" and "Criollos", are mainly dedicated to subsistence agriculture, transhumance livestock and parallel use of biological and ecological resources that the forest offers, through knowledge and ancestral practices that include wild products collection for their diet and a traditional cattle grazing system moving towards the forest during the winter, to take advantage of fruits, water, and better climatic conditions. Many tree species are used as food, medicine, forage, fuel, dye, tanning, stimulants, cosmetics, making of agricultural tools, kitchen utensils, musical instruments, crafts and for building lintels, ceilings, furniture, and fences, among others.

Most of the tree species recorded in this study are part of the courtship of the northern Yungas of Argentina ethnobotanical species. The 60% of the identified species are used as medicinal plants; the 37% for construction and elaboration of tools, utensils, and artisan instruments; 27% are used for food and fodder; 23% for dyeing and tanning and 17% for fuel (Table 3).

Table 3. Species with ethnobotanical value and their main uses in the area.

Ethnobotanic species	Uses
Juglans australis	Food, dyeing and tanning, construction and elaboration of tools, utensils, and instruments
Myrcianthes pungens	Food
Allophylus edulis	Food and fodder
Carica quercifolia	Food
Oreopanax kuntzei	Food and medicinal
Sambucus peruviana	Food and fodder
Celtis iguanaea	Food, fodder, medicinal, construction and elaboration of tools, utensils, and instruments
Tecoma stans	Medicinal
Boungainvillea stipitata	Medicinal, fuel, construction, and elaboration of tools, utensils, and instruments
Parapiptadenia excelsa	Medicinal
Cupania vernalis	Medicinal
Myrcianthes mato	Medicinal
Parapiptadenia excelsa	Medicinal
Maytenus verticillata	Medicinal
Styrax subargenteus	Medicinal
Bocconia integrifolia	Medicinal, dyeing, and tanning
Zanthoxylum coco	Medicinal, dyeing and tanning, construction and elaboration of tools, utensils, and instruments
Erythrina falcata	Medicinal, construction, and elaboration of tools, utensils, and instruments
Nectandra angusta	Medicinal
Pisonia zapallo	Medicinal
Prunus tucumanensis	Medicinal
Ocotea porphyria	Medicinal, dyeing and tanning, construction and elaboration of tools, utensils, and instruments
Tipuana tipu	Medicinal, dyeing and tanning, construction and elaboration of tools, utensils, and instruments
Vassobia breviflora	Fodder
Parapiptadenia excelsa	Fuel, dyeing and tanning, construction and elaboration of tools, utensils, and instruments
Blepharocalyx salicifolius	Fuel
Myrsine laetevirens	Fuel, dyeing and tanning, construction and elaboration of tools, utensils, and instruments
Myrsine coriacea	Fuel
Podocarpus parlatorei	Fuel, dyeing and tanning, construction and elaboration of tools, utensils, and instruments
Alnus acuminata	Dyeing and tanning, construction and elaboration of tools, utensils, and instruments

Likewise, plants and forest with their spirituality sites (sacred and magical places) are linked to the historical, archaeological, mythological and symbolic heritage of the local communities, reflected in their ritual practices and pagan and religious festivals (such as the "marcadas", "señaladas" and "pialadas" of the cattle, the "Pachamama Madre Tierra," the "Souls Days" and the "Carnival" celebrations, among others), besides being part of an attractive landscape for sustainable tourism, due to its scenic value and the basin location that allows access to other important tourist circuits of the province (Quebrada de Humahuaca, Puna and warm valleys).

Conclusions

This research shows the natural attributes as well as the ethnocultural, landscape, and educational value of the subtropical mountain forests of Jordan river middle basin, an unexplored area of Yungas in Jujuy. The results provided by the floristic study enabled us to know the forest species composition and richness of the basin forest formation. The assessment of the forest vegetation offered preliminary information about its state and the relevance it has from the biological and ecological point of view and within the tangible and intangible cultural heritage of the local communities. For conservation biology, the data obtained is a tool for assessing the area diversity that can contribute to its inclusion within Calilegua National Park Core Zone, to ensure the preservation of its biological, ecological, cultural, spiritual and recreational values.

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Appendix 1. Valuation table of the Jordan River middle basin vegetation and Interest Conservation (INCON).

Conservation status criteria	Score obtained for each criterion	Justification
Phytocenotic	1. Diversity (specific richness):10 puntos	Maximum score for having more than 40 taxa.
	2. Maturity: 20 points	Maximum score for being permanent mature vegetation.
Territorial	3. Endemicity:5 points	Due to the presence of 6 endemic taxa (0.5 points per taxon) and exclusive endemic plant group of the Biogeographic Districts of the Montane Rainforest and the Montane Forest (2 points).
Mesological	4. Geomorphological Function: 20 points	Maximum score for being permanent, dense, and pluristratified tree vegetation with dense undergrowth.
	5. Climatic Function: 10 points	Maximum score for being dense tree vegetation, with dense undergrowth.
	6. Hydrological Function: 10 points	Maximum score for being dense tree vegetation, with dense undergrowth.
	7. Edaphic Function: 10 points	Maximum score for being tree vegetation with organic matter high production rate of organic and well developed and permanent root system.
	8. Faunistic Function: 10 points	Maximum score for being well developed and polyspecific forests, with special trophic importance and as shelter.
Cultural	9. Ethnobotanical Value: 20 points	Maximum score due to the presence of plants and vegetation linked to the ancestral culture as resources with high ethnocultural value (food, medicinal, ritual, historical, archaeological and mythological, among others).
	10. Perceptual Value: 10 points	Maximum score for being forests with high scenic and attractive value, representatives of the reliable natural landscape of the northern Argentine Yungas.
	11. Didactic Value: 10 points	Maximum score for educational value of the natural and cultural aspects of the vegetation.
INCON	Total score: 135 points	High Conservation Interest

Appendix 2. Some views from Jordan river and Serranía de Calilegua (Las Yungas, Argentina). Up, general view of the Serranía; bottom, ephiphytic plants and ferns form part of the diversity of these forest.