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*Research Article*

# The Cuabal of Callejón de Los Patos, in Santa Clara: Need for Its Sustainability

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**Abstract:** In Cuba, the great diversity and high endemism of the plant formations on serpentine stand out. Cuabales (scrub xeromorphic thorny on serpentine) present important natural values for the sustainability of Cuban biodiversity, but with a high degree of vulnerability. Although there are currently several investigations into the flora and vegetation of these ecosystems, there is a scientific vacuum on the conservation of these plant formations, from the social point of view. In the Callejón de Los Patos of Santa Clara, there is a cuabal, although it presents a high level of deterioration, due to anthropic activity. This research focused on assessing environmental management for the sustainability of the cuabal of Callejón de Los Patos of Santa Clara. The methodological perspective that predominated in the research process was qualitative and quantitative analysis of the data was incorporated to better visualize the trend in the analysis of the results. The investigative methods used were: observation, document analysis, in-depth and structured interviews. The diagnosed results showed insufficient knowledge, in the inhabitants of Callejón de Los Patos, related to the cuabal, its sustainability, and its importance. The absence of collective projection of actions to mitigate environmental problems identified in the settlement, that affect the deterioration of said plant formation was detected; results demonstrate poor environmental management for the sustainability of cuabal.

**Keywords:** Sustainability of Cuban Biodiversity; Sustainability of Cuabal; Environmental Management in the Callejón de Los Patos of Santa Clara

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## 1. Introduction

The natural resources of Planet Earth are fundamental for the economic and social development of humanity; its finite character constitutes a concern of Science. Consequently, there is a growing recognition of the importance of biodiversity as a global good and its inestimable value for the sustainability of present and future generations.

This concern is manifested both globally and locally and is expressed in various documents that indicate the way forward. The Sustainable Development Goal 15 (2015) highlights that: "Promoting the sustainable use of terrestrial ecosystems, combat desertification, halt and reverse land degradation and halt the loss of biological diversity" is a goal for society.

To achieve this objective, the Aichi Biodiversity Targets (2011-2020) declare the need to promote the value of biological diversity, its conservation, and sustainable use.

Human settlements are fundamentally responsible for the change in biological diversity [1]. Therefore, the education of society is a priority to achieve a sustainable relationship with the environment, which favors the sustainable use of biodiversity [2].

Regarding Cuban biodiversity, it is recognized that the scrub xeromorphic thorny on serpentine (cuabales) presents the great floristic richness and high endemism [3-5]. In

addition to their biological value, environmental functions, economic and social uses have been identified for cuabales [6]. However, the greatest threats that affect it are related to anthropic activity [5-12].

Therefore, studies [15] expressed concern about the state of conservation of biodiversity in serpentine outcrops in Cuba, especially because of the irreversible loss of a genetic heritage that until the 1990s had not been sufficiently studied. Currently, there are several investigations on the flora and vegetation of these ecosystems [6-41], and the conservation of their species [8, 15, 20, 33, 42, 43]. However, there is a scientific gap in its conservation, from the social point of view, since few studies have been found in this regard [2, 44-46].

Concerning this, studies [23] warn about the vulnerability of the ecosystems of cuabal; which makes the sustainable use of the territories where they are essential [11-14]. From this, it is derived that the sustainability of this plant formation requires intensifying the work of awareness and education about its importance for the population that lives near it [2]. Thus, supporting the fulfillment of objective four of the World Strategy for the Conservation of Plant Species: 2011-2020, which highlights the need to "Promote education and awareness about the diversity of plant species, their role in livelihood sustainability and its importance for all lives on Earth".

In Santa Clara, there are several spaces where serpentine soils predominate, in which the xerophytic characteristics of the vegetation that develops with them are evident [4]. One of these places is the Callejón de Los Patos, next to the Universidad Central "Marta Abreu" de Las Villas (UCLV).

Callejón de Los Patos is a rural settlement belonging to the University Popular Council (CP), which is located on the Highway to Camajuaní, km 6 ½, in the municipality of Santa Clara, Villa Clara province.

The CP is nestled in an area of valleys. The closest elevations, to the south, are Cerro Calvo, Pelo Malo, Peña Blanca and the Sierra Alta del Agabama, and El Capiro elevation. The geographical physical space is part of the hydrographic basins of the Sagua la Grande, Sagua la Chica, and Agabama rivers.

The Callejón de Los Patos is home to 659 people (341 male and 318 female) and 257 families; a high rate of elderly people is evidenced.

In the Callejón de Los Patos, there is an area of cuabal vegetation, which is very fragmented and presents a high level of deterioration, although there are preserved patches [47]. The greatest damage to the cuabal of the Callejón de Los Patos derives from anthropic activity. This was corroborated in the execution of the "Parque Cuabal" Project, which was developed in 2017, by the Botanical Garden of the UCLV [47], and which constitutes the antecedent of this research.

From this problem, the general objective of the research was drawn: to assess the environmental management for the sustainability of the cuabal of the Callejón de Los Patos, in Santa Clara.

## 2. Cuabal (scrub xeromorphic thorny on serpentine). Budgets that support the need for sustainability

The need for sustainability of cuabales has been recognized in similar situations in nearby islands such, as Hispaniola, because these plant formations, on special substrates (serpentines), as endemic communities of high botanical-ecological value, and therefore of interest for conservation. The vulnerable nature of these communities has led the authors to propose his conservation since the danger of this these communities are due to human pressure [11-14].

Cuba has third place in the world for the richness of its serpentine flora, highlighting its endemism [3]. It is commonly known as the flora and vegetation of serpentine which develops on soils derived from serpentine rocks [8].

Serpentinite soils in Cuba have a great extension compared to the area they occupy worldwide [5] and are the largest in the Caribbean [48]. They constitute the serpentine axis throughout the Island, in an interrupted chain of outcrops that extends from Cajálbana, Pinar del Río province, to Baracoa, Guantánamo province, with a total of 7,500 km2 [15, 49]. These regions present the highest levels of diversity and endemism in Cuba [5, 15, 49, 50]; which gives these areas great scientific and conservation interest [11-14, 22].

Serpentinite soils are shallow, skeletal, with an abundance of heavy metals (Ni, Cr, Co), and poor in macronutrients (Ca, N, P, K) [49]. These soils are ferro-magnesial fersialitic, characterized by high osmotic pressure, which causes a high-water retention power, constituting the main limiting factor for plant life. This aspect, together with its low power, as well as its undulating to hilly topography and well-established drainage, cause its physiological drought [4].

Vegetable formations on serpentine have a particular ecology, since the ecological specificities of the soil give it the highest endemism and species richness of Cuban flora: 31.2% (920 species) of Cuban endemisms grows on serpentine outcrops, this represents 14.6% of the total flora; even though these rocks occupy only 7% of the national territory [3, 5]. Although, studies indicate that the climate in the areas where these plant formations predominate is quite favorable to the development of any plant [49].

The scrub xeromorphic thorny on serpentine is a scrub with a 2-4 meters dense shrub layer, with 4-6 meters emergencies, scattered herbaceous, palms, epiphytes, and an abundance of lianas. It occurs, mainly, in plains and low altitudes, on soils derived from serpentinites [51].

Most of the plants of cuabal are low, thorny shrubs, with small and hard leaves to efficiently take advantage of the humidity and several uniquely evolved cacti. In this vegetal formation, the genus of species stand out: *Bonania emarginata, Bourreria spp., Bucida ophiticola, Bursera angustata, Buxus spp., Coccoloba spp., Coccothrinax spp., Copernicia spp., Eugenia spp., Guettarda spp., Leucocroton spp., Neobracea valenzuana, Oplonia nannophylla, Phyllanthus orbicularis., Pseudocarpidium ilicifolium, Rondeletia spp., Scolosanthus crucifer s.l., Tabebuia spp., Zanthoxylum spp*. [51].

This plant formation is located almost throughout the national territory, in the serpentine areas between Cajálbana and Holguín. Found on the southern slope of the Sierra de Cajálbana, east of Pan de Guajaibón to the southern part of Bahía Honda; south of Campo Florido, between Arcos de Canasí and Matanzas; south of Camarioca and San Miguel de los Baños (Matanzas), southeast of Santa Clara (Cubanacán); north of Jatibonico (Arroyo Blanco) and north of the cities of Camagüey and Holguín [52].

In addition to its biological value, studies [6] identified 19 environmental functions for the flora of cuabal. Of which 16 represent *direct use values*: ecotourism, source of pollen and nectar, plants edible by man and/or animals; *indirect*: carbon fixation, source of organic and inorganic matter, erosion control, soil builder, an indicator of nickel, chromium and cobalt deposits, water filter, watershed protection, biological corridor preserver, nutrient retention, habitat of species; *option*: studies of serpentinites on a national and international scale, medicinal plants, extraction of wood for handicrafts and *non-use* (existence value): endemic flora and ecosystem of a restricted area.

Said studies [6] also recognized 14 types of *economic uses* for the flora of cuabal: medicinal, artisan, soil improvement, industrial, timber, toxic or stinging, ornamental, edible by animals and/or man, production of posts and fences, honey, forage or pasture, ofiticolas, strict (indicators of nickel, chromium, and cobalt) and esoteric.

Medicinal species were found among the most representative species for social uses, distinguishing between them: *Koanophyllon villosum (Sw.)*; following, in order of importance, the timber species, highlighting in this group: *Comocladia dentata Jacq*. Artisanal species ranked third in importance, being *Coccothrinax miraguama (Kunth.) Becc*. the only one registered in the price lists managed by the artisans of the Cuban Fund of Cultural Goods [6].

Despite its demonstrated importance, it is highlighted that the intensive development of mining, starting in 1880, to obtain naphtha and natural gas, as well as agricultural and forestry activity in the second half of the last century, caused the disappearance of extensive areas of the original vegetation, with an extreme reduction of the area of occupation of the spiny xeromorphic scrub on serpentine [9].

Currently, these plant formations are still frequently altered by human activities such as: mining, urbanization, livestock, grazing, agricultural development, the introduction of species of economic interest, forest management, and fires, among others [8, 10]. Being mining exploitation the main cause of the destruction of the most significant serpentine communities of Cuba and the grazing and the introduction of species of economic interest, through the forest plantation, the principles of the degradation of these regions [5, 7].

Among the damages caused, from the ecological point of view, to the flora of cuabal by economic activities, studies [6] state: the increase in the populations of exotic species, both invasive: *Dichrostachys cinerea (L.) Wight et Arn*., *Acacia farnesiana (L.)* and *Heteropogon contortus (L.) P. Beauv*; as non-invasive, mostly cultivated.

Likewise, it warns about the danger of decreasing the number of individuals of the native species of the cuabal, as a result of the reduction of its available area and the biological corridors; changes in the pH, structure, and quality of the soil, given by the anthropic action and the cattle mass and the affectation of biological processes such as the exchange of propagules between the outcrops of serpentinites, always discontinuous due to the natural fragmentation of these ecosystems [6].

From the economic perspective, a series of effects on the cuabales were also found, such as: the loss of local endemic and / or threatened species of commercial importance, such as: *Amyris balsamífera (L.) Sarg*., *Bursera simaruba (L.) Sarg*. and *Andira inermis (W. Wrigth) DC.* [6].

Taking into account the current and potential threats that affect the cuabales, a study [8] set conservation objectives to eliminate them:

- Control the invasion of exotic species in natural areas under protection.
- Promote that the development of new civil constructions is not carried out in areas with the highest biodiversity values and commit the companies that develop civil constructions with the conservation of diversity (especially useful for cases in which the area does not it is so diverse, but there is an important endemic).
- Limit actions related to the reestablishment of species introduced in forest plantations where they have not developed well due to the natural recovery of the original flora of the area and ensure that the exploitation of existing plantations is carried out in a limited way and under control that guarantees that what has been naturally recovered will not be destroyed.
- Minimize the development of agricultural plans in ecosystems due to the unproductiveness of said soils for these activities.
- Rescue the areas of cuabal that were the object of mining activity in the past.
- Minimize the exploitation of new deposits in the areas with the highest biodiversity values.
- Control compliance with fire safety regulations to reduce the incidence of fire in the extinction of endemic species in natural areas.
- Create training plans for human resources in protected areas for the restoration of ecosystems on serpentine through the Provincial Courses-Workshops for the Restoration of Ecosystems.
- Promote and prioritize research that contributes to rescuing and reassessing knowledge about the traditional use and management of native species.

- Introduce locally the results of prioritized research to accelerate the rescue of cuabales by their sustainable management.

**3. Cuabal in the landscape of Plains, heights and mountains of Santa Clara**

The province of Villa Clara presents diverse vegetal formations and around 15 species of local endemic plants have been registered [53]. In this regard, a study [54] highlighted that the original vegetation that predominated in the province was of the spiny xeromorphic type on serpentines and semi-deciduous mesophilic sub-evergreen broadleaf tropical forest. However, the region has been affected by numerous threats that have destroyed much of the original vegetation, among which deforestation predominates [53].

A study [26] highlights that the province still has numerous locations of importance for the Cuban flora, which justifies the need for their study. These authors highlight that the latest research carried out on the flora and vegetation of different locations in this province [16, 17, 21, 55] has contributed to the development of conservation programs and the creation of new protected areas.

In Villa Clara, the most important serpentine outcrops, by extension and endemism, are located south of the city of Santa Clara, among which the following stand out: Sierra Alta de Agabama, Cerro de Pelo Malo, La Hoya, El Playazo, and on the margins of the city, between the José Martí neighborhood and "Los Caneyes" Hotel. Another significant outcrop in Villa Clara is the one in Motembo [24]. Part of the identity image of the region that surrounds this city is provided by the cuabal.

Studies [57, 59] suggest that the Serpentines district of Santa Clara occupies an approximate extension of 730 km (10% of the Cuban serpentine area), with rocks of Cretaceous origin on which very young skeletal soils (quaternary) have developed, which contrast for their endemism with other much older serpentine outcrops in Cuba.

Other studies [5, 60] contribute that the serpentine elements in this district are divided into patches of different sizes and distances from each other. However, despite the isolation that occurs between them, the flora is quite uniform and is characterized by the presence of pan-Cuban endemics and the existence of local endemics, for example: *Dorstenialanei, Eugenia clarensis, Guettarda clarensis, Groigiana, Harpalyce macrocarpa, Karwinskia oblongifolia, Melocactus actinacanthus* and *Xylosma acunae*; from Motembo specifically mentions: *Cheilophyllum sphaerocarpum, Paspalum edmondi, P. motemboense* and *Scleria motemboensis*.

A list of the Santa Clara serpentine flora [16] lists 426 species of flowering plants belonging to 286 genera and 90 families. Among the genera mentioned are *Acuneanthus (Rubiaceae)* and *Rhodogeron (Asteraceae),* two of the endemic genera of the flora of Cuba, which grow exclusively on serpentine *Rhodogeron*, an endemic monotypic genus, is the only exclusive one of the Santa Clara serpentinites.

According to these authors, 30.2% of the species collected in this outcrop are endemic, an aspect that is related to the high endemism of the serpentine flora of Cuba. A study [61] clarifies that, among said species collected, a high number are local endemics [18], which, added to nine endemic taxa of the old province of Las Villas, constitute 18.6% of taxa with a restricted area of distribution. This confirms the contribution of the serpentine to the endemism of central Cuba [62] and we agree with the studies [13, 14] that affirm the habitats in which territories with high rates of endemism are found, should also be considered endemic.

The most interesting thing about cuabal in Santa Clara is not only its wild plant nature, reminiscent of a kind of semidesert, with the vast majority of small plants, hard leaves, and branches covered with thorns. It is also because the species that live adapted to such soil, making them plants with high local endemism. Thus, many of the plants of the cuabal inhabit naturally restricted to the area that the zone.

However, the people who live near these plant formations show an insufficient perception of the natural values and importance of cuabal. Therefore, the main threats that affect it are caused by the inhabitants of the regions where they develop, such as: the opening of trails, dumping of garbage, intentional fires, and logging, among others [2, 45].

Regarding the problems that impact biological diversity, associated with human activity in settlements, a study [63] affirms that the community has little participation in decisions about environmental problems that affect their surroundings. Which in most cases do not know, unless there is a serious and obvious direct impact on them. This means that the population does not feel identified with its surrounding environment and on many occasions, it does not protect it, but rather deteriorates it.

Due to the natural, economic, social, cultural value, and environmental functions that cuabales have, mainly because of the high endemism that these plant formations present in Villa Clara, it is evident the loss that their destruction, as a result of the anthropic activity, would represent for Cuban biodiversity [2, 45, 46].

## 4. Materials and Methods

The methodological perspective used in the research is qualitative, with elements of the quantitative, favoring a more complete analysis of the results and better visualizing their trends.

The investigative methods used were:

The observation [64] was developed, during the excursions to cuabal relict (Appendix A), to verify the deterioration that it presents and the vegetal species that predominate in it.

Document Analysis [64] was used in the characterization and diagnosis of the University Popular Council (CP) (local government structure), because the Callejón de Los Patos belongs to that CP.

Interviews were applied, according to the age, educational level, or knowledge of the topics to be addressed, by the participants, and the questions asked were readjusted (Appendix B1, B2, B3, Table 1, Table 6).

In-depth interviews [64] were conducted with:

- the delegate (the highest government authority at the CP level), to learn about the characteristics of the population settlement;
- to senior citizens who were familiar with the species of cuabal, to determine the uses that the population makes of this species;
- a peasant, who lives adjacent to the cuabal vegetation, and a forest worker, who identified existing species in that plant formation and their usefulness.
- Specialists from the Botanical Garden of the UCLV were also interviewed on topics for research purposes, to learn about the studies and background projects carried out concerning cuabal and its conservation, its results, and limitations.

Structured interviews [64] were applied to: peasants, housewives, older adults, and residents in general of Callejón de Los Patos, as well as teachers and schoolchildren of 4$^{th}$, 5$^{th}$, and 6$^{th}$ grade of the Rural Normal School (ENR) Carlos Manuel de Céspedes, present in the town, to learn about the environmental problems identified in the CP, possible actions to develop to contribute to the sustainability of the cuabal and verify his knowledge about the cuabal, the damages that it affect and possible ways for their conservation.

Group interview [64], was carried out with the teachers of the ENR Carlos Manuel de Céspedes, to consult the treatment of the environmental issue that they do in their classes and incorporate the biodiversity of the area (example: the cuabal).

Triangulation of data was used to corroborate and analyze the information obtained through the aforementioned methods, because it provides a holistic, multiple and highly enriching vision of the phenomenon to be investigated; greater confidence and validity of

the results, more interpretive flexibility and creativity in the approach to the study; productivity in data collection and analysis; the proximity of the researcher to the object of study and capacity for innovation in conceptual and methodological frameworks [64].

The population selected for the research are the residents of Callejón de Los Patos. From this, 145 people were intentionally chosen as a non-probabilistic sample (divided into: 18 housewives, 12 retirees, 6 farmers, 32 inhabitants with different professions, 12 teachers, and 45 schoolchildren, included in 4$^{th}$ , 5$^{th}$, and 6$^{th}$ grades of the ENR Carlos Manuel de Céspedes). The 3 key informants also constitute part of the sample (the delegate, the forest worker, and the peasant, who lives adjacent to the cuabal vegetation).

The selection of the subjects who make up the sample is based on the following indicators:

- Housewives, because they are predominant among the female sector of the settlement and because of the knowledge they, generally, possess about the usefulness of plant species that develop in the spaces where they live;
- the elderly, due to the wealth of knowledge they possess and transmit to other generations;
- the peasants, because the research is carried out in a rural settlement and because of the knowledge about the biodiversity of the area that these people have;
- the teachers for their social in-charge as trainers of environmental culture in the children who live in the Callejón de Los Patos;
- the schoolchildren, for the commitment to the Cuban Primary School Model, which aspires that the school becomes the most important cultural center of the community.
- Finally, the rest of the sample used responded to the willingness of the subjects to participate in the research.

## 5. Results and Discussion

### *5.1. Environmental characterization of the Callejón de Los Patos and its cuabal*

Among the main environmental problems of the Callejón de Los Patos, the delegate, highlights:

- an existing lagoon behind the school, which is currently overflowing, due to the obstruction of its spillway system, and contaminated with sewage;
- the presence in the area of several pig farms, without the required hygienic conditions, which pollute the environment and affect the community's water supply, due to the high use they make of it;
- most of the drinking water wells in the locality are contaminated due to the proximity between the sewage pits of the houses and drinking water wells;
- the high presence of dogs in the streets, without adequate medical and nutritional care.
- For their part, the residents, interviewed by the researchers, identify the main environmental problems:
- the large amount of solid waste scattered in the area,
- the lack of containers for storing garbage and the lack of systematic collection thereof,
- burning garbage that pollutes the environment;
- drought and problems with the water supply.

By way of generality, they recognize in the locality:

- environmental pollution: air; the waters, the wells, and sound;
- soil degradation;
- deforestation, logging, and forest fires.

Other environmental problems identified by the researchers, through observation, in the Callejón de Los Patos are:

- high rates of deforestation,
- low-level of awareness about the importance of environmental conservation,
- Insufficient Environmental Education towards the sustainability of biodiversity and the existing cuabal in the area,
- the high level of deterioration of said plant formation.

On the other hand, it is recognized that initially, in the locality, xerophytic vegetation predominated over serpentinite. Currently, there are remnants of the cuabal vegetation, which are in areas belonging to the Forestry Company, and are located mainly approximately two kilometers from the entrance of the Callejón de Los Patos.

From the interviews carried out, existing plant species were identified in the cuabal of the Callejón de Los Patos, which the residents know by their common names. What validates that the cuabal stands out as a significant element of the biodiversity of the area [45] due to the high endemism and floristic variety of the plant species that develop in these plant formations [3-5], mainly for its contribution to the endemism of the central region of Cuba [62].

The presence of invasive species also stands out in the cuabal area [45], which displaces and excludes endemics due to their low competitive capacity [7]; as well as others of commercial interest, planted by the Forestry Company [45], which has caused the disappearance of extensive areas of the original vegetation, with an extreme reduction of the area of occupation of the cuabal. The loss of diversity of the degraded cuabal to the forest plantation shows the harmful effect of this use on the flora [25]. Elements that confirm the damage caused, from the ecological point of view, to flora of cuabal, by economic activities, raised by various studies [5-10].

The utility of cuabal species was also identified, according to popular knowledge of the residents of Callejón de Los Patos: timber, medicinal, decorative, and edible for poultry [45]. These evaluations coincide with the social uses stated in a study [6] for the species of cuabal. In addition, the inhabitants affirm that in the cuabal area the presence of several wild birds is observed, which use this ecosystem as a habitat or refuge from predators [45].

However, the cuabal of Callejón de Los Patos is very fragmented and presents a high level of anthropization, which is evidenced in the species that have been cultivated by the Forestry Company, displacing and excluding the endemic ones due to their low competitive capacity [7]. In addition, the solid waste that is thrown in the area of cuabal, which has been turned into a garbage dump, by the habitants [45], and the degradation of the scrubland favors the invasion by exotic plants [25].

From the analysis of the sociocultural characterization of the cuabal of the Callejón de Los Patos, elements are inferred that support the need for the sustainability of this plant formation:

- Its sustainability contributes to the conservation of Cuban biodiversity, supported by the criteria of several studies [3-5, 57,62] and by its *existence value* [6]: endemism of flora and ecosystem of a restricted area.
- Due to its *direct use values* [6]: source of pollen and nectar, edible plants for animals, and *indirect* [6]: carbon fixation, source of organic and inorganic matter, erosion control, soil former, a filter of water, watershed protection, biological corridor preserver, nutrient retention, and species habitat.
- Uses that the community can make of its plant species, which are recognized as *economic uses* [6]: medicinal, artisanal, timber, ornamental, edible by animals, production of posts and fences, fodder, or pasture.
- Due to its *option values* [6]: an opportunity for educational excursions for the students of the ENR Carlos Manuel de Céspedes, educational practices

for the students of the Biology and Agronomy careers of the UCLV, and studies for the researchers of the UCLV Botanical Garden.

### *5.2. Diagnosis of environmental management for the sustainability of the cuabal of Callejón de Los Patos*

The results of the diagnosis made are presented below:

The observation confirmed the considerations of the Botanical Garden researcher [47], who was developing the "Parque Cuabal" Project, regarding the high level of deterioration of the existing cuabal patches in the Callejón de Los Patos.

Confirmation that supports the criteria of several studies [63, 65-68] regarding the transformations of natural characteristics that occur in territories occupied by population settlements, the incidence of anthropization in said territories, and the effects of habitat fragmentation, destruction, and modification on ecosystems.

The assessment of the state of conservation of the existing cuabal patches, validated the statements of a study [25] that raises the loss of diversity of the cuabal, degraded by the forest plantation evidence the harmful effect of that on the cuabal flora. In the savanna and forest plantations, the destruction of the shrub layer leads to a decrease in the specific richness of the scrub, because this layer is the one that contributes the most to the diversity of the serpentine flora, and of Cuba in general.

The analysis of the threats that affect it confirms the criteria of a study [6] that affirms the damage caused to the flora of cuabal by the increase in the populations of exotic species, both invasive and non-invasive, mostly cultivated, and the decrease in number of the individuals of the native species of cuabal. The confirmed assertions reaffirm the proposals of several studies [5-12] on the frequent alterations suffered by cuabales due to human activities.

For its part, the analysis of the characterization of the University CP showed that there is no examination of the current state of the cuabal or proposal of actions to be developed with the population for its sustainability.

From the analysis of the characterization of the University CP, it was possible to infer the presence of various deficiencies and social problems in the rural settlement, emphasizing those of an environmental nature, which show the need to influence the Environmental Education of its inhabitants.

The potentialities of the Callejón de Los Patos for the sustainability of the cuabal were also identified, such as:

- the collaboration of the delegate;
- the experience and knowledge about the usefulness of cuabal species of the elderly people of the settlement;
- the proximity with the faculties of the Biology, Agronomy, and Botanical Gardens of the UCLV and the experience of its specialists on this plant formation;
- the ENR Carlos Manuel de Céspedes and the involvement of its teachers;
- the interest of the students of the Sociocultural Studies career of the UCLV to carry out community projects in that CP

The in-depth interviews yielded valuable results:

- The one made to the delegate contributed to the identification of environmental problems and potentialities of the rural settlement for the sustainability of cuabal.
- Those carried made to the forest worker and the peasant who lives adjacent to the remnants of xerophytic vegetation, allowed the identification of cuabal species and the use that the population makes of them.
- The information obtained from the elderly people of the settlement contributed to the uses that the population gives to species of cuabal [45].

The results obtained through these interviews reaffirmed the assertion of a study [63] that highlights the potential of the rural population for the conservation of national biodiversity, supported by its important values of knowledge and uses of biological diversity. Therefore, we agree with the criteria of a study [12] that highlights the conservation of these areas should be entrusted to small indigenous populations (in this case: rural) that have traditional knowledge of these species, as has been shown in other territories.

In addition, the natural, economic, sociocultural, and environmental functions of the cuabal present in Callejón de Los Patos were verified, validating the statements of several studies [6, 59] on this plant formation and its importance to contribute to the conservation of Cuban biodiversity [2-5, 45, 46].

- Meanwhile, in-depth interviews with specialists from the Botanical Garden of the UCLV, with research related to the subject, corroborated the information obtained on the importance of cuabales, assumptions that support their conservation, and the effectiveness of Environmental Education projects aimed at that interest.

In the group interview carried out with the teachers of the ENR Carlos Manuel de Céspedes, insufficient knowledge and skills were evidenced to identify the cuabal and its plant species; what has led to it not being included in the classes. Regardless of it, teachers recognize its importance for biodiversity. In addition, they assume that the main damages that affect it are related to the anthropic activity. Therefore, they highlight the need to inform and educate the community in this regard; agreeing their opinions with those of various studies [2, 45, 46, 69, 70].

In the application of the instrument, the presence of the school director was valuable, due to his knowledge of cuabal, who explained it to the rest of the teachers, adding that formerly, in his childhood, the entire settlement was an area of cuabal. However, the director clarified that the cuabal is not popularly known by that name, but rather as "charrascal" or "manigua" (which constitutes another plant formation with similar characteristics).

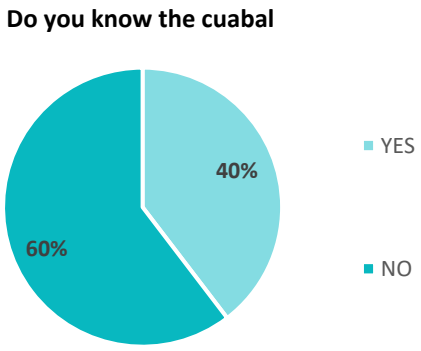
In the conclusion of the group interview, the importance of cuabal for biodiversity was highlighted because several species inhabit it. Their threats were also highlighted, since annually, during the drought period, the nearby eucalyptus forests catch fire, due to the negligence of people, and these fires affect the cuabal, wild birds, and species of fauna.

The results obtained from the structured interviews (Table 1), applied to residents of the Callejón de Los Patos contributed to diagnosing the current state of environmental management aimed at the sustainability of cuabal, based on the knowledge, skills, values, and behaviors of the residents towards the conservation of biodiversity, with an emphasis on cuabal.

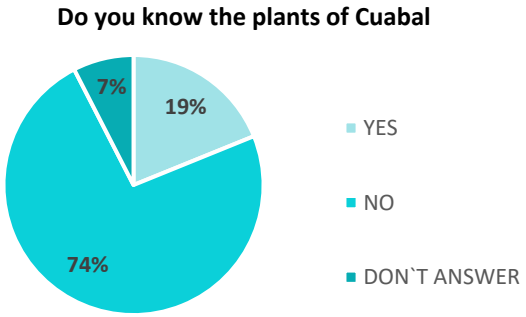
**Table 1.** Questions of the structured interviews, applied to the inhabitants

| Questions | Possible answers |
|---|---|
| 1. Do you know the cuabal in your community? | Yes or No |
| 1.1. How is the cuabal in your community? | Open answer |
| 2. Do you know the plants that are in that cuabal? | Yes or No |
| 2.1. Which | Open answer |
| 3. Do you know if there were plants in the cuabal that have already disappeared? | Yes or No |
| 3.1 Which | Open answer |
| 4. What importance do you attribute to the cuabal of your community? | Very important, Important, Less Important or Nothing Important |
| 5. What do you consider to be the state of conservation of the cuabal? | Very Good, Good, Regular or Bad |
| 6. What do you think are the main damages that affect the cuabal? | Open answer |
| 7. Do you think it is important to conserve the cuabal that exists in your community? | Yes or No |
| 7.1 Why | Open answer |
| 8. What do you think can be done to take care of the cuabal? | Open answer |

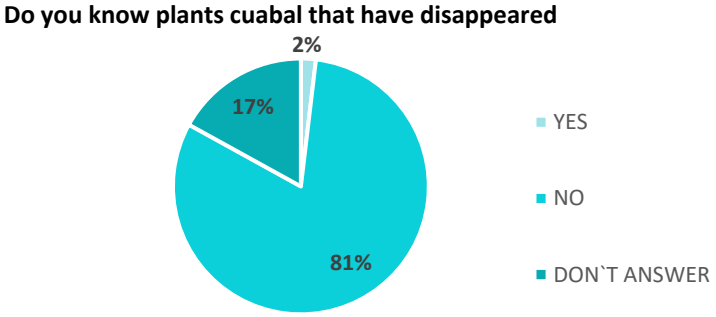
In Figures 1, 2 and 3 highlights the diversity of opinions, of the inhabitants interviewed, regarding knowledge about the cuabal and its species.




**Figures 1.** Knowledge about the cuabal and its species (Do you know the cuabal)




**Figures 2.** Knowledge about the cuabal and its species (Do you know the plants of cuabal)




**Figures 3.** Knowledge about the cuabal and its species (Do you know plants cuabal that have disappeared)

Those who claim to know the cuabal identify it as (Table 2):

**Table 2.** Knowledge about the characteristics of cuabal.

| Correct answers | Acceptable Answers | Wrong answers |
|---|---|---|
| Thorny, with flowers of different colors. | Cactus | Aroma[1] |
| A thicket where there are thorny bushes. Spiny, small-leaved shrubs. They grow in not very fertile soils. | | |

Interestingly, most of the interviewees stated that they did not know the cuabal, not even when its characteristics and location in the settlement were explained to them. In addition, they do not recognize it by the name of cuabal. Among their species, they only identify cactus and the aroma, or they point out that they do not know the names; they also do not recognize cuabal plants that have disappeared. These elements demonstrate the criteria of a study [63] regarding the little identification of the population with their natural environment and show inefficient environmental management, in the Callejón de Los Patos, aimed at the sustainability of the biodiversity of the area, with an emphasis in the cuabal.

1 Refers to: *Acacia farnesiana (L.)*

Another interesting result is the absence of answers about the importance of the cuabal, as can be seen in Figure 4; a value that may be in correspondence with the people who said they did not know it and that reaffirms the statements of the study [63].

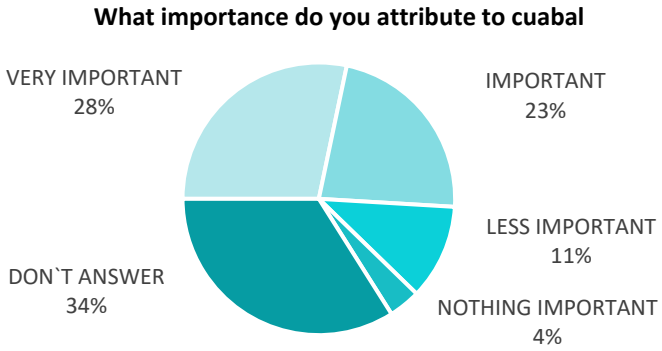



**Figure 4.** Considerations about the importance of cuabal

It is significant in the results that, regarding the state of conservation of the cuabal, the interviewees, for the most part, did not answer the question or show a difference of opinions that evidence a lack of recognition of the affectations that this plant formation presents; as can be seen in the following Figure 5. Considerations that demonstrate the criteria of the study [63] on the ignorance of the population regarding the environmental impact of their surroundings.

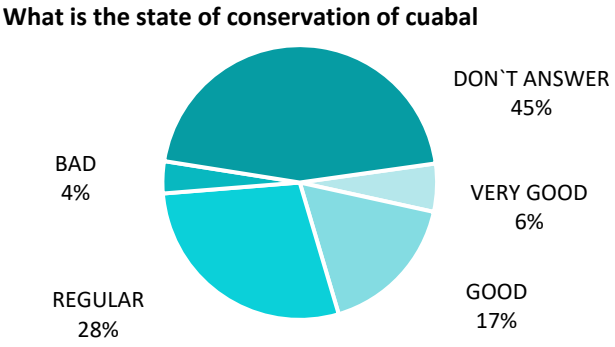



**Figure 5.** Considerations about the state of conservation of cuabal

Among the problems that affect the cuabal, the habitants raise (Table 3):

**Table 3.** Considerations about the affectations of the cuabal.

| Correct answers | Acceptable Answers | Wrong answers |
|---|---|---|
| The community harms him, mistreats him / cuts him off (by unknown). | Environmental pollution; environmental impacts. | The weather |
| The ignorance of people about this plant and its importance. | They do not give them due maintenance. | Drought, water shortage. |
| They throw trash on it. | Some plague, bacteria or parasite that affects it. | They do not water the plants, nor do they add organic fertilizer. |
| Fires and logging. | | |
| The animals[2] | | |

Some criteria are based on the reality that can be perceived empirically, others constitute elements applicable to all species of flora and the latter are wrong; therefore, they show ignorance about the natural characteristics of cuabal.

It is considered positive that, despite the lack of knowledge about the cuabal, most of the interviewed residents recognize the need for its conservation. This demonstrates a positive environmental awareness, pointing out the need to preserve all species of flora, as can be seen in the following Figure 6.

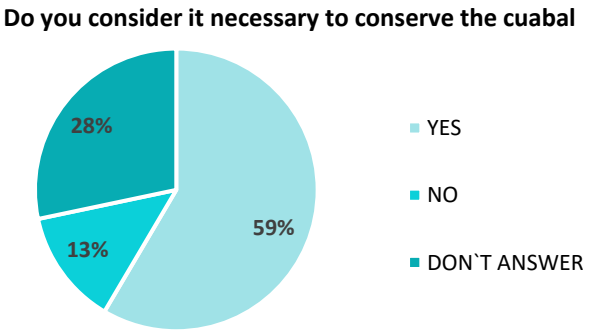



**Figure 6.** Considerations about the need to conserve the cuabal

Regarding the importance of its conservation, the inhabitants argued that (Table 4):

**Table 4.** Considerations about the importance of conserving the cuabal.

| Correct answers | Acceptable Answers |
|---|---|
| Enrich the oxygen of the Environment. | Is in danger of disappearing. |
| They absorb carbon dioxide. | To help reforestation. |
| It is a rare plant / they are endemic. | |
| To conserve the existing plant species in the area. | |

2 They refer to grazing

| |
|---|
| We must take care of our flora. |
| To contribute to caring for the environment. |

The criteria, provided by the interviewees, correspond to the importance of cuabal, defended by a study [6] in terms of its indirect use and non-use values (existence value).

Among the actions necessary for its conservation, the habitants stated (Table 5):

**Table 5.** Actions necessary for the conservation of cuabal.

| Correct answers | Acceptable Answers | Wrong answers |
|---|---|---|
| Do not mistreat the plants, do not cut them. | Take better care of it. | Water the plants, add fertilizer. |
| Contribute to their care. | Plant more plants / Work on their repopulation. | Avoid the attack of pests, bacteria and parasites. |
| Clean and protect the place where it is located. | Do not remove it from its habitat. | |
| Avoid fire and logging. | | |

On the other hand, it is valued as positive that the actions that the inhabitants consider necessary for the conservation of cuabal are related to the care of their vegetation, based on: *Informing, explaining, and guiding the community about its existence and importance.* For which they propose: *To create campaigns for their care through educational talks / Assemblies and meetings; give the children a tour of the cuabal and show them its importance, among others*. In a more general order: S*olve environmental problems / Avoid environmental pollution*.

The structured interview (Table 6) applied to 4th, 5th and 6th grades students of the ENR Carlos Manuel de Céspedes provided the following results:

**Table 6.** Questions of the structured interviews, applied to the students

| Questions | Possible answers |
|---|---|
| 1. Do you know the cuabal in your community? | Yes or No |
| 2. What do you know about the cuabal? | Open answer |
| 3. Do you like the cuabal that is in your community? | Yes or No |
| 3.1. Why? | Open answer |
| 4. Would you like to take care of the cuabal in your community? | Yes or No |
| 4.1 Why? | Open answer |
| 5. How do you think we can take care of the cuabal? | Open answer |

In Figure 7 the knowledge about the cuabal of the schoolchildren can be seen as a trend, although they do not know it by that name either.

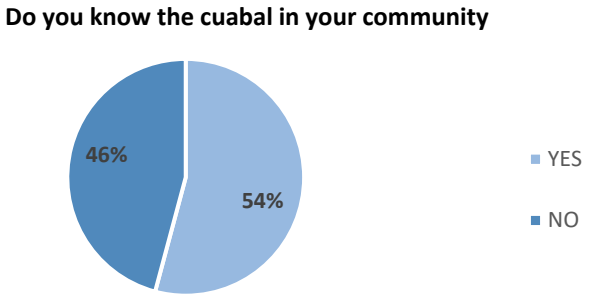


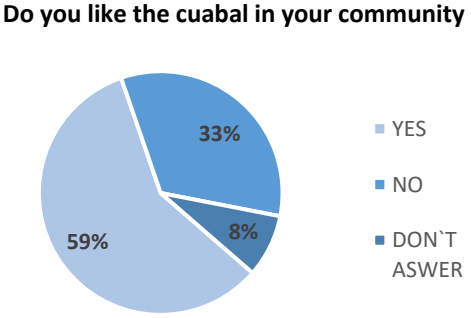

**Figure 7.** Knowledge of schoolchildren about cuabal

There is greater recognition of cuabal in students than in adults; values that correspond to the statements of the children, who recognize that they play or hunt wild birds, in areas of cuabal.

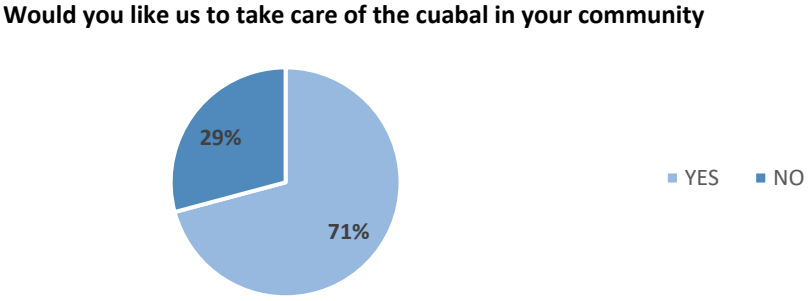
They identify it as:

- *a thorny flowering plant, resembling the aroma and that stores water during drought*
- *a plant that has many thorns, very beautiful that also blooms*
- *is spiny, with flowers and is medium*
- *a flowering plant*
- *a plant that has many thorns*
- *a bush that has white and pink flowers*
- *a bird / a leaf (wrong answers).*

It can be seen in Figures 8 and 9, as a positive result, that most schoolchildren say that they like cuabal and that they would like to keep it.




**Figures 8.** Students' considerations about the cuabal and its conservation (Do you like the cuabal in your community)




**Figures 9.** Students' considerations about the cuabal and its conservation (Would you like us to take care of the cuabal in your community)

Their arguments provided to keep it are:

- *Although it is thorny, it is in the environment and has beautiful flowers*
- *It is a plant of the Environment, and it is a living being*
- *It is important for nature*
- *It is very pretty and of different colors*
- *They are bushes that flourish, and adorn the community*
- *It is a very nice place*
- *They are very precious to me and they should be to other people*
- *Provides us shade.*

The schoolchildren consider that we can take care of the cuabal (Table 7):

**Table 7.** Considerations of the students to conserve the cuabal.

| Correct answers | Acceptable Answers | Wrong answers |
|---|---|---|
| Avoiding fires. | Not taking away the flowers that make it more beautiful. | Watering it every day. |
| Not mistreating him, taking care of him, protecting him. | | Pouring it with monthly water; Pouring water. |
| Do not hit it, nor cut it. | | |
| Not cutting down the places where he lives. | | |
| Leave the cuabal alone. | | |

By way of generality, the results of the diagnosis validated the criteria of several studies [63, 69, 70] on the consequences of the population's ignorance of the economic and cultural value of Cuban biodiversity.

In addition, they show gaps in the environmental management of the town, towards the sustainability of the biodiversity of the area and the cuabal, which are:

- the presence of environmental problems in the CP about which there is no question from the inhabitants, for example, those referring to the deterioration of the cuabal.
- insufficient knowledge, among the residents of the Callejón de Los Patos, related to the biodiversity of the Popular Council, the cuabal as a prominent element of it in the area, its conservation, and its importance.
- the lack of projection of actions for its conservation, with the participation of the people who live in the settlement.

This situation is manifested, although the National Strategy for Biological Diversity in Cuba (ENBIO) (2016-2020), which constitutes the fundamental basis for the construction of Social Development in the country, states among its priority areas: "Provide opportunities to develop action programs related to education, environmental awareness, environmental legislation and community participation in the protection, management and sustainable use of biological diversity".

It should be noted that the objectives set for the conservation of the cuabales [8] are not being applied to the cuabal of the Callejón de Los Patos:

- In the area of cuabal, actions related to the reestablishment of species introduced in forest plantations are carried out without taking into account the natural recovery of the original flora of cuabal and without guaranteeing that what has naturally been recovered is not destroyed.
- It is not known that actions have been carried out to rescue or preserve the areas of cuabal.

- There is no evidence of control or compliance with fire safety regulations, to reduce the incidence of fire in the extinction of endemic species in natural areas.
- There are no training plans for human resources in the community for the restoration of ecosystems on serpentine.
- No research was found that contributes to rescuing and reassessing the knowledge of the residents of Callejón de Los Patos about the traditional use and management of the native species of cuabal.
- No records of studies were found on the existing species in the cuabal of Callejón de Los Patos or their conservation status.
- The results of the prioritized investigations to accelerate the rescue of cuabales due to their sustainable management have not been introduced locally, in the Callejón de Los Patos.

It is recognized that the specialists of the Botanical Garden of the UCLV have carried out study expeditions of the cuabal of the Callejón de Los Patos, in other of its extension areas, which reach the Loma de Los Güiros [47] (another settlement rural, about 3 km from the University).

It is identified as a contradiction that no evidence of actions was found, from the Environmental education, for the conservation of the cuabal of Callejón de Los Patos, until the study [46]; despite its proximity to the Botanical Garden of the UCLV. Also, the existence, at the University, of other careers such as Biology and Agronomy with the potential to developing, in inhabitants, knowledge, skills, and values about conservation of cuabal.

## 6. Conclusions

Due to the natural, economic, social, cultural value, and environmental functions that cuabales have, mainly by the high endemism they present in Villa Clara, is evident the loss of Cuban biodiversity sustainability that represent the progressive deterioration to which is exposed the cuabal of the Callejón del Los Patos.

In the population of the Callejón de Los Patos, there are inadequate environmental practices, ignorance, and insufficient perception about the importance of cuabal, which is influencing its deterioration.

The absence of environmental management actions for the sustainability of the cuabal of the Callejón de Los Patos is verified, until the completion of the study [46]; evidenced in the insufficient knowledge, in the inhabitants, related to the cuabal and the lack of collective projection of actions for the environmental mitigation of the problems identified in the settlement, which affects the deterioration of said plant formation. Therefore, the need to continue carrying out actions aimed at its conservation is highlighted.

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**Author Contributions:** "Conceptualization, Y.M. and G.C.; methodology, Y.M. and G.C.; software, Y.M.; validation, Y.M; formal analysis, Y.M. and G.C.; investigation, Y.M.; resources, Y.M.; data curation, Y.M.; writing—original draft preparation, Y.M.; writing—review and editing, Y.M.; G.C. and J.A.C; visualization, Y.M.; supervision, G.C. and J.A.C; project administration, G.C. All authors have read and agreed to the published version of the manuscript."

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**Appendix A**

Observation Guide for the relict of cuabal of the Callejón de Los Patos.

Objective: Capture empirical data to confront them with the formulated demand.

- Place where the investigation is carried out: _____
- Location of the cuabal.
- Name by which the population knows it.
- Evident effects.
- Species originating from the cuabal vegetation present in it.
- Predominant plant species.
- Other plant species present.
- Utility or use that the population makes of the species present in the cuabal.
- Common names with which the population knows the species present in the cuabal.
- Potential for its conservation.

Prepared by MsC. Yaima Mederos Jiménez, Dra. C. Georgina Castro Acevedo.

**Appendix B1**

Guide for an in-depth interview with the delegate of the University Popular Council

Objective: To know the characteristics of the University Popular Council.

Greetings. Based on the research we are carrying out, we need to know some characteristics and data about the Popular Council. For this, we ask for your help through your answers in this interview. They will be of great importance for the outcome of the investigation.

Interview topic: _____

Interview date: _____

Full name of the person interviewed: _____

Age: _____

Degree of instruction: _____

Specialty: _____

Occupation: _____

- Socio-economic and cultural characteristics of the Popular Council.
- Gender relations in the Popular Council (history and evolution).
- Relations of the Popular Council with projects, (characteristics).
- The following are some subtopics that can be included:
- Total population of the Popular Council disaggregated by sex.
- Basic services and personnel working in them (health, education, etc.).
- Natural characteristics of the area.
- Main elements of Biodiversity in the area.
- Management of natural resources.
- Main environmental and biodiversity conservation problems.
- Representative ecosystems. Representative species of flora and vegetation and fauna.
- Ways of using resources to ensure their survival.
- Main advantages and threats to biodiversity in the Popular Council.
- Plant species present in the cuabal of the Popular Council.
- Uses that the population makes of these species.
- Damages that affect the cuabal.
- Potential of the Popular Council for its conservation.

Taken from Tréllez (s.f) Guide manual for communities. Environmental education and biodiversity conservation in community development.

Reworked by MsC. Yaima Mederos Jiménez, Dra. C Georgina Castro Acevedo.

**Appendix B2**

Guide for in-depth interviews with elderly people, natives of the settlement, a forestry worker and, a peasant who lives next to the cuabal.

Objective: Capture information from popular knowledge to shape and enrich the characterization of the cuabal.

Greetings. We are conducting research about the conservation of the cuabal in the Callejón de los Patos. For this, we ask for your help through your answers in this interview. They will be of great importance for the outcome of the investigation.

Interview topic: _____

Interview Date: _____

Full name of the person interviewed: _____

Age: _____

Years living in the settlement: _____

Degree of instruction: _____

Specialty: _____

Occupation: _____

If Retired, what occupation did you have before you retired: _____

1. Do you know the cuabal in the Callejón de Los Patos?

If you answer No

1.1 By what name do you know the plant formation found after the Poultry Farm, in areas of the Forestry Company?

2. How is that plant formation?

3. What plants do you know are in it?

4. Do you know if before there were some plant species that have disappeared from that area?

If yes, which ones?

5. Of the plants that are in that plant formation, do you know the usefulness or use of any of them?

6. What birds or animals abound in the area of that plant formation?

7. Do you think that plant formation is important?

7.1 Why?

Thank you very much for your answers.

Prepared by MsC. Yaima Mederos Jiménez, Dra. C Georgina Castro Acevedo.

**Appendix B3**

Guide for in-depth interviews with vegetation specialists on streamers from the UCLV Botanical Garden.

Objective: Capture specialized information to confront the formulated demand, the empirical data captured, and the starting theoretical references.

Greetings. We are conducting research on the conservation of the cuabal in the Callejón de Los Patos. For this, we ask for your help through your answers in this interview. They will be of great importance for the outcome of the investigation. In addition, we ask for your permission to record your responses.

Interview topic: _____

Interview date: _____

Full name of the person interviewed: _____

Age: _____

Specialty: _____

Occupation: _____

Workplace: _____

Years of work experience: _____

1. What are the characteristics of cuabales?

2. What is its importance for the conservation of biodiversity?

3. What are the main threats that affect them?

4. In addition to their biological importance, are they beneficial for the people who live near them?

5. Generally, how do people perceive cuabales?

6. Do you consider it necessary to educate the communities for the conservation of the cuabales?

7. What actions are carried out for its conservation?

8. What other actions do you think could be carried out?

9. Do you know the cuabal in the Callejón de Los Patos?

10. What are its characteristics?

11. What state of conservation does it present?

12. What are the main threats that affect it?

13. Do you consider it necessary to carry out actions for its conservation?

14. What potential do you think the Callejón de los Patos has for the conservation of its cuabal?

15. What actions do you think could be carried out in this regard?

Thank you for your answers.

Prepared by MsC. Yaima Mederos Jiménez, Dra. C Georgina Castro Acevedo.

Guide for an in-depth interview with an Environmental Education specialist from the UCLV Botanical Garden.

Objective: To know about the cuabal conservation projects that have been carried out, their results, and limitations.

Greetings. We are conducting research on the conservation of the cuabal in the Callejón de los Patos. For this, we ask for your help through your answers in this interview. They will be of great importance for the outcome of the investigation. In addition, we ask for your permission to record your responses.

Interview topic: _____

Interview date: _____

Full name of the person interviewed: _____

Age: _____

Specialty: _____

Occupation: _____

Workplace: _____

Years of work experience: _____

1. What actions have you carried out, from Environmental Education, for the conservation of the cuabales?

2. What have been the main results and limitations?

3. What are the main motivational elements for children regarding the conservation of cuabales?

4. How can you get childrem lern about this thorny plant formation?

5. What elements of the cuabal do they promote in children?

6. What actions could be carried out to preserve the cuabal, with the childrem performance ?

7. What actions could be carried out to contribute to the conservation of the cuabal of the Callejón de los Patos?

Thank you for your answers.

Pepared by MsC. Yaima Mederos Jiménez, Dra. C Georgina Castro Acevedo.

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