Foundational Conception of the Botanical Garden of Camagüey

Isidro E. Méndez Santos[1]

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ABSTRACT

Research done by the multidisciplinary team of specialists who designed the botanical garden of the province of Camagüey, Cuba, is discussed in this paper, which also includes the rationale for the opening of the garden in the summer of 2015. The site selected for the garden, the exhibition areas, and other facilities for public use and research were characterized. The basic ideas concerning the landscape and architecture of the work were described as well. The particular work goals and the legal framework to support the creation of the scientific institution were studied in depth.

KEY WORDS:/ botanical gardens, preservation, plant diversity, environmental education.

INTRODUCCION

Puerto Príncipe (currently Camagüey City) was probably the first region outside Havana, Cuba, that projected the construction of a botanical garden. Evidence is shown in the minute of the Ordinary Session of the City Hall, October 6, 1814, in which a proposal was made by French physician Sir Luis Cabanis to set up an institution of that kind in town (Crespo, 2016).

After 170 years, the idea gained strength within the framework of the Cuban State policy aimed to create a botanical garden in every province, which had been announced by the historical leader of the Cuban Revolution, Fidel Castro Ruz, on January 6, 1968. Between 1970 and 2005, several attempts were made to complete such aspiration of the Cuban people. However, all of them failed, mostly due to the economic hardships of the period.

By the 2010s, in face of the clear deterioration of Camagüey´s native flora and vegetation, and despite the aspirations of the local population and enthusiasm of specialists in charge of designing the facility, Camagüey was still one of the few provinces with no botanical garden. Within the new context of renovation in line with the 500th anniversary of the city, the long desire of the locals was satisfied.

This article discloses the procedures followed by the city to generate an initial collective conception based on consensus decision, which led to the start-up process.

MATERIALS AND METHODS

Following instructions of the Communist Party of Cuba and the Provincial Assembly of the People's Power in Camagüey, in late 2014, a multidisciplinary working group was set up by

[1]Ph.D. Biological Sciences. Full Professor. Center for Environmental Management Studies. Ignacio Agramonte Loynaz University of Camagüey, Circunvalación Norte, Km 5 ½, Camagüey, Cuba: isidro.mendez@reduc.edu.cu

pecialists from different institutions of the province[2], with the task of conceiving the emerging entity and designing the project at different stages. Starting in 2015, this assignment was taken up as a territorial project besides the program, as part of the Science and Technological Innovation Plan of Ignacio Agramonte University of Camagüey in the 2015-2016 period.

All the participants worked within the framework of collective-conception workshops, which helped identify the necessary data first, and then compiled and processed these data preliminarily, either individually or in temporary sub-commissions. Later, the primary information was collectively analyzed and partial decisions were made by consensus, which, in turn, produced new empirical confirmation and theoretical appraisals. The working group rendered account to the political and governmental authorities of the progress made during the conception of the project and its design, generating a positive feedback process that occasionally conditioned a reorientation of the procedures to follow.

First, the team analyzed the national and international contexts during the projection of the new institution, particularly the priorities set by the Decennial of the UN on Biodiversity (General Assembly of the United Nations, 2010); the Strategic Plan of the Convention on Biological Diversity 2011-2020, known as the Aichi Goals (Secretariat of the Convention on Biological Diversity, 2011); the National Program of Biological Diversity and its Plan of Action 2016-2020 (Anonymous, 2015); the National Plan of Biological Diversity to support implementation of the Strategic Plan of CDB 2011-2020, in the Republic of Cuba (Government of the Republic of Cuba, UN Program for Development and the World Fund for the Environment, 2010), and the Guidelines of the Social and Economic Policies of the Republic of Cuba (Communist Party of Cuba, 2011).

Other documents related to the design, conception, and assignments given to botanical gardens were studied as well (Wyse & Sutherland, 2000; Leiva, 2008; Molina, 2009; Heyd, 2010; Leiva, 2012; Ministry of Science, Technology and the Environment, 2012; Convention on Biological Diversity, 2012, and Sharrock, 2012), including the legal framework to support legal compliance by the new institution (Council of State, Republic of Cuba, 2014; and the Ministry of Science, Technology, and the Environment, 2014).

The experience from other similar institutions set up in the last 45 years in Cuba, was also assessed, particularly those near Camagüey. Other botanical gardens were visited (Tunas, Holguín, and Cupaynicú in Granma province) to discuss experiences with their specialists, and to evaluate their recommendations.

To locate the garden, several previously suggested sites were reevaluated. The selection was based on the preservation and natural values of the site chosen. A place where the public's needs

[2]Including the author of this paper, this working group was composed of the following specialists: Rudy Montero Mata (Environmental Unit), Eduardo Suárez Falcó(Environmental Unit), Roselia Iglesias Moronta (Science and Technology Unit), Jorge Aguilar Pérez (Company for the Protection of Wildlife), Tomás Gómez Puga (Provincial Office of Physical Planning), Lilian Mendieta Sosa (Provincial Office of Physical Planning), Ricardo Montero Casas (Provincial Soil Laboratory), Wilfredo Rodríguez (Company of Engineering Projects and Architecture No. 11), Eddy Martínez Quezada (Center for Environmental Research), Betsy Rodríguez Cardoso (Provincial Office the National Institute of Hydraulic Resources), Oscar Parrado Álvarez (University of Camagüey), Irene Florat Vega (University of Camagüey), Julio C. Rifá Téllez (University of Camagüey), Marisela Guerra Salcedo (University of Camagüey), Daemar Ricardo Marrero (University of Camagüey), Rayner Morales Pérez (University of Camagüey), Roberto Caballero Puentes (University of Camagüey), Roberto Adán Pérez (University of Camagüey), Fernando Crespo Carbó (Historian Office of the City of Camagüey), Rafael Risco Villalobos (Forest Experimental Station), among others.

could be served better, and where the lands were not as much engaged in other economic and social uses. The history of the location and its significance for the city was also considered in this decision.

The property of the terrain was decided by the Provincial Office of Land Ownership, Ministry of Agriculture. Water availability and water quality were evaluated, according to previously recorded data collected by the Provincial Office of Hydraulic Resources, in Camagüey.

The edaphic evaluation included information from the Basic Map of Soils (1:25 000), based on the Second Genetic Classification of Soils of Cuba (Soils Institute, 1990), and a scale topographic survey (1:5000) of the crop area from Alvaro Barba Machado Polytechnic School, made by the Provincial Soil Laboratory. This last study was updated with field work to set up check points using a Dutch-type auger, GPS-georeferencing, and mapping by the System of Geographic Information Soil/2009, on MapInfo, version 12.02.

The local flora and vegetation were preliminarily evaluated through *de visu* identification of species, along with floristic-physiognomic characterization of plant formations.

After ownership conciliation of the land with the best natural attributes for the botanical garden, a decision was made concerning the total area for the facility. The available resources and the experience of other similar gardens were taken into account, not only for the initial investment, but also in terms of real possibilities to guarantee sustainability over time.

RESULTS AND DISCUSSION

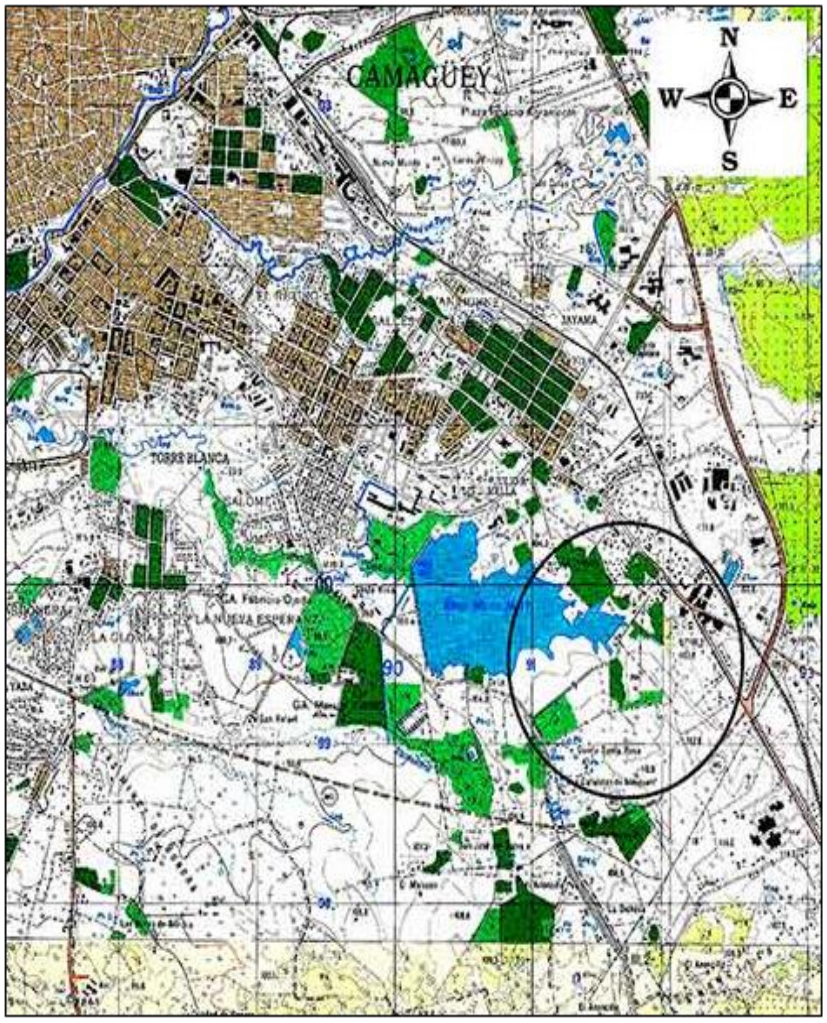
The multidisciplinary work group suggested establishing the garden (see Figure 1) on the crop self-consumption terrains of Alvaro Barba Machado Polytechnic (the former Farming School of Camagüey), on Carretera Central vía al Este, km 5 ½, Camino de Jagüey and Micro Embalse No 17 “Monte Carlos” (Mendieta and Gómez, 2014).

Among the reasons that support the previous decision were,

-Accessibility. It is within the perimeter of the highway circumventing the city, and the access to Carretera Central. Other two recreational facilities near the selected location are very popular among the local urban population. The main city bus lines run near the location.

-Historical tradition. The former Farming School of Camagüey founded in 1917 was for many years the leading institution in training human resources in agriculture, agricultural extension, and management of biodiversity. Various exotic and native plant species were planted there then, especially trees. This scenario inspired the citizens to visit the place for recreational purposes in the 1930s, until it became customary. More details can be read in Méndez (2009).

-Soil quality. There is predominance of brown soils, without carbonates (Soil Institute, 1990), with proper physical, chemical, and morphological features for a botanical garden; as well as brown-gray soils, which might need assisted fertilizing for certain plantations. In general terms, these soils offer a diversity which benefit the garden’s species multiplicity.



(Fig. 1. General location of the Botanical Garden of Camagüey Cartographic database of Camagüey scale 1: 900 000 (Source: Mendieta and Gómez, 2014. Photo by Raudel Valdés Ramos).

-Availability of water supply sources. There are various wells with a proven capacity for irrigation. A creek flows east-west across the selected area, into a mini-dam located west of the garden. Although high pollution of the river is a handicap to meeting the water demands of the botanical collections initially, it contributes to soil moisture and proper environment for the plants.

-State ownership of the land. Most of the land was owned by Alvaro Barba Machado Polytechnic School (Ministry of Education) and the Forest Company of Camagüey (Ministry of Agriculture). After conciliation, it was transferred to the garden, in an effort to foster the collections of the botanical garden. Other small areas were granted a usufruct (decrees 259 and 300) by the Council of State of the Republic of Cuba; the relocation of the beneficiaries was sanctioned by the corresponding authorities.

-Existence of usable facilities. Several previously built facilities at the Alvaro Barba Polytechnic School (Ministry of Education) and the National Institute of Hydraulic Resources were identified

and ceded by their owners. These facilities were rebuilt and refurbished for the new use, and could be assimilated.

-Plant coverage. Although most of the area was used for cattle raising, (largely deprived of trees) small forest areas were identified in the northwestern borderline. Some of these spots had been planted by the school, and others were being used by the Integrated Forest Company (Ministry of Agriculture) to produce seeds. These areas should be strengthened, enriched, and diversified before they can be exhibited to the public in the near future, though they require previous clearing, thinning, and waymarking.

-Access to the national electric grid.

The area comprises 65.47 ha.

This garden is part of the urban development strategy of the city, particularly by increasing the inner green spaces to make it more appealing, and to improve the quality of the environment (for more information about the potential of these institutions, see Torres, Mena Mosquera & Álvarez Dávila, 2017).

The botanical garden of Camagüey has been conceived as a scientific, educational, and recreational institution. It has been designed to lead plant research in the territory, as a recipient of the long botanical tradition of Camagüey, which produced outstanding botanists like Manuel de Monteverde and Bello (see some appraisals of his work in Méndez and Puig, 1997, and Méndez, 2008), Tomás Pío Betancourt (see the comments on botanical learning made by Rodríguez, 1876, and Saco, 1960); also, Julián Acuña Galé (a synthesis of scientific work can be read in Martínez Viera, 1980; Moncada, 1980, and Muñiz, 1980), just to mention a few relevant examples.

In the context of this research, the priority identified was *ex situ* and *in situ* preservation of phytodiversity, particularly in the province of Camagüey, in a joint effort with the system of protected areas.

The Botanical Garden of Camagüey will join the National Network of Botanical Gardens of Cuba (Ministry of Science, Technology, and the Environment, 2012). In view of the previous, the multidisciplinary group that took part in its design set up ties with the Garden's Board of Directors and several other related institutions. As a result, the initial conception was improved with the recommendations derived from the discussions.

The new institution is to preserve, communicate, and develop an integrated culture in terms of plant organisms. In that sense, it must become the main local reference center with information related to plants. Besides crops, it will have a specialized library with information about other collections, herbarium, xylo library, carpo library, sperm library, etc. It will also host art works in relation to phytodiversity and fans of taxonomic groups, and it will set up alliances with other scientific societies and non-governmental organizations devoted to the preservation of nature.

Additionally, it will become a teaching institution of every level of the National Education System, including human resource training for sustainable management of phytodiversity, and it will conduct vocational orientation and environmental education actions (Leiva, 2012), directed to a wide range of targets. The goal of the garden will be to educate in the preservation of phytodiversity, by enhancing people's knowledge of plants and plant formations, and to foster modes of action and values that seek harmonization of social interests with the preservation of the

environment.

It will look to become a healthy and instructive choice of recreation, as well as a therapeutic alternative to reduce stress.

Accordingly, it was assumed that the botanical garden could become a center of attraction for tourism as part of the increasing importance this leisure activity has for the economy of the province, particularly, in the capital city. In that sense, it will be a choice to the long-established sun and sea tourism in the area, along with the appealing historic city center (World Cultural Heritage since 2008).

Besides the green areas and gardening to be developed surrounding the facilities, other fifteen special exhibition sites have been planned (see Figure 2).

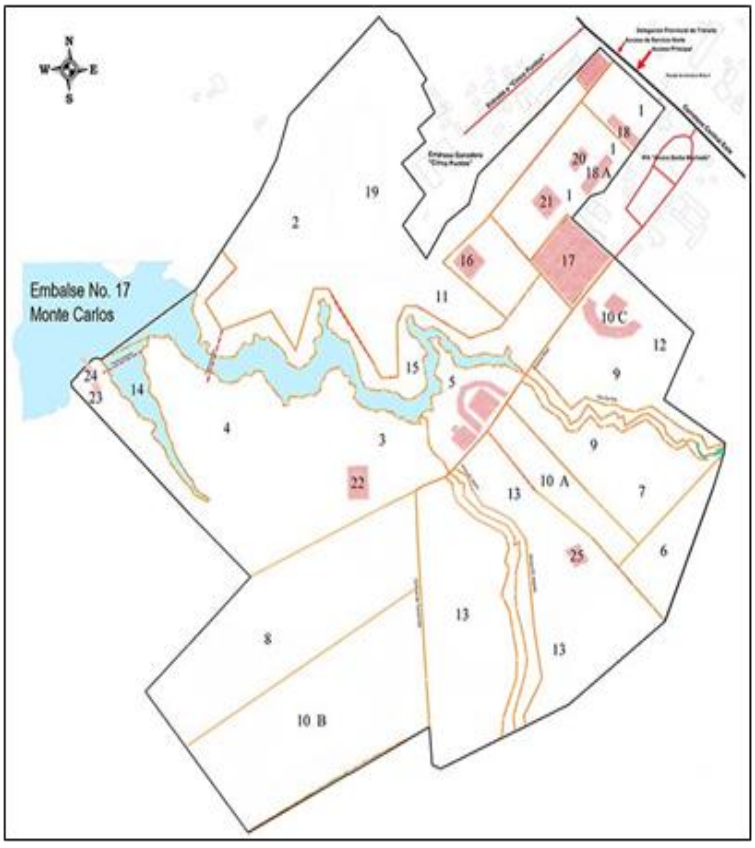


Fig. 2. Diagram of the Botanical Garden of Camagüey, scale 1: 2 300. (Source: Mendieta and Gómez 2014; photograph composition: Julio Cesar Rifá Téllez).

-Forest area. This area will be established in the lot for seed production, formerly owned by the Integrated Forest Company of Camagüey, located to the northeast. It will include a representation of the most commonly planted tree-like species in the country, especially in Camagüey, regardless of its natural distribution.

-Jucaro and hat palm. This is the name given to a plant formation spreadout in the southern plains of Camagüey. The vegetation is secondary, on poorly drained soils, a successive stage derived from forest destruction. It has an open and high tree-like layer, with species of *Bucida* (mostly *B.*

bucera L.) and *Sabal palmetto* (Walter) Lodd. ex Schult. & Schult. f., as well as other palm tree types of genera *Copernicia* and *Coccothrinax;* whereas the grass layer is dense, populated with graminaceae and ciperaceae. Although Berazaín (1979) claimed that this formation may also occur as a forest, it is typically found in the savannas of the province, at least currently. This physiognomy is to be shaped in the exhibition area, located in lowlands, around mini-dam No. 17, which are occasionally flooded during the rainy season, when the water level reaches the highest.

-Anthropic savanna. The intention is to represent the phytodiversity of the Camagüeyan meadows, which are a symbol of the region. It will include the trees that usually provide shade to cattle, and some of the grass that spreads out naturally in the territory, which is extensively used.

-Conuco. It will include the most commonly harvested crops by farmers near their homes. It will also feature the farmer's home and other adjacent facilities (privy, pigsty, hen house, utility room, warehouse for crops, etc.). The design will be made, according to Esquivel & Hammer (1989, 1992a, 1992b and 1994).

-The cuaba plantation. It is a sample of thorny xeromorphic shrubs on serpent soil, which is widespread within the ultramafic nucleus of Camagüey, and extensively characterized by Berazaín, Rankin, Arias & Gutiérrez (1985); Méndez, Risco, Romano, and Aguilera (2004-2005); Méndez, Risco and Reyes (2003); and León, Ricardo, and Enríquez (2003), among other authors. The garden looks to treasure the flora and vegetation of brown-red fersialitic soils (see Marrero, Beyra, Barreto, and Enríquez 1986; Martínez-Quesada, Godínez, and Álvarez 2007), similar to the purple fersialitic soils, also known as latosols (see Barreto, Ávila, Enríquez, Oviedo, Toscano, and Reyes, 2008, and Martínez-Quesada, 2010).

-Palmetum. The aim is to plant a representation of all the palm tree types of the province, as well as from other regions of Cuba. They will share their space with other species in the group, which will be inserted in the other exhibition areas, including imported specimens used in gardening.

-Systematics zone. In this area, the genealogical interactions established throughout the evolution of plants will be represented, according to the most widely accepted classification systems at the time the garden was conceived. The criteria of Judd, Campbell, Kellogg, Danforth, Stevens & Donoghue (2016) were assumed for the design. Other criteria will be included as well: Qiu, Wang, Chen, Knoop, Groth-Malonek *et al*. (2006), Burleigh & Mathews (2004), and from the Angiosperm Phylogeny Group(2009).

-Natural forests. This area will show the floristic composition and physiognomy of these tree-like formations, with special emphasis on the features these acquired in Camagüey, previously described by, Méndez, Trujillo and Martínez (1985); Elenevski, Méndez, Trujillo, Martínez, and Risco (1988); Méndez, Elenevski, Risco, Martínez, and Trujillo (1989); Méndez, Martínez, Caballero, Risco, Morales, Mena *et al*. (1990); Pérez, Ávila, Enríquez, Herrera, Oviedo, and Cárdenas (1992); Barreto, Herrera, Enríquez, and Espín (1992); Pérez, Ávila, Herrera, and Enríquez, (1994); Pérez, Enríquez and Oviedo (1994); Méndez, and Risco (1999); Barreto, Godínez, León, Plasencia, Vilató, and Enríquez (2006); Barreto, Godínez, Plasencia, Reyes, and Enríquez (2006); Díaz, Alverson, Barreto & Wachter (2006), Godínez, Plasencia, and Enríquez (2006), and Barreto, Godínez, Enríquez, and Reyes (2007).

-Area of commercial crops. It will be established in three stages: 1) A display of taro cultivars (*Xanthosoma sagittifolium* (L.) Schott, *X. violaceum* Schott, *Colocasia esculenta* (L.) Schott),

cassava (*Manihot esculenta* Crantz), sweet potato (*Ipomoea batatas* (L.) Lam.), yam (*Dioscorea* spp.), plantain and banana (*Musa* spp.), sugar cane (Saccharum officinarum), and different species used as pastures and forages. 2) A collection of fruit trees. 3) An area with crops usually harvested in Cuban organoponics near the urban areas. It will have an appealing circular design; the vegetables produced will be consumed in the restaurants of the garden.

-The coffee plantation. Although coffee production is not strongly attached to the provincial agriculture, a small area formerly used by the polytechnic school to study a coffee plantation (*Coffea arabica* L. and *C. liberica* Hiern.), and cocoa (*Theobroma cacao* L.), will be used following the traditions of eastern Cuba. It includes trees to produce shade and a layer of lawn to cover the soil and block the spread of undesirable weeds and erosion. It will complement the area of commercial crops.

-Acunan collection. This is the name of an area displaying trees associated to Julián Acuña Galé, a Camagüeyan botanist, whose name has been suggested for the garden. It will also include the species he described, others dedicated to him, and others he studied thoroughly.

-Exotic forest. This site covers an area where the most representative tree-like species introduced in Cuba will be planted. It will also comprise other naturalized plant species as well as others cultivated today, though they are just in special institutions, like botanical gardens, arboretums, and germplasm libraries. The richness of this collection is expected to distinguish this garden from the rest in the country.

-Aquatic plants. Another goal is to foster the flora that normally grows in the fresh water reservoirs of the province, which could be sown in the shallow waters of the adjacent of mini-dam No.17 (Monte Carlos) that borders the garden to the west. The descriptions made by Plasencia (2008) will be used as reference.

-Bambusetum. A collection of bamboo trees (*Bambusa* sp) introduced in Cuba will be fostered according to the compilation made by Catasus (2003).

-Exhibition pavilions. The aim is to build two of them, one for shady plants, and other for xerophytic species. A typical colonial home garden with a collection of plants strongly influenced by the Andalusian culture will be built between the two pavilions.

A nursery with four production sections (three for xerophytic and one for shady species) has been designed to foster the collections of the garden. This plan also comprises outdoor rows, areas for bagged plants (some in the natural shade), a foster field for selection, indoor areas with tables for planting, areas for storing and processing substrates, irrigation systems, utility room, warehouse, and other facilities.

To ensure control of the new taxons in the collection of the garden, the input record was adjusted, also used at the botanical garden of Holguin, on Microsoft Access (Fig.3).

Fig. 3. Screenshot of application to introduce information as part of the database to register the new taxons recorded in the collections of the Botanical Garden of Camagüey. Adapted by: Irene Florat Vega.

Apart from the social and administrative facilities, further special infrastructure was conceived for scientific research in Botany, such as, a laboratory, a herbarium, a xylo library, a sperm library, a carpo library, a literature library, a conference room, a residence for researchers, etc. A butterfly farm was also designed, which will facilitate research on insect-plant interaction, and it will contribute to the preservation of native species of lepidoptera and environmental education.

Several other public spaces were designed; namely, a scale model of the garden, the main square, restaurants, cafeterias, the library, permanent and transitory exhibition areas, shops for plants and art craft, restrooms, stables (the public will be allowed to ride horses), a lookout, a dock (to provide ferry service between the garden and the Lago de los Sueños Park on the other side of the mini-dam), and a playground for children. To get around the park, a grid of roads (for cars, including parking lots), and trails for pedestrians, with pergolas, mini-parks, lookouts, etc., were conceived. Additionally, administrative facilities were also designed, such as offices, areas for staff, parking for guests, workshops, warehouses, etc.

The scientific goals of the collections were adjusted to the preservation of the natural landscapes that could be included in the general conception of the place; some were given more relevance, like recreation, and others were linked to the main economic items of the province: cattle raising and agriculture. The site's landscape has been designed to keep the vigor and coloring of the sites, by combining plant species that preserve foliage and colors throughout the year. The inclusion of windbreakers is critical, which in addition to preserving the ecology, they set area boundaries without disrupting the most prominent views. The buildings remind the public of the

Spanish-African roots of the Camagüeyan society, particularly observed in the architecture, gardening, and catering facilities (Rodríguez, 2014). The changes applied after the project was implemented are self-evident (Fig.4).

Fig. 4. Photo testimony. A and B. Existing vegetation when the area was selected. C. Design of the main square (source: Rodríguez 2014). D. Main entrance after opening to the general public.

Architectonically, the idea was to integrate the environmental factor to building design, in order to make better use of solar energy to save electricity (lighting), and to reduce the impact of the wind and rain. Mostly, local materials were used for the construction of walls, flooring, and roofs, including furniture and interior design. Bricks made of red clay and reinforced concrete blocks (both bare) were used, leaving the marks made by the formwork wood exposed). Other materials included rock slates, Cuban and French roof tiles, thatch roofs, and slight adobe closing. Paving was made following economic sustainability criteria (Rodríguez, 2014).

As a scientific institution, the creation of the Botanical Garden of Camagüey is endorsed by decree 323, Chapter 1, Article 2 and Final Provisions, Chapter IV, as an entity of development

and innovation (Council of State, Republic of Cuba, 2014), registered in the National Record of Science, Technology, and Innovation Institutions, according to Resolution 164/2014 (Ministry of Science, Technology, and the Environment, 2014).

Considering the previous, and after consulting the experiences of the botanical gardens of Las Tunas, Granma, and Holguín, the payroll and administrative scheme were designed as follows (Fig.5).

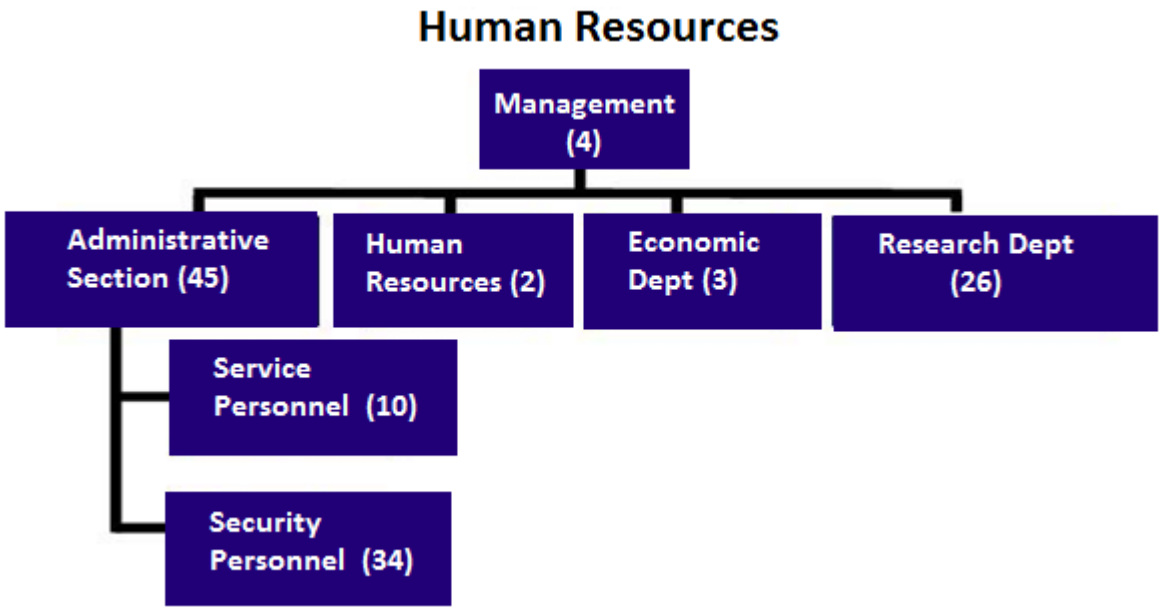


Fig. 5. Recommended staff chart for the Botanical Garden of Camagüey (made by: Roselia Iglesias Moronta).

agement.

Director and secretary.

Science Deputy Director and secretary.

Administrative Department.

1-Head of services.

1-Service personnel.

1-Warehouse clerk.

2-Drivers D.

1-Chef.

1-Kitchen assistant.

4-General services assistants.

1-Machinist in agriculture.

Security personnel.

1- Chief of security and protection.

33-Security guards.

Human Resources.

1-Head of Human Resources.

1-Technician.

Economic Department.

1-Head of department.

2-Technicians.

Research Department.

6-Senior researchers

10-Research assistants for the botanical sites.

10-Technicians (4 guides and 6 area technicians: 1 plant nursery, 1 herbarium, and 4 other collections).

Total: 80 workers.

CONCLUSIONS

The garden opened its doors on September 6, 2015. By then, the multidisciplinary work team had finished the architectonic design of the main areas planned, and made a considerable progress in the conception of the exhibition areas, still under construction.

By 2015, other works completed included the nursery, the administrative and social building, the scientific residence, the main square, roads for vehicles, one of the exhibition pavilions, the rustic structure of Conuco, two restaurants, a cafeteria, the stable, the lookout, the dock, and other facilities for public use. The provincial Administration Council has earmarked more funds to complete the remaining areas in the plan during the coming years.

Likewise, other areas with existing trees (forest area, the coffee plantation, and areas near the main entrance) were prepared. The bambusetum was initiated, and production was fostered in the nursery, in order to supply the plantlets required to establish other foreseen collections.

This institution has initially been named Botanical Park of Camagüey, though it can further be recognized as Garden, as it grows and takes shape, compared to the rest of the botanical gardens of the country. The goals set during conception of the park are expected to be entirely accomplished.

The Camagüeyan experience ratifies the importance of an inter-discipline approach to deal with botanical gardens, by mobilizing more local skilled human resources where the gardens will be established. In addition to it, the political will of the political and government authorities will ensure the success of the project.

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