Delpinoa **56-57**: 69-103. 2014-2015

The greenhouses of the Botanical Garden of Naples, Italy

G. SIBILIO

Orto Botanico di Napoli, Università degli Studi di Napoli Federico II, Via Foria 223, 80139 Napoli, Italy
gsibilio@unina.it

Riassunto. L'Orto Botanico di Napoli dispone di tre serre per la coltivazione di specie tropicali: la Serra Monumentale Merola, la cui costruzione risale alla fondazione dell'Orto (1810) e che ospita una selezione di piante a fiore; la Serra Califano, la più estesa (5.000 mq), edificata nel 1967, che ospita la grande maggioranza delle collezioni, tra le quali una delle raccolte più rappresentative del mondo delle rarissime Cycadophyta; la Serra Tropicale De Luca, di più recente istituzione (2005), in cui sono stati ricostruiti vari ambienti tropicali, tra cui una piccola foresta formata da mangrovie. Per ciascuna Serra vengono descritte le specie coltivate e il significato scientifico e didattico.

Abstract. The Botanical Garden of Naples, Italy, has three greenhouses: the Monumental Greenhouse Merola, dating back to the time of the foundation of the Garden (1810) and hosting a selection of flowering plants; the Greenhouse Califano, the largest one (5,000 sqm), built in 1967, hosting the vast majority of collections, among which one of the most representative collection in the world of the very rare Cycadophyta; and the Tropical Greenhouse De Luca, more recently built (2005), which hosts the reconstruction of several tropical environments, among which a mangrove forest. The cultivated species and their scientific and didactic significance are described for each Greenhouse.

Key words: Botanical Garden of Naples, Greenhouses, Plant collections

THE BOTANICAL GARDEN OF NAPLES

The Botanical Garden of Naples is one of the most prominent botanical gardens in Europe for the relevance of its collections and number of cultivated species (LONGO 1937, 1943; CATALANO 1958; GIACOMINI 1965; VALLARIELLO 1985; DE LUCA 1992, 2008-2009; DE LUCA & MENALE 1997; BARONE & MENALE 2000; MENALE & BARONE 2000; MENALE & DE LUCA 2007, 2008-2009). The Garden has a great scientific significance thanks to the mild climate of Naples, that allows to cultivate outdoors, besides numerous temperate species, also several subtropical species, and because it was conceived as the botanical garden of the capital of a kingdom (the Kingdom of the Bourbons), with an important harbour where new species of plants could easily arrive (LACK 2008-2009).

The foundation decree of the Garden was signed in 1807. Michele Tenore (Fig. 1) was the first director of the Garden, from 1810 to 1860 (CATALANO 1958). During his 50 years of direction, the plant collections increased more and more, with the number of cultivated species reaching about 9,000. Tenore also organized the first exhibition areas according to the criteria of the time, keeping in mind the function of public instruction and the multiplication of beneficial species to agriculture and industry (CATALANO 1958; BRUNO 1992; MENALE & DE LUCA 2008-2009; GRAVAGNUOLO 2008-2009).

Nowadays, the Garden covers an area of twelve hectares (Fig. 2), which include open exhibition areas, arranged according to systematic, ecological and ethnobotanical criteria, and greenhouses, mainly devoted to the cultivation of sub-tropical and tropical plants. Today, the species in the Garden are approx. 15,000 (SIBILIO *et al.* 2017), 20 % of which are cultivated in the greenhouses.

The continuous increase in the number of plant species with particular ecological properties has made it necessary to create new greenhouses, which have been added to the Monumental Greenhouse (Fig. 3), the only

one dating back to the time of the foundation of the Garden. Today there are three greenhouses in the Botanical Garden of Naples: the Monumental Greenhouse Merola, the Greenhouse Califano and the Tropical Greenhouse De Luca (Fig. 2).

In this paper, we reconstruct the history of these Greenhouses and describe their collections and functions.

THE MONUMENTAL GREENHOUSE MEROLA

The Monumental Greenhouse Merola (Figs. 2A, 3 and 4) takes its name from the eminent botanist Aldo Merola (Fig. 5), director of the Botanical Garden of Naples from 1963 to 1980, to whom the Greenhouse was dedicated in 1988.

The Greenhouse was built on the first decade of the foundation of the Garden by the will of Michele Tenore, to protect exotics specimens in the winter season. Designed by the architect Giuliano de Fazio, the work of realization started in 1808 (CATALANO 1958). It was in operation three years after the beginning of the works, although it took many years more to complete the project, with the addition of steps and the internal flooring. It is in the neoclassical style, similar to the "Orangery" of the eighteenth century hosting citrus collections in many northern European countries during cold months. The Greenhouse has a rectangular plan and measures 48 m in length by 11 m in width. Its façade is adorned by columns in Doric style, with seven round arches, closed by wooden and glass doors (Fig. 6). The doors are very particular: they open thanks to two pins placed at the centre of each element, according to a mechanism defined as "central pivotal". This results in two large gaps that permit the entrance and the exit of large potted plants (Fig. 6). A very innovative feature for the time (RUSSO 1992; BARONE & MENALE 2000). The entablature of the building is characterized by metopes with sculptural decorations which alternately depict plants and flowers with triglyphs (Fig. 7). The metopes probably depict plant entities cultivated in the Garden at the opening of the Greenhouse. Despite the missing documentation, according to the general opinion, Friedrich Dehnhardt, chief-gardener of the Botanical Garden (MENALE & BARONE 2000), realized the metopes or superintended the work. Some metopes represent plants easily identifiable, both spontaneous species of Italy, as *Acanthus mollis* L. and *Hedera helix* L., and exotic species, as *Cornus capitata* Wall., *Eucalyptus* sp., *Rosa centifolia* L., *Zantedeschia elliottiana* (W. Watson) Engl., *Opuntia maxima* Mill. The latter species was described for the first time by Michele Tenore. Other depicted species are *Vitis vinifera* L., *Olea europaea* L. and *Ficus carica* L.

Originally the Monumental Greenhouse did not have a heating system, hence the terms of “Cold Stove” to identify this Greenhouse. However, the exposition to the south allowed to heat up its interior by sunlight from sunrise to sunset, and the large glass doors held the heat during the night. Inside the Greenhouse, during the winter, the temperature was not very high and for this reason only species from temperate-warm regions were hosted in it. To improve the cultivation conditions, in 1825 supplemental heat was provided during the winter by wood-fired iron stoves. In the course of subsequent restoration interventions carried out in 1982 and supervised by the Superintendence of Cultural and Architectural Heritage of Naples and Province, the Greenhouse Merola was equipped with a heating system (PISANO 1992).

Today the Greenhouse hosts tropical and sub-tropical collections of various groups of Magnoliophyta (Figs. 8-13) organized by systematic criteria (MUOIO 2011) to show to the public visiting the Garden and to students of university courses in botany the adaptive radiation of flowering plants in different climatic regions; among these plants, *Goethea strictiflora* Hook. f. (Fig. 8) native of Brazil, *Plumeria alba* L. (Fig. 9) native of Central America and Caribbean, *Hibiscus schizopetalus* (Dyer) Hook. F. (Fig. 10) native of eastern Africa, *Acokanthera oppositifolia* (Lam.) Codd. (Fig. 11) native of Central and Southern Africa, and *Cestrum elegans* (Brongn. ex Neumann) Schtldl. (Fig. 12) native of the warm area of America. The plant collection is completed with some specimen of Arecales, from tropical and subtropical areas (Fig. 13).

THE GREENHOUSE CALIFANO

With an extension of 5,000 sqm, the Greenhouse Califano is the largest one of the Garden (Figs. 2B and 14). This Greenhouse was built at the end of the '60s by the will of director Aldo Merola, and thanks to the support of Luigi Califano (Fig. 15), head of the medical school of the University of Naples Federico II and eclectic scholar of botany, to whom the Greenhouse was dedicated in 1976.

The profitable activity of Aldo Merola, that established contacts with several Italian and foreign botanical gardens, allowed to exchange many seeds and plantlets and made it possible to organize new botanical collections of considerable scientific value, which over time have been further enriched. Moreover, from 1969 to 1974, Aldo Merola organized many botanical expeditions, with the participation of some young researchers, among which Paolo De Luca (Fig. 16 and 21) (later become director of the Botanical Garden of Naples), and Sergio Sabato (Figs. 16 and 17) (founder of the Botanical Garden of Lecce, Italy). During these expeditions, specimens and seeds of Cycadales, Cactaceae and Bromeliaceae were collected to enrich the collection of the new Greenhouse. Numerous further expeditions, organized with the same purpose between 1974 and 1994 by Paolo De Luca, Sergio Sabato and Aldo Moretti (Fig. 18) (later become Director of the Department of Plant Biology of the University of Naples), with the collaboration of Mario Vazquez Torres (Fig. 26) of University of Veracruz, Mexico, and Dennis Wm. Stevenson (Fig. 28) of the New York Botanical Garden allowed to collect new species belonging to cycad genera *Ceratozamia* Brong., *Dioon* Lindl. and *Zamia* L. Other expeditions covered territories of Caribbean, South America, Central and South Africa and Indonesia, where new wild unknown species were collected (DE LUCA *et al.* 1995). In the last few years, thanks to the work of Paolo Caputo (Fig. 19), present director of the Garden, the cycad collection has been enriched by exchanges between research institutes and by purchases from specialized plants nurseries around the world.

The Greenhouse Califano consists of different sections, in each of which specific environmental parameters are regulated by a computerized system (SIBILIO 2011a). Therefore, each sector has different values of temperature, wetness, and brightness according to the plant group (i.e., succulents, ferns, bromeliads, etc.). The most important section is undoubtedly that of Cycadophyta (Fig. 20), that occupies three rooms. This ancient group of plants includes 331 species of living plants belonging to 11 genera (OSBORNE *et al.* 2012). The collection at the Botanical Garden of Naples was reported to be the most important and representative in the world (OSBORNE 1992). Today, the collection is formed by 550 specimens belonging to 110 species. This collection is of particular importance, considering that the Cycadophyta are among the rarest plants in the world and of great scientific interest. Moreover, many of them are part of the Red List and need *ex situ* conservation, one of the functions performed by the Botanical Garden of Naples thanks to the technicians and researchers involved in the management of greenhouses and in the study of its plants. *Dioon*, distributed in the New World, is the most represented genus in the Neapolitan cycad collection. There are numerous plants of the species *Dioon edule* Lindl., *D. purpurisii* Rose and *D. mejiae* Standl. & L.O. Williams, as well as of species described by Neapolitan botanists examining plants collected in Mexico and transferred to the Greenhouse Califano; some of these new species were devoted to Italian botanists, as *D. califanoi* De Luca & Sabato (Fig. 21), *D. caputoi* De Luca, Sabato & Vàzq. Torres (Fig. 22), *D. merolae* De Luca, Sabato & Vàzq. Torres (Fig. 23), *D. tomasellii* De Luca, Sabato & Vàzq. Torres, or to foreign botanists, as *D. rzedowskii* De Luca, & al. (Fig. 24) and *D. holmgrenii* De Luca, Sabato & Vàzq. Torres (Fig. 25). Another interesting species is *D. spinulosum* Dyer ex Eichl, discovered in the mid nineteenth century in Mexico. This is one of the few non-endangered species, with the largest natural population among the Mexican cycads. The specimens are magnificent, and they can grow up to 10 m in the field (Fig. 26).

The cycad collection includes also several species of *Zamia* Miq. (Fig. 27), another cycad genus from the New World with many species included in the Red List of highly endangered species (HILL *et al.* 2005), among which *Zamia angustifolia* Jacq. var. *angustis-*

sima (Miq.) from Caribbean islands, *Z. vazquezii* D.W. Stev., Sabato & De Luca native of Veracruz, Mexico, *Z. pygmaea* Sims ex J. Schust native of Cuba and *Z. polymorpha* D.W. Stev., A. Moretti & Vázq. Torres (Fig. 28). For their peculiar cytological features, many plants of various species of *Zamia* cultivated in this Greenhouse have been material of study by many Italian and foreign researchers. Several species of *Zamia*, in fact, are characterized by the rare phenomenon of intraspecific karyotypic variation (MORETTI *et al.* 1991; CAPUTO *et al.* 1996; NAPOLITANO *et al.* 2004). *Ceratozamia* Brongn. is another cycad genus almost exclusively of Mexico, with several species represented in the Greenhouse, such as *Ceratozamia hildae* G.P. Landry & M.C. Wilson (Fig. 29), *C. latifolia* Miq. and *C. kuesteriana* Regel. Many specimens of *Ceratozamia* in the Greenhouse Califano were collected in nature and well studied by Neapolitan botanists in relation to systematic and geographical distribution (MORETTI *et al.* 1980, 1992; SABATO *et al.* 1981).

Numerous in the collection are also specimens of cycads from Africa, Asia and Australia.

Relatively to Africa, the two genera endemic to this continent, i.e., *Encephalartos* Lem. and *Stangeria* T. Moore, are represented by several species. We cite here *Encephalartos arenarius* R.A. Dyer (Fig. 30), an extremely rare species from the Cape Province, disappeared in most of its natural habitats due to indiscriminate collection and increase of crops, and *Encephalartos sclavoi* De Luca, D.W. Stev. & A. Moretti (Fig. 31), a species endemic of Tanzania and described by Paolo De Luca, Aldo Moretti and D.W. Stevenson and devoted to Jean Pierre Sclavo, scholar of botany who first discovered and recognized it as new species (STEVENSON *et al.* 1987-1988). *Stangeria* T. Moore., from Southern Africa, is represented in the collection by *Stangeria eriopus* (Kunze) Baill. (Fig. 27), the only species known for this genus.

Specimens of Asian species of the genus *Cycas* L. and Australian species of genera *Cycas, Lepidozamia* Regel and *Macrozamia* Miq. complete the collection of cycads, among which *C. panzhihuaensis* L. Zhou & Y. Yang native of China, and *L. hopei* (W. Hill.) Regel, and *M. moorei* F. Muell. native of Australia (Fig. 32).

The ecological peculiarities of cycad species necessarily require greenhouse cultivation. In the Greenhouse Califano, environmental parameters of temperature, wet, solar irradiation and soils mixtures are adjusted in order to recreate the ideal conditions for the growth of each group of these species.

Other sections of the Greenhouse Califano are devoted to the cultivation of succulent species (Fig. 33A); most of them cannot survive outside at latitudes of Naples. These sections are only partially covered by Perspex panels in order to ensure a higher light intensity, as required by these plants. Parts of these succulent plants are also grown outside (Fig. 33B) and used to replace, when necessary, plants that die in the "Desert", an open-air area of the Garden. Each of these sections is organized to represent a specific theme. A section exhibits succulent plants with different shapes according to their morphological adaptations to different dry environments. Another section hosts plants organized by geographical distribution: plants from different desert environments of South Africa, Mexico and South America are represented. In this latter section is also cultivated *Welwitschia mirabilis* Hook. f. (Fig. 34), a very “strange” species exclusive of desert of Namibia. Its plants have singular shape; for all their life, they produce only two leaves with continuous growth up to 5 m in length; the leaves then do not lengthen further because their extremities are wear out. *W. mirabilis* survives in a dried condition thanks to roots which extend deeply in the substrate, where moisture is preserved for a long time. Also, the shape of the leaves allows the plants to collect by condensation the few water particles in the air of the desert.

Other genera cultivated in the Greenhouse belonging to Gnetopsida, the same group of *Welwitschia* Rchb., are *Gnetum* L. (Fig. 35) and *Ephedra* L. In addition to their attractiveness, these genera are of particular biological and didactic interest representing an important step in the evolutionary history of plants.

Also interesting are the collections devoted to genera *Haworthia* Duval and *Sansevieria* Thunb. Collections of these plants are characterized by a high number of species, selected

to explain the morphological variability that characterize them. *Haworthia* is endemic to South Africa. *Sansevieria,* a genus with almost all African species (Fig. 36), is represented by numerous plants in the collection. These plants present a subterranean rhizome from which leaves emerge. The leaves are lanceolate, sub-cylindrical or cylindrical, with different ornaments generating marbled effects. These collections have been deeply studied by Neapolitan researchers of ecology for their typical CAM (Crassulacean Acid Metabolism) photosynthesis (VIRZO DE SANTO *et al.* 1981-1982).

The Greenhouse Califano also shows a collection of insectivorous plants which attracts the attention of visitors, especially the youngest ones. The insectivorous plants, known also as "carnivorous plants", can capture and digest insects in order to find nutrients, especially nitrogen compounds, absent in the soil and water. This collection includes many species, among which *Drosera* L., that have leaves by stalked gland to attract, ensnare and digest little insects, and “pitcher plants”, as *Cephalotus follicularis* Labill. (Fig. 37), *Nepenthes* L. spp. and *Sarracenia* L. spp. The most peculiar insectivorous plant in the collections is undoubtedly the Venus flytrap, *Dionaea muscipula* J. Ellis, that possesses an active trapping mechanism to capture insects with one of the most rapid movements in the plant kingdom, as described by Darwin; flytraps close in 0.3 s (VOLKOV *et al.* 2008). This species is a real attraction for young visitors to the garden and is extremely useful for introducing to them simple concepts of evolution and ecology compatible with their level of knowledge.

A further section is represented by genera typical of mangrove ecosystems, such as *Avicennia* L., *Conocarpus* L., *Laguncularia* C.F. Gaertn. and *Rhizophora* L. Mangrove ecosystems are distributed on coastal lagoons and river estuaries in the intertidal zone in tropical and subtropical regions. Mangrove is a general name of salt-tolerant species which can survive in saline environments, poor of oxygen and with muddy soils. The specimens of mangrove in cultivation are hosted in big tubs with a mud and water in order to ensure the typical soil where these kinds of plants live; the temperature is always held above 10 °C. A mangrove mesocosm is also displayed in the Tropical Greenhouse De Luca; it will be discussed later.

The Greenhouse Califano guests a collection of Bromeliad plants, which include 40 species of *Tillandsia* L., with a total of 300 specimens, among which *Tillandsia califanii* Rauh devoted to Luigi Califano (Fig. 38). Many of these plants were collected during botanical expeditions in North and Central America and identified the first time in Naples. *Tillandsia* has epiphyte plants growing up on trees; during the flowering, they change the entire colour of the leaves that become brightly red to be high visible to the pollinators, as *Tillandsia brachycaulos* Schltdl. (Fig. 39). Another interesting aspect of these species is that they show typical morphological adaptations of xeric plants although they prevalently live in tropical rainforests.

The last section of the Greenhouse Califano is the reconstruction of the environment of ferns and other species with similar characteristics. Are here observable, *inter alia*, *Equisetum giganteum* L. and *Psilotum nudum* (L.) P. Beauv. (Fig. 40), a small herbaceous plant with remarkable primitiveness.

THE TROPICAL GREENHOUSE DE LUCA

The Tropical Greenhouse De Luca (Figs. 2C and 41) measures 23 m in length by 12 m in width. This Greenhouse has replaced a previous old one built in 1818 (CATALANO 1958). The old greenhouse was a hot greenhouse with a rectangular base, placed between the present Greenhouse Merola and a little building, today no longer present, inside which two donkeys moved a winch for extracting water out of a well. The entire greenhouse was rebuilt in 1871, increasing its size. Between 1951 and 1954 a circular tub for the cultivation of the water plants was added. After the earthquake in 1980, one of the strongest in Italia seismic history, this greenhouse was abandoned, and the collections were transferred to the Greenhouse Califano.

In 2005, the old greenhouse was entirely rebuilt, thanks to University of Naples Federico II and the Superintendence of Environmental and Cultural Heritage of Naples, by the will of Paolo De Luca, director of the Garden at that time. The new project was drawn by architects

Maurizio Pinto and Tommaso Russo. The new Tropical Greenhouse is similar to the nineteenth-century greenhouses: it is made of iron and glass, with a vaulted roof made of lighter Perspex. Inside, an ample space is dedicated to a 10 m long, 5.5 m wide and 1.6 m deep ovoid tub (Fig. 42). On June 4, 2016, it was dedicated to the former retired director Paolo De Luca, after his thirty years direction of the Garden.

The particularity of the Tropical Greenhouse De Luca consists in the fact that the chosen species are cultivated reproducing their natural environments (Fig. 43). The Greenhouse is almost entirely devoted to tropical rain forest environments of Mexico. Many species in the collection were collected in the area of the Lake of Catemaco in the State of Veracruz, during botanical expeditions promoted by the Botanical Garden and in collaboration with the University of Veracruz (MENALE *et al.* 2009).

Among the various species in cultivation, *Acacia cornigera* (L.) Wild., a small tree called Bullhorn acacia (Fig. 44), is of particular interest for its myrmecophily. Its plants live in symbiosis with a species of ants (*Pseudomyrmex ferruginea* Smith F.) that live in the hollowed thorns produced by the plant. The ants eat the protein-lipid nodules product by the leaves of *Acacia* Mill. These nodules, known as Beltian bodies, have no known function.

Many arboreal essences grow around the tub, some with particular shapes of flowers, such as *Plumeria* spp., *Costus scaber* Ruiz & Pav. (Fig. 45), *Jatropha podagrica* Hook (Fig. 46), and *Couroupita guianensis* Aubl., the latter known as "cannonball tree" (Fig. 47).

On the back wall of the Greenhouse grows *Vanilla planifolia* Jacks. ex Andrews (Fig. 48), an orchid native of Mexico and nowadays widely cultivated in different tropical and subtropical areas of the planet. The flowers are produced in conditions of low moisture and strong sunlight; they are waxy and with light yellow petals. After the pollination, the flower's ovary turns into the vanilla pod, containing one of the most precious spices in the world.

In the tub for aquatic plants, there is the reconstruction of a small forest of tropical mangroves, with some representative species, such as the white mangrove (*Laguncularia racemosa* (L.) C.F. Gaertn.), the black mangrove (*Avicennia nitida* Jacq.) and the red mangrove (*Rhizophora mangle* L.), all representative species of the Alvarado Lagoon in the Mexican State of Veracruz. Another interesting mangrove species from Mexico in the collection is the button mangrove (*Conocarpus erectus* L.). All mangroves have been collected in nature as embryos or seeds and successfully propagated in the Garden for several years.

The water tub hosts other aquatic species; among these, *Victoria cruziana* A.D. Orb. (Fig. 49), with floating leaves with a diameter that can reach two meters (Fig. 50). Other species of genera *Cabomba* Aubl., *Vallisneria* L. and *Salvinia* Sèg. are interesting aquatic plants in cultivation, too.

The Greenhouse also hosts an interesting collection of Mexican epiphyte species belonging to *Tillandsia* (Fig. 51) and to Cactaceae (i.e., *Selenicereus anthonyanus* (Alexander) D.R. Hunt, Fig. 52) and Orchidaceae (i.e., *Brassavola nodosa* (L.) Lindl., Fig. 53).

The Greenhouse offers to visitor an itinerary in a forest of Mexico without abandoning the boundaries of the city of Naples (SIBILIO 2011b).

CONCLUSIVE REMARKS

The favourable climate of the city of Naples allows the cultivation of innumerable temperate and subtropical species of plants in the outdoor exhibition areas of the Garden. The Greenhouses allow expanding the possibility of cultivation to tropical plants. The creation of microenvironments in the Greenhouses together with specific competences by operators involved in the management of the Greenhouses as well as the collecting of plants in the field in the course of the numerous botanical expeditions organized in the last decades by researchers belonging to the University of Naples have allowed to obtain in Naples collections of plants grown indoor that can be today considered among the most interesting exotic cultivated plants in Italy and Europe.

The set of these collections represents a clear attraction for any type of visitor of the Garden and has an important scientific significance for any scholar of botany. Very numerous are

the scientific works published in specialized international journals of botany that have had as a study material the plants of the Greenhouses.

The educational interest of the collections is important, too. The collections are frequently examined by students of naturalistic and biological university courses. These students have free access to the Botanical Garden of Naples to observe live the plants in the Greenhouses that are treated in their classes. Academic professors, equally, take advantage of the existence of these collections to organize their practical exercises aimed to the identification and examination of the plant entities of which they speak about in their courses.

Moreover, the Botanical Garden of Naples is visited annually by about 15,000 students of primary, secondary and high schools, for which the visit of the Greenhouses represents a moment of great interest and cultural significance.

Also, some collections are formed by endangered species in need of *ex situ* conservation (SIBILIO *et al.* 2010, 2014). Part of these species, after their cultivation and propagation in the Greenhouses, has been reintroduced into their habitats of origin where they had disappeared or are in danger of extinction (SOLLINO & VALLARIELLO 2008; PIOTTO *et al.* 2010).

The importance of the Neapolitan Greenhouses has recently improved thanks to the hectic and intense activity of Paolo Caputo, actual director of the Botanical Garden of Naples. Paolo Caputo has strongly increased relations with international botanical institutions with which the exchange of seeds and plants for the Greenhouses has intensified. He has also placed emphasis on selecting the most accredited nurseries in the world specialized in growing tropical plants to turn to for the acquisition of new plants for the Greenhouses. The new director, with its work of continuous improvement of the greenhouses, is perpetuating in the Botanical Garden of Naples the scientific traditions which began over two centuries ago.

Acknowledgments. Special thanks to my friend Giovanni Iovino for his help in the final review of the work.

Fig. 1 - The statue of Michele Tenore, first director of the Botanical Garden of Naples, exposed in the Garden.

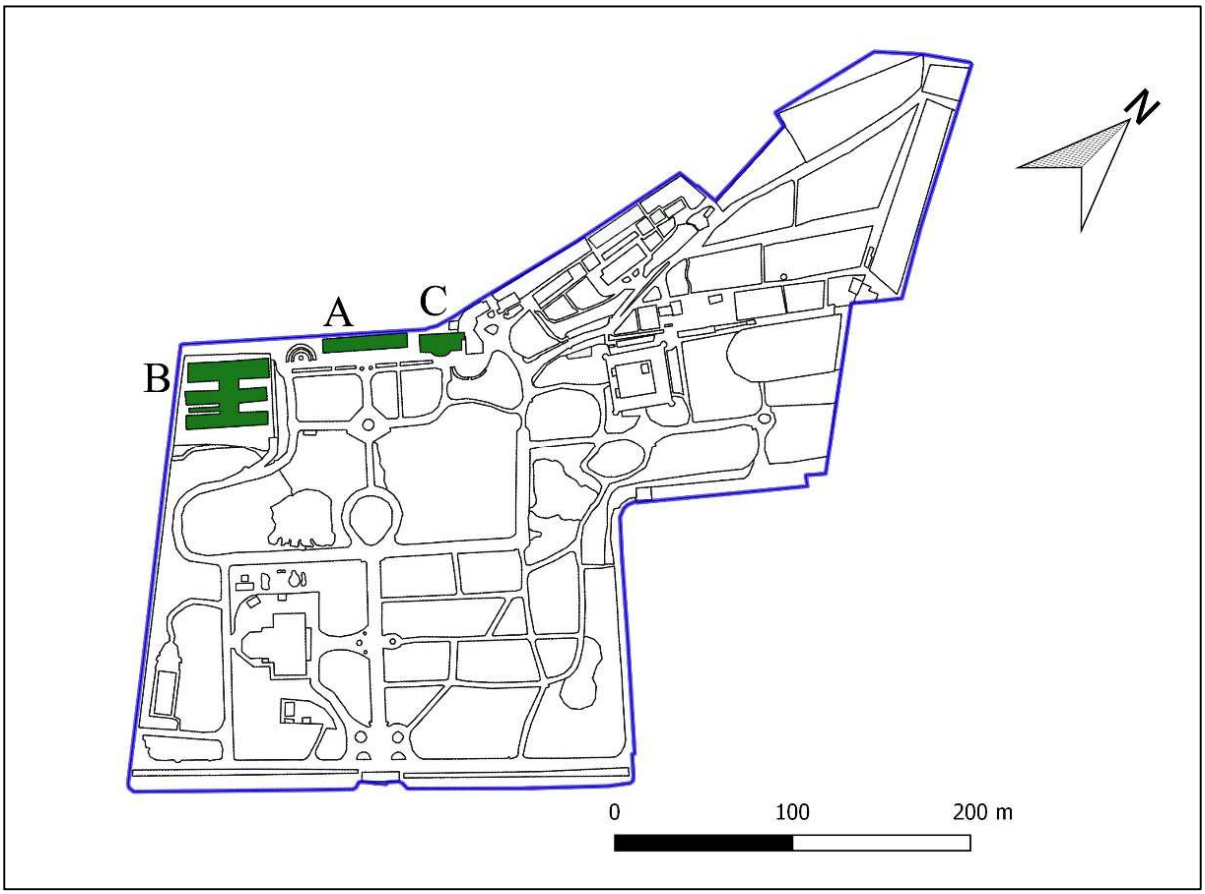

Fig. 2 - Planimetry of the Botanical Garden of Naples. **A**. The Monumental Greenhouse Merola. **B**. The Greenhouse Califano. **C**. The Tropical Greenhouse De Luca.

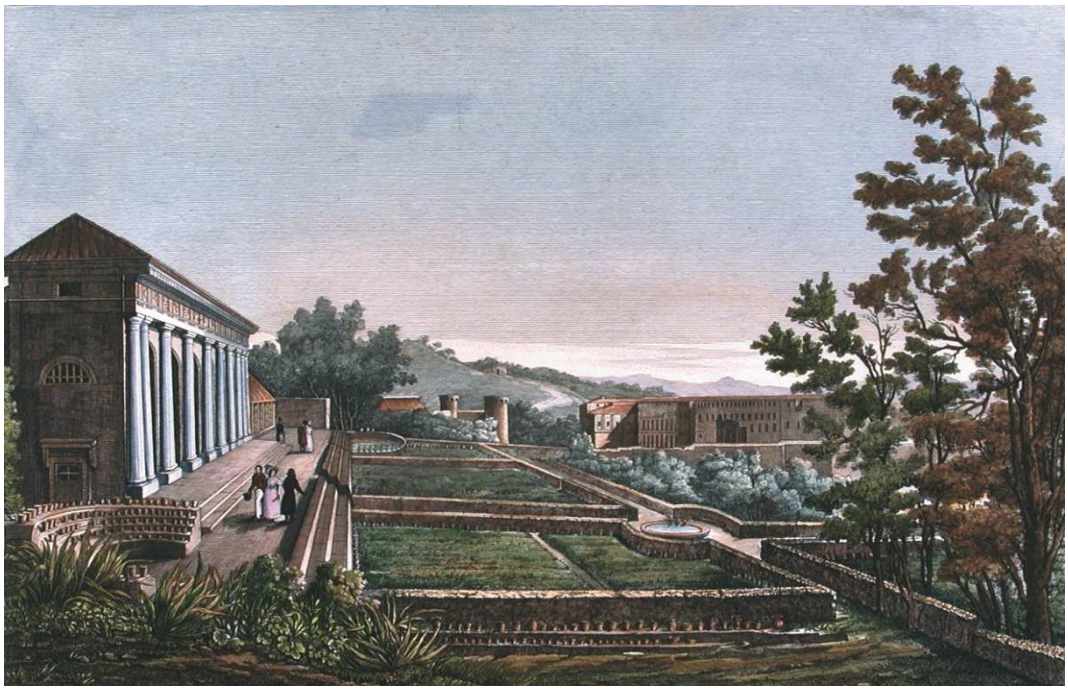

Fig. 3 - Copper engraving, attributed to Giacinto Gigante (ZUCCAGNI ORLANDINI 1835-1845), showing a glimpse of the Garden with the Monumental Greenhouse on the left.

Fig. 4 - A night view of the Monumental Greenhouse Merola.

Fig. 5 - Aldo Merola.

Fig. 6 - The doors and columns of the Monumental Greenhouse Merola.

Fig. 7 - Details of metopes and triglyphs of the Monumental Greenhouse Merola.

Fig. 8 - *Goethea strictiflora* in the Monumental Greenhouse Merola.

Fig. 9 - Inflorescence of *Plumeria alba* in the Monumental Greenhouse Merola.

Fig. 10 - *Hibiscus schizopetalus* in the Monumental Greenhouse Merola.

Fig. 11 - *Acokanthera oppositifolia* in the Monumental Greenhouse Merola.

Fig. 12 - *Cestrum elegans* in the Monumental Greenhouse Merola.

Fig. 13 - Specimens belonging to Arecales hosted in the Monumental Greenhouse Merola.

Fig. 14 - View from the outside of the Greenhouse Califano.

Fig. 15 - Luigi Califano with a specimen of *Tillandsia.*

Fig. 16 - The two figures in the center on the car are Paolo De Luca (right) and Sergio Sabato (left). In the van to the passenger side, Luigi Califano. Photo taken in the course of an expedition in Mexico.

Fig. 17- Sergio Sabato with a leaf of *Zamia* in Mexico.

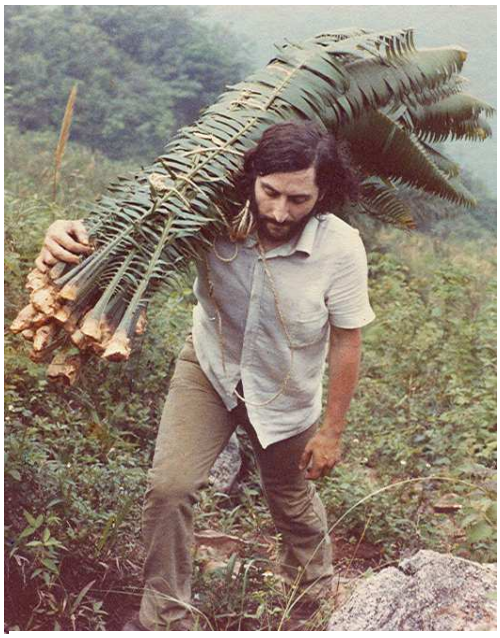

Fig. 18 - Aldo Moretti with leaves of *Dioon rzedowskii* in Mexico.

Fig. 19 - Paolo Caputo examining the collection of *Dioon* in the Greenhouse Califano.

Fig. 20 - Cycad collection in the Greenhouse Califano.

Fig. 21 - Paolo De Luca with a specimen of *Dioon califanoi* in the Greenhouse Califano.

Fig. 22 - *Dioon caputoi* in the Greenhouse Califano.

Fig. 23 - *Dioon merolae* in the Greenhouse Califano.

Fig. 24 - **A**. *Dioon rzedowskii* in the Greenhouse Califano. **B**. Plants of this species in their natural habitat, in Mexico (Photo by A. Moretti).

Fig. 25 - **A**. *Dioon holmgrenii* in the Greenhouse Califano. **B**. A plant of this species in the field, in Mexico (Photo by A. Moretti).

Fig. 26 - **A.** *Dioon spinulosum* in the greenhouse Califano. **B**. A plant of this species in the field, in Mexico, with Mario Vàzquez Torres (Photo by A. Moretti).

Fig. 27 - Specimens of *Zamia* and *Stangeria* in the Greenhouse Califano.

Fig. 28 - **A**. *Zamia polymorpha* in the Greenhouse Califano. **B**. A plant of this species in the field, in Belize, with Dennis Wm. Stevenson (Photo by A. Moretti).

Fig. 29 - *Ceratozamia hildae* in the Greenhouse Califano.

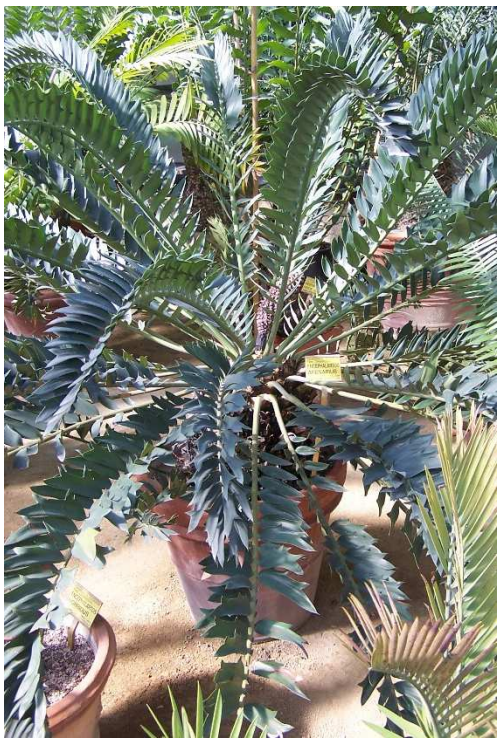

Fig. 30 - *Encephalartos arenarius* in the Greenhouse Califano.

Fig. 31 - *Encephalartos sclavoi* in the Greenhouse Califano.

Fig. 32 - *Macrozamia moorei* in the Greenhouse Califano.

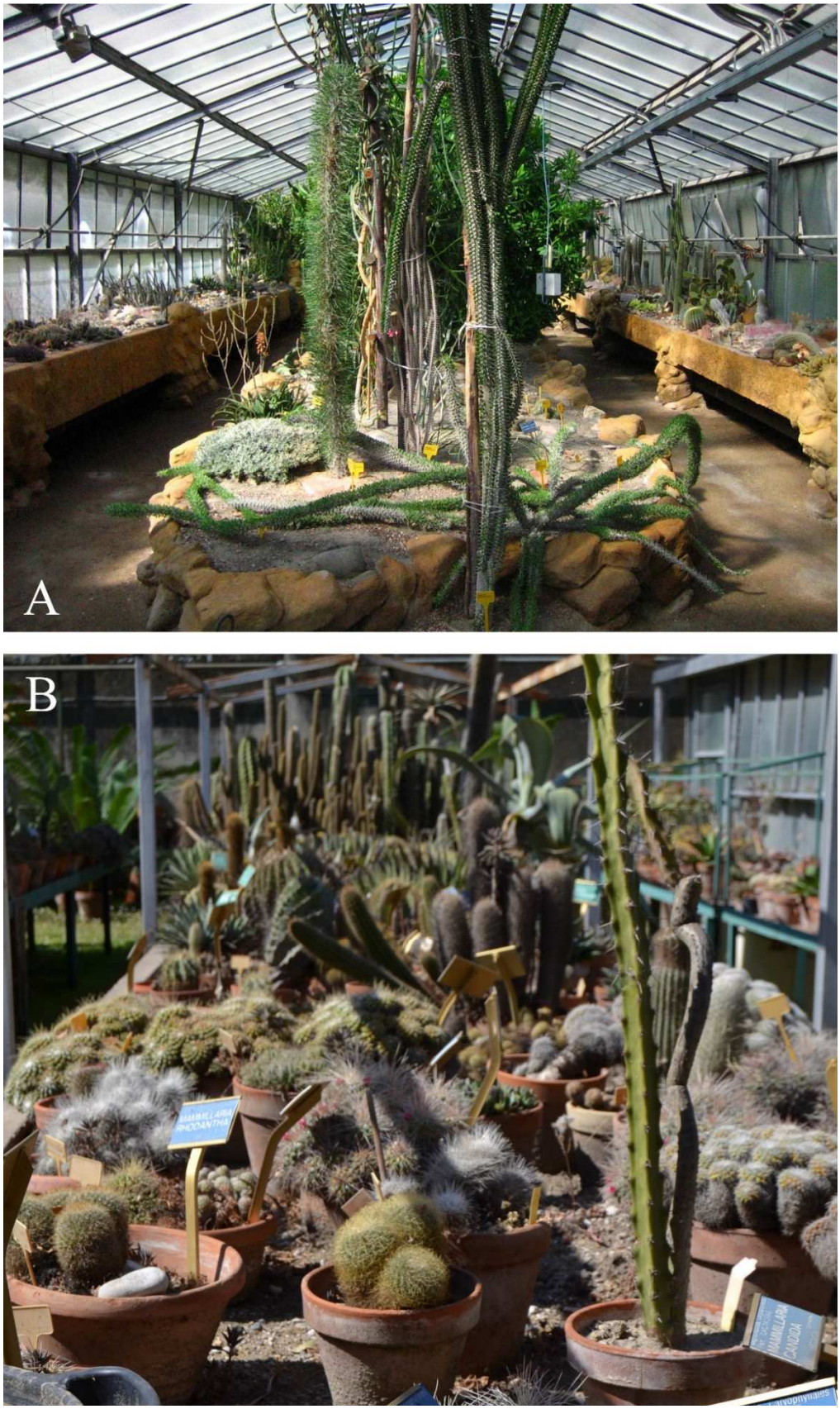

Fig. 33 - **A**. Succulent species in the Greenhouse Califano. **B**. Succulent plants grown outside and used to replace, when necessary, plants that die in the open-air area of the Garden.

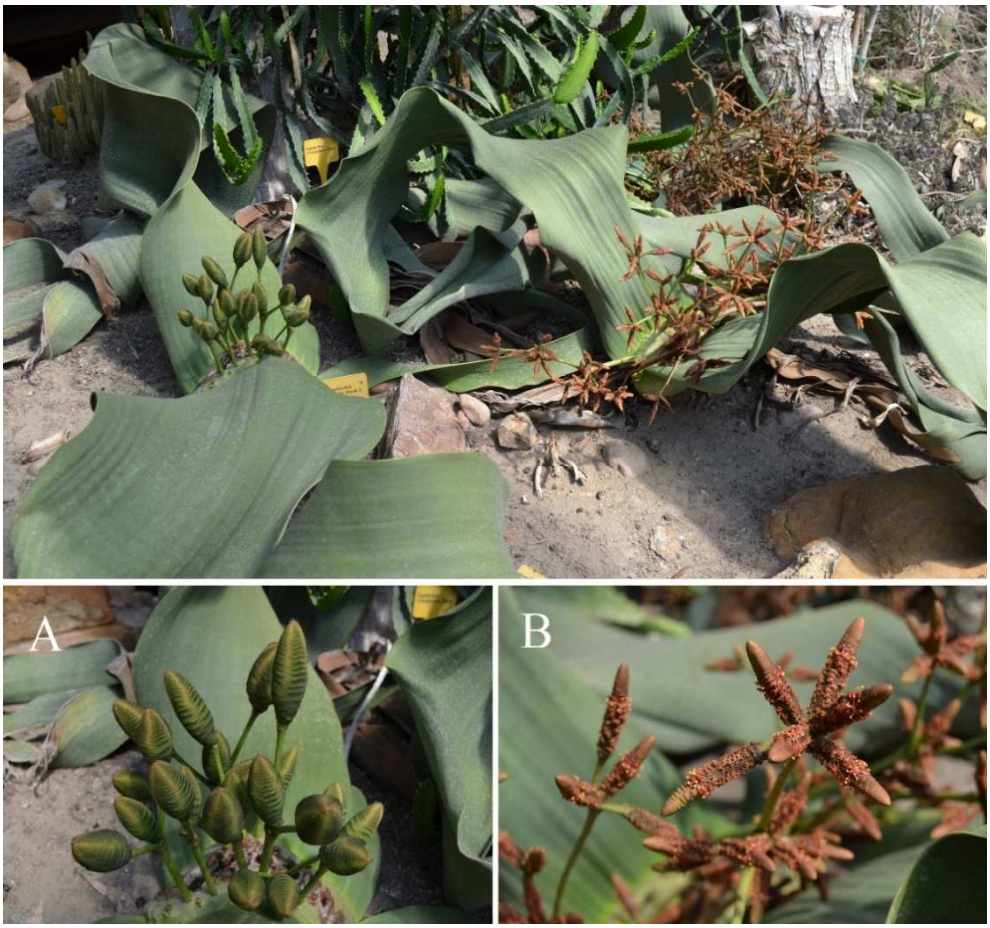

Fig. 34 - *Welwitschia mirabilis* in the Greenhouse Califano. Details of its reproductive cones are shown. **A**. Female cones. **B**. Male cones.

Fig. 35 - Male and female cones of *Gnetum gnemon* in the Greenhouse Califano.

Fig. 36 - *Sansevieria singularis* in the Greenhouse Califano.

Fig. 37 - *Cephalotus follicularis* in the Greenhouse Califano.

Fig. 38 - *Tillandsia califanii* in the Greenhouse Califano.

Fig. 39 - *Tillandsia brachycaulos* in the Greenhouse Califano.

Fig. 40 - *Psilotum nudum* in the Greenhouse Califano.

Fig. 41 - Outside of the Tropical Greenhouse De Luca.

Fig. 42 - The tub in the Tropical Greenhouse De Luca.

Fig. 43 - The Mesocosm of Mangrove and tropical plants in the Tropical Greenhouse De Luca.

Fig. 44 - *Acacia cornigera* in the Tropical Greenhouse De Luca. The so-called “Beltian bodies” are visible on the end of leaflets.

Fig. 45 - *Costus scaber* in the Tropical Greenhouse De Luca.

Fig. 46 - *Jatropha podagrica* in the Tropical Greenhouse De Luca.

Fig. 47- *Couroupita guianensis* in the Tropical Greenhouse De Luca.

Fig. 48 - Flower of *Vanilla planifolia* in the Tropical Greenhouse De Luca.

Fig. 49 - Flower of *Victoria cruziana* in the water tub of the Tropical Greenhouse De Luca.

Fig. 50 - Leaves of *Victoria cruziana* in the water tub of the Tropical Greenhouse De Luca.

Fig. 51 - *Tillandsia* spp. in the Tropical Greenhouse De Luca.

Fig. 52 - *Selenicereus anthonyanus* in the Tropical Greenhouse De Luca.

Fig. 53 - *Brassavola nodosa* in the Tropical Greenhouse De Luca.

LITERATURE CITED

BARONE LUMAGA M.R., MENALE B. 2000. Le serre realizzate nell'Orto Botanico di Napoli nel periodo tenoreano. In: AA.VV. La Botanica a Napoli nel periodo borbonico. Delpinoa 42: 27-29.

BRUNO S. 1992. Il vecchio istituto di botanica. In: Russo T. (Ed.). L'Orto Botanico di Napoli "1807-1992". pp. 85-98. Grafiche Cimmino, Napoli.

CAPUTO P., COZZOLINO S., GAUDIO L., MORETTI A., STEVENSON D.W. 1996. Karyology and phylogeny of some Mesoamerican species of *Zamia* (Zamiaceae). Amer. J. Bot. 83 (11): 1513-1520.

CATALANO G. 1958. Storia dell'Orto Botanico di Napoli. Delpinoa 11: 5-170.

DE LUCA P. 1992. L'Orto Botanico dell'Università di Napoli. In: AA.VV. Orti Botanici, Giardini Alpini, Arboreti italiani. pp. 123-134. Ed. Grifo, Palermo.

DE LUCA P. 2008-2009. L'Opera dei direttori dell'Orto Botanico di Napoli. Delpinoa 50-51: 5-21.

DE LUCA P., MENALE B. 1997. L'Orto Botanico di Napoli. Le Dimore Storiche 34: 18-19. Silgraf, Roma.

DE LUCA P., MORETTI A., BALDUZZI A. 1995. Twenty-five years of field studies on cycads at the Botanical Garden of Naples, Italy. Encephalartos 42: 11-18.

GIACOMINI V. 1965. L'Orto Botanico di Napoli. In: AA.VV. Orti Botanici delle Università italiane. pp. 89-102. Orto Botanico di Napoli.

GRAVAGNUOLO B. 2008-2009. L'Architettura del "Real Giardino di Piante" di Napoli. Delpinoa 50-51: 35-40.

HILL K.D., STEVENSON D.W., OSBORNE R. 2005. The World List of Cycads / La Lista Mundial de Cìcadas. Proceedings of the Third International Conference of Cycad Biology, Cycad Society of South Africa. pp. 55-56.

LACK H.W. 2008-2009. L'Orto Botanico di Napoli: alcuni eventi critici della sua storia. Delpinoa 50-51: 23-25.

LONGO L. 1937. Contributo alla storia del Real Orto Botanico di Napoli. Bullettino dell'Orto Botanico della Regia Università di Napoli. Tomo XIV: 5- 9

LONGO L. 1943. Secondo contributo alla storia del R. Orto Botanico di Napoli. Bullettino dell'Orto Botanico della Regia Università di Napoli 16: 9-15

MENALE B., BARONE M. 2000. L'Orto Botanico di Napoli e la pianificazione dei Siti Reali: il ruolo di Federico Dehnhardt. Delpinoa 42: 39-41.

MENALE B., DE LUCA P. 2007. L'Orto Botanico di Napoli. Delpinoa 49: 111-135.

MENALE B., DE LUCA P. 2008-2009. The Botanical Garden of Naples. Delpinoa 50-51: 41-60.

MENALE B., SIBILIO G., VALLARIELLO G. 2009. Ricostruzione di un ambiente lagunare (Mangrovieto) delle aree costiere tropicali di Veracruz, Messico. EURAC book n° 56. pp. 249-258. ISBN 978-88-88906-55-3.

MORETTI A., CAPUTO P., GAUDIO L., STEVENSON D.W. 1991. Intraspecific chromosome variation in *Zamia* (Zamiaceae, Cycadales). Caryologia 44: 1-10.

MORETTI A, CAPUTO P., SINISCALCO GIGLIANO G., COZZOLINO S., STEVENSON D. W., WURTZEL E.T. 1992. A phylogenetic analysis of *Ceratozamia* Brongn. (Zamiaceae, Cycadales). Giorn Bot. Ital. 126 (2): 294.

MORETTI A., SABATO. S., VAZQUEZ TORRES M. 1980. The distribution of *Ceratozamia* Brongn. (Zamiaceae). Delpinoa 22: 115-117.

MUOIO R. 2011. La Serra Merola. In: De Luca P., Menale B. (Eds.). Il Real Orto Botanico di Napoli. Fridericiana Editrice Universitaria, Napoli. pp. 117-120.

NAPOLITANO A., CAPUTO P., MORETTI A. 2004. Karyology, phytogeography, and the origin of intraspecific karyotipic variation in *Zamia paucijuga* and *Z. polymorpha* (Zamiaceae). Delpinoa 46: 71-83.

OSBORNE R. 1992. 1991-1992 World cycad census: new and progress. Encephalartos

30: 25.

OSBORNE R., CALONJE M.A., HILL K., STANBERG L., STEVENSON D. 2012. The Word List of Cycads/La Lista Mundial de Cicadas. In: Stevenson D., Osborne R., Blake A.S.T. (Eds). Proceedings of 8th international conference on Cycad Biology, Panama. Memoirs of The New York Botanical Garden. 106. pp. 480-508.

PIOTTO B., GIACANELLI V., ERCOLE S. 2010. La conservazione ex situ della biodiversità delle specie vegetali spontanee e coltivate in Italia. Stato dell'arte, criticità e azioni da compiere. Manuali e linee guida ISPRA 54/2010. pp. 89-94.

PISANO P. 1992. Le "Stufe" dell'Orto Botanico di Napoli. In: Russo T. (Ed.). L'Orto Botanico di Napoli "1807-1992". pp. 73-80. Grafiche Cimmino, Napoli.

RUSSO T. 1992. La serra monumentale. In: Russo T. (Ed.). L'Orto Botanico di Napoli "1807-1992". pp. 66-69. Grafiche Cimmino, Napoli.

SABATO S., BALDUZZI A., MORETTI A, TOMASELLI R. 1981. Distribuzione e fitogeografia di *Ceratozamia* Brongn. (Zamiaceae). Giorn. Bot. Ital. 115: 417.

SIBILIO G. 2011a. Le Serre Califano. In: De Luca P., Menale B. (Eds.). Il Real Orto Botanico di Napoli. Fridericiana Editrice Universitaria. Napoli. pp. 101-115.

SIBILIO G. 2011b. La serra tropicale. In: De Luca P., Menale B. (Eds.) Il Real Orto Botanico di Napoli. Fridericiana Editrice Universitaria. Napoli. pp. 121-125.

SIBILIO G., BARONE LUMAGA M.R., DE MATTEIS TORTORA M., MENALE B., MUOIO R. 2010. Gli Orti Botanici e la tutela della biodiversità: il ruolo dell'Orto Botanico di Napoli. Poster e Abstract, XX Congresso S. It. E. Roma, 27-30 Settembre 2010. pp. 185.

SIBILIO G., MUOIO R., MENALE B., CAPUTO P. 2017. Open Web Mapping (webGIS) for the description and historical analysis of the exhibition areas of the Botanical Garden of Naples. Vol. GISDAY 2017. Ed. Aracne. pp. 23-35. DOI 10.4399/97888255179103.

SIBILIO G., RUSSO A., VALLARIELLO R., MENALE B., DE LUCA P., DE CASTRO O. 2014. The past, present and future pf thermophilous *Cyperus polystachyos* Rottb. (Cyperaceae) on the island of Ischia (southern Italy). Plant Biosystems. pp: 933-942. DOI 10.1080(11263504.2014.951713.

SOLLINO G. VALLARIELLO G. 2008. Gli ambienti fumarolici dell'isola d'Ischia e il *Cyperus polystachyos* Rottb. In: Cozzolino S. (Ed.). Cratere dell'Arso, un parco tra rarità botaniche e geologia fantastica. Barano d'Ischia. Comune di Barano Press. pp. 63-76.

STEVENSON D.W. MORETTI A., DE LUCA P. 1987-1988. *Encephalartos sclavoi* De Luca D., Stevenson and Moretti (Zamiaceae), a new species from Tanzania. Delpinoa 29-30: 3-5.

VALLARIELLO G. 1985. Le Cycadales dell'Orto botanico di Napoli. Natura e Montagna 32 (4): 19-29.

VIRZO DE SANTO A., FIORETTO A., ALFANI A. 1981-1982. The adaptive significance of growth form, leaf morphology, and CAM in the genus *Sansevieria*. Delpinoa 23-24: 307-323.

VOLKOV A.G., TEJUMADE A., MARKIN V.S., JOVANOV E. 2008. Kinetics and mechanism of *Dionaea muscipula* trap closing. Plant Physiology 146: 694-702. DOI.org/10.1104/pp.107.108241

ZUCCAGNI ORLANDINI A. 1835-1845. Corografia fisica, storica e statistica dell'Italia e delle sue isole, corredata di un atlante, di mappe geografiche e topografiche, e di altre tavole illustrative. Vol. 1° [XII]. Forum Auctions, Firenze.

Pubblicato nel mese di settembre 2019