

**COMPARISON BETWEEN THE WHEELER-THANHAUSER ORCHID
COLLECTION AT BALL STATE UNIVERSITY AND THE ORCHID
COLLECTION RIYADH SAUDI ARABIA**

A THESIS

**SUBMITTED TO THE GRADUATE SCHOOL
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS**

**FOR THE DEGREE
MASTER OF ART**

BY

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MUNCIE, INDIANA

DECEMBER 2015

ABSTRACT

THESIS: Comparison between the Orchid Collection in North of America (Indiana) and the Orchid Collection in Central Region of Saudi Arabia (Riyadh)

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DEGREE: Masters of Art

COLLEGE: Science and Humanities

DATE: December, 2015

PAGES 29

The beauty, complexity as well as the implausible diversity of the orchid flowers are unrivaled in the world. Orchids can be found in the equatorial tropics as well as the arctic tundra. The main logic behind the diversity of the orchid plants is in their ability to adapt to the environment normally located. There are numerous varieties of orchids that normally thrive in a wide range of different growing conditions, making it possible to find an orchid in almost any man-made environment as well.

In this study, a comparison of orchids from two diverse collections was made utilizing printed materials (books and articles), and online database resources. The detailed analysis of the descriptive information of orchid genera with similar features between the two collections is presented.

ACKNOWLEDGEMENTS

First of all, I would like to thank Allah who gave me the power and patience to complete my high education. Without his helping I am sure I will not be able to be in this stage.

I dedicate my master degree work to my father and mother. Their prayers and support made it easy, even though they live far away from me. Their calling every day made me overcome any difficulty I have faced.

Also, I would like to express my thank to my brothers (Saud, Abdulaziz) and sisters (Wed, Waad) who guided and advised me to do the best. I am more than grateful to my dear and beloved husband Homoud, who was the biggest supporter throughout the years. He stood by me during difficult times. Without his support, I could not have done it. My little angels, Abdullah and Sara were there for me every day. Their smiles after a hard day's work made all the difference.

This master degree could not have come into existence without the help of the lovely professor Dr. C. Ann Blakey. She supported me in every stage since I started my program in 2012, and lavished me with useful suggestions and ideas that helped me in this journey.

I would like to extend my thanks and appreciation to my advisor Dr. David LeBlanc, who was the first person that I have met in the department and his advice guided me to achieve my goal.

I am grateful to Dr. Cheryl LeBlanc, curator\Orchid Research Technician for her help suggesting the topic of my final research paper. Her effort is highly appreciated.

I am thankful to all my friend in Saudi Arabia and Muncie. Their praying helped and gave me the push needed to be in this position.

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CHAPTER ONE

Introduction: What are orchids?

The orchid family also known as the Orchidaceae encompasses the biggest flowering plants family found on earth and has more than 30, 000 species. It additionally is one of the oldest plant families found on Earth, having developed more than 84 million years ago. The fact that they are very old makes it possible for the orchids to be able to develop into organisms that are very specialized. It normally is the orchid flower in place of the foliage, has been able to develop into the specialized way. Although the orchids in most cases look extremely exotic, they are plants that are normally very primitive. With the over 3000 orchid family as well as more than 120000 man-made orchid hybrids, there can never be a shortage of choice about the orchid family (Bohman, et al., 2014).

The orchids can be found located on every continent on earth other than the Antarctica. Although most of the people normally associate orchids exclusively with the tropical places, they are also found in a wide assortment of the ecosystems. For instance, the Indiana forests boast of having more than 40 species of the orchid although the Hawaii, which is a tropical island has, just three native species of the orchid (Crain & Tremblay, 2014). In support of the assertion that people normally have found orchids mainly in the tropics, the

densest populations of orchids are found in the tropical areas of South America, as well as South Asia.

In particular the greatest number of orchids is normally located in the rainforests, as they love the humidity along with the shade available from the same environments. It is not all the orchids that like the hot conditions although most of them need climates that are cool as they grow in the mountains where there are high altitudes and possibility of temperatures falling very low at night.

The majority of the cultivated orchids are on most occasions native to the tropics. There are two major classifications of orchid: sympodial and monopodial, where the sympodial orchid with growth moves sideways on the other hand, monopodial orchid plants grow continuously taller upwards (Shah Alam, 2010).

They are also classified according to growing habits that divide them into terrestrial, epiphytic and lithophytic kinds of nature. While in their natural habitat, many of these orchids are saprophytic orchids attach themselves to the back of the trees as well as the surface of the other plants. There are other orchids that are able to grow without a host, but are not the focus of this research. The saprophytic orchids thick white roots that the orchids normally possess make them possess the ability to absorb moisture as well as nutrients from these diverse environments (Dearnaley,2006).

The fact that these tropical orchids normally grow high on the trees instead of the floor of the forest, they are accustomed to a plentiful supply of air

as well as light. They normally prefer a 12-hour a day throughout the year in addition to high intensities of light. The orchid family encompasses one of the most important families of the plants from a horticultural point of view. One of the uses that the orchid is applied, other than the usual horticultural needs are in the making of vanilla from the species *Vanilla planifolia*. The additional uses of orchids are for diverse folk medicines. In some regions, they are boiled for curing poisons, while in others they are used to prevent sickness following childbirth.

Modern growth and production technology allow orchids to be accessible to a broader market in the society (Brown et al., 2014). New hybrid production is one of the best, and most lucrative businesses in the world. Only a few plant species have flowers open that once darkness falls. Some flowers are open until shortly before or after sunrise (Schuiteman et al., 2011). These include the Queen of the Night, the Midnight Horror (*Oroxylum indicum*) and the night-blooming jasmine (*Cestrum nocturnum*). But no night-flowering orchid species have been reported, although it is the largest family with more than 25,000 species (Schuiteman et al., 2011).

North America contains more than 200 species of orchids. Over half of these are endangered in their native state. The North American Orchid Conservation Centre (NAOCC, 2014) established by the Smithsonian Institution attempts to ensure the survival of these orchids. The focus of the Centre aims at collections of seed and orchid mycorrhizal fungi as well as restoring all native orchid species. The center collection, consists of orchids that display quality,

educational value, instrumental and rare occurrences. The genera include *Cattleya*, *Encyclia*, *Laelia*, *Brassavola*, *Epidendrum*, *Isochilus* and *Sobralia* (NAOCC, 2014).

It is has been clearly shows quite evident that the orchids found in the Arabian Peninsula are the terrestrials types and comprise about two dozen species. They have adaptations to arid conditions such as underground tubers, pseudolobulba and rhizomes that store water and nutrients (Hansen, 2006). Here, the genera include *Bonatea*, *Disa*, *Epipactis*, *Eulophia*, *Habernaria*, *Holothrix* and *Orchis*.

In this study, a comparison of orchids from two diverse collections (North America Orchid Conservation Collection, USA, and the Arabian Peninsula Collection in Riyadh, SAUDI ARABIA) was made utilizing printed materials (books and articles), and online database resources. The detailed analysis of the descriptive information of orchid genera with similar features between the two collections is presented.

CHAPTER TWO

Introduction: Orchid Structure and Pollination

Structure of Flowers

The structure of the orchid flower is normally unique about the other types of floral plants. The orchid possesses an outer whorl that has three sepals, inner whorl that has three petals as well as a large unitary column, the gynostemium contains the males stamens appended to the female pistil in the core. The sepals are the shielding cover of the flower bud. Once the flower opens, the sepals can become enlarged as well as colored. In the majority of the orchid species, the sepals are of equal size and additionally look like sepals. Then two lateral petals normally flank the greatly enlarged flamboyant bottom petal encompassing the lip or the labellum modified to attract and additionally trap the potential pollinators. The reproductive organs of the orchid normally combined into a unitary column gynostemium that is unlike the usual separate stamen and female pistil configurations in other flowers. The distinction is normally the chief identification feature of an orchid (Moré, et al., 2012).

The Sepals

The sepals that normally are the remains of the flower bud are doing not as distinguished from the parts of the flower compared most other flowering

plants. However, with the orchids, there have been modifications of the sepals to become a component of the orchid's flower. On most occasions, they mimic the appearance of the petals although they always operate with the rest of the flower in their attempt to trick the pollinators to take their pollinia to a different orchid flower. The orchid flower normally has three sepals, except in the case of the some slipper orchids such as the *Paphiopedilums* that possess an overgrown dorsal sepal as well as the fused lateral sepals (Barthet, Moukarzel, Smith, Patel, & Hilu, 2015).

The Petals

The sepals found on the orchid are normally unique as they can mimic the petals. An orchid normally possesses three petals, with the bottom petal forming the orchid's lip

The Lip

The entire orchid family normally possesses petals that normally form a lip or labellum that is the lower petal of an orchid. For the pollinator, the lip normally serves as the landing pad for pollination. The majority of the orchids normally turn in the development of the bud to ensure that the lip is at the bottom of the flower although some have a lip at the top thus called the "non-resupinate."

The Seed

The orchid seeds are normally very small, contain undifferentiated embryos and do not have an endosperm. A single orchid seedpod normally contains a

huge number of smaller individual seed that are ideal for dispersal via the wind. For the orchid seeds to germinate as well as grow in the nature, they require the presence of a type of fungus known as mycorrhiza (Faria, Dias, Melo, & Carvalho 2013).

The fungus normally penetrates the seed and additionally contributes to the growth of the seed through the production and supplying of most the necessary nutrients. The availability of the fungus normally facilitates the uptake of nutrients by penetrating and leaching of these nutrients from the roots material of the epiphytic species. For example, the ghost orchid known as the *Dendrophylax lindelii* is an endangered species is normally lifeless and relies on a symbiotic type of relationship with the fungi to be able to circulate the nutrients throughout the plant. Thus, the specific fungus species involved normally resides inside the roots of the orchid and additionally protrudes outside the roots thus being able to gather the nutrients from the soil (Lee & Yeung, 2010). Most of the tropical orchids species normally survive as epiphytes, while nearly all of the orchids in the temperate zones are terrestrial.

Multipurpose Roots

The roots of the epiphytic orchids have managed to evolve into a status whereby they serve numerous functions. Such roots of the orchid normally function by gaining the ability to transfer water as well as nutrients to the entire plant. Additionally they serve the function of anchoring the air plant to a tree and additionally carry out photosynthesis, as is the case with the leaves in the other

type of plants. The roots of an epiphytic also have the ability to store water in a similar manner as the stem of the succulent plants. In this case, the roots make it possible for the orchid plant to survive on the top of high trees being able to get more sunlight than those plants living below them (Bohman, et al., 2014).

The Stem Pseudobulbs

The epiphytic orchids normally live above the soil, where they have managed to develop bulblike structures that undertake the same work of water and nutrients storage. These orchids accomplish this task in a similar manner to the underground bulbs of other plant species. In the context of the epiphytic orchids, one or more sections of the stem normally bulge outward and additionally become areas that are darkened, forming the pseudobulbs. The types of orchids that normally possess the pseudobulbs typically have the ability to survive in those regions that have dry months between their rainy seasons (Joko et al., 2014).

Vascular system

The vascular system of the orchids in their leaves is normally not well developed as with other plants, thus leading to the development of foliage that is not always impressive (Lee & Yeung, 2010).

Pollination of The Orchid Flowers

The pollen found among the orchid plants is very primitive, encompassing a fine dust just as the spores of the ferns and concentrated in the packets

referred to as the pollinia. The fact that the pollen normally comes in packets that do not have the ability to float freely in the air, the orchids are entirely dependent on pollinators. Over their eons of development, they have been able to modify their flowers in a manner that can trick a wide assortment of pollinators into transferring their pollen from one flower to the other (Lee & Yeung, 2010).

The rostellum is a small growth that serves as the protective barrier for the penetration of self-pollination. Additionally, some types of orchids normally produce the male and female flora structures separately to try and prevent self-pollination. The overall shape of the flower is typically bilateral and symmetrical in most of the orchids making it easy for the bees to penetrate. The majority of the tropical orchid species rely on a unitary species of the *Euglossine* bee for their pollination and additionally the bee normally visits just the specific species of orchid. Additionally some species of orchid have developed a pollinator association with gnats, flies, butterflies, moths, bats as well as hummingbirds (Teixeira et al., 2014).

Orchids have managed to develop an assortment of unusual flowers that attract the creatures that facilitate their pollination. Some of the flowers normally resemble their pollinating agents like the ones of the moth orchid. Their wide petals that situated at the top of the flowers are normally reminiscent of the moth wings. The flowers of the Venus slipper orchids, the *Paphiopedilum*, each possess a petal that has the shape of a pouch for directing the bees as well as the birds straight to the source of the pollen. An additional attribute, in this case,

is the assertion that for pseudocopulatory the flowers of the orchid looks like a female insect. The flower normally releases a scent into the air smelling like the pheromones of a female fly, bee, wasp or any other species of insect that the orchid needs to attract for pollination. When the male insect goes to “mate” with the supposed female, the pollen attaches them to the insect and stays on the insect until it reaches the next flower thus facilitating pollination (Teixeira et al., 2014).

Although most flowering plants normally reward their pollinators by offering them tasty nectar, the majority of the orchid species use trickery to lure the pollinators. Some normally use the food deception as they produce flowers that smell and look like food built are not edible on the inward. The other types of orchids apply sexual deception whereby they produce flowers smelling like the female insects mainly targeting the bees as well as wasps. The male insects consequently attracted to the sexy female flowers, and as they attempt to mate with it, they collect pollen on their bodies that normally fertilize their next orchid (Bohman, Bet al., 2014). Although the plants that have the ability to produce nectar possess a superior rate of pollination in comparison to the deceptive nectar flowers, these genetic deceptions enjoy a greater diversity of their composition. For example, the Green Veined orchids actually depend on this particular deception for their continued survival. More than 1000 species of orchids normally depend on the sexual deception whereby they attar pollinators via the production of the scents that mimic the sex pheromones. The best

example of the orchid species that applies this trick is the *Chiloglottis trapeziformis*, which lures the male pollinators, the Thynnine wasp, by producing the pheromone identical to the one produced by the female Thynnine wasp (Pellegrino, Bellusci, & Palermo, 2015).

CHAPTER THREE

The Light Conditions of the Growth of Orchids

Orchids normally prefer high light unobstructed light which streams through a clear south facing window or greenhouse for a minimum of 6 and a maximum of 8 hours per day (Faria, Dias, Melo, & Carvalho, 2013). Orchids normally get classified into three groups depending on their need for intensity of light that the specific group normally requires. These groups are the high-intensity light group requiring, 3000-foot candles, the medium-intensity group requiring 2000-foot candles, and the low intensity group requiring 1500-foot candles. Although, of the orchids require plenty of light they must have minimum of three hours of light in a day (da Silva et al., 2014). On the other hand, the preponderance of the orchids can withstand less than the recommended amount of light although the provision of more light enhances the potential for flowering. However, the exposure to inadequate light results in the prevention of flowering of the orchids. The availability of too much direct light makes the leaves to sunburn, bleaching them out to white and finally turning them from graying to black

The western and eastern exposures are, on most occasions the medium-light intensity plant group locations even though the western exposure is normally warmer. It follows that in this case, the light intensities are normally the same but

there is an increase in the temperature (Tsunplin, et al., 2015). By comparison the medium to low orchid light intensity species, such as the *Phalaenopsis* as well as the *Paphiopedilums*, grow well in the warmer western light conditions. The setting of the window could be west or east, but should not have direct exposure to the sunlight. . For example, the medium light orchids that include the *Phragmipediums*, *Dendrobium*s, as well as the *Oncidium*s normally grow in those locations that have light, but not the directly sunlight. In addition the window could be open to the northern exposure so long as it has no obstruction in additional amounts of reflected sunlight. The jewel orchid is an example that grows best in the low light limited by t northern exposure along with any exposure whereby there is the blocking of direct light by buildings or overhang such as trees.

The main benefit associated with growing of the orchid plant is the fact that the intensity of light does not always needs to be high. The attribute for this assertion is that artificial light is normally very uniform. If the windows that provide adequate light are unavailable, it would be a wise consideration to cultivate the orchid beneath the artificial lights. (Faria, Dias, Melo, & Carvalho, 2013).

How Much To Water?

Most of the orchids that people grow indoors normally come from the tropics, whereby the tropics are normally more humid than the average living room. The general rule that people apply in the growing of orchids is that they

should only water once in a week. The growing medium needs to be left to dry prior to the subsequent watering. Excess water should not be allowed to come into contact with the roots.

It is better for the plant to obtain its moisture from the air or humidity than direct watering to the soil. By grouping the plants together, the plants are able to maintain the level of humidity around them. Additionally it is imperative that one knows the diverse genus of the orchids being grown as this normally determines the moisture levels that are necessary for optimum survival (Swett & Uchida, 2015). The majority of the orchid plants have the ability to tolerate drought better as compared to their ability to tolerate excess moisture.

The common assertion is the sitting in a waterlogged environment kills the plant extremely fast. The failure to have adequate air circulation, the plant normally suffocates and consequently dies. *Phalaenopsis* normally requires receiving even moisture throughout the year. Slipper *Paphiopedilum* requires an even distribution of the moisture by comparison but needs to be allowed to almost dry out prior the subsequent watering. The *Brassia* orchid requires moisture during the spring as well as the summer when it is in active growth, but requires less moisture while it is in its resting. The *Cattleya* orchid requires plenty of irrigation during its active growth, but needs to be left to dry out between watering. It should additionally receive less watering when it is resting. The *Dendrobium* expects to be left to dry between the various watering (Swett &

Uchida, 2015). Most succulents will rot if kept constantly moist, thus watering well then allowing it to dry between waterings.

CHAPTER FOUR

Adaptations of the Orchids

It follows that the orchids first appeared on earth almost 100 million years ago and over time it encompasses both the terrestrial types that normally grow in the soil. Additionally there are the epiphytic types that normally thrive in the air as well as water. There currently are over 25000 naturally occurring species of orchid that exist on every continent, and they all exhibit specific attributes as well as adaptations. Even though these species are normally diverse, they share similar strategies that are meant to guarantee their survival (Joko, et al., 2014).

Orchid Collection in the North of America

North America is normally full of wild orchids. Irrespective of where one travels, they will always find a diversity of orchid species in the area. North America is home to more than 200 species of orchids, even though more than half of them face the threat of extinction in other regions. The environmental adaptability of the orchids is phenomenal although some orchids can be exacting with regards to their growing environment, thus as well as allowing minimal variation. For instance, the *Spiranthes vernalis* species found in the tidal salt water of North Carolina, as well as Florida, survive, well in these conditions. Although the soil as well as topography normally has an impact on the terrestrial

species, it is also apparently clear that moisture as well as temperature are instrumental in the growth of the orchid family. These two attributes are essential in the regulation of the distribution as well as the survival of the orchids in the context of both the terrestrial as well as epiphytic (Joko, Subandi, Kusumandari, Wibowo, & Priyatmojo, 2014).

In the tropical and the subtropical regions of North America, the greatest numbers of orchids found are the epiphytes in the rain forests on the average cool mountain slopes. There are extremely few species of the orchid family found in the arid regions and mainly include the lithophytic or epiphytic which are possess specially adopted tissues for the storage of water. In the subtropical southern peninsula of Florida, the majority of the epiphytes are found in the moist Everglades especially the many numerous peculiar hammock formations located throughout the Everglades. Every hammock normally possesses a distinctive flora. In the hammocks that are normally the areas that are considerably elevated support, a huge assortment of vegetation beyond the ordinary epiphytes but also the terrestrial orchids also confided in these regions (Di Pardo., 2015).

In the temperate and the boreal region of North America, the orchids are divided into those ones occurring in open bogs, fields, meadows, prairies and similar habitats, versus those growing in the wooded areas. The orchid types as the species of the *Habernaria*, *Spiranthes* as well as the *Hexelextris* offer the impression that they thrive extremely well in the dry as well as competitive conditions. In the arid as well as the semi-arid regions of the southwest and west,

the dependence of the orchid flora on the moisture is normally evident. With some exceptions, the species are normally found in the canyons, valleys as well as the mountain ravines and depressions along the watercourses (Crain & Tremblay, 2014).

The *Spiranthes* and *Hexalectris* can occasionally spread into the dry open country but in most cases the species are normally found in the moist areas. About the Arctic as well as above the tree line on the high mountains, the fact that the icebound water is not available to the plants makes the habitat physiologically dry. Thus the orchids, in this case, get localized in those localities that have readily available moisture. The greatest number of orchid species in the region normally found in the mesophytic areas that normally are the ancient sections of the continent. Out of the approximately 200 species as well as variants in the orchid flora, almost 110 are normally in the southeast US alone (Fox, et al., 2013). The orchids normally exist in large numbers in the favorable habitats to an extent they constitute the dominant plant community. In the Henderson County in the North Carolina Mountains, there has been the identification of 14 species in an estimate of a sphagnum bog encompassing less than an acre.

The General Attributes of the Orchids in the Region

Orchids are normally perennials and are normally either epiphytic, terrestrial, semiaquatic, lithophytic or in rare cases subterranean. The majority of the species found in these temperate zones are the terrestrial species while the

greater number of the subtropical and tropical orchids is the epiphytic or the litholytic. The subterranean genera that encompass two genera, the *Cryptanthemis* and *Rhizanthlla* are mainly found in Australia. The terrestrial, as well as the majority of the epiphytic orchids normally, possess a sympodial main axis, leading to a stream of successive annual axes. In the model of growth, the inflorescence could either be terminal on the shoot and in other cases borne on the side of the shoot located on a short, lifeless branch. The alternative model of growth is the monopodial, which occurs in the event the main axis grows fast onward on a yearly basis leading to the production of new leaves at the apex. Additionally these bear flowers on the lateral shoots and normally arises in the axils of the older leaves (Hinojosa-Díaz, Feria-Arroyo, & Engel, 2009).

Orchid Collection in Saudi Arabia (Riyadh)

The classification of orchids is as either lithophytes in that they normally grow on bare rocks, epiphytes as they grow supporting themselves on trees and terrestrial in that they grow on the ground. The majority of the orchids found in this region of Saudi Arabia are normally terrestrial. Their unique characteristics are the adaptation to the arid conditions inclusive of the underground tubers, rhizomes as well as pseudobulbs that serve the role of storing waters as well as nutrients. The genera that the orchids in this group normally encompass *Disa*, *Bonatea*, *Eulophia*, *Epipactis*, *Habenaria*, *Holothronix*, *Satyrium*, *Orhis* as well as the *Nervilia*. The majority of the orchid's species in this region are around the

Arabian Peninsula along the mountainous western escarpment facing the red sea (Zhai, et al., 2013).

It encompasses the models of drought decisions, dense cloud of forests that offer excellent habitat for the terrestrial orchids. At the moment, the habitats have significantly been reduced and existing as isolated pockets. The main issues that have affected these habitats include the human activities as irrigation, extensive terracing, and deforestation for the collection of wood for cooking as well as grazing. The orchid habitat additionally found on the northeast coast of the Arabian Peninsula. The interior sections of the peninsula are however too dry for the orchid family to survive. It encompasses mainly the vast seas of the sand mill as well as the largely parched rocky desert that are both unsuitable for to accommodate even the most adaptable species of orchid (Vale, Rojas, Álvarez, & Navarro, 2013).

Of all the orchid species found in Riyadh Saudi, the *Eulophia petersii* is the most robust as well as interesting in the context of their ability to adapt to the harsh conditions of the region. In this case, the species normally grows on a thin layer of soil in the open as well as stony scrubland. Additionally the species exhibits the most beautiful blooms in comparison to all the orchids found in the region. Despite the harsh conditions of the region, the orchid stem normally grows from between 1.5 to 2 meters having large, oval as well as cream-colored pseudobulbs at the ground level. The thick, as well as fleshy leaves normally make it possible for the plant to conserve and retain moisture (Joko et al., 2014).

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