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MORPHOLOGICAL DIVERSITY ANALYSIS OF SOME EXISTING AND ENDANGERED *DENDROBIUM* ORCHID SPECIES IN BANGLADESH

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Abstract

Dendrobium is a sympodial, epiphytic orchid that belongs to the family of Orchidaceae. Bangladesh has a total of 188 different species under 78 genera of this tribe. Among them, there are 27 species of *Dendrobium*. Considering the potential value, the 16 species of *Dendrobium* are especially highlighted for herbal, horticultural, and ornamental purposes. They are also valuable for flowering as pot plants or hanging baskets. *Dendrobium* orchids are highly important in economically, socially, culturally, and as medicinal orchids. The basic needs of humans, the morphological characteristics of these orchids, such as the shape of pseudobulb, leaf, variation of inflorescence, floral characteristics, and their biodiversity evaluation in Bangladesh, are very important, and have been taken up for the present study. Besides these, ruthless collection by people who are thirsty for beauty has made the species endangered. On the other hand, the species has lost its habitat due to the removal of large trees. So, this research program has been conducted to save these valuable species from extinction. In addition, by studying their morphology, scientists and researchers gain insights into the evolutionary adaptations, reproductive strategies, and ecological interactions of orchids. For the present study exist and endangered *Dendrobium* about 2-3 years old and flower bearing matured plants were studied for development of morphological characterization of these orchids were flourished.

Key words: *Dendrobium,* epiphytic, morphological descriptors, orchids, sympodial.

Introduction

Orchids are important plant in the floriculture industry because of their colorful, fragrant flowers, their long lasting cut flowers, uses in various social and cultural events, their house decoration and for their medicinal properties (Bhattacharjee et al. 2014). Orchidaceae is a highly specialized and one of the largest family of flowering plants, consisting nearly 30,000 species under 800 genera which produce a variety of flowers and are distributed all over the world (Nongdam and Chongtham 2011, Sandamali et al. 2020). The family is particularly species - rich in the humid tropics and subtropics but is widely distributed from the equator to the Arctic Circle and from the lowlands to the frost line.

In the national and international markets, orchids have a high potential value (Kumar et al. 2002). The *Dendrobium is* a sympodial, epiphytic orchid which belongs to the family Orchidaceae that consists of 1600 species (De et al. 2015). This is one of the biggest groups in the family Orchidaceae all around the world and it is mostly found in the tropics and subtropics (Burke et al. 2008). Considering the potential value,

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Dendrobium is especially highlighted for horticultural, agricultural, and medicinal purposes (Begum et al. 2009, Yao et al. 2009, Bhattacharjee et al. 2014, Bhattacharjee and Islam 2015).

A great diversity is seen in morphological and flowering parts of the *Dendrobium* orchids. Such as stem enlarged or irregularly bulbous, pseudobulb single or multi-segmented leaves one to several, inflorescence racemose, with one to many flowers. Flowers are often marginal or lateral and very showy. Corolla is short to filamentous, the lateral corollas forming a fairly distinct mentum at the base of the enlarged column. Petals are as like as sepals. Lip non-segmented to three fragmented. Polinia arranged in groups of 4 and 2, respectively. Attractive colour, variety of texture, aroma, medicinal properties and long durability are special feature. In one word, in the flower kingdom the *Dendrobium* orchid flower is an undeniably beautiful flower. Be amazed at the variety of orchid flower structures, the ancient Chinese philosopher Confucius (551–479 BCE) (https://en.wikipedia.org/wiki/Confucius) called the orchid flower as 'the best flower'. Once upon a time Philosophers Plato, Aristotle, Theophrastus were impressed by the beauty and named these flower orchids (Pearn 2012). The Asian continent is with the highest orchid diversity observed in Bangladesh, India, Sri Lanka and Nepal There are 188 species under 78 genera of this family are found in Bangladesh. Among these genera *Dendrobium* is the largest one, which includes 27 species. The *Dendrobium* species can produce pollen and dust-like seeds which can travel a very long distance by various pollinators and the winds, and as a result is generally believed to help the regular gene flow among the populations (Arditti and Ghani 2000).

Orchid conservation has now become a matter of global concern for several reasons. Because their seed germination and regeneration are very slow and only 0.2-0.3% seeds germinate in nature. On the other hand, the population of many of these indigenous orchids is decreasing rapidly day by day in natural habitats for ruthless collection by leading orchid growers and also for destruction of habitats which is one of the leading causes of reducing their natural populations (Chugh et al. 2009). But the demand of these orchids is increasing day by day both in local and foreign markets. Biotechnological approaches my one of the suitable way to multiplicity and conserve orchid species and there are several reports done by Bhattacharjee and Islam (2014), Bhattacharjee et al. (2015) and Islam et al. (2015).

The world's largest *Dendrobium* orchid's producer is Thailand, which supplies the majority demand (97%) of America and other countries. They are earning billions of dollars just by trading orchids. Orchid cultivation has therefore attained the status of an industry in Thailand. Seeing and knowing this, it seems that with the orchid resources we have, we can go a long way like them. In Bangladesh, greater Sylhet, greater Chattogram, Chattogram Hill Tracts, Gazipur, Mymensingh, Jessore and Rajshahi can be identified as potential areas for orchids. *Dendrobium* is popular for its colorful, fragrant flowers and long lasting of cut flowers and also for house decoration. They are not only important for floricultural value but also some of them are used as medicine and food (De et al. 2014). As *Dendrobium* orchids are highly important in economically, socially and culturally. Therefore, if floriculture, horticulture and pharmaceuticals industries can be developed in Bangladesh through Government and private initiatives, millions of people will get self-employment opportunities.

On the other hand, it will be possible to earn a lot of foreign exchange by exporting abroad besides meeting the domestic demand for flowers and medicines. Considering the demands of orchids the present research work has been undertaken to evaluate their morphological characteristics of *Dendrobium* orchids and partially reviewed the status of orchids in Bangladesh.

Materials and Methods

The morphological diversity analysis was done by using all vegetative parts of *Dendrobium* spp. of the family Orchidaceae. The observations were carried out in *ex-situ* conditions in different parts of Bangladesh. For morphological studies, plastic bags, rulers, scissors, ropes, duct tape, stationery, cameras were used to evaluate the existing and endangered *Dendrobium* species in Bangladesh. In this case about 2-3 years old and flower bearing mature plants, *viz*. *Dendrobium aduncum, Dendrobium anceps, Dendrobium aphyllum, Dendrobium bensoniae, Dendrobium chrysotoxum, Dendrobium crepedatum, Dendrobium densiflorum, Dendrobium farmeri, Dendrobium fimbriatum, Dendrobium moschatum, Dendrobium nobile, Dendrobium parishii, Dendrobium pendulum, Dendrobium ruckeri, Dendrobium aggregatum* and *Dendrobium chrysanthemum* were considered. For this study healthy and vigorous plants were selected for observation of morphological characteristics. All observations were focused on different part of flowering plants namely disparity in pseudobulb shape, leaf shape, floral characteristics, number of flowers per inflorescence, different parts of flower colour, variation in sepals, variation in lips, variation in petals and inflorescence orientation.

Results and Discussion

The observation of morphological characters was carried out on plant parts, namely stems, pseudobulbs, inflorescence, flowers, leaves which were identified and documented. Leaves on orchids have several variations from elongated round to round like in general. It was observed that the presence of pseudobulb reduced the loss of water content in leaves during drought by proper channeling. Table 1 show that there are similarities and dissimilarities in pseudobulb shape of various *Dendrobium* spp.

Morphology of *Dendrobium* orchids

Morphological differences among the sixteen species of *Dendrobium* were studied which also showed in Fig.1. In this regard their habitat, structure of flowers, colors of flower, type of inflorescence, arrangement of flowers, number of flowers per inflorescence, size and shape of leaves, structure of pseudobulb and stem etc. were studied and showed in Fig. 1 (A-P).

Fig. 1 (A-P): A) *D. nobile*, B) *D. chrysotoxum*, C) *D. moschatum*, D) *D. parishii*, E) *D. anceps,* F) *D. crepedatum,* G) *D. densiflorum*, H) *D. farmeri*, I) *D. aphyllum*, J) *D. pendulum,* K) *D. fimbriatum*, L) *D. aggregatum,* M) *D. aduncum,* N) *D. bensoniae,* O) *D. chrysanthum,* and P) *D. ruckeri.*

Stem

Dendrboium are sympodial orchids, they produce a series of adjacent shoots which are dilated or thickened to formis called pseudobulb. Pseudobulb is single or multilobed. They contain nutrients and water for drier periods. On the basis of natural habitat *Dendrobium* are aboreal, woody or rarely terrestrial. A great diversity is seen in the nature of stem like cane woody, cane clavate fleshy or bulbous round (Fig. 2 a-c).

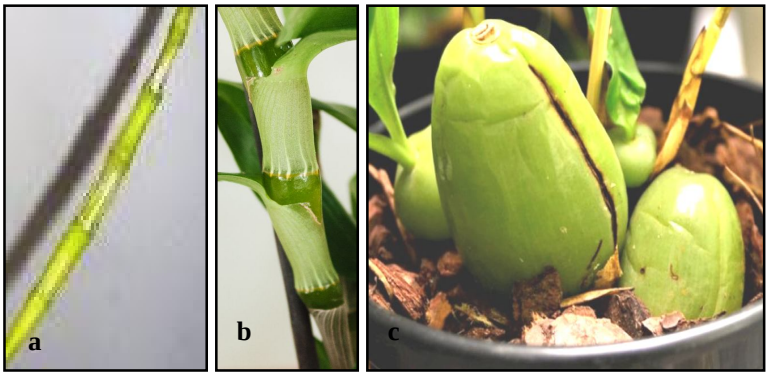

Fig. 2(a-c): Nature of stem *Dendrobium*. a) Cane (woody), b) Cane clavate fleshy, and c) Bulbous (round).

Roots

Dendrobium's root is made up of spongy tissue. The roots are aerial and very long. This helps the plant to cling to a tree or rock. Besides, its root helps to absorb oxygen and essential nutrients from water and air. The velamen tissue of older roots helps to absorb moisture (De 2020).

Pseudobulb

In *Dendrobium* has an enlarged stem which uses as a storage organ is called Pseudobulb. There are two types of pseudobulb in orchids: On the basis of number of internodes, they are may be Heteroblastic or Homoblastic. If any pseudobulb contains a single internode that's called Heteroblastic. On the other hand Homoblastic pseudobulbs contains two or more internodes e.g. *Dendrobium* (Arditti 1992). The pseudobulb in orchids is work as a preserver of water and nutrients. This type of epiphytic orchids has fleshy organs which help to increase the ability to survive and grow in hostile environment. Pseudobulbs may be cane woody, cane clavate fleshy or bulbous round shaped in *Dendrobium* (Table 1).

Table 1. Disparity of pseudobulb shape in *Dendrobium.*

Genus	Shape	Name of the species
Dendrobium	Cane woody	*Dendrobium aduncum, Dendrobium aphyllum, Dendrobium ruckeri, Dendrobium bensoniae*
	Cane clavate fleshy	*D. nobile, D. parishii, D. pendulum*
	Bulbous round	*D. aggregatum, D. chrysotoxum*

Leaves

Some *Dendrobium* species have large leaves that can reach 3 to 10 inches in length and one inch in width, which calls for brighter light exposure to help them grow their best. These leaves turn from their bright light green color to dark green when sunlight exposure to the orchid is low. Epiphytic orchids like *Dendrobium* generally have five to several leaves. The leaves are thick and succulent with thick cell walls and cuticles (Sailo et al. 2014). Deciduousness is the special character in *Dendrobium* which helps to avoid water stress during the dry season. Like monocot plants, orchid leaves are simple and have parallel veins, although some *dendrobium* is associated with reticular venation. They are either linear, eliptic, lanceolate, ovate or flat in shape (Table 2, Fig. 3).

Table 2. Disparity of Leaf shape in *Dendrobium.*

Genus	Shape	Name of the species
Dendrobium	Linear	*Dendrobium crepidatum*
	Elliptic	*Dendrobium nobile, Dendrobium densiflorum, Dendrobium bensoniae*
	Lanceolate	*Dendrobium aduncum, Dendrobium chrysotoxum, Dendrobium chrysanthum, Dendrobium farmeri*
	Ovate	*Dendrobium moschatum*
	Flat	*Dendrobium anceps*

Fig. 3(a-d): Leaf shape of *Dendrobium*: a) Linear, b) Eliptic, c) Lanceolate, and d) Ovate.

Flowers

As *Dendrobium* orchids are epiphytic. So, it grows naturally on the branches and trunks of trees. They have a great variation in growth and floral characteristics. The flower are often marginal or lateral and very showy. Corolla is short to smooth, lateral corollas forming conspicuous mentum at the base of the enlarged column, the mentum often pendunculate. Petals are as like as sepals. Lip are unbroken to 3 segmented, foot joined with column stalks. Polinia arranged in groups of 4 and 2, respectively. The flowers are different in colour such as white, green, yellow, or pink to purple. The labellum is about egg-shaped (Zhu et al. 1799). The morphological diversity means different parts of *Dendrobium* like roots, stems, leaves, pseudobulbs, flowers (Fig. 4 to 6) which are commercially important are given in Table 3 to 6.

Table 3. Floral characteristics in *Dendrobium* orchids.

Genera	Floral characteristics
Dendrobium	In *Dendrobium* orchids have a great variation in floral characteristics. The flower are often marginal or lateral and very showy. Corolla short to smooth, lateral corollas forming a fairly conspicuous mentum at the base of the enlarged column, the mentum often pendunculate. Petals are as like as sepals. Lips are unbroken to 3 segmented. Polinia arranged in groups of 4 and 2, respectively. The flowers are different in color such as white, green, yellow, or pink to purple. The labellum is about egg-shaped.

Table 4. Number of flowers per inflorescence in *Dendrobium.*

Genus	States	Example varieties and species
Dendrobium	Medium (7- 10)	*Dendrobium fimbriatum, Dendrobium bensoniae.*
	Many (>10)	*Dendrobium densiflorum, Dendrobium moschatum*

Table 5. Pre-dominant colour variations in *Dendrobium.*

Characteristics	State	Example species
Petal main colour	White	*Dendrobium formosum, Dendrobium pendulum, Dendrobium aphyllum, Dendrobium bensoniae*
	Yellow	*Dendrobium ruckeri*
	Purple	*Dendrobium farmeri, Dendrobium aduncum, Dendrobium nobile, Dendrobium parishii*
Sepal colour pattern	Uniform	*Dendrobium chrysotoxum, Dendrobium chrysanthum*
	Blotched	*Dendrobium pendulum*
	Mixed	*Dendrobium nobile*
Petal colour pattern	Uniform	*Dendrobium chrysotoxum, Dendrobium chrysanthum, Dendrobium densiflorum, Dendrobium fimbriatum*
	Spotted	*Dendrobium aduncum*
	Blotched	*Dendrobium pendulum*
	Shaded/striped	*Dendrobium bensoniae*
	Mixed	*Dendrobium aphyllum. Dendrobium moschatum. Dendrobium nobile*

Table 6. Variations in sepals, lips and petals in *Dendrobium.*

Variation in sepals, lips and petals	State	Species
Lateral sepal shape	Oblong	*Dendrobium fimbriatum*
	Obovate	*Dendrobium aphyllum*
	Triangular	*Dendrobium aduncum*
Petal shape	Linear	*Dendrobium ruckerii*
	Elliptic	*Dendrobium bensoniae, Dendrobium nobile*
	Obovate	*Dendrobium moschatum, Dendrobium chrysotoxum, Dendrobium fimbriatum*
Lip shape	Oblanceolate	*Dendrobium aphyllum, Dendrobium bensoniae*
	Ovate	*Dendrobium nobile*
	Sub-orbicular	*Dendrobium fimbriatum, Dendrobium densiflorum*
Sepal curvature	Incurved	*Dendrobium chrysotoxum, Dendrobium densiflorum*
Petal curvature	Straight	*Dendrobium fimbriatum, Dendrobium nobile*
	Reflexed	*Dendrobium moschatum, Dendrobium chrysotoxum, Dendrobium chrysanthum*
Lip curvature	Incurved	*Dendrobium aduncum*
	Straight	*Dendrobium aphyllum, Dendrobium chrysotoxum, Dendrobium chrysanthum, Dendrobium densiflorum*
	Reflexed	*Dendrobium fimbriatum*

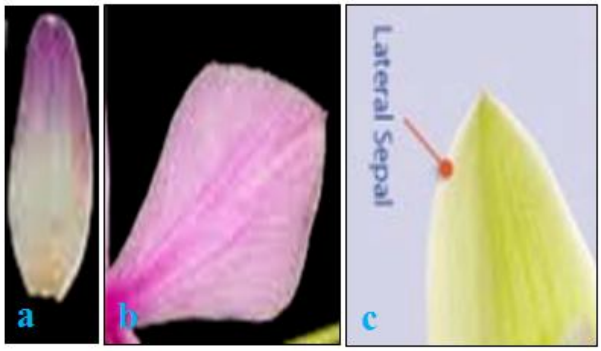

Fig. 4(a-c): Lateral sepal shape of *Dendrobium*: a) Oblong, b) Obovate, and c) Triangular.

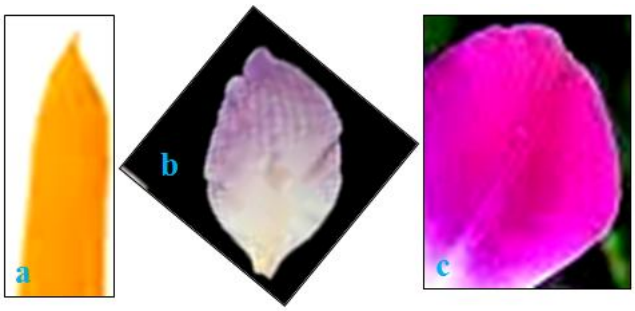

Fig. 5 (a-b): Petal shape of *Dendrobium.* a) Linear, b) Elliptic, and c) Obovate.

Fig. 6(a-c): Lip shape of *Dendrobium.*a) Oblanceolate, b) Ovate, and c) Sub-orbicular.

Inflorescence

Dendrobium flowers are arranged on an inflorescence, which is racemose, 5 to 20 flowered, erect, pendulous or drooping, lateral or marginal. Some orchids produce single flower like *Paphiopedilum*. The variation of inflorescence depends upon genera and species. Most of the orchids, the inflorescence is terminal but lateral in orchids like *Eulophia nuda* while majority of epiphytic orchids like *Dendrobium* produce flowers on lateral inflorescence (Table 7).

Table 7. Inflorescence orientation in *Dendrobium* orchids.

Characteristics	States	Example species/ varieties
Inflorescence orientation	Erect	*Dendrobium aphyllum, D. fimbriatum*
	Arching/ horizontal	*Dendrobium nobile, D. bensoniae*
	Drooping/ pendulus	*Dendrobium densiflorum*

Conclusion

Maintaining the genetic diversity it is very important in making sure of the continued survival of the species and continues to keep the evolutionary potential to meeting the commercial demands and saving the wild, rare, endangered and economically important orchids in Bangladesh. Many of the *Dendrobium* species in Bangladesh possess great conservation and economic value is threatened to extinction because of the

excessive exploitation, and therefore proper study and conservation of these species are very important. Under this study it was emphasized on morphological diversification of *Dendrobium* orchids and their efficiency on cultivation in Bangladesh. This investigation on morphological diversity of indigenous species can play an important role in conservation of germplasm for pot culture, cut flowers, herbal preparation or any kind of research. The present findings and report will play a potential role for further development of orchid's industry, biodiversity evaluation and advance biotechnological works in Bangladesh.

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Conflict of interest: The authors declare that there is no competing interest.

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