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Morphological diversity in orchids

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Abstract
The present investigation was conducted using all vegetatively propagated species and hybrids of commercially grown orchid genera viz. *Cattleya* Lindl., *Cymbidium* Sw., *Dendrobium* Sw., *Mokara (Arachnis X Ascocentrum X Vanda)*, *Oncidium* Sw., *Paphiopedilum* Pfitz, *Phalaenopsis* Blume and *Vanda* Jones ex R. Br. With the study of morphological diversity of 8 orchid genera, 53 descriptors in *Cattleya*, 62 descriptors in *Cymbidium*, 52 descriptors in *Dendrobium*, 61 descriptors in *Mokara*, 60 descriptors in *Oncidium*, 77 descriptors in *Paphiopedilum*, 58 descriptors in *Phalaenopsis* and 54 descriptors in *Vanda* were developed. Amongst different morphological descriptors of commercially grown orchid genera, diversity in pseudobulb shape, leaf shape, inflorescence variation, floral characteristics and their diversity were studied in details.

Keywords: *Cattleya, Cymbidium, Dendrobium, Mokara, Oncidium, Paphiopedilum, Phalaenopsis, Vanda*, morphological descriptors

1. Introduction
Orchids are the second largest families of flowering plants [1] and are distributed throughout the world. The family orchidaceae is divided into five subfamilies (*Apostasioideae, Cypripedioideae, Vanilloideae, Orchidoideae, Epidendroideae*).Orchids account for c. 8% of angiosperm species diversity [2]. Till date, 29,199 species have been identified and accepted [3], although several hundred new species are added each year. By the end of 2017, the IUCN Global Red List included assessments for 948 orchid species, of which 56.5% are reported to be threatened [4]. Orchids are monocot plants. They may be epiphytic, terrestrial and lithophytic. About 70% of the world's orchids are epiphytic and/or lithophytic, 25% are terrestrial and 5% of the world's orchids grow in mixed substrates (both lithophytic, epiphytic and terrestrial) [5].

In addition to their geographical and taxonomic diversity, orchids are also widely used for a variety of reasons, both legally and illegally, sustainably and unsustainably [6]. One of the best-known plant groups in the global horticultural and cut flower trades [7, 8], orchids are also harvested, grown and traded for a variety of purposes, including as ornamental plants, medicinal products and food. Orchid species are also admired for their unusual growth habits (e.g. leafless orchids, such as species of *Dendrophylax* Rchb.f. and *Chiloschista* Lindl.), miniature size (e.g. species of *Platystele* Schltr. and *Bulbophyllum moniliforme* F. Muell.), scent (e.g. species of *Cattleya* Lindl. And *Dendrochilum glumaceum* Lindl.), patterned leaves (e.g. jewel orchids in the genera *Anoectochilus* Blume, *Goodyera* R.Br., *Ludisia* A.Rich. and *Macodes* Lindl.) and as cut flowers (*Renanthera imschootiana*, *Vanda coerulea*). Several local species of *Ascocentrum, Calanthe, Cymbidium, Dendrobium, Paphiopedilum* and *Vanda, etc.* are in great demand in international market for breeding materials [9].

2. Materials and Methods
The experiment was conducted using all vegetatively propagated species and hybrids of commercially grown orchid genera viz. *Cattleya* Lindl., *Cymbidium* Sw., *Dendrobium* Sw., *Mokara (Arachnis X Ascocentrum X Vanda)*, *Oncidium* Sw., *Paphiopedilum* Pfitz, *Phalaenopsis* Blume and *Vanda* Jones ex R. Br, of the family Orchidaceae. For all the varieties and species, full grown 20 plants with at least two pseudobulbs/shoot were selected for study. Usually, healthy and insect pest and disease free plants are required for testing for taking morphological observations without any chemical and bio-physical treatment. The experiment was conducted for two similar flowering seasons at two different places under greenhouse conditions ensuring satisfactory growth for the expression of the relevant characteristics of the variety and species. All observations were taken by measuring or counting made on 10 plants or parts taken from each of 10 plants. Normally, growth regulators are not applied. All observations were taken of the shoot on the flowering shoot, of the leaf on the longest leaf of a flowering shoot, of the inflorescence and the flower at the time when 50% of the flowers on the inflorescence have opened and on the most recently fully opened flower on the inflorescence before fading of colour, of the length and width of the flower and parts of the flower in the spread out position, of the colour of sepal, petal, lip and column on the inner side. For the assessment of colour characteristics, the Royal Horticultural Society (RHS) colour chart was used.

3. Results and Discussion
A variety can be registered if it essentially fulfils the criteria of Distinctiveness, Uniformity and Stability (DUS) which means that the candidate variety must be distinguishable by at least one essential characteristic from a variety which is sufficiently uniform in expression of its essential

characteristics which should remain fixed even after repeated multiplication. The variety should also have a single and distinct denomination [10]. With the study of morphological diversity of 8 orchid genera, 53 descriptors in *Cattleya*, 62 descriptors in *Cymbidium*, 52 descriptors in *Dendrobium*, 61 descriptors in *Mokara*, 60 descriptors in *Oncidium*, 77 descriptors in *Paphiopedilum*, 58 descriptors in *Phalaenopsis* and 54 descriptors in *Vanda* were developed.

Morphological characteristics of orchids

Orchids are evergreen or deciduous herbaceous perennial. Due to inherent slow growth and reduced photosynthetic capacity some species like *Cypripedium calceolus* has long vegetative period [11]. Orchids are bilaterally symmetric (zygomorphic), many resupinate, one petal (labellum) is always highly modified, stamens and carpels are fused, and the seeds are extremely small.

Stem: Based upon growth habit they can be classified into monopodial and sympodial orchids. In monopodial orchids, the stem emerges from a single bud, elongates and produces leaves from the apex each year. The flower stem emerge from the base of the uppermost leaves. e.g., *Phalaenopsis*, *Vanda* and *Vanilla*. In sympodial orchids, the plant produces a series of adjacent shoots which grow to a certain size, bloom and then stop growing, to be then replaced. The base of the stem of sympodial epiphytes, or in some species essentially the entire stem, may be thickened to form what is called a pseudobulb that contains nutrients and water for drier periods, e.g., *Cymbidium, Cattleya, Dendrobium, Oncidium*.

Based upon natural habitat, orchids are classified in to three categories, namely epiphytes, terrestrial and saprophytes. Epiphytes are grown on trees, rocks or in leaf litter. Nutrients mainly come from animal droppings and other organic detritus on their supporting surface. Epiphytic orchids are characterized by thick and succulent leaves with thick cell walls, cuticles and small sub-stomatal chamber whereas those of terrestrial species are thin. Epiphytes generally have smaller stomata than terrestrial species. E.g. *Vanda, Dendrobium, Phalaenopsis.* Terrestrial orchids may be rhizomatous or form corms or tubers which contain reserve carbohydrates. Glucomannan is the major constituent of reserve carbohydrate in tubers. The free mannose, glucose, manobiose and maltose formed from the reserve polysaccharides are transformed to sucrose and transported to new tubers and to the newly formed upper part of plant. In warm and humid climates, many terrestrial orchids do not need pseudobulbs. E.g. *Calanthe, Eulophia, Phaius, Paphiopedilum, Spathoglottis*. Saprophytic orchids obtain their food from dead organic matter instead of by photosynthesis, are found in a number of orchid groups. The majority of orchids pass through a saprophytic seedling stage, which may last for months, especially in terrestrial species. E.g. *Neotia* spp. [12].

Roots: Epiphytic and most lithophytic orchids have clinging roots for anchorage, absorbing roots which penetrate the humus on bark and the aerial roots hang free in the air and help to the absorption of moisture. Many a times the epiphytic roots contain chlorophylls, are capable of performing photosynthesis. The roots of genera like *Phalaenopsis* become flat and assist the plant to creep over the surface, while those of *Aerides* and *Vanda* help the plant to trail. Roots of orchids are white and thick. Epiphytic orchid roots are covered with a spongy tissue that helps the orchid cling to a tree or rock and absorb water and nitrogen from the air. Epiphytic orchids have modified aerial roots that are sometimes be few meters long. In the older parts of the roots, a modified spongy epidermis called velamen has the function to absorb humidity. It is made of dead cells and can have a silvery-grey, white or brown appearance. The cells of the root epidermis grow at a right angle to the axis of the root to allow them to get a firm grasp on their support. But very few terrestrial orchids have velamen [5]. In terrestrial orchids, in addition to the simple absorbing roots with root hairs, sometimes large root tuber as in *Habenaria* or root tubercles as *in Nervilia* are also present.

Pseudobulbs: Most orchids have conspicuous storage organs. Corms, rhizomes, or tuberoids are common in terrestrial orchids while storage organs in epiphytic orchids are enlarged stems called pseudobulbs. Pseudobulbs are also found in some terrestrial orchids like *Cymbidium, Eulophia* and *Spathoglottis*. Orchid pseudobulbs are of two types: heteroblastic or homoblastic. Heteroblastic pseudobulbs consists of only one internode, e.g. *Oncidium, Cattleya* and *Miltonia*. Homoblastic pseudobulbs consist of two or more internodes, e.g. *Eria* and *Dendrobium* [5]. Orchid pseudobulbs serve as important water storage organs. The epiphytic biotope is characterized by frequent periods of water and nutrient shortage. Presence of fleshy organs in roots, stems or leaves confers epiphytic orchids the ability to survive and grow in adverse climate. Pseudobulbs of *Oncidium* maintain relatively high water contents of 90–95% throughout development. In *Stanhopea* and *Pleione*, pseudobulbs are made up of an abundance of water-storing cells [5]. In addition, most orchid pseudobulbs possess a thick cuticle that are totally impervious to water and gases. In *Cymbidium sinense* pseudobulbs are able to retain about 64% of their water content after 42 days of water stress conditions [13]. In *Oncidium* 'Goldiana', uptake of nitrate is reported highest during the formation of new pseudobulbs. In addition, it is observed that mineral allocation to pseudobulbs within connected shoots of *Oncidium* 'Goldiana' is most active during formation and development of a new pseudobulb [14]. Although impervious to water and gases, pseudobulbs of *Oncidium* 'Goldiana', nevertheless are capable of photosynthesis. Pseudobulb photosynthesis in *Oncidium* functions essentially for the refixation of respiratory carbon produced by the underlying massive parenchyma [15]. Enzymes within the tissue of the pseudobulb for carbon fixation are ribulose-1,5bisphosphate carboxylase/oxygenase and phosphoenolpyruvate carboxylase. While most orchids are impervious to the external environment, gas exchange with the ambient atmosphere is mediated by a cavity rich in stomata on top of the pseudobulb in *Bulbophyllum minustissimum*. In the CAM orchid, *Laelia anceps*, photosynthesis of leaves is largely affected by irradiance of the pseudobulb [16]. Exposure of the pseudobulb to light is necessary for leaves to conduct daily gas exchange with the atmosphere. It has been proposed that the organic acid fixed during the night is transported to the pseudobulb and decarboxylated the next day and that the transport of organic acid is enhanced by exposure of the pseudobulb to light. It appears that the pseudobulb can regulate the capacity for CAM in leaves of *Laelia anceps* although evidence in CAM orchids for the basipetal transport of organic acids from leaves to pseudobulb is lacking. Studies on both *Catasetum*

viridiflavum [17] and *Oncidium* 'Goldiana' [14] have shown that carbohydrate reserves in orchid pseudobulbs are important in the initiation of new growth. The pseudobulb of *Oncidium* accumulates massive amounts of carbohydrates during vegetative development. These carbohydrate reserves are subsequently remobilised to support new shoot and inflorescence development.

Pseudobulbs may be rounded and globular as in *Bulbophyllum*, oblong and thumb shaped as in *Eria*, flat and button shaped as in *Porpax*, elongated, cane and club shaped as in *Dendrobium*, conical, round to ovoid in *Cymbidium*, clavate in *Cattleya* and grooved in *Oncidium* (Table 1).

Table 1: Variation of pseudobulb shape in orchids

Orchid genera	States	Example varieties & species
Cymbidium	Round	*Cym. dayanum, Cym. gammieanum, Cym. tigrinum* Cym. 'Lucky Rainbow'
	Ovoid	*Cym. pendulum, Cym. elegans, Cym. hookerianum, Cym. erythraeum, Cym. tracyanum, Cym. aloifolium, Cym. irridioides* Cym. 'Soul Hunt ', Cym. 'Fire Storm', Cym. Bob Marlin 'Lucky', Cym. 'Winter Beach Sea Green', Cym. 'Madrid Forest King', Cym. 'Show Girl', Cym. 'Sleeping Nymph'
	Conical	Cym. elegans, Cym. 'Luna Pink'
Dendrobium	Cane woody	Den. gibsonii, Den. bensoniae, Den. aphyllum, Den. ruckeri, Den. aduncum, Den. cathcartii
	Cane clavate fleshy	Den. primulinum, Den. nobile, Den. parishii, Den. pendulum, Den. loddigesii, Den. 'Bangkok Blue', Den. 'Big White Jumbo', 'Den. 'Thongchai Gold', Den. 'Erika', Den. 'Triple Pink', Den. 'Madam Pink'
	Bulbous round	Den. aggregatum, Den. chrysotoxum, Den. jenkensii, Den. 'Julie'
Cattleya	Cylindric	Blc 'Guanmiau City', C. 'Queen Sirikhit'
	Clavate	Lc 'Purple Cascade Fragrant B', Blc 'Mem Ann Balmores Convess', Blc 'Hsinging Catherine', Blc 'Chinese Beauty Orchid Queen'
	Globular or Ovoid	Lc 'Ahmad Sheikhi
Oncidium	Elliptic	Colm. Wild Cat Carmera, Colm. Wildcat Bobcat
	Ovate	ONC. Hawai Yellow, ONC. Ramsey Orange, Colm. Wildcat Yellow, ONC. Sweet Sugar, Brassidium Butterfly, ONC. Kampangsean Snow, ONC. Big White, ONC. Blue, ONC. Red, ONC. Pink Small Flower, ONC. Pink/Yellow, ONC. Red Mini Little Cherry, ONC. Taka, ONC. Sharry Baby Sweet Fragrance

Leaves: Like most monocots, orchids generally have simple leaves with parallel veins, although some Vanilloideae have a reticulate venation. They may be ovate, lanceolate, or orbiculate and very variable in size (Table 2). They are normally alternate on the stem, often plicate, and have no stipules. Orchid leaves often have siliceous bodies called stegmata in the vascular bundle sheaths (not present in the Orchidoideae) and are fibrous. The attractive mottle of the leaves of Lady's Slippers from tropical and subtropical Asia, (*Paphiopedilum)* is caused by uneven distribution of chlorophyll. Also *Phalaenopsis schilleriana* is a pastel pink orchid with leaves spotted dark green and light green. The Jewel Orchid (*Ludisia discolor*) is grown more for its colorful leaves than its fairly inconspicuous white flowers. Number of stomata per unit surface area is always higher in upper leaves on the same stem due to stronger light intensity on the upper leaves. Epiphytes generally have smaller stomata than terrestrial species. Epiphytic orchids are characterized by thick and succulent leaves with thick cell walls, cuticles and small substomatal chamber whereas those of terrestrial species are thin [12]. Usually mature leaves are photosynthetically active. Leaves are sites for reduction of transpiration, water storage organs, retention of rain or condensed water and absorption of water as liquid or vapour. The hard leathery leaf type of orchids are drought tolerant with very thick cuticle and thick walled epidermis together with extensive lignification offer excellent protection against desiccation. Thick leaves have Crassulacean Acid Metabolism (CAM), a very important adaptation to water stress. All thin orchid leaves show C3 photosynthesis. Small and narrow leaves are better adapted exposed sites than larger ones because they lose heat more efficiently by convection. Leaf hair may help conserve water by increasing the boundary layer thickness of air around the leaf and lengthening the diffusion pathway. Deciduousness occurring in sympodial orchids avoid water stress during the dry season by shedding their leaves and entering a dormancy period. In monopodial orchids, the number of leaves on stem depends on the age of the plant while the orchid like *Cattleya* has one leaf per pseudobulb and *Dendrobium* has 5-20 leaves per pseudobulb.

Table 2: Leaf shape variation in orchids

Orchid genera	States	Example varieties & species
Cymbidium	Linear	Cym. hookerianum, Cym pendulum, Cym. lowianum, Cym. aloifolium, Cym. erythreaum, Cym. irrioides, Cym. 'Yankilla', Cym. 'Soul Hunt', Cym. 'Fire Storm', Cym. Bob Marlin 'Lucky', Cym. 'Winter Beach Sea Green',Cym. 'Madrid Forest King', Cym. 'W.W. Wondrous', Cym. 'Sleeping Nymph
	Linear -oblong	Cym. devonianum, Cym. dayanum, Cym. lancifolium, Cym. 'Lucky Rain Bow', Cym. 'Sainte Lapine'
	Lanceolate	Cym. gammieanum, Cym. erythraeum, Cym. elegans, Cym. tigrinum, Cym. iridioides, Cym. lancifolium, Cym. 'Stanley Fouraker White Magic'
Dendrobium	Linear	Dendrobium crepidatum, D. devonianum
	Elliptic	D. bensoniae, D. bulboflorum, D. thyrsiflorum, D. nobile, D. densiflorum
	Lanceolate	D.aduncum, D. candidum, D. chrysotoxum, D.chrysanthum, D. farmeri

	Ovate	D. moschatum
	Flat	D. anceps, D. acinaciforme
Vanda	Terete	Vanda teres, V. 'John Clubb', V. 'Miss Joaquim'
	Semi-terete	V. Emma van Deventer, V. Ruby
	Channelled	Vanda sanderiana, Vanda lamellata
	Strap	Vanda coerulea, Vanda cristata, Vanda parviflora, Vanda coerulescens, Vanda tassellata, V. stangeana, Vanda alpina, V. 'KS.SD', V. 'Prao Sky Blue', V. 'Pures Wax', V. 'RBSD Black', V. 'PAT D', V. 'Sansai Blue', V. 'Motes Indigo', V. 'Pakchong Blue', V. 'Roberts Delight Blue'
Paphiopedilum	Oblong	Paph. concolor, Paph. spicerianum, Paphiopedilum fairrieanum
	Elliptic	Paph. lawrenceanum x Paph. 'Winston Churchill', Pl x PW-29
Phalaenopsis	Oblong	P. Taida Salu, Dtps. Tying Shin Zebra, Dtps. Taida Salu Red, P. Kaleidoscope, P. Luchia Pink, P. Jin Cheng Sun, P. Sin Yuan Golden Beauty, Dtps. Chian Xen Magpie, P. Little Gem Stripe, P. Surf Song, Dtps. Lian Her Happy, P. Timothy Christopher
	Narrow obovate	Dtps. Shulong Sun Beauty, Dtps. Chin Ann Diamond 'Alisun', Dtps. Gan Lin Diamond, Dtps. Gan Lin Fairy 'GL'

Inflorescence: Orchids are arranged with flowers on an inflorescence, which is a spike, a raceme or a panicle (Table 3). Some orchids like *Paphiopedilum* produce single flower. The origin of the inflorescence varies depending upon genera and species. In most of the terrestrial orchids, the inflorescence is terminal but lateral in orchids like *Eulophia nuda* while majority of epiphytic orchids produce flowers on lateral inflorescence. However, in orchids like *Porpax* inflorescences are terminal. A saprophytic orchid produces only leafless flowering shoot. In orchids like *Eulophia nuda* inflorescence emerges before leaves while in *Geoderum densiflorum* leafy shoot emerges before inflorescence.

Table 3: Inflorescence variation in orchids

Characteristics	States	Example species/ varieties
No. of inflorescence /pseudobulb	One	Cym. tracyanum, Cym 'Jungfrau Snow Queen', Cym. 'Fire Storm', Cym. Bob Marlin 'Lucky', Cym. 'Winter Beach Sea Green', Vanda tessellata
	Two	Cym. elegans, Cym. 'Sleeping Nymph', Vanda stangeana, Vanda cristata
	More than two	Cym. lowianum, Cym. 'H.C. Aurora', Dendrobium 'Julie'
Inflorescence orientation	Erect	Cym. eburneum, Cym 'Jungfrau Snow Queen', Cym. 'Sleeping Nymph', Dendrobium aphyllum, D. fimbriatum, D. kingianum, Vanda coerulea, Vanda tessellata
	Arching/ Horizontal	Cym. erythrianum, Cym. hookerianum, Cym. tracyanum, Cym. 'Fire Storm', Cym. Bob Marlin 'Lucky', Dendrobium nobile, D. bensoniae
	Drooping/ pendulus	Cym. devonianum, Cym. aloifolium, Cym. Lowianum, Cym. Elegans, Cym. dayanum, Dendrobium densiflorum, D.thyrsiflorum, Vanda parishii
Inflorescence type	Raceme	Dendrbium hybrids, Cymbidium hybrids
	Panicle	ONC. 'Taka Yellow', ONC. 'Sweet Sugar'
Inflorescence length	Short (<30cm)	Cym. devonianum, Cym. ebuneum, Cym. erythraeum, Cym. tigrinum, D. 'Thongchai Gold', ONC. 'Blue', ONC. 'Pink Small Flower', Ianopsis Utriculariodes, ONC. 'Red Mini Little Cherry'
	Medium (30-60cm)	Cym. elegans, D. 'Abraham', D. 'Emma White', ONC. 'Sweet Sugar'
	Long (>60cm)	Cym. lowianum, Cym. aloifolium, D. 'Lervia', D. 'Big White 4N', ONC. 'Sharry Baby 'Sweet Fragrance', ONC. 'Taka Yellow'

Flowers: Orchids are monocotyledonous plants bearing flowers with seven floral parts- three sepals, three petals and the column or gynostemium. The orchid flowers show a great diversity in size, colours and form. The range of size varies from that in some species of *Oberonia* (0.15cm across) to *Pecteilis gigantea* (10 cm. across). The predominant shades are white, yellow, green and purple occurring in pure state or in every possible combination. The orchid flowers exhibit mimicry like Spiders, Dancing girls, Bees, Ladies slipper, or Insects. In few cases like *Oberonia* and *Malaxis* the flowers are in an upside down position, having twisted through 180° on its pedicel. The inferior ovary or the pedicel usually rotates 180 degrees, so that the labellum, goes on the lower part of the flower, thus becoming suitable to form a platform for pollinators. It is called resupination. Some orchids have secondarily lost this resupination, e.g. *Zygopetalum* and *Epidendrum secundum*. The inflorescence of *Geoderum densiflorum* bends down in 180° and present the flowers in upside down position. One of the most important characteristics of all orchid flowers is that they are zygomorphic and bisexual or very rarely unisexual. The orchid flowers may have or have not spur which is the appendage of lip meant for storing nectar. It may be short or long in size and vary in shape. The orchid flowers consist three outer most floral parts- the sepals are more or less similar in appearance. But in few cases like *Bulbophyllum*, the dorsal sepal is of different size from the laterals. They may be coloured (petaloid sepals) and free from one another or united forming sepaloid tube. The inner whorl of three segments called the petals. The two lateral petals are alike and the other one, called the lip or labellum, is highly modified and enlarged. The labellum is the most prominent and distinctive part of the orchid flower. The petals may be similar to sepals and are filiform or fimbriate. The lip is attached to the base of the column loosely or firmly. The colour pattern, size and shape of the lip vary in different genera. The most fascinating aspect of the lip is its habit of mimicry to facilitate pollination.

The column or gynostemium is located at the center of the flower, is the unique structure distinguishing the orchids from all other kinds of plants. It is the reproductive part of the flower formed by the union of the male and female organs. It bears one to three movable or rigidly attached anthers at its tip or on the sides. On the basis of one or more

fertile anthers, orchids are called as Monandrae or Pleonandrae, respectively. The anther contains a mass of pollen called pollinium which is varying from 2, 4 and 6 to 8. The pollinia are contained in a cavity called the clinandrium. Just below the anther, on the ventral surface of the column, is a hollow cavity of sticky and viscid mass known as stigmatic surface. It is formed by the fusion of two fertile stigmas. The anther and stigmatic surface is separated by the structure called rostellum, which is actually the third stigma. The rostellum serves to prevent from self-pollination. The genera like *Eria* and *Dendrobium*, the column is extended below into a structure called foot. The orchidaceous ovary is generally inferior, tricarpellary, one-celled, with numerous number of ovules on three parietal placentas. It is stalked or sessile. Morphological diversity of flowers and their different parts of commercially important orchid genera are given in Table 4 to Table 7.

Table 4: Floral characteristics in orchids

Genera	Floral characteristics
Cattleya	The present day hybrid cattleyas belong to the unifoliate group. The flowers are 5 to 15cm in size and they occur in all colours except true blue and black. Unifoliate cattleyas bear upto 5 flowers per inflorescence whereas bifoliate possesses 2 to 25 flowers per inflorescence. Both dorsal and lateral sepals are incurved or straight.
Cymbidium	The spikes are with 2 to 15 flowers. The individual florets are 1cm to 12.5cm across and are of various colours or shades of colour. Cymbidium hybrids are classified into three groups-Standard, Intermediate and Miniature hybrids. Standard and Intermediate hybrids produce 90 to 120cm long spikes with 8 to 15 flowers per spike. Miniature hybrids produce green, yellow or brown coloured flowers, 30cm tall and each spike contains 30-40 flowers of 2.5 to 8.5cm across.
Dendrobium	In some groups, the flowers joined in pairs or three on small peduncle on the entire length of the pseudobulbs, with caduceus leaves. In some species, with persistent leaves, the flowers are grouped in pairs or threes or alternately closely set forming erect or pendent thyrses. In another group, flowers are generally solitary and small, arising from the axils of leaves. The inflorescences are terminal or subterminal and arranged with one to several dozens of flowers with extremely diverse dimensions, size and ranges of flower colour.
Oncidium	Usually, single inflorescence is produced from a single growth or in some cases, two inflorescences may be produced. Inflorescences develop from the base of the pseudobulbs or from the axil of leaves. The flower size varies from 1cm to 12.5cm across. The flower colours are mostly shades of yellow and brown, in some cases are red, pink, magenta, green or white. In general, all three sepals are alike in size, shape and colour, in some cases, these vary. The two lateral petals are similar in size and shape while dorsal sepals are larger. *Oncidium* species are characterized by (i) presence of coloumn wings (ii) presence of complicated callus on the lip (iii) without or with pseudobulbs with one or three leaves (iv) several basal bracts at the base of pseudobulbs.
Paphiopedilum	The flowers are borne singly or in few flowered racemes on a short to elongate inflorescence. The inflorescence is 60 cm tall and often purplish brown. The dorsal sepals are distinct with markings. The two lateral sepals are fused to form a vertical sepal. The lateral sepals are narrow and long with wavy margins. The petals are right angle to the sepals and sometimes curve forward towards the lip. Mostly lips are pitcher or bowl shaped.
Phalaenopsis	The inflorescence arises from the axil of leaves, drooping or erect bearing spikes of 100cm length. The flowers are spectacular, long lasting and white, pink, yellow or mottled. *Phalaenopsis* has two types. In the first type, leaves are thick and fleshy, elongate-elliptic and obtuse in apex. The flowers petals are broader than the sepals and the lip possesses two attractive centre lobes and appendages. The flowering stem is upto 60 cm long and bears 15 or more blooms. Species belonging this group are *Phalaenopsis parishi*, *P. aphrodite*, *P. stuartiana*, *P. schilleriana* and *P. sanderiana*. In the second type, plants are short stemmed bearing fewer blooms. The flowers are smaller with equal sizes of sepals and petals and without any appendages. Species belonging this group are *Phalaenopsis cormi-cervi*, *P. leuddemanniana*, *P. equestris* and P. *mannii*.
Vanda	The inflorescence arise from the axil of the leaves in strap leaved orchids whereas in case of terete leaved orchids inflorescence emerge from on the side of the stem of opposite leaf. The inflorescence is axillary, erect, and simple. The flowers are small to large, few to many, fleshy, heavy textured, long lasting and yellow, brown, purple, magenta, blue, lavender in colour. The flower size varies from 2.5 to 10 cm.

Table 5: Variation of number of flowers per inflorescence in orchids

Orchid genera	States	Example varieties & species
Cattleya	Few (<3)	Blc 'Chinese Beauty Orchid Queen', Lc 'Manriner Far Horizon x L. anceps coerulea, Lc 'Ahmad Sheikhi'
	Many (>3)	C. 'Queen Sirikhit', Blc 'Guanmiau City', Lc 'Purple Cascade Fragrant B'
Cymbidium	<12	*Cym. pendulum, irridoides, Cym.* Bob Marlin 'Lucky', *Cym.* 'Winter Beach Sea Green', *Cym.* 'W.W. Wondrous', *Cym.* 'Sleeping Nymph'
	12-20	*Cym. devonianum, Cym.* 'Madrid Forest King', *Cym.* 'Red Star', Cym. 'Red Beauty Evening Star'
	>20	*Cymbidium lowianum, Cym. aloifolium*
Dendrobium	Few (<7)	Den. 'Thongchai Gold', Den. 'Bangkok Blue', Den. 'Earsakul', Den. 'Kating Dang', Den. 'Madam Pink', Den. 'Triple Pink'
	Medium (7-10)	*Den. bensoniae, D. fimbriatum*, Den. 'Abraham', Den. 'Big White Jumbo', Den. 'Erika', Den. 'Lervia'
	Many (>10)	*Dendrobium densiflorum, Den. mochatum Den. thyrsiflorum,* Den. 'Emma White', Den. 'Julie'
Oncidium	Few (<10)	ONC. Big White, ONC. Blue, ONC. Red, ONC. Pink Small Flower, ONC. Pink/Yellow, Ianopsis Utricullariodes, ONC. Red Mini Little Cherry, Colm. Wild Cat Carmera, Colm. Wildcat Bobcat, ONC. Popki Red VG
	Medium (10-30)	ONC. Sweet Sugar, Brassidium Butterfly, ONC. Kampangsean Snow, ONC. Taka, ONC. Sharry Baby Sweet Fragrance
	Many (>30)	ONC. Ramsey Orange, ONC. Sharry Baby 'Sweet Fragrance', ONC. Gower Ramsey, ONC. Sharry Baby 'Sphacelatum', ONC. Hawai Yellow
Paphiopedilum	Solitary	*Paph. concolor, Paph. hirsutissimum, Paph insigne, Paph. spicerianum, Paph.villosum, Paph. lawrenceanum x*

	(Single)	*Paph. 'Winston Churchill', Paphiopedilum fairrieanum, Pl x PW-29*
	Few (Two)	
	Many (> Two)	Paph. 'Koopwitz'
Phalaenopsis	Few (<5)	Dtps. Plum Rose x Ox Black Jack, Dtps. Acker's Sweetie, Dtps. Big Red Robe, Dtps. Mount Lip Taisuco, P. Miki Wata Nabe, Dtps.Shih Hua Long First Love, P. Kaleidoscope, P. Jin Cheng Sun, P. Sin Yuan Golden Beauty, Dtps. Chian Xen Magpie, P. Lucyna, P. Brother Girl, P. Memoria Francis Hunter, Dtps. Ox Prince Thunder
	Medium (5-10)	Dtps. Hsin Yang Fortune, P. Strawberry, Dtps. Tying Shin Zebra, P. Luchia Pink, Dtps. Lian Her Happy, P. Timothy Christopher Dtps. Happy UFO, Leodora, P. Magic Kiss, Goldie, Dtps. Leopard Princess M611, P. Ho's Little Caroline, Dtps. Shu Long Pearl, Dtps. Chin Ann Diamond 'Alisun', Taida Saln. Red
	Many (>10)	Dtps. Younghome Orange Lip, Dtps. Taida Salu Red, P. Big White Pink Stripe, P. Medium Pink.
Vanda	Few (<5)	*Vanda* 'Prao Sky Blue', V. 'PAT D'
	Medium (5-10)	*V.* 'Pures Wax', V. 'RBSD Black', *V.* 'Sansai Blue', *V.* 'Motes Indigo, *V.* 'Pakchong Blue', *V.* 'Roberts Delight Blue'
	Many (>10)	--

Table 6: Predominant colour variations in orchids

Characteristics	States	Example species/ varieties
Dorsal sepal main colour	Green	*Cymbidium lowianum, Cym. hookerianum, Cym.* 'Yankilla', *Cym.* 'Winter Beach Sea Green', Cym. 'Madrid Forest King', *Paphiopedilum hirsutissimum, Paph insigne, Paph. venustum, Paph.villosum,Vanda alpina*
	White	*Cattleya* 'Queen Sirikhit', *Cymbidium mastersii, Cym.* 'Takarjoke', *Cym.* 'W.W. Wondrous', *Paph. spicerianum, Paph. lawrenceanum x Paph. 'Winston Churchill', Paphiopedilum fairrieanum, Phalaenopsis* 'Miki Wata Nabe'
	Yellow	*Cymbidium tracyanum*, Cym. 'Angelica December Gold', Cym. 'Hawtescens', *Oncidium sphacelatum*, ONC. 'Taka Yellow', *Paph. Concolor, Vanda cristata*
	Pink	*Dendrobium* 'Triple Pink', Den. Madam Pink', Den. 'Ear Sakul'
	Red	*Cymbidium iridioides, Cym.* 'Fire Storm', *Cym.* Bob Marlin 'Lucky', ONC. 'Popki Red'
	Purple	*Cattleya bowringiana*, Cattleya 'Purple Cascade Fragarnt Beauty', *Phalaenopsis* 'Strawberry','*Vanda* 'Pat Delight'
	Brown	*Cym.* 'Tracey Reddaway'
	Blue	*Vanda coerulea, Vanda* 'Prao Sky Blue', *Vanda* 'Pakchong Blue'
	Violet	*Vanda* 'Motes Indigo'
Petal main colour	Green	*Den. bulboflorum, Den. acinaciformae*, Den. 'Daang Saard', *Paphiopedilum fairrieanum Paph. spicerianum*
	White	*Den. formosum, Den. longicornu, Den, amoenum, Den. devonianum, Den. pendulum, Den. aphyllum, Den. secundum,. Den. bensoniae, Den. draconis, den. tranparens, Den. falconerii*, Den. 'Big White 4N', Den. 'Emma White', Den. 'Big White Jumbo', Den. 'Lervia'
	Yellow	*Cymbidium pendulum, Cym.* 'Pine ClashMoon Venus', *Cym.* 'Sun Gold' *Den. ruckerii, Den. jenkensii, Den. williamsonii*, Den. 'Thongchai Gold', Dtps. 'Shih Hua long First Love'
	Pink	Den. 'Madam Pink', Den. 'Triple Pink', Den. 'Ear Sakul'
	Red	Cym. 'Fire Storm Blaze', Cym. 'Bob Marlin Lucky', Cym. 'Red Beauty Evening Star', Den. 'Kating Dang', ONC. 'Popki Red'
	Purple	*Cymbidium devonianum, Den. aduncum, Den. nobile, Den. parishii, Den. primulinum, Den. loddigessii, Den farmeri, Den.* 'A. Abraham', ONC. 'Wildcat Bobcat', *Phalaenopsis* 'Strawberry'
	Brown	ONC. 'Sharry Baby Sweet Fragrance'
	Blue	*Den.*'Thongchai Blue', *Vanda* 'Roberts Delight Blue'
	Violet	*Den. kingianum*, Den. 'Bangkok Blue', *Vanda* 'Sansai Blue', *Vanda* 'Pakchong Blue'
Lip main colour	Green	
	White	*Dendrobium* 'Big White 4N', *Den.* 'Emma White', ONC. 'Sharry Baby Sweet Fragrance', '
	Yellow	*Cattleya* 'Queen Sirikhit', *Cymbidium elegans, Den.* 'Thongchai Gold', ONC. 'Sweet Sugar'
	Pink	
	Red	Blc 'Chinese Beauty Orchid Queen', ONC. 'Popki Red'
	Purple	Blc 'Hsinging Catherine', *Cymbidium devonianum, Den.* Julie', Den. Lervia, *Den.* 'Madam Pink' Lc 'Purple Cascade Fragrant B',
	Brown	*Mokara* 'Chark Kuan Red'
	Blue	*Den.* 'Thongchai Blue', *Vanda* 'RBSD Black'
	Violet	*Den.* 'Bangkok Blue', '*Den.* 'Erika', *Den.* 'Triple Pink', *Vanda* 'Motes Indigo', *Vanda* 'Pures Wax'
Sepal colour pattern	Uniform	*Cymbidium aloifolium, Cym. eburneum, Cym. hookerianum, Cym. lancifolium, Cym.* 'Madrid Forest King' , *Cym.* 'Levis Duke Bella Vista, *Dendrobium chrysotoxum, Den. chrysanthum, Phalaenopsis* Memoria Francis Hunter
	Spotted	*Cym.* 'Ammesbury', *Cym.* 'Winter Beach Sea Green', *Den. aduncum, Paph. hirsutissimum, Paph insigne, Paph. concolor, Phal.* Leodora, *Phal.* Magic Kiss, Goldie, *Vanda cristata, V.* 'Pures Wax', *V.* 'RBSD Black' *V.* 'PAT D'
	Blotched	*Den. pendulum, Den. primulinum, Vanda parviflora, V.* 'KS.SD', *V.* 'Roberts Delight Blue'

	Shaded/Striped/Streaked	*Cymbidium devonianum, Cym. irridoides, Cym. tracyanum, Cym.* 'Red Star', *Cym.* 'Takarjoke' , *Paph insigne, Paph. spicerianum, Paph. venustum, Paph.villosum, Paphiopedilum fairrieanum, P.* Miki Wata Nabe, Dtps.Shih Hua Long First Love, *P.* Kaleidoscope, *Vanda alpina, V. teres*
	Mixed	*Den. kingianum, Den. nobile, Den.* 'Julie', *Den.* 'Earsakul', *Phal.* Brother Girl,
	Netted/Tessellated	*Den.* 'Abraham', *Den.* 'Bangkok Blue', *Den.* 'Kating Dang', *Den.* 'Triple Pink', ONC. Sharry Baby Sweet Fragrance, ONC. Popki Red, *Paph. hirsutissimum, Paph.villosum*, Dtps. Tying Shin Zebra, *Phal.* Sin Yuan Golden Beauty, *Vanda coerulea, V. tessallata, V.* 'Prao Sky Blue', *V.* 'RBSD Black', *V.* 'PAT D', *V.* 'Sansai Blue', *V.* 'Motes Indigo', *V.* 'Pakchong Blue'
	Brindled	*ONC.* Sweet Sugar, Brassidium Butterfly, *ONC.* Taka, *Colm.* Wild Cat Carmera
	Edged	*Colm.* Wildcat Bobcat, *Tolu.* Jairak Firm 'Strawberry', *Phal.* Strawberry, *Phal.* Carlotta
Petal colour pattern	Uniform	Blc 'Mem Ann Balmores Convess', *Cattleya* 'Queen Sirikhit', *Blc* 'Hsinging Catherine, *Cym.* 'Sungold', *Den. chrysanthum, Den. chrysotoxum, Den. densiflorum, Den. fimbriatum, Den.* 'Emma White', *Den.* 'Big White Jumbo', ONC. Sweet Sugar, *Phal.* Amabilis, *Phal.* Ivory pearl, *Vanda alpina, V. cristata*
	Spotted	Blc 'Guanmiau City', *Cym.* 'Jungfrau Dos Pueblos', *Cym.* 'Winter Beach Sea Green', *Den. aduncum, Paph. concolor, Paph. spicerianum, Phal.* Champion Porter, *Phal.* Surf Song, *Phal.* Magic Kiss, *V.* 'Pures Wax', *V.* 'RBSD Black', *V.* 'PAT D', *V.* 'Roberts Delight Blue'
	Blotched	*Den. kingianum, Den. pendulum, Den. primulinum*, ONC. Big White, ONC. Blue, ONC. Lucky Goldstar
	Shaded/Striped/Streaked	Blc 'Chinese Beauty Orchid Queen', *Cym. devonianum, Cym. Pendulum*, Cym. 'Madrid Forest King', Cym. 'Yankilla', *Den. bensoniae, Den.* 'Lervia', *Den.*'Madam Pink', ONC. Sharry Baby Sweet Fragrajnce, ONC. Popki Red, ONC. Pink Small Flower, *Paphiopedilum fairrieanum, Phal.* Miki Wata Nabe
	Mixed	*Den. aphyllum, Den. moschatum, Den. nobile, Den.* 'Abraham', *Den.* 'Bangkok Blue', *Den.* 'Julie', Den. 'Earsakul', Den. 'Triple Pink', *Paph. hirsutissimum, Paph insigne, Paph. venustum, Phal.* Kaleidoscope, *Phal.* Memoria Francis Hunter
	Netted/Tessellated	*Den.* 'Kating Dang', *Paph.villosum*, Dtps. Chian Xen Magpie, *Vanda corulescens, V. stangeana, V.* 'Prao Sky Blue' *V.* 'KS.SD', *V.* 'Sansai Blue', *V.* 'Motes Indigo', *V.* 'Pakchong Blue'
	Brindled	ONC. Ramsey Orange, *Colm.* Wildcat Yellow ONC. Sweet Sugar, Brassidium Butterfly, *Colm.* Wild Cat Carmera,
	Edged	ONC. Red Mini Little Cherry, *Colm.* Wildcat Bobcat, *Phal.* Strawberry
Lip colour pattern	Uniform	*Den.* 'Emma White', *Den.* 'Big White Jumbo', ONC. Ramsey Orange, *Colm.* Wildcat Yellow, ONC. Red Mini Little Cherry, *Colm.* Wildcat Bobcat,
	Spotted	Blc 'Guanmiau City', Lc 'Ahmad Sheikhi', *Cym. hookerianum, Cym. tigrinum,* Cym. 'Jungfrau Dos Pueblos', Cym. 'Takarjoke', Cym. 'Fire Storm', Cym. Bob Marlin 'Lucky', *Paph. concolor, Paph. hirsutissimum, Paph. spicerianum, Vanda parviflora*
	Blotched	*Cym. devonianum, Cym. Pendulum, Cym.* 'Pine Clash Moon Venus', *Cym.* 'H.C. Aurora', ONC. Ramsey Orange, *Colm.* Wildcat Yellow, ONC. Big White, *Colm.* Wild Cat Carmera, *Paphiopedilum fairrieanum, Vanda cristata*
	Shaded/Striped/Streaked	Lc 'Purple Cascade Fragrant B', Blc 'Mem Ann Balmores Convess', C. 'Queen Sirikhit', *Cym.* 'Red Star', ONC. Sweet Sugar, ONC. Taka, ONC. Sharry Baby Sweet Fragrance, ONC. Popki Red, *Phal.* Memoria Francis Hunter, *Vanda alpina, V. coerulescens, V.* 'Prao Sky Blue', *V.* 'Pures Wax', *V.* 'RBSD Black', *V.* 'PAT D', *V.* 'Sansai Blue', *V.* 'Pakchong Blue'
	Mixed	Dtps. Hsin Yang Fortune, *Phal.* Miki Wata Nabe, *Phal.* Champion Porter, *Phal.* Amabilis, *Phal.* Strawberry, Dtps.Shih Hua Long First Love,
	Netted/Tessellated	*Den.* 'Bangkok Blue', *Den.* 'Lervia', *Den.* 'Earsakul', *Den.* 'Dang Saard', *Paph insigne, Paph. venustum, Paph.villosum, Vanda tessallata*
Column main colour	Green	Den. 'Big White Jumbo', *Paph. hirsutissimum, Paph. spicerianum, Paph. venustum, Paphiopedilum fairrieanum*
	White	Lc 'Manriner Far Horizon x L. anceps coerulea, *Colm.* Wild Cat Carmera, *Phal.* Kaleidoscope, *Phal.* Miki Wata Nabe, Dtps. Hsin Yang Fortune, Dtps.Shih Hua Long First Love, *Phal.* Memoria Francis Hunter
	Yellow	*Cym.* 'Sun Gold', *Cym.* 'H.C. Aurora', *Den.* 'Lervia', ONC. Sweet Sugar, ONC. Taka Yellow, *Paph. concolor, Paph insigne, Paph. villosum,*
	Red	ONC. Popki Red
	Purple	*Den.* 'Abraham', *Den.* 'Julie', ONC. Sharry Baby Sweet Fragrance, *Colm.* Wildcat Bobcat, *P.* Strawberry, Dtps. Plum Rose x Ox Black Jack

Table 7: Variation in sepals, petals and lips in orchids

Characteristics	States	Example species/ varieties
Dorsal sepal shape	Linear	*Cymbidium aloifolium*, Cym. 'Yankilla', ONC. Sweet Sugar,
	Lanceolate	Blc 'Guanmiau City', ONC. Taka, Colm. Wildcat Bobcat
	Elliptic	*Cattleya* 'Queen Sirikhit', *Cym. devonianum*, Cym. 'H.C. Aurora', *Cym.* Bob Marlin 'Lucky', *Den.* 'Big White Jumbo', *Den.* 'Erika', *Den.* 'Lervia', Dtps. Hsin Yang Fortune, *Vanda* 'KS.SD', *V.* 'Prao Sky Blue', *V.* 'Pures Wax', *V.* 'PAT D'
	Oblong	Lc 'Purple Cascade Fragrant B', Blc 'Chinese Beauty Orchid Queen', *Cym. hookerianum, Cym.* 'Winter Beach Sea Green', *Cym.* 'Madrid Forest King', *Den.* 'Big White-4N', Den. 'Thongchai Gold', *Den.*

		'Bangkok Blue', *Den.* 'Julie', *Den.* 'Earsakul'
	Obovate	*Cym. lowianum, Cym.* 'Soul Hunt', *Den.* 'Emma White', *Colm.* Wild Cat Carmera, *V.* 'RBSD Black', *V.* 'Motes Indigo', *V.* 'Roberts Delight Blue'
	Ovate	Tolu. Jairak Firm Ruddy, Tolu. Jairak Firm' Fuscous, Tolu. Jairak Firm 'Deep Red', Tolu. Jairak Firm 'Butterfly', Hwra. Lava Burst, Tolu. Jairak Firm 'Chocolate Drop', *Paph. concolor, Paphiopedilum fairrieanum, Phal.*. Miki Wata Nabe, *Phal.* Champion Porter, *Phal.* Strawberry, Dtps.Shih Hua Long First Love,
	Cordate	*Paph. venustum*
	Orbicular	*Paph. spicerianum, Paph. lawrenceanum x Paph. 'Winston Churchill'*
Lateral sepal shape	Linear	*Cymbidium aloifolium, Cym. tigrinum, Den. secundum, Vanda cristata*
	Lanceolate	Blc 'Guanmiau City', Colm. Wildcat Yellow, ONC. Sweet Sugar, ONC. Sharry Baby Sweet Fragrance, Colm. Wildcat Bobcat, ONC. Popki Red
	Elliptic	*Cattleya* 'Queen Sirikhit', Blc 'Chinese Beauty Orchid Queen', *Cym.* 'Fire Storm', *Cym.* Bob Marlin 'Lucky', *Vanda* 'Prao Sky Blue', *V.* 'Pures Wax'
	Oblong	Lc 'Purple Cascade Fragrant B', *Cym.* 'Winter Beach Sea Green', *Cym.* 'Madrid Forest King', *Den. gibsonii, Den. fimbriatum*
	Obovate	*Cymbidium erythreanum, Cym.* 'Soul Hunt', *Cym.* 'W.W. Wondrous', *Den. aphyllum, Den.* 'Big White-4N', *Den.* 'Emma White', *Den.* 'Thongchai Gold', *Den.* 'Big White Jumbo', *Den.* 'Earsakul', *Colm.* Wild Cat Carmera
	Ovate	Blc 'Mem Ann Balmores Convess', Blc 'Hsinging Catherine', Dtps. Taida Saln Red, *P.* Strawberry, Dtps. Hsin Yang Fortune, Dtps. Shih Hua Long First Love, *P.* Memoria Francis Hunter, Dtps. Ox Prince Thunder, Dtps. Chian Xen Magpie
	Triangular	*Den. aduncum, Den. kingianum, Den.* 'Bangkok Blue', *Den.* 'Lervia', *Den.*'Madam Pink', *Den.* 'Triple Pink'
	Orbicular	
Petal shape	Linear	*Cymbidium dayanum, Cymbidium irrioides*, Cym. 'Red Star, *Den. ruckerii*
	Lanceolate	*Cymbidium lowianum, Cym.* 'Madrid Forest King', *Paphiopedilum fairrieanum*
	Elliptic	*Cymbidium lancifolium, Cym. devonianum*, Lc 'Purple Cascade Fragrant B', Blc 'Guanmiau City', Lc 'Ahmad Sheikhi', *Cym.* 'Tracey Reddaway', *Cym.* 'Fire Storm', *Den. bensoniae, Den. gibsonii, Den. nobile, Colm.* Wildcat Bobcat
	Oblong	*Cym. aloifolium, Den. primulinum, Paph. hirsutissimum, Paph. spicerianum, Paph. venustum*
	Obovate	*Cym. hookerianum, Cym.* 'Soul Hunt', *Cym.* 'H. C. Aurora', *Cym.* Bob Marlin 'Lucky', *Cym.* 'Winter Beach Sea Green, *Den. moschatum, Den. chrysotoxum, Den. fimbriatum,* Den. 'Abraham', *Den.* 'Emma White', *Den.* 'Big White-4N', *Den.* 'Thongchai Gold', *Den.* 'Bangkok Blue', *Den.* 'Erika', *Den.* 'Dang Saard', *Den.* 'Kating Dang', ONC. Sweet Sugar
	Ovate	Blc 'Mem Ann Balmores Convess', C. 'Queen Sirikhit', Blc 'Hsinging Catherine', Blc 'Chinese Beauty Orchid Queen, *Den. draconis, Den.* 'Big White Jumbo', *Paph. concolor,* Dtps. Plum Rose x Ox Black Jack, Dtps. Younghome Orange Lip, Dtps. Acker's Sweetie, Dtps. Big Red Robe, Dtps. Mount Lip Taisuco, *P.* Miki Wata Nabe, *P.* Champion Porter, *P.* Strawberry, *P.* Taida Salu, Dtps. Taida Salu Red, *P.* Kaleidoscope,
	Sub Orbicular	Dtps. Hsin Yang Fortune, *P.* Amabilis, Dtps. Tying Shin Zebra, *P.* Medium Pink, *P.* Magic Kiss, Goldie, *P.* Leodora, *P.* Lucyna, Dtps. Leopard Princess M611, Dtps. Sogo Soft., Dtps.Shih Hua Long First Love
Lip shape	Lanceolate	*Vanda* 'Sansai Blue', *V.* 'Motes Indigo', *V.* 'Pakchong Blue',
	Oblong	Blc 'Chinese Beauty Orchid Queen'
	Oblanceolate	*Den. aphyllum, Den. bensoniae, Vanda coerulea*
	Elliptic	*ONC.* Royal Robe, Dtps. Hsin Yang Fortune,
	Ovate	*Cymbidium irridioides, Cym.* 'Jungfrau Dos Pueblos', *Den. nobile,* ONC. Sweet Sugar, ONC.Gold Singer, Hwra. Lava Burst, Tolu. Jairak Firm 'Chocolate Drop', *Vanda pumila, V.* 'Pures Wax', *V.* 'RBSD Black', *V.* 'PAT D', *V.* 'Roberts Delight Blue'
	Obovate	*Cymbidium devonianum*
	Sub-orbicular	*Den. gibsonii, Den. fimbriatum, Den. densiflorum, Vanda bicolor*
	Orbicular	Blc 'Hsinging Catherine', Den. 'Abraham', Den. 'Big White-4N', ONC. Baipai, Brassidium Butterfly,
	Bowl	*Paph. concolor*
	Pitcher	*Paph. spicerianum, Paph insigne, Paph. hirsutissimum, Paph. venustum, Paph.villosum, Paph. lawrenceanum x Paph. 'Winston Churchill', Paphiopedilum fairrieanum, Pl x PW-29*
	Obdeltoid	P. Memoria Francis Hunter, Dtps. Ox Prince Thunder
	Rhombic	Dtps. Plum Rose x Ox Black Jack, Dtps. Younghome Orange Lip, Dtps. Acker's Sweetie, Dtps. Big Red Robe, Dtps. Mount Lip Taisuco, *Phal.* Miki Wata Nabe, *Phal.* Amabilis, Dtps. Shih Hua Long First Love, *Phal.* Taida Salu, Dtps. Taida Salu Red, *Phal.* Kaleidoscope
Sepal curvature	Incurved	*Cattleya* 'Queen Sirikhit', *Blc* 'Chinese Beauty Orchid Queen', *Cym. elegans, Cym. tigrinum, Cym.* H.C. Aurora, *Cym.* 'Fire Storm', *Cym.* Bob Marlin 'Lucky', *Cym.* 'Winter Beach Sea Green', *Den. densiflorum, Den. chrysotoxum*, ONC. Sharry Baby 'Sphacelatum', *Paph. hirsutissimum, Paph insigne, Paph. spicerianum, Paph. venustum, Paph.villosum, Paph. lawrenceanum x Paph. 'Winston Churchill', Paphiopedilum fairrieanum,* Dtps. Ox Prince Thunder, Dtps. Hsin Yang Fortune, *Phal.* Kaleidoscope
	Straight	Blc 'Mem Ann Balmores Convess', Blc 'Hsinging Catherine', Cym. 'Miss Sanders', *Den. moschatum, Den. primulinum,* Colm. Wildcat Bobcat, *Paph. concolor,* V. 'Roberts Delight Blue'
	Reflexed	*Cymbidium dayanum, Cym. aloifolium, Cym. devonianum,* Lc 'Ahmad Sheikhi', *Den. bulboflorum, Phal.* Taida Salu, Phal. Jin Cheng Sun, *V.* 'Prao Sky Blue', *V.* 'Pures Wax', *V.* 'RBSD Black'
Petal curvature	Incurved	C. 'Queen Sirikhit', *Cymbidium dayanum, Cym.* 'Yankilla', *Cym.* 'Sleeping Nymph, ONC. Sharry Baby Sweet Fragrance, *Paph. concolor,* Pl x PW-29, Phal. Miki Wata Nabe, *Vanda alpina, Vanda cristata, V.* 'KS.SD', V. 'PAT D', *V.* 'Sansai Blue', *V.* 'Pakchong Blue'

	Straight	Blc 'Mem Ann Balmores Convess', Lc 'Ahmad Sheikhi', *Cym. elegans, Cym.* 'Red Beauty', *Cym.* 'H.C. Aurora', *Cym.* 'Hawtescens', Den. *fimbriatum, Den. nobile, Colm. Wild Cat Carmera, Paph.villosum, Paph. spicerianum, Paph. venustum, Paph. Insigne, Phal*. Strawberry, *Vanda stangeana, V.* 'Motes Indigo', *V.* 'Roberts Delight Blue'
	Reflexed	Blc 'Hsinging Catherine', Blc 'Chinese Beauty Orchid Queen', *Cym. devonianum, Cym. lowianum, Cym.* 'Soul Hunt', *Cym.* 'Fire Storm', *Cym.* Bob Marlin 'Lucky', *Cym.* 'Madrid Forest King', *Den. chrysanthum, Den.chrysotoxum, Den. moschatum, Den.* 'Abraham', *Den.* 'Big White-4N', *Den.* 'Emma White', *Den.* 'Thongchai Gold', *Den.* 'Bangkok Blue', *Den.* 'Julie', *Den*. 'Big White Jumbo', *Paphiopedilum fairrieanum, P*. Brother Girl, *Vanda parviflora, V. tessallata, V.* 'Prao Sky Blue'
Lip curvature	Incurved	*Dendrobium aduncum*, ONC. Taka, ONC. Sharry Baby Sweet Fragrance, *Phal*. Strawberry
	Straight	*Dendrobium aphyllum, Den. chrysanthum, Den. chrysotoxum, Den. densiflorum, Den. nobile, Den.* 'Emma White', *Den.* 'Thongchai Gold', *Den*. 'Bangkok Blue', Den. 'Julie', *Den*. 'Erika', *Colm*. Wild Cat Carmera, *Colm.* Wildcat Bobcat, *Vanda alpina, V. cristata, V.* 'PAT D', *V.* 'Sansai Blue', *V.* 'Motes Indigo', *V.* 'Pakchong Blue', *V.* 'Roberts Delight Blue'
	Reflexed	*Cymbidium aloifolium, Cym. devonianum, Cym. lowianum, Cym.* 'Winter Beach Sea Green', *Cym.* 'Madrid Forest King', *Cym.* 'W.W. Wondrous', *Cym*. 'Sleeping Nymph', *Den. fimbriatum, Den. kingianum, Den.* 'Dang Saard', *Den*. 'Madam Pink', ONC. Sweet Sugar, *Vanda parviflora*
Number of keels/lip	Absent	*Cymbidium devonianum, Vanda alpina, V. cristata*
	Two	*Cym. aloifolium, Cym. dayanum, Cym. lancifolium, Cym. lowianum, Cym. Pendulum, Cym.* Bob Marlin 'Lucky', *Cym*. 'Winter Beach Sea Green', *Cym.* 'Madrid Forest King', *Cym*. 'W.W. Wondrous', *Vanda tessallata*
	Three	*Cym. eburneum, Vanda parviflora, V. stangeana*
	More than three	*Vanda coerulescens*
Spur type	Saccate	*Vanda alpina*
	Conical	*Vanda coerulea, V. cristata, V.stangeana, V. tessallata, V*. 'Prao Sky Blue', *V*. 'Pures Wax', *V*. 'RBSD Black', *V*. 'PAT D', *V*. 'Sansai Blue', *V*. 'Motes Indigo', *V*. 'Pakchong Blue', *V*. 'Roberts Delight Blue'
	tubular	*Vanda parviflora*

Hundreds of natural inter-generic, inter-specific or intra-specific natural hybrids of Dendrobium are found in nature. Most of Indian species of Cymbidium, Dendrobium and Vanda studied have been recognized in breeding programme specially to produce primary hybrids due to their inherent attractiveness coupled with their ability to transmit these characters to hybrids. In Dendrobium, offsprings of reciprocal crosses show variations in characters like cane length and flower colour, flower size, flowering season and flower yield [18]. In Cymbidium, fragrance is the most important character sought after by breeders [19]. Herman [20] reported that the large flowered Cattleya hybrids are the results of breeding involving fifteen Cattleya species, two *Laelia* and *Brassavola digbyana*. Thomas [21] viewed the requirements for flower forms of commercial growers of Phalaenopsis like strong self -supporting erect inflorescences, long duration of blooms, compact plant size, wide temperature tolerance, disease resistance, firm substances and consistency of colours.

4. Conclusions and Recommendations

A good morphological study is required for conservation and utilization of endangered orchids. Native species can be effectively utilized for development of inter-generic, inter-specific or intra-specific natural hybrids of commercially orchid general like *Cattleya, Cymbidium, Dendrobium, Mokara, Oncidium, Paphiopedilum, Phalaenopsis a*nd *Vand*a and their compatible alliances which would be market driven having export value as well as tolerant to biotic and abiotic stresses. Investigations on morphological diversity could open up avenues for identification of new and elite germplasm for pot culture, cut flowers, dry flowers, herbal preparations and exhibits for market displays.

5. References

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