INTRODUCTION
India is considered as one of the Mega Biodiversity regions in the world with two major Biodiversity Hot-spots – The Eastern Himalayas and the Western Ghats. These Hot-spots with their lush green and diverse forest types are the real treasure-houses of multitudinal biotypes remarkably co-existing in diverse environmental conditions. One such precious treasure we inherit in our country in these treasure houses is perhaps the ORCHIDs – the loveliest of all the flowers in angiosperms and precious gift of nature.

John Lindly erected the family Orchidaceae in 1836 after the genus *Orchis* so named by Theophratus (372-285 B.C.) for a plant with a paired underground tuberoid which look like human testicle (Withner, 1959). This was retained and adopted by Linnaeus (1753) in his book *Species Plantarum*.

Orchids are considered to be highly evolved and specialized in the Plant Kingdom with adaptive excellence, displaying ingenuity in reproductive mechanisms and high degree of mimicry alluring and enticing the pollinators with attractive shape, colour, nectar, etc. In view of the long lasting flower qualities - beauty, texture and designs beholding the onlookers, orchids are today, considered as “gems” or “Blooming Gold” in Floriculture with multi-million dollar business world over. Besides, orchids are also known for their medicinal properties and have been used in traditional system of medicines in various parts of the world. There are more than 50 species in India which have been used in various traditional systems of medicines. Vanilla is one of the important commercial orchids used in aromatic industry (Hegde, 1984).

**Habitat distribution**

Orchids belonging to the family Orchidaceae are known for their diversity of habits and habitats. Today, orchids are regarded as the largest family of angiosperms representing a culmination of evolution among the monocotyledons
containing about 25,000 – 35,000 species belonging to 600-800 genera (Arditti, 1977) distributed all over the world, inhabiting every conceivable biotic zone of the earth. Maximum concentration is seen in tropical and sub-tropical regions.

In India, “Hot Spot” regions viz. (1) Eastern Himalayas and (2) Western Ghats are the richest orchid habitats in our country. However, some orchids occur even in other parts of our country with thin distribution. There are about 1200 species in 167 genera in our country. Out of the same, North- East India with eight states alone contributes around 839 species in 144 genera under the family Orchidaceae (Hegde, 1984, 1986, 1997, 2005, 2007; Katakai et al., 1984; Manilal and Sathish Kumar, 2004; Pradhan, 1976 and 1979). Abraham and Vatsala (1981) have recorded 250 species of 70 genera from South India. However, recent update (Bhat, 1999) has shown the number of species of orchids in South India as 320.

In the Western Ghats with six states, there are 283 species in 76 genera (Rao and Hegde, 2006; Rao and Sridhar, 2007). Break up of species distribution in each state is:

<table>
<thead>
<tr>
<th>State</th>
<th>Species</th>
<th>Genera</th>
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<tr>
<td>Gujarat</td>
<td>16</td>
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<td>Maharashtra</td>
<td>73</td>
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<td>Goa</td>
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<td>Karnataka</td>
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<td>Kerala</td>
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<td>Tamil Nadu</td>
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Besides North Eastern parts of country viz. Assam, Nagaland, Manipur, Arunachal Pradesh, Himachal Pradesh etc, Orchids are also distributed in the Western Himalayas with about 250 species, in Gangetic Plains with about 60 species and in the Central parts of India with about 40 species.

**Habitat - ecology**

Orchids are found in diverse climatic situations. They are found at the sea level and at the mountaintops, in the tropical rain forests and in the torrid deserts and in the arctic zone and in the equatorial part. They appear to have an innate ability to adjust, survive and reproduce in any of the environments. Therefore, except for true deserts and permanently frozen tundra, there is no land habit where some orchids do not grow (Sanford, 1974). Even under inhospitable environmental conditions, some of them continue to survive. For example, a species of *Brassavola* is found along the sea coast under frequent salt spray, while species of *Dendrobium* and *Bulbophyllum* are epiphytes of mangrove swamps (Sanford, 1974). A few of them such as *Oncidium cebollata* of Mexico thrive on dry rocky soils staying extremely baked by intense sun shine for several months of the year (Mac Dougal, 1959). *Habenaria repens* and *Disa emini* are known to survive in swamp bogs or on floating grass islands of Uganda. A limited number of them such as species of *Dendrobium* can withstand low temperature of high alpine regions of Himalayas while *Laetia speciosa* of Mexico can withstand freezing (Halbinger, 1941). Some, like *Orchis maculata* and a few of African species of *Eulophia* can survive and regenerate even after a forest fire (Sanford, 1974).

The most important factor for their healthy growth is high humidity in most part of the year not below 60 %. Most of the species do not like direct sun light and hence shady condition is required either on the ground or on the standing trees. However, some orchids like *Arundina graminifolia*, *Goodyera procera*, some *Vanda*, etc, occurs in the open areas indicating their liking for sun light. In
India, various forest types are a home for varieties of orchids giving rise to rich and amazing diversity in the family Orchidaceae. Hence, they are one of the largest flowering plant families - Orchidaceae, under Monocotyledons. It is significant to note that one in every 15 species of flowering plants is that of Orchids (8% of flowering plants; 40% of Monocotyledons), displaying high degree of compatibility between species and genera; thus having about one lakh man-made registered hybrids of commerce.

**Extent of Diversity**

Orchids are highly evolved group of plants with tremendous modification in their vegetative and flower structures besides their habits and habitats. So diverse is their habit! So bizarre is their flower structure! At times one finds them leafless, colourless and even stem-less; but, often with variously modified stem, leaf and flowers. They are found on ground, on rocks and on trees; but always attracting one’s attention with their curious shape and brilliant colour adding beauty to the land and landscape.

Based on the habit, orchids can be either

**Epiphytes** – growing perched on tree trunks with clinging and aerial roots having velamen tissue with an enormous capacity to absorb moisture from air

*eg. Aerides, Dendrobium, Vanda etc.*

They may be sympodial or monopodial.

**Lithophytes** – growing on moss covered rocks, like *Eria, Bulbophyllum* etc.

**Terrestrials** – leafy orchids growing on earth/humus soil *e.g. Calanthe, Geodorum, Habenaria*, etc.

Or

**Saprophytes** – leaf-less orchids growing on decaying organic matters, *e.g.* *Epipogium, Aphyllorchis* etc.
Based on the vegetative characters, orchids can either be

**Sympodials** - giving out side-branches/vegetative growths – stems or bulbs, in clusters or at a distance eg. *Coelogyne, Dendrobium*, etc,

or

**Monopodials**– having no side branches or with only single apical meristem, e.g. *Vanda*.

All orchids are associated with an endophytic symbiotic fungus, especially in their roots, whether they are terrestrial or epiphytic. The terrestrial forms include those inhabit the floor of the forests growing under dense shade, such as *Acanthophippium* and *Eulophia* which are evergreen with pseudo bulbs. Those that grow in the open grasslands and stay underground during dry season are species of *Habenaria, Peristylus* and *Ipsea* (Abraham and Vatsala, 1981). The most curious of the terrestrial are the saprophytic species like *Epipogium roseum, Epipactis purpurata* and others in which the entire vegetative body is an underground micorrhizic tuber or rhizome which puts forth an over ground inflorescence at the reproductive phase, when alone it is recognized in the field. An extreme case of this category is that of *Rhizanthella garneri* of Western Australia in which the inflorescence nearly remains underground, the bracts of it barely protruding out a few millimeters and therefore difficult even to recognize except for its sweet scent that too during warm weather and then faintly (George and Cooke, 1981).

Those orchids that grow as epiphytes show perhaps the greatest degree of diversity and specialization, assuming curious forms. Most of them have evolved water and food conserving structures, the pseudo bulbs of various shapes and sizes, enabling them to exist perched high on the branches of the trees receiving
direct or indirect sun light and capable of living in somewhat xerophytic environment, away from the ground. The roots of these plants are endowed with a special water absorbing tissue, the velamen. In extreme cases such as species of *Taeniophyllum*, *Polyrrhiza* and *Campylocentrum*, the stem is highly reduced, meant to produce the flowering scape, and leaves, if present, scale-like, while the roots alone carry on the functions of anchorage, absorption and photosynthesis.

In addition to marked specialization of the vegetative body, the flower of the orchids exhibits an unlimited diversity in size, shape and structure. The flowers are usually borne in inflorescences. They are deeply sunk on a short fleshy axis in species of *Bulbophyllum*. As a contrast, the inflorescence may be as long as four meters in *Renanthera lowii* (Rendle, 1953). The flower may be minute measuring across a millimeter or so in species of *Oberonia* and a little more in *Stelis stocksii*, *Pachyphyllum schultesii* and *Octomeria pygmea*. On the other hand, in others exemplified by certain hybrids of the genus *Cattleya*, it averages 30 centimeters across or more (Arditti, 1966). Some of the orchid flowers emit odours ranging from the pungent to an extremely agreeable and satisfying fragrance.

The most intriguing feature of the orchid flower is their striking resemblances to various forms of animals like bee, moth, butterfly, scorpion, spider, lizard, dove, etc., due to their brilliances in colour, remarkable range of sizes and manifold shapes.

The flower is of typical of monocotyledons. It is homochlamydous, trimerous, three tepals arranged in two whorls, zygomorphic and epigynous. The posterior tepal called labellum or lip shows high modification and its extra appendage where the nectar is stored called spur. The union of stamens, style and
stigma that forms a column called gynostegium or gynandrum is very interesting. The pollinia are connected to a small disc like structure called carpusculum through a stalk called caudicle or reticule. The ovary is tricarpellary, syncarpus, inferior ovary with parietal placentation. The stigma is trilobed where two lobes are fertile. One lobe is projected into a beak like structure called rostellum (Fig. 1). The resupination of the flower at anthesis, the infinite structural diversity displayed by the labellum and the intricate organization of the column associated with the production of a very large number of ovules after pollination such as noticed in the orchids have no parallels in any way of the angiospermous families. Further, the large output of minute spore-like seeds containing an externally undifferentiated embryo and no endosperm are special adaptive features peculiar to the orchidaceae.

The pollination mechanism in orchids is equally interested. The construction of the flower, its colour, the scent and the nectar always lure the pollinators. For example, Coryanthes, the bucket orchid, secretes so much nectar that insect slip into the pouch-like petal, which stores the fluid, must swim out to avoid drowning. In doing so, the insect is guided past the plant’s sexual structures, there by pollinating the flower. Another group of orchids, Ophrys, have flowers with one highly modified petal that mimics female insects. Male insects are fooled into copulating with the flower and, while doing so, pollinate the plant. The labellum is made to function as a landing place for the insect visitor after a twist of 180 degree at anthesis facilitating the visitor to work and effect cross-pollination. In fact the association between the species of orchid and its pollinator is so intimate that without that very species of insect there cannot be pollination and seed set at all.
Fig. 1. Structure of orchid flower (Ex. Aerides ringens)

1. Front view of flower
2. Lateral view of flower
3. Column with lip
4. Pollinia
Thus, Orchids display tremendous variation and specialization in both vegetative and floral characters. Yet, they derive similarities in their fundamental and diagnostic features such as

- Minute dust like seeds without food reserve and requiring mycorrhizal association for germination and development,

- Flower structure with trimerous condition, zygomorphic or bilateral in that when the flower is cut vertically in one plane only from the mid of the flower passing through the column, labellum or lip and pedicel ovary, one part is exactly the mirror image of the other,

- Resupination of pedicel-ovary at 180 degree turn,

- Fused sexual organs to form column,

- Pollinial and stigmatic structures,

- Being insect pollinated,

- Presence of velamen tissue in the aerial roots with enormous capacity to absorb moisture from the air, and

- Lastly and most importantly, modification of one of the petals to form labellum or lip facilitating the vector (insect) to effect pollination – a striking feature found in all the species of orchids.

Variations in the vegetative and floral characters are diagnostic in deciding the identity of a species and genera in the classification of various taxa in the family Orchidaceae.

Present status in their natural habitat

Today, orchids, our precious heritage, have become rare, vulnerable, endangered, threatened and on the verge of extinction due to man’s various activities. It is significant to note that out of 1200 species in India, there are about
314 endemic species found only in our country in specific habitat areas. In Northeast India, 187 species are endemic while as, in Western Ghats Region as many as 113 endemic species of orchids are found (Hegde, 1997). Further, it is interesting to note that there are as many as 215 species in India which are considered as endangered requiring immediate conservation measures \textit{in situ} or \textit{ex situ} in sanctuaries and Orchidarium. Thus, our precious heritage is dwindling in nature day by day with the multifarious developmental activities and indiscriminate collection for trade, giving no need for conservation. The blue and red Vandas that adored the forests of North East India in the past, and collected in head loads, by the earlier Botanists like J. D. Hooker in the 18\textsuperscript{th} century, are today hardly found in the wild and are listed under threatened category of Wildlife conservation Act. So also, the curious Paphiopedilums – the lady slipper orchids are like \textit{Paphiopedilum wardii} and \textit{P. druryii} are under threat and on the verge of extinction. According to Dr. Sanford, a renowned orchid ecologist: \textit{“It is the h of folly to destroy orchids and their habitats without knowing exactly what their role may be – to say nothing of the psychological scar that destruction of natural beauty leaves permanently upon man”}.

In view of the above, to augment our knowledge on diversity and distribution of orchids in different types of vegetation and host-orchid interaction, the present investigation has been undertaken.

\textbf{Phenology}

Plant phenology is concerned with the study of different phenophases like leafing, flowering and fruiting and their seasonal pattern in relation to the climate. These studies are important for better understanding of ecological adaptations, interaction of individual species and also from the point of view of germplasm conservation (Thomson, 1980). The general phenology of more than hundred horticultural important species of orchids has been published from Arunachal
Pradesh (Hegde, 1984). Number of workers (Allison and Dennis, 1989; Sabat and Ackerman, 1996) conducted phenological studies of orchid species mainly on flowering time, display size, floral phenology and costs of reproduction. As for the orchids of Chikmagalure district is concerned, there is no comprehensive studies on complete phenological data of orchids except flowering and fruiting seasons. Therefore, in the present study, details phenological investigations of some orchids have been undertaken.

**Seed Morphometry**

The morphological characters of seeds serve as a source of taxonomic markers. It also can be used to deduce phylogenetic relationship and to identify their involvement in hybrid genotypes (Arditti *et al.*, 1979).

Clifford and Smith (1969) first pointed out the taxonomic importance of the seed characteristics. Dressler (1981) has proposed several classificatory schemes for orchids based on conventional micro morphological characteristics. Seed morphology serves as a source of systematic character to circumscribe sub-generic groups or hypothetical relationships among species within a genus (Augustine *et al.*, 2001; Larry, 1995; Mathews and Levins, 1986; Ness, 1989). The morphological characteristics of the seeds not only serve as taxonomical markings but also serve in deducing phylogenetic relationships (Barthlott, 1976). This play a significant role in studying of hybrid genotype (Arditti *et al.*, 1979). The morphometric characters of seeds are ever challenging to the taxonomic and phyllogenetic issues which would be a great help both in academic as well as in applied ventures (Rani *et al.*, 1993; Augustine, *et al.*, 2001).

As the seeds of orchids are the smallest among the seeds produced by flowering plants, it is difficult to study their structural details with an ordinary optical microscope (Arditti *et al.*, 1980). The seeds of orchids vary in size, morphology, structures, colour and finer details. The seed size varies from 150 to
6000 μm and in majority of taxa; the range is from 300-800 μm (Molvray and Kores, 1995). The number of cells that forms the testa varies greatly among the different species, ranging from 2 to 20 cells (Molvray and Kores, 1995). The size of the cells may be uniform or some cells may be appreciably larger or smaller within areas such as medial region or chalazal end (Augustine, et al., 2001). The wall of the testa can be smoother or reticulated. If reticulation is present, the pattern may be diverse. Testa and embryos of different taxa of the orchidaceae may vary in their size, shape, colour and the ratios between their volumes (Arditti, et al., 1980 and Augustine, et al., 2001).

Barthlott and Zeigler (1981) reported 20 different seed types in orchids based on the overall seed shape, relative elongation of some cells in the seed coat, height and sculpturing of walls and features of adhesive zones, between adjacent cells including the presence of intercellular gaps and beading.

Orchid seeds are smallest among the seeds produced by flowering plants and vary considerably in size, morphology, structure, colour and fine details. Seeds can be vary in shape from filiform to fusiform, clavate to ellipsoidal and prominently winged (Augustine, et al., 2001). Thousands of seeds produced in each capsule are essentially without stored food as no endosperm is formed. Seeds comprises an undifferentiated small and oval embryo enclosed within the transparent integument or often fusiform seed coat/testa (Arditti et al., 1979).

In India, very few reports are available so for on orchid seed morphometry (Vij et al., 1992, 1994; Krishna Swamy et al., 2004a&b).

The present study, therefore, delays with the morphological characters of seeds of selected nine species of orchids found in Chikmagalure district.
**Ex-situ Performance**

The wild orchids have interesting biology, deceitful mechanism for pollination (Mimicry), slow growth and a highly ornate value. They require all attention in conservation in their wild niches and also for replication in an Orchidarium. *Ex-situ* method of conservation in an Orchidarium is the most ideal, followed by tissue culture techniques. In this way, sapling can be made available to the public so as to reduce the pressure on wild population of orchids. The epiphytic orchids shows excellent performance in pots and also when tied to tree having rough textured bark (Geetha, 2000). The shade of the trees, intermittent sun light and cool and sub-humid condition made available have resulted in excellent performance.

For successful cultivation of orchids, it is necessary to provide them with conditions as identical as possible with the environment under which they generally grow in the nature. As structure of the plants, growth pattern and nutritional requirement vary considerably from species to species, orchids require appropriate techniques of cultivation to achieve healthy growth. Potting of orchids is paramount important in successful orchid cultivation. Both plastic as well as mud pots are used for growing orchids and size of pots is depending on size of plants. Repotting is necessary when the plants have filled the pot and there is hardly any more space to grow. Repotting is done immediately after flowering season and when the plant starts putting forth new leaves and pseudobulbs (Rao and Srivastava, 1996).

For growing the orchids in pots or in beds, they are not put in ordinary soil mixes as is the case with other plant groups. So as to enable orchid roots to have plenty of air around them at all times, special orchid mixes are made which provide (i) support to the plant (ii) allow water and nutrients to the plant (iii) provide enough air for the roots to breath. For this purpose, various materials
are placed in the pots for making special orchid mixes viz. wood bark, charcoal, coconut coirs and tree fern roots. After planting, the pots are either hanged or placed in shaded places (Rao and Srivastava, 1996).

Under natural conditions, the terrestrial orchids any way get all the necessary inorganic nutrients from the soil and organic nutrients from the decaying/decomposing vegetable and animal debris. However, when under cultivation all these can be supplied. Watering is depends upon several factors: climatic condition, types of media used, type and size of the pot used. Over watering is always a hazard. For most of the orchids, water should be supplied only when the medium has gone almost completely dry. The pests which attack the orchids are chiefly ants, aphids, snails, slugs, rats and mice. Proper management and regular supervision of orchid plants can minimize the extent of damage (Rao and Srivastava, 1996).

In this manner, in the present work, the *Ex-situ* performance of some orchids available in Chikmagalure district is also documented.

**Previous orchid diversity work**

The critical perusal of the earlier literature shows that the botanical exploration of Orchids starts right from the time of White (1840-1853) who collected some orchids in Karnataka. Hooker (1872-1897), Cooke (1901-1908) and Gamble (1915-1936) have also reported orchids of Karnataka in their works. However, the regional studies of orchid diversity were not taken up in Karnataka until 1966. In the book of orchids of Bombay, Santapau and Kapadia (1966) have included orchids from North Canara district. Saldanha and Nicolson (1976) have described 95 species of orchids belonging to 41 genera including 4 new species in their Flora of Hassan district. Rao and Razi (1981), similarly, have included some orchid taxa of Mysore district in their work on flora of Mysore district. Singh (1981) in his work on flora of the districts of Eastern Karnataka has recorded 15

The present comprehensive work of diversity, distribution and host interactions of orchids was undertaken for a thorough exploration of the area and it has been carried out intensively for a period of 5 years.