2.0. REVIEW OF LITERATURE

India is recognized as one among the 14 mega diversity centers identified in the world having rich biodiversity of vast flora and fauna coupled with different topographical, ecological, climatic zones with about 18,664 taxa of Angiosperms including 5725 endemics (Nayar, 1996). India exhibits a vast diversity of forest communities along with varied biodiversity due to its varied climatic and topographic conditions and the current forest resources cover only 19.27% of the total area of the land (Khoshoo, 1991). The Western Ghats is reported as one among the important topographical feature of Peninsular India, and also the second largest endemic centre of India with 1550 endemics out of the 5000 species of vascular plants estimated (Nayar, 1997).

Forest plays a significant role in maintaining life on earth, precise renewable natural resources and contributing substantially to the wealth of the nation. Forest vegetation is composed of a diversity of plants or units of vegetation formed and arranged in accordance with definite biological laws and it is not an aggregation of trees together by chance (Toumey and Korstian, 1947). The forest is the greatest storehouse of Biodiversity, capable of providing many useful products. It also maintains climate, soil, hydrological regime, biodiversity, the global carbon balance and overall security of human community (Puri, 1960).

Nair (2007) reported that the continuous growth of human population, pressures for diversion of forest land for urbanization, agriculture, industrialization, illicit cutting, and unregulated harvesting of NWFPs and forest degradation have considerably exploited the growth of forest and its biodiversity. In recent years, increasing proportions of tropical forest have been modified into more open secondary forest or savannah or have been completely destroyed through activities such as agriculture or mining. This extensive deforestation and habitat conversion for commercial purpose are recognized as the biggest factor in the present biological diversity crisis. The models of habitat loss suggest that, their process may produce an extinction debt, a pool of species likely to go extinct unless the habitat is repaired or restored. Several plantation programs have been practiced and successfully managed in many tropical countries.
**2.1. Sacred groves: the last refugia of endemic biota**

Sacred groves are one of the finest examples of traditional in situ conservation practices in India, established to protect biodiversity much prior to the modern concept of wildlife reserves. These are patches of natural near-climax vegetation, managed as a part of the local cultural tradition. Sacred groves are found in a wide range of ecological situations, from coast to the Ghats (Gadgil et al., 1976). Nayar (1996) considered Devavanams or Kavu as some of the last refugia for our endemic flora and fauna. It is also a sacred place in which plants and animals are worshiped along with gods and goddess. The general structure of sacred groves of Kerala is extremely complex in structure with species richness and diversity. Occasionally, an aggressive species may find an opportunity for rapid expansion and species like *Vateria indica* and *Hopea ponga* invade the disturbed sacred groves.

Sacred groves are belonging to the traditional practice of protecting, patches of vegetation, religious grounds subtended by cultural practices. They have been identified from all over the world and in all shades of cultures. In India, the groves have been reported from the forest ranges in the hills, arid regions like the deserts and agricultural lands (Ramakrishnan et al., 1998). Whereas, the larger groves are considered as mini-biosphere reserves, the smaller ones have also biological value as they harbour some old and magnificent specimens of trees and climbers (Gadgil and Vartak, 1975).

The biodiversity potential of the sacred forest was found to be very high when compared to well-protected evergreen vegetation formations of South India. The estimated area of groves in Kerala is about to be 90 sq. km. Ecological investigation of the sacred groves of Kerala has been done earlier by Induchoodan (1992), Menon and Sasidharan (1994), Rajendraprasad (1995) and Rajendraprasad et al. (1998). Induchoodan (1998) worked on the phytosociological and ecological aspects of sacred groves of Kerala and carried out the detailed ecological investigations of Iringole Kavu, one of the largest sacred groves existing in Kerala. Menon and Sasidharan (1994) evaluated the optimum productivity of the sacred grove systems.

**2.2. The genus *Hopea***

The family Dipterocarpaceae was derived from its type genus *Dipterocarpus*, which include about 17 genera with more than 500 species (Maury-Lechon et al.,
1998) in the world. About, 10 genera and 99 species are exclusively found in South Asia (Fao, 1985). Within the Indian forest boundary, the family is diversified by 31 species with 16 endemics. Dipterocarpaceae is the major component of the evergreen forests of the Western Ghats and species *viz.*, *Hopea cannarensis*, *H. ponga*, *H. parviflora*, *Vatica chinensis*, *Vateria indica* and *Dipterocarpus indicus* were reported as dominant.

Dipterocarpaceae is one of the major timber yielding plant family in the forests of Southeast Asia, which forms a high proportion of the emergent and main canopy strata of the forest (Manokaran, 1995). The members of the family Dipterocarpaceae, besides playing a vital role as potential timber species that form an important means of economy in the timber market (Appanah, 1998; Poore, 1989). They also act as a source for other non-timber products for the livelihood of the forest dwellers (Panayotou and Ashton, 1992). The species of Dipterocarpaceae often locally referred as Gurjan, which is extensively utilized for the extraction of resins. From the oleoresins of *Dipterocarpus alatus* and *D. grandiflorus*, Gurjan oil is produced, which is used as medicine to treat various skin ailments and ulcers. The resins also have industrial application as varnish and anti-corrosive coatings. The hard solid resin, commonly called as rock dammar derived from *Hopea* species is used for making boats and handicrafts (Shiva and Jantan, 1998).

The members of Dipterocarpaceae has two-winged fruits which play a dominant role in the ecology and economics of Asian forests in a way that no comparable family plays in other rain forest regions. The members of the trees also have excellent timber qualities and they are marketed internationally as luan plywood and as sawn timber under names such as Philippines red mahogany. Saha *et al.* (1992) reported that the trees of Dipterocarps are being continuously exploited for timber, firewood, construction and other purposes. The bark of the tree is also a good tanning material and astringent with the slow speed of diffusion (Muralikrishna *et al.*, 1994).

2.3. The genus *Syzygium*

Myrtaceae is taxonomically and economically an important family. Most of the taxa of this family from south India have not been investigated properly (Vijayakumar and Subramanian, 1985). *Syzygium* is one among the genera of the family reported with wide distribution with commercial value. The genus *Syzygium* has been reported with a diversity of species and mainly distributed in the tropical
regions of Africa and Asian continents. The genus *Syzygium* comprises more than 1200 species, mainly distributed in the old world tropics from Africa to the west pacific with a major concentration in Malesia (Parnell *et al*., 2007). A recent taxonomic compilation revealed that 55 taxa are recorded from India (Govaerts *et al*., 2008) and the Western Ghats stands the highest concentration of the genus in India with 50 taxa (Govaerts *et al*., 2008; Sheeba *et al*., 2003; Murugan and Manickam, 2004). In addition to the *Syzygium* flora of India, few new species have been added (Govaerts *et al*., 2008; Shareef *et al*., 2012; Shareef *et al*., 2013; Krishnaraj and Shareef, 2013). Recent taxonomic enumeration of the genus revealed, about 43 taxa were reported in Kerala state alone including four exotics (Nayar *et al*., 2006, 2012; Shareef *et al*., 2012).

This genus is of commercial important with timber yielding (*S. aqueum* and *S. bracteatum*) and fruit-yielding (*S. cumini*) plants and the medicinally valuable (*S. aromaticum*). The fruits of many species of this genus are edible and some are medicinally important (Radha *et al*., 2002). *Syzygium* is one of the economically important tree species which includes timber trees and cultivated ornamentals such as *Callistemon, Chamelaucium* (Simpson, 2010). The species of *Syzygium* also includes many economically important food plants, agricultural crops and ornamentals. The species like clove (*Syzygium aromaticum*), all spice (*Pimenta dioica*) and bay rum (*Pimenta racemosa*) and the fruits of *Psidium* (guava), *Eugenia, Syzygium, Plinia* and *Luma* are the best examples of economically important species (Reynertson *et al*., 2008). Since being commercially important group of plant, many species in the wild were over-exploited and about 23 species of Western Ghats were included in the Red list by IUCN.

2.4. Population Studies

Several authors have confirmed that the population dynamics of forest trees must be understood for the conservation needs of tropical forest ecosystems (Hubbell and Foster 1992; Condit 1995; Sheil *et al*., 2000). Several studies have been examined on the long-term effects of forest structure and composition (Cannon *et al*., 1994; Plumptre, 1996; Chapman and Chapman, 1997; Struhsaker, 1997). Tropical forest is the important source to understand the biological diversity and also to assess the conservation values and needs of such sub-optimal areas. The studies have shown tropical forest fragmentation to cause ecological changes to the plant community and
composition by increasing large tree mortality and loss of live biomass (Lovejoy et al., 1986; Ferreira and Laurance, 1997; Laurance et al., 1998; Laurance et al., 2000). Sukumar et al. (1992) had worked on regeneration pattern in many Indian forests, including the forests of Western Ghats. Successful conservation of forest ecosystem will ultimately depend on the understanding of forest ecosystem dynamics. The sustainable management of natural tropical forests is not possible without a better holistic understanding of forests actually work ecologically and interact with humans (Hubbell and Foster, 1983). Population studies of some threatened plants have been undertaken to analyse the depletion process of their populations by a wide-scale of ecological disturbance and habitat fragmentation. Grinnell (1917) and Hutchinson (1957) described that the role of ecological niche in the community and explained that it is the quantity that governs the limits of geographical distribution of species.

2.5. Ecological Studies

Ecological studies deal with the distribution of individual species, the association between species, patterns of distribution and various indices of diversity. These parameters help to understand the structure of the forests (Longman and Jenik, 1987). The forest structure, including species composition, stand height, stem density, age and volume are the focus of forest inventories worldwide. The analysis of forests helps the forester to develop resource management plans to ensure effective and sustainable use of the forests (Lin and Paivinen, 1999). Niche differentiation is one of the potential mechanisms that contribute to the maintenance of high species diversity in tropical forests (Thomas, 1996). Trees determine the structure and organization of forest ecosystems, which provide the habitat for the species of plants, animals, and microorganisms used directly and indirectly by humans.

Khan et al. (1986) studied the species composition, regeneration status and survival of seedlings and sprouts of tree species in tropical and subtropical forests of Meghalaya. The subtropical humid semi-evergreen forests of Upper Shillong and Mawphlang were dominated by Manglietia insignis, Pinus kesiya, Quercus dealbata, Q. griffithii, Rhododendron arbores, Schima khasiana and Prunus undulata whereas, the tropical deciduous forest lying at a lower altitude (Burnihat) is dominated by Artocarpus chaplas, Duabanga sonneratoides and Shorea robusta. The species composition of the tree community at the periphery was different from that of the forest stand at the centre.
The study of floristic composition and phytosociological attributes are useful for comparing one community with the other tree species. Kanade et al. (2008) used two indices Species Importance Value (SIV), also known as Importance value index and FIV (Family important value index) for vegetation analysis. By using the above indices, they have reported on the vegetation composition and woody species diversity of Chandoli National Park, Northern Western Ghats, India.

Sonali (2001) compared the vegetation structure and composition of Tectona grandis (teak) plantations and with the neighboring dry deciduous secondary forests in Satpura hills of Central India. Species richness is the simplest way to describe community and regional diversity (Magurran, 1988). Species richness is a natural measure of biodiversity (May, 1988). Quantifying species richness is important, as it would provide a method to compare among sites (Cornell, 1999). Species richness is often regarded as the fundamental unit of biodiversity and is the most frequently applied measure in community ecology (Gaston, 1996; Martinez, 1996; Williams and Martinez, 2000).

The vegetation dynamics of forest systems are controlled by several factors such as an available pool of species, the physical characteristics of the land, soil fertility, climate and disturbance regime characteristics (Major, 1951). Habitat fragmentation and the resulting decline in the local abundance of plant species can affect biological interactions (Kaisa et al., 2001). The regeneration of forests is very much important for the continued existence of the forest and for its inhabitants. Factors limiting regeneration are varied with forest types (Brown et al., 2003).

Elouard et al. (1997) have investigated the structure and dynamics of moist evergreen forests of Kadamakal reserve in Kodagu district. Other studies on the structure of forests include those from the deciduous forests of Mudumalai in Nilgiris (Sukumar et al., 1992), the semi-evergreen forests of Eastern Ghats (Kadavul and Parthasarathy, 1999), the wet evergreen forests of Western Ghats (Bonadie and Bacon, 1999) and lowland Dipterocarp forests of south-east Asia. Pascal (1989) conducted a detailed study on the ecology, structure, floristic composition and succession of wet evergreen forests of the Western Ghats of India.

2.6. Phenological Studies

A phenological study of the trees reveals the phenomenon of flushing, flowering, fruiting, seed setting, seed maturation, and seedling formation.
Phenological events are mainly controlled by a combination of abiotic and biotic factors that determine their occurrence or inhibition (Van Schaik et al., 1993). Leaf fall usually occurs during the end of the dry season and flushing in the wet season. Leaf fall and flushing can also be continuous for certain groups of species or at sites where moisture stress is never marked, resulting in the trees never being completely leafless (Singh and Kushwaha, 2005).

Trees of the upper canopy have a tendency to be more deciduous and seasonal than the lower storeys (Bradley et al., 2011). Distinct seasonal flushing of leaves are small but more significant in the seasonality of leaf abscission and leaf flushing is shown in the canopy of the central Amazonian forests (Haugaasen and Peres, 2005). With regards to the reproductive phenology, flowering peaks have been observed at the end of the dry season (Stevenson et al., 2008), but canopy trees tend to flower during drier periods (Van Schaik et al., 1993). Bhat (1992) studied the phenology of tropical trees of Karnataka and reported that increasing day length and rise in temperature during the pre-monsoon dry period are responsible for leaf flush and maturation, while shorter day length and decrease in temperature have induced leaf drop during the post-monsoon period.

The timing of fruiting often coincides with the start of the rainy season (Morellato et al., 2000), but patterns of fruit production are highly variable. Usually, the fruiting season starts at the end of the wet season and dry season or to be extended throughout the entire dry season. In recent years, increased interest in plant phenology has been seen because, it is an important mechanism behind the ecosystem response to future global climate change (Morisette et al., 2009; Korner and Basler, 2010).

Phenology is the study of periodically occurring phenomena in relation to climate and seasonal cycle. It is an important trait of plant species since, it determines the duration and timing of growing season as well as the period of reproduction (Lechowicz, 1984; Hanninen, 1990; Reich et al., 1992; Kikuzawa, 1998). Leith (1970) and Leith and Radford (1971) have validated the concepts and significance of phenological studies. The seasonal periodicity and sequential patterning of the phenological activity differ from one species to another. Several factors govern the phenology of the flowering plants and determine the reproductive success of the plant species. Among these factors, the time, frequency, and duration of the flowering period are obviously of greater importance.
The phenological study deals with vegetative and reproductive phases corresponding to seasonal changes of a particular area and determines the degree of reproductive synchrony with other plant species (Rathcke, 1988). Synchrony among species might be advantageous to the presence of one species may facilitate the frequency of the visit of pollinators and therefore enhance fruit/seed set in another species (Rathcke and Lacey, 1985). The phenological study is important for plant management and afforestation, floral biology, estimation of reproductivity and regeneration (Mulik and Bhosale, 1989). Flowering phenology differs from species to species in accordance with the ecosystems where they associates, thereby suggesting that specific patterns of flowering phenology can be characteristic of specific ecosystem types (Pojar, 1974; Heinrich, 1976).

2.7. Floral Biology

Studies on floral biology are largely concerned with the function of flowers to promote pollination and mating. The first stage of the flowering process is the floral induction or evocation and the conversion of vegetative meristem to a reproductive meristem. Floral initiation is the first morphological change, which can be observed in the bud stage. In many cases, floral bud initiation may occur in weeks or months prior to the macroscopic appearance of buds. Information about floral biology is available only for a limited number of tree genera such as Populus, Tsuga, Magnolia, Eucalyptus, Artocarpus, Picea, Prunus, Acacia, Cassia, Avocado, Litchi, Bauhinia, Macadamia, Myristica, Pyrus, Mangifera and Betula, (Fechner, 1972). Reproductive biology, dispersal, and population structure of Pittosporum undulatum have been studied by Mullett (1996). An adequate understanding of reproductive strategies of plant requires detailed studies of their floral biology, reproductive phenology, pollination and breeding systems.

The reproductive biology and population history of the species and reduced pollinator service may have several negative impacts on the plant population, including reproductive failure (Jennersten, 1988) or decreased effective population size through reduced gene flow and increased selfing (Bawa, 1990; Menges, 1991; Aizen and Feinsinger, 1994). The altered reproductive patterns of plant community may cause loss of genetic diversity and reduced fitness of progeny due to inbreeding depression (Menges, 1991; Barrett and Kohn, 1991). However, self-fertile individuals may be at a selective advantage in some particular habitats if out-crossing is
disfavoured, because plant density is low or if pollinators are scarce and cross-pollination is inadequate (Jain, 1976; Lloyd, 1980; Schemske and Lande, 1985; Wyatt, 1988; Barrett, 1989). In addition, in highly self-fertile plants, lethal genes that are expressed early in development may already have been purged (Latta and Ritland, 1994; Husband and Schemske, 1996).

### 2.8. Pollination Biology

Pollination, a basic force for gene recombination in flowering plants which plays a key role in plant breeding programmes. In angiosperms, the pollination mechanism is typically developed in three phases; the release of pollen from the anther, transfer of pollen from the anther to stigma and finally successful placement of the pollen on the receptive stigma surface, followed by germination of pollen grains which begins the next phase of fertilization. Each of the three phases shows great diversity (Kukade and Tidke, 2013). Pollination is also ecologically important as it is an essential component of reproduction through seeds for the overwhelming majority of plant species (Knight et al., 2005).

Plant reproductive success often depends on pollination biology, including the frequency and identity of floral visitors, capability for autonomous self-pollination, or the magnitude of pollen limitation (Banks, 1980; Mehrhoff, 1983; Burd, 1994; Gaston and Kunin, 1997; Knight et al., 2005; Lavergne et al., 2005; Rymer et al., 2005; Aizen and Harder, 2007). A number of specialized pollination systems have been described in global hotspots, where exceptional concentrations of endemic species are found such as the Cape Floral Region of South Africa (Goldblatt and Manning, 2000; Pauw, 2006).

Pollination is a fundamental aspect of plant reproduction and pollination by animals is largely considered as a co-adaptive process in which plants evolve traits to attract certain pollinators whereby pollinators then evolve traits to exploit better floral resources of particular plants, with the occurring natural selection mediated by that pollinator (Faegri and Van Der Pijl, 1980; Heinrich, 1983). In cacao, even pollination is carried out by small insects such as midges (Entwistle, 1972; Young, 1994) and some ants are suggested to play important roles in the regulation of insect and pests (Entwistle, 1972; See and Khoo, 1996).
2.9. Fruit and Seed Biology

Seeds play an important role in the persistence of the species populations, although not all of them are equally important in different groups of plants. They have been modulated by prevailing environmental conditions in each community, in interaction with the distinctive life history traits of the plant populations. The four roles of plants are reproduction, dispersal within the same community, expansion to new territories or other habitats, and survival of the germplasm through seasons or environmental conditions that are unfavorable for growth (Fenner, 1985). Natural seed germination usually occurs just after abscission and within the first week (Barnard, 1950). Many studies have been aimed at determining storage conditions to maintain seed viability and delay germination (Maury-Lechon et al., 1993). Ecological longevity of seeds is the mean duration of dormancy in natural conditions; the mean interval elapsing between seed maturation and dissemination, and seed germination or death in the soil, whereas potential longevity is the maximum duration of germination capacity of dormant seeds in optimal storage conditions (Bewley et al., 1985; Fenner, 1985).

Seeds have evolved mechanisms to recognize environmental conditions which enable them to confine their germination in particular periods and locations to allow for a greater probability of seedling establishment and survival knowledge on the ecology of germination. Seedling growth is vital not only for understanding the community processes of plant recruitment and succession but also for developing strategies for the conservation of biodiversity and restoration of tropical forests.

Tree regeneration by seed is a critical and frequently studied component of forest succession (Augspurger, 1984; Schupp, 1990; Gill and Marks, 1991). The success of tree regeneration in a forest is determined by successful completion of several events in the lifecycle of trees such as seed production and its dispersal to safe sites, germination and seedling emergence, establishment and onward growth (Barik et al., 1996). These events serve as a bottleneck that restricts regeneration of a particular species (Jones et al., 1994). Seeds are the basic raw materials for silvicultural research on native species and for forest management, reforestation and breeding programs (Ramos and Zanon, 1984). Several studies carried out at different temperature regimes showed the thermal dependence of seed germination and have
revealed temperature limits for the optimum in many species (Labouriau and Osbom, 1984; Jacobsen and Bach, 1998).

Seed germination tests are often inadequate and do not express their true viability (Mirov, 1936). Viability is the potential of the seed to produce a seedling which is the basic requirement in forest dynamics. Although the best condition for maintaining viability is obtained through the control of both temperature and humidity, the seeds can be protected at atmospheric temperature for a reasonable period, provided the relative humidity is reduced to 20 percent or less (Hopkins et al., 1947).

The effect of desiccation on germination and vigour of the seed of Hopea parviflora and H. ponga was carried out by Dayal and Kaveriappa (2000). Muralikrishnan and Chandrashekar (1997) investigated the seed viability of H. ponga. Ashton (1990) has carried out the effect of dewinging, seed maturity, light and soil environment on the germination and survival of Shorea trafiliflora. According to Roberts (1973), seeds of certain species which suffer from damage on desiccation below a critical level cannot be stored for long periods. It is widely believed that seeds of many species of Dipterocarpaceae are generally short-lived and incapable of overcoming desiccation (Chan, 1980; Sasaki, 1980; Nautiyal and Purohit, 1985; Tompsett, 1987; Saha et al., 1992). Wing loading, as a cause for limiting seed dispersal, has been well reported in different wind-dispersed species (Augsperger and Hogan, 1983; Ganeshiah and Shaanker, 1988, 1991), but there is only one ecological report on the occurrence of clumped formations and invasion of Hopea ponga into newly exploited areas (Pascal, 1989).

Dispersal of seeds ensures that the seeds are dispersed far away from the parent trees where predation rates may be high (Janzen, 1970) and may allow the seeds to end on sites favorable for germination (Harper et al., 1965). Seed dispersal by animals influences the distribution and abundance of plant species and the dynamics and survival of their populations (Schupp and Fuentes, 1995). Benitez-Malvido and Martinez (2003) studied the germination and seed damage in tropical forest plants of Mexico caused by two species of Iguanas. Their study showed that the iguanas were selective in their choice of seeds and may play a significant role in the reproductive strategies of some plants.

Some species of ants, mammals, birds and reptiles can play an important function in removing the seeds (Baskin and Baskin, 2001) from host plants. Seed
dynamics, dispersion, predation and germination are ecological processes, which alter
the maintenance of populations and colonization in space and time (Alexander et al.,
2001). Seed pools may maintain the population growth rate in the long term and then
prolong the time until extinction (McCue and Holstford, 1998).

2.10. Insect and Pest Association

There are several major and minor pests have been identified which infect
leaves, flowers, fruits, seeds, and barks, but the perusal of literature revealed that there
is no consolidated account available on the insects associated fruits/ seeds in India.
The fruit of Syzygium paniculatum is frequently attacked by insects and propagation
requires pre-treatment to remove damaged seed prior to sowing. Insect feed internal
tissues of leaves, fruits, inflorescences, stem and roots of plants. For instance, leaf
mining is a type of internal leaf feeding techniques by insects and it has divided into 6
categories viz. linear leaf mine, serpentine leaf mine, blotch mine, digitate mine,
needle mine or any combination of the above-mentioned types. But this is not strictly
bounded to each type because early immature stages of some species are serpentine
miners and late stages are blotch miners. Finally, this mine results into grayish-white
around the leaves (Butani, 1979). Grubs of Platypriya andrewesi mine the leaves and
eating out to small cavities or pockets. Likewise, several insects cause internal injury
to seeds, fruits and cones through boring and internal feeding.

Stem borer also causes severe damage to plants through boring and feeding on
the internal wood. Several Lepidopterous insects such as Scalmatica and Trachytyla
(Tinidae) as well as some species of Meteoristis (Gelechidae) bore inside aerial roots.
Paropta (Cossidae) bore the branches of Ficus carica (Watt et al., 1997; Avidoz and
Harpez, 1969). Batocera spp. attack Ficus, jackfruit, mango, mulberry, papaya and
apple. The immature stages of these make a tunnel into the trunks or main stem
moving upwards, feeding on the internal tissues (Butani, 1979).

Wood boring insects cause damage to the phloem, wood or to the growing
shoot. Except for few Lepidopteran species, most of the available records are of
Coleoptera such as Buprestidae, Bostrichiade, Scolytidae and Cerambycidae. Sinoxylon
is the cosmopolitan genera of Bostrichidae family, generally found in the
forests as in timber depots, sawmills and factories. Approximately, 11 species from
the genera Sinoxylon were found damaging the forest plants in India and neighboring
countries. The beetle bores through the bark forming a gallery which passes through
the inner sapwood and finally toward its circumference. Grubs form wide galleries by running upwards and downwards through sapwood which is of several inches. The beetle also bore inside green shoots and twigs for the purpose of feeding or forming axial tunnels. Several species of *Batocera* are reported as common wood destroyers (Fukuda, 1992; Beeson, 1941).

Generally, *Sinoxylon crassum* and *Sinoxylon anale* were recorded as pests to infest *Dalbergia sissoo* in Punjab. They also infest *Terminalia tomentosa, Acacia catechu, Anogeissus, Pterocarpus, Albizia, Prosopis* in the forests of Assam, Sind and parts of Western Maharashtra. Weevils of the family Attelabidae have wide distribution with varied diet breadth. Leaf twisting weevil, *Apoderus tranquebaricus* has been reported from Tamil Nadu and Uttar Pradesh which infests *Mangifera indica, Terminalia catappa, T. tomentosa, T. arjuna* and *Syzygium cumini* (Ayyar, 1940; Lefroy, 1909; Premchand, 1995; Jha and Sen- Sarma, 1994; Butani, 1979). The lasiocampid defoliater *Metanastria hyrta* scattered throughout the Sri Lanka, Tamil Nadu, Madhya Pradesh, Orissa, Eastern Himalaya, Assam (Hampson, 1892; Fletcher, 1914).