Chapter 1:

INTRODUCTION
Forests are some of the most important natural landscapes of the world. Population growth, rapid pace of development and unmindful over exploitation of the natural resources has exerted an immense pressure on the forests and also caused biological impoverishment, leading to disastrous changes in natural ecosystems. The scarcity of raw material and ecological imbalance forced the forest-based industries and forest departments to go in for reforestation drives, especially the monoculture plantations, to meet the need of the day and overcome the imbalances.

In forestry sense, a monoculture forest is dominated by a single species of tree. This is very common feature in forests that grow back after natural disturbances such as fire, floods, landslides or insect attacks. Natural monocultures are common in northern coniferous forests such as the temperate rainforests and boreal forests of North America, Europe and Russia. These forests may be technically monocultures as the word is used in forestry. But they are fully functioning ecosystems containing thousands of species of mosses, ferns, fungi, herbs, insects, reptiles, amphibians and mammals.

While, manmade monoculture plantation forests are farms with monoculture of trees planted in rows, many a times exotic and hybridised. These forests are often established on lands that have already been cleared of its original forest or on grasslands/fallow. Plantations can be of two types namely managed and unmanaged systems. In managed system, management practices such as watering, manuring, weeding, etc are carried out at regular intervals. In unmanaged plantations, management practices are resorted to only during initial 2-3 years and later the trees are allowed to grow on their own with least human indulgence.

The clear understanding of the biology of plant and animal life that manifests the quality of the particular ecosystem is one of the prerequisites for evolving a management programme for any tropical forest biotope (Balasubramanian & Bole, 1993). The general understanding is that the large-scale anthropogenic disturbances contribute to the biological impoverishment of the ecosystems (Laurance and Bierregaard, 1997). Conversely quite a few reports have also indicated that large scale
disturbances such as forest fragmentation, deforestation or monoculture plantation have contributed to the high biological diversity found in many tropical ecosystems (Gentry, 1986; Johns, 1986; Salo et al. 1986 and Bush 1994). Irrespective of the relative merits of these opposing views, ecological sustainability can be assessed by the status of ecosystem components and biodiversity is one of them. Biodiversity is frequently interpreted as an indicator of the ecosystem health (Magurran, 1988). There are some studies that have used birds as indicators to assess the factors influencing changes in biodiversity (Williamson, 1970; Johsingh & Joshua, 1994; Jayson and Mathew, 2002). Birds depend on plants; plants in turn are dependent on soil fertility, which is affected by litter decomposition and nutrient recycling.

Physiognomy or phenology of the vegetation in the form of leaf fall, sprouting of new leaves, flowering and fruiting schedules are important for evolving management programmes for any forest as it refers to quality of forest ecosystem and its capacity to support fauna (Chhangani, 2004).

Seasonal climatic changes bring about variations in phenological pattern of plants. Birds and insects dependent on plants may also vary accordingly (Balasubramanian & Bole, 1993).

The undergrowth or understorey is one of the integrated components of any natural forest. There are diverse opinions as to the existence of healthy undergrowth in monocultures in terms of the composition as well as the magnitude. Carrere & Lohmann, (1996) opined that plantations lack undergrowth. Contrarily, Lima (1993) reported extensive undergrowth in plantation though it was abandoned or unmanaged one.

Litterfall is an essential component of energy and biogeochemical cycles in any ecosystem, the forests being no exceptions. The integrity of any land ecosystem is maintained by transfer of matter and energy through litterfall. A substantial portion of the accumulated nutrients in the plant biomass is returned to the soil through litterfall (Vidyasagar et al. 2002). Litter production is of great importance for the fertility of forest soils. Litter enters the decomposition subsystem and is broken down by decomposing organisms. The faster the rate of the decomposition, the more is the nutrient availability and consequently, the greater is the forest productivity. Litter of
different species differs with respect to their physical texture, chemical composition and rate of decomposition (Pandit et. al. 1993). Hence nutrient content derived from diverse plant species may vary and hence the variations in single species based plantations of exotics/hybrid varieties.

Soil is the loose, natural material that forms the topmost layer of the earth. Water and mineral nutrients that sustain the life processes of plants come from soil. The soil properties are considerably influenced by the interaction of vegetation. Nutrients added to soil through litterfall create zone of enrichment under trees. Vegetation adds organic matter to the soil, decomposition of these release minerals, which maintain fertility of the soil. Favorable soil condition is necessary to the thriving of forest population.

Fisher (2001) has attributed poor bird diversity to low nutrient status of the soil that limited productivity. Different topsoil canopy cover types may affect downward movement of water in the soil in different ways. (Meghan and Salterland, 1962; Nazaror, 1969), hence different plantations may have their different effects on soil nutrients. The heterogeneous distribution in soil properties has been attributed to greater erosion of soil nutrients by the different canopies and the uptake and sequestration of nutrients in accumulated litter or soil organic mater (Jha et. al., 2000). According to some workers plants in monoculture plantation remove particular nutrients from the soil, hence depleting the soil of specific nutrients over a time span.

While on the contrary, Singh et.al.(2001) have found that available content of macronutrients such as nitrogen, phosphorus and potassium in the soil under pure stand was found to be higher than soil of the intercropped stands.

Insects, one of the dominant groups of animals exist in nearly all habitats and in most areas of the world. They form an important component of almost all types of ecosystems. As much as they serve as pollinators of plants they also serve the dietary requirements of other animals including the large contingents of insectivorous birds. The views differ as to the relation between insect abundance and richness of plant species. According to Risch et. al. (1983) the loss of plant diversity causes higher insect abundance and lower species diversity. Conversely Haddad et. al.(2001)
opined that higher plant species diversity increased insect diversity as well as abundance.

Birds are considered as good biological indicators due to their ecological specialization, high sensitivity to disturbances and also due to their conspicuous behaviour, rapid and reliable identification, ease of sampling, stable taxonomy and diversity (Scotz, et. al. 1996). Bird communities have been frequently used for conservation assessment and monitoring (Daniels et. al. 1990). The pioneering studies of Mac Arthur et. al. (1962) established the relationship between bird diversity and vegetation structure. According to Jayson and Mathew (2002) bird population density correlated positively with habitat heterogeneity in tropical forest. The distribution of birds in an area is mainly controlled by plant community structure and plant cover at different height levels and availability of the preferred plant species (Mc Clure, 1972). Habitat quality and heterogeneity has also been reported to affect the abundance and diversity of breeding birds in forests (Berg, 1997).

Past studies from tropical rainforest regions (Daniels et. al. 1990; Raman, et. al. 1998, Kunte et. al. 1999) have shown that agroforestry plantations, generally harbour fewer bird species and have altered community composition as compared to primary forests. However, Weins (1983) showed negative relationship between habitat heterogeneity and bird availability.

The spatial and temporal distribution of resources is, to a great extent, determined by seasonal patterns. Thus seasonality is shown to play an important role directly and also with food resource dynamics as intervening variables (Karr, 1980). But according to Karr (1976) seasonal variation in avian community structure decreases with increasing vegetation complexity. The feeding guild is a useful tool for analyzing community structure. Breaking down assemblages of species into feeding guilds (Root, 1967) or functional groups (Cummins, 1973) is one of the main techniques animal ecologists have developed to try to grasp community structure and dynamics. A few environmentalists in India and abroad like Vandana Shiva (1993) and Lohmann (2000) are extremely critical about monoculture plantations. They
consider some plantations as a threat to ecological stability describing them as the deserts lacking food, shelter and opportunities for reproduction, hence almost devoid of local fauna. According to Pramod et. al. (1997) monocultures support species of widespread occurrence drawn from different habitat types. Bell (1979) and Fisher (2001) in their studies on teak and eucalyptus respectively found that bird diversity was poor in plantations. While Gray (1974) opined that the eucalyptus plantations have enhanced the local avifauna by providing stable vegetation. Some workers are of the view that plantations extend the area of forest canopy available for biodiversity conservation (Thiollay, 1995) and deserve protection (Williams et. al, 1995; Perfecto et. al. 1997; Moguel and Toledo, 1999).

Even though controversies surround the monocultures it may be too early to give up the practice completely in view of the ever-increasing industrial demand and need to bring the barren lands under green cover. Plantation practices are felt to be critically important to fulfill national need of forest products and to achieve 33% of forest cover to maintain ecological balance. Hence it is necessary that we develop complete information base on the comparative effectiveness of various monoculture system with definite criteria and indicator parameters such that we may be able to choose suitable systems if an option is available.

In Goa, monoculture of quite a few species of trees such as teak, acacia, eucalyptus, cashew, rubber and oil palm are being practiced, of which cashew, teak and acacia are most common and extensively cultivated varieties.

The cashew, *Anacardium occidentale*, a native of Brazil is one of the important cash crops of Goa. Among the plantation crops it occupies the largest area of about 56%. Nuts and apples are the two important products of the plant that earns considerable foreign exchange to the state.

The Teak, *Tectona grandis*, a deciduous tree and an important timber species of the world is indigenous to India. It is valuable due to its matchless properties such as lightweight, strength, attractiveness and resistance to termites, fungus and water. Teak wood is a preferred timber in furniture industry. It covers about 9 million ha of area in India and about 9507 ha in
Goa. Teak trees were plentiful in the basins of west coast rivers of India. During British occupation the main aim of the forest working plan was extraction of this timber. The ever rising demand for teak in housing needs and furniture production, and in turn its depletion in nature initiated teak monoculture (Chandran, 1997)

*Acacia auriculiformis*, native to Australia, has been introduced in India in 1946 by virtue of its fast growth and easy establishment (Amanulla, et. al. 2004). It is known to thrive well on hilly eroded rocky and degraded soils. Acacia is mostly used in raising the green cover in barren areas. It also meets the local demands of fuel, furniture and paper pulp.

In this background the present work was planned to study a comprehensive and comparative profile of the ecology of three monoculture plantations viz. cashew, teak, and acacia, the most common in Goa in comparison with natural forest as a control system for reference. The ecology of avifauna from multifarious angles was kept in the centre stage of study to reflect upon the intricate interdependences to arrive at logical conclusions. The study was to encompass plant phenology cycles, nature and magnitude of undergrowth, quantum of litterfall, rate of litter decomposition, release patterns of litter nutrients, levels of soil nutrients, abundance of insect population, avifaunal dynamics along with habitat utilization. The study was carried out for two complete years from March 2001 to February 2003. The study was intended to throw light on the efficacy and relative merits of different monoculture systems with the bird life at the center stage. The study was also aimed to update the database on the birds of forests in general and monoculture plantations in particular within the state.