CHAPTER-1
INTRODUCTION

The Earth is populated by an incredible number of different living creatures. The term that is used to define this “crowd” of organisms that populate every corner of the Planet, and that have adapted even to the most extreme environments, is biodiversity or biological diversity. Biological diversity – or biodiversity – is the term given to the variety of life on Earth. It is the variety within and between all species of plants, animals and micro-organisms and the ecosystems within which they live and interact – CBD 1992.

The estimated number of living species ranges between 10 and 15 million, but just two million have been named and the answer to the basic question on the number of species inhabiting on the planet earth is very far from being complete. For the greatest majority of the described species, however, we know just the name, and how the adults look like. Our ignorance is enormous both in terms of what are the species and of what they do.

Each and every species has a particular function in an ecosystem. Some species can capture energy in various forms: for example they can produce organic material, contribute to the energy cycle of the ecosystem, control soil erosion, act as agents to protect from pollution of the atmosphere and regulate the climate. Ecosystems contribute to improving the production of resources, as for example, soil fertility, pollination of plants and decomposition of vegetables and animals. They also carry out real services such as: purifying the air and water, moderating the climate and controlling rain or drought, and other environmental disasters. Obviously all these important functions are fundamental for human survival. The more varied the ecosystem is, consequently the greater the biodiversity, the greater its resistance to environmental stress will be. The loss of even only one species often can provoke a decrease in the capacity of the system to remain preserved in case of degradation. Biodiversity is like a large tank, from which humans can draw food, pharmaceutical products and even cosmetics.
The exploration of biodiversity was a primordial urge for our species, in most cases stemming from simple curiosity, but in 1992 the Rio de Janeiro Convention on Biological Diversity agreed that we are leading species to extinction and habitats to destruction, and that some measures had to be taken. Man, in this vision, is part of Nature and cannot survive without it: if we destroy Nature, we destroy the premises for our very existence. After the Rio Convention, the exploration of biodiversity became more imperative than ever, since we cannot defend or manage something if we do not know it. It is clear, however, that we cannot wait to know all species and everything about each one of them before we can do something to preserve biodiversity. Action must be rapid because man-induced degradation of nature is rapid. Our ignorance about Nature is still enormous, but this is just what science is all about: its aim is to reduce ignorance.

Charles Darwin published *The Origin of Species* in year 1859 and since then, our way of seeing the world changed radically.

Zhang (2011) reported that the kingdom Animalia represented with 1,552,319 species have been described in 40 phyla. Among these, the phylum Arthropoda alone represents 1,242,040 species, or about 80% of the total. The most successful group, the Insecta (1,020,007 species), accounts for about 66% of all animals, or 82% of arthropods. The most successful insect order, Coleoptera (387,100 species), represents about 38% of all species in insect orders. Another major group in Arthropoda is the class Arachnida (112,201 species), which is dominated by the mites and ticks (Acari 54,617 species) and spiders (43,579 species). Other highly diverse arthropod groups include Crustacea (66,914 species), Trilobitomorpha (19,606 species) and Myriapoda (11,885 species). The phylum Mollusca (117,358 species) leads, by a significant margin, among other invertebrate phyla in diversity. Significant groups include: Platyhelminthes (29,285 species), Nematoda (24,783 species), Echinodermata (20,509 species), Annelida (17,210 species) and Bryozoa (10,941 species). The phylum Craniata, including the vertebrates, represents 64,832 species (for Recent taxa, except for amphibians). Blackburn & Wake (2011; this volume) presented a new consensus classification for amphibians, with an estimate of 7,694 described species.
Eschmeyer & Fong (2011) summarised data from the “Catalog of Fish” (31,958 species). Wilson & Reeder (2011, this volume) updated their list of 5,750 species of Mammalia.

In many terrestrial ecosystems, arthropods comprise the greatest faunal species diversity, biomass, and number of individuals (Wilson 1985; Gaston 1991; Ponder and Lunney 1999). Understanding the ecological importance of arthropods means gathering facts about the largest group of animal division on the face of the Earth. Arthropods have been in existence since prehistoric period, yet some of them disappeared in these modern times. Arthropods are biologically distinct groups of animals, whose physical characteristics and diversity enabled them to support a wide range of ecological communities through millions of years of existence. Arthropods are said to comprise about three-fourths of the animals existing on Earth and are found both on land and water. Arthropods, world-wide are represented as- insects, crustaceans, spiders (arachnids), millipedes (diplopods) and centipedes (chilopods). This information alone is sufficient to understand as to how broad and diverse their domain could be, and hence the immeasurable ecological importance of arthropods.

It has been suggested that terrestrial arthropod taxa may be very useful in ecosystem monitoring because they are diverse and abundant, they have rapid population growth rates and short generation times, and they are sensitive to minor changes in microclimate and microhabitat conditions (Mattoni et al. 2000; Andersen and Majer 2004; Schowalter 2006). Arthropods with an amazing 1 million named species (and estimates of total species numbers rising to 30 million) are the most numerous of living creatures encountered. The Arthropods represent over 80% of the Animal Kingdom and probably at least half of all living organisms.

Arthropods get their name from their jointed (arthros) legs (podos). Arthropods range in size from microscopic to several centimetres in length. They include insects, such as springtails, beetles, ants, termites; crustaceans such as sowbugs; arachnids such as spiders and mites; myriapods, such as centipedes and
millipedes; and scorpions as encountered in the present study. Nearly every soil is home to many different arthropod species. Other groups of arthropods include Diptera, Thysanura, Thysanoptera and Orthoptera.

Arthropods are amazingly diverse in form and function. They play an important role in many ecosystem processes, such as litter decomposition and nutrient cycling, anthropogenic influences that substantially alter arthropod community composition or abundance could have long-term effects on ecosystem processes and services. In addition, arthropods are a dominant component of biodiversity on local to global scales. Arthropod communities are sensitive to changes in vegetational composition, structure and quality. Changes in soil nutrient availability may indirectly affect arthropod communities through changes in the plant community and/or environmental conditions. Natural ecosystems are losing biodiversity at an increasing rate due to anthropogenic impacts such as habitat fragmentation. Such perturbations and subsequent decline in biodiversity may affect the ecosystem functioning thus maintaining ecosystem integrity presenting an important challenge for resource managers.

The fossil record of insects goes back to the earliest record of terrestrial life, with Collembola and lower insects recorded from the lower Devonian, almost 400 million years ago, and possibly, there are even earlier traces from the Silurian. Insects have been prominent members of the fossil record ever since, with most prominent major groups having been preserved from late Paleozoic or early Mesozoic formations (200-250 million years ago) (Chandra 2011).

There is ample proof that insects were systematically investigated many centuries before Aristotle. Hymns of Atharva Veda on the control of insects attacking crops reflect the variety of pests. Manudharma Sastra (1000 BC) identifies bees and biting insects such as mosquitoes and ants, while the treatise of Charaka (1200 BC) on bees and Shushmita’s (100-200 AD) work on stings and his classification of ants (piplika) and flies (mahashikala) are of interest. Amarasimha coined the term shashpada for the Hexapoda nearly 1000 years ago (Ananthakrishnan, 2000).
In the olden days, farming activities went on at a pace that was natural to man and ecosystem hence, there seemed to be a balance of existence between human beings, plants, and animals. However, as world populations grew, the human need for food increased and also at a faster rate. Technological developments and advancements provided solutions that could increase food production in the agricultural sector. Land became widely used for commercial farming and grew increasingly important as a source of crops and vegetation. However, the animals ecological system was being disrupted and the habitats of most insects, arachnids, centipedes, and millipedes were being destroyed. Hedgerows were brought down to expand the crop fields to far reaching realms. These land arthropods’ natural instincts were to migrate and seek food elsewhere, where it could be found abundantly. It wasn't long before they came back and discovered their old habitats but in a new form. The area became a vast region of field crops, orchards, and vegetations where they could resume their ecological communities and perform their natural functions. But it is pertinent to understand why biodiversity has been neglected in Agriculture. Many biologists have previously taken the view that agricultural systems are of low biodiversity which has tended to limit the level of scientific interest that they hold. However, research and reviews are showing that biodiversity in some agricultural systems is higher than previously thought. As a result, there is a move towards looking at how conservation concerns can be accommodated within agricultural work and also how agricultural theory and practice can benefit from lessons learnt in natural systems (Vandermeer & Perfecto, 1997). The reasons why biodiversity in agricultural systems is of interest come from two main arguments: 1) globally, ‘managed’ land covers 95% of the land surface, compared to 3.2% remaining as natural habitats (Pimentel et al. 1992): the level of biodiversity within these artificial landscapes is, therefore, important from a land cover viewpoint; and 2) where agricultural practices are not monocultures, dependent on external support from mechanization and chemicals, the support base for agriculture is essentially the existing natural system, so the health of this system is important for the sustainability of agriculture.
Managed ecosystems, especially agro-ecosystem, dominate tropical landscapes, and remnant primary forest is often only patchily embedded in the agricultural landscapes (Power, 1996; Schelhas and Greenberg, 1996; Laurance and Bierregaard, 1997). Natural ecosystems make up only about 5% of the terrestrial environment in contrast to approximately 50% of land that is under agricultural production and 20% is commercial forestry (Western and Pearl, 1989). Given this pattern, there is increasing recognition that most species interact with agricultural system, even if their primary habitat is in natural areas. Moreover, a large proportion of the total species of a region are likely to be found in agro-ecosystem (Pimental et al. 1992). The management of these agricultural systems can dramatically affect overall levels of biodiversity, as well as the success of particular species. Efforts to preserve biodiversity have focused on these natural ecosystems and the potential value of agro-ecosystem for conservation has been often ignored.

It is important to assess the current status of arthropod biodiversity with reference to entomofauna in agro-ecosystems. Reports suggest that nowhere are the consequences of biodiversity reduction more evident, than in the realm of agricultural pest management. Some investigations carried out in different parts of the world in this direction and briefly narrated herewith:

The relative pest status of predominant species in the arthropod community is affected by the overall community structure and dynamics. Sampling of arthropods fauna on collards by Root(1973) recorded 93 species of herbivores, 78 species of predators and 103 species of parasitoids among the 60,492 arthropods in the bag samples and vaccum net collections, over a period of three years. The collard fauna is thus regarded a relatively distinct system, interacting with other components in the surrounding community to only a limited extent as it is less species rich compared to 1,584 resident insect species in a meadow as reported by Evas and Murdoch (1968). Mayse and Price (1978) carried out the seasonal studies on the development of arthropod community on soybean by direct observation and recording of the number of individual
arthropod species at four sites in each of the three east central Illinois soybean field at weekly intervals from plant emergence until harvest.

Modern entomological systematic work was initiated with the establishment of the East India Company, through the abiding interest of amateur entomologists in the armed, civil, forest and medical services. The first entomologist who made an extensive study of Indian insects was J. C. Fabricius (1745-1808), and the publication of Carl Linnaeus’ (1758) Systema Naturae (10th edition) provided the earliest record of Indian insects, with descriptions of 28 species. Westwood’s (1847) ‘Cabinet of Oriental Insects’ provides a selection of some of the rarer and more beautiful species of insects native to India (Ananthakrishnan, 2000). Since much of the pioneering work was carried out by British amateur entomologists, who explored various parts of the Indian subcontinent, particularly the hilly areas of the eastern and western Himalaya, the Western Ghats and popular places, much of their material was taken to their country for identification. These efforts led to the publication of several volumes on the Fauna of British India. With the establishment of the ZSI at Kolkata in 1916, regular surveys were carried out in all parts of India including unexplored and inaccessible areas. The Forest Research Institute (FRI), Dehradun, presently under the Indian Council of Forest Research and Education (ICFRE), and the Indian Agricultural Research Institute (IARI), under the Indian Council of Agricultural Research (ICAR), have contributed to our knowledge of economically important insects of forests and agriculture, respectively (Chandra 2011).

In recent years considerable research has been undertaken to understand the growth of insect communities associated with crop plants in different countries especially under different cropping systems. Despite the fact that several studies have been reported from India and elsewhere concentrating on individual pest species like Helicoverpa armigera, information on the entire arthropod community in different agro-ecosystems is lacking. Singh and Singh (1978) at Water Technology Centre, IARI New Delhi, recorded 17 insect pest species with
8 major and 9 minor pests. Naranda Reddy, et al. 1998 reported 37 insects and 1 mite species. Most studies of insects on crops have focused only on phytophagous insects (Dhaliwal and Arora, 2001).

Keeping these factors in view the present study is carried out to understand arthropod diversity with reference to entomofauna in agricultural ecosystem of semi-arid region in Kalaburagi, Karnataka. By the experience of the past century the Indian arid and semi-arid regions experience drought situations once in alternate three years.

Kalaburagi district lies in semi-arid region and is one of the most pronounced drought prone districts of Karnataka State. The total cultivated area in Kalaburagi district is 12.55 lakh hectares, out of which kharif area is 6.66 lakh hectares and Rabi area is 5.89 lakh hectares. The district normally has three cropping seasons namely (Report of Government of Karnataka, Contingency plan for Drought Relief Work, 2003) kharif, Rabi, and summer. The (major) principal crops grown in the district are tur, bajra, ground nut, sunflower and rabi jowar and chickpea. Sugarcane is also grown to an extent of 7000 hectares. Red gram is the single monocrop, occupying the largest area in the state and in the country. Hence, Kalaburagi is popularly known as “RED GRAM BOWL OF SOUTH INDIA”. The only major irrigation project in the district is Upper Krishna Project, which covers 3 talukas, namely, Shahapur, Shorapur and Jewargi, providing irrigation to 1.96 lakh hectares of land. At present, out of a total cultivated area, only 18 per cent is under irrigation. The remaining cultivated area totally depends on rainfall only. The present work is carried out in agriculture fields of Hadgil Haruthi village which is totally rain-dependant area for cultivation which is located 10km away from southwest of Kalaburagi city.

Literature survey reveals lacunae in studies on arthropod and insect diversity of semi-arid regions and north Karnataka especially of Kalaburagi. There is less information from few works of Yelshetty (1999), Benen (2000) and Srilaxmi (2010) which is restricted to biodiversity of pestiferous insects. The present investigation was undertaken to study the diversity patterns of arthropods
with specific reference to entomofauna of agro-ecosystem in agriculture fields of Hadgil Haruthi village, Kalaburagi, so far there is no systematic report on abundance and diversity of Arthropods.

The present study emphasizes on variations in species richness, abundance and diversity of arthropods as observed in different agro-ecosystems and their vegetations, entomo-faunal abundance and richness of agriculture fields with reference to higher arthropods. The present study intends to provide a starting point in understanding the distribution pattern of assemblages and diversity of different arthropod taxa with specific reference to insects diversity.

The specific objectives of the study were:
1. To study the pattern of assemblages of Arthropods diversity in agro-ecosystem;
2. To study the abundance, richness, evenness and diversity of insects;
3. To study seasonal variation of diversity of arthropods with specific reference to insects in different agro-ecosystem.