CHAPTER 1
INTRODUCTION
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The variety of biological life on earth depends on both the variety of earth’s environment and the processes of evolution, dispersal, and extinction as they have acted through geological time. A recent estimated number of species worldwide is 13 million, though the number of animal species named, and thus validated, is about 1.7 million in total. Of these, some 9, 50,000 are insects. To put the figure into better perspective, there is a total of about 45,000 species of vertebrata (mammals, birds, reptiles, amphibians and fishes) and 2,50,000 are plants (Groombridge, 1992). Thus 80% of known animal species in the world are insects. Recent survey work in the tropical rain forest (South East Asia and South America) has disclosed many hitherto unknown species of insects that are as yet unnamed. This has led to some discussion in the scientific press as to just how many undescribed insect species remain to be found in the tropical rain forest of the world. Some proponents suggest that there could be a grand total of up to 4-5 million different species of insect inhabiting the world; some believe the figure could be even higher and it would seem that some of these estimates are rather imaginary, but an overall figure of up to 2 million species that is, double existing figure is not unreasonable to assume. Thus out of a total of 22, 00,000 species of animals in the world, some 90% are insects.

There are several hundred thousand kinds of insects which have been documented, and there are about the same number which is yet to be identified. As abundantly successful organisms, insects play key roles in all fresh water and terrestrial ecosystems. Except the Oceans, insects have the unique ability to pre-empt every available space, to take possession of every square yard of our planet, and to thrive and multiply in these places. Certain areas on the globe show exceptional concentration of species with high levels of endemism and unusually rapid rate of depletion called the “Hot Spots” and are found in certain Coral reefs, Mediterranean ecosystems, and tropical evergreen forests (Myers, 1988). Thus, Insects are found virtually in all habitats on earth except the marine environments. Insects are however, highly sensitive to environmental
instability. Modern entomological study commenced in the early 18th century when a combination of rediscovery of the classical literature, the spread of rationalism, and availability of ground-glass optics made the study of insects acceptable for the thoughtful privately wealthy. Although people working with insects hold professional positions, many aspects of the study of insects remain suitable for the hobbyist. Charles Darwin studied insect evolution and communicates with amateur entomologists throughout the world. Much of our present understanding on insect diversity around the globe derives from studies of non professionals. Many such studies come from collectors of attractive insects such as butterflies and beetles, but others with observing close-up activities of insects like Henri Fabre. We can discover much of scientific interest at little expense concerning the natural history of even well described insects. The variation in size, structure, and color of insects is amazing, whether depicted in drawing, photography, or film. A popular misperception is that professional entomologists emphasize killing or at least controlling insects, but in fact entomology includes many positive aspects of insects because their benefits to the environment outweigh their harm.

However, many insects have been described as new species more than once, due to failure to identify variation or through lack of previous studies, so, the actual number of described species is uncertain. The described insect species are scattered unevenly amongst the higher taxonomic groupings called orders. So far, 34 insect orders have been classified. Five orders stand out for their high species richness which include the beetles (Coleoptera), wasps, ants, and bees (Hymenoptera), flies (Diptera), butterflies and moths (Lepidoptera), and the true bugs (Hemiptera).

The Coleoptera have about 400,000 described species and comprises 40% of the total identified insects, Hymenoptera have nearly 250,000 described species, with the Diptera and Lepidoptera having between 125,000 and 150,000 species, and Hemiptera approaching 95,000. Of the remaining orders of living insects, none exceed the 20,000 described species of the Orthoptera (grasshoppers,
locusts, crickets, and katydids). Most of the insect orders have from few hundreds to some thousands of described species. The order Dermaptera (earwigs) have less than 2000 described species and the cosmopolitan cockroaches belong to an order (Blattodea) with only 4000 species. Even so, there are only twofold as many species described in birds as in the “small” order Blattodea.

India has a rich biodiversity and thus included among the 17 Mega–diversity countries of the world. Our country encompassed a width spectrum of habitats from tropical rainforests to alpine vegetation and from temperate forest to coastal wetlands and from cold Himalayas in the north to the hot Thar Desert in western part of India. According to Zoological Survey of India (1988), about 67,000 species of insects have been described from India and of these, 16000 insect species have been recorded from Indian forests.

The present day family Coccinellidae first appeared in Systema Naturae (Linnaeus, 1758) under genus Coccinella, with 36 Species. Classification of Korschefsky (1931) recognized three subfamilies viz., Epilachninae, Coccinellinae, and Lithophilinae under family Coccinellidae. But Sasaji (1968, 1971) revised the classification of Coccinellidae, proposing six subfamilies: Sticholotidinae, Coccidulinae, Scymninae, Chilocorinae, Coccinellinae and Epilachninae. This classification system was widely accepted and remains the primary reference for the family.

The Coccinellidae is a well known, abundant, and diverse family and nearly 6000 species are known worldwide (Vandenberg, 2002). Sasaji (1967a) reported that a total of 4800 species of coccinellids belonging to 490 genera have been described from different parts of the world. There is a considerable variation in reported coccinellid diversity between countries. Hodek and Honek (1996) reported 78 species consisting of 37 genera from Poland, 71 species from eastern Germany, and 67 species belonging to 33 genera from the eastern Ukraine. Gordon (1985) reported 475 species from North America with
subsequent additions (Vandenberg, 2002), the species have increased to a total of 481. McNamara (1990) recorded 162 coccinellid species from Canada and Alaska. Hodek and Honek (1996) reported 78 species consisting of 37 genera from Poland, 71 species from eastern Germany, and 67 species belonging to 33 genera from the eastern Ukraine. Gary (2004) reported 61 coccinellid species in which 4 species belonged to subfamily Coccidulinae; 27 species belonged to Scymninae; 7 species of Chilocorinae; 20 species of Coccinellinae and 3 species of Epilachninae. Omkar and Pervez (2004) recorded 261 species of predaceous coccinellids (Coleoptera: Coccinellidae) belonging to 57 genera from India. The Netherlands have 86 native coccinellid species while Great Britain has only 46 coccinellid species (Majerus et al. 2006). Audisio and Canepari (2009) reported that there are approximately 253 species and subspecies of ladybeetles from Europe. Majka and McCorquodale (2010) reported records of 51 coccinellid species from Atlantic Maritime Ecozone. Hesler and Kieckhefer (2008) updated list of 79 species of Coccinellidae from South Dakota from the existing 66 species. About 400 species of coccinellids have been reported from different parts of our country (Poorani, 2002b).

The study of population dynamics is an old discipline with roots that antedate the modern science of ecology. The relative stability of most natural populations, as well as the occasional wild fluctuations, has interested researchers and natural historians since the beginning of historical time. Population dynamics is a subject with history of provoking heated debate among ecologists. Throughout the 20th century, interest in the debate decreased and the exact focus had shifted towards the evolution of terminology. Early authors were interested in whether biotic factors or climatic factors controlled population. Nicholson (1933) insisted on the important point that in order for populations to be regulated, they must be subjected to factors that act in density dependent manner. The density dependent factors impose more severely upon the population when its density is high. In many animal populations, it is known that resources determine the level of population (Begon et al., 1986). Predators
also plays important role as a regulatory or disturbing factors of a prey population. The determination of population dynamics of predators should be investigated from the aspect of predator prey interaction. Predaceous coccinellids are common insect predators and have received much attention mainly from biological control aspect. In experimental field study of coccinellids, the cumulative effect of many individuals can produce strong population level aggregation of the ladybird beetles in areas with high aphid density, although the responses of individual beetles to aphid density (Ives et al., 1993). Some field studies have explored the consequences of seasonal heterogeneity of habitats for insect population dynamics throughout the whole lifetime. It is always difficult to interpret the precise roles of environmental seasonality on population dynamics using conventional techniques.

Ladybird beetles vary greatly in size from minute (one mm in length) to large (10-15 mm long). The shape is usually short oval or round or distinctly elongated. The dorsal surface (dorsum) is convex, glabrous or with sparse to dense pubescence. Many species have bright red, orange or yellow elytra with distinctive spots, stripes and other markings or patterns. The body of a coccinellid beetle is divided into three basic parts: the head, thorax and abdomen. In general, males are smaller in size than females.

Agriculture provides livelihood to the majority of Indian population. Scarcity of food is not uncommon, after the independence India faced a serious crisis of food shortage but during the late 1960’s the green revolution was launched which made our country self sufficient in food production. It was made possible by the introduction of high yielding varieties of various crops and by intensive cultivation practices with the use of fertilizers, pesticides and other bio control agents. Approximately one third of the global food production is estimated to be destroyed annually by over 20,000 species of insects, diseases, weeds, mites, nematodes, rodents and other field and storage pests (McEvan, 1978). The highest lost occur in developing countries of Asia and Africa reducing about
42% of the total agricultural production annually. Report of Union Ministry of Agriculture, India, pointed out that the pests related damages result in an estimated loss of Rs. 50,000 crore annually in agricultural production (Sathe and Bhosale, 2001). Thousands of insects and mites have been attacking agriculture, horticulture and forest crops and livestock. Most of them are considered insect pests because their activities result in an economic loss.

The role of insects in the ecosystem is well documented. Many insects are extremely valuable to man and human society but could not exist in its present form. Apart from pollinating activities, some insects play a major role in the transfer of energy stored in plants and making it available to other organisms in the ecosystem while others play a very important role in controlling those insects and plants that cause injuries to economically important plants and animals. The ladybird beetles are predaceous in their larval and adult stages. They feed on variety of small pestiferous insects especially aphids, jassids, mealy bugs, whiteflies, soft bodied scale insects, psyllids, plant hoppers, thrips, eggs and larvae of other insects. They are, therefore, widely used in biological pest control programme. Sathe and Bhosale (2001) described that more than 4500 species of coccinellids are predaceous in nature. There are many predatory coccinellids which are well exercising natural control in different ecosystems including agriculture fields and orchards. The members of subfamily Coccinellininae of the tribe Coccinellini have been reported to be excellent predators particularly on the homopteran pests like aphids, whiteflies and plant hoppers. These voracious feeders need to be exploited more for their role in successful biological control mainly insect pest management. Many insects of this group, though well known in several agro ecosystems and forest ecosystem, have not been successfully exploited for biological control. The main reasons for this may be lack of knowledge on the detailed life cycle, difficulties in mass rearing, and augmentation in different crops so as to effectively manipulate them. Biology of many important coccinellid beetles has been studied under different climatic and ecological conditions. The techniques of mass
Productions of coccinellid beetles have been developed for control of serious and potential pests. Biological potentials of large number of predatory coccinellid have been carried out. Coccinellids, like other group of insects, are subjected to the threats of other animals. Their main predators are birds and reptiles, but they are also the prey of frog, wasps, spiders, ants, and dragonflies. However, habitat destruction is the worst threat, especially in the tropics where most insect diversity lives. Invasive alien organisms, global climate change, and use of genetically modified crops which greatly reduces the population of prey e.g. Aphids, mealy bug, scale insects etc. are other threats causing synergistic effects on this beneficial group. The use of pesticides, insecticides and other chemicals also hampers the coccinellid populations. Smith and Krischik (2000) conducted a study on the effects of biorational pesticides on coccinellid beetles and reported that Sevin (biorational pesticide) caused 100% mortality for all species in all replicate bioassays, except one by 8 hours and in all replicates by 72 hours. M-Pede was the only biorational pesticide to affect survival of all four species. The survival of Coleomegilla maculata was reduced by soap in all three replicates by 8 hours. M-Pede reduced survival in one of three replicates for Harmonia axyridis and Cryptolaemus montrouzieri, and two of three replicates for Hippodamia convergens. BotaniGard had no effect on H. convergens or H. axyridis, but dramatically decreased survival of C. Montrouzieri in all three replicates by 72 hours. BotaniGard reduced C. maculata survival after 8 hours. Azatin affected survival of one species, C. maculata, in only one replicate. Sun spray oil had no effect on any of the species. Puritch et al. (1982) found that a commercial insecticidal soap at a concentration of 0.5%, caused 94% mortality for larval and adult life stages of Trialeurodes vaporariorum and more that 82% mortality for pupae. The present investigation is aimed at understanding the systematic and population dynamics of coccinellid beetles, feeding potential and their role in controlling insect pests. It is hoped that the information recorded as a result of this present study would contribute to the understanding of structural and functional aspects of this important insects.
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