1. INTRODUCTION

1.1. Preamble

Agricultural ornithology is defined as the science of birds in relation to agriculture. It may be taken as ecology and management of birds in agro-ecosystems. The dual role of birds in agriculture is well known (Ali, 1971). Agriculture provides a concentrated and highly predictable source of food to birds. This food in general is of three kinds: (i) grain, seeds and fruits, (ii) green vegetation of the crop plants and grasses, and (iii) insects, other arthropods, rodents, etc., found in the soil, crops and other plants (O’Connor and Shrubb, 1986). Agricultural landscapes in India, especially in the intensively cultivated areas like Punjab, have a number of fish, dairy, poultry and honeybee farms interspersed among crop fields. These farms along with a variety of native and exotic agro-forestry trees provide additional food to birds in the form of fish, bees, animal feeds, tree-fruits, seeds, nectar, etc. Birds of agricultural areas, therefore, include granivores, frugivores, insectivores, carnivores, nectarivores and omnivores (Dhindsa and Saini, 1994).

A few granivorous and omnivorous bird species have been able to harvest energy and reproduce very efficiently in agricultural habitats
leading to their large population build-ups. Insectivorous and carnivorous bird species are considered to be useful to agriculture since they keep a very potent check on populations of insect and rodent pests of crops.

A large proportion of the normal food of birds consists of insects that are in the highest degree injurious to man and his concerns. Birds of many species not only take heavy toll of the marauding locust hordes all along their flight lines but also scratch up and devour their eggs in the quantities as well as the different stages of the young locust after hatching. An idea of the extent birds do in destroying insect pests may be had from the fact many young birds in the few days of their lives consume more than their own weight of food in 24 hours. A German ornithologist has estimated that a single pair of Tits with their progeny destroys annually at least 120 million insect eggs or 150,000 caterpillars and pupae. Therefore, where birds have not been unwisely interfered with they constitute one of the most effective natural checks upon insect numbers (Ali, 2002).

Agricultural ornithology aims at obtaining scientific information on birds in relation to agriculture and using that information for their management. Avian management includes both conservation of useful species and control of pest birds. The assessment of environmental impact of various control techniques is also an essential component of
management. We need to study in detail the food and feeding behaviour, reproduction, roosting, population dynamics and damage / useful potential of all important species. Management questions can be answered only if we have sound knowledge on these ecological aspects. Jayson and Mathew (2000) made a study on the diversity and species abundance and distribution of birds in the tropical forest of Silent Valley, Kerala. Today we have a good deal of information on various aspects of agricultural ornithology. Although this information is far from sufficient, it has enabled us start looking into various questions of bird management with confidence. Further, studies of Daniel et al., (1990) also explain the role of birds in man-made ecosystems.

1.2. Community Structure and Population Ecology

Bird community in agricultural lands is characterized by over dominance of only a few granivorous and omnivorous species while the rest of species are represented in very small numbers, some of which are rare. Toor et al., (1986) described community structure of birds at a grain store in Punjab. Among 66 species recorded at the store, House Sparrow *Passer domesticus* was the most abundant species having 77% dominance in the community. Dhindsa et al., (1988) studied bird community richness of 68 species. Ten of these species were granivorous, 12 omnivorous, 38 insectivorous and 8 others. The first four species in
order of abundance (2 omnivorous and 2 granivorous) represented 47% of total birds of all 68 species. In contrast, 38 insectivorous species represented only 30% of total birds. In Britain also farmland bird community consists of a few very abundant and widespread core species and about 20 less abundant but fairly widespread species while some other species are rare (O'Connor and Shrubb, 1986). Dominance by a few very common species is typical of disturbed habitats (MacArthur, 1970) and agricultural areas have one of the highly disturbed habitats. Chhangani (2000) made a study on birds of difference sub-habitats in and around Jodhpur, Rajasthan, India.

Detailed information of population dynamics is not available even on the very common species of Indian birds. Our knowledge of population structure, natality, morality, dispersal, etc, is almost non-existent. However, some studies have been conducted on seasonal changes in population density and other indices of a few species in agricultural habitats (Toor et al., 1986). Some estimates of density of breeding Weaver birds *Ploceus* spp. have been made in Andhra Pradesh (Mathew, 1976) and Punjab (Dhindsa, 1986). Asokan *et al.*, (2009b) made a study on some of the common birds occupying the agricultural environments in Nagapattinam District, Tamil Nadu, India.
An important aspect of the ecology of the birds pertains to factors that influence their number and richness. A general concept that birds select habitats based on vegetation structure or habitat physiognomy has been expressed by several authors (Lack, 1933; Odum, 1950; James, 1971). Avian densities can also be influenced by the singular or interactive influence of predations, intra and interspecific resource competition, parasites and diseases, habitat availability and weather (Boer and Gradwell, 1970), Andrewartha and Birch (1984) and Thiyagesan (1991).

The study of diversity of organisms can provide a measure as to the general health of the environment (Odum, 1971). Further, an interpretation of species diversity is that the more advanced the system, the more complex its function by virtue of the increased number and availability of different ecological mates; the more niches, the more diversified the flora and fauna; the more diversities the biota, the less likelihood that a shift in one component would adversely affect the system as a whole (Odum, 1950).

A perusal of literature reveals that works on avian diversity in South India is meager (Praveen and Nameer, 2009). The above authors analyzed the avian diversity in the Western Ghats. In view of the above
considerations, the above aspect formed one of the objectives of the present investigation.

1.3. Food and Feeding Ecology

Our information on food and feeding of some common bird species in cultivated and natural habitats is quite good. Although some of this information is purely qualitative and preliminary, the rest is based on detailed analytical and quantitative studies. Food of 13 species of birds of agricultural importance has been analyzed in detail. Nine of these species are granivorous, seven omnivorous and one insectivorous. Mathew et al., (1978) analyzed the food and feeding habits of 9 species of birds affecting agriculture in India.

Recently, gut content analyses have been supplemented by field observation on feeding behaviour and captivity experiments on food preference of the concerned species (Mathew, 1976; Mathew et al., 1978; Dhindsa and Toor, 1990; Saini and Dhindsa, 1993). When feeding ecology is studied to estimate the impact of a species on agriculture, gut content analyses alone do not serve the purpose. Field observations on feeding behaviour must also be recorded to pinpoint the sources of various foods. For instance, Dhindsa and Toor (1990) found that rice was the principal food type in the guts of three species of Weaver birds Ploceus spp. in
Punjab. Field observations, however, revealed that most of the rice grains taken by these birds were either left in the stored straw or shed during the crop harvest and thus already wasted.

Another important aspect of feeding ecology is food preference of captive birds. Food preference studies may be helpful in the management of pest species since a preferred crop may be used as a decoy crop to reduce damage to more important crop (Cummings et al., 1987; Fairaizl and Pfeifer, 1988). The amount of food consumed by captive or wild birds has been employed to calculate indirectly the damage potential of a species (Avery 1979; Toor et al., 1986; Saini and Toor, 1991). Unfortunately, only a little work has been done in this direction. Mathew (1976) and Dhindsa and Toor (1990) studied preferences of captive Baya Weaver birds *Ploceus philippinus* for different food types in Andhra Pradesh and Punjab, respectively. Both of these studies have provided conflicting results. Food preferences of captive Rose-ringed Parakeets *Psittacula krameri* have also been studied (Simwat and Sidhu, 1974; Saini and Dhindsa, 1993).

Some estimates of dietary overlap of co-existing species (Dhindsa and Toor, 1990; Saini and Toor, 1994) and seasonal changes in diet diversity (Saini and Dhindsa, 1991; Saini and Toor, 1991, 1994; Saini et
al., 1995) have also been made. Food of three co-existing species of Weaver birds has been found to overlap to the extent of 95-99% in adults and 85-97% in nestlings in an intensively cultivated area of Punjab (Dhindsa and Toor, 1990). This extensive dietary overlap between these species does not seem to threaten their coexistence in this area because of superabundance of food and fine scale interspecific differences in diet. Similarly, dietary overlap of 57-84% was found among Ring Dove Streptopella decaocto, Little Brown Dove S. bengalensis and Red Turtle Dove S. tranquebarica (Saini and Toor, 1994). In the same area, food of Jungle Babbler Turdoides striatus and Common Babbler T. caudatus overlapped by 53% (Saini et al., 1995).

Mukherjee et al., (2007) evaluated the role of birds in matter and energy flow in the ecosystem wherein they reported that the rate of flow from the sparrows fed on mullets and eggs can be compared to that of the grasshopper larvae or other small insects.

Studies of Asokan et al., (2008b) indicated that the regurgitated pellets of the Common Myna Acridotheres tristis consisted of Coleopteran insects. Another study by Asokan et al., (2009b) on White-breasted Kingfisher Halcyon smyrnensis, Small Bee-eater Merops orientalis and Black Drongo Dicrurus macrocercus indicated that their diet consisted of
more than 60% harmful insects of the agro environments and thereby we understand the role of insectivore’s birds in controlling the crop pests. In view of the foregoing account, an attempt has been mode on the food and feeding habits of few birds viz., the Black Drongo *D. macrocercus* and the Indian Roller *C. benghalensis*.

### 1.4. Time Activity Budget

Activity budget analysis has been useful in determining ecological, behavioural and physiological adaptation of avian species. Analysis of time budget allows evaluation of temporal relationships behaviour relative to habitat component and structure (Wiens *et al*., 1970 quoted in Plumpton and Lutz, 1993). Changes in time activity budgets through time are often used to determine seasonal differences in behaviour (Quinlan and Baldassarre, 1984; Bergan *et al*., 1989; Beyer and Haufler, 1994) or changes due to progressive phases of the nesting cycle (Verner, 1965; Dwyer, 1975; Afton, 1979; Maxson and Bernstien, 1984) or to describe dominant relationships (Paulus, 1984; Hepp and Hair, 1984), foraging strategies (Alexander, 1979). The proportion of time spent foraging and time activity budget studies can also indicate the relative abundance of food (Bell and Ford, 1990). Based on these considerations, the time activity budget of these birds viz., Black Drongo *D. macrocercus*, Indian
Roller *C. benghalensis* and Common Myna *A. tristis* were undertaken presently.

### 1.5. Damage Estimation

It is interesting to note that only 05 out of 1000 species of birds found in India (i.e. only 2.1%) have been reported to inflict damage to crops and fruits. Damage by these species to important crops and fruits has been estimated in different parts of India. Most of these are localized estimates that are not applicable over large areas. However, they do indicate damage potential of the species involved. Toor *et al.*, (1986) estimated bird damage at a grain store in Punjab. In their study, Ring Doves, Sparrows and Weaver birds consumed 4074 kg of rice in five months. Besides this direct loss of grains, these birds damaged gunny bags, spoiled the site and contaminated grains with their droppings. If we take into consideration the number of such stores in India, the damage would be enormous. Bird congregations at grain stores and rice-shelling yards in Punjab are reported to be a real problem. Saini and Toor (1991) estimated damage potential of Blue-rock Pigeon *Columba livia*. They reported that a flock of 1000 pigeons can consume 18 kg/day of sprouting maize, 15 kg/day of sprouting pulses, 18 kg/day of maturing lentil or 01 kg/day of maturing gram.
1.6. Beneficial Role of Birds

Although it is well known that insectivorous and predatory birds play a very useful role in controlling insect and rodent pests of crops, only a few attempts have been made to evaluate their role and that too only in case of insectivorous birds. Our knowledge on the impact of predatory birds on rodent populations in India is very few Neelanarayanan et al., (1995). Patel et al., (1987) found that House Sparrow *P. domesticus*, Common Myna *A. tristis*, Red-vented Bulbul *Pycnonotus cafer* and three other bird species in addition to wasps play important role in reducing *Catopsilla* spp. larvae in a medicinal crop, *Cassia angustifolia*. Several species of insectivorous birds have been found to feed on insect pests of crops including *Helicoverpa armigera* (Chakravarthy, 1988; Parasharya et al., 1988; Singh et al., 1990). In doing so, some of these species transmit nuclear Polyhedrosis virus infecting *H. armigera* to healthy larvae of this pest (Vyas et al., 1988a). Bird predators of some other insect pests have also been found to play an important role in biological control of insect pests through disease transmission (Vyas et al., 1988b), besides direct predation.

House Crow *Corvus splendens* and Blue-rock Pigeon *C. livia* have also been considered to be harmful. House Sparrow, Ring Dove and Baya Weaver bird have a neutral status in relation to agriculture while large majority of the species in the agricultural bird communities are useful. Bee-
eaters are commonly observed feeding on flying insects including honeybees but there has been no study to substantiate the claim that bee-eaters are pest birds (Dhindsa and Saini, 1994).

Despite ecological importance and global awareness of conservation nothing has been done to protect endangered and threatened species in intensively cultivated areas. Gaston (1984) examining the status and distribution of endemic passerine species in India and Pakistan, suggested that such species may become vulnerable to extinction in areas where habitat destruction is extensive. The populations of birds of prey have dwindled to insignificant levels because of habitat destruction and food-chain poisoning (Dhindsa, 1984). Agricultural areas in India probably experience the most heavy and indiscriminate use of pesticides leading to direct and indirect mortality of predatory and frugivorous birds (Dhindsa et al., 1980). The population of Sarus Crane *Grus antigone* is reported to be dwindling in some parts of India due to agricultural expansion (Parasharya et al., 1994).

1.7. Breeding Biology

Breeding ecology is the area that has attracted the keenest attention of Indian ornithologists. Earlier studies on breeding of Indian birds were in the form of natural history notes. A very good work on nidification of Indian
birds was that of Baker (1930-1935). Probably, the first detailed description of breeding of a species, i.e. Baya Weaver bird, was published by Ali (1931) followed by Crook (1960, 1963). Several aspects of breeding ecology of this and three other species of Weaver birds have been described which included nest building behaviour, nest-site selection, mortality factors, nest appropriation, clutch size, brood parasitism and reproductive success (Ambedkar, 1968; Davis, 1971, 1974; Dhindsa, 1983a, 1983b, 1986; Dhindsa and Toor, 1994; Dhindsa and Sandhu, 1988). Asokan et al., (2008a) made a study on nest construction and nest microclimate of the of the Baya Weavers *Ploceus philippinus* in Nagapattinam and Tiruvarur District, Tamil Nadu, India.

Basic data on breeding of House Crow and its brood parasitism by Asian Koel *Eudynamys scolopacea* were recorded by Lamba (1963). Information on breeding of House Sparrow is available from Gujarat (Naik and Mistry, 1972, 1980; Mathew and Naik, 1986), Andhra Pradesh (Kumudanathan *et al.*, 1983), Punjab (Simwat, 1977) and Rajasthan (Rana and Idris, 1989). Not much is known on breeding ecology of Rose-ringed Parakeet, probably because it is a hole nesting species. Other birds of agricultural importance whose breeding has been studied in some details include mynas, doves, babblers, bulbuls, etc. Asokan (1996) studied the breeding habits of the Small Green Bee-eater *M. orientalis* in a portion of
Nagapattinam District, Tamil Nadu. Asokan et al., (2009a) made a study on nest-site selection and nestling growth pattern of the Common Myna *A. tristis* in Nagapattinam District.

Although we have a good deal of information on various breeding aspects of many common species, yet experimental studies on the impact of various factors on reproductive success are lacking. Another aspect that requires special attention is nest-site selection by common species.

From the foraging account it is obvious that works on the breeding ecology of the birds of agriculture importance are minimal and hence an attempt has been made on the same.

Further, an attempt has been made to suggest management measures to protect the birds of agriculture importance in the study area.

In view of the above considerations the work was attempted with the following objectives:

1. To investigate the avian species diversity and richness among the various crops *viz.*, paddy, pulses, banana, cotton and groundnut sugarcane in three habitats during 2004 to 2006.
2. To compare the avian species diversity in various stages of crops such as ploughed land, seedling, transplantation, pre-milky, post-milky, harvested and post-harvested stages of crop lands.

3. To estimate the prey availability in the study areas.

4. To analyze the regurgitated pellets of two birds viz., Black Drongo *Dicrurus macrocercus* and Indian Roller *Coracias benghalensis*.

5. To record the time activity budget of Black Drongo *D. macrocercus*, Indian Roller *C. benghalensis* and Common Myna *Acridotheres tristis*.

6. To evaluate the extent of damage caused by selected birds to crops by comparison of yield in natural plots and enclosed plots.

7. To understand the breeding biology of the above mentioned 3 bird species with special reference to nest site characters, egg morphometry and nestling growth pattern.