INTRODUCTION

Bio-diversity refers to all species of plants, animals and microorganisms existing and interacting within an ecosystem (Vandermeer and Perfecto, 1995). In an ecosystem, bio-diversity performs services to the ecosystem by addition to production of food, fiber and fuel. They participate in recycling of nutrients, control of local microclimate, regulation of local hydrological processes, regulation of the abundance of un-desirable organisms and detoxification of noxious chemicals. These renewal processes and ecosystem services are largely biological; therefore their persistence depends upon the maintenance of biological diversity (Altieri, 1994). Many ecosystems are loosing their biodiversity as a result of large scale intervention made by human being (Rudd, 1964).

In India the status of wildlife according to IUCN is that 172 species of animals are globally threatened or 2.9 % (threatened animals) of the World' s total threatened animals are residing in India (Groombridge, 1993). These include 53 species of mammals, 69 species of birds, 23 reptiles and 3 amphibians. India encounters globally important population of some of the Asia' s rarest animals such as the Bengal Fox, Asiatic Cheetah, Marbled Cat, Asiatic Lion, Indian Elephant, Asiatic Wild Ass, Indian Rhinoceros, Markhor, Guar, Wild Asiatic Water Buffalo etc.

The selection of different habitats by the wildlife is wide and a reference of its adaptability includes forest, desert, grassland, wetland, agriculture, parks and even human habitation. Globally several ecologists have highlighted the importance of agricultural ecosystem for birds. Agriculture, perhaps having more human activity than any other habitat, has caused an adverse impact on wildlife (Deniels, 1994; Parasharya *et al.*, 1996, Borad *et al.*, 2001). Clearing forested lands for agriculture, agriculture itself, and agriculture' s side effects are the major causes of worldwide species loss. Recent trends in agricultural practices such as reduction of uncultivated field boundaries, increased chemical inputs and lower crop diversity point to mono ecosystem simplification, with ominous implications for local wildlife (O' Connor and Shrubb, 1986). It is heartening to say the inadequate conservation efforts concentrate on protected areas that cover only about 9% of the world land area and ignore the vast remaining landscape under agriculture. In India also about 7 % of the land is under legal protection, while remaining area either is under agriculture, cultivation or for other uses, does not have any specific policy for protection of biodiversity. The most of our wildlife have been threatened in such habitats (particularly in agricultural landscape) due to intervention of human for their own interest/ selfish motto.

Agricultural techniques are developing to improve the yield of crops and pesticides are used to get crops free from pests. Pesticides are unique amongst the toxic substances. They are not the by products of any chemical process or the waste of industries or the exhaust of fuel engine They are specifically and target fully produced with range of toxicity to control agricultural pests and thus enter in the environment. Thus the regulation of pesticides does not focus solely on assessing the toxicity but also managing the risk by controlling the exposure.

The chlorinated hydrocarbon have been developed after Second World War and appeared in public with DDT. Organochlorine compounds have carbon, hydrogen and chlorine as their basic molecular constituents and some compounds may have oxygen and sulphur also. German chemist Zeidler first synthesized DDT in 1874, but its insecticidal properties were not discovered until the work of Paul Muller 1939. DDT is a contact and stomach poison and has long residual action. It affects the sensory organs and nervous system and causes violent agitation, which is followed by paralysis and death. After invention of DDT, the trend in chemical control of crop pest has been increased which had accelerated the decline in bio-diversity in agricultural landscape The avian species that are dependent either directly or indirectly on agricultural area for food (seeds and insects) are treated with pesticides. It is generally found that compared to terrestrial birds, the wetland dependent birds show more tendency of pesticide bio-magnification (accumulation) in their body tissue. Amongst the other pesticide components, the organochlorine does not metabolize fast in the body, and thus are easily detectable in the tissue. Keeping this fact in mind, the present study was initiated.

Of the long list of organochlorine compounds discovered, over 30 of them were put into practice and half of this organochlorine is widely used (Smith, 1991) Some of them are associated with worldwide spread environmental problems (Table 1). There are tremendous differences in responses of various taxa as a result of exposure to organochlorine pesticides. The most serious effects are mortality, egg shell thinning, reduced reproductive success, population decline and extirpation that occurred amongst the birds particularly the raptors, seabirds, water birds in orders of Strigiformes, Falconiformes, Pelecaniformes, Ciconiformes and Podicipediformes (Blus,1995), which are apparently observed. However, many more effects might be happening but still have remained unnoticed or lack proper investigation. Organochlorine pesticides and their related compounds have been detected in significant amount in the environment and in human body tissues (Edwards, 1976). Environmental contamination from persistent organochlorine has been recognized as a threat to wildlife. Many residues have been found in the tissue and eggs of the birds in Europe and North America (Eades, 1966; Robinson and Roberts, 1968; U.S.D.I Fish and Wildlife studies, 1968; Turner *et al.*, 1978).

Table 1: Organochlorine pesticide compounds mainly responsible for environmental hazards.

Sr. No.	Common name	Chemical name
1	DDT	1,1,1- trichloro-2, 2- bis (4-chlorophenyl) ethane
2	DDD	1,1,1- dichloro-2, 2- bis (4-chlorophenyl) ethane
3	DDE	1,1,1- dichloro-2, 2- bis (4-chlorophenyl) ethylene
4	Aldrin	1,2,3,4,10,10, -hexachloro1, 4,4a, 5,8,8a-hexahydro-*endo*-1, 4-*exo*-5, 8-dimethanonapthalene
5	Heptachlor	1,4,5,6,7,8,8-heptachloro-3a, 4,7,7a-tetrahydro-4, 7-methanindane
6	HCH	1,2,3,4,5,6-hexachlorocyclohexane
7	Lindane	Gamma isomer of HCH
8	Chlordane	1,2,4,5,6,7,8,8-octachloro-3a, 4,7,7a-tetrahydro-4, 7-methanoindan
9	Dieldrin	1,2,3,4,10,10-hexachloro-6, 7-epoxy-1, 4,4a, 5,6,7,8,8a-octahydro-endo-1, 4-exo-5, 8-dimethanonapthalene
10	Endrin	1,2,3,4,10,10-hexachloro-6, 7-epoxy-1, 4,4a, 5,6,7,8,8a-octahydro-1,4-endo, endo-5,8- dimethanonapthalene

Source: Smith, 1991

In the last 20 years, ten million breeding individuals of ten species of farmland birds have disappeared from the British countryside. For example the Corn Buntings and Tree Sparrow have declined over a decade, at the rate of more than 5 % per year. The decline in the birds in the parts reflects invertebrates and plant species they survived on. Parallel changes have taken place in many other countries although no systematic documentation has been done. Census of 116 farmland birds carried out by British Trust of Ornithology showed decrease in population of European birds, which forced them to look for their conservation (Krebs *et al.*, 1999)

Wildlife is exposed to insecticides when they consume granules or residues on plants and on insects. For instances some birds' feed on dead or dying insects following applications of insecticides. Birds entering the field during or soon after an insecticide has been sprayed, come in contact through the skin that is exposed heavily to the pesticides or inhale the vapor. Exposure to highly toxic insecticides can result into death of the animal. Whereas, sub-lethal dose exposure may cause sickness Such birds are prone to predation, suffering from diseases and probably death. Birds exposed to organochlorine or phosphates have been found to neglect their young ones, or even abandon the nest. Wide variety of insecticides used on crop fields toxic to bird depending upon the time of exposure, quantity applied and duration of inhalation/consumption. Many of the soil-applied insecticides are especially hazardous to wildlife; they include carbofuran, aldicarb, and aldrin. All of these insecticides are extremely toxic and lethal to birds.

However, the detail report of degree of damage done by organochlorine pesticides to avian community is not known in India. There is biomagnifications due to food web. Kaphalia *et al.* (1981) have reported residues of HCH, Linden and DDT in body organs of few Indian wild birds like pigeon, crow, kite, etc. The significant negative correlation between

DDE residues in the egg and eggshell thickness is well documented in various species of birds. The experimental induction of shell thinning by DDE at levels encountered in the environment was established in various families of birds (Heath *et al.*, 1969; Wiemeyer and Porter, 1970; McLane and Hall, 1972).

Looking to the above facts about the organochlorine pesticides from their introduction for pest control as one of the major cause of the biodiversity loss. Thus it is a prime requirement to investigate what is the current impact of these pesticides on the wildlife specially birds. Predictive capabilities of pesticide impact would allow at least some opportunities to reduce or eliminate the hazard of given pesticides to our bird community. The objective of the present study is to report the concentration of organochlorine (HCH and DDT) contaminants in tissue and eggs and its impact on breeding success of the avian species.

1. General description of organochlorine pesticides

The organochlorine pesticides are aryl, carbocyclic or heterocyclic compounds of molecular weight ranging from 291 to 545. These include DDT and its analogous hexachloro cyclohexane (HCH), cyclodienes and similar compounds, toxaphene and related chemicals and similar structures and the caged structure of mirex and chlordecone (Smith, 1991). The major compounds include DDT and its principal metabolites aldrin, dieldrin, heptachlor, chlordane endrin and HCH including the Gamma isomer (lindane). Except for chlordane, which is a pale yellow liquid, all other is white (DDT Heptachlor, endrin, aldrin, dialdrin) or wince to white (HCH) crystal solids structures of the technical compound may differ from pure compound. i.e. Technical DDT is a waxy solid

Common characteristics of these compounds are low solubility in water and relatively high solubility in oil and fats including lipids and organic solvents. These compounds are stored in lipids throughout the body. The half-life depends on many factors including compound itself, interaction with other compounds, and condition of the animal, age, sex and various other stress factors. The lipid solubility is instrumental in bioaccumulation, which results in build up in concentration of organochlorine from food or solely from water through gills, epidermis or similar structures (bio-concentration).

The half-life of organochlorine compounds may vary from days to months, is and also the carrying capacity of the individual. Even the toxicity also varies with the chemical and within individuals. For example methoxychlor is less toxic and is stored less readily than DDT whereas endrin is more toxic but is stored less readily. Also the solubility of the compound in lipids is not always directly related to its rate of storage in the body fat because of differential metabolism according to taxa, age, sex and many other physiological factors Intestinal absorption of organochlorine pesticides is influenced by fiber and fat constituent of the diet, in addition to total intake of food (Smith, 1991).

2. Biological effect

For birds the best known sub-lethal effects include failure of some adults to breed, eggshell thinning and a decrease in hatchability of eggs or survival of the young ones that lead to decreases reproductive success. The studies carried out in the different parts of the world on biological effects of the organochlorine pesticides residues on birds, clearly indicates that the adverse impact of contaminant is exhibited at certain level of residues in specific tissues, which varies with species to species. However, it can be generalized for the birds by studying individual compound for contaminant level in specific tissues and its respective biological effect for large number of bird species or integrating results obtained through scattered studies. It can be helpful in determining the level of specific contaminant in the tissue, which exhibits the biological effects. So efforts were made to intregate such studies and presented in Appendix 1 to identify the critical level. The critical level can be used as reference for deciding the biological effects of current residue levels detected. The critical level of residues of DDT/DDE/DDD are equivalent to 10 DDT, Dieldrin: $\geq$ 5 mg/kg; Endrin· 8 $\geq$ mg/kg; heptachlor epoxide $\geq$ 8 mg/kg and oxychlordane . $\geq$ 1.1 mg/kg in brain cause mortality of the individual. The critical residues level of DDE is $\geq$ 4 for eggs which leads to decrease in eggshell thickness, population decline and sometimes total failure of egg hatch. The 18 % reduction in the eggshell thickness is critical for eggs thinning, and the point when population decline is observed.

It is difficult to decide critical level of HCH and lindane, because large number of studies has reported that HCH and lindane have no adverse impact on reproduction success and eggshell thickness.

3. Study area

Kheda district is situated in the central part of Gujarat State (Figure 1). The total area of the district is 7194 0 sq. km , which is 3.7 per cent area of Gujarat State. Entire district is flanked by two major rivers; Mahisagar on the eastern side and Sabarmati on the western side. The northern part of the district shares boundary with Sabarkantha district. Ahmedabad district is on its western side and Panchmahals and Vadodara on the eastern side The southern side is attached to the gulf of Khambhat. Major area is a plain land except a small hilly area in Kapadvanj and Balasinor tahsils. The region has typical fertile soil popularly known as "Goradu soil" with loamy sand of alluvial origin, which is known for its productivity and hence intensive cropping, is practiced throughout the year. Agriculture and

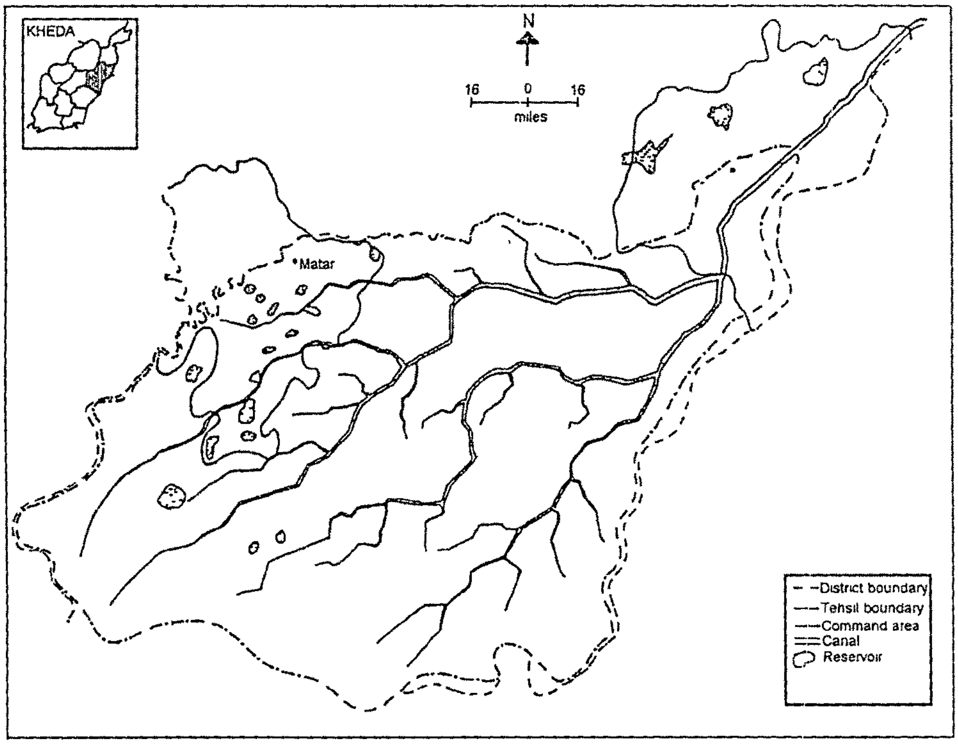

Figure 1: Map of Kheda district showing the cultuirable command area of MRBC.

dairying are the priority activities of the rural area. About three fourth of the population depends on agriculture.

The total cultivated area of the district is 6,58,495 hectare. The major area of the district has canal irrigation facility and therefore, irrigated farming is practiced; whereas in Kapadvanj and Balasinor tahsils, rain-fed farming is practiced. The important crop of the district is tobacco (*Nicotina tobacum*) Kheda district occupies more than 60 per cent area of tobacco cultivated land of the state. Paddy (*Oryza sativa*) crop area of the district is 20.24 per cent of total paddy area of the state. The other crops of the district are pearl millet (*Pennisetum typhoides*),wheat (*Triticum aestivum*), maize (*Zea mays*), sorghum (*Sorghum bicolor*), sugarcane (*Saccharum officinarum*), cotton (*Gossipium hirsutum*) and castor (*Ricimus communis*) ; while in some patches pulses, vegetables and fruits viz., banana (*Musa paradisiaca*), papaya (*Carica papaya*), mango (*Mangifera indica*), etc., are also grown. Now a days, farmers have started growing cash crops viz , cumin (*Cuminum cyminum*) and fennel (*Foeniculum vulgare*) in most parts of Thasra, Kapadvanj and Balasinor tahsils on tubewell irrigation (Director of Agricultural Extension, Nadiad, pers. com.). There is no real forest in the district, but has a great diversity of flora. Babul (*Acacia nilotica)*, Manila Tamarind *(Pithecellobium dulce)* Neem *(Azadirechta indica)* and *Eucalyptus* spp. are the most common trees amongst many others growing on the farm borders and roadsides.

The district comprises of ten tahsils for the revenue record. The present study was chiefly concentrated in Matar tahsil.

2.1. Matar tahsil

Matar tahsil is located at latitude of 22°30'-22°51' N and longitude of 72°32'-72°49'E. Out 577 km^2 area of Matar tahsil, 426.04 km^2 is cultivable land (District Census Book, Sr. 5, 1971). River Vatrak, enters the tahsil on north-eastern side near Matar and passes across the tahsil diagonally to merge into Sabarmati river at Palla. The Sabarmati river flows only during South-West monsoon, but during the remaining part of the year it turn into a narrow gutter carrying polluted water of industries situated on the outskirts of Ahmedabad city.

As mentioned the land is plain and its soil, at most of the places, is sandy loam to clay loam. However, in small patches around wetlands, the soil shows coastal saline characters. On government record, total salt affected area in the tahsil is 2,819 hectares (Director of Agricultural Extension, Nadiad, pers. com.). However, recent studies through satellite remote sensing show that total 6499 ha area is salt affected (Sugumaran *et al.*, 1994). There are very few trees, even on the farm borders. Most of the fields are without hedges and hence, the agricultural area looks like an open plain.

Agriculture in the study area is dependent on canal irrigation. Mahi Right Bank Canals are ramified to its maximum in Matar tahsil, which is most favorable condition for paddy cultivation. There are atleast 15 storage reservoirs linked with the canals, which provide water for irrigation and drinking purpose. These reservoirs are relatively shallow and perennial in nature. As a result, they are highly productive and rich in growth of aquatic vegetation, both within the water and on the fringes.

Since canal water is chiefly supplied during monsoon over most of the cultivable land, paddy is the main crop, which occupies 51 02 per cent of the cultivable land. The other important crops of the area are pearl millet during monsoon and summer, sorghum during summer (mainly for fodder purpose) and wheat and chickpea during winter. Since irrigation facility is provided to a limited area during winter and summer, rest of the area remains fallow during these seasons. The data of land use pattern and cropping pattern of Matar and Thasra tahsils are given in Appendix 2, and 3, respectively

3. Climate

3.1. Monsoon

The climate of the region is semi-arid, tropical monsoon type. Southwestern currents in the summer bring monsoon rain from the third week of June to September end or early October. Peak precipitation was recorded during July and August. Total annual rainfall during study period was 557.97 mm in 1998, 648.97 in 1999 and 431.70 in 2000 The mean monthly temperature fluctuated from 28.45^0C to 34.60^0 C and the relative humidity corresponds 83.34 % to 58.26 % respectively.

3.2. Winter

Its surrounding regions through which the cold wind blows from northern side of India influence the climate of the area. The winter season begins from December and terminates by March. During this period the mean monthly temperature varied from 18.22^0C to 22.9^0 C. However, the coldest month was January.

3.3. Summer

With the onset of summer by mid March, the temperature starts rising and reaches to its peak in May. Highest temperature was always recorded during May. The mean monthly temperature varied from 24.84^0 C to 33.58^0 C. The summer was characterized by highest temperature and lowest relative humidity. The fall in temperature starts from mid June Meteorological data of the nearest observatory at Gujarat Agricultural University, Anand is given in (Appendix 4).

The study was broadly planned as follows:

1. Process Documentation Research on pattern of pesticide use

2. Selection of Key bird species

3. Food habit of selected birds

4. Pesticide residue analysis

5. Impact of organochlorine pesticides on reproduction

6 A Case study of wetland dependent birds