I N T R O D U C T I O N

Barring a few domesticated animal species, the vertebrates are known for their cyclic patterns of reproduction. The functional and non-functional states of gonads (recrudescence and regression) are under the constant influence of external stimuli, the effects of which are mediated via the central nervous system leading ultimately to the release of the adenohypophyseal gonadotrophins. The neurohormones (hypothalamic releasing hormones/factors) that are released from the median eminence are transported by the hypophyseal portal system to pars distalis where they regulate the secretion of gonadotrophins; variations in the levels of which determine the cyclic rhythmicity of the gonadal development. This mechanism apparantly is operative in all the vertebrates (Jørgensen, 1968). The

neuroendocrine machinary (Lofts and Murton, 1973), and perhaps the pineal gland too, exhibit a fine integration and balanced co-ordination, linking the organism on one hand and the environment on the other.

To exploit the environmental conditions to the fullest and derive maximum possible benefits, it would be natural for the vertebrates to breed at such times of the year when environmental conditions are most favourable. Avian species, for example, reproduce at such times when on an average their offsprings can most profitably be brought up and thus can have maximum chances for survival (Lack, 1950). Benoit (1964) has emphasized the importance of light as a regulatory factor, which involves the retino-hypothalamo-hypophyseal complex. It has been aptly said- "the supreme virtue of light as a regulator is its regularity"- a comment which speaks for itself.

Other than the domesticated species (eg. fowl), it is interesting to note that certain temperate zone populations of feral pigeons inhabiting the towns and cities breed throughout the year or atleast they have the capacity to do so. This is because of the abundance and continuous availability of food supply made possible by the benevolent public (Loft et al., 1966). Further, Lofts et al. (1966) remarked that natural selection, however, exerts its impact towards establishment of annual reproductive cycles. In equatorial region where the climate and food supply are

relatively similar throughout the year, breeding may often take place at any time (Bentley, 1976). Many investigators have worked on the reproductive cycles of Columbiformes. Noteworthy works among these are those on the rock dove (Lees, 1946), feral pigeons of Britain (Lofts et al. 1966, 1967, 1969); the wood pigeons Columba palumbus (Murton, 1958, 1960); feral pigeons (Murton et al., 1973) and the frugivorous rain forest and ground feeding pigeons of Australia (Frith et al., 1974). These studies have ultimate implications pointing out that these species of birds have a continuous breeding activity. Some other recent investigations on the breeding biology and seasonal histophysilogy on Columbiformes include those on the Sweedish wood pigeons (Ljunggren, 1969); urban pigeons (Cramp , 1972); feral pigeons C. livia Var. (Murton et al., 1972, 1973), wood pigeons C. palumbus (Murton et al., 1974); purple crowned pigeons of Australia (Crome, 1975a) and the band-tailed pigeons (March and Sadlier, 1975). Frith et al. (1976), while studying the sexual cycles of some pigeon species in arid and semiarid Australia remark that in each species, some males produce abundant sperms and some females have enlarged ovarian follicles in each month of year. They conclude that though changes in photoperiod played a major role in controlling gonadal cycles, food availability and rainfall were important in modifying the cycle.

In case of male birds, over and above the traditional criteria employed (e.g. testicular size, volume, weight, stages of spermatogenesis, Leydig cell histo - morphology etc.), direct assays of gonadotrophins and/or gonadal hormones by radioimmunoassay techniques have undoubtedly gone a long way in the understanding of the physiological states of gonads. Hasse et al., (1976) have quantified testosterone, estradiol- 17β and progesterone in the domestic pigeon correlating the results with certain social and seasonal factors. A specific radioimmunoassay technique for avian LH has been reported by Follett et al., (1972) and since then, this method is widely applied in many domestic and wild avian species. The Indian blue rock pigeon (Columba livia intermedia Strictland) is a pest on grains and a variety (cereals and pulses) of standing crops (Simwat and Sidhu, 1973). Field investigations particulary on nidification, by these workers have shown that the population of pigeons in the state of Punjab (India) breed from June to December.

The aim of the present investigation was to determine whether the feral populations of Indian feral blue rock pigeons (Columba livia) show any periodicity in reproductive patterns, and, if so, what possible physiological factors contribute to this phenomenon. Keeping in view the aforesaid investigations on pigeons, some histo-enzymological and endocrinological investigations were planned and carried

out on the feral pigeons (commencing from 1973 and ending in 1978).

Since cholesterol serves as the chief precursor material for the synthesis of variety of gonadal sex hormones, and the sex steroids would consequently affect the synthesis and distribution of this important intermediate metabolite, levels of the same were estimated quantitatively in the liver, gonads and blood plasma of both the sexes of the birds throughout the year. These preliminary investigations were undertaken to know the turnover rates of cholesterol in the different tissues, togather with the content of total lipids, which were also assayed quantitatively in both the sexes (Chapter I). This initial work and certain behavioural observations (pairing, nest building, mating etc.) threw light on the physiological state of gonads with respect to steroidogenesis.

To substantiate the above findings, it was thought necessary to carry out certain histochemical experiments on lipid localization, and in particular, changes in the intensities of some enzymes involved in steroid hormone biosynthesis. Literature on the cyclic histophysiological changes on avian testes in various species is abundant (Chapter II). A more recent parameter employed in understanding the physiological state of gonads is the occurrence of steroid dehydrogenase activity. One of the cardinal enzymes of this group is the Δ^5 3β-hydroxysteroid

dehydrogenase (Baillie et al., 1966). Fluctuations in the intensities of these dehydrogenases in the gonads could signify alterations in the levels of circulating sex hormones. Hence, histochemical study on total and neutral lipids and Δ^5 -3β-HSDH was undertaken in the male birds on seasonal basis. Later, another enzyme (17β-hydroxysteroid dehydrogenase) was also studied in the testes during the breeding and non-breeding phases.

As compared to the cyclic histophysiological studies on male birds, much less attention has been focussed on the annual reproductive cycles in female birds. Lofts and Murton (1973) have aptly commented that except for the Rook -Corveus frugilegus (Marshall and Coombs, 1957), in which some detailed seasonal ovarian histophysiology is discussed, literature on other wild species of birds is almost nil. Since then however, Chalana and Guraya (1974; 1976 a&b, 1977; 1978) and Guraya (1976 a&b) have reported several studies on the ovarian histophysiology of a variety of Indian birds including the pigeon (C. livia).

As in the case of male birds, a histochemical investigation of the patterns of variation in the distribution of total and neutral lipids and Δ^5 -3β-HSDH and 17β-HSDH was undertaken simultaneously in order to throw some light on possible cyclicity in the ovarian histophysiology. This could give a more clear picture of

ovarian regression and recredscence. In both the above cases (males and females), attention has also been paid to probability of correlation of the intensities and localization of enzymes with steroid hormone metabolic pathways and the probable synthetic sites.

The important role played by liver and the kidney in steroid hormone catabolism has been ascertained both clinically and biochemically (Baillie et al., 1966) mostly in case of mammals. Such studies in avian species and other sub-mammalian vertebrates are scarce. Assuming that the turnover rates of sex hormones would be lower in the non-breeding phase and higher in the breeding months (Chapters I,II & III), two enzymes viz. 3 α-hydroxysteroid dehydrogenase (3 α-HSDH) and 17β-HSDH, which are actively involved in steroid catabolism, were studied histochemically in the liver, kidney and intestine from June to October, 1977 (Chapter IV). Intestine was chosen as one of the organs involved because the possibility of excretion of steroids along with bile through the gastrointestinal tract and further interconversions therein cannot be ruled out.

After characterizing the breeding and the non-breeding phases more precisely, it seemed worthwhile to extend the investigations to an assessment of possible influence of ascorbic acid (AA) in steroidogenesis and also that of

certain lipogenic enzymes. Apart from providing active assistance in biosynthesis of glycosimonoglycans (GAG), collagen, reticulin, dentine etc., AA is also known to be involved in steroidogenesis (Biswas and Deb, 1970). Dieter (1969) has commented that the levels of AA is the tissues of cockerels are under hormonal (androgens) control. Concentrations of AA were hence, estimated colorometrically in the liver, kidney, gonads and blood serum during the breeding (March-April) and the non-breeding (June-July) months, 1977 (Chapter V).

The classical findings of Goodriage and Ball, (1966, 1967) remark that unlike the adipose tissue of mammals, it is the liver of pigeons which is the major site of de novo fatty acid synthesis accounting for more than 90% of the total lipogenesis. This has also been proved to be the case in the fowl (Goodridge, 1968; O'Hea and Leveille, 1969) and probably other birds too may bear the fact. Other interesting observations correlate the gonadal sex hormones in the levels of lipogenic enzymes and the rate of lipogenesis, done on immature and mature fowls and laying and non-laying hens (Pearce, 1971; Pearce and Brown, 1971; Pearce, 1972). In order to study the fluctuations in the levels of lipogenic enzymes during the breeding and non-breeding phases and thereby making a possible correlation of lipogenesis with gonadal hormones, levels of 'malic enzyme' and Glucose-6-phosphate

dehydrogenase, both of which are known to cater to the demands of reduced cofactor essential for fatty acid biosynthesis, were assayed spectrophotometrically in the liver and gonads during breeding and non-breeding phases.

All the above investigations were carried out in both the sexes of birds and hence, the levels of metabolites and enzymes of males were compared with those of female birds during the tenure of whole project to point out any probable sex differences.

The cumulative body weights, gonadal weights and gonadal histological characteristics were studied in relation to important states of the breeding cycles of both the sexes to substantiate evidences obtained during the course of the present work (Chapter VII).