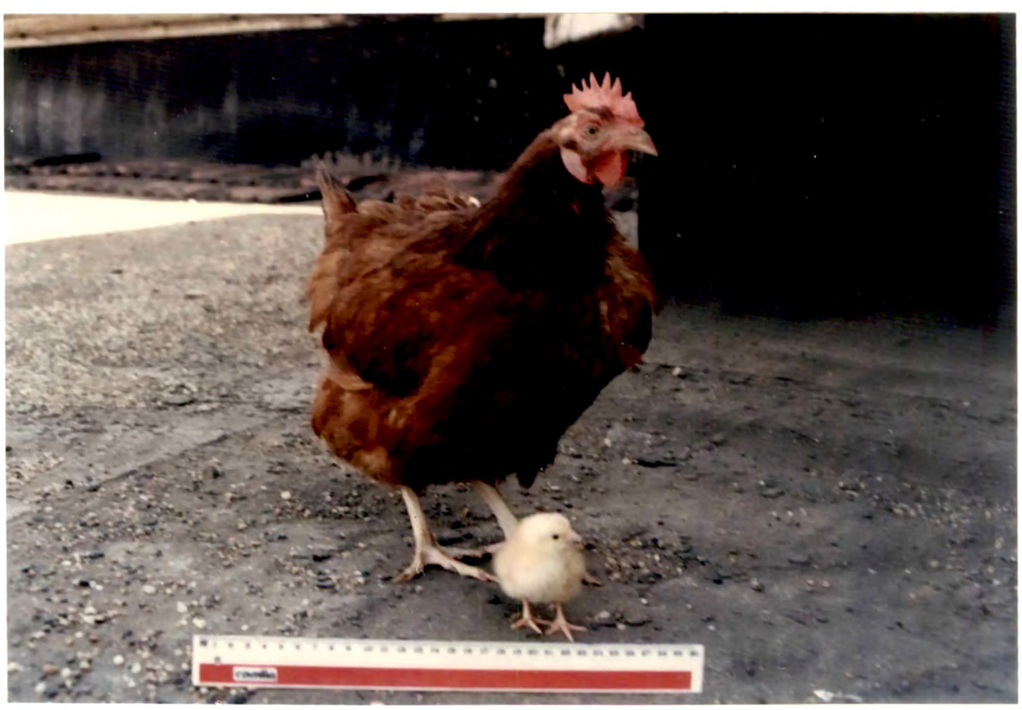
INTRODUCTION

During the last four decades poultry science has made all round progress on varied aspects like genetics, nutrition, disease control, management technology and marketing. Inspite of India being in the first top ten countries, there has always been a need felt to raise egg production by another 8-10 folds to be at par with the developed countries. The poultry production units in the country are also changing rapidly these days into specialized units like hatchery, feed formulation and manufacturing, pullet replacement, development of equipment and poultry house construction, flock management, product processing and marketing. Effective egg handling, preservation and packaging are taken care of to minimize losses. The poultry population in India consists of indigenous (desi) and exotic (improved) strains of hens. The desi breeds are sturdy and well adapted to withstand diversified agroclimatic conditions prevailing in Indian villages. These breeds have better resistance towards most of the diseases. The genetically superior individuals from the desi as well as exotic breeds are identified and bred on pure lines to develop a parent stock. The nucleus population of selected stock in the great grand parent generation is expanded by mating with pure line to produce grand parent generation. In the succeeding generations parent males are mated with the parent females to produce commercial egg laying hens or broiler chickens. The heritability of egg production is not the same in all cases as it might be quite low in certain offsprings making it difficult to assess the relative impact on egg production of genetic selection, improved disease control, advances in nutrition science and combination of factors commonly

DAY OLD RIR CHICK AND ADULT HEN



referred to as management. If the rate of egg production of the best stocks available is not altered, then the feed efficiency and / or age at sexual maturity have been substantially changed through genetic selection. In a Canadian random sampling test it has been observed that the average rate of lay per hen rose from 180 eggs/year in 1950 to 250 eggs/year in 1985 and at the same time the number of breeds decreased from 32 to 4. It seems likely that part of the change in the average rate of egg production is due to elimination of poor stocks from the market place. The interpretation of this record can be substantiated by examining the rate of lay of two breeds *ie.* Shaver 288 and Babcock 300 during this period. Other than genetic selection, these results may be attributed to factors like use of laying cages (in 1969), vaccination(against Marek's disease in 1976) and other better management practices (see Etches, 1996). During this period egg laying tests were also carried out on dual-purpose breeds such as Barred Plymouth Rock and Rhode Island Red (RIR) which have a large body mass.

The Indian RIR breed is obtained by crossing the English RIR breed with the Kalinga brown of Bhuvaneshwar. The subsequent generations have better resistance against diseases and environmental factors and can survive well in the hilly areas. The Indian RIR is one of the common breeds in the Indian poultry industry used for dual purpose (egg production and meat). The laying hens are reared in well ventilated hen houses (deep litter system) or in laying cages (tier system). The lighting regimen comprises of continuous light phase for the first 8 weeks of post-hatch development. Nightlights during brooding avoids overcrowding and piling-up of chicks and guides the chicks to find their way to the hover, feeder and water trays. However, artificial light is not provided after 8 weeks of age to avoid early initiation of egg laying which results in small eggs of less economic value. The pullets at 17 to 20 weeks of age are transferred to the laying cages and are provided a lighting regimen of 16 hrs of light per day, which includes 12 hrs of natural day light and 4 hrs of artificial light. The chicks and laying hens are vaccinated regularly against contagious diseases like Ranikhet, fowl pox, fowl cholera, etc. Debeaking is also done to control feather pulling and cannibalism amongst layers and the feed and water are provided *ad libitum* throughout the period of rear. This rearing schedule is followed in India for the poultry birds in most of the government and private poultry farms. However, a universally optimal photic schedule cannot be defined because some of the parameters that are influenced by the photoperiod such as size and number of eggs are negatively correlated. The appropriate photic schedule and rearing conditions that can improve the reproductive potential or maximize the production features are greatly dependent on the genetic breed and the climatic conditions. Though the studies for defining the pertinent photoschedule for poultry productivity are being extensively carried out in Europe and America, adequate studies have not been attempted on Indian poultry birds creating a clear lacuna on this front.

The manipulation of reproductive functioning in birds by winter lighting was amongst the first technological advances used in poultry industry to enhance egg production. The influence of light on reproduction was first demonstrated by Rowan (1926) in migrating Juncos. It became a starting point for a series of physiological studies aimed at understanding how photoperiodic signals are perceived by birds and how these signals initiate the events that culminate in egg and sperm production. In birds, light is perceived through photoreceptors in the hypothalamus which act as biological transducers that convert photon energy into neural impulse, which in turn, are amplified by the endocrine system to control ovarian and testicular function and consequently the multitude of reproductive functions, behaviour and secondary sexual characters (see Etches, 1996). The extra retinal photoreception and the non-involvement of retinal photoreceptors in birds are evident from the fact that the responses of blinded and sighted birds to light-dark cycles are identical.

In seasonally breeding birds, successful reproduction demands the temporal organisation of gamete preparation in relation to the mate and environmental resources of energy. Photoperiodism is the process whereby endogenous circadian and circannual rhythms of body function are synchronized with external daily and seasonal rhythms. The reproduction in birds involves processes like gametogenesis, nest-building, fertilization and oviposition which are intricately interrelated and controlled by environmental stimuli (light, temperature, food, etc) which triggers a cascade of changes in the general physiology and hormonal milieu of birds. A range of environmental stimuli is transmitted through the CNS to effect the liberation of neurohormones or releasing hormones (RH) in the median eminence of the pituitary gland. These neurohormones are transported via portal blood vessels to the anterior lobe of pituitary to release pituitary hormones, mostly gonadotropins which in turn regulate gametogenesis and synthesis and secretion of steroid hormones (see Sturkie, 1986).

Birds exhibit a wide spectrum of adaptive photoresponsiveness which phase the hypothalamic neurosecretions which eventually regulate migratory fattening, moult, gonad development and other photoperiodic functions. Reports on the effects of skeleton and ahemeral photic schedules have shown varied effects on gonad development and reproduction in seasonally breeding birds (Menaker, 1965;

Hoffmann,1971; Enright, 1965; Follett and Sharp, 1969; Hamner, 1965). A definite role of pineal in reproduction is however highlighted by many studies showing influences of photoperiodism in regulating the annual gonadal cyclicity of temperate species of birds (Wigfield and Farner, 1980; Follett, 1980). Whereas, studies on tropical species of birds have indicated that annual gonadal cyclicity may not be directly dependent on photoperiodism though many of them are shown to be responsive / sensitive to photoperiodic manipulations (Marshall and Disney, 1956; Lofts,1962; Epple *et.al.* 1972; Lewis *et al*, 1974; Thapliyal, 1981; Patel *et al*, 1992). The house finch for example, is non-stumulatory to short days (LD 6:18), but long days (LD 18:6) leads to rapid testis growth and spermatogenesis (Hamner,1964).

As in seasonally breeding birds, photoperiodism is an important factor in poultry birds and manipulation of the same is one of the most powerful management tools in poultry industry. Hence, it is important to know how many hours of light must be given before domestic birds will recognize that they have been exposed to long days and to know how day length is related to subsequent rate of gonadotrophin secretion and gonadal growth. Poultry birds like chicken, turkey and quail are known to utilize internal circadian rhythms to differentiate between short day and long day. The long days are known to stimulate gonadotrophin secretion since they are known to illuminate the "photosensitive phase" of the 24 hrs. cycle (Follett, 1974). Similar effects are observed by intermittent lighting regimens which are equally effective in controlling the reproductive process in domestic birds (see Etches, 1996). Acquisition of photosensitivity post-hatch has been observed in chicks after exposure to short days for 8-12 weeks for them to respond to transfer to long days. But long exposure to short days provide no stimulation since it is required only to dissipate photorefractoriness. Short exposure to long days provides a large stimulatory response resulting in increased plasma LH and increased egg production in layers. Long exposure to long days sets in photorefractoriness and dissipates the stimulatory effect of long days. These responses are assumed to be the sum of inhibitory and stimulatory inputs to the GnRH secreting neurons depending upon previous exposure to light (Sharp, 1993). Morris (1994) has suggested depressed egg yield in hens transferred from natural summer day length to artificial short days at 18 weeks or getting more egg output but smaller ones by manipulating the age at sexual maturity. Increasing (step-up) photoperiod advance sexual development in pullets and tends to stimulate the rate of lay after maturity whereas decreasing (step-down) photoperiod has an opposite effect. By contrasting a step-up and step-down rearing programme it is possible to obtain a difference of 6 weeks or more in age at 50% lay and there are important consequential effects on yield. Flocks brought into lay early will lay smaller eggs not only when they start laying, but at all the subsequent ages. Total egg output (Kg. eggs/hen) is usually curvilinear function of age at 50% lay with a maximum value for flocks which have been brought into lay near the middle of their potential range. However, most of the studies are restricted to the temperate species of laying hens like ISA Brown, Shaver 288, Babcock 300, etc. (Lewis *et al*, 1996 a,b&c) but, reports are scant on tropical species of domestic fowl with practically no report of the Indian RIR on its egg laying cycle. Hence it was thought pertinent to study the effect of a step-down photic schedule on the egg laying cycle in RIR hens.

An avian egg is a biological structure which protects and provides complete nourishment for the developing embryo and hence is considered the most complete food in the human diet. Its composition in the domestic fowl is of important economic interest as many factors that can affect their size, composition and viability. A variety of factors or a combination of some are known to have a definite effect on the egg size and composition. In general, the composition as opposed to the size of the egg is fairly resistant to manipulation through alterations in the diet fed to the hen. Since the proteins in albumen and phospholipoproteins in yolk are deposited in the egg in order to meet specific requirements of developing embryo, the major components in egg are relatively insensitive to dietary changes. Although reports suggest influence of environment, dietary and genetic manipulations on egg composition (Cruikshank, 1941; Gutteridge and O'Neil, 1942; Everson and Sounders, 1957; Patton and Palmer, 1958; Cunningham *et al*, 1960; Edwards, 1964; Chung and Stadelman, 1965; Marion *et al*, 1965; Sibbald, 1979; Washburn, 1979), most of the studies have a nutritional bias as they are restricted to the lipid (cholesterol, phospholipids and triglycerols) (Riemenschneider *et al*, 1938; Cruikshank, 1941; Shortland, 1951; Rhodes and Lea, 1956; Evans and Bandemer, 1961; Edwards, 1964; Christie and Moore, 1970; Christie and Moore, 1972) and protein (Patton and Palmer, 1958, Parkinson, 1966, Cunningham and Lee, 1978) components of egg. Egg size is another important parameter which has been worked upon by scientists (to increase the size of egg) as smaller eggs have a low economic value. One of the ways of achieving desired egg size is by restricted diet during the pullet stage and / or a non-stimulatory photoschedule which delays sexual maturity. This enables the pullets to attain ideal body weight prior to lay. Methionine and linoleic acid fed with the diet are known to improve the egg size in laying hens (see Sandoval and Gernat, 1996). These changes in egg size are achieved through different physiological mechanisms as changes in protein and amino acid content in diet are known to affect primarily the deposition of albumen, whereas changes in consumption of linoleic acid alter yolk formation. Also, increased temperature and humidity reduce egg size as they reduce the food intake in laying hens.

The liver of a domestic fowl is site for synthesis of lipoprotein complexes which are transported via plasma to the ovary (McIndoe, 1959; Evans and Bandemer, 1961) and the magnum region of the oviduct synthesizes and secretes major part of albumen (Sturkie, 1986). A chicken egg is made up of 11% shell, 31% yolk and 58% albumen. Eggs on the whole are known to have 11.5% fat, 12.9% protein 73.7% water and 0.9% carbohydrates. The major components of albumen are water (88%) besides, having protein and fat (12.5% and 11.8%) respectively. The yolk is known to have 48% water, 16.6% protein and 32.6% fat. Taylor (1960) has reported that out of all these components of egg studied, yolk is resistant to drastic changes in composition and hence is called as the conservative component of a hen's egg. In recent years, much attention has been focused on the fat, fatty acid and cholesterol contents of egg. Although, cholesterol content of egg was found to be increased / altered by factory like genetic constitution, higher rate of lay, and seasonal variations, factors like oral hypocholestremic agents are also known to reduce the same (see Panda 1995). However, critical level of cholesterol is known to be maintained in the egg, below which the egg laying terminates abruptly.

A long photic schedule during the rearing period is known to improve the egg size by delaying sexual maturity. The present study aims at assessing changes in egg composition of pullets reared under a step-down photic schedule as compared to an NLD schedule (normal light-dark) and also see the possible effects of adrenocortical manipulations alone and in combination with a step-down photoschedule.

Adrenocortical and thyroid hormones are physiological indicators of various forms of stress in the fowl (Edens and Siegel, 1975; Etches 1976, Freeman 1978; Beuving and Vonder 1978; Siegel, 1980). Changes in the circulating levels of these hormones in the growing period would affect the growth and metabolism of various developing tissues. The study of effect of thyroid hormones on various facets of metabolism during post-hatch development have shown that though the inadequacy of growth and thyroid hormones have severe retarding effects, administration of either of the two to the normal animal was unable to stimulate growth appreciably. Apparently, growth is regulated by a complex and subtle endocrine milieu and not under the purview of a single hormone *per se*. Role of adrenocorticoids in avian post-hatch development is well known. Apart from their direct effect on various facets of intermediary metabolism, corticosteroids also exert permissive effects on secretions and functions of other hormones as well. Injections of corticosterone in chicks and castrated pheasants has been reported to depress body weight and to increase carcass fat content (Baum and Meyer, 1960; Nagra and Meyer, 1963; Nagra *et al*, 1963). Magai and Hutson (1974) reported decreased body weight in their studies on three week old male chicks treated with dexamethasone (DXM) and corticosterone (CORT). Similar results have been reported by a previous study in this laboratory in White leghorn cockreals (Joseph and Ramachandran, 1992). Injections of CORT, deoxycorticosterone and adrenocorticotrophic hormone (ACTH) have been reported to induce ovulation in laying hens. Injections of metyrapone can influence the timing of ovulation and injections of dexamethasone can block ovulation (see Etches, 1996). Gross *et al* (1980) reported that feeding chickens with CORT for 10 days resulted in dose related decrease in weight gain, reduced size of lymphoid organs (spleen, thymus, bursa), testis, adrenal and breast muscle, and increased body and liver fat.

The present study aims at assessing the changes in body weight and histo-gravimetic changes of thyroid, adrenal and ovary and, gravimetric changes of liver and lymphoid organs under induced mild hypercorticalism (by corticosterone) and hypocorticalism (by metyrapone) during post-hatch development (0-90days) and the changes in serum T_3, T_4, progesterone and corticosterone levels thereat.

In a nutshell, the thrust of the experimental investigations of the present thesis is -

1 To study the changes in first and second cycle of lay under normal light-dark (NLD) and step-down photic schedule of LD 18:6 (LP) and further see the effect of mild hyper. or hypocorticalism alone or in combination with LP (Chapters II, III and IV).

2. To assess the effect of chicks reared under NLD or LP on some of the physical features and chemical composition of their eggs and further see the effect of mild hyper. or hypocorticalism alone or in combination with LP on the same (Chapters V, VI and VII).

3. To understand the effect of NLD or LP or in combination with hyper. or hypocorticalism on body weight and organ growth, serum hormone profile and histometrics of the ovarian follicles in post-hatch chicks till 90 days of age and to co-relate these changes with the initiation of egg laying (chapters VIII, IX, and X).