STUDIES ON GROWTH PERFORMANCE, MORPHOLOGY, REPRODUCTIVE TRAITS AND BEHAVIORAL ASPECTS OF RING NECKED PHEASANTS IN CAPTIVITY

BY

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To,

The Controller of Examinations,
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We, the Supervisory Committee, certify that the contents and form of the thesis, submitted by **Ms. Sana Ashraf, Registration No. 2008-VA-726** have been found satisfactory and recommend that it should be processed for further evaluation by the External Examiner(s) for award of the Degree.

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PROF. DR. MUHAMMAD AKRAM
IN THE NAME OF ALLAH, 
THE MOST COMPASSIONATE, 
AND 
THE MOST MERCIFUL.
Order Galliformes includes pheasants, which consist of species referred to as game birds; the megapodes (Megapodiidae), cracids (Cracidae), guinea fowl (Numididae), New World quails (Odontophoridae), turkeys (Meleagrididae), grouse (Tetraonidae), partridges, Old World quails, and pheasants (Phasianidae) (Delacour 1977). Worldwide there are 181 species of pheasants while 49 of them are present in Asia (McGowan 1994). Five species of Himalayan pheasants i.e. Monal (*Lophophorus impeyanus*), Koklass (*Pucrasia macrolopha*), Western Horned Tragopan (*Tragopan melanocephalus*), White Crested Kalij (*Lophora leucomalana*), and Cheer (*Catreus wallichii*) are indigenous to Pakistan (Andersson 1994). According to wildlife survey reports of cheer pheasant is locally extinct while western horned tragopan is threatened. The population of monal and kalij pheasants is declining day by day however number of koklass is abundant but needs simple protection.

In developing world pheasant production and shooting is one of the most productive businesses (Pacec 2006). The industry is important in managing and conserving rural areas (Grahn et al. 1993). Two main attributes that make pheasants more important flagships include (i) they are eye catching and most impressive species in nature, therefore they are often put on display in aviaries and on posters for conservation and educational purposes and (ii) they are widely used as a source of food (McGowan and Garson 1995; Fuller and Garson 2000). Pheasants are favorite game birds for hunters not only for their nutritious meat with low fat, high essential amino acids and fatty acids content as compared to broilers, duck and geese (Tucak et al. 2004; Adamski and Kuzniacka 2006; Strakova et al. 2006).
On hunting grounds pheasant production is inadequate due to their decreasing natural habitat, poor feeding conditions and increasing number of hunters. Supplementary feeding in hunting grounds may to a definite level affect the number of birds (Hoodles et al. 2001). So pheasants are bred in captivity under control conditions, similar to broilers and at certain age are released in the wild (Brittas et al. 1992). In wild, pheasants have poor survival rate due to their predators, parasites and condition failure. However, breeding and growing of pheasants under controlled conditions in captivity is of remarkable economical impact.

Pheasants are sexually dimorphic. Males are adorned with ornaments while females are simple. Males are heavier and have colorful brilliant plumage (Mcgowan 1994). Many experiments were conducted to find out the influence of diet components, nutrition, incubation parameters and internal quality of eggs on pheasant reproduction and chick quality (Nowaczewski and Kontecka 2005; Kozuszek et al. 2009; Krystianiak et al. 2005).

Eggs include in very nutritious food that sustain life during embryonic development. Eggs of most bird species have almost similar nutritional composition but the information on egg quality characteristics is limited mostly to domestic fowl (Scott and Silversides 2000). It has been defined in literature that in laying season a pheasant laid 10-170 eggs (Slaugh 1988; Tepeli 1998). Egg quality either external or internal influence the acceptability to buyer however external quality factors include freshness, egg weight and shell quality. On the other hand internal quality factors such as albumin index, yolk index and proportion of egg components are very important in egg product industry (Song et al. 2000). Egg characteristics are also influenced by different factors including feeding, flock health, storage conditions and housing (Hurnik et al. 1997).
Protein and nutrient deficiency can cause poor growth and feathering in wild birds (Cain and Creger 1975; Woodard et al. 1977; Beer 1988; Ohlsson and Smith 2001) and also reduce the resistance to wet and cold weather (Scott et al. 1954). In wild, pheasant chicks need dietary protein for their development and survival. The size of adult pheasants has been shown to differ between cohorts (Wittzell 1991) and during chick development the size of juvenile birds in winter was related to weather conditions. In contrast, Woodard et al. (1977) found that a low protein intake during the growth stage resulted in slower growth in pheasants but had no effect on final weight.

Genetic relationship among body weight and egg weight has been reported by many researchers (Duncan and Mench 2000; Santos et al. 2000). Wilson (1991) observed positive correlation between egg weight and hatched chick weight. The reason may be that the larger eggs provide more nutrition to the developing chicks and higher weight (O’Connor 1984). Caglayan and Inal (2006) reported increasing chick weight with increasing egg weight for quails and Ipek and Dikmen (2007) for pheasants. Khurshid et al. (2003) reported that new born chick performance is affected by shell weight, shell thickness, egg weight, weight of egg yolk and albumen.

In captivity, zoos, laboratories, or in intensive farming systems animals often experience the environmental deprivation that results in the performance of abnormal or stereotyped behaviors (Mason 1991). Shepardson et al. (1990) reported that the success of additional developments in improving welfare is defined by an observed difference in behavior such as rise in the activity levels of animals. However, there is no independent criteria for measuring the value of the observed changes in behavior. Dawkins (1990) developed a model by applying concepts from human consumer demand theory, in which the relative value of behaviors
could be judged from the animals’ point of view. It was argued that in captivity if animals are deprived of opportunities to perform their behaviors then the animal’s welfare is at risk. Concern over the welfare of laying hens, mostly those kept in intensive systems has led to the suggestion that the "natural" behavior of the species should be used to assess the welfare of intensively kept birds (Thorpe 1965; Farm Animal Welfare Council 1986).

However, not all departures of captive or domestic animals from the behavior of their wild ancestors constitute a welfare problem and independent evidence is needed that such departures cause suffering (Hughes 1980; Dawkins 1988). For example, high motivation to perform prevented behavior can be measured by seeing how much of a cost an animal is willing to pay to obtain access to or to avoid being in contact with something (Rushen 1986; Dawkins 1988).

At early stages of post hatching, immune system depends on the food quality, because during this stage lymphoid organs are developed and leukocytes are increased in number (Klasing 1998). However during this stage deficiency of specific nutrients which are required for the development of lymphoid organs affects the immune system later (Klasing 1998). Confined systems are always helping to increase the population of game birds but in special breeding systems high density of birds is responsible for transferring mycotic and parasitic agents which cause diseases and heavy losses. Prevalence of endoparasites has been recorded up to 82.5% in pheasant farms (Kotrlá et al. 1984). In wild and reared game birds, the most pathogenic species are roundworms (Syngamus trachea, Capillaria spp., Heterakis isolonche, Ascaridia spp.) and coccidia (Eimeria spp.), which are common and reduce the breeding success (Goldová et al. 1993). However, outbreak of diseases can be avoided by knowing the biological cycles,
transmission ways and survival of infective stages of parasites. In range birds, parasites have an indirect life cycle and are responsible for severe losses (Goldová et al. 1993).

In Pakistan as well as in many other countries pheasant farming is becoming more popular due to human consumption. In Iran several commercial pheasant farms have been established as a new agricultural activity for commercial production of meat while each year number of the pheasants reared has been increasing exponentially. Numerous studies have informed the values of blood parameters in gallinaceous poultry (Jerabek et al. 1993; Suchy et al. 2004; Tumova et al. 2004; Meluzzi et al. 1992; Strakova et al. 1993; Itoh et al. 1995; Bounous et al. 2000), but in literature only a few experiments on the biochemical parameters for pheasants have been reported (Schmidt et al. 2007a, b, c; Suchy et al. 2010). Jain (1993) reported that blood examination is performed for numerous reasons such as screening procedure to assess the general health. Moreover, the blood parameters are affected by age, gender, genotype, physiological condition, diet, micro- and macroclimatic conditions, rearing method, season, and pathological factors. While sample collection and the examination methods of blood parameters also play a vital role (Meluzzi et al. 1992).

Big pheasantries regularly pay attention on health status examinations. So the hematological examination is among the important methods which may contribute to the recognition of some changes in health status, which may not be seeming during physical examination but affect the fitness of the birds (Kronfeld and Medway 1969; Bradley and Threlfall 1974; Gavett and Wakeley 1986).

There is increasing awareness of the potential for domestication to occur as a by-product of wild animals being kept and bred in captivity (Price 1999, 2002). However much of the work on captivity is based on production rather morphological, ornamentation or reproductive traits
which could have important implications for the management of wild and captive populations as a whole, but as yet these have received little attention. There is an essential difference between the aims of productive business and conservation, therefore the birds reared under captivity are not analyzed for their biological characteristics, ornamentations, ethological and reproductive traits (Hollister 1917; Howell 1925; Price 1999, 2002). The present study was therefore planned to study growth performance, morphology, reproductive traits and behavioral aspects of ring necked pheasants in captivity.
Pakistan has a rich animal diversity which stems from its unique geographic position. The country is composed of a blend of three of the world’s six biogeographic regions – the Oriental, the Palaearctic and the Ethiopian. Pakistan lies at the western end of the South Asian subcontinent which is a suture between the Indo-Malayan and the Palaearctic regions whereas it is connected to the Ethiopian region through a land mass towards the southwest. The Indus demarcates a boundary between the Indo-Malayan and Palaearctic regions as Indo-Malayan forms are predominant in the east of the Indus while the mountains of the north and west hold the Palaearctic forms. The Palaearctic species include a mixture of those common to a large part of Eurasia, along with resemblances to the Middle East, West Asia (Afghanistan and Iran), Central Asia and Tibet. The unification elements from different origins ensure a unique and diverse mixture of fauna and flora (Roberts 1997; Mahmood-ul-Hassan et al. 2009).

The pheasants are Asian in their native distribution, except Congo peafowl, which is endemic to the Democratic republic of Congo in central Africa. These pheasants can be easily divided into two groups as high altitude species, which inhabit snow bound habitat of Himalayas or in the higher mountain ranges of China, Japan and Taiwan, and low altitude species which need heat and protection to survive in winter with below freezing temperature. Low altitude species are found mainly in Malaysia, Indonesia and Philippines. Red jungle fowl is another important member of family Phasianidae which inhabit middle of the above extreme altitudinal profile. The incredible variety of domestic poultry, such as Polish bantams, millefleurs, Brahmas, battery hens, and fighting cocks are all derived from Red Jungle fowl.
All pheasant species are either threatened or vulnerable due to habitat disturbances in most of their native range. Over one-third of total species of pheasants are officially listed as in danger of extinction from their native habitat (Howman 1993; IUCN 2006). Pheasants have always been a source of attraction for humans. The reason behind this attraction and interest is their beautiful feathers. They are also easy to trap or shoot and they are a rich source of protein (IUCN 1998). Pheasants are important sources of economic and social improvement through sustained and managed harvesting (Long 1981), developing potential habitat sites as game reserves to boost employment and revenue for local people and land owners (Aebischer 1997a,b), source of cultural traditions, visible in art, religion, and folklore of different ethnic groups in Asia (McGowan 1994), potential for enhancing ecotourism, hunting, and social improvement of local communities in developing countries by their scientific management in their natural habitats as well as by rearing in captivity (Malik 2003). Pheasant species can be used as a biological indicator to monitor the health of the ecosystem and other associated wildlife species (Malik 2003).

The ring-necked pheasant is a sexually dimorphic species, with males being larger and extensively ornamented compared to the cryptic females. The males’ various ornaments are used in both intra- and inter-sexual selection (Mateos 1998). Pheasants have a socially polygynous mating system and males do not participate in the rearing of young. In a Swedish population of pheasants, spur length was the most important trait for female mate choice, with a female preference for long-spurred individuals among after-second-year old males (Von Schantz et al. 1989; Goransson et al. 1990). In a study of pheasants in Spain, the length of male spurs was correlated to physical condition and dominance, however there was no female preference for long spurred males (Mateos and Carranza 1996). Instead, female choice seemed to be based on
characteristics of the wattle as well as the length of ear tufts and tail feathers (Mateos and Carranza 1995). In a study of English pheasants, the brightness of the wattle was important for female choice (Hillgarth and Wingfield 1997). The red wattle in male pheasants is a striking character that can be engorged and is used during courtship as well as in dominance behaviour between males (Taber 1949; Mateos 1998).

It has been experimentally shown that by compensatory growth early weight gain losses due to poor feeding can be recuperated (Ohlsson and Smith 2001). However, body mass of pheasants in the moment in which they are settling is very important for their survival when feeding conditions on the hunting grounds are poor. Due to the above, great attention is paid to pheasant nutrition in hatcheries. Feeding is at the beginning very intensive and is based mainly on concentrated feeds. Later on, feedstuff such as greens and grains is introduced in order to mimic natural feeding conditions (Kokoszynski et al. 2008).

Each year, around 25 million hand-reared juvenile common pheasants *Phasianus colchicus* are released in late summer into the British countryside to supplement wild stocks for shooting (Tapper 1999). The scale of pheasant rearing operations means that most of these birds hatch from eggs carried in mechanical incubators and are reared in pens without the presence of adult birds until release at, typically, 6-8 weeks old (Anonymous 1996).

Strakova et al. (2006) explored amino acid composition of breast and thigh muscles of common pheasant and compared it with that in broiler chickens. The experimental feeding of both pheasant and broiler chickens proceeded for a period of 42 days at the identical conditions employing the same diet and rearing technology. Muscles were analyzed for the content of amino acids. The results show that the levels of most amino acids in thigh and breast muscles of pheasants (related to dry matter content) were significantly higher than those in broiler chickens.
In case of broiler chickens the levels of most amino acids in breast muscles were significantly higher than those in thigh muscles. In the case of pheasant chickens, the difference between breast and thigh muscles was not confirmed which indicates that both muscles have high nutritive value. The results of amino acid composition of pheasant and broiler meat have proven a high nutritive value of pheasant meat in respect to human nutrition.

Tufarelli et al. (2011) investigated the effect of pelleted diets differing by levels of grinding preparation (2 or 4 mm) to evaluate pellet quality and diet preferences in adult breeders poultry species guinea fowl (Numida meleagris), layer hen (Gallus domesticus) and pheasant (Phasianus colchicus). The parameters evaluated in 4 week feeding trial included: live body weight, feed intake, feed efficiency and pellet durability index. Dietary treatments influence body weight gain, feed intake and feed efficiency in each poultry species. The present data suggest that pellet particle size is advantageous in terms of feed intake and efficiency in poultry.

Differences in growth conditions during early life have been suggested to cause long-lasting effects on morphology and quality of adult birds. The effect of early growth conditions on the expression of sexual ornaments later in life in male ring-necked pheasants (Phasianus colchicus) was investigated by manipulating dietary protein intake during the first eight weeks post hatching. Males receiving fodder with 27% protein during the first three weeks of life grew larger and more colorful wattles at sexual maturity than males receiving a low-protein diet (20.5% protein). Spur length was unaffected by diet treatment. Manipulation of food protein levels during weeks 4–8 after hatching had no effect on the development of ornaments (Ohlesson et al. 2002).

Oxidative stress may provide a proximate link between investment in growth and reproduction and investment in self-maintenance. Dietary antioxidants, such as carotenoids and
vitamin E, provide potentially important roles in regulating these trade-offs. Recent work suggests that carotenoids may have synergistic effects in combination with non-pigmentary antioxidants (e.g. vitamin E) in adults (Orledge et al. 2012).

Nowaczewski and Kontecka (2005) investigated effects of three doses of vitamin C (100, 200 and 300 mg/kg) added to the feed of reproductive pheasants on egg production, egg fertility and parameters of hatchability. In experiments I and II, birds were kept in outdoor aviaries. In experiment II, air temperatures recorded on the farm during the experiment were high (25–30ºC), differing considerably from those recorded in the preceding years. In experiment I no statistically significant differences were shown between the control pheasants and those supplemented with 100 and 200 mg/kg vitamin C in terms of egg production, egg fertility and parameters of hatchability. The poorest results were found in the group of birds receiving a feed supplemented with 300 mg/kg vitamin C. In experiment II, statistically higher egg production and egg fertility were noted, compared to the control group, in the groups supplemented with 100 and 200 mg/kg vitamin C. Compared to the control group, pheasants from these groups were also characterized by higher hatchability from set eggs and fertilized eggs and smaller number of unhatched chicks and dead embryos after day 10 of incubation. In experiment II, the beneficial effect of 100 and 200 mg supplements of vitamin C on the studied parameters could result from the soothing action of the vitamin on the effects of heat stress.

The high cost of high-protein pelleted feed (pheasant grower diet) means there is a motivation among game managers to revert to a grain-only diet as early as possible in the growth cycle of a juvenile pheasant. Studies of pheasants indicate that deficiencies can occur if this switch is made too early. Deficiencies in proteins and nutrients in particular can cause poor growth and feathering (Cain and Creger 1975; Woodard et al. 1977; Beer 1988; Ohlsson and
Smith 2001) and reduce resistance to cold and wet weather (Scott et al. 1954). On the other hand, continued availability of pelleted feeds can lead to poor adaption to wild foods, particularly in relation to foraging behavior and development of the alimentary tract (Thomas 1986).

There are a number of recommendations which differ greatly in the quantity of nutrients. According to AEC (1987) pheasants' requirement for proteins are as follows: 24% for the first period from 0 to 4 weeks of age and 24% for the second period of growth. INRA (1984) recommendations are 23.1% - 28.7% crude proteins in the first phase and 14.8 - 17.2% during the second phase. Woodard et al. (1983) recommend 18% crude protein for battery fattening of pheasants and 16% when floor reared. On the other hand reference values in the last years are increasing and range from 20 to 40% proteins (Sheppard et al. 1998). According to NRP (1994) protein levels in feeds for the first phase of growth are 28% and 24% for the second period. Dietary protein level is relevant for production due to the fact that 50 - 80% of production expenses are for nutrition (Dordevic et al. 2009).

Recently, there have been some trends to revive and develop intensive pheasant farming. Pheasant farms and nurseries have to ensure that game bird receives adequate nutrition throughout the year, using supplemental or complete feeding mixtures. Number of authors studied the dietetic assessment of pheasant meat who focused particularly on basic analyses such as content of water, protein content, fat and ash, yield of carcass and individual parts of the bird (Richter 1992; Richter et al. 1992).

Exact data on the detailed chemical analysis of pheasant meat are not currently available in the scientific literature. Pheasant meat has a specific taste which results from distribution of peptides, as compared with other kinds of meat (Straka and Malota 2005). The quality of the carcass of farmed pheasant and broiler chickens can be assessed on the basis of a large number
of criteria to evaluate sensory, morphological, histological, physical, chemical, health, hygienic and technological properties and features. Uherova et al. (1992) drew conclusion that game meat contains higher levels of essential amino acids, as compared with the traditional, currently produced kinds of meat. Ricard and Petitjean, 1989 compared the composition of pheasant carcass with the carcass of broiler chickens of similar bodyweight.

The expression of ornaments may be dependent on the ability of bearer to defend itself against pathogens (Folstad and Karter 1992; Von Schantz et al. 1996; Westneat and Birkhead 1998). As red pigmentation has been shown to relate to infestation of parasites (Milinski and Bakker 1990; Brawner et al. 2000). According to this theory, the bearer of a high-quality ornament signals a high resistance to parasites and diseases. Food quality during the first weeks post hatching is likely to be important for the development of the immune system, because during this period there is a rapid expansion of leukocyte populations and seeding of lymphoid organs (Klasing 1998). A deficiency (or an extreme excess) of nutrients during this critical period may affect immunity later in life (Klasing 1998).

The early stages of somatic growth and development constitute a critical period, with high energetic demands. A poor ability to handle nutritional stress during this period may result in retarded growth and smaller size, or even death (Boag 1987; Richner 1989; Dahlgren 1990; DeKogel and Prijs 1996; Lindstrom 1999). There may be link between early development and later expression of ornaments. The effect of nutrition and environment on the growth of young pheasants is an issue of concern both in natural and farm conditions (Woodard et al. 1979; Kjær 1997; Tucak and Klaic 1997; Krystianiak and Torgowski 1998). However, there are few publications providing information on body weight and morphometric measurements of pheasants at different ages (Kuniacka and Adamski 2010; Kokoszynski et al. 2011).
Females often base their choice of mates on the expression, size, or colour intensity of male sexual ornaments, and it has been suggested that females with such preferences obtain good genes for their offspring (Andersson 1994). To be a reliable signal of good genes, these traits must reveal something about the bearers’ quality (Zahavi 1975, 1977; Grafen 1990; Iwasa et al. 1991). If the expression of male sexual ornaments is affected by nutrition, the ornament is condition-dependent and may signal both phenotypic and genotypic quality. The bright yellow, orange and red colours commonly found in the combs, wattles, beaks, skin patches, eyes and feathers in birds are in most cases caused by carotenoid pigmentation (Ralph 1969). In several bird species, these carotenoid based colours function as ornaments and are used by females when selecting mates (Burley and Coopersmith 1987; Hill 1990). In Swedish pheasants, it has been shown that males with longer spurs gain larger harems and have higher viability (Von Schantz et al. 1989; Göransson et al. 1990), and they sire more offspring that survive better (Von Schantz et al. 1994). Moreover, males with certain MHC haplotypes, a highly variable gene complex that is important for immune function as it underlies recognition of pathogens, had longer spurs and higher survival, suggesting that spur length may reflect both viability and immune function (Von Schantz et al. 1996). It has been argued that there are reasons to believe that both spur length and immune function are sensitive to oxidative stress, and thus also to access to antioxidants such as carotenoids and vitamins (Von Schantz et al. 1999). Hence, spur length could be an ornament that is reflecting the carotenoid (and vitamin) content of the diet.

External and internal qualities of eggs are of major importance to the egg industry worldwide. Egg shell quality may be measured as size of egg, specific gravity of egg, shell colour, shell deformation, shell breaking strength, shell weight, shell thickness, percentage shell, and shell ultrastructure. Time to time new methods arise to measure the egg quality parameters.
Internal quality of egg is measured as colour of yolk, the strength of the perivitelline membrane, and albumen quality. Many factors influence the egg quality characteristics such as strain, age of hen, diets, nutritional factors such as calcium, phosphorus, vitamins, water quality, enzymes, non-starch polysaccharides, contamination of feed, induced moulting, stress, heat, disease, storage and production system. An understanding of these factors is essential for the production of high quality eggs (Roberts 2004).

Nowaczewski (2010) compared the egg weight with regard to their shape, time of storage, hatchability and body weight of one-day old chicks in Japanese quail. Small weight eggs, stored for one day, with the smallest yolks were characterized by their highest content contrary to the heavy weight eggs, with biggest yolks were characterized by their smallest percentage content. Higher weight eggs have certain increase in weight, yolk and albumin percentages as compared to smallest ones. Moreover, lengthening of the egg storage did not significantly affect the albumens weight. The yolk and albumen index as well as Haugh units were slightly higher for smaller weight eggs as compared to bigger ones after one-day storage. However small and medium weight eggs were more spherical in shape while large and extra-large eggs had smaller weight losses during hatching. Heavy weight eggs were characterized by the best fertilization, hatchability results, less percentage of dead embryos and unhatched chicks. The heaviest chicks were obtained from eggs of the highest weight, while the lightest from eggs of the smallest weight.

In the process of domestication a population of animals is genetically changed as a result of selection by man (Hale 1962). So throughout the domestication animals have been able to utilize improved and increased resources provided by man such as protection against predators and unfavourable conditions of weather conditions and food delivery, which has transformed
selection pressures and may have produced modified behaviour. It is usually believed that domestication and artificial selection have only altered the frequency of behaviours by changing the thresholds of the behaviours, rather than adding or eradicating behaviours to the animal's behaviour catalogue (Price 1998). However in farm animal's selection only emphasized on production traits while less attention is being paid to other behaviours. Behaviour may be secondarily affected by selection and studies of such correlated responses may proposed new visions that how behaviour is improved under different environmental limitations, and hence into its evolution.

Behaviors may be considered as states or as events. Events are instantaneous while states have considerable duration. So in reality behavior include some performances which take a brief amount of time (Altmann 1974). A study was conducted on semi-wild jungle fowl to allocate their time budget between different activities. During the active part of the day hens spent the high proportion of time in foraging activities such as ground pecking and ground scratching (Dawkins 1989).

Zheng (2009) reported that non-provisioned birds spent more of their time budget in foraging and feeding while less of the time in resting as compared to provisioned birds. The amount of time a bird allocate to different activities may mirror its energy budgets (Ricklefs 1996). In breeding season wild ring-necked pheasants are territorial, protecting harems from potential enemies by showing different displays such as calling, wing flapping, and aggressive acts such as chasing fighting and pecking (Taber 1949; Ridley and Hill 1987; Mateos 1998). However non-territorial males do not display or fighting behaviour but nevertheless may mate with unaccompanied females (Burger 1966). Moreover at the end of the breeding season males do not show the territorial behavior, mate defending and become friendlier to other males.
However, in enclosed multi-pens it is not possible to maintain territories, stable harems, leading to more male-male fighting, and greater disturbance of courtship between males and females. High stocking density can progress to other undesirable responses including more aggressive pecking and feather pecking. In pheasants aggressive pecking is generally focused at the head region for short duration (Hoffmeyer 1966). Aggressive pecking can be associated with competition for resources, establishment of hierarchies (Hoffmeyer 1966). By contrast, feather pecking includes gentle pecks to any area of the body such as wings, chest and back, it also involves plucking and ingestion of feathers (Hoffmeyer, 1966). High stocking density increases feather pecking damage (Cain et al. 1984; Hoffmeyer 1966; Kjaer 2004) by reducing chance to interact with natural forage substrates, whereas increasing the chance to peck feathers due to smaller inter-bird distances.

The purpose of haematological parameters and plasma metabolite levels may provide highly valuable information on the physiological state and form the basis of the medical diagnosis of diseases (Hauptmanova et al. 2006; Harr 2002). Number of factors such as diseases, nutritional status, body condition, sex, age, diet, circadian rhythms, and captivity influence the clinical haematology and blood chemistry (Fudge 2000). So, understanding of the blood elements in the birds is a relevant diagnostic tool in veterinary medicine, and these values can be used as physiological indicators (Perelman 1999). Additionally, different examines for haematological and biochemical values in birds compared with mammals due to the anatomical and physiological differences can be used. For this reason, it is also important to make appropriate interpretation of these parameters used in avian medicine (Harr 2002).

Schmidt (2007b) reported that age has influence on hematological and serum biochemical parameters in juvenile ring-necked pheasant. Statistical analysis showed the difference in values
among different blood parameters related with age. In juvenile ring necked pheasants lymphocytes are the major circulating leukocyte while values for the red blood cells were lower for 60 day-old pheasants and higher were for 74, 88 and 102 day-old pheasants. The value for hemoglobin was higher in 88 day-old pheasants. The WBC, the heterophil and the lymphocyte values were significantly higher for 60 day-old pheasants. Total serum protein, albumin and globulin values for 25 and 60 day-old pheasants were significantly lower than the values for 42, 88 and 102 day-old pheasants.

It is well known that in several birds plasma biochemistry along with hematology is essential for medical diagnosis of disease, limited information is available for pheasants. Moreover, numerous studies have reported the values of blood parameters in gallinaceous poultry (Jerabek et al. 1993; Suchy et al. 2004; Tumova et al. 2004; Meluzzi et al. 1992; Strakova et al. 1993; Itoh et al. 1995; and Bounous et al. 2000), but in literature only few analysis on the biochemical parameters in pheasants have been reported (Schmidt et al. 2007a, b, c; Suchy et al. 2010), and the knowledge of serum chemistry parameters in pheasants still remains incomplete. Usually, blood examination is performed to assess general health of birds (Jain 1993). Glucose, calcium, cholesterol, total protein, uric acid, alkaline phosphates, sodium, potassium and chloride levels are diagnostic values for diabetes mellitus, liver disease, hypoparathyroidism, chronic hepatopathy, gout, kidney disease, chronic diarrhea, and dehydration. In birds clinical signs of diseases are frequently subtle so clinical chemistry is essential to evaluate the cellular damage (Ritchie et al. 1994). The blood parameter values are affected by many factors such as age, genotype, gender, physiological condition, diet, micro- and macroclimatic conditions, the method of rearing, season, and pathological factors. In addition,
the collection samples of biological material and the methods of laboratory analysis also play an important role (Meluzzi et al. 1992).

Common pheasants Phasianus colchicus are susceptible to high levels of parasitic infection (Draycott et al. 2000; Milla’n et al. 2002). Draycott et al. (2002) reported that the most common gastrointestinal worms are *Heterakis gallinarum*, *Capillaria spp.* and the tracheal worm is *Syngamus trachea* that infect the pheasants in Britain. Lund and Chute (1974) reported that pheasants are the prime host of *H. gallinarum* and Tompkins et al. (2000) reported that pheasants act as a reservoir for of infection for other species including grey partridges *Perdix perdix*.

Beer (1988) reported that such parasites are transmitted via an infective egg stage which can be directly ingested by ingesting the faecal matter or soil or indirectly via soil-feeding organisms including earthworms. However, Recent studies have shown that in juvenile pheasants helminth parasites can have negative influence on survival (Milla’n et al. 2002), and also on survival of the adult hens during incubation (Woodburn 1999).

Common pheasant is widely dispersed and abundant as a game bird in Britain (Tapper 1999). Stocks of the wild game birds such as pheasants and grey partridges have been significantly declined due to farmland owing to agricultural intensification over the last 40 years (Potts 1980; Campbell et al. 1997). Parallel with there has been an increased demand for game shooting (Tapper 1999), so these days, approximately 12 million pheasants are harvested each year in Britain (Tapper 1999). To uphold this high level of harvest, each year about 25 million hand reared juveniles are released on farms and estates throughout the British countryside (Tapper 1999). Usually in each summer these birds are released at 6–8 weeks of age into open-topped pens in woodlands by the game managers to increase numbers of birds available for shooting the following winter (Draycott et al. 2002).
Sage et al. (2005) reported that after release these pheasants acclimatize to their new environment and gradually scattered from the pens into the surrounding countryside. On game shooting lands pheasants are released at densities of almost 250 birds km\(^{-2}\) (Aebischer 2003) at a stocking density of around 1800 birds per ha of release pen (Sage et al. 2005). Pheasants in and around release pens are vulnerable to parasitic infection. Similarly, intensively managed wild pheasant populations can reach densities of around 150km\(^{-2}\) in the autumn (Draycott 2006) and are also susceptible to relatively high levels of parasite infection (Draycott et al. 2002, 2005).

Goldova (2006) studied 1030 samples of ring necked pheasant faeces to determine the endo- and ectoparasites at the Game Management Centre (GMC) in Rozhanovce. Coprological analysis of faeces revealed the presence of *Eimeria spp.* and eggs of nematode (*Capillaria spp.*, *Syngamus trachea*, *Heterakis isolonche*, *Ascaridia spp.* and *Trichostrongylus tenuis*). Two species of mites *Dermanyssus gallinae*, *Ornithonyssus sylvarium* (Acarina, Mesostigmata) and one species of burrowing mite *Knemidocoptes mutans* (Astigmata) were obtained while four species of chewing lice were described for the first time in the Slovak Republic: *Goniocotes chrysocephalus*, *Goniodes colchici*, *Amyrsidea perdicis*, *Lipeurus maculosus*. Chewing lice in game birds had been previously described in the Czech Republic and Poland; they had not been reported previously in the Slovak Republic.

Khattak et al. (2012) reported that ectoparasites increase birds’ sickness by sucking the blood and cause irritation to them so they affect their economic production. Comparative prevalence of ectoparasites was studied in domesticated and wild black (*Francolinus francolinus*) and grey partridges (*Francolinus pondicerianus*) from Khyber Pakhtoonkhwa province of Pakistan. Sixteen species of ectoparasites, including eight lice, four mite, three tick and one flea species, were collected from wild and domesticated black and grey partridges.
Domesticated and wild grey partridges were infected by seven lice species (*Menopon gallinae, Goniocotes gall, Menacanthus stramineus, Genero columbicola, Lipeurus caponis, Brueelia coquimbana, Coculogaster heterographus*), three species of ticks (*Haemaphysalis leporispalustris, Ixodes pacificus, Amblyomma maculatum*) 2 species of mites (*Ornithonyssus sylviarum, Dermanyssus gallinae*) and a flea species (*Pulex irritans*). While 57 black partridges (35 domesticated and 22 wild) were infested by 7 species of lices (*Coculogaster heterographus, Brueelia coquimbana, Menacanthus stramineus, Genero columbicola, Menopon gallinae, Lipeurus caponis, Goniodes gigas*), four species of mites (*Tyroglyphus spp., Dermanyssus gallinae, Ornithonyssus sylviarum, Sternostoma tracheacolum*), two species of ticks (*Ixodes pacificus, Amblyomma americanum*) and a flea specie (*Pullex irritans*). Studies on captive-bred animals provide a unique opportunity to assess the relative importance of environmental and genetic influences on morphology, which may have important taxonomic and evolutionary implications, and may affect the conservation and management of wild-living and captive populations. This latter point will become increasingly important as wild and captive populations of ring necked pheasants are managed together. Given that the current aim of zoos is to maintain self-sustaining, genetically diverse populations for up to 200 years (Soule et al. 1986), it is time that the consequences of morphological and physiological changes in captivity are quantified and addressed. The objectives of the present study therefore are,

**Statement of Problem**

Human population is increasing at an unprecedented rate and the situation demands for more and diversified food sources. Although poultry industry made remarkable progress during recent years however, the industry is facing lot of challenges like disease outbreak and resistance
against environmental stresses. The need of the day is to include more breeds that are resistant to the harsh climates and can be easily grown.

The core objectives of the present study include:

i. To study the reproductive performance and hatching traits of ring necked pheasants in captivity.

ii. To study the relationship between egg weight and growth traits in ring necked pheasants.

iii. To study the behavioral aspects of captive populations of ring necked pheasants.

iv. To determine seasonal variability in parasitic populations between two localities and sexes.

v. To record the hematological parameters of ring necked pheasants at different ages in captivity.
Literature Cited


CHAPTER 3

EXPERIMENT NO. 3.1

Title: Correlation of egg weight with egg quality parameters and growth traits in ring
necked pheasants (*Phasianus colchicus*) in captivity

This manuscript has been accepted in the Journal of Animal and Plant Sciences
CORRELATION OF EGG WEIGHT WITH EGG QUALITY PARAMETERS AND GROWTH TRAITS IN RING NECKED PHEASANTS (*PHASIANUS COLCHICUS*) IN CAPTIVITY

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Abstract

Present study was conducted to find out the relationship of egg weight with egg quality parameters and growth traits of ring-necked pheasant *Phasianus colchicus*. Total of 450 eggs were collected and were divided into three egg weight categories viz. light (20.0-26.0g), medium (27.0-32.0g) and heavy (33.0-40.0g) egg weight eggs. Fifty eggs for each of the egg category were reserved for the evaluation of internal egg quality parameters. External egg quality parameters i.e. egg length, breadth, egg volume and surface area varied significantly (P<0.05) between all the three egg weight categories. Similarly, significantly higher albumen and yolk weight were recorded in heavy weight egg category while non-significant relationship of egg weight was observed for shell and membrane thickness, yolk percentage, yolk index, yolk pH and albumen pH of the egg. The hatching percentage for the remaining 300 egg kept in incubator was 47.33%. Forty chicks from each of the egg weight category were selected and chick weight, wing length and wingspan were taken at the time of hatching and thereafter increase in these parameters were noted on weekly basis. The effect of egg weight on chick weight, live weight gain, wing length and wingspan was significant (P<0.05) from 1st to 12th month of age. Our
studies revealed that egg weight has strong influence on external and internal characteristics of the eggs and the growth parameters in *P. colchicus* chicks.

**Key words:** Galliformes, Egg geometry, Haugh unit, Chick weight, Wingspan

**INTRODUCTION**

Eggs provide nutrition and protection to the developing chicks, therefore the egg quality is of immense importance for the hatchlings. A positive correlation has been observed between egg weight, hatched chick weight, chick growth and its biometric traits in many of the bird species (Wilson, 1991). Hearn (1986) suggested that if eggs are separated by their weight and size in hatchery, and the hatched chicks reared separately, the slaughtering age variability would be reduced and the growth of each group would be optimized. Egg size affects the proportions of components of the hatching egg and the reduction in the proportion of yolk could be a disadvantage for developing embryos in eggs with small yolks. Similarly, shell quality plays significant role in gas exchange and moisture loss during incubation (Wangensteen *et al*., 1971) while poor shell quality may lead to the higher egg moisture loss and low hatchability (Reis *et al*., 1997; Peebles *et al*., 2001; Narushin and Romanov, 2002). The yolk (30-33%), albumen (60%) and the shell (9-12%) are the main components of an egg (Stadelman, 1995).

The strength of the egg is dependent not only on thickness of shell but also on its construction material and the egg breaking strength (Solomon, 1991; Roberts and Brackpool, 1995; Nys *et al*., 1999). In cases, where shell weight and thickness are good but shell breaking strength is poor, the explanation lies with the ultrastructure of the shell, or how well the shell has been constructed. Techniques, such as the measurement of dynamic stiffness of egg shell are being developed and compared with traditional measurements of egg shell strength (de Ketelaere *et al*., 2002). The quality of the newly hatched chick is a major factor in determining its
livability, growth and health. Sklan et al. (2003) considered chick weight as an accurate predictor of final body weight whereas for others this has not been the case (Gardiner, 1973; Shanawany, 1987). Most of the old breeder flocks lay heavier eggs and as a result heavier chicks are produced (Suarez et al., 1997; O’Dea et al., 2004). However, higher percentage of chicks with low quality scores was reported in older (45-wk) than in younger (35-wk) flocks (Tona et al., 2004). Poor chick quality, as reflected by high number of culled chicks, has been associated with heavier than average egg weight for a particular flock age (Kumpula and Fasenko, 2004; Lawrence et al., 2004).

Pheasant farming industry is flourishing in many parts of the world and the quality of eggs is considered the backbone for successful pheasant farming (Sogut et al., 2001). Moreover, the growth of chicks is directly linked with external and internal quality traits of eggs (Altinel et al., 1996). Pheasants are considered one of the favorite game birds for a large number of hunters, not only for their meat characterized by low fat and high essential fatty acids and amino acids content which make it of a higher quality compared to broilers, ducks and geese, but for hunting characteristics as well (Tucak et al., 2004; Adamski and Kuzniacka, 2006; Strakova et al., 2006). Current knowledge on the ecology, social behavior and biology of pheasants is minimal and there are opportunities for research and studies for biologists and avian scientists. The present study was therefore planned to find the relationship of egg weight with egg quality traits and growth parameters in P. colchicus in captivity.

MATERIALS AND METHODS
Eggs of the ring necked pheasant were collected from Captive Breeding Facilities, Department of Wildlife and Ecology, Ravi Campus, University of Veterinary and Animal Sciences, Lahore. The collected eggs were weighed and classified into light (20 to 26 g), medium (27 to 32 g) and heavy
(33 to 40g) weight egg categories. A total of 450 eggs comprising 150 eggs from each category were selected.

**External and internal egg quality parameters:** The external egg quality parameters viz., egg weight was taken by digital weighing balance measuring up to 0.1 g(make and model), egg length and egg breadth were taken by ordinary vernier caliper measuring up to 0.01 cm, while egg volume, shape index and egg surface area were calculated by using the following formulae;

**Egg volume (cm$^3$) = V = KvLB$^2$ (Narushin, 1997)**

Where;
- **Kv** = Coefficient for volume calculation= k$^V$ = 0.496
- **L** = Length of egg in cm
- **B** = Breadth of egg in cm

**Shape index (%) = Egg breadth/egg length x 100 (Parmar et al., 2006; Monira et al., 2003)**

**Egg surface area (cm$^2$) = k (πLB$^2$/6)$^{0.67}$ (Etches, 1996)**

Where;
- **k** = is constant
- **L** = Egg length in cm
- **B** = Egg breadth in cm

For internal quality parameters, 50 eggs from each egg weight category were broken in a glass plate and after five minutes, long & short diameters and height of both albumen & yolk were measured with vernier caliper while albumin index and yolk index were calculated using following formulae following (Abu-Tabeekh, 2011);

**Albumen index (%) = Albumen height /albumen diameter x 100**

**Yolk index (%) = Yolk height /yolk diameter x100**

The yolks and albumins were separated and were weighed using digital weighing balance. Yolk and albumen pH were recorded using digital pH meter (Make; HI 98107 pHep®).
Shells of the broken eggs were washed with tap water, air dried and weighed. Then stubby diameter, sharp diameter and equator diameter of shell with membranes were determined by vernier caliper. Shell membrane was then removed and its stubby diameter, sharp diameter and equator diameter were recorded accordingly.

Shell thickness, shell membrane thickness, shell ratio, yolk ratio, albumen ratio and Haugh unit were calculated using following formulae (Kirikci et al., 2003; AbuTabeekh, 2011);

**Shell thickness (mm)** = (sharp point thickness + equator thickness + stubby thickness)/3

**Shell membrane thickness (mm)** = (sharp point membrane+ equator membrane+ stubby membrane)/3

**Haugh Unit** = 100 x log (Albumen weight + 7.57 - 1.7 x egg weight x 0.37)

**Shell ratio (%)** = Shell weight/ total egg weight x 100

**Albumin ratio (%)** = Albumin weight/ total egg weight x 100

**Yolk ratio (%)** = Yolk weight/ total egg weight x 100

**Growth and egg weight relationship:** One hundred eggs from each of the three egg weight categories were selected for the investigation of the relationship of egg weight with growth traits in pheasants. These eggs were incubated in Victoria incubators (Italian made Make, model etc.) under standard conditions of incubation (North and Bell (1990). The eggs were then transferred to hatching machine for three days. A temperature of 36.5 °C and relative humidity of 85 % was provided for the eggs at hatching period.

After completion of hatching, 40 chicks for each of the egg weight categories were selected and tagged individually. Chick weight, wing length and wing span of day-old chicks were recorded at the start of experiment and thereafter subsequent increase in body weight, wing length and wingspan were recorded on weekly basis from 1st to 12th week of age.
Statistical analysis: The data were analyzed by using statistical software SAS 9.1 and Analysis of Variance (ANOVA) was applied to compare the means while correlation was applied to find out the relationship between egg weight and the chick weight from 1st to 12th week of age.

RESULTS AND DISCUSSION

Production of meat by chicken is linked with quality of eggs obtained from the breeder stock (Sogut et al., 2001; Altinel et al., 1996; McDaniel et al., 1979). The egg weight in *P. colchicus* varied from 20 to 40g with an average of 26.94±5.37g. The average egg length was 4.19±0.20cm, width 3.36±0.18cm, egg volume 23.10±3.639cm³, egg surface area 80.80±12.728cm² and shape index was 80.11±2.93%. Song et al. (2000) documented average egg weight in *P. colchicus* as 25.79±2.17g, egg length 4.23±1.57cm, egg breadth 3.36±0.93cm and egg surface area as 47.31±9.12cm². However, Demirel and Kirikci (2009) reported average egg weight in *P. colchicus* varied between 28.10 to 33.6g. Kirikci et al. (2005) recorded egg surface area ranging from 77.87 to 81.24cm².

Egg length and breadth varied significantly between heavy, medium and light weight eggs in the present study. Likewise, Bell and Weaver (2002) reported that heavier strains laid eggs with higher length and breadth. Chick weight is dependent on egg geometry, shell quality (Narushin, 2001; 2005) and egg interior quality (Narushin and Romanov, 2002; Narushin, 2005). During present study, significantly higher (P<0.05) values for shape index (81.22 ± 3.37 %) were observed for medium weight egg category while the same was lowest for heavy weight category. Significantly, higher egg volume (26.10 ± 4.16 cm³) and egg surface area (91.30 ± 14.58 cm²) were observed in heavy egg weight category followed by medium and light ones. According to Song et al. (2000) all the bird species have ovalish conical shaped eggs with pointed and blunt
ends, however, egg volume and shape index are influenced by age and strain of the laying hens (Rayan et al., 2010; Esen et al., 2010; Ali et al., 2012).

The shell percentage was higher (13.54±0.54%) in medium weight egg category followed by heavy (12.50±0.50) and light (11.62±0.68) weight egg categories (Table 1). These values were higher than the values documented by Song et al. (2000). Our findings are in line with the results of Song et al. (2000) who reported comparable yolk weight (9.31±1.05g) and albumen weight (14.34±1.05g).

A significantly higher (P<0.05) albumen (12.66±0.28g) and yolk (10.08±0.31g) weight was observed in heavy egg weight category as compared to medium and light weight categories (Table 1). Similar findings were observed by Birkhead and Nettleship (1984) who reported increase in amount of yolk with increase in egg weight. The percent egg yolk (38.55±3.44%) and the albumen (49.30±3.97%) recorded in the present study were higher than those reported by Song et al. (2000) i.e. 35.7±2.34% and 55.6±2.55%, respectively.

During present study non-significant differences in yolk index and yolk percentage were recorded in all the three egg weight categories. Birkhead and Nettleship (1984) reported that absolute amount of yolk increased with egg size and further explained that egg weight and chick weight is correlated. The values of yolk index and yolk percentage recorded during the present study were lower than the values noted by Kirikci et al. (2005).

Higher albumen index (2.94±0.04%) was observed in light weight egg category while the same was lowest in medium weight egg category (Table 1). Average albumen index, shell thickness, membrane thickness and shell weight were 2.82±0.33%, 3.62±0.45mm, 0.003±0.0007mm and 3.00±0.58g, respectively. The average albumen index reported by Kirikci
et al. (2005) was 1.47±0.37%, similarly Song et al. (2000) documented values of shell thickness as 0.241±0.035 mm and shell weight 2.22±0.39 g.

During present study significantly lower shell weight 2.50±0.15 g was observed in light weight egg category while shell and membrane thickness showed non-significant differences in all the three egg weight categories. Similarly, non-significant differences in albumen pH were observed in all the three egg weight categories while significantly higher yolk pH (5.56±0.10) was observed in medium weight egg category. Average Haugh unit values 89.95±4.28 recorded during present study were higher than the values 79.64±1.23 noted by Song et al. (2000). Significantly, lower Haugh unit (87.15±1.49%) was observed in heavy weight egg category. Silversides and Villeneuve (1994) and Silversides and Scott (2001) reported that Haugh unit is affected by the age of bird whereas Williams (1992) documented that bird nutrition did not affect albumen quality.

During present study 300 eggs were reserved for hatching purposes and 141 were successfully hatched. The average egg weight was 29.95 g while average chick weight was 15.16 g and the hatchability percentage was 47%. A positive correlation was observed between egg weight and chick weight during 1st, 10th and 12th week of age for heavy weight eggs (table 2). Similarly, positive correlation existed between egg weight and chick weight during 2nd, 3rd, 6th, 9th, 10th, 11th and 12th week of age for medium weight eggs (table 3) and in light weight eggs, positive correlation was observed between egg weight and chick weight during 8th, 9th, 10th and 12th week of chick age (table 4). In domestic fowls positive correlation existed between egg weight and hatched chick weight (Wilson, 1991) and heavy weight chicks got high value nutrition reserve that way they show high live rate (O’Connor, 1984). During present study, chick weight varied significantly between all the three egg weight categories and the chick
weight at hatching in light, medium and heavy egg groups was noted as 19.5 g, 21.8 g and 22.6 g, respectively. Ipek and Dikmen (2007) documented that a significant (P<0.01) relation exists between egg weight and the chick hatch weight and live weight. Chick weight in ring necked pheasants from day old chick to 3-month stage varied significantly between heavy, medium and light weight egg categories (Table 5).

Increase in chick weight in heavy weight egg groups ranged from 11.4g to 102.7g during 2nd and 9th weeks, respectively. Similarly increase in chick weight in medium category was minimum 8.75g during 2nd week and maximum 82.1g during 12th week. Overall minimum increase in chick weight was observed during 1st week and maximum during 8th week of chick age. Increase in chick weight in light weight egg category ranged from 6.88g during 2nd week to 68.6g during 9th week of its growth. During present study it was determined that hatching chick weight increases with increasing egg weight (Table 5). Caglayan and Inal (2006) reported increasing chick weight with increasing egg weight for quails and Ipek and Dikmen (2007) documented the same for pheasants.

Non-significant variations in average increase in body weight, wing length and wingspan was observed from 1st to 12th week of age among male and female pheasant chicks. Increase in wing length varied significantly between heavy, medium and light weight egg categories from day old chick to 3-month stage. Day old chick wing length ranged from 4.13 ± 0.122cm in light weight category to 5.39 ± 0.110 cm in heavy weight category. Increase in wing length in heavy weight egg groups ranged from 0.76 cm to 4.15 during 12th week and 2nd week, respectively. Similarly increase in wing length in medium weight egg groups was minimum 1.34cm during 12th week and maximum 3.32cm during 2nd week. Increase in wing length in light weight egg category ranged from 1.42cm during 2nd week to 3.09cm during 8th week of its growth. In all the
three egg weight categories the increase in wing length ranged from 0.76cm to 4.15cm in heavy weight category during 12th and 2nd week, respectively. Overall minimum increase in wing length was observed during 12th week and maximum during 2nd week of chick age. Day old chick the average wing length ranged from 17.15cm to 18.20cm in light weight category, 17.70cm to 20.01cm in medium weight category and 20.26cm to 20.51cm (Table 5). Wing length is the second element of the species and gives indications on the quality of flight. At the game pheasants released, their flight affects the beauty and excitement of the game. Delacour (1977) reported that cheer males have wing lengths of 23.5-27.0cm while females have wing lengths of 22.5-24.5 cm. According to Popescu-Micloșanu et al. (2011) wing length is the second element of the species and gives indications on the quality of flight. At the game pheasants released, their flight affects the beauty and excitement of the game. Wing length of females ranged between 17.1 and 22.8 cm, averaging 19.71.0.180 cm. The coefficient of variation was 8.21%. Male pheasants that year had wing length between 22.2 and 24.8 cm, averaging 23.45 0.145 cm.

Increase in wingspan in heavy weight egg groups ranged from 1.92cm to 8.98cm during 12th week and 2nd weeks, respectively. Similarly increase in wingspan in medium category was minimum 2.42cm during 11th week and maximum 7.35cm during 2nd week. Increase in wingspan in light weight egg category ranged from 2.32cm during 3rd week to 2.32cm during 11th week of its growth. In all the three egg weight categories the increase in wingspan ranged from 1.92cm in heavy weight category to 8.98cm in heavy weight category during 12th and 2nd week, respectively. Gorecki et al. (2012) observed overall minimum increase in wingspan during 11th week and maximum during 5th week of chick age.

During present study minimum average increase in body weight was observed after 2nd week while maximum after 9th week. Similarly, maximum increase in wing length was recorded
during 2nd week of age while minimum during 10th week. Maximum increase in wingspan was observed during 2nd week and minimum during 10th week of age (Figure 1). According to Baker (1993) the sex of the properly fed pheasant chicks can be determined during 8th week of the age. However, during present study the sex of the chicks was prominent after 11th week which may be attributed to the lower dietary proteins.

It can be concluded from present study that chick weight is directly linked with the weight of the eggs as heavier eggs provide more nutrients to the growing chicks. It was further observed that the chicks from heavier eggs show relatively better growth patterns than the chicks from lighter eggs.

**References**


Table 1. Relationship of egg weight with internal and external qualities of egg in ring necked pheasants

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Egg weight category</th>
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<tbody>
<tr>
<td></td>
<td>Egg weight category</td>
<td>Heavy</td>
<td>Medium</td>
<td>Light</td>
<td>Heavy</td>
<td>Medium</td>
</tr>
<tr>
<td>Egg weight (g)</td>
<td>36.18 ± 2.46</td>
<td>26.88 ± 1.29</td>
<td>22.86 ± 1.61</td>
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<tr>
<td>Egg length (cm)</td>
<td>4.37 ± 0.20</td>
<td>4.20 ± 0.12</td>
<td>4.09 ± 0.18</td>
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<tr>
<td>Egg breadth (cm)</td>
<td>3.48 ± 0.19</td>
<td>3.41 ± 0.14</td>
<td>3.25 ± 0.14</td>
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<tr>
<td>Egg volume (cm³)</td>
<td>26.10 ± 4.16</td>
<td>23.96 ± 2.38</td>
<td>21.14 ± 2.93</td>
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<td>Egg surface area (cm²)</td>
<td>91.30 ± 14.58</td>
<td>83.81 ± 8.33</td>
<td>73.96 ± 10.24</td>
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<tr>
<td>Shell ratio (%)</td>
<td>12.50±0.50</td>
<td>13.54±0.54</td>
<td>11.62±0.68</td>
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<td>Albumen ratio (%)</td>
<td>48.71±1.09</td>
<td>47.91±0.81</td>
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<td>Yolk ratio (%)</td>
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<td>Albumen Index (%)</td>
<td>2.66±0.14</td>
<td>2.86±0.05</td>
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<td>Yolk Index (%)</td>
<td>32.26±0.87</td>
<td>33.43±1.02</td>
<td>31.13±0.71</td>
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<td>Haugh unit</td>
<td>87.15±1.49</td>
<td>90.95±0.93</td>
<td>91.73±0.80</td>
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<td>Shell weight (g)</td>
<td>3.25 ± 0.13</td>
<td>3.25 ± 0.13</td>
<td>2.50 ± 0.15</td>
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<td>Shell thickness (mm)</td>
<td>3.72 ± 0.12</td>
<td>3.52 ± 0.13</td>
<td>3.63±0.13</td>
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<td>Membrane thickness (mm)</td>
<td>0.002 ± 0.0001</td>
<td>0.003 ± 0.0002</td>
<td>0.002 ± 0.0002</td>
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<tr>
<td>Albumin weight (g)</td>
<td>12.66 ± 0.28</td>
<td>11.50 ± 0.19</td>
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<tr>
<td>Yolk weight (g)</td>
<td>10.08 ± 0.31</td>
<td>9.25 ± 0.21</td>
<td>8.25 ± 0.25</td>
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<td>Albumin pH</td>
<td>8.04 ± 0.07</td>
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<td>Yolk pH</td>
<td>5.54 ± 0.09</td>
<td>5.56 ± 0.10</td>
<td>4.30 ± 0.06</td>
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</table>

Means with similar letters in a row are statistically non-significant.
Table 2. Correlation of heavy egg weight category with chick weight in ring necked pheasants from 1st to 12th week of age.

<table>
<thead>
<tr>
<th></th>
<th>1st week</th>
<th>2nd week</th>
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<th>4th week</th>
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Table 3. Correlation of medium egg weight category with chick weight in ring necked pheasants from 1st to 12th week of age.

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Table 5. Relationship of egg weight with wing length and wingspan of ring necked pheasants.

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<th>Egg weight</th>
<th>Egg length</th>
<th>Egg width</th>
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<tbody>
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<td></td>
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<td>Chick weight</td>
<td>Wing length</td>
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<td>Light weight</td>
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<td>3.15±0.03c</td>
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<td>3.31±0.05b</td>
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<td>Heavy weight</td>
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<td>3.50±0.06a</td>
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<td>5.39±0.11a</td>
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</tbody>
</table>

Means with different letters in a column are statistically significant.

Figure 1. Comparison of average weight, wing length and wingspan between male and female ring-necked pheasants from 1st to 12th week of age.
EXPERIMENT NO. 3.2

Title: Time budgets of ring necked pheasants (*Phasianus cholchicus*) season in captivity

This manuscript has been submitted in the Pakistan Journal of Zoology
Time budgets of Ring necked pheasants (*Phasianus colchicus*) during non-breeding season in captivity

Sana Ashraf¹, Arshad Javid¹, Muhammad Ashraf² and Muhammad Akram³

¹Department of Wildlife and Ecology, University of Veterinary and Animal Sciences, Lahore
²Department of Fisheries and Aquaculture, University of Veterinary and Animal Sciences, Lahore
³Department of Poultry Production, University of Veterinary and Animal Sciences, Lahore

Abstract

The present study was planned to evaluate the time budgets of ring necked pheasants *Phasianus colchicus* in captivity. The birds were kept in cages of 5 ft × 5 ft × 3 ft (length × width × height) and were housed in a 20 ft × 20 ft (length × width) well ventilated room at Department of Wildlife and Ecology, Ravi Campus, University of Veterinary and Animal Sciences, Lahore. Captive birds were divided into three categories viz. adult male, adult female and chicks and were placed into separate cages. Behavioral parameters viz. jumping, aggression, preening, feather pecking, walking, standing, sitting, litter pecking, drinking, feeding, body shaking, voice call and feather flapping were assessed for 30 birds from each of the three categories through scan sampling. Statistically significant variations were recorded in behavioral aspects among all the three categories. Male birds spent significantly higher times in aggression (155.26±3.10 sec), preening (74.04±3.05 sec), walking (1370.93±54.45 sec), drinking (74.00±3.18 sec), body shaking (24.92 ±3.11 sec), voice call (20.08±3.17 sec) and feather flapping (15.42±3.11 sec) while female *P. colchicus* spent significantly higher times in sitting (364.57±3.74 sec). Similarly, the chicks spent significantly higher times in jumping (36.17±2.75 sec), feather pecking (265.19±3.17 sec), standing (1230.13±23.86 sec), litter pecking (234.89±2.97 sec) and feeding (115.44±3.11 sec) as compared to the adult female and male birds.

**Key words:** Pheasant chicks; feeding; aggression; captivity.
Introduction

The understanding of behavioral aspects of poultry birds in captivity helps not only in assessing poultry welfare but also to deal with production issues and to develop management practices that may lead to higher economic returns. However, in modern agriculture, poultry welfare has been regarded as a notorious topic because of the divergence of opinions regarding how animals should be treated and maintained. The welfare of animals can be assessed through behavioral and physiological characteristics (Cunningham and Mauldin 1996). Furthermore, these behaviors are influenced by management strategies, bird housing, environmental conditions and genetic issues (Julian 1995; Sanotra et al. 2001).

Birds in captivity perhaps spend more time in maintenance behaviors than in wild because they are free from foraging and vigilance constraints (Walther and Clayton 2005).

Furthermore, in field behavioral observations of organisms provide valuable insight towards male ‘quality’, which is targeted by sexual and natural selection (Irschick et al. 2007). Therefore, behavioral observations on ornamental species are essential and can be verified from captive populations.

Pheasant industry is making progress and playing important role in conserving peri-urban and urban communities of pheasant populations (Grahn 1993; Burger 1996; Pacec 2006; Farm Animal Welfare Council 2008). However, the conditions in captivity are significantly different from natural habitat (Taber 1949). Many bird species are reared in cages but little is known about behavioral aspects of domestic birds (Collias and Taber 1951; Schenkel 1956, 1958; Heinz and Gysel 1970; Mateos 1998).

Behavior of pheasants is an indication of physiological states and overall health of the birds. In addition, the management strategies like environment and the nutritional efficacy can also be
assessed by the behavior of the birds. The significance of behavioral studies is much pronounced in controlled environments where the stocking density of birds is high and even higher in pen rearing system as compared to open rearing system (Grahn 1993; Pennycott 2000; Deeming and Wadland 2001; Leif 2005). This higher stocking density can negatively affect the captive populations of birds and these effects are apparent from the behavioral responses i.e. aggressive pecking as well as feather pecking of the birds and this may elevate feather damage (Kjaer 2004; Butler and Davis 2010). The aim of present study was to record different behavioral activities of ring necked pheasant in captivity.

Materials and methods

Animal keeping

The study was conducted at Captive Breeding Facilities for Birds, Department of Wildlife and Ecology, Ravi Campus, University of Veterinary and Animal Sciences, Lahore. A total of 90 birds were used to study the behavioral parameters of ring necked pheasants. These birds were divided into three categories viz. male, female and chicks, 10 birds were selected from each category and were placed into different cages of dimensions ft × 5 ft × 3 ft (length × width × height). The cages were placed in a 20 ft × 20 ft (length × width) well ventilated room. All birds were provided commercial poultry feed and ad libitum water supply.

Observation procedure

Thirty observers noted different behavioral parameters viz. jumping, aggression, preening, feather pecking, walking, sitting, standing, ground pecking, drinking, feeding, body shaking, voice calls and wing flapping during morning hours daily. The definitions of all the behavioral parameters recorded during present study are mentioned in table 1. These observations were noted from naked eye through instantaneous-scan sampling following Altman (1974).
observers quietly positioned themselves to avoid any possible disturbance and recorded different behavioral characteristics for 180 minutes.

**Table 1. Definitions of behavioral parameters recorded during present study**

<table>
<thead>
<tr>
<th>Behavioral Parameters</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jumping</td>
<td>Jumps with wing movements.</td>
</tr>
<tr>
<td>Aggression</td>
<td>Gives or receives peck, the giver's beak being above the receiver's head. Follows or is followed by another bird in an aggressive context. Peck on pen's walls.</td>
</tr>
<tr>
<td>Preening</td>
<td>Trimming of plumage with beak.</td>
</tr>
<tr>
<td>Feather pecking</td>
<td>Peck gently with beak at other bird, non-aggressive.</td>
</tr>
<tr>
<td>Walking</td>
<td>Movements of leg in normal speed.</td>
</tr>
<tr>
<td>Sitting</td>
<td>Sits alert, neck stretched, eyes open.</td>
</tr>
<tr>
<td>Standing</td>
<td>Stands alert, neck stretched, eyes open.</td>
</tr>
<tr>
<td>Ground pecking</td>
<td>Pecks at ground.</td>
</tr>
<tr>
<td>Drinking</td>
<td>At the water containers.</td>
</tr>
<tr>
<td>Feeding</td>
<td>At the feed containers.</td>
</tr>
<tr>
<td>Body shaking</td>
<td>Rapid quivering of whole body, accompanied by ‘fluffing’ of feathers.</td>
</tr>
<tr>
<td>Voice call</td>
<td>Produce loud voice.</td>
</tr>
<tr>
<td>Wing flapping</td>
<td>Moving wings out from the body and flapping.</td>
</tr>
</tbody>
</table>

**Statistical analysis**

The obtained data was analyzed using statistical software SAS (version 9.1) and Analysis of Variance (ANOVA) was applied to compare the means.

**Results**

During present study different behavioral aspects were examined for male, female and chicks of ring-necked pheasants (*Phasianus colchicus*) in captivity. Chicks of *P. colchicus* spent significantly greater time in jumping (36.17 ± 2.75 sec) as compared to male (25.35 ± 3.05 sec) and female (14.31 ± 2.97 sec) birds. The male birds spent significantly greater time in aggression behavior (155.26 ± 3.10 sec) as compared to the female (25.36 ± 3.05 sec) birds and the chicks (14.16 ± 3.34 sec).
Table 2. Observation on different behavior parameters in ring necked pheasant

<table>
<thead>
<tr>
<th>Categories</th>
<th>Male</th>
<th>Female</th>
<th>Chick</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jumping</td>
<td>25.35±3.05B</td>
<td>14.31±2.97C</td>
<td>36.17±2.75A</td>
</tr>
<tr>
<td>Aggression</td>
<td>155.26± 3.10A</td>
<td>25.36±3.05B</td>
<td>14.16 ± 3.34C</td>
</tr>
<tr>
<td>Preening</td>
<td>74.04±3.05A</td>
<td>64.41±3.16B</td>
<td>44.84 ±3.53C</td>
</tr>
<tr>
<td>Feather pecking</td>
<td>215.09±2.93C</td>
<td>234.82±2.99B</td>
<td>265.19±3.17A</td>
</tr>
<tr>
<td>Walking</td>
<td>1370.93±54.45A</td>
<td>1342.23±21.62B</td>
<td>1339.97±22.54B</td>
</tr>
<tr>
<td>Standing</td>
<td>1222.45±51.64B</td>
<td>1224.70±21.20AB</td>
<td>1230.13±23.86A</td>
</tr>
<tr>
<td>Sitting</td>
<td>193.98±3.29A</td>
<td>364.57±3.74A</td>
<td>234.62±3.01B</td>
</tr>
<tr>
<td>Ground pecking</td>
<td>144.11±3.36C</td>
<td>164.50±3.74B</td>
<td>234.89±2.97A</td>
</tr>
<tr>
<td>Drinking</td>
<td>74.00±3.18A</td>
<td>65.44±3.37B</td>
<td>65.06±3.14B</td>
</tr>
<tr>
<td>Feeding</td>
<td>64.41±3.16C</td>
<td>74.00±3.18B</td>
<td>115.44±3.11A</td>
</tr>
<tr>
<td>Body shaking</td>
<td>24.92±3.11A</td>
<td>15.52±3.20B</td>
<td>15.42±2.73B</td>
</tr>
<tr>
<td>Voice call</td>
<td>20.08±3.17A</td>
<td>4.94±2.56B</td>
<td>1.353±1.05C</td>
</tr>
<tr>
<td>Feather flapping</td>
<td>15.42±2.73A</td>
<td>5.21±2.59B</td>
<td>2.74±1.84C</td>
</tr>
</tbody>
</table>

During present study, male birds spent more time in preening (74.04 ± 3.05 sec) and it was followed by the females (64.41 ± 3.16 sec) and the chicks (44.84 ± 3.53 sec). Chicks spent significantly greater time in feather pecking (265.19 ± 3.17 sec) which was followed by the female (234.82 ± 2.99 sec) and the male (215.09 ± 2.93) categories.

Statistically significant variations were recorded in walking behavior among all the three categories during present study. Male birds spent significantly greater time in walking (1370.93 ± 54.45 sec) than female birds (1342.23 ± 21.62) and the chicks (1339.97 ± 22.54) while the chicks spent significantly more time in standing behavior (1230.13 ± 23.86 sec) as compared to female (1224.70 ± 21.20 sec) and male birds (1222.45 ± 51.64 sec), respectively. The female birds, on contrary spent greater time in sitting (364.57 ± 3.74 sec) followed by the chicks (234.62 ± 3.01 sec) and the male birds (193.98 ± 3.29 sec). During present study chicks of *P. colchicus* spent significantly more time in ground pecking (234.89 ± 2.97) as compared to the female (164.50 ± 3.74) and male birds (144.11 ± 3.36).
During present study, male birds spent significantly greater time in drinking as compared to female and chick categories while feeding behavior was significantly higher in chicks (115.44 ± 3.11 sec) as compared to female (74.00 ± 3.18 sec) and male (64.41 ± 3.16 sec) birds. Male birds spent significantly higher time (24.92 ± 3.11 sec) in body shaking while non-significant differences were observed among female (15.52 ± 3.20 sec) and chicks (15.42 ± 2.73 sec). Male birds spent significantly higher time budgets in voice call (20.08 ± 3.17 sec) followed by the female (4.94 ± 2.56) and the chicks (1.353 ± 1.05). Similarly, male birds spent significantly greater time budgets in feather flapping (15.42 ± 2.73 sec) as compared to the female birds (5.21 ± 2.59 sec) and the chicks (2.74 ± 1.84 sec).

Discussion

Birds devote a significant amount of time on maintenance behaviors including preening, scratching, bathing, dusting, sunning, shaking and ruffling of feathers (Moyer et al. 2003). All these behaviors require energy and time. Energy and time devoted to maintenance cannot be devoted to feeding, vigilance, or other activities (Redpath 1988). Most of the bird species spend 9.2% of their diurnal time budgets in maintenance behaviors (Cotgreave and Clayton 1994). The gender effects in social discrimination can be related to the stronger social attachment in females and aggressive responses in males (Vallortigara 1992).

Delius (1988) reported that preening is usually a maintenance activity of body-surface while Lefebvr (1982) documented that rhythmicity’s is also a reason of preening in uninterrupted environments. Pecking may reflect a frustrated tendency or conflict situation. There might be the ground-pecking and pecking at conspecifics; the latter might be very strong. The tendency to perform a particular behavior may either be the response of internal states e.g. the internal state of energy or the external incentive stimuli the food (Duncan and Wood-Gush 1972). Feather-
pecking is considered as one of the serious problems in poultry industry. It may result in feather damage, wounded birds and reduced productivity. This may be explained by the fact that fowls have a high tendency to peck at inedible objects throughout life (Kruyt 1964) and therefore a certain basal level of pecking at conspecifics is expected. This feather-pecking may therefore be considered as exploratory behavior or allopreening (Harrison 1965). In poultry, ground-pecking is a part of feeding system and is mostly directed to edible material, however, their tendency to peck at inedible objects remains high throughout the life (Kruyt 1964).

Our findings are in line with Zhou tian-lin (2005) who reported that koklass pheasant (Pucrasia macrolopha) spend much of their time budget on main activities like resting 47.0%, walking 30.4%, feeding 11.1%, preening 8.6%, egg-laying 1.3% and others including call, drinking, dusting, attacking, excreting etc. 1.6% during breeding season. Non-significant differences were observed in major activities viz. including resting, walking, preening, feeding and breeding among both the sexes of P. macrolopha. However, Yang et al. (1995) reported significant differences in time budgets among male and female lady Amherst’s pheasant (Chrysolophus amherstiae).

Heinz and Gysel (1970) reported the evidence of other forms of sexual display such as crowing and wing-flapping in wild pheasants. Yang and Yang (1996) documented that the green peafowl spend only 5% of their time budgets on feeding while 80% from remaining time budget spend on resting (Zhang 1998). This might be due to lack of conspecific competition and availability of ample food (Lu 1997).

**Conclusion**
The behavior of the birds are the indication of overall health and also represent the management conditions. Present study indicates that behavior of the ring-necked pheasants vary with age and also there are differences in the behavior of the male and female birds in captivity.

**References**


EXPERIMENT NO. 3.3

Title: Studies on parasitic prevalence in ring necked pheasants (*Phasianus colchicus*) in captivity

This manuscript has been published in the Journal of Animal and Plant Sciences
Studies on parasitic prevalence in ring necked pheasants (*Phasianus colchicus*) in captivity

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Abstract

Fecal and blood samples of ring necked pheasants, *Phasianus colchicus* were analyzed to record the parasitic prevalence in these pheasants. A total of 1000 samples, 500 blood and 500 fecal samples were collected from Captive Breeding Facilities for Birds, Department of Wildlife and Ecology, Ravi Campus, University of Veterinary and Animal Sciences, Lahore. Parasitic genera identified from blood samples of *P. colchicus* include *Leukocytozoon*, *Plasmodium* and *Haemoproteus*. Prevalence of *Leukocytozoon* was 16% while the prevalence of *Haemoproteus* was 14.3%. Parasitic genera identified from fecal samples of *P. colchicus* include *Eimeria*, *Isospora*, *Trichomonas* and *Giardia*. Eggs of five species of nematodes viz. *Capillaria*, *Syngamus trachea* and *Ascaridia*, *Heterakis isolonche* and *Heterakis gallinarum* were also identified from the fecal samples. The ectoparasites include one species of burrowing mite *Knemidocoptes mutans* and two species of chewing lice i.e. *Amyrsidea perdicis* and *Lipeurus maculosus*.

**Key words:** *Phasianus colchicus*, *Cryptoporidium*, endoparasites, ectoparasites, captivity

Introduction

Pheasant farming has tremendous potential for raising livelihoods of the people from developing countries by enhancing ecotourism, game reserves and hunting (Malik, 2003). Moreover,
Pheasant species can be used as biological indicator to monitor the health of the ecosystem and other associated wildlife species (Malik, 2003).

Confined systems are always helping to increase the population of game birds. In many countries birds are kept in aviaries on the ground. In such conditions, several factors such as stress and atmospheric conditions affect the health of these birds. Furthermore, birds remain in continuous contact with the ground, in which a number of pathogenic microorganisms as well as intermediate hosts of endoparasites exist (Krystianiak et al., 2007).

Bird growth, egg production rate and increase susceptibility to other infections is affected by parasites (Dranzoa, 1999). Parasite abundance depends upon the following factors such as host size, host genotype, host condition, distribution in different geographical regions and seasonal variations (Gregory et al., 1990; Forbes and Becker, 1990; Weatherhead and Bennett, 1991). In confined system high density of birds is responsible for transferring the mycotic and parasitic agents which cause diseases and heavy losses. In wild and reared game birds, the breeding success is reduced by pathogenic species such as roundworms (Syngamus trachea, Heterakis isolonche, Capillaria spp., Ascaridia spp.) and coccidia (Eimeria spp.) (Goldová et al., 1993). Plasmodium, Haemoproteus sp. and Leucocytozoon sp. showed significantly high intensity in number of domestic and feral birds. However, they also cause serious mortality in wild avian species (Aguirre et al. 1986).

The mites (Acarina: Mesostigmata) are widespread and high infestation of mites and lices were reported in grey and black partridges from Khyber Pakhtoonkhwa Province of Pakistan (Khattak et al., 2012). Dermanyssus gallinae and Ornithonyssus sylviarum are important blood feeding mites of birds. These mites irritate birds, cause anemia and spread diseases. Infected bird loses egg laying ability and sometimes may die (Goldová et al. 2006). Chewing lice (Phtiraptera:
Amblycera, Ischnocera) are mostly irritant to their hosts, the infected birds scratch their head and body which shows discomfort caused by these chewing lice (Wall and Shearer, 2001). Primary aim of this study was to know the prevalence of ecto- and endoparasites in ring necked pheasants in captivity. Complete knowledge of biological cycles and ways of transmission of parasites can help to prevent the outbreaks of diseases.

**Materials and Methods**

This one year study extending from April, 2013 through March, 2014 was conducted at Captive Breeding Facilities, Department of Wildlife and Ecology, Ravi Campus, University of Veterinary and Animal Sciences, Lahore. A total of 1000 (500 fecal + 500 blood) samples were collected to record internal parasites while the captive birds were examined on weekly basis to ascertain ectoparasites.

Blood samples were collected directly from brachial vein, a drop was placed on a clean microscopic slide and blood smear was prepared. The smear was then fixed with methyl alcohol and stained in Giemsa's solution for 10 to 15 minutes. The slides were washed with distilled water, dried and examined for blood parasites under a microscope following Greiner and Ritchie (1994). The examined parasites were identified up to genera using dichotomous keys following LaMann (2010). Furthermore, the fecal samples were collected on weekly basis to observe the fecal parasites. For this purpose, the collected fecal samples were processed by direct fecal smear method and qualitative flotation method following Seivwright et al. (2004). The parasites were identified up to species level where possible by examining morphology of the oocysts and eggs (Pellérdy, 1965).
To ascertain ectoparasites, the birds were visually inspected and their whole body was fully examined. The parasites were collected using forceps, observed under stereo microscope and were identified.

**Results and Discussion**

The prevalence (%) of various parasitic genera identified during present study are presented in table 1. *Leukocytozoon* spp., *Plasmodium* spp. and *Haemoproteus* spp. were identified from blood samples of ring necked pheasants (*Phasianus colchicus*). Prevalence of *Leukocytozoon* spp. was 16 %. It is the leading haemoparasite in birds which cause malaria and rigorous anemia in poultry and other avian species (Van der Heyden, 1996; Atkinson and Van Riper, 1991). Similarly, prevalence of *Haemoproteus* spp. was 14.3%. It has similar life cycle like *Plasmodium* spp. and *Leukocytozoon* spp. However, the schizonts develop completely in the endothelium of different visceral organs while the gametocytes mature in the circulating erythrocytes (Gylstorff and Grimm, 1998). In this study, the prevalence of *Plasmodium* spp. was recorded as 10%. *Plasmodium* sporozoites are transmitted through saliva of blood sucking mosquitoes and many major clinical problems leading to increased morbidity and mortality are common in many avian species (Gylstorff and Grimm, 1998).

Coccidian species such as *Eimeria* and *Isospora* are widely distributed around the globe (Zucca, 2000). *Eimeria* is strictly host-specific (Gylstorff and Grimm, 1998), commonly found in poultry, Galliformes, and Columbiformes. In *Eimeria* sp., sporulated oocysts have four sporocysts with two sporozoites each (Greiner and Ritchie, 1994). It is the most important protozoal pathogen of poultry industry (Zajac and Conboy, 2012) so removing of damp litter and wet spots can prevent the build-up of oocysts in the environment. During present study, *Eimeria* spp., *Isospora* spp., *Trichomonas* spp., *Giardia* spp. and *Cryptosporidium* spp. were identified.
from feces of *P. colchicus*. Prevalence of *Eimeria* spp. and isospora was 40% and 4%, respectively. The infectious stage of the coccida is during the maturation process when the sporulated oocysts get divided into sporocysts with sporozoites (Greiner and Ritchie, 1994). The prevalence of *Trichomonas* spp. was 11.5%, *Giardia* spp. was 44% and *Cryptosporidium* spp. was 2%. *Trichomonas* spp. is transmitted by contaminated food or water. *Trichomonas gallinae* is most common pathogenic species in free-range as well as captive birds such as Passeriformes, Psittaciformes, Falconiformes, and Phasianiformes (Gylstorff and Grimm, 1998). In clinical symptoms weight loss and walnut size lesions are formed in mouth, esophagus, and crop. Birds show ruffled feathers and cannot eat properly (Greve, 1996a; Gylstorff and Grimm, 1998) so segregate the young birds from adults and recovered carriers from susceptible stock. Similarly *Giardia* spp. are found in motile trophozoite and a cyst stage in many bird species (Greve, 1996a; Greiner and Ritchie, 1994). In juvenile birds, *Giardia* infestation can lead to weakness, poor plumage, reduced growth and high mortality rate of up to 50% (Greiner and Ritchie, 1994). *Cryptosporidium* spp. causes infection in more than 30 species of wild and cage birds (Fayer, 1997; Sreter and Varga, 2000; Ng *et al.*, 2006) such as pheasants, chicken, quails, turkeys, geese, ducks as well as ostriches and swans (Fayer, 1997). The most important symptoms are severe diarrhea, depression, dehydration, ruffled feathers, and a high mortality rate (Xiao *et al.*, 2002).

Five species of nematode eggs were found in pheasants. Higher prevalence of *Capillaria* spp. 43%, *Syngamus trachea* 51% and *Ascaridia* spp. 17.2% was found. This nematode can be found in poultry as well in many other avian species (Trainer *et al.*, 1968). *Capillaria* spp. are thread like nematodes with typical two poles of the eggs and located in the gastrointestinal tract especially in the crop, esophagus, and small intestine regions (Greiner and Ritchie, 1994; Zucca, 2000). In poultry severe infections in the upper digestive tract can be observed, while the clinical
outline in other avian species is not unified (Gylstorff and Grimm, 1998). In environment eggs can survive up to several months, especially in humid conditions and moderate temperatures (Zucca, 2000). The nematode *Syngamus trachea* affect respiratory tract of birds. Bird species that are generally affected are chicken, turkeys, quails, guinea fowl, peafowl, geese and pheasants (Ruff, 1984). Disease symptoms are opening of the beak, and respiratory sound which lead towards death (Gylstorff and Grimm, 1998). The roundworms of the species *Ascaridia* can be commonly found in birds (Greiner, 1997). However, they are moderately common in cage and aviary birds (Greve, 1996a). It has ellipsoidal, smooth, and colorless eggs that can survive in the environment for several months (Greve, 1996a). Infection spread through contaminated water and feed. Control of infestation is obtained through good sanitary practices.

Prevalence for *Heterakis isolonche* was 13.6% while for *Heterakis gallinarum* was 8%. In the Czech and Slovak Republics 83.6% of pheasants and 11% of partridges on game–bird farms were infected by *Heterakis isolonche*. In the wild 68.5% of game birds are infected (Kotrlá et al., 1984).

One species of burrowing mite *Knemidocoptes mutans* (Astigmata) was identified. The *Knemidocoptes spp.* mites can be found on the face and leg region of various bird species. These mites burrow into the epidermis where they lay eggs (Greve, 1996b). Frequent inspection of the birds is the key to mite control. The best control for mites is to treat their hiding places, such as cracks and crevices in housing.

Two species of chewing lice *Amyrsidea perdicis* and *Lipeurus maculosus* were identified. Chewing lice (Phthiraptera: Amblycera, Ischno-cera) are familiar ectoparasites of domestic and wild birds. They are generally widespread among gallinaceous birds and cause massive infestations in some avian species (Kettle, 1990; Mullen and Durden, 2002). These lice’s cause
the damage to feathers and irritation of skin, which may cause overall weakening and even death of the birds (Porkert, 1978; Jurasek and Dubinsky, 1993). Inspect birds and housing at least twice per month. Several treatments on the birds and in their housing may be necessary to break the cycle of infestation.

The above mentioned blood parasites can be controlled by controlling the invertebrate vectors and screening the aviaries. If controlling measures are not taken then these parasites can cause high mortality in flock. Similarly the parasites that identified from fecal material such *Eimeria* spp., *Isospora* spp., *Trichomonas* spp., *Giardia* spp., *Cryptosporidium* spp., *Ascaridia* spp., *Capillaria* spp., *Syngamus trachea*, *Ascaridia* spp., *Heterakis isolonche* and *Heterakis gallinarum* can be controlled by providing the good management conditions in captivity. Parasites affect bird growth, egg production rate and increase the susceptibility to other infections (Dranzoa, 1999). While the ectoparasites damage to feathers and irritation of skin, which may cause overall weakening and even death of the birds (Porkert, 1978; Jurasek and Dubinsky, 1993).

**Conclusion**

This study confirmed the occurrence of endoparasites in pheasants. The incidence of parasites increased in relation with the concentration of pheasants. From the blood analysis *Leukocytozoon* spp., *Plasmodium* spp. and *Haemoproteus* spp. were identified. The most frequent species infecting the cage-breeding game birds were *Eimeria* spp., *Giardia* spp., *Trichomonas* spp., *Ascaridia* spp., *Capillaria* spp., *Syngamus trachea*, *Heterakis isolonche*, *Heterakis gallinarum*, *Isospora* spp. and *Cryptosporidium* spp.
In ectoparasites one species of burrowing mite *Knemidocoptes mutans* (Astigmata) while two species of chewing lice (Phtiraptera: Amblycera, Ischnocera) *Amyrsidea perdicis* and *Lipeurus maculosus* were identified.

**References**


Table 1. Prevalence (%), symptoms, predilection site, transmission, control measures and economic significance of various parasitic genera in *Phasianus colchicus*.

<table>
<thead>
<tr>
<th>Parasites</th>
<th>Prevalence (%)</th>
<th>Symptoms</th>
<th>Predilection site</th>
<th>Transmission</th>
<th>Control measures</th>
<th>Economic significance</th>
</tr>
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<tbody>
<tr>
<td><strong>Endoparasites</strong></td>
<td></td>
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<tr>
<td><strong>Blood Parasites</strong></td>
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</tr>
<tr>
<td><em>Leukocytozoon spp.</em></td>
<td>1</td>
<td>Severe anemia, in appetite, dyspnea, cough,</td>
<td>Erythrocytes</td>
<td>Sporozoites are transmitted through the saliva of blood sucking black flies</td>
<td>Control invertebrate vectors by screening of aviaries.</td>
<td>Mortality rates are extremely high, especially among young birds.</td>
</tr>
<tr>
<td><em>Plasmodium spp.</em></td>
<td>10.9</td>
<td>Anemia, vomiting and cramps ()</td>
<td>Erythrocytes</td>
<td>Sporozoites are transmitted through the saliva of blood sucking black flies</td>
<td>Control invertebrate vectors by screening of aviaries.</td>
<td>It causes high mortality in free range while commercially low loss recorded</td>
</tr>
<tr>
<td><em>Haemoproteus spp.</em></td>
<td>14.3</td>
<td>Erythrocytes are affected, poor feeding,</td>
<td>Erythrocytes</td>
<td>Sporozoites are transmitted through blood sucking insects i.e. <em>mosquitoes</em>,</td>
<td>Measures to control invertebrate vectors, such as screening of aviaries, help</td>
<td>Mortality and flock loss.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>apathy and anemia</td>
<td></td>
<td>biting midges and louse flies</td>
<td>prevent transmission and heavy infections.</td>
<td></td>
</tr>
<tr>
<td><strong>Fecal Parasites</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><em>Eimeria spp.</em></td>
<td>40</td>
<td>Asymptomatic in birds or cause depression and</td>
<td>Small intestine</td>
<td>Oocysts are shed in the feces of infected birds and must be ingested to produce disease</td>
<td>Elimination of infected fecal material of birds. Prevent to build-up of oocytes</td>
<td>Loss of egg production, morbidity and death.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>diarrhea</td>
<td></td>
<td></td>
<td>in the environment by removing damp litter</td>
<td></td>
</tr>
<tr>
<td><strong>Giardia spp.</strong></td>
<td>44</td>
<td>Weakness, poor plumage, reduced growth, diarrhea, enteritis and depression</td>
<td>Intestinal tract</td>
<td>Cysts can be transmitted directly when the host ingests food with contaminated feces.</td>
<td>Reduced stress and molting in birds. Also provide good food and ventilation to birds.</td>
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<td></td>
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<tr>
<td><strong>Trichomonas spp.</strong></td>
<td>11.5</td>
<td>Weight loss, lesions up to ulcer in the mouth, oropharynx, esophagus, and crop</td>
<td>Anterior end of the digestive and respiratory tracts</td>
<td>Infection may spread through stagnant pools, contaminated water, old straw stacks and generally moist, unsanitary conditions.</td>
<td>Segregate young birds from adults and recovered carriers from susceptible stock</td>
<td></td>
</tr>
<tr>
<td><strong>Ascaridia spp.</strong></td>
<td>17.2</td>
<td>Inflammation and weight loss</td>
<td>Small intestine</td>
<td>Infection spread through contaminated water and feed.</td>
<td>Control of infestation is obtained through good sanitary practices</td>
<td></td>
</tr>
<tr>
<td><strong>Capillaria spp.</strong></td>
<td>43</td>
<td>Regurgitation, dysphagia, weight loss, diarrhea, and melena</td>
<td>Entire intestinal tract</td>
<td>Infective eggs may build up in the litter or in the soil. Spread through contaminated food.</td>
<td>Hygienic measures should be strictly enforced to avoid the contamination</td>
<td></td>
</tr>
<tr>
<td><strong>Syngamus trachea</strong></td>
<td>51.5</td>
<td>Coughing, opening of the beak, and respiratory</td>
<td>Trachea and lungs</td>
<td>Ingestion of infective eggs or larvae</td>
<td>Good ventilation and best hygienic measures should be available in the rooms</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Usually infected birds declines and death arrives through</td>
<td></td>
</tr>
<tr>
<td><strong>Parasite</strong></td>
<td><strong>Symptoms</strong></td>
<td><strong>Location</strong></td>
<td><strong>Infection</strong></td>
<td><strong>Health Impact</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
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<td>---</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><em>Heterakis isolonche</em></td>
<td>Nodular lesion</td>
<td>Caeca</td>
<td>Ingestion of eggs</td>
<td>Good management and sanitation in confined operations will generally lower the parasite levels in the birds. Severe health problems by reducing growth and egg production.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Heterakis gallinarum</em></td>
<td>Lesions characterized by congestion, thickening, petechial hemorrhages of the mucosa</td>
<td>Caeca</td>
<td>Ingestion of eggs</td>
<td>Improvement of management and sanitation in confined operations will generally lower the parasite levels in the birds. Mild health problems, reduced growth and egg production.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Isospora spp.</em></td>
<td>Asymptomatic in birds or cause melena, depression, and diarrhea</td>
<td>Small intestine</td>
<td>Coccidial oocysts are shed in the feces of infected birds and must be ingested to produce disease.</td>
<td>Good feeding practices and good management include in control measures. Damages the host’s intestinal system, causing loss of egg production, morbidity and death.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Cryptosporidium spp.</em></td>
<td>Diarrhea and enteritis</td>
<td>Bursa</td>
<td>Contaminated water</td>
<td>Best hygienic measures should be applied to control it. High mortality rate in birds.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ectoparasites</strong></td>
<td><strong>Symptoms</strong></td>
<td><strong>Location</strong></td>
<td><strong>Infection</strong></td>
<td><strong>Health Impact</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Knemidocoptes mutans</em></td>
<td>Itching and irritation, plucking of feathers, weight loss and reduced egg production</td>
<td>Legs</td>
<td>Birds infected through direct contact.</td>
<td>Frequent inspection of the birds is key to mite control. The best control for mites is to treat their hiding places, such as cracks and crevices in housing. Loss of plumage, weight loss and reduced egg production.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Amyrsidea perdicis</strong></td>
<td>Extensive damage to feathers and marked irritation of the skin, which may cause overall weakening</td>
<td>Breast and legs</td>
<td>Birds infected through direct contact.</td>
<td>Prevent contact of healthy birds from infested ones by replacement. Inspect birds and housing at least twice per month. Several treatments on the birds and in their housing may be necessary to break the cycle of infestation.</td>
<td>It cause poor health conditions i.e. skin and feather damage in flock.</td>
<td></td>
</tr>
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<td>------------------------</td>
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<td>-------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Lipeurus maculosus</strong></td>
<td>Feather damage, irritation, restlessness and weakness.</td>
<td>Skin</td>
<td>Birds infected through direct contact.</td>
<td>Prevent contact of healthy birds from infested ones by replacement. Inspect birds and housing at least twice per month. Several treatments on the birds and in their housing may be necessary to break the cycle of infestation.</td>
<td>It causes poor health conditions such as feather and skin damage in flock.</td>
<td></td>
</tr>
</tbody>
</table>
Title: Variations in hematological parameters in ring necked pheasant (*Phasianus colchicus*) with age.

This paper has been submitted in the Journal of Animal and Plant Sciences
Variations in hematological parameters in ring necked pheasants (Phasianus colchicus) with age.

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Abstract

Variations in hematological parameters during different life history stages were recorded in ring-necked pheasants (Phasianus colchicus) for a period of 1 year. Thirty birds were selected for analysis of selected hematological parameters viz. red blood cells count, white blood cells count, hemoglobin, mean corpuscular hemoglobin concentrations, total serum protein and leucocyte count. These birds were kept in cages, each cage having separate drinking and feeding facilities. Five birds per cage were confined and these cages were housed in a well-ventilated 20 × 20 feet (length × width) room. Blood samples were taken from ulnar vein and variations in blood parameters were recorded on monthly basis. Significantly, lower RBC’s count was observed during 2nd month of age while during same month significantly higher WBC count was noticed. Significantly lower values of hemoglobin were observed during 1st and 2nd month of age. Significantly higher mean corpuscular hemoglobin concentration percentage (MCHC%) was recorded during 6th and 7th month of age. Lower packed cell volume (PCV) values were observed during 2nd and 6th month of age while the total serum protein concentrations were recorded maximum during 10th month of age. Significantly, higher heterophils count was recorded during 2nd and 10th month of age while maximum lymphocyte count was observed during 2nd and 7th months of age. Significantly, higher concentrations of monocytes were recorded during 11th, 12th and 10th month of age. The eosinophils count varied from minimum (110 ± 13.50) during 3rd month to maximum (902 ± 93.22) during 11th month of age. Similarly, significantly higher
values of basophils were recorded during 1st month of age. It can be concluded from the present study that the blood profile of the pheasants changes with age.

**Key words:** Phasianus colchicus, RBC, leukocytes, age, captivity

**Introduction**

Ring-necked pheasant (*Phasianus colchicus*) production is increasing in many parts of the world. The species is preferred not only due to its meat characterized by low fat content, high essential fatty acids and amino acids content which makes it of a higher quality compared to broilers, duck and geese but for hunting characteristics, as well (Tucak et al. 2004; Adamski and Kuzniacka 2006). The species originated from central and eastern Asia and has been introduced worldwide including North and South America, Europe, Australia and New Zealand (Schmidt et al. 2007). Pheasant industry is making progress but facing challenges like viral, parasitic and bacterial infections (Goldova et al. 2000; Lloyd and Gibson 2006). Hematological records of the captive populations are useful in diagnosis of many diseases. Moreover, the treatment of abnormalities in birds needs an understanding of how changes in blood biochemical profile affects bird production (Fudge 1997).

The hematological parameters vary with age. In juvenile ring necked pheasants, lymphocytes are the major circulating leukocyte while values for the red blood cells were lower for 60 day-old pheasants than and higher for 74 day-old pheasants. Hemoglobin values were higher in 88 day-old pheasants while white blood cells, heterophil and the lymphocytes were significantly higher for 60 day-old pheasants. Values for total serum protein, albumin and globulin varied significantly during different ages (Schmidt 2007b).
The analysis of hematological parameters also provides valuable information about the physiological state of birds (Hauptmanova et al. 2006; Harr 2002). Blood chemistry and clinical hematology is influenced by many factors such as nutritional status, diseases, sex, body condition, age, diet, circadian rhythms and captivity (Fudge 2000). Knowledge of the blood constituents in birds is a relevant diagnostic tool in veterinary medicine and these values can be used as physiological indicators (Perelman 1999). Present study was therefore planned to record variations in hematological parameters in ring necked pheasant (*Phasianus colchicus*) with age.

**Materials and methods**

Present study on hematological parameters of ring necked pheasants was conducted at Department of Wildlife and Ecology, Ravi Campus, University of Veterinary and Animal Sciences, Lahore. Ninety birds were selected for analysis of different hematological parameters. These birds were kept in cages and each cage was equipped with separate drinking and feeding facilities. Five birds per cage were confined and these cages were housed in a well-ventilated 20 × 20 feet (length × width) room. Blood samples were collected from the ulnar vein of wings. For hematological analyses 3 mL blood samples was taken in a syringe and immediately transferred to a tube containing ethylenediamine tetra acetic acid (EDTA). The blood collection tubes were kept in ice cool containers to avoid denaturation of proteins, and were taken to the laboratory within 2 h of blood withdrawal and hematological analyses were performed following Jain (1986).

In the laboratory, the microcapillary tubes were centrifuged at 13,000 rpm for 5 min and the haematocrit values was determined directly in a microhaematocrit reader. Total red blood cells (RBCs) and total white blood cells (WBCs) count were performed using hemocytometer with
blood diluted on after mixing with Natt-Herrick solution in the ratio of 1 to 200 (Natt and Herrick 1952). The hemoglobin concentration was measured by Sahli’s haemoglobinometer method while the mean corpuscular volume (MCV) was calculated. For the differential leukocyte counts the smears were stained with Giemsa solution and cells were examined using a 100X objective. Total serum protein was determined by Biuret method for quantitative estimation of total serum protein.

**Statistical analysis:** Data thus obtained was subjected to statistical software SAS 9.1 and Analysis of Variance (ANOVA) was applied to find out the relationship of hematological parameters (Steel et al. 1997).

**Results and discussion**

The hematological parameters are the indicators of overall health of birds and provide insight to the management strategies of the caged birds (Bounous et al. 2000; Quintavalla et al. 2001; Hauptmanova et al. 2006). The hematological and biochemical parameters have been determined and reported in some domestic avian species (Konuk et al. 1981; Woodard et al. 1983). However, the literature on hematological parameters for pheasants is scanty (Schmidt et al. 2007; Lloyd and Gibson 2006; Hauptmanova et al. 2006). These parameters are also influenced by species, age, sex, season, geographical area, diet and physiological status (Perelman 1999; Fudge 2000). During present study, significant differences in various hematological parameters were recorded during different ages of juvenile ring-necked pheasants. Pujman and Hanusova (1970) recorded higher RBCs in adult and young pheasants. In chickens and domestic turkeys higher lymphocyte count has been documented (Bounous et al. 2000). Significantly, lower values for red blood cells (/mm$^3$) 774000 ± 177212.99 and higher values for white blood cells (/mm$^3$) 26350 ± 5144.04 were recorded during 2$^{nd}$ month of age as compared to all the other months.
Our findings are in line with the results of Tufan and Ramazan (2011), who documented RBCs values $1.96 \pm 0.5 \times 10^6$ for chicks, $2.42 \pm 0.5 \times 10^6$ for young and $2.61 \pm 0.5 \times 10^6$ for adult birds. The WBCs values for chicks were reported $21.1 \pm 7.0 \times 10^3$, these values were $30.5 \pm 7.4 \times 10^3$ for young and $24.6 \pm 8.0 \times 10^3$ for adult birds. Similar counts for RBCs were observed by Schmidt et al. (2007) for pheasants, and by Keskin et al. (2002) for partridges, however, Hauptmanova et al. (2006) recorded lower RBCs values for pheasants.

During present study, significantly lower values for hemoglobin (%) were recorded $6.46\pm0.76 \%$ and $7.34 \pm 1.57 \%$ during 1st and 2nd month of age, respectively. Tufan and Ramazan (2011) recorded hemoglobin concentrations of $7.8 \pm 0.8 \%$ for chicks, $9.1 \pm 1.5 \%$ for young and $9.1 \pm 1.5 \%$ for adult ring necked pheasants and reported increase in hemoglobin increase with increase in age. The age-related findings were substantiated by Schmidt et al. (2007) for pheasants, Palomeque et al. (1991) for ostriches, Keskin et al. (1995) for Japanese quails, Puerta et al. (1989) for storks, and Islam et al (2004) for chickens. However, our results are contradictory to the findings of Keskin et al. (2002), who reported non-significant differences in partridges during different ages.

Higher values for mean corpuscular hemoglobin concentrations (%) of $29.16 \pm 2.96$ were observed during 6th month of age while same was recorded lowest as $18.52 \pm 2.79$ during 1st month of age. Tufan and Ramazan (2011) recorded MCHC concentrations of $27.8 \pm 3.4\%$ for chicks, $27.8 \pm 5.1\%$ for young and $26.7 \pm 2.4\%$ for adult ring necked pheasants. During present study, lower PCV (%) of $32 \pm 2.40 \%$ were observed during 2nd month of age. Tufan and Ramazan (2011) recorded PCV values of $28.7 \pm 4.7 \%$, $33.3 \pm 4.3 \%$ and $35.7 \pm 4.8 \%$ for chicks, young and adult ring-necked pheasants, respectively. The values recorded during present study are in line with the results of Schmidt et al. (2007) for pheasants. Maximum values for
total serum protein (g/dL) $4.14 \pm 0.65\%$ were recorded during 10th month of age during present analysis Table 1. These results for the total serum protein are in accordance with the findings of Schmidt et al. (2007), who recorded total serum protein values $4.22 \pm 0.44\%$ for juveniles and $6.77 \pm 0.28\%$ for adult pheasants. These proteins are produced in the liver, transported in the blood and incorporated into the oocytes of the ovary (Lumeij 1997).

Heterophils are the most abundant leukocytes in the peripheral blood of most avian species, whereas some avian species are lymphocytic (Fudge 2000; Latimer and Bienzle 2000). Juvenile ring-necked pheasants of all ages had lymphocytes as the major circulating leukocyte. Hematological studies of chickens and domestic turkeys showed a similar condition (Bounous et al. 2000). However, a similar distribution of heterophils and lymphocytes in adult and young pheasants was reported (Schmidt et al. 2007). Higher values for heterophils cells were recorded $10869 \pm 3257.57$ during 2nd month of age. Similarly maximum values for lymphocytes were observed $12264 \pm 2941.48$ during 2nd month of age while the same was lowest $6839 \pm 1652.15$ during 1st month of age. Higher values for monocytes were observed $1316 \pm 287.45$ during 11th month of age while these values were lowest $301 \pm 11.73$ during 3rd month of age. The eosinophil’s count varied from minimum $110 \pm 13.50$ during 3rd month to maximum $902 \pm 93.22$ during 11th month of age. However, significantly higher values of basophils were recorded during 1st month of age. Schmidt et al. (2007) recorded hematological parameters of pheasants from 5th week to 52nd week of life and documented values for heterophils $6824 \pm 2283$ for juveniles to $13372 \pm 6023$ for adults, for lymphocytes the values varied from $8960 \pm 2738$ for juveniles to $11917 \pm 1754$ for adults. The values of monocytes were $723 \pm 290$ for juveniles and $20948 \pm 595$ for adults. Eosinophils were recorded $367 \pm 222$ in juveniles and $1285 \pm 183$ in adults. The values for basophils varied from $1510 \pm 938$ for juveniles to $5258 \pm 1079$ for adult
birds. The WBC and the different types of leukocytes are influenced by age, hormones and stress (Maxwell 1993; Latimer and Bienzle 2000). Although young birds demonstrate a great variability in total leukocyte count until 4th to 6th month of age (Fudge 2000), birds often become excited when handled. Thus, the blood collection process usually results in a physiologic leukocytosis, that represents a transient phenomenon and this physiologic response increases the concentration of heterophils and lymphocytes in the peripheral blood (Thrall 2004).

It can be concluded that the hematological parameters change with increase in age and complete knowledge of their reference values and ranges in during different ages is necessary for management of captive populations.

References


Table 1. Selected hematological parameters in ring necked pheasant at different weeks of age.

<table>
<thead>
<tr>
<th>Months</th>
<th>RBC (/mm$^3$)</th>
<th>WBC (/mm$^3$)</th>
<th>Hb%</th>
<th>MCHC%</th>
<th>PCV %</th>
<th>Total Serum Protein (g/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>2006000±592718.78$^{DE}$</td>
<td>19975±3893.01$^{BC}$</td>
<td>6.46±0.76$^{E}$</td>
<td>18.52±2.79$^{C}$</td>
<td>35±1.76$^{BCD}$</td>
<td>3.56±0.19$^{BC}$</td>
</tr>
<tr>
<td>2nd</td>
<td>774000±177212.99$^{G}$</td>
<td>26350±5144.04$^{A}$</td>
<td>7.34±1.57$^{DE}$</td>
<td>22.90±4.75$^{B}$</td>
<td>32±2.40$^{E}$</td>
<td>3.72±0.42$^{ABC}$</td>
</tr>
<tr>
<td>3rd</td>
<td>1588000±290088.11$^{EF}$</td>
<td>19650±1820.87$^{BC}$</td>
<td>7.86±0.69$^{CD}$</td>
<td>23.58±2.09$^{B}$</td>
<td>33±2.27$^{CDE}$</td>
<td>3.46±0.37$^{BC}$</td>
</tr>
<tr>
<td>4th</td>
<td>2792000±347268.71$^{A}$</td>
<td>20490±552.16$^{BC}$</td>
<td>8.46±1.03$^{ABCD}$</td>
<td>25.12±1.78$^{B}$</td>
<td>34±2.54$^{CDE}$</td>
<td>3.53±0.15$^{BC}$</td>
</tr>
<tr>
<td>5th</td>
<td>2057000±683358.54$^{CDE}$</td>
<td>21070±4662.32$^{BC}$</td>
<td>8.00±2.16$^{BCD}$</td>
<td>22.16±6.87$^{B}$</td>
<td>37±3.99$^{B}$</td>
<td>3.49±0.36$^{BC}$</td>
</tr>
<tr>
<td>6th</td>
<td>1460000±810980.20$^{F}$</td>
<td>20050±1367.89$^{BC}$</td>
<td>9.30±0.88$^{AB}$</td>
<td>29.16±2.96$^{A}$</td>
<td>32±1.24$^{E}$</td>
<td>3.45±0.29$^{BC}$</td>
</tr>
<tr>
<td>7th</td>
<td>1324500±709907.86$^{F}$</td>
<td>20760±1299.10$^{BC}$</td>
<td>9.38±1.20$^{A}$</td>
<td>29.31±4.04$^{A}$</td>
<td>32±3.41$^{DE}$</td>
<td>3.37±0.22$^{C}$</td>
</tr>
<tr>
<td>8th</td>
<td>2176000±884297.59$^{BCD}$</td>
<td>19469±2197.52$^{BC}$</td>
<td>7.98±0.90$^{BCD}$</td>
<td>22.16±2.05$^{B}$</td>
<td>36±2.49$^{BC}$</td>
<td>3.80±0.29$^{ABC}$</td>
</tr>
<tr>
<td>9th</td>
<td>2566000±697570.39$^{ABC}$</td>
<td>19113±2077.35$^{C}$</td>
<td>8.38±0.83$^{ABCD}$</td>
<td>22.31±2.12$^{B}$</td>
<td>38±3.40$^{AB}$</td>
<td>3.84±0.48$^{AB}$</td>
</tr>
<tr>
<td>10th</td>
<td>2612000±174151.91$^{AB}$</td>
<td>22332±3034.20$^{B}$</td>
<td>9.14±1.69$^{ABC}$</td>
<td>22.90±3.22$^{B}$</td>
<td>40±3.73$^{A}$</td>
<td>4.14±0.65$^{A}$</td>
</tr>
<tr>
<td>11th</td>
<td>2705000±187631.44$^{AB}$</td>
<td>21771±2623.00$^{BC}$</td>
<td>8.91±1.32$^{ABC}$</td>
<td>22.33±2.92$^{B}$</td>
<td>40±2.76$^{A}$</td>
<td>4.09±0.59$^{A}$</td>
</tr>
<tr>
<td>12th</td>
<td>2801000±490180.24$^{A}$</td>
<td>20548±3357.12$^{BC}$</td>
<td>8.91±1.32$^{ABC}$</td>
<td>22.33±2.92$^{B}$</td>
<td>40±2.76$^{A}$</td>
<td>4.09±0.59$^{A}$</td>
</tr>
</tbody>
</table>

Means with similar letters in a column are statistically non-significant.
Table 2. Differential leukocyte count in ring necked pheasant at different weeks of age

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Differential Leucocyte Count</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Heterophils</td>
<td>Lymphocytes</td>
<td>Monocytes</td>
<td>Eosinophils</td>
<td>Basophils</td>
</tr>
<tr>
<td>1st</td>
<td>7875±1288.99^C</td>
<td>6839±1652.15^E</td>
<td>809±272.48^B</td>
<td>629±246.49^C</td>
<td>3743±782.23^A</td>
</tr>
<tr>
<td>2nd</td>
<td>10869±3257.57^A</td>
<td>12264±2941.48^A</td>
<td>454±101.18^C</td>
<td>179±74.85^DE</td>
<td>2474±1450.14^B</td>
</tr>
<tr>
<td>3rd</td>
<td>7580±468.56^C</td>
<td>10256±567.78^BC</td>
<td>301±11.73^C</td>
<td>110±13.50^B</td>
<td>1020±214.99^B</td>
</tr>
<tr>
<td>4th</td>
<td>5407±466.09^D</td>
<td>11542±518.43^AB</td>
<td>864±32.58^B</td>
<td>286±25.62^B</td>
<td>1948±64.93^RC</td>
</tr>
<tr>
<td>5th</td>
<td>7714±2577.64^L</td>
<td>11706±1561.45^AB</td>
<td>443±127.23^L</td>
<td>178±58.13^TH</td>
<td>1431±495.80^CD</td>
</tr>
<tr>
<td>6th</td>
<td>5429±145.74^D</td>
<td>11666±1024.10^AB</td>
<td>728±110.39^B</td>
<td>724±241.53^BC</td>
<td>1430±147.57^CD</td>
</tr>
<tr>
<td>7th</td>
<td>5630±271.51^D</td>
<td>12040±987.37^A</td>
<td>824±85.95^B</td>
<td>592±338.20^C</td>
<td>1623±144.47^C</td>
</tr>
<tr>
<td>8th</td>
<td>5092±842.37^D</td>
<td>11795±1494.10^AB</td>
<td>807±108.85^B</td>
<td>692±203.79^C</td>
<td>1013±39.65^D</td>
</tr>
<tr>
<td>9th</td>
<td>5266±949.57^D</td>
<td>11474±1381.95^AB</td>
<td>759±170.51^B</td>
<td>660±208.00^L</td>
<td>997±92.18^H</td>
</tr>
<tr>
<td>10th</td>
<td>9593±1287.72^AB</td>
<td>8875±2101.04^CD</td>
<td>1175±222.36^A</td>
<td>864±105.29^AB</td>
<td>1766±650.55^C</td>
</tr>
<tr>
<td>11th</td>
<td>8979±1437.18^BC</td>
<td>8604±1486.05^D</td>
<td>1316±287.45^A</td>
<td>902±93.22^A</td>
<td>1912±577.60^RC</td>
</tr>
<tr>
<td>12th</td>
<td>8282±2008.63^BC</td>
<td>8306±1618.26^D</td>
<td>1260±193.70^A</td>
<td>859±94.60^AB</td>
<td>1725±636.64^C</td>
</tr>
</tbody>
</table>

Means with similar letters in a column are statistically non-significant.
Title: Gender wise variations in serum chemistry in ring-necked pheasants (Phasianus colchicus) in captivity
Gender wise variations in serum chemistry in ring-necked pheasants (*Phasianus colchicus*) in captivity

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Abstract

Variations in hematological parameters for adult male and female ring-necked pheasants (*Phasianus colchicus*) were recorded. Forty adult ring-necked pheasants (20 ♂, 20 ♀) were kept in separate cages, each cage having separate drinking and feeding facilities. Five birds per cage were confined and these cages were housed in a well-ventilated 20 × 20 feet (length × width) room. Blood samples were taken from ulnar vein. Different blood and serum chemistry parameters such as red blood cells (RBCs), white blood cells (WBCs), hemoglobin (Hb) concentrations, mean corpuscular hemoglobin concentration (MCHC), packed cell volume (PCV), heterophils, lymphocytes, monocytes, eosinophils, basophils, ALP, uric acid, cholesterol, total serum protein, albumin and creatinine were determined among adult male and female pheasants. Non-significant differences in RBCs, WBCs, heterophils, eosinophils, MCHC and Hb values were observed among male and female pheasants. Significantly, higher values of lymphocytes, monocytes and PCV were observed in males while higher basophil count was observed in female as compared to male birds. Significantly higher values for ALP, cholesterol, total serum protein and creatinine were observed in males while higher uric acid values were observed in females as compared to male *P. colchicus*. However, non-significant differences in albumin were recorded among male and female birds.

**Key words:** *Phasianus colchicus*, lymphocytes, cholesterol, creatinine, gender
Introduction

Pheasants are amongst the most preferred bird species for hunters and have been broadly introduced in many parts of the world as a game bird. Many pheasant species have quality meat and their commercial farming is rising in many countries. In Iran, several commercial pheasant farms have been established as a new agricultural activity for commercial production of meat and this commercial scale farming of pheasants is increasing exponentially (Nazifi et al. 2012). However, the developing pheasant industry is facing some challenges like bacterial, viral and parasitic diseases (Lloyd and Gibson 2006; Goldova 2000).

Clinical hematology and serum chemistry are important parameters for diagnosis of bird diseases as in birds clinical signs of illness are frequently subtle and clinical chemistry is necessary to evaluate the cellular changes (Fudge 1997). According to Meluzzi et al. (1992), the blood parameters of birds are influenced by gender, age, genotype, physiological condition, diet, micro- and macroclimatic conditions, rearing method, season, and pathological factors. In addition, wever, sample collection methods and method of laboratory examination also play a vital role. Although, blood analyses have been used to assess health of several domestic bird species but limited information is available for pheasants (Schmidt et al. 2007).

Serum parameters are equally important diagnostic parameters (Pampori and Saleem 2007; Patodkar et al. 2008; Lukasiewicz and Michalczuk 2009) and it is well accepted that plasma biochemistry along with hematology is essential for medical diagnosis of diseases in many bird species. Moreover, numerous studies have reported the values of blood parameters in gallinaceous poultry (Jerabek et al. 1993; Suchy et al. 2004; Tumova et al. 2004; Meluzzi et al. 1992; Strakova et al. 1993; Itoh et al. 1995; and Bounous et al. 2000), but in literature only few analysis on the biochemical parameters in pheasants have been reported (Schmidt et al. 2007a, b,
suchy et al. 2010), and the knowledge of serum chemistry parameters in pheasants still remains incomplete. Glucose, calcium, cholesterol, total protein, uric acid, alkaline phosphates, sodium, potassium and chloride levels are diagnostic values for diabetes mellitus, liver diseases, hypoparathyroidism, chronic hepatopathy, gout, kidney disease, chronic diarrhea and dehydration (Ritchie et al. 1994).

There is no differences in serum parameters among the adult male female and chicks such as albumen, globulin and total protein (Schmidt et al. 2007) and serum calcium concentrations is low during egg production (Peebles et al. 2009). Glucose and cholesterol provide energy while total proteins shows the level of albumin and globulin of the blood (Adeyemo et al. 2010), and these values can be used as physiological indicators (Perelman 1999). The present study was planned to compare the hematology and serum profile of male and female Phasianus colchicus.

**Materials and Methods**

Present study was conducted at Captive Breeding Facilities for Birds, Department of Wildlife and Ecology, Ravi Campus, University of Veterinary and Animal Sciences, Lahore. Forty ring-necked pheasants, Phasianus colchicus (20 ♂ + 20 ♀) were placed separately in different cages, provided with separate feeding and drinking facilities.

**Analysis of hematological parameters**

Blood (2 ml) of the P. colchicus was collected from ulnar vein through a syringe and transferred to a tube containing ethylenediaminetetraacetic acid (EDTA). This tube was kept in container containing ice to avoid denaturation of proteins and processed in laboratory following Jain (1986). Microcapillary tubes containing blood were centrifuged at 13,000 rpm for 5 min and
the hematocrit values were determined directly in a microhematocrit reader. Total red blood cells (RBCs) and total white blood cells (WBCs) count were recorded using hemocytometer with blood diluted on after mixing with Natt-Herrick solution in the ratio of 1 to 200 (Natt and Herrick 1952). The hemoglobin concentration was measured through Sahli’s hemoglobinometer method. For the differential leukocyte counts the smears were stained with Giemsa solution and cells were examined under microscope using a 100X objective.

**For serum chemistry study**

For serum chemistry analyses 2 ml blood sample was taken in a syringe and immediately transferred to a 10 ml plain glass tube, containing no anticoagulant. Then sera were separated by centrifugation at 750×g for 15 min. Then serum samples were analyzed for cholesterol by modified Abell–Kendall/Levey–Brodie (AK) method, total protein by biuret method, creatinine by Jaffe method and uric acid by phosphotungstic acid method. The enzyme activities of ALP were evaluated using modified Bowers and McComb method. Enzyme activities were measured at 37°C (Burtis and Ashwood 1994). The biochemical parameters were measured using a standard autoanalyzer (Cobas-Mira, ABX-Diagnostics, Japan).

**Statistical analysis**

The obtained data were subjected to statistical software SAS 9.1 and Analysis of Variance (Steel et al. 1997) was applied to find out the relationship among different parameters under study.

**Results and Discussion**

Examination of blood parameters is important in assessment of general health of caged-birds. It is well known that in several birds plasma biochemistry along with hematology is
essential for medical diagnosis of disease, limited information is available for pheasants (Jain 1993). Meluzzi et al. (1992) documented that blood parameter values are affected by so many aspects including age, gender, genotype and physiological condition and pathological factors. During present study, non-significant differences were observed in RBC (/mm$^3$) values for male (2516000.00 ± 586746.21) and female (2591000.00 ± 175210.98) birds. Our findings are in line with Schmidt (2007), who reported non-significant differences in RBCs count between adult male and female ring-necked pheasants. Kececi and Ramazan (2011) recorded higher number RBCs count in adult pheasants as compared to young ones (Pujman and Hanusova 1970).

White blood cells are influenced by age, hormones and stress (Maxwell 1993; Latimer and Bienzle 2000). During present analysis, non-significant differences in WBCs (/mm$^3$) were observed between male (23755.00 ± 3389.24) and female (22370.90 ± 2008.66) $P.\ colchicus$. Schmidt (2007) documented similar results for adult male and female ring-necked pheasants. Similarly, during present study non-significant differences in heterophils were observed between for male (9309.10 ± 1387.89) and female (9894.90 ± 877.70) sexes. These results confirmed the findings of Kececi and Ramazan (2011), who reported non-significant variations in heterophils among both the sexes. During present study, significantly higher values for lymphocytes were observed in male (10684.80 ± 1581.50) as compared to female (8664.00 ± 844.33) birds. Kececi and Ramazan (2011) recorded significant differences in lymphocytes however, the values were significantly higher in female as compared to male birds.

During present analysis non-significant differences were observed in eosinophils between male (872.50 ± 99.310) and female (878.00 ± 221.14) pheasants. Kececi and Ramazan (2011) recorded non-significant differences in eosinophils between male and female birds. Schmidt (2007) also documented non-significant variations in eosinophils between male and female
gender. During present study, higher monocyte values were observed in male (1404.00 ± 360.345) as compared to female (1030.90 ± 306.40) *P. colchicus*. Schmidt (2007) and Kececi and Ramazan (2011) reported non-significant differences among male and female common pheasants. Significantly lower values for basophils were observed in male (1461.50 ± 238.234) as compared to female (1908.00 ± 526.28) ring-necked pheasants during present study. Our findings confirmed the results of Schmidt (2007), who documented significantly higher values of basophils in female and compared to male birds. However, Kececi and Ramazan (2011) reported non-significant differences in basophil cells between male and female gender. Fudge (2000) reported that young birds demonstrate a great variability in total leukocyte count until 4 to 6 months of age. Higher values for packed cell volume (PCV %) was observed in male (45.00 ± 1.63) as compared to female (36.80 ± 1.31) birds during present analysis. Our findings are in line with the results of Schmidt (2007). Adult ring-necked pheasant males had higher PCV levels than adult females and young birds. In general, the PCV increases with age and are higher in male than female birds. Estrogen depresses erythropoiesis, whereas androgens and thyroxin stimulate erythropoiesis (Herbert et al. 1989). The age-related variation of PCV is similar to that reported for adult and young pheasants (Pujman and Hanusova 1970), for 42 day-old broiler chickens (Bounous and Stedman 2000) and for Thai indigenous chickens (Simaraks et al. 2004). During present study, non-significant differences were recorded in hemoglobin concentrations between male (10.00 ± 1.414) and female (9.03 ± 0.374) birds. Schmidt (2007) and Kececi and Ramazan (2011) also reported non-significant differences in hemoglobin concentrations (%) between male and female *P. colchicus*. During present study, non-significant variations in MCHC% were recorded between male (22.27 ± 3.463) and female (24.56 ± 1.22) birds. Our results are in line with the findings of Kececi and Ramazan (2011).
Marked increase in plasma ALP activity appears to be specific for osteoblastic activity and bony change associated with growth, trauma, repair, osteomyelitis, neoplasia, nutritional secondary hyperparathyroidism and egg-shell deposition (Lumeij and Westerhof 1987). During present study, higher ALP (U/L) values were recorded in male (2000 ± 900) as compared to female (1400 ± 420) birds. Nazifi (2012) also reported higher ALP values in male ring-necked pheasants as compared to females. Blood uric acid concentration is influenced by age, species and diet (Campbell 2004). Uric acid is the major end product of nitrogen metabolism and higher uric acid concentrations (µmol/L) were recorded in female (534.60 ± 19.05) as compared to male (403.00 ± 54.57) *P. colchicus* during present analysis. Nazifi (2012) also reported higher uric acid values in females as compared to male birds while gender wise non-significant variations in uric acid concentrations were documented by Schmidt (2007) and Kececi and Ramazan (2011). Scholtz et al. (2009) reported no sex-related differences between male and female Japanese quails. Suchy et al. (2010) reported concentrations of 117.60 µmol/l uric acid in common pheasants and these values are lower than the values recorded during present study. During present study, higher values of cholesterol (mmol/dL) were recorded in male (3.71 ± 0.01) ring-necked pheasants as compared to females (3.23 ± 0.02). Nazifi (2012) also reported higher values of cholesterol for male birds as compared to female ring-necked pheasants. Mean cholesterol concentrations recorded during present study are in line with those reported in pheasants by Suchy et al. (2010). The cholesterol values found in pheasants also comply with those reported in broilers (Meluzzi et al. 1992). Harr (2002) reported that metabolism of cholesterol in avian species is like that of mammals, but plasma cholesterol levels can considerably increase during vitellogenesis and egg formation in birds. It is also documented that
wide variations in cholesterol concentrations among avian species may depend on circadian rhythms and diet (Harr 2002; Villegas 2002).

During present study, higher total protein (g/dL) values were recorded in male birds (4.42 ± 0.35) as compared to females (3.43 ± 0.30). Schmidt (2007), Kececi and Ramazan (2011) and Nazifi (2012) observed similar results. A range of total protein values in most birds have been described from 3 to 5 g/dl (Coles and Campbell 1986; Coleman et al. 1988; Kaneko et al. 1997; Khazraiinia et al. 2006). Lloyd and Gibson (2006) and Suchy et al. (2010) reported values of 35±0.6 g/l and 49.2±6.8 total protein in pheasants. Sex-related differences in serum total protein were observed in this study. Blood proteins in birds may differ due to age, sex and season (Fudge 2000).

During present study, non-significant differences in albumin concentrations (g/dL) were observed between male (1.85 ± 0.345) and female (1.85 ± 0.154) common pheasants. However, Schmidt (2007) reported significant variations in albumin concentrations between male and female birds. It is documented that blood proteins in birds are influenced by age, sex and season (Fudge 2000). Creatinine is key indicator of protein metabolism and renal integrity. Derived from the breakdown of phosphocreatinine in muscle, creatinine increases with high levels of activity, such as flying, and is also affected by diet. During present study, higher creatinine concentrations (µmol /L) were recorded in male (32.00 ± 1.632) as compared to female (25.60 ± 1.83) birds. Our findings are in line with the results of Nazifi (2012), who reported higher creatinine values for males as compared to female. This might be due to sex differences in nitrogen metabolism, growth and muscle mass (Szabo and Milisits 2007).

It can be concluded from present study that hematological parameters viz. lymphocytes, monocytes, basophils and packed cell volume and serum biochemical parameters viz. ALP, uric
acid, cholesterol, total proteins and creatinine vary significantly between male and female ring-necked pheasants.

References


Table 1. Haematological values of adult male and female ring-necked pheasants.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Gender</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBC (/mm$^3$)</td>
<td>Male</td>
<td>2516000.00 ±586746.21$^\lambda$</td>
<td>2591000.00 ±175210.98$^\lambda$</td>
</tr>
<tr>
<td>WBC (/mm$^3$)</td>
<td>Male</td>
<td>23755.00 ± 3389.24$^\lambda$</td>
<td>22370.90 ± 2008.66$^\lambda$</td>
</tr>
<tr>
<td>Heterophils</td>
<td>Male</td>
<td>9309.10 ± 1387.89$^\lambda$</td>
<td>9894.90 ± 877.70$^\lambda$</td>
</tr>
<tr>
<td>Lymphocytes</td>
<td>Male</td>
<td>10684.80 ± 1581.50$^\lambda$</td>
<td>8664.00 ± 844.33$^b$</td>
</tr>
</tbody>
</table>
Table 2. Serum chemistry values for adult male and female ring-necked pheasants.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Gender</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALP (U/L)</td>
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<td>2000 ± 900&lt;sup&gt;A&lt;/sup&gt;</td>
<td>1400 ± 420&lt;sup&gt;B&lt;/sup&gt;</td>
</tr>
<tr>
<td>Uric acid (µmol/L)</td>
<td></td>
<td>403.00 ± 54.57&lt;sup&gt;B&lt;/sup&gt;</td>
<td>534.60 ± 19.05&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cholesterol (mmol/dL)</td>
<td></td>
<td>3.71 ± 0.01&lt;sup&gt;A&lt;/sup&gt;</td>
<td>3.23 ± 0.02&lt;sup&gt;B&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total protein (g/dL)</td>
<td></td>
<td>4.42 ± 0.35&lt;sup&gt;A&lt;/sup&gt;</td>
<td>3.43 ± 0.30&lt;sup&gt;B&lt;/sup&gt;</td>
</tr>
<tr>
<td>Albumin (g/dL)</td>
<td></td>
<td>1.85 ± 0.345&lt;sup&gt;A&lt;/sup&gt;</td>
<td>1.85 ± 0.154&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Creatinine (µmol/L)</td>
<td></td>
<td>32.00 ± 1.632&lt;sup&gt;A&lt;/sup&gt;</td>
<td>25.60 ± 1.83&lt;sup&gt;B&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Means with similar letters in a row are statically non-significant.
CHAPTER 4
SUMMARY

Besides ecological importance, pheasants also have aesthetic values which mainly contribute to their decline in population due to poaching in their native habitat. Among 49 species of pheasants in the world, 5 are endemic to Pakistan with distribution in the Himalaya and remote northern parts of the country. Due to increase in human population, intrusion, poaching, and habitat disturbance pheasants are threatened. However, much of the work on captivity is based on production rather morphological, ornamentation or reproductive traits which could have important implications for the management of wild and captive populations as a whole. Some studies still remain to be explored.

Present study was conducted to find out the relationship of egg weight with egg quality parameters and growth traits of ring-necked pheasant *Phasianus colchicus*. Total of 450 eggs were collected and were divided into three egg weight categories viz. light (20.0-26.0g), medium (27.0-32.0g) and heavy (33.0-40.0g) egg weight eggs. Fifty eggs for each of the egg category were reserved for the evaluation of internal egg quality parameters. External egg quality parameters i.e. egg length, breadth, egg volume and surface area varied significantly (P<0.05) between all the three egg weight categories. Similarly, significantly higher albumen and yolk weight were recorded in heavy weight egg category while non-significant relationship of egg weight was observed for shell and membrane thickness, yolk percentage, yolk index, yolk pH and albumen pH of the egg. The hatching percentage for the remaining 300 egg kept in incubator was 47.33%. Forty chicks from each of the egg weight category were selected and chick weight, wing length and wingspan were taken at the time of hatching and thereafter increase in these parameters were noted on weekly basis. The effect of egg weight on chick weight, live weight gain, wing length and wingspan was significant (P<0.05) from 1st to 12th month of age. Our
studies revealed that egg weight has strong influence on external and internal characteristics of the eggs and the growth parameters in *P. colchicus* chicks.

The present study was planned to evaluate the time budgets of ring necked pheasants *Phasianus colchicus* in captivity. The birds were kept in cages of 5 ft × 5 ft × 3 ft (length × width × height) and were housed in a 20 ft × 20 ft (length × width) well ventilated room at Department of Wildlife and Ecology, Ravi Campus, University of Veterinary and Animal Sciences, Lahore. Captive birds were divided into three categories viz. adult male, adult female and chicks and were placed into separate cages. Behavioral parameters viz. jumping, aggression, preening, feather pecking, walking, standing, sitting, litter pecking, drinking, feeding, body shaking, voice call and feather flapping were assessed for 30 birds from each of the three categories through scan sampling. Statistically significant variations were recorded in behavioral aspects among all the three categories. Male birds spent significantly higher times in aggression (155.26±3.10 sec), preening (74.04±3.05 sec), walking (1370.93±54.45 sec), drinking (74.00±3.18 sec), body shaking (24.92 ±3.11 sec), voice call (20.08±3.17 sec) and feather flapping (15.42±2.73 sec) while female *P. colchicus* spent significantly higher times in sitting (364.57±3.74 sec). Similarly, the chicks spent significantly higher times in jumping (36.17±2.75 sec), feather pecking (265.19±3.17 sec), standing (1230.13±23.86 sec), litter pecking (234.89±2.97 sec) and feeding (115.44±3.11 sec) as compared to the adult female and male birds.

Fecal and blood samples of ring necked pheasants, *Phasianus colchicus* were analyzed to record the parasitic prevalence in these pheasants. A total of 1000 samples, 500 blood and 500 fecal samples were collected from Captive Breeding Facilities for Birds, Department of Wildlife and Ecology, Ravi Campus, University of Veterinary and Animal Sciences, Lahore. Parasitic genera identified from blood samples of *P. colchicus* include *Leukocytozoon, Plasmodium* and
Haemoproteus. Prevalence of Leukocytozoon was 16% while the prevalence of Haemoproteus was 14.3%. Parasitic genera identified from fecal samples of P. colchicus include Eimeria, Isospora, Trichomonas and Giardia. Eggs of five species of nematodes viz. Capillaria, Syngamus trachea and Ascaridia, Heterakis isolonche and Heterakis gallinarum were also identified from the fecal samples. The ectoparasites include one species of burrowing mite Knemidocoptes mutans and two species of chewing lice i.e. Amyrsidea perdicis and Lipeurus maculosus.

Variations in hematological parameters during different life history stages were recorded in ring-necked pheasants (Phasianus colchicus) for a period of 1 year. Thirty birds were selected for analysis of selected hematological parameters viz. red blood cells count, white blood cells count, hemoglobin, mean corpuscular hemoglobin concentrations, total serum protein and leucocyte count. These birds were kept in cages, each cage having separate drinking and feeding facilities. Five birds per cage were confined and these cages were housed in a well-ventilated 20 × 20 feet (length × width) room. Blood samples were taken from ulnar vein and variations in blood parameters were recorded on monthly basis. Significantly, lower RBC’s count was observed during 2nd month of age while during same month significantly higher WBC count was noticed. Significantly lower values of hemoglobin were observed during 1st and 2nd month of age. Significantly higher mean corpuscular hemoglobin concentration percentage (MCHC%) was recorded during 6th and 7th month of age. Lower packed cell volume (PCV) values were observed during 2nd and 6th month of age while the total serum protein concentrations were recorded maximum during 10th month of age. Significantly, higher heterophils count was recorded during 2nd and 10th month of age while maximum lymphocyte count was observed during 2nd and 7th months of age. Significantly, higher concentrations of monocytes were recorded during 11th, 12th
and 10th month of age. The eosinophils count varied from minimum (110 ± 13.50) during 3rd month to maximum (902 ± 93.22) during 11th month of age. Similarly, significantly higher values of basophils were recorded during 1st month of age. It can be concluded from the present study that the blood profile of the pheasants changes with age.

Variations in hematological parameters for adult male and female ring-necked pheasants (*Phasianus colchicus*) were recorded. Forty adult ring-necked pheasants (20 ♂, 20 ♀) were kept in separate cages, each cage having separate drinking and feeding facilities. Five birds per cage were confined and these cages were housed in a well-ventilated 20 × 20 feet (length × width) room. Blood samples were taken from ulnar vein. Different blood and serum chemistry parameters such as red blood cells (RBCs), white blood cells (WBCs), hemoglobin (Hb) concentrations, mean corpuscular hemoglobin concentration (MCHC), packed cell volume (PCV), heterophils, lymphocytes, monocytes, eosinophils, basophils, ALP, uric acid, cholesterol, total serum protein, albumin and creatinine were determined among adult male and female pheasants. Non-significant differences in RBCs, WBCs, heterophils, eosinophils, MCHC and Hb values were observed among male and female pheasants. Significantly, higher values of lymphocytes, monocytes and PCV were observed in males while higher basophil count was observed in female as compared to male birds. Significantly higher values for ALP, cholesterol, total serum protein and creatinine were observed in males while higher uric acid values were observed in females as compared to male *P. colchicus*. However, non-significant differences in albumin were recorded among male and female birds.
Literature Cited


