CHAPTER 1

1. GENERAL INTRODUCTION

1.1 General

The birds are warm-blooded, bipedal, oviparous vertebrates characterized by bony beak, pneumatic bones, feathers and wings. They are beautiful natural resources and are beneficial for human beings in several ways such as economic returns, environmental controller, meat production, bio-indicators, source of knowledge and source of recreation (Araki *et al.*, 1989). There are around 10,000 species of birds in the world, descended from one another through the process of adaptation by natural selection (Lepage, 2008). Birds are widely recognized as good bio-indicators of the quality of the ecosystems and health of the environment (Gill, 1994). They are being used as tools for the conservation of environment. Since stone age, aves are thought to have close relation with human beings as their glimpses were engraved on caves in Spain which are supposed to be 25,000 years old (Harikrishnan *et al.*, 2010). Galliformes species are useful indicators of environmental quality and the assessment of their status is essential for management purposes (Fuller and Garson, 2000). The Indian peafowl (*Pavo cristatus*) is the national bird of India. It is a large, colourful and charming bird (Jaiswal *et al*., 2013). The Indian peafowl originated in India and later introduced in most of the countries of the world. This bird is also designated as a national bird of India and the provincial bird of Punjab. The Indian peafowl is wild birds but are also raised as ornamental birds (Titilincu *et al.*, 2009). It inhabits South Asia in the wild state but as a domesticated bird it is found in almost all parts of the world (Harihar and Fernandes, 2011; Jain and Rana, 2013). The Indian peafowl, also called blue or common peafowl, is the largest among the pheasants. This bird was declared as the National Bird of India in 1963 due to its flagship value found on its glorious position in mythology that was honoured by the ancient Greeks. This bird belongs to the family Phasianidaeand under the order Galliformes (Ali and Ripley, 1989; Johnsgard, 1986). The Indian peafowl is commonly called as Myur. It is cosmopolitan in distribution; however, India, Sri Lanka, Pakistan, Nepal and Myanmar are considered to be its native homeland (Ansari, 1957). The Arakan hills and mountains of Himalayas have prevented the migration of this bird to the east and the north, respectively (Vijayarani *et al.,* 2010). Though once common in Bangladesh, it may now be extinct in that country (IUCN-Bangladesh 2015).

1.2 Indian Peafowl *(Pavo cristatus)*

The male Indian peafowl, commonly known as the peacock, is one of the most recognizable birds in the world (Blau, 2004). The spectacular appearance of the male Indian peafowl, or ‘peacock’, is well known throughout the world. These large, brightly coloured birds have a distinctive crest and an unmistakable ornamental train (Harrison and Worfolk, 1999). In spite of their large size, peacocks are capable of flight. In fact, they are one of the largest and heaviest flying birds in the world (Maria, 2018). The Indian peafowl is the most beautiful, royal and big bird with long and colourful feathers. Among all the pheasants it is considered as the most beautiful and handsome pheasant widely in the world. The pheasants are group of birds belong to the family Phasianidae of the order Galliformes that includes pheasants, partridges and quails which are commonly known as game birds (Delacour, 1977). Pheasants are important indicator species since their presence or absence in an area is a good indicator of the healthiness of the bionetwork. The peacock symbolizes glory, grace, joy, splendor, love and pride (Kushwaha and Kumar, 2016). The significance of peafowl is closely related to the cultures of India, Far East, Ancient Persia, Greek and Christian. The peacock is known sacred in Hindu tradition as the transport of the god Kartikeya the son of Lord Shiva and his partner Parvati, and a brother of elephant-headed Ganesha. It is also a subject of voluminous folklore throughout the country for an account of its place in mythology and Sanskrit literature and poetry (El-Shahawy, 2010). The Indian peafowl also plays an important role in the Muslim history of creation. The figure of peacock is painted in various Islamic religious buildings (Thapar, 1998). This role of the peacock in different religions, folklore and mythology had traditionally acted as a safeguard against their being killed. In Christianity, the peacock was also known as the symbol of the 'Resurrection' (Kushwaha and Kumar, 2016). Tughlak kings were so fascinated by the peafowl feather that they adopted its design for the state emblem and prescribed its use in various ways, including the headgear of the soldiers. The fifth century AD, during the Gupta period several coins depicting the peacock were issued and it was also a favourite subject for the art and architecture of that time (Trivedi and Johnsingh, 1996). During the seventeenth-century Golden Age of Dutch and Flemish painting, the peacock was frequently presented in pictures of both the barnyard and aristocratic gardens (Yasmin, 1997). The excessive use of their feathers for this purpose contributed to the establishment of the Society for the Protection of Birds in 1891 and the National Audubon Society of America (NASA) in 1886. At the end of the nineteenth century and the beginning of the twentieth, they were such an integral and iconic part of the Arts and Crafts and Art Nouveau movements, outpouring of metalwork, tiles, glass, ceramics and other artifacts that it was impossible to avoid their image. During the middle Ages, it was a source of feathers for fletching arrows and for personal adornment of men’s helmets and hats, and on heraldic devices (Somes and Burger, 1993). The long ocellated feathers of the peacock's train are shed after the breeding season, picked up, and collected in large quantities by villagers for export chiefly to Europe and America, and for being made up locally into fans and other gaudy gimcracks (Hart, 2002). It has been a survivor, a truly remarkable bird reputed to have an angel's feathers, the voice of a devil and the feet of a thief (Khulape *et al.*, 2014).

The first reported introduction of Indian peafowl into the continental United States of America (USA) occurred in 1879. Today, semi-domestic or feral populations persist mostly in California and Florida. The Indian peafowls were presumably transported by ship to the Persian Gulf and Athens by overland caravans across Persia and Mesopotamia to the Mediterranean. The peafowl reached Greece by the late 6th century BCE, probably first on the island of Samos, where they were sacred to the goddess Hera. Within a century, they were brought to Athens, whereas rare curiosities, they were first exhibited in a private zoo. In 4th century BCE, they were common luxuries in Athens and both birds and eggs were eaten. Aristotle also knew a good deal about their habits. At the time of spread of Greek influence and colonization, peafowl were taken into the Mediterranean region and North Africa. This bird also popular in ancient Rome, being raised in large numbers as ornamental fowl and as ostentatious food served at feasts. Wall paintings and mosaic pavements document their further spread into regions under Roman influence, reaching Britain by the 4th century A.D. By medieval times, the birds had been introduced in Western Europe, as evidenced by their frequent depiction in manuscript illustrations, paintings, and architectural elements (Kannan and James, 1998). The peafowl originated in India and was later introduced in Europe in 7-8 century B.C., through Greece and Italy. The blue peacock was so much admired that it was taken from its native haunts in India and Sri Lanka, thousands of years ago and gradually distributed around the western world. That such an exotic bird became as familiar as an inhabitant of our gardens and barnyards is a tribute to its hardiness and adaptability as much as to its beauty (Ramesh and McGowan, 2009). Indian peafowl is the source of cultural societies, skill, conviction, and folklore of dissimilar ethnic crowds in Asia (Stewart *et al.*, 1996). The family Phasianidae, being of the largest families of Galliformes, including the largest size peafowls (Hoyo *et al.*, 1994). The Phasianidae family is the largest and the most diverse assemblage (Johnsgard, 1986) and comprises of 38 genera, 155 species and 399 taxa distributed throughout the old world. Pheasants and Indian peafowl have more than 180 species worldwide that belong to order Galliformes and class Aves (Gupta *et al.,* 2005). Worldwide basis, more than 250 species of turkeys, grouse, chicken, quails and pheasants belong to order Galliformes (Crowe *et al.,* 2006). In the world, 51 species of pheasants are present but only 17 species occur in India with very little ecological information (Fuller and Garson, 2000). Globally, three species of peafowl are found such as Burmese peafowl from eastwards to Sumatra, African peafowl in Belgian Congo and Indian peafowl or blue peafowl in Indian subcontinent (Dharmakumarsinhji and Lavkumar, 1981). Indian peafowl in full plumage is surely among the most beautiful of birds in the world. Because of its appearance, the bird has long been famous outside its native range, and consequently kept and bred across the world (Yasmeen, 1995). Indian Peafowl is widely distributed in India, Pakistan and Sri Lanka (Samour *et al.,* 2010). Green peafowls are considered to inhabit dry forest of Cambodia, Thailand, Vietnam, China and Indonesia (Liu *et al.,* 2009; Naseer *et al.,* 2018). African Congo Peafowl mostly found in forests of the Democratic Republic of Congo (Mulotwa *et al.,* 2010). This Congo peafowl is the only peafowl species that is distributed outside Asia (Jackson, 2006).

The distribution of Indian, blue or common Indian peafowl, is mainly confined to the Indian subcontinent; southern part of the Himalayas, across Pakistan, eastern part of the Indus river valley, in Sri Lanka (Saini *et al.*, 2007). The resident of Indian peafowl in elevation, rarely even 2000 meter in the outer Himalayas and peninsular hill (Khulape *et al.*, 2014). In India, peafowl is distributed in Gujarat, Haryana, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh. The distribution of peafowl is almost widespread and quite common in northern India (Johnsgard, 1986). In the 1940s and up to independence it was fairly widespread in the better water parts of Sindh (Nasser *et al.*, 2018a). It survives today still in good numbers in the extreme southern border regions of Tharparkar around Islamkot and Nagar Parkar where predominantly Ramesh and McGowan, (2009). Up in the Punjab there used to be a small feral population around at Kallar Kahar in the Salt Range, given some protection because of their habit of roosting by the local Mosque (Munir *et al.,* 2012). This is also very common and abundant in Gujarat and Rajasthan and introduced successfully also in the Port Blair area and elsewhere in the Andaman Island (Nakamura *et al.,* 2009). In Tamilnadu, fairly large population can be seen in Ramanathapuram, Madurai, Pudukottai and Nilgiri districts (Sudhahar, 2003). It is protected throughout the country, especially under the Schedule-I of the Indian wildlife protection Act (1972) and its subsequent amendment and Appendix-1of CITES (Dodia, 2011).

The Indian peafowl was described by Linnaeus in his work, *Systema Naturae,* in 1758 and it still bears its original name of *Pavo cristatus* (Linnaeus, 1758). It was first described and taxonomy by Linnaeus in his "SystemaNaturae" in 1758. The continuing past two centuries in artificial conditions have been created many colour mutations of ordinary Indian Peafowl (Johnsgard, 1999). Linnaeus in 1758 classified the scientific classification or Zoological Classification of Indian peafowl.

Kingdom: Animalia

Phylum: Chordata

Class: Aves

Order: Galliformes

Family: Phasianidae

Subfamily: Phasianinae

Genus: *Pavo*

Species: *P. cristatus*

Indian peafowl is widely distributed in the wild across the south Asia and protected both culturally in any areas and by law in India. Conservative estimates of the population put them at more than 100,000. Peafowls have been maintained in captivity for centuries across the world and there are introduced populations in USA, Europe, Hawaii Islands, West Indies, South Africa, New Zealand, Australia etc. (Ramesh and and McGowan, 2009). Indian peafowl is thought to be one of the largest flying birds and its attractive train and plumage are the reasons behind their worldwide fame (Liu *et al.,* 2005). In South Asia, particularly India has the highest diversity of Indian peacock species. Indian peacocks, predominantly the males are distinctively large colourful birds. These are among the most marvelous birds of the entire poultry world El-shahawy, (2010). Finally it can be conclude with Indian peafowl is wild birds as well as rose as ornamental birds (Titilincu *et al*., 2009).

1.3 Weight gain

As we know, weight-gain is an important trait of poultry as well as other birds that determines the size or weight of the birds and its influences the subsequent performance of birds. The live weight depends on both environment and heredity (Jull, 1952). In case birds, the weight of the newly hatched depends primarily on the weight of the egg from which it is hatched, a trait greatly determined by the genotype of the female. The females that lay larger eggs may possess superior genetic profiles for size, growth or aggressiveness in competing for feed. Thus, their offspring would receive a similar superior genetic endowment for these traits (Skogland and Seagar, 1952). No result about weight-gain up to one year of Indian peafowl was found in earlier studies. For this reason this parameter consider for the present study.

1.4 Phenotypic characteristics

Biological characteristics play a key role to identify the species, which is the most important thing to conserve the animals but it, cannot be achieved without morphologically cryptic species are accurately identified. Molecular genetics, investigate the relationship between cryptic species and their structural features, to differentiate among them (Murari *et al.*, 2005). In order to increase the contribution of native chickens and birds to the national poultry production and provide breed characterization, the genetic improvement strategies should be a priority. Lack of sufficient information regarding phenotypic characterization is one of the major barriers in the improvement of native chickens and birds (Maharani *et al.,* 2019). Regarding the phenotypic characteristics, there were no findings about all of the characteristics of Indian peafowl in summarized form in any earlier studies. Therefore, the current study selected this parameter for properly know about phenotypic characteristics of Indian peafowl.

1.5 Breeding

Breeding ensures a continuous improvement of farm animals as well as birds, generation after generation. Several animal traits are measured and the best animals are used as parent-animals by this way, breeders provide livestock farmers with a next generation of animals. The breeding consists out of two phases: breeding and reproduction. Breeding and genetics has played and will continue to play an important role in the welfare of domestic animals (Rodenburg and Turner, 2012). This breeding for increased productivity over the past 50 to 60 years has been very successful in terms of increased growth rate, milk yield, and egg production; however, it has also had negative consequences on behavior and welfare (Rauw *et al.,* 1998). Behavior and welfare traits are starting to play a more important role in breeding programs in general. For such systems to be successful, genetic selection should focus on successful groups rather than, or as well as, successful individuals (Cheng, 2010). White variety of Indian peafowl is a result of selective breeding in captivity and is often mistaken as a mutant or albino peafowl (Parveen *et al.*, 2018). Without this, black shoulder and pied variety are also a result of selective breeding of Indian peafowl. There was no finding about most of breeding and reproduction parameters of Indian peafowl in past studies. For this reason the present study selected this objective to fulfill the breeding and reproduction data gaps of Indian peafowl.

1.6 Feeds and feeding ecology

Generally, acknowledgement of food and hunger are closely related with acceptance of food. Without this other factors may be recorded as follows; colour, odour, flavour, shape, feeding time, social aspects, light, method of presentation, including quantity and frequency of feeding. The acceptance of food may increase by colour of diet while food preference of birds the use of taste buds also seems to be modest (Lint, 1975). As a result, pheasants in captivity provided with extra feed are bred and reared under control and are released into the wild after a specific time span, similar to broilers chicken that produced for meat consumption (Harikrishnan *et al.*, 2010). As we know different individuals require different amount of food depending upon the aspects that meet the individuals age, sex, physical activity and state of health (Rees, 2011). There is a wider choice of diet in the wild, the case is opposite in captivity where a limited number of items are offered to the animal. The confined space is also bound to put the animal under stress affecting its behavior and diet (Parveen *et al.*, 2018). The conventional method of livestock improvement mainly, genetics and breeding, nutrition, and disease management have been used in the past for increasing livestock productivity (Asmare, 2014). Chakravarthy and Thyagaraj (2005) reported that although peafowl is an omnivore and adaptable feeder but they are mainly granivorous because in the agronomic ecosystem they mostly feed on paddy. Though according to bird keeper site the preferable food of peafowl was poultry feed but as per research findings food of preference was maize and millet, this finding may be useful to cut down the budget require to purchase the poultry feed and provision of food of choice to captive birds (Parveen *et al.,* 2018). As we know animal or bird feed in captivity specially support for health and production. Based on several species nutrition level and feed ingredients are selected for their feed management. Peafowl's, being brilliantly coloured are often confined for pleasure in zoos, parks and even houses by many people and although the feeding behavior of peafowl has been studied in the wild by many researchers but no study has been observed regarding the feed and feeding behavior of peafowl under captive conditions. Thus the present study selected this parameter to know about feeds and feeding ecology of Indian peafowl in captivity of BNZ.

1.7 Habitat

The habitat is type of natural environment where a particular species lives and it is very important for living all species. Artificial habitat also can be created for different plants and animal within your indoor space, so the consideration of habitat of Indian peafowl start with whole earth, then continent, then subcontinent, then country, then natural living space of part of a country and finally the house, aviary and room of the Indian peafowl in the zoo. Therefore, in our study we considered the habitat as aviary and house of Indian peafowl with the roosting site of that place in the BNZ. As we know peafowl or bird habitat is the area with the ecological and environmental characteristics where a species has adapted to find essential elements such as food, water, shelter, and mates for reproduction. Birds can fly and are seemingly everywhere, but they occupy habitats that meet all or part of these essential elements. All habitats type has a specific composition and structure to which a species is well adapted. This adaptation comes in the form of shape and length of the bill, legs, wings, plumage patterns and colouration, and behavior (www.avianreport.com, 2018). No study was done earlier about habitat of Indian peafowl into zoo for this reason we considered habitat in the present study.

1.8 Livability

Livability means the percentage of live birds for a specified time, which affects the productive and reproductive performance of poultry and other birds. Livability of chicks is a final measure of a bird's reproductive performance (Anisuzzaman, 1988). The peachicks can be moved to normal pens around three months of age in warm weather. By this time, they will have 'full' feathers (except for their heads) and be better able to cope with any medical problems that may arise, but anyone may still want to keep a heat lamp on them over winter the first year, depending on where peafowl live (Kedreeva , 2015). Peahens grant the peacocks by the whole of the practically eyespots for her chicks will hopefully follow in the footsteps of the male's superior immune position and have a greater expose at survival (Ismail *et al.,* 2010). It is a good practice to use only breeders whose progeny live well. The traits livability, fertility and hatchability are of paramount importance to poultry breeders, because they incur loss in breeding operations. Poor fertility, low hatchability and less livability significantly affect net returns (Azizul and Reza, 1980). Therefore, higher fertility of hatching eggs, higher hatchability of fertile eggs and lower mortality of birds should be of direct interest (Banerjee, 1993). Poultry breeders must look into these three traits of significance to overcome the problems of infertility, poor hatchability and low livability (Ahmed *et al*., 1991). Livability is the potentiality of an individual to survive up to its normal life. In chicken, life begins just after fertilization and continues until death (Khan, 2003). Earlier no study was done about livability of Indian peafowl due to this livability was included in this current study.

1.9 Disease conditions and Abnormalities

The wild and domesticated peafowl's are prone to many bacterial, viral and parasitic infectious diseases (Hopkins, 1997). Various factors are contributing for infections in peafowl's such as unnatural habitat, the human encroachment of the forestlands (Perrins, 1990), availability of vectors and intermediate hosts etc. There were approximately 80 infectious diseases that are somewhat regularly diagnosed in peafowl. The diseases and health of peafowl are about the same as those in domestic poultry, especially turkeys (Schwartz, 1997). Most of the abnormalities like curled toes, lameness etc. was found due to lack of vitamins or minerals (Schwartz, 1997). Without these abnormalities accident are also occurred commonly. When a bird keep in zoo, it is important to be aware of common health problems and ailments that can affect birds. Generally, when a bird is ill, its health deteriorates very quickly. Therefore, it is important to make a quick diagnosis of any changes in energy, behavioral patterns or eating habits. There were some scattered information about disease and abnormalities of Indian peafowl were detected by few researchers. Therefore, the diseases and abnormalities data of Indian peafowl were recorded in current study which reared in captivity of BNZ.

1.10 Prevention and Control measures of disease conditions and abnormalities

Restricting the free movement of visitors in wildlife parks as well as zoos and adopting the proper bio-security measures is vital to minimize the risk of infectious diseases in Galliformes (Nadeem *et al.*, 2014). The flock health begins with obtaining eggs or stock from reputable suppliers with disease-free flocks. Any new stock that is obtained should maintain together in their source groups, and quarantined for at least 30 days prior to introduction to the main flock. Following basic sanitary and bio-security measures is often the most important preventative of the vast majority of diseases ailments that can occur with turkeys. Keeping food and water inaccessible to pest species by placing them properly and vaccination may be a good option for protecting flocks against some diseases. The vaccines available for turkeys were found: Fowl Cholera, Turkey Pox, Avian Encephalomyelitis, and Newcastle Disease from past study. Properly building and maintaining the health of the flock of peafowl is the strongest defense in the fight against any disease. Birds should get plenty of exercise and are healthiest when feed taken more than the necessities. Vitamin and mineral supplements and probiotics can be used to increase vigour and ability to remain healthy (Nadeem *et al.*, 2014). The preventive and control measures of disease conditions and several abnormalities were not present specifically for Indian peafowl from past studied results. Hence the present study selected this objective for properly know about preventive and control measures of diseases and abnormalities of Indian peafowl of BNZ.

1.11 Importance of Indian peafowl study

The Indian peafowl serves as a useful indicator of habitat and environmental quality, a major prey base for predatory birds and mammals, and indicators of adverse human impacts on their ecosystems. Pheasants are important indicator species since their presence or absence in an area is a good indicator of the healthiness of the bionetwork (Thaker, 1963). For the last hundred years, Indian peafowl has again merged into the background, seen only in large gardens where they can roam in a semi-domesticated state. For thousands of years, these magnificent birds have had a close association with man in diverse ways (Stewart *et al.,* 1996). The association between people and peafowl could be traced back to the Sangam period of Tamil literature (300 B.C. to 300 A.D.). The peafowl is mentioned in the Greek work, ‘The Birds, a play’ by Aristophanes, as early as 400 B.C. The peacock figures in the Bible and in Greek and Roman mythologies, where it appears as the favourite bird of the Goddess Hera, or Juno. The bird was also known to the Pharaohs of Egypt. Phoenician traders during the era of King Solomon (1000 B.C.) introduced the birds to present-day Syria and the Egyptian Pharaohs. In 1963, the Peacock was declared as the national bird of India because of its continuing association with the life and culture of the people. Today, its population is under threat due to habitat destruction, poaching and contamination of its food sources. Peacocks are in demand for their beautiful feathers and even for their fat, which is erroneously believed to be useful in the treatment of arthritis. The bird is protected under the Wildlife Protection Act, 1972 (Schedule I) and killing is illegal. The export of peacock feathers, articles and handicrafts made from them, has been banned under the Convention on International Trade in Endangered Species (CITES) and the export-import policy of India. Although the killing and export of peacocks has been banned, poaching for its meat, feathers and fat continues. According to some reports peacock meat is sold in local food outlets or dhabas. The peacock meat is very low in fat content (1%) and high levels of protein, vitamins, calcium and other micro nutrients. Since the nutritional value is very high the bird is sold at a high price in China and Malaysia. Apart from killing for meat, it is also killed for feathers in many parts of our country. Peacock feathers are considered symbols of good luck and well-being in many parts of the world **(**Sundaramoorthy, 2018).

There are two main reasons suggested behind the decline in number of vertebrates in Southeast Asia (Jain and Rana, 2013). Continuous deforestation may result in permanent loss of natural habitats of vertebrates, is the major reason of declining the population of vertebrates in Southeast Asia (Zhou *et al.,* 2015). While, uncontrolled preying and hunting of vertebrates for food, medicines and trades also resulting the decrease in population of vertebrates (Weiss and Kirchner, 2010). He has also suggested that development of policies on national level to conserve the natural habitats. Hence, adaptation of policies on national and international level to increase the natural habitats of animals and vertebrates may result in their conservation and protection. Moreover, uncontrolled hunting and preying must be discouraged (Takahashi and Hasegawa 2008; Munir *et al.*, 2012). Though there has been increasing concern over the declining peafowl population, it is difficult to arrive at a realistic plan unless the current population size, the rate of decline and the causes of decline are scientifically quantified. Conservation initiatives for peafowl need consideration, one must look beyond the 'fire-fighting approach' towards 'keeping the common species common' in order to be efficient with conservation investments as well as instill greater public participation (Ramesh and Mcgowan, 2009)**.** It is estimated officially that above 1/3 of pheasant species are itemized as in risk of elimination. The reason behind this interest is the charming sound and beautiful feathers. This beauty of nature is easy to trap or shoot and obviously, their meat is a rich source of protein (Freeman and Hare, 2015). Currently, the number of Indian peafowl's is declining due to excessive hunting for feathers, meat and chicks either for sale or for pet keeping. Indian peafowl is considered as a vulnerable species in the revised IUCN Red List (Trivedi and Johnsingh, 1996).

Once upon a time, the abundance of Indian Peafowl used to be a resident in the deciduous forests and dry regions in the central, northwestern and northern areas of Bangladesh (Khan, 2018). Peafowl was present in all the Sal (*Shorea robusta*) forests of the Bangladesh a century back. The last confirmed record of Indian peafowl by calls heard at night was in the deciduous forest in Rathura, Sreepur, Gazipur in March 1986. Without this, the vagrant individuals are occasionally found in the border areas of northwestern Bangladesh (Khan, 2018). Indian peafowl is declining in the wild and currently it is declared as a threatened species according to International Union for Conservation of Nature (IUCN) Red List. World Wide Fund for Nature (WWF) and other environmental groups estimated that the population of Indian peafowl has gone down by almost 50 percent when compared to the population at the time of independence means 1947 (Kushwaha and Kumar, 2016). Therefore, breeding in captivity of this species is common for its conservation (Naseer *et al.*, 2018). To conserve these species and ensure sustainable use of their genetic diversity, it is important to evaluate their phenotypic characteristics and performance under traditional management conditions (Zarate, 1996). Without this when the breeding behavior of Indian peafowl is studied, the following parameters, such as feeding and displaying etc., are of great interest (Harikrishnan *et al.*, 2010). The Romans graced their table with peacock meat and kept the bird to decorate their land. The peacock feather is used in form of ash or water as treatment against the snake bite and to treat various problems of lungs. Peafowl's have been maintained in captivity across the world for centuries and there are introduced populations in USA, Hawaii Islands, West Indies, South Africa, New Zealand, Europe, Australia etc. On the economic point of view, peafowl have economic significance to humans. The peacock is a wild bird by nature; they have been domesticated in many countries. In zoos and parks, people are privileged to see many variations of peacocks, blue, green, gold, and white and purple colours attract people (Murari *et al.*, 2005). Indian peafowl is a potential source for improving ecotourism, hunting, and public betterment of native societies in emerging republics in their natural habitats and in captivity as well (Mushtaq-ul-Hassan *et al.*, 2012).

Peacock feathers are considered sacred and are an item important element in the temple festivals in India. The collection for this purpose could not be restricted. The export of peacock feathers, from India for ornamental purposes to Europe during the middle ages resulted in the fall in population (Sundaramoorthy, 2018). Prominent in many cultures, the peacock has been used in numerous iconic representations, including being designated the national bird of India in 1963. Illegal poaching for meat however continues and declines have been noted in parts of India. Peafowl breed readily in captivity and as free-ranging ornamental fowl. Zoos, parks, bird-fanciers and dealers across the world maintain breeding populations that do not need to be captured from wild birds (www.animals.fandom.com, 2019). However human have done the most damage to peafowl populations and are considered to the greatest enemy. Human have been destroying their natural range, reducing their habitat, hunting them for sport, and eaten them and their eggs (Jackson, 2006). The declining trend of Indian peafowl is very dangerous therefore; this trend should be stopped now. For this reason to conserve the Indian peafowl in Bangladesh we have to know the data gaps about peafowl like breeding and feeding as well as others related parameters to estimate proper reintroduction and conservation plan. In conclusion, it can be said that the conservation of the Indian peafowl in Bangladesh is important ecologically and ethically.

1.13 Objectives

There is no Indian peafowl left in the and there is no published data on the feeding and breeding as well as other related parameters about them in Bangladesh. In Bangladesh National Zoo (BNZ), more than 200 peafowls were reared with proper breeding strategy in in the local climatic condition. There was no previous systematic research by anyone about Indian Peafowl breeding and feeding in Bangladesh. For this reason, this research was carried out on breeding and feeding under captive condition in Bangladesh National Zoo. The objectives of this study were as follows –

1. To know about weight gain and other phenotypic characteristics of Indian peafowl.
2. To know the breeding parameters under captive condition.
3. To know about feed, feeding ecology and habitat under captive condition.
4. To know the livability up to fledgling age for *ex-situ* conservation.
5. To know about the diseases and different abnormalities of Indian peafowl and its management procedure.

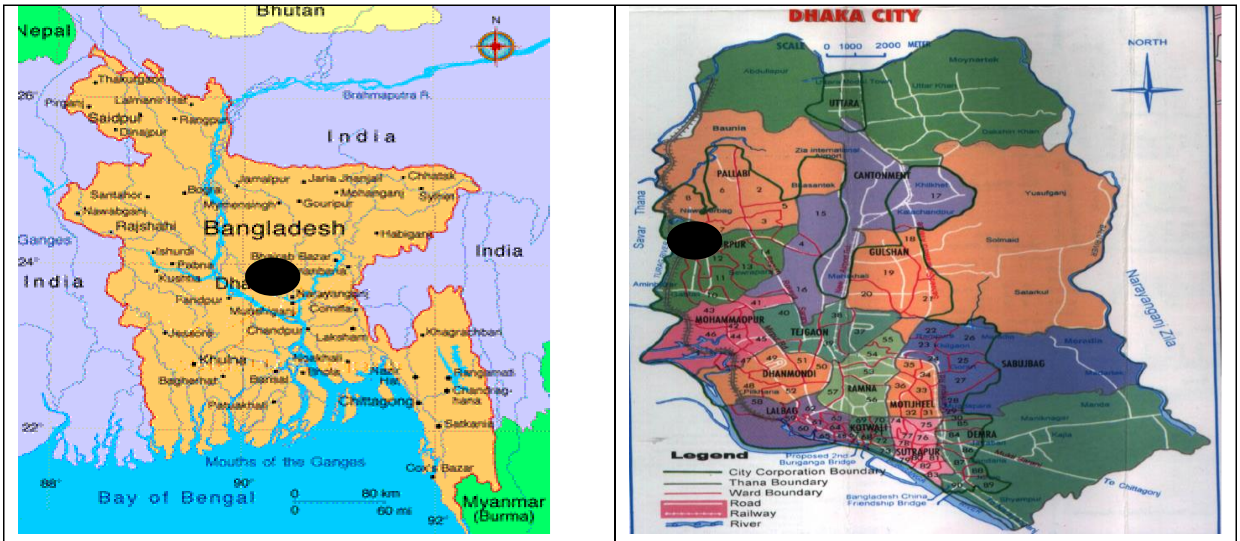
2. GENERAL MATERIALS AND METHODS

2.1 Study description

The research work was conducted in Bangladesh National Zoo (BNZ) for a period of 3 years and 9 months. The Indian peafowl was selected for this research work because the bird is already extinct from our wild habitats, but a big number (n=214) of Indian peafowl remains in captivity in BNZ, with a well planned breeding strategy. Therefore, this bird has an importance for reintroduction and *ex-situ* conservation. Before starting the experiments, the researcher took a training class of the staffs about experiment for taking data properly on breeding and feeding as well as others related parameters about Indian peafowl. Then the present study was planned to investigate breeding and feeding as well as others related parameters of Indian peafowl's reared in captivity in Bangladesh National Zoo.

2.2 Study Area

Bangladesh is located in the tropical region and its climate is characterized by high temperature, heavy rainfall, often excessive humidity, and fairly marked seasonal variations. Bangladesh extends from 20°34'N to 26°38'N latitude and from 88°01'E to 92°41'E longitude. Except the hilly southeast, most of the country is a low-lying plain land. The study area was selected due to the availability of Indian Peafowl in the BNZ, Bangladesh.



Study area of Dhaka district and Study area of Dhaka city

Figure 2.1: Map showing the location of study area in Dhaka city.

Dhaka is located in central Bangladesh at 23°42′N and 90°22′E, on the eastern banks of the Buriganga River. This is the busy city with more than 15 million people living in the city. The city is surrounded by several rivers and the landscape is plain in this area. The river Turag is running beside he Bangladesh National Zoo area of Dhaka city.

2.3 The climate of Dhaka city

Dhaka city experiences the tropical monsoon type of climate. Three main seasons can be distinguished: Summer season stretches from April to May, Monsoon spans from June to July and winter continues from November to January. The highest, lowest, average temperature and humidity as well as average rainfall were considered for the research period. The tabular form of those parameters added in appendix part of the thesis.

2.4 Bangladesh National Zoo

Bangladesh National Zoo is located in the Mirpur area of the capital city of Bangladesh, at 23.812674° N and 90.3446102° E. The total zoo land were 86.37 hectors where two lakes are also available, south lake 7.29 hector and north lake 5.67 hector.

Figure 2.2: Bangladesh National Zoo Map

About 4 million visitors visit Bangladesh National Zoo every year. Main objectives of Bangladesh National Zoo are wildlife conservation through collection and breeding of rare and endangered species of wild animals, research & education and recreation. The zoo has 137 enclosures with 237 rooms for the animals, birds, reptiles and fishes. The zoo management also divided into fifteen sections for easy management of everything. From these sections avian or bird section is one of the most important section, which is also related with section of nutrition, section of veterinary hospital and section of research.

The zoo contains many native and non-native animals, it has more than 11,55 birds from 57 species, and visitors can expect to see peacocks, rhea, African grey parrots, cassowary, owls,ostrich, emus, teals, finches, babblers, owls, vultures, eagles and too many others to mention. The Indian peafowl at Bangladesh National Zoo always fascinate visitors.

Finally, the study area was selected on the base of availability of Indian peafowl and the strategic management of that Peafowl's for breeding.

From the above mentioned section the avian/bird section do management of the houses, feeds and feeding, breeding and other managements of birds. Then several data based on objectives were collected by direct observing, weighting and measuring, from record book and by using questionnaires. A well formed questionnaire based on objectives which used for data collection added in appendix part of the thesis.

2.5 Weight-gain and Phenotypic characteristics

The data about weight-gain was collected by digital weight balance and phenotypic characteristics were collected by direct observing, and by using measuring scale and digital weighting balanec. On the other hand, like mature male and female Indian peafowl's weight, colour, number and some others data were also collected by using well-formed questionnaire.

2.6 Breeding parameters

The breeding related data were collected by using pre-tested questionnaire, and parameters were taken using weighting balance, measuring scale and direct observation. Breeding parameters data such as fertility and hatchability were estimated and calculated by below stated formula (Singh and Kumar, 1994). Without these some cases we also used questionnaire for data collection.

2.7 Feed and feeding ecology

The information about supplied feed of the Indian Peafowl was collected by direct observation and measuring scale. Ecological setting for feed and feeding were observed properly by direct keen observation at different interval. Adult and young peafowl habituation with the feeds also helped to detect feeds and feeding ecology of Indian Peafowl. Related some others information collected by using questionnaire.

2.8 Habitat

The habitat of the Indian Peafowl was considered the total landscape of Bangladesh National Zoo, but the zoo administration seated the houses for the peafowl, which was a large size aviary and one big house of 12 separated rooms. Therefore, the measurement of two houses or habitats of the peafowl was measured by measuring scale also by direct questioning and observation. The internal setup of aviary and houses also observed for looking roosting, resting and egg laying sites. Extra information was collected by direct questioning.

2.9 Livability

Livability up to fledgling age was considered for that study because at the early stage mortality rate is high. Here fledgling age (3 month of age) was considered due to at that age Peafowl become in full finished plumage. The cause of mortality also was known by using questionnaire. Then the livability and mortality data were collected from day 1 to 15 days old and then 16-90 days old were calculated by below stated formula. Others related data were collected by using questionnaire and from record book data.

2.10 Disease conditions and different abnormities with its management

Disease and abnormality data were collected by using questionnaire and direct observing. Later the preventive measure and treatment schedule were collected from registrar book of the veterinary hospital. The extra information collected by using questionnaire and by direct observation.

2.11 Mathematical calculation and analysis

The livability of Peachicks from day-old to up to 3-month age was calculated by using the formula (Singh and Kumar, 1994).

$$\text{Livability} = \frac{\text{No. of live peachicks up to specified time}}{\text{Total peachicks}} \times 100$$

Fertility and hatchability of eggs was determined based on fertile eggs and hatched out chicks. Infertile eggs were detected by candling method. The eggs, which failed to develop embryo was regarded as infertile eggs. Candling to detect fertility was done after a week of incubation.

Fertility Indian peafowl egg was detected by using the following formula.

$$\text{Fertility} = \frac{\text{No. of fertile eggs}}{\text{No. of total eggs}} \times 100$$

Then hatchability of the peachick was calculated by using the following formulae.

$$\text{i) Hatchability/total eggs} = \frac{\text{No. of hatched out peachicks}}{\text{No. of total eggs}} \times 100$$

$$\text{ii) Hatchability/fertile eggs} = \frac{\text{No. of hatched out peachicks}}{\text{No. of fertile eggs}} \times 100$$

The diseases and abnormalities were diagnosed by clinical sing and symptom some time by postmortem as required. Some time for the confirmatory diagnosis, sample sent in diagnostic laboratory.

Then the mortality of peachicks was determined by using the formula:

$$\text{Mortality} = \frac{\text{No. of dead peachicks up to specified time}}{\text{No. of total peachicks}} \times 100$$

The space required for per adult peafowl was detected by using below formula.

$$\text{Required space for per peafowl} = \frac{\text{Total space in the house}}{\text{Total number of peafowl in the house}}$$

Data collection and analysis:

A 15 days interval was followed for data collection, supervision and observation of management for clear conception. On the other hand, one person was engaged in Bangladesh National Zoo to collect data continuously. The data generated from this experiment as well as questionnaire-based data were entered in Microsoft Excel worksheet, organized and processed for further analysis. Two mean of male female parameters were compare by unpaired t-test also without this the uni-variate analysis have been done for separate single variable. On the other hand fertility, hatchability, livability and mortality data were presented as percentage. Most of cases tabular form results were presented but in some cases bar diagrams and pie charts were also presented. The collected data were analyzed by using the computer software like Microsoft Excel, SPSS 16 and STATA 13.

Weight-gain and Other Phenotypic Development of Indian Peafowl in Captivity

Abstract

Weight-gain is an important trait of poultry as well as other birds that influence the subsequent performance of birds. Apart from species characterization, the weight-gain is important to know the nature of animal conservation and their genetic variation, which will help further explore genetic traits and have a solid understanding on the breeding nature of different animals. Therefore, it is essential to know the phenotypic and genotypic status of any species. Due to this, the current research was carried out with Indian Peafowl based on weight-gain and phenotypic characteristics. The data on these parameters were collected from April 2015 to December 2018 in Bangladesh National Zoo (BNZ) by directly interacting, observing and using a structured questionnaire to the BNZ staffs. The weighing and the measuring strategies were done by a digital balance, slide calipers, and a measuring scale. At first, up to 6 months, the male-female differentiation could not be identified; therefore, the combined weight was taken on the baby peafowl. Then, after 6 months, when the male and the female characteristics have developed and became well visible, the weight-gain data was being taken separately for the male and the female in one-month interval and the system has been repeated for up to one year. The average live weights of a day-old and 6-month old Indian Peachicks were found as 65.7±3.00 gm and 1982.05±38.58 gm, respectively. There was statistically increasing trend in the weight in different ascending age groups, but the trend was found good harmonic up to 60 days of age. Then the average weight-gain from 61 days up to 180 days of Indian Peachicks increased sharply, which was 265.1 gm to 1982.05 gm. By this time, the weight-gained about double from 60 days to 75 days and 75 days to 90

days of age. On the other hand in the last month of observation the weight-gained sharply from 1375.55 to 1982.05 gm. The bodyweight of a day-old Peachick was ranged from 58 gm to 71 gm and that the body weight gained at the age of 180 days ranged from 1935 gm to 2079 gm. The overall comparison of weight-gain of male and female Indian Peachicks has been revealed that the male gained better weight in all stages of development compared to the female peachicks from 210 days to up to 365 days. At the age of 210 days, the male and the female weight was found to be 2426.1 gm and 2272.6 g, respectively. In the last month of our study, the growth rate was low in case of both male and female chicks. At one year of age, the male Peafowl gained 3266.2 gm weight, whereas the female Peafowl gained 2830.4 gm at the same age. The growth rate varied significantly ($P<0.001$) in all age groups of male Peafowl's compared to the female Peafowl's. A significant variation was found at the individual level for all age groups in the same age range found from the SD value and the minimum-maximum ranges.

The Peacock was larger than the peahen and the colour variation of male and female body parts varied highly. Beak colour and the shape was the same in both male and female that was light brownish as well as curved and pointed. Shank colour of juvenile male and female was found blackish-brown, but in adult male shank colour varied, like blackish-yellow, brownish-yellow and yellowish and the female shank colour also varied brownish-yellow and yellowish. The eye colour was found blackish-brown in both male and female, but the upper breast colour was found bright-blue for male and metallic green for female. The throat colour was found green in case of male and white in case of female peafowl. On the other hand, nape, neck and belly colour of male peafowl was found shining blue, glossy blue and blackish blue and the colour of female was found shining green, bronzed and green and creamy white. However, in case of White variety of Indian peafowl feather and plumage colour of male and female were white and shank colour was light yellow in both cases. The weight of mature Peafowl was found 5.35 kg and 3.14 kg for male and female that differed highly significant ($P < 0.001$). Without this in case of shank length, spur length, crest length, beak to tail length and wingspan length, the male and female peafowl differed highly significant ($P < 0.001$) The beaklength and the number of tail feather in male and female Indian peafowl were found to differ significantly ($P < 0.05$). The train feather was absent in the female peafowl, but the toes and spur number was found the same in both male and female.

The number of train feather of Indian peafowl in the BNZ was found 192.95±6.66 and the average length of large and small train feather was found 157.85±3.48 cm and 13.4 ±1.19 cm, respectively. The present study recorded that the female peafowl possessed a total length and wingspan length of 92.75±2.53 cm and 146.65±2.13 cm, respectively, but the male peafowl had a total length and wingspan length of 229.05±3.89 cm and 153.25±2.84 cm. The weight gain was found satisfactory during the study period because of supply of proper and balanced feed as well as good management for peafowl rearing. Good weight-gain performance up to one year supports for meat purpose rearing and the phenotypic characterization helps for making conservation plan of Indian peafowl in a wider range of practical applications.

1. Introduction

1.1 Weight-gain

Weight gain is an important trait of poultry as well as other bird's that determines the size or weight of the birds. The weight-gain also influences the subsequent performance of birds. Live weight depends on both environment and heredity (Jull, 1952). In poultry, the weight of the newly hatched depends primarily on the weight of the egg from which it is hatched, a trait greatly determined by the genotype of the female. The females that lay larger eggs may possess superior genetic profiles for size, growth or aggressiveness in competing for feed. Thus, their offspring would receive a similar superior genetic endowment for these traits (Skoglund *et al.*, 1952). The body weight and body weight uniformity is the best indicator that how well the pullet flock is performing. The pullet rate of body weight gain can be controlled partially by lighting program moreover the rate of body weight gain influenced by nutrition, number and time of beak trimming and vaccination. Body weight should be monitored weekly during the growing period and at least up to peak weight (www.hyline.com, 2018). Abrar *et al.*, (2017b) was found statistically maximum feed consumption rate (29.80%) was observed during the 1st week of study when the mean ambient temperature was recorded as 35.2 °C. As the ambient temperature was decreased up to 26 °C during the study period and the age was increased, there was a significant decline was noted in feed consumption rate. At the 9th week of age, the minimum feed consumption rate was found only 6.62%. Another study also supported by the findings of (Reece and Lott, 1983) who performed an experiment to find the effect of temperature and age on body weight and feed efficiency of broiler chickens and found the growth rate was declined with the decline of temperature i.e. the growth rate at 26.7°C were 6% less at 35th days and 10% less at 55th days than at 15.6°C. The positive and significant correlation between body weight with body length, wingspan, shank length and head length suggests that selection for any of these body parameters will cause direct improvement in body weight (Bhowmik *et al.*, 2014). During the first few weeks of the growth period, environmental influence is greater than heredity (Hammond, 1947). Temperature, light, diet, management and disease affect on weight gain (Wu *et al*., 1983; Reddy *et al*., 1965). Weight gain, live weight, size and fleshing are highly hereditary trait and are easy to improve by breeding (Yeasmin *et al*., 1989; Malony *et al.*, 1963). The body weight of Indian peafowl at day-old, 1-week, 2-week, 6-month and 3-years of age were 61.85±0.44 gm, 82.40±0.56 gm, 105.75±1.14 gm, 2.19±0.1 kg and 4.59±0.25 kg, respectively. Males were significantly ($P<0.01$) heavier than female in all age groups (Talha *et al.*, 2018). Female weight 2.75-4 kg and males are much larger weight 4-6 kg (www.totontozoo.com, 2019). Above described past finding did not estimated the body weight-gain up to one year for peachicks. Therefore, the current study selected this objective which is very important trait for poultry and birds.

1.2 Phenotypic characteristics

To formulate the conservation and genetic improvement strategies for the given animal and for that animal characterization, it is essential to know the phenotypic and genotypic status of any species (Mbap, 2000). The future utilization of genetic resource depends on breed characterization (FAO, 2010). Biological characteristics play a key role to identify the species, which is the most important thing to conserve the animals, but it can not be achieved without morphologically cryptic species are accurately identified. Previous studies in molecular genetics abler us to investigate the relationship between cryptic and identification and their structural features to differentiate among them (Murari *et al.,* 2005). The Indian peafowl is very familiar and almost universally known. The fan-shaped crest of spatula-tipped wire-like feathers together with the brilliant glistening blue neck and breast, and the sweeping metallic bronze-green train, boldly ocellated with purplish black-centered coppery discs or eyespots, make the cock unmistakable (Saini *et al.*, 2007). Lower backlight bronze-green narrowly scalloped with black. Scapulars and the outer surface of wings close barred with black and buff. A good deal of chestnut in wings of primaries and their coverts are available (Takahashi and Hasegawa, 2008). This is a bird of distinctive character with the wonderful brilliant plumage and extraordinary performance in raising its long train in a remarkable display. We think of the peacock as a thoroughly masculine bird, proud, showing off, flamboyant and aggressive (Parasharya and Mukherjee, 1999). The female Indian peafowl is smaller, also peaked however without the general prepare. Above head and scruff, rufus-dark coloured and rest of upper parts dark coloured, faintly mottled paler. Underneath, lower neck metallic green rather than blue; bosom bad tempered darker sparkled with green; mid-region buffy white. Primaries dark coloured with no chestnut as in male. A juvenile male is like grown-up female yet with the primaries to a great extent chestnut (Nasser *et al.*, 2018a).

The length, wingspan and weight of peacock measured 175-235 cm, 125-165 cm and 3.5-6.5 kg, respectively. Whereas the peahen length was found 85-105 cm, wingspan 75-135 cm and weight 2.6-4.5 kg respectively (Payne, 2010). Peacocks are a larger sized bird with a length from bill to tail of 100 to 115 cm (39 to 45 in) and to the end of a fully grown train as much as 195 to 225 cm (77 to 89 in) and weigh 4–6 kg (8.8–13.2 lb). The females, or peahens, are smaller at around 95 cm (37 in) in length and weigh 2.75–4 kg (6.1–8.8 lb). Indian peafowl are among the largest and heaviest representatives of the Phasianidae. Their size, colour and shape of crest make them unmistakable within their native distribution range (www.animals.fandom.com, 2019).

The general information about Indian peafowl; Peahen weight 2.75 to 4 kg and length 86 cm on the other hand peacock were found much larger weighting 4-6 kg and length 107 cm except for breeding season in which their plumage extended up to 2.12 m. (www.torontozoo.com, 2019). There are about 200 train-feathers of an adult peafowl, which it sheds from august onwards and then fully developed new feathers appear February onwards (Sharma, 1974; Ali and Ripley, 1980a). An average adult cock's full train contains about 200 + feathers. The wings are coppery or barred buff and black in colour, and the tail colour is brown but seldom seen except outside the breeding season. The iridescent green scale-like feathers look bright on the upper back and these entire feathers end with an elaborate eyespot. Some of the outer feathers lack the spot and end in a crescent-shaped black tip (Blanford, 1898). The adult peahen has a rufousbrown head with a crest as in the male but the tips of the chestnut edge are green. The upper body is brownish with pale mottling. The colour of primary, secondary tail feathers is dark brown. Under parts are whitish in colour (Whistler and Hugh, 1949). The tail is dark brown and the train is made up of elongated upper tail coverts where more than 200 feathers but the actual tail has only 20 feathers. Most of the train feathers end with an elaborate eyespot. The underside of Indian peacock is dark glossy green shading into blackish under the tail. The thighs are buff coloured. The male has a spur on the leg above the hind toe (Whistler and Hugh, 1949; Blanford, 1898). Peacock (male peafowl) is one of the largest known bird among pheasants and flying birds. It shows sexual dimorphism, polygamy with no paternal care to offspring, and an elaborate male display during courtship (Zahavi, 1975; Ramesh and Mcgowan, 2009).

The ornamental and sexual characteristics of peacock are distinct from other birds and are absent in closely related species such as chicken and turkey; this presents an ideal set-up to look for the genomic changes underlying the phenotypic divergence of peacock. Moreover, the origin of ocelli in the peacock feathers is relatively recent and independent of the other ocellated genera of birds such as *Argusianus* and *Ploypectron* in the Phasianidae family (Sun *et al.*, 2007). The soft and fluffy young have a pale buff colour with a brown mark on the nape, which connects with the eyes. Young male birds may look like females but the wings are chestnut-coloured (Baker, 1928). The Indian Peacock is a long-legged and long-necked bird, comparable in size to a rangy domestic turkey. The iridescent dark blue head, neck and breast of resplendent cock is familiar to all, offset by a featherless white cheek patch and the fan-shaped crest of wiry black quills topped by small spatulate iridescent green tips. The mantle and back is brilliant golden bronzy green, each feather margined with black, the lower belly is dull black, wing coverts barred black and grey and the flight feathers are largely pale chestnut, unbarred. In light, the under-wing coverts are black. The tail is dull grey-brown and wedge completely hidden under the greatly elongated and decorative upper tail coverts, which form its well-known train (Jain and Rana, 2013). Legs and feet greyish brown to dark horny brown; claws blackish. While chicks are Pale buff; a dark brown mark across the nape from one eye to the other; back darker rufousbrown; wing pale dull chestnut mottled with brown (Barbieri *et al*., 2012). Several past studies presented the few phenotypic characteristics mainly for wild ranged peafowl. For this reason the present study intended to find out most of important phenotypic characteristics which will help to make conservation plan for Indian peafowl in Bangladesh. From the above described information, we found that the weight-gain and other phenotypic characteristics of Indian peafowl are very important parameters for research and study.

2. Material and Methods

2.1 Study site and period

The research work was conducted to determine the weight-gain and phenotypic characteristics of Indian peafowl in Bangladesh National Zoo (BNZ). The experiment of Indian peafowl was conducted for 3 years and 9 months. Indian peafowl's were selected for this research work because the bird is already extinct from our wild area and at the time of starting work a big number (n=214) Indian peafowl in BNZ with a well-planned breeding strategy. Therefore, this bird has importance for reintroduction and ex-situ conservation. The research work was done in Bangladesh National Zoo, which is located in the capital of Bangladesh and situated middle part of Bangladesh. The experimented period was April 2015 to December 2018. Before starting the experiments, the researcher took a training class of the staffs about the experiment for taking data properly on weight-gain and phenotypic characteristics of Indian peafowl.

2.2 Weight-gain and Phenotypic characteristics

The weighting and the measuring strategies were done by a digital balance, slide calipers, and a measuring scale. The data on weight gain was collected by digital balance and phenotypic characteristics of Indian peafowl was collected by direct observing, by using measuring scale and by using slide calipers. On the other hand, some data were collected by using a questionnaire. For these purposes, 20 mature male and 20 mature female Indian Peafowl were selected randomly. The peafowl's were cached by large and small fishing net based on age and size of peafowl and restrained physically after catching for data collection.

Figure 2.1: Catching of Indian peafowl by by using a catching-net.

Figure 2.2: Weighing of Indian peafowls of different ages.

The data of weight-gain were collected by taking 20 individuals of several ages of Peafowl by using digital weighing balance. At first, up to 6 months, the male-female differentiation could not be identified; therefore, the combined weight was taken on the baby peafowl. Then, after 6 months, when the male and the female characteristics have developed and became well visible, the weight-gain data was being taken separately for the male and the female in one-month interval and the system has been repeated for up to one year. Up to 3-month ages, data were collected 15 days interval system. Then three to six months of age data were collected 30 days interval. Finally after six months of age, when male and female could be differentiated the data were collected for male and female as a system of 30 days interval. Then the last one in 365 days of age was collected for knowing the one-year's weight of male and female Indian peafowl. Without this t-test was used to compare the difference in the means of male and female weight.

Figure 2.3: Mature male (left) and female (right) of Indian peafowl.

Figure 2.4: Mature male (left) and female (right) of albino Indian peafowl

Twenty male and twenty female captive rearing Indian peafowls were restrained physically for taking qualitative as well as quantitative phenotypic characteristics. The phenotypic characters like size, crest colour, crest shape, forehead colour, eye colour, white patches present, beak colour, beak shape, throats colour, nape colour, neck colour, upper breast, belly colour, shank colour, shank colour (Juvenile), thigh colour, train feather colour, eye spots colour, tail feather colour, saddle colour, flight feather colour, wing shape, tail shape, toes colour, spur colour, skin colour, feather and plumage colour (white), beak and eaye colour (white), shank colour (white), eye spots colour (white) were recorded carefully by keen closed observations of several times. Body length, shank length, spur length, crest length, wingspan and beak length were measured with measuring scale and slide calipers. Number of tail feather, train feather, ‘T’ feather, ‘Eye’ feather, toes, spur were counted properly by counting several times for twenty individuals. Large train feather and Small train feather length were measured from twenty numbers by using measuring scales. The colour of the feather at different regions of the body, beak, skin, shank, eye and eyelid were known by direct keen close observation of Indian peafowl. Shape and size also detected by several times keen observation. On the other hand black shoulder and pied varities Indian pefowls exceptional colour only observed due to few numbers were found in the zoo. Without this, a well-formed questionnaire with objective based questions was used for collecting data properly.

2.3 Data collection and analysis:

A 15 days interval was done for data collection, supervision and observation of management for clear conception. On the other hand, one person was engaged in the BNZ to collect data continuously. The data generated from this experiment were entered in Microsoft Excel worksheet, organized and processed for further analysis. Two means of male-female parameters were compared by unpaired t-test also without this the uni-variate analysis have been done for a separate single variable. The *P*-value cosidered significant when value was lower than .05 means $P < 0.05$. And if the *P*-value lower than the .01 or below this value that considered highly significant and presented as $P < 0.01$. The collected data were analyzed using Microsoft Excel, SPSS 16 and STATA 13.

3. Results and Discussion

3.1 Weight gain up to 180 days of Indian peafowl

The live weight and weight gain of Indian peafowl at several ages interval up to 6-month of ages are shown in Figure 3.1. The average live weight of day-old peachick and 6-month ages peachicks was found 65.7 gm and 1982.05 gm, respectively. There was statically increasing trend in the weight in different ascending age groups but the trend was found good harmonic up to 60 days of age (Figure 3.1). Then the average weight-gain from 61 days up to 180 days peachicks increased sharply, which was 265.1 gm to 1982.05 gm (Figure 3.1).

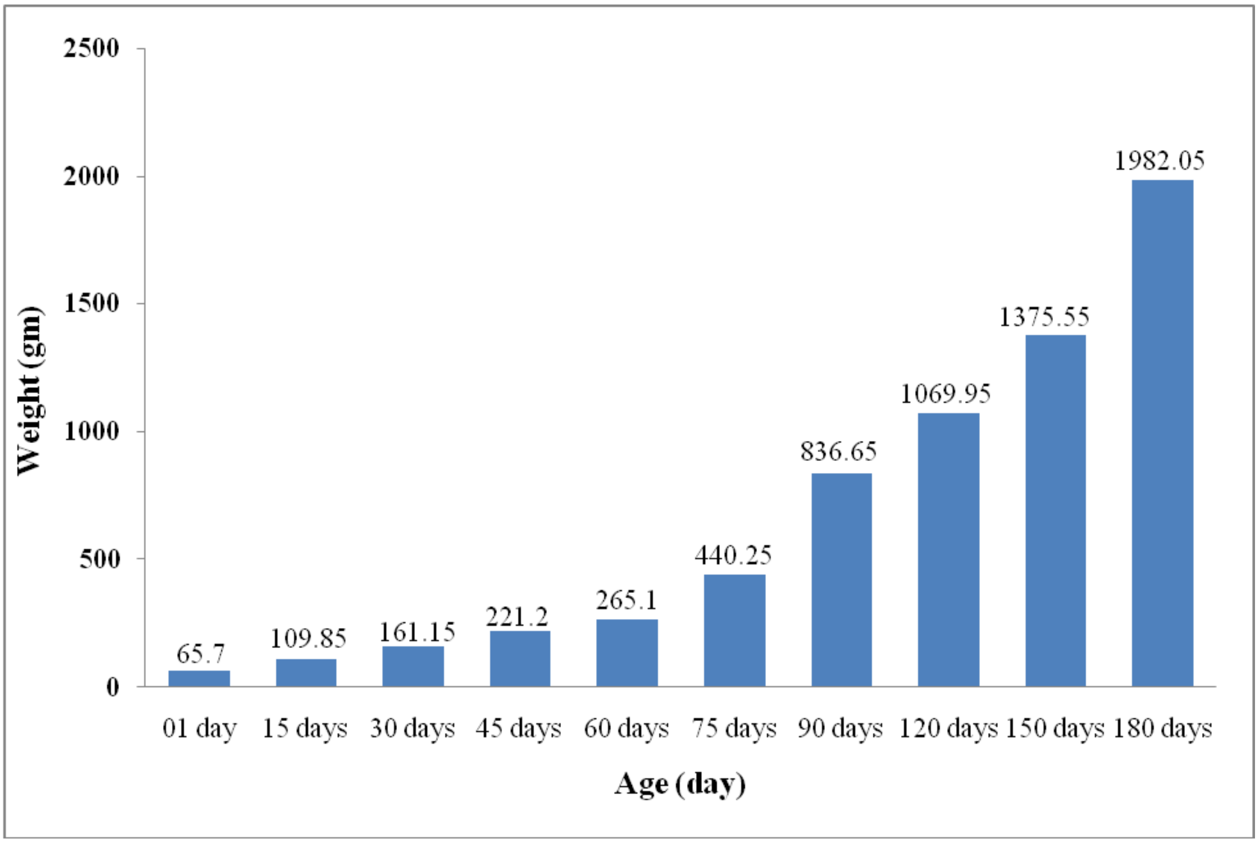


Figure 3.1: Weight gain up to 180 days of Indian Peafowl in BNZ

Without this, the figure also presented that the weight-gain about double 265.1 gm to 440.25 gm and 440.25 gm to 836.65 gm from 60 days to 75 days and 75 days to 90 days of age, respectively (Figure 3.1). Peachicks gain weigth arround 200 gm from day old age to 60 days age. On the other hand in the last month, the weight-gained sharply from 1,375.55 gm to 1982.05 gm. At the age of 4 month the peafowl gain the weight 1069.75 gm, means more than 1 kg which revealed rapid grown in early stage. On the other hand peachicks gain around 1 kg from age 120 days to 180 days (Figure 3.1).

The live weight of several age groups of Indian Peafowl is shown in Table 3.1. Results of several age groups showed that body weight increased in different ascending age groups (Table 3.1).

Table 3.1: Weight gain from 01 day to 180 days of Indian Peafowl in BNZ

Age (day)	N	Mean±SD (gm)	Minimum (gm)	Maximum (gm)
01 day	20	65.7±3.00	58	71
15 days	20	109.9 ±4.20	101	117
30 days	20	161.15±4.10	151	170
45 days	20	221.2±8.20	207	233
60 days	20	265.1±7.91	249	275
75 days	20	440.25±14.69	418	468
90 days	20	836.65±11.52	821	859
120 days	20	1069.95± 19.95	1030	1102
150 days	20	1375.55± 16.28	1345	1407
180 days	20	1982.05±38.58	1935	2079

The body weight of day-old Peachick was found (65.7±3.00) gm where the minimum and maximum weight range was found 58 gm and 71 gm and that body weight gain at age 180 days was found (19,982.05± 38.58) gm where minimum and maximum weight range was found 1,935 gm and 2,079 gm. Variation was found very high at the individual level for all age groups in the same age. The SD values of all age groups also was found very high which was ±3.00, ±4.20, ±4.10, ±8.20, ±7.91, ±14.69, ± 11.52, ± 19.95, ± 16.28 and ± 38.58 in age groups 01 day, 15 days, 30 days, 45 days, 60 days, 75 days, 90 days, 120 days, 150 days and 180 days, respectively (Table 3.1). Without this we found the ranges of several age groups were fond fron more than 10 gm to up to 144 gm in the same age groups. The ranged weight of several age groups were 101 gm to 117 gm, 151 gm to 170 gm, 207 gm to 233 gm, 249 gm to 275 gm, 249 gm to 275 gm, 448 gm to 468 gm, 821gm to 859 gm, 1030 gm to 1102 gm and 1345 gm to 1407 gm, in age groups 15 days, 30 days, 45 days, 60 days, 75 days, 90 days, 120 days, and 150 days, respectively (Table 3.1). The SD values of all age groups as well as maximum-minimum ranges in the same age group was found high in value compared to total weight- gain, which proved significant variation in individual level in same age group.

One of the past study by (Talha *et al.,* 2018) was found that the body weight of Indian peafowl at day-old, 1-week, 2-week and 6-month of age were 61.85±0.44 gm, 82.40±0.56 gm, 105.75±1.14 gm and 2.19±0.1 kg, respectively. Live weight differed in the present study for the day-old Peachick (65.7 gm) and at the end of 6 months (1982.05 gm) respectively with the compared result of the past study finding (Talha *et al.*, 2018). This difference in live weight may be due to different environmental and temperature, light, diet, management and due to disease effect on weight gain. The average day-old weight was highest by Khawaja *et al.*, (2012) in RIR (31.30 gm), intermediate in Desi (25.9 gm) and lowest in Fayoumi (20.90 gm). Similar trend was observed by Farooq *et al.*, (2001), who reported higher day-old chick weight in RIR (35.32±0.86 gm), in comparison to Desi (33.84±0.67 gm) and Fayoumi chicken (30.74±0.72 gm). On the other hand the average 20 weeks old weight was highest by Khawaja *et al.*, (2012) in RIR (1608.00±4.36 gm), intermediate in Desi (1155.63±3.33 gm) and lowest in Fayoumi (1145.70±3.59 gm). These results presented several breeds of chicken which were found very low weight of day-old chicken compared with day-old peachicks and later weight-gain were also found very low at the age of 20 weeks. The difference in growth rate of chicken is due to interplay of multiple genes and this trait could be improved through genetic selection (Chambers, 1990). These differences in body weight could also be attributed to the environmental conditions such as seasons, temperature, humidity and management (Khawaja *et al.,* 2012). On the other hand the early development of the chick has a crucial influence on its later growth and meat yield. Besides dietary supplementation during the post hatching growth period, efforts have been made to increase the supply of amino acids (AA) and achieve higher protein synthesis by injecting AA directly into the egg (Ohta *et al.,* 2001; Bhanja *et al.,* 2004). When chicks arrive on the farm they should have immediate access to clean, fresh feed and water, which are essential to maximise the genetic potential and take advantage of the modern chick's voracious appetite. Pelleting feeds usually results in increased density and intake of the ration, and also improves growth and feed efficiency. Water intake is correlated with feed intake and thus any decrease in water consumption due to failure in the water supply or lack of watering space would result in decreased consumption of feed to a varying extent, depending on the age of the chickens (Leeson *et al.,* 1976). Without this the weight of fast growing broiler was found 3426 ± 50.8 gm at the age of 10 weeks when supplied the more protein and amino acid content feed (Rezaei *et al.,* 2018). On the other hand in poultry, the weight of the newly hatched depends primarily on the weight of the egg from which it is hatched, a trait greatly determined by the genotype of the female; females that lay larger eggs may possess superior genetic profiles for size, growth or aggressiveness in competing for feed. Thus their offspring would receive a similar superior genetic endowment for these traits (Skoglund *et al.,* 1952). The present study was also done based on same intension as well as agreed with past finding of those results, where peachicks' intake pellet form layer starter feeds with more protein and aminoacid and adlibitum water that helped to gain more weight. Without this the egg weight of peahen was found about double of chicken egg which also support for getting more weight of day-old peachick and as well as later grow fastly compared to chicken. This current studies, finding supported by the past finding of Skoglund *et al.,* (1952). Earlier several studies on poultry and birds based on growth rate were found that live weight depends on both environment and heredity (Jull, 1952). Peachicks require lots of care like to be fed, watered, handled, observed and otherwise cared for each and every day (Mountain, 2014). The present study also found that the peachicks were taken more care for getting good results in several aspects like weight gain and livability that was also supported by the past study results.

The feeding, housing as well as good management helped to gain more weight in the early stage of Peachicks in BNZ. The present stduy result found that at the age of 4 month the weigth gain more than 1 kg and at the age of 6 month the weight gain around 2 kg which, also supported by the past study, during the first few weeks of the growth period, environmental influence is greater than heredity (Hammond, 1947). Without this the present study results are also in close agreement with the findings of those of some researchers (Lebbie *et al.,* 1981) they reported that food restriction significantly increased body weight loss and final body weight. Once the fertile eggs hatch, place the peafowl chicks under a standard brooder lamp at 95 degrees F. Decrease the temperature of the brooder by five degrees each week until it is down to room temperature (Mountain, 2014). Temperature, light, diet, management and disease affect on weight gain (Wu *et al*., 1983; Reddy *et al*., 1965). Weight gain, live weight, size and fleshing are highly hereditary trait and are easy to improve by breeding (Yasmin *et al*., 1989; Malony *et al.,* 1963). Past finding of the weight-gain of Fayoumi chicks after 8 weeks was higher (226.0 gm) than Sonali (170.7 gm) and it differed significantly ($\chi 2$ = 7.71, df = 1, $p < 0.01$). The Fayoumi chicks of Chittagong site gained higher weight (285.4 gm) than that of Noakhali (171.1 gm). In case of Sonali chicks, the weight gain of day old to eight weeks aged showed the similar performance in both Districts. Chicks of both breeds gained better weight in Chittagong than Noakhali significantly (Fayoumi: $\chi 2 = 28.6$, df = 1, $p < 0.001$; Sonali: $\chi 2 = 10.01$, df = 1, $p < 0.01$). That means the more temperature help to gain more weight for both Fayoumi chicks and Sonali chicks (Miazi *et al.,* 2011). Which results are in close aggrement with the finding of present study where we found all the year round temperature is high in Dhaka city which, increase the metabolic rate and help to gain more weight of peachicks. Peachicks are a lot bigger than baby chickens, ducks, guineas and other poultry and they grow very fast (Mountain, 2014). The present study was also found the paster growth rate of peachicks and the day-old peachicks weight was found double compared to chicken which agreed with the past study results.

Live weight gain in early stage to 6 months was found very well because of properly taking care of peachicks in early stage for good health and protection against diseases in BNZ for Indian peafowl. This weight gain was found very well during the study because of supply proper and balanced feed as well as the good management of all other steps. In the third month, the weight gain was very high may be due to the transfer of Peachicks into the new house for adaptation with next step of captive rearing in the BNZ. On the other hand, at the 6 months of age the peachicks gain 606.5 gm this may be the results of adaptation of the adlibitum feeding system as well good management system of peachicks rearing. Without this variation in individual weight in same age groups was found high, which was may be due to semi-wild in nature of rearing compare to domesticated rearing system. In the BNZ up to the 6 months of age the supplied adlibitum balanced feed to their peachicks and take extra care with vaccination against several important diseases and vitamin-mineral supplied against deficiency-related diseases and abnormalities which helped to gain more weight properly.

The present study also found that the peachicks started their weigth doubled compared to chicken and grow faster therefore they gain more weight within few days of age. In the brooding shed the zoo authority manage proper brooding temperature, start from (95 degrees F) for their peachicks so physiological activities of peachicks were activated properly which also help to gain more weight in early stage.

Peachicks gained more weight at the age of six month about two kg weight compared to normal chicken species because the genetic makeup with faster growt weight gene. Without this, the temperature of BNZ area was higher most of time, which increases the metabolic rate of the chicks that enhances the chicks to eat more feed, and hence gained more weight. It was also well documented that several types of peafowl's favorite feed, as well as nutritious feeds for vitamin-mineral like boiled egg, fruits and vegetables was supplied with the starter poultry layer feeds that helped to gain more weight. The protein percentage was foun high in layer starter arround 20% protein as well as the more protein generally get from the egg which, help to get more weight gain in early age of peachicks. Without this adlibitum ammont of feed and fresh drinking water also supplied to the present studied peachicks up to six months so the peachicks intake feeds and water as per their own requirement that also help to peachicks to get more weight gain in early stage. On the other hand normal chicken gain less weight compared to the peafowl in all stage of life. Therefore, peafowl is better than the chicken for producing meat. As we know the peafowl now reared as a game bird as well as pet bird in Bangladesh and many others countries. In some countries the Peafowl also reared as farm bird therefore, later this bird will reare for the purpose of egg as well as meat production. The weight gain more than one kg at the age of 4 month and around two kg at the age of six month will support for rearing this peafowl to meat purpose, as we know the flesh of Indian peafowl is very tastey.

3.2 Weight gain from 210 days to 365 days of Indian Peafowl

The overall comparison of weight gain of male and female Indian Peachicks has been revealed that the male gain better weight in all stage of development compared to the female peachicks from 210 days to up to 365 days. The weight at 210 days male was found 2,426.1 gm but in case of female 2,272.6 gm (Figure 3.2).

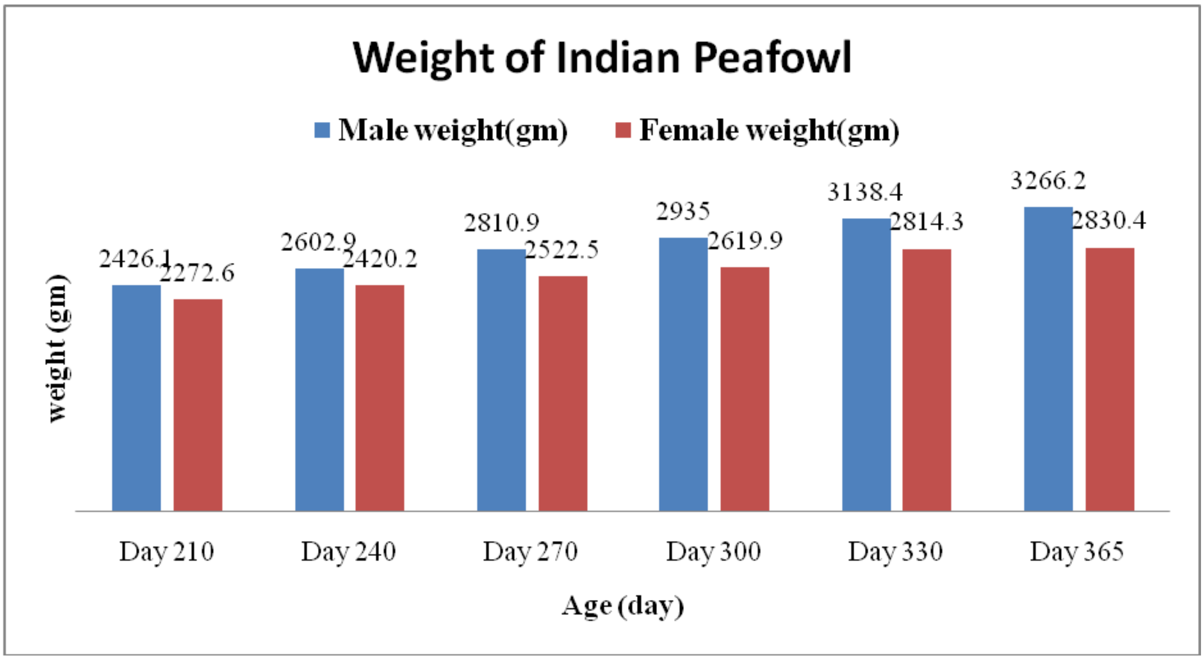


Figure 3.2: Weight gain from 210th day to 365th day of Indian Peafowl in BNZ.

The weight gain of male pefowl was found 2,426.1 gm, 2,602.9 gm, 2,810.9 gm, 2,935 gm, 3,138.4 gm and 3,266.2 gm at the age of 210 day, 240 day, 270 day, 300 day, 330 day and 365 day, respectively. Whereas the female peafowl weight gain was found 2,272.6 gm, 2,420.2 gm, 2,522.5 gm, 2,619.9 gm, 2,814.3 gm and 2,830.4 gm at the age of 210 day, 240 day, 270 day, 300 day, 330 day and 365 day, respectively (Figure 3.2). Weight gain in monthly interval system from 210 days to 365 days in case of the male was found higher, most of the cases 200 gm but not less than 100 gm (Figure 3.2). In case of female weight gain was found near to 100 gm to 200 gm from 210 days to 330 days in case of 30 days interval system. In the last month at the age between 330 days to 365 days, the growth rate was low in case of female 2,814.3 to 2,830.4 gm only. Male peafowl gain arround 200 gm at age 210 days, 240 days, 270 days, 330 days and more than 400 gm at age 365 days compared to female peafowl. In the one year of age, male Peafowl gained 3,266.2 gm whereas female Peafowl gained 2,830.4 gm at the same age (Figure 3.2).

The growth rate varied highly significant ($p< 0.001$) in all age groups from 210 days to 365 days of male Peafowl's compared to female Peafowl's (Table 3.2).

Table 3.2: Weight gain from 210th day to 365th day of Indian Peafowl in BNZ

Age (day)	Variables	N	Mean±SD	Min-Max	Std. Err.	[95% Co. Interval]		*P-value*
210 day	Male	20	2426.1±41.77	2340-2495	9.34	2406.55	2445.65	<*0.001*
	Female	20	2272.6 ±30.48	2227-2315	6.82	2258.33	2286.87	
240 day	Male	20	2602.9±21.08	2570-2641	4.71	2593.03	2612.77	<*0.001*
	Female	20	2420.2±38.50	2341-2505	8.61	2402.13	2438.18	
270 day	Male	20	2810.9 ±23.04	2775-2851	5.15	2800.07	2821.63	<*0.001*
	Female	20	2522.6 ±31.37	2479 -2595	7.01	2507.87	2537.23	
300 day	Male	20	2935.1± 62.18	2801-3033	13.90	2905.95	2964.15	<*0.001*
	Female	20	2619.9±57.13	2501 -2775	12.78	2593.11	2646.59	
330 days	Male	20	3138.4 ± 48.43	3070 -3245	10.83	3115.74	3161.06	<*0.001*
	Female	20	2814.3 ±12.32	2795 -2839	2.75	2808.53	2820.07	
365 day	Male	20	3266.2 ±62.55	3201-3400	13.99	3236.88	3295.42	<*0.001*
	Female	20	2830.4 ±30.49	2795 -2890	6.82	2816.08	2844.62	

The variation in individual-level in the same age group of male and female Peafowl's also high showed in the minimum-maximum range. The minimum-maximum range of male and female peafowl weight was found 2,340-2,495 gm and 2,227-2,315 gm at age of 210 days, on the other hand, 3201-3400 gm and 2,795-2,890 gm at the age of 365 days. The Mean±SD value of male and female Indian peafowl at 210 days, 240 days, 270 days, 300 days, 330 days, and 365 days were found 2,426.1±41.77 gm and 2,272.6 ±30.48 gm, 2,602.9±21.08 gm and 2,420.2±38.50 gm, 2,810.9 ±23.04 gm and 2,522.6 ±31.37 gm, 2,935.1± 62.18 gm and 2,619.9±57.13 gm, 3,138.4 ± 48.43 gm and 2,814.3 ±12.32 gm, 3,266.2 ±62.55 gm and 2,830.4 ±30.49 gm respectively (Table 3.2). The mean and standard deviation value of weight also showed that high variation in age groups of male and female peafowl as well as individual variation in same age group also. Without this the Table 3.2 shown that the standard error value of the male and female Indian peafowl 9.34 and 6.82, 4.71 and 8.61, 5.15 and 7.01, 13.90 and 12.78, 10.83 and 2.75, 13.99 and 6.82 at the age groups of 210 days, 240 days, 270 days, 300 days, 330 days and 365 days ages respectively (Table 3.2). The standard error value of means of those age groups was found very low compared to mean value of age groups, this means the precision of result was very high and sample means of several age groups represent properly the population means. Without this 95% confidence interval ranges also found low compared mean value of those age groups that's also expressed that the sample mean values represent signicantly of the population size.

There was no past finding of one year aged Indian peafowl and the other ages but only the adult male-female Indian peafowl weight of past study was found. The past study result based on live weight where found the male gain more weight compared to female in the adult age which also supported by the present study result. The past studied result we found that the mature female weight 2.75-4 kg but mature males were much larger weighting 4-6 kg (www.torontozoo.com, 2019). Another past finding of Peacocks weighed 9–13 pounds and Peahens weighed 6–9 pounds in adult age (www.animalcorner.org, 2018). This difference of weight gain, male and female Indian peafowl occurred may be due to the different genetic makeup of male and female peafowl though they are living in the same management and environmental condition. The body weight of Indian peafowl at 6-month and 3-years of age were 2.19±0.1 kg and 4.59±0.25 kg (Talha *et al.,* 2018). The results of the present study are in close agreement with findings of Talha *et al.,* (2018) where obtained similar results partially. Weight gain, live weight, size and fleshing are highly hereditary trait and are easy to improve by breeding (Yasmin *et al*., 1989; Malony *et al.*, 1963). The increased and improved weight gain trend by breeding as well as feeding management of Indian Peafowl in BNZ which was supported by past studied results of Yasmin *et al*., (1989) and Malony *et al.* (1963). In the last month the female peafowl gain only 15 gm but male peafowl more than 100 gm because of female get maturity in early age (1.5 to 2.0 years) but male get maturity around 3rd years old. Without this weight-gain trend was found very well up to one year's old male and female peafowl's because of good feeds and feeding as well as other management systems. A past studied was found that males were significantly *($P<0.01$*) heavier than female in adult condition (Talha *et al.,* 2018) which also supported by this present study, where in all age groups weight gain significantly differ in case male and female peafowl. The difference of several age groups in case of weight gain is a general phenomenon but differences in individual level of the same age group for weight gain due to differences of feed intake and disease condition micro-environmental condition. This result also may be supported by earlier study result temperature, light, diet, management and disease affect on weight gain (Wu *et al*., 1983; Reddy *et al*., 1965). Male get highly significant weight-gain compared to female peafowl's in all age groups because the mature weight of male peafowl is around 5.0 kg but the mature weight of female peafowl is around 3.0 kg.

Without this competition of taking feed male take more feed compared to the female which also help to gain more weight of male compared to female peafowl. In addition, differences in the genetic makeup of male and female peafowl caused weight-gain different. Variation in individual level in same age group also showed the present study, which, support that the semi-wild rearing of Indian peafowl in BNZ. Though so much information about weight gain were found in case of chicken but thre was no specific study of weight-gain of Indian pefowl was found earlier. Because yet now, no farm was developed for rearing peafowl for meat pouduction purpose. But now the days he peafowl are reared as pet birds as well as they do breed to their peafowl. Therefore, in future some farm will develop for meat as well as egg production from the peaowl because in intensive rearing system the peachicks, gain weight about 2 kg withn six month. Without this at the age of one year male peafowl gained 3,266.2 gm and female peafowl gained 2,830.4 gm. No past study was done about finding of several age groups weight gain up to one year for Indian peafowl. Therefore, this study result will help to justify the meat purpose rearing as well as future research on weight gain of Indian peafowl.

3.3 Phenotypic characteristics

Phenotypic and genotypic status of any species is essential to formulate the conservation and genetic improvement strategies for the given animal and for that, animal characterization are important (Mbap, 2000).

3.3.1 Phenotypic characteristics (Qualitative) of Indian peafowl

Table 3.3 showed that the peacock was larger than the peahen and colour variation of male and female body parts varied highly. Beak colour and shape was the same in both male and female. Shank colour of juvenile male and female was found blackish-brown but in adult male shank colour varied like blackish-yellow, brownish-yellow and yellowish and female shank colour also varied brownish-yellow and yellowish (Table 3.3).

Table 3.3: Phenotypic characteristics (qualitative) of Indian peafowl in BNZ

Parameters	Male	Female
Size	Larger	Smaller
Crest colour	Blue	Light brown
Crest shape	Fan shaped	Fan shaped
Forehead colour	Shining blue	Light brown
Eye colour	Blackish-brown	Blackish-brown
White patches present	Above and below the eyes	Above the eyes only
Beak colour	Light brownish	Light brownish
Beak shape	Curved and pointed	Curved and pointed
Throats colour	Green	White
Nape colour	Shining blue	Shining green
Neck colour	Glossy blue	Bronzed and green

Upper breast	Bright blue	Metallic green
Belly colour	Blackish-blue	Creamy white
Shank colour	Blackish-yellow, brownish-yellow and yellowish	Brownish-yellow and yellowish
Shank colour (Juvenile)	Blackish-brown	Blackish-brown
Thigh colour	Buff	Grayish-brown
Train feather	Present	Absent
Eye spots colour	Green, golden, bronze and blue	Absent
Tail feather colour	Grayish-brown	Grayish-brown
Saddle colour	Iridescent green	Grayish-brown
Flight feather colour	Brown	Grayish-brown
Wing shape	Rounded	Rounded
Tail shape	Fan-shaped	Fan-shaped
Toes colour	Gray	Gray
Spur colour	Gray	Gray
Skin colour	Blackish-white	Blackish-white
Feather and plumage colour (White)	White	White
Beak colour(White)	Light pinkish	Light pinkish
Shank colour (White)	Light yellow	Light yellow
Eye spots colour (White)	White	Absent
Eye colour (White)	Brown	Brown

Eye colour was found blackish- brown in both male and female but the upper breast colour was found bright blue for male and metallic green for female (Table 3.3). The throat colour was found green in case of male peafowl but in case of female peafowl, throat colour was white. On the other hand nape, neck and belly colour of male peafowl were found shining blue, glossy blue and blackish blue on the other hand the colour of female was found shining green, bronzed and green and creamy white (Table 3.3). Without this eyespot colour of male pefowl was found green, golden, bronze and blue and tail colour of male and fmale peafowl was grayish-brown. Moreover the thigh colour of male and female was detected buff and grayish-brown and flight feather colour was detected brown and grayish-brown in male and female pefowl, respectively. The toe, spur skin and tail feather colour of male and female peafowl were found same gray, gray, blackish-white and grayish-brown, respectively (Table 3.3).However, in case of white variety Indian peafowl feather and plumage colour of male and female were white and shank colour was light yellow in both cases. Eye colour of male and female of white variety Indian peafowl was found same brown (Table 3.3).

Without this we found one black shulder or black winged Peacock and two pied variety female Peahen in BNZ. The black shoulder Peacock comprises of black colour shoulder and wing and the pied Peahen comprises of sparkled blackish gray colour spot on white body plumage and brown colour neck and head plumage. Present findings of white, pied and balack wingined varities of peaowl colour also supported by the past findings. There are three types of Indian peafowl. White feathered peafowl have white plumage throughout the body (Khan *et al.,* 2009); they should not be confused with albinos as the latter belong to pure white breeders having brown eyes. Pied peacock is another type with white feathers in plumage randomly (Amoudi, 1988). Incomplete dominant gene is considered to be responsible for these colour variations. Black-winged peafowl is a mutated breed having dark feathers with blue-green tips (Athar *et al.,* 1996; Stewart *et al.,* 1996).

The peacock has a metallic blue head and a bright blue neck and upper body, while the peahen has a chestnut brown crest and neck with feathers bordered in bronze and green.

Females are smaller than males (Santiapillai and Wijeyamohan, 2015). The peacock's large body size, brilliantly ornamented plumage and long train-feathers are surely attractive looking. Indian Peafowl is iridescent blue-green or blue in the head, neck and breast. The back or scapular, feathers are vermiculated in black and white, while the primaries are orange-chestnut. The actual tail feathers are short and grey-coloured and can be seen from behind when a peacock's train is fanned in a courtship display (Johnsingh and Murali, 1981). The phenotypic characteristics of several body parts male peafowl was found near to similar findings of the present study which were the fan shaped crest of spatula-tipped wire-like feathers together with the brilliant glistening blue neck and breast, and the sweeping metallic bronze-green train, boldly ocellated with purplish black-centered coppery discs or eyespots, make the peacock unmistakable (Saini *et al*., 2007). The Peacock neck and breast are of bright blue colour, golden feathers have lines on their sides and backs, while trains sparkle with multiple colours (Pabisch *et al.,* 2010). Their size, colour and shape of crest make them unmistakable within their native distribution range. The male is metallic blue on the crown, the feathers of the head being short and curled. The fan-shaped crest on the head is made of feathers with bare black shafts and tipped with bluish-green webbing. A white stripe above the eye and a crescent shaped white patch below the eye are formed by bare white skin. The several sides of the head have iridescent greenish blue feathers. The back has scaly bronze-green feathers with black and copper markings. The scapular and the wings are buff and barred in black, the primaries are chestnut and the secondaries are black (www.animals.fandom.com, 2019). Spreading out of male's train, shine in green, gold, brown and black feathers (Hart, 2002). The present study found the throat, neck and upper brest colour green, glossy blue and bright blue and eye spots colour green, golden, bronze and blue which are in close agreement with the finding of past study results. Moreove the several phenotypic characteristics of female peafowl were also found near to similar from one of the past study where found characteristics were female Indian peafowl are smaller and above head and scruff, rufus-dark coloured and rest of upper parts dark coloured, faintly mottled paler. Underneath, lower neck metallic green rather than blue; bosom bad tempered darker sparkled with green; mid-region buffy white (Nasser *et al.*, 2018b). Peahen has a rufous-brown head with a crest as in the male but the tips are chestnut edged with green (Kushwaha and Kumar, 2016). The adult peahen has a rufous-brown head with a crest as in the male but the tips are chestnut edged with green. The upper body is brownish with pale mottling. The primaries, secondaries and tail are dark brown. The lower neck is metallic green and the breast feathers are dark brown glossed with green (www.animals.fandom.comp, 2019). The female peafowl is duller in colour than male. It is mostly brown, with pale under parts and some green iridescence in the neck, and lacks the long upper tail feather coverts of the male (Johnsingh and Murali, 1981). The tail is dull grey brown and wedge completely hidden under the greatly elongated and decorative upper tail coverts, which form its well-known train (Jain and Rana, 2013). The crest on the head also present in the both males and females peafowl (Johnsingh and Murali, 1981) that also supported by the present study result. The skin and eye colour of Indian peafowl of both male and female was recorded white and dark brown and in case of white variety eye colour was found light blue (Talha *et al.,* 20180).

But in the present finding of skin and eye colour was found blackish white and blackish brown and in case of wite variety eye colour was found brown. So the past finding differed little bit compared present finding of skin and eye colour. The beak shape was found same long slightly curved and pointed in both male and female peafowl and beak colour of peacock and peahen was found same grey with white spot at base but in case of white variety beak colour was found white (Talha *et al.,* 2018). Whereas the present study foud curved and pointed beak shape as well as beak colour was found light brownish in both male and female peafowl but in white variety it was found light pinkish. Hance the past findings are in close agreement with the present study result based on beak shape and colour. The underside is dark glossy green shading into blackish under the tail. The thighs are buff coloured. Legs and feet of India peafowl grayish-brown to dark horny brown; claws blackish (Barbieri *et al.,* 2012). This bird has lengthy and robust grayish brown legs that are equipped with brush for their protection from predators (El-Shahawy, 2010). The thighs are buff coloured. The male has a spur on the leg above the hind toe (Whistler, 1949; Blanford, 1898). The toes and spur colour was found gray in the present study where as toes or claws colour was found blackish in past study which is near to similar. Without this the buff colour thigh in psent study is also supported by the past study results where buff colour thigh was detected. The colour of the shank of peacock and peahen was found same grayish brown but in case of white variety shank colour was found yellowish white (Talha *et al.,* 2018; Barbieri *et al.,* 2012) was found the shank colour grayish-brown to dark horny brown. On the other hand shank colour foun in the present study blackish-yellow, brownish-yellow and yellowish for peacock and brownish-yellow as well as yellowish for peahen which differed greatly from the past finding. Phenotypic characteristics of male and female peafowl as found near to similar finding in most of cases from several studies which also supported by the present study. But in some cases the phenotypic characters varied in male and female which is may be due to differences in age, feeds as well as weather condition. Without this colour description of several viewers some time differ because of the observational point as well as identified views.

3.3.2 Phenotypic characteristics (quantitative) of Indian peafowl

Weight of mature peafowl was found 5.35 kg and 3.14 kg for male and female which differed highly significant ($P<0.001$) showed in Table 3.4. Without this in case of shank length, spur length, crest length, bill to tail length and wins span length, male and female peafowl differed highly significant ($P<0.001$).

Table 3.4: Phenotypic characteristics (quantitative) of Indian peafowl in BNZ

Variables	Category	N	Mean±SD	Std. Err.	[95% Co. Interval]		*P-value*
Mature	Male	20	5.35±.41	.09	5.15	5.54	< 0.*001*
weight (kg)	Female	20	3.14 ±.29	.06	3.00	3.27	
Shank	Male	20	15.14±.12	.03	15.08	15.19	< 0.*001*
length (cm)	Female	20	11.67±.21	.05	11.57	11.77	
Spur length	Male	20	2.53±.09	.02	2.48	2.57	< 0.*001*
(cm)	Female	20	2.38±.09	.02	2.33	2.42	
Crest length	Male	20	7.05±.39	.09	6.87	7.23	< 0.*001*
(cm)	Female	20	5.82±.27	.06	5.70	5.94	
Beak length	Male	20	4.09±.07	.02	4.05	4.12	*0.003*
(cm)	Female	20	3.98±.08	.02	3.94	4.02	
Beak to tail	Male	20	229.05±3.89	.87	227.23	230.87	< 0.*001*
length (cm)	Female	20	92.75±2.53	.57	91.57	93.93	
Wing span	Male	20	153.25±2.84	.64	151.92	154.58	< 0.*001*
length (cm)	Female	20	146.65±2.13	.48	145.65	147.65	
Number of	Male	20	20±1.12	.25	19.47	20.53	*.008*
Tail feather	Female	20	19±1.21	.27	18.43	19.57	

Table 3.4 also showed that the beak length and number of tail feather male and female Indian peafowl were also found differed significantly ($P<0.05$). The shank and spur length of Peacock and Peahan was found 15.14±.12 cm and 11.67±.21 cm and 2.53±.09 cm and 2.38±.09 cm, respectively (Table 3.4). On the other hand, crest length of male and female peafowl was found 7.05±.39 cm and 5.82±.27 cm (Table 3.4).

The spur length for male peafowl was found 2.53±.09 cm whereas female peafowl was found 2.38±.09 cm. Finally, the counted number of tail fethers of male and female peafowl was 20±1.12 and 19±1.21 (Table 3.4). This study recorded that the female peafowl weight and length was found 3.14±.29 kg and 92.75±2.53 cm but the male peafowl weight and length was found 5.35±.41 kg and 229.05±3.89 cm. Wing span length was found for male and female peafowl were 153.25±2.84 cm and 146.65±2.13 cm (Table 3.4). The standard error of mean values were found very low in every characteristics as well as the 95% confidence interval values agreed with the sample size enough for represented population.

Train feather absent in the female Peafowl but toes and spur number (4 and 1) was found same in both male and female (Table 3.5).

Table 3.5: Phenotypic characteristics (quantitative) of Indian peafowl in BNZ

Parameters	**Male (**Mean±SD)	**Female (**Mean±SD)
Number of Train feather	192.95±6.66	Absent
Number of 'T'feather	39 ±2.87	Absent
Number of 'Eye' feather	153.95±5.86	Absent
Large train feather (cm)	157.85±3.48	Absent
Small train feather (cm)	13.4 ±1.19	Absent
Toes number	4±0.00	4±00
Spur number	1±0.00	1±00

The number of train feather of Indian peafowl in BNZ was found 192.95±6.66 and the average length of large and small train feather was found 157.85±3.48 cm and 13.4 ±1.19 cm, respectively. Moreover the number of 'T'feather and 'Eye' feather were counted 39 ±2.87 and 153.95±5.86 (Table 3.5).

Present study recorded that the female peafowl weight and length was found 3.14±.29 kg and 92.75±2.53 cm but the male peafowl weight and length was found 5.35±.41 kg and 229.05±3.89 cm. Wing span length was found for male and female peafowl were 153.25±2.84 cm and 146.65±2.13 cm. However, an earlier study found the length of male bird 175-235 cm, while wingspan measured 125-165 cm and weight 3.5-6.5 kg. The length of female bird was 85-105 cm, wingspan of 75-135 cm and weight of 2.6-4.5 kg (Payne, 2010). Another past study results about length; wingspan and weight of mature India peafowl were recorded .86-2.12 m; 1.4-1.6 m and 2.7-6 kg respectively (Jackson, 2006; Somes and Burger ,1993). Moreover the past study findings, female weight 2.75-4 kg and had a length of approximately 86 cm. and male were heavier weight (4-6 kg) and had a length of approximately 107 cm, except for breeding season in which their plumage extends to 2.12 m. (www.torontozoo.com, 2019). Least-Square Mean±SE of body length, wingspan length was found 71±0.98 cm. and 102±1.99 cm. and mature body weight of female and peafowl 2.19±0.1 kg and 4.59±0.25 kg, respectively (Talha *et al.*, 2018). Delacour, (1977) reported that adult (third-year or older) males have wing lengths of 440-500 mm and tail-covert lengths of 1400-1600 mm (rectrices of 400-450 mm), while females have wing lengths of 400-420 mm and tail lengths of 325-375 mm. Males range in weight from 4000- 6000 g, and females from 2750-4000 g (Ali and Ripley, 1974). Their mean weight amounts to 2.7±06 kg; length varies between 0.86 meter to 2.12 meter, and the wingspan stretches from 1.4 to 1.7 meters (El-Shahawy, 2010). Female around 95 cm in length but male length from bill to tail of 100 to 115 cm and to the end of a fully grown train as much as 195 to 225 cm (Kushwaha and Kumar, 2016). A peacock has weight of about 10 pounds. The male can be 6-8 feet long, including 4-6 feet of colourful feathers Berman, (1996). Peafowl are large birds with males measuring up to 2.3 meters' (7.5 feet) in length and females being smaller at 86 centimeters (34 inches) in length. The tail length of the male Peafowl can be 4–5 feet. Peacocks weigh 9–

13 pounds and Peahens weigh 6–9 pounds (www.animalcorner.org, 2018). So the most of results found from the past study about weight and length and measurement also supported by the present study results. But in some cases weigth was also differe significantly found from several studies which, may be due to the nutrient supply status as well as reared in captivity or in wild ranges. The wing span of peafowl obtained in this study was more closely related to the findings of Ramesh and McGowan, (2009) where they found wing span ranges from 110-120 cm. There are a number of biological factors influencing wing span which also influence the feather length, e.g. sex, age, population, abrasion of the feathers, moult and differences between years (Pienkowski and Minton, 1973). However, the wingspan length was differed highly in present study result compared to past one study result. These differences may be due to the size of peafowl of those studies differed highly and their habitat and management system was different for differing in their size.

Least-Square Mean±SE of shank length, beak length and crown feather length of mature peafowl were 10.94±0.31 cm, 3.99±0.04 cm and 5.79±0.05 cm. respectively (Talha *et al.*, 2018). However the present study findings of shank length, creast length and beak length of male an female peafowl was found 15.14±.12 cm and 11.67±.21 cm, 7.05±.39 cm and 5.82±.27 cm and 4.09±.07 cm and 3.98±.08 cm respectively which differed from the past finding. The differences of results may be due to they past study presented combined male female results but present results shown several male and female parameters differently as well as size of peafowl may be different.

The male has a spur on the leg above the hind toe (Whistler and Hugh, 1949; Blanford, 1898). Both male and female Peafowl have crests on top of their heads. Like other members of Galliformes, both male and female Peafowl have sharp, powerful metatarsal spurs (www.animalcorner.org, 2018). Spur of about 2.5 cm in length are fortified in both sexes; males use them to compete with other males during breeding season (Rao and

Acharjyo, 1984). The spur length for male peafowl was found 2.53±.09 cm whereas female peafowl was found 2.38±.09 cm in present study that was supported by one of past study by (Jackson, 2006; Somes and Burger, 1993) where the average spur length of male and female peafowl was found around 2.5 cm.

Present study noted that adult male peafowl has 199±8 train-feathers and male and female have 20±2 and 18±2 tail feathers. Without this number of 'T'feather was found 39 ±2.87 wich is supported by the pas study finding, arround the outer edges of fan about 35-45 v-shaped ocelli are present (Hart, 2002). This intricate pattern gives advantage to the bird to disappear in foliage and is also beneficial in mating (Sahajpal and Goyal, 2008; Hart, 2002). Several past studies also reported that an adult peafowl has about 200 train-feathers, which it sheds from august onwards; fully developed new feathers appear February onwards (Sharma, 1973; Ali and Ripley, 1980b). The tail is dark brown and the "train" is made up of elongated upper tail coverts (more than 200 feathers, the actual tail has only 20 feathers) and nearly all of these feathers end with an elaborate eye-spot. A few of the outer feathers lack the spot and end in a crescent shaped black tip. The underside is dark glossy green shading into blackish under the tail (www.animals.fandom.com, 2019). An average adult cock's full train contains about 200 + feathers. In 1963 the peacock was publically titled as the National Bird of India (Harihar and Fernandes, 2011; Jain and Rana, 2013). The train is formed by 100 to 150 highly specialized upper tail-coverts. Each of these sports an ornamental ocellus disintegrated barbs, giving the feathers a loose, fluffy look. The female lacks the train, with a greenish lower neck and dull brown "train" is in reality made up of the enormously elongated upper tail coverts brown and short as in the peahen (Blau, 2004). The colour of tail feather is dark brown and the train is made up of elongated upper tail coverts where more than 200 feathers but in the actual tail has only 20 feathers. Nearly all of these train feathers end with an elaborate eyespot. The tail and train father's number were found near to similar in present study compared to past studied results. The length of train feather was found 1.2 m in the past study by (Jackson, 2006; Somes and Burger, 1993). Train of almost 1.3 m length is seen in males during June-December. They use to discard this train in January, but during breeding season this train grows more rapidly (Sahajpal and Goyal, 2008), which diffred highly from present study were recorded length was 157.85±3.48 cm. This difference was occurred might be due to the age and size of peafowl differed in several studies.

There are several colour mutations of Indian peafowl. These very rarely occur in the wild, but selective breeding has made them common in captivity. The black-shouldered or Japanned mutation was initially considered as a subspecies *P. c. nigripennis* (or even a species), and was a topic of some interest during Darwin's time. It is however only a case of genetic variation within the population. In this mutation, the adult male is melanistic with black wings (www.animals.fandom.com, 2019). This finding also supported by current study finding which, was detected black-winged/ black-shouldered male variety of Indian peafowl.

From the above presented qualitative and quqntitative phenotypic characters we found male differe significantly compared with female because of male and female differences in genotypic makeup as well as size. Without this, we found some characteristics were same for Peacock and Peahen due to the same species. On the other hand we also found difeernces in same characteristics in several studies this is because of different envirionmenteal effect as well as managemental differences of several studies. On the other hand, the age differences of Indian peafowl in several studied groups also different though they were adult.

Phenotypic characteristics is very important for know about genotype of any species. Therefore proper phenotypic characterization is very important to know about any species. Without tis phenotypic characteristicks of any species aw ell as bird in early stage help to make conservation plan properly. This characterization also helps to differencite several types of peafowls from each other. Those statements also supporte by past finding in spirit, phenotypic and molecular characterizations of Animal Genetic Resources are used to measure and describe genetic diversity as a basis for understanding and utilizing them sustainably. To conserve these species and ensure sustainable use of their genetic diversity, it is important to evaluate their phenotypic characteristics and performance under traditional management conditions (Zarate, 1996). Finally it can be concluded that phenotypic characterization of any species helps to differenciate that species to other species as well as male and female differenciation of same species. Without this, most of the past finding study results were presented based on little smple size for few phenotypic characteristics as well as from wild or farm rearing peafowl. And they presented the scattered results based on few sample and presented as ranges of that parameters or coloured was descrived intensively for few characters. But the present study presented the most of the qualitative and quantitative characteristics of Indian peafowl from good sample size in semi-wild rearing system in BNZ. And described several colour properly as well as quantitative parameters presented with (Mean±SD). Therefore, the present results on weight-gain and phenotypic characteristics are more authentic for future research on Indian peafowl compared to past finding results.

4. Conclusion

At the time of the study period, we informed about weight-gain and phenotypic characteristics of Indian peafowl of BNZ. The results of this study revealed that body weight increase when age increase. The average body weight of day-old Peachick was found 65.7±3.00 gm and that body weight gain at the age of 180 days was found 1,982.05±38.58 gm. Significant, individual-level variation in weight of same age group was found in the present study. Individual-level variation in same age group support that the management of Indian peafowl maintains a semi-wild management system for growing wildlife as wildlife style. The overall comparison of weight gain of male and female Indian Peafowl has been found that the male gain better weight in all stages of development compared to the female peafowl's from 210 days to 365 days and the differences were highly significant ($P<0.001$). The male Peafowl gained 3266.2 gm weight whereas female Peafowl gained 2830.4 gm at the age of one year. So weight-gain up to one year of age was found very well. Most of the phenotypic quantitative characteristics differ significantly for peacock and peahen. However, in case of colour neck and upper barest was found glossy blue for peacock but in case of peahen neck and upper breast colour was found metallic green. On the other hand, a white variety of peafowl both peacock and peahen plumage colour is white. Peacock has the train feather but peahen has no train feather. The peacock is more beautiful than Peahen respect to colour and attractiveness. There was no finding of past study about weight gain up to one year for Indian peafowl, therefore, the present result help for future study of weight gain and meat purpose rearing of Indian peafowl.

Weight of mature Peafowl was found 5.35 kg and 3.14 kg for male and female which differed highly significant ($P<0.001$). Without this in case of shank length, spur length, crest length, bill to tail length and wingspan length, male and female peafowl differed highly significant (*P<0.001*. The beak length and the number of tail feather of male and female Indian peafowl were also differed significantly (*P<0.05*). The male peafowl length and wingspan length was found 229.05±3.89 cm and 153.25±2.84 cm whereas the female peafowl length and wingspan length was found 92.75±2.53 cm and 146.65±2.13 cm, respectively. The number of train feather of Indian peafowl in BNZ was found 192.95±6.66. Moreover, the number of 'T' feather and 'Eye' feather were counted 39 ±2.87 and 153.95±5.86. No other past studies presented the thoroughly qualitative and quantitative several phenotypic characteristics of Indian peafowl but the present study has done this research thoroughly on most of the phenotypic characteristics. Therefore, the results of present study on weight-gain and phenotypic characteristics help to do future research on Indian peafowl properly.

Finally, it can be concluded that the more weight-gain of peachicks support for meat purpose production as well as future performances of peafowl. As we know the biological characteristics play a key role to identify the species as well as to conserve that species. Therefore, the beautiful phenotypic characteristics make intension to conserve and help to make conservation plan of Indian peafowl. Moreover, the pet bird rarer can choose the Peacock for rearing because of this bird is more attractive compared to the Peahen. Since it is a large ornamental bird, its breeding has the commercial prospect to the sale as a pet bird or for meat.

Breeding of Indian Peafowl in Captivity

Abstract

Captive breeding is a controlled system, mostly practiced to preserve ecologically endangered wildlife species, enables us to observe the response to animal behavior, design for surroundings, attention to nutrition, cleanliness, and detailed records of their genealogy with respect to their heath and other habits. The Indian peafowl (*Pavo cristatus*) was reared in captive condition in the Bangladesh National Zoo (BNZ) and the study focused on breeding, as well as other related reproductive parameters, under captive condition. The study was conducted from April 2015 to December 2018 in BNZ by direct interacting, observing, using structured questionnaire and finally taking record book of data.

The male nature in breeding season was found walking, displaying and calling excitedly, but the female nature in breeding season was found slowly walking beside the displaying male and mate was chosen based on attractiveness. On the other hand, the male appearance in breeding season was found colourful body with glossy blue neck, well arranged elongated train and strong smooth tail, but the female appearance in breeding season was found shiny brown body with smooth shape. The Indian peafowl is dimorphic, mature male and female can be easily differentiated properly by observing the physical structure. In the breeding season, every single male maintained a territory that consisted with 3 or 4 females. The breeding season was found from February to August (n=105). Only a single breeding season maintain by the Indian peafowl in all around the year. The current study also reported that the male: female ratios in breeding sheds were 1:1, 1:2, 1:3, and 2:5 and in an aviary, it is 2:3. The male became sexually mature at the age of 2.79± 0.20 years, whereas the

females became sexually mature at the age of 1.77±0.19 years. The displaying time was found 3.3± 0.92 minutes, in general condition, and 14.6±2.1 minutes at the time of courtship, and 27.2±3.6 minutes when extremely egger to mate. The first laying age was 675.45±65.74 days. The egg colour variation was found, which was brown, light brown, pale white and light creamy, and the egg size was larger than the chicken egg. The weight, length, and width of egg and the clutch number were found in this study in the range of 107.84±6.27 gm, 7.53±0.50 cm, 5.43±0.24 cm, and 11.25±1.02, respectively. A high variation in the egg weight, egg size and egg shape were found. The incubation temperature maintained by the zoo authority was 99-100 ^{0}F, but the humidity was not strictly maintained. Turning of the eggs were done 3-6 times at early stage of setting in the incubator machine. The incubation period was found 29.45±0.69 days. In case of natural brooding, generally 10-12 eggs were seated under a broody peahen. The overall fertility was 45.61% (*n*=592), but the overall hatchability was 40.20%, based on total eggs (*n*=592) and 88.15%, based on fertile eggs (*n*=270). On the other hand, the fertility rate was found as the highest (49.13%; *n*=230) in 2015 and the lowest (40.80%; *n*=125) in 2017. The hatchability rate was found as the highest in 2018 and the lowest in 2014 that were 44.44% (*n*=90) and 35.83% (*n*=120), respectively. The year-wise variation in the fertility and the hatchability patterns were also found. The fertility rate of Indian peafowl in natural brooding and machine brooding was found almost similar, 45.46% (*n*=55) and 45.61% (*n*=592), respectively. However, the hatchability rate, based on fertile eggs, was found higher in natural brooding (100%; *n*=55) compared to machine brooding, based on fertile eggs (88.15%; *n*=270). The breeding parameters are very important to propagate day-old peachicks, which has economic and *ex-situ* conservation potential of Indian peafowl.

1. Introduction

Breeding means mating of male and female peafowls and producing next generation. All of the characters of any individual encoded in genotypes, which express in the phenotypic form that is the final result of breeding. The Indian peafowl has 38 pairs of chromosomes (2n) which comprises of many thousands of genes (Lukanov, 2013). The Indian peafowl has three varieties. The white variety of Indian peafowl has white feathers in its train, along with ocelli barely visible. White peacock is a mutation of the Indian peafowl. Whereas using the word Indian peafowl, peacock indicate the male of a species and peahen indicate the female (Ramesh and McGowan, 2009; Siddiqui, *et al*., 2008). This white variety is not considered albinos as they are basically true breeders. In another variety known as pied version, random white feathers are in the plumage due to the results of an incomplete dominant gene (Dutta *et al*., 2013). Another variation results due to mutation with dark feathers having blue and green tips, called the black-winged Indian peafowl. In addition, *Pavo cristatus* is often hybridized with Green peafowl (*Pavo muticus*) so new mutation in the plumage almost every year has been discovered in the last decade (Khulape *et al.*, 2014). The Indian and the Green can be crossed with each other and produce fertile offspring. The United Peafowl Association (UPA) has referred 225 possible peacock plumage colours variations and mutations.

In Indian peafowl, sexual dimorphism is a definite prerequisite for behavioral part of selection and directional selection, which selects evolution of such distinguishing characters as the peacock's tail. The evolution of sexual dimorphism applied to the forces of sexual selection acting upon both sexes of species. In male and female Indian peafowl, dimorphic plumage signals and the presence of crest are related to sex (Sahajpal and Goyal, 2008). His best presumption was that females preferred more beautiful males for aesthetic reasons alone, although the great variety of male ornaments suggested to him that there could be mate choice for novelty's sake as well (Darwin, 1871). Although peacocks never provide food for peahens during the courtship nor they offer post-mating parental care, hypothesis are focused on the transfer of beneficial aspects to the peahen and the advantage of 'good parenting' are not sufficient to provide information about the evolution of the male's tail (Trivedi and Johnsingh, 1996). The complicating male liking behavior in Indian peafowl can be considered as kin selection and can not be considered as direct selection (Landman and Gruys, 1998; Parasharya and Mukherjee, 1999). Indian peafowl is reported to be polygamous (Ali and Ripley, 1969), polyandrous (Lank *et al*., 2002) and have a lek like mating system. In this system, males defend small and clumped territories in their breeding season (Hillgarth, 1984; Rands *et al*., 1984; Loyau *et al*., 2007a). Males with more extravagant secondary sexual characteristics, such as bigger, luminous trains tend to have better genes in the peahen's perspective. These genes will directly benefit the peahen's offspring, as well as the fitness and reproductive success. Females have often shown to distinguish among potential mates, and to prefer mating with individuals bearing the most exaggerated characters. In some cases, those males have shown to produce more successful, healthy and vigorous males (Christopher, 2016).

In the 1990s, scientists made careful observations of females and their choice of mates and proved that the apparently disinterested and otherwise engaged females are actually far more observant than would appear. They choose for mates, and lay more eggs for, males with the largest trains (Ismail *et al.,* 2010). The peahen's discerning eye carefully selects the most glamorous and mature male, rejecting younger, less splendid birds (Takahashi and Hasegawa, 2008). The elaborate train and its display of the male Indian peafowl, which is a visual signal, directed at female, has long been a subject of fascination and debate in the scientific world (Harikrishnan *et al.,* 2010). Peacocks are known for their highly elaborate train feathers, displayed during courtship and assessed by peahens during mate choice (Dakin and

Montgomerie, 2011). Indian Peafowl is polygynous and generally has two to three breeding peahens in its harem (Roberts, 1992). These birds stay in small flocks of 1 peacock and 3-5 peahens and tend to remain closed together during breeding season (Mushtaq-Ul-Hassan, 2012; Grimmett *et al*., 1999). A recent study of a feral population suggests that Indian peafowl does not defend its harem due to small breeding territory (Landman and Gruys 1998; Dakin, 2011; Dodia, 2011; Rands *et al*., 1984). Visiting peahens wander through several territories, sometimes making repeated visits, before selecting a peacock for mating (McGowan and Garson, 1995). The Indian Peafowl (*Pavo cristatus*) is a lek-breeding, dimorphic species, with males having an elaborate tail called the train. The breeding season of Indian peafowl is not fixed but mostly it breeds in rainy season from April to August. But Naseer *et al*., (2018c) observed that most of birds at Government Zoological Gardens breed in month of May on the other hand most of birds at Private Sectors breed in the month of August. Indian peafowl breeds from April through October. Approximately an adult peacock has shed their feathers from August to onward, fully developed new tail feathers appear in February (Samour *et al.,* 2010).

Adult males with a completely developed train establish display territories in mid-April, and maintain them until the end of the breeding seasonin September when molting of train feathers begins (Yasmin and Yahya, 1996). A skewed distribution of mating towards a few males has been reported in Indian Peafowl by Rands *et al.*, (1984) and Petrie and Halliday, (1994) attributed variance in mating success to the variance in train morphology. Male mating success could be a result of the combined effects of male behavior and active female choice based on phenotypic traits (Rands *et al.,* 1984). Peafowl breeds from April through October-to-October (Mushtaq-ul-Hassan *et al.,* 2012). During a peacock's performance, peahens pay close attention to the various parts of the peacock's train (Jobson and Christopher, 2016). According to sexual selection theory male with highly ornamented feather have greater reproductive success (Kodric-Brown and Brown, 1984). Researchers agreed that the peacock attract females for mating by using its ornamental tail (Crawshaw and Boycott, 1982; Chumbe *et al.,* 2015). The elaborate trains and display of the peacock act as an honest signal of good genes and male quality at the time of mating (Miller *et al.,* 1998; Parasharya and Mukherjee, 1999; Nasser *et al.,* 2018c). The tail ornamentation is the most interesting factor among peacocks. It can merely be considered as a beneficial trait in intra-sexual selection but actually it is a poor weapon in maneuvering sexual copulate successfully (Hanotte *et al.,* 1991a). Due to this reason, females have over reproduction; peahen preference is applying the basic driving force of sexual selection over peacocks (Miller *et al.,* 1998). The ornamentation of the peacock's train has been measured with the number of eyespots, train length and area of eyespots, density of eyespots, and proportion of feathers with eyespots, diameter of eyespots, and eyespot colour and iridescence. Currently, the consensus is that the peacock's train is a handicap but it is also considered an indicator of good genes (Araki *et al.,* 1989; Dutta *et al.,* 2013; Zhou *et al.,* 2015). If eyespots were experimentally roiled from a male's score below the sierra of disparate individual's eyespot numbers, mating wealth decreased significantly (Amoudi, 1988).

Adult males spent significantly more time in preening than sub-adult males and females which suggesting they incurred a high maintenance of being a handicap because of the elaborate ornamentation of train feathers (Walther and Clayton, 2005). It was found that adult males spend more time in displaying than sub-adult males whereas, females spend more time in feeding and roaming around displaying adult males (Dookia, 2015). Peafowl are best known for the male's extravagant display feathers which, despite actually growing from their back, are thought of as a tail. The "train" is in reality made up of the enormously elongated upper tail coverts. Fully developed train is found in birds older than four years. Peafowl forage on the ground in small groups, known as musters that usually have a cock and 3 to 5 hens. After the breeding season, the flocks tend to be made up only of females and young (www.animals.fandom.com, 2019). There is a positive correlation between an Indian peafowl's train and success of Indian peafowl mating. This correlation is actually due to female's preference for well elaborate trains on their mates (Dodia, 2011). Mating success was normally more successful with the large number of eyespots also called ocelli on the train of the peacock (Parasharya and Mukherjee, 1999; Jaiswal *et al.*, 2013). In a few winged creature animal categories, these carotenoids based hues work as decorations and are utilized by females for choosing mates. However, during 'train rattling' display, a basic pre-copulatory action, male is directed 45˚ right to the sun in front of female to enhance the eyespots on feathers (Landman and Gruys, 1998; Nakamura *et al.*, 2009). During the courtship behavior, the crested male of peacock shows his lengthened higher tail coverts a wonderful green and gold erectile train decorated by blue-green 'eyes' earlier the dull-plumaged peahen. The declaration of male sexual decorations is influenced by nourishment; the trimming is condition-subordinate and may hail both phenotypic and genotypic quality (Khan *et al.,* 2009; Ismail *et al.,* 2010; Khulape *et al.,* 2014). Females would consciously choose the male to mate with precisely because of its 'handicap', rather than in spite of it and thus pass on the genes to the next generation (Gadagkar, 2003). The female of polygamous Indian peafowl normally lay clutches of six and often more than six eggs (Pabisch *et al.,* 2010).

There is a general hypothesis that fluctuating selection driven by sex ratio dynamics contributes to explain the maintenance of genetic variation in personality traits, so any change in the ratio exhibits a marked effect on fertility and hatchability of eggs (Newcombe, 1996; Kiers, 1997; Del Giudice, 2012). Egg length was significantly correlated with egg width. Proudfoot and Hulan, (1981) reported positive correlation between size of hatching egg and body weight of chick in broilers and in other chicks. Without this the weight of egg was found significantly correlated with egg length and egg width. Egg weight, egg length, egg width, incubation period, clutch size, and age at first egg were 104.85±21.93 gm, 7.34±0.19 cm, 5.7 1±0.06 cm, 29.4±0.13 days, 9.30±0.10 and 744.20±0.96 days, respectively (Talha, *et al.,* 2018). Age at sexual maturity is influenced by genetic makeup of the individual and it also influenced by feed intake, lighting, increase and decrease of day length and other environmental factors (Morris and Fox, 1960; Wessels, 1962). Age at sexual maturity is an important trait from the economic standpoint. The age of days that laying commences is important with respect to its bearing on total first year lay (Lush, 1945). It is also important, because the earlier in life that a pullet commences laying, the sooner she produces revenue. Date of hatch has direct influences on age at sexual maturity (Weatherup *et al*., 1980). Some investigations showed that white leghorn pullets hatched from about the middle of November to the middle of January commenced lying at approximately 170 days of age. On the other hand, pullet hatches from about the middle of April to the middle of June commenced lying at about 210 days of age (Rahman *et al*., 1997). Age at sexual maturity is inherited just like other traits. Sex linked as well as autosomal genes are involved in the inheritance (Laun, 1962).

In breeding flocks of birds, mating ratio of male to females plays a pivotal role in optimizing fertility and hatchability in the eggs produced by a flock (Altan and Oguz, 1993). Male to female ratios is very important for optimum fertility and hatchability that varies from species to species i.e. in chicken 8-9 males/100 females (Hazary *et al*., 2001; Lesson and Summers, 2001; Griskevicius *et al*., 2012), in ostrich 1 male: 3 females (Lambrechts *et al*., 2004) and 1 male: 2 females in quails (Shanaway, 1994). Mushtaq-ul- Hassan *et al*., (2012) found 1:2 sex ratios showed better results in terms of egg production and egg weight and 1:3 sex ratios showed better results in terms of fertility and hatchability percentage in Indian peafowl. Normally, males are virtually suppliers of unlimited, extremely small and inexpensive gametes in the reproductive process. In contrast, females produce large, nutritive and expensive gametes in far lower quantities, a quality that actually dictates their role as the limiting reproductive reagent. Clutch size of Indian Peafowl is usually 4 to 9 eggs in natural habitat but in captivity the hen lays 8-20 eggs and the incubation period is about 28-30 days (Landman and Gruys, 1998; Dakin, 2011; Anon, 2002). The eggs are creamy buff, unmarked and the usual clutch is 4 to 6 eggs (Nakamura *et al.,* 2009; Mushtaq-ul-Hassan *et al.,* 2012). Egg colour is influenced by genetic effect, housing system etc. reported by Samiullah *et al.,* (2015). The weight of egg is influenced by the total egg production per year, sequence of egg in the clutch, level of protein in ration, feed and drinking water, ambient temperature, stable type and disease (Darwati *et al.*, 2010). The egg size also varies with female age, year, seasonal variations and laying order (Murphy, 1994). Peafowl will start to lay their eggs when they are reached to 2-2.5 years of age (Sharma, 1973). In addition, females provide the possible parental care to their offspring, hence reproductive success is dependent on the basic factors like number of eggs produced and how they nurturing their young ones towards maturity (Hart, 2002).

Fertility refers to the percentage of incubated eggs that are fertile while hatchability is the percentage of fertile eggs that hatch. It is therefore, important to understand the factors that influence fertility and hatchability of eggs (King'Ori, 2011). An egg is said to be infertile when it fails to show any evidence of developing embryo (Warren, 1953). Fertility of eggs depends on various factors such as breed, variety, shape index, season, pre-incubation, holding period, storage temperature, humidity, rate of egg production, level of nutrition, breed type, mating and time of mating. Lighting and sperm quality play a significant role in the processes of fertilization (Jull, 1958; Yeasmin, 2000). Crossbreeding and out crossing do not affect fertility (Marias, 1965). The fertility is significantly higher in Deshi breed (90.96% to 93.12%) than that of the crosses of White Leg Horn (78.15%) and Rhode Island Red

(86.40 %) (Kumar *et al*., 1976) and the fertility of Sonali is 84.4% (Islam *et al*., 2004*)*. The successfully escape of embryo from the shell of egg is called hatchability (Tarek, 1992). Good hatchability of egg determined by a complicated genetic constitution and the environment but it is also some extent heritable character. The climate and fertile eggs represent the hatchability on the basis fertile eggs (Amber, 1994). It has been observed that the mortality of crossbred embryos is somewhat less compared to representative purebred embryos. The hatchability of RIR ♂ X Fayoumi ♀ (i.e., sonali) was found to be 86.8% (Islam *et al*., 2003). Hatchability was found for Indian Peafowl in sex ratio 1:1, 1:2 and 1:3 was 24.76%, 40.39% and 61.59% (Mushtaq-ul-Hassan *et al.,* 2012). The hatching percentage varied from 39% in 2009 to 64% in 2010, 69% in 2011 and 55% in 2012. Overall hatching was 58% (Tariq *et al.,* 2018). In breeding flocks of birds, mating ratio of male to females plays a pivotal role in optimizing fertility and hatchability in the eggs produced by a flock (Altan and Oguz, 1993).

There is a general hypothesis that fluctuating selection driven by sex ratio dynamics contributes to explain the maintenance of genetic variation in personality traits, so, any change in the ratio exhibits a marked effect on fertility and hatchability of eggs (Newcombe, 1996; Kiers, 1997; Del Giudice, 2012). Sachdev *et al*., (1985) found a higher fertility and hatchability in fertile eggs of Japanese quail in heavy eggs (10.1-11.00 g) than light eggs (7.01-8.90 g). Sarica and Soley, (1995) also observed similar result the highest fertility and hatchability rate in incubated eggs in Japanese quail having egg weight 11.6 g and over. They lowest level of fertility and hatchability rate in eggs determined by them, that had a weight of 9.5 g and lower. Seker *et al*., (2004) reported an increase in hatchability rate when increase the egg weight in Japanese quail. Higher egg fertility (%) was showed when the sex ratio 1:3 as compared to other ratios. The fertility of the eggs is one of the major factors determining hatchability of all egg set (Deeming and Wadland, 2002). Jayarajan, (1992) reported environment and management often influence the effect of breed on egg fertility and hatchability. Egg quality and fertility are two important factors, which affect hatchability if management is not a limiting factor. Fertility also affect on hatchability during the process of incubation and hatching. The hatchability rate reduced with reduction in fertility (Farooq *et al*., 2001). The most influetial egg parameters that influence hatchability are; weight, shell thickness and porosity, shape index and consistency of the contents. Heat stresses reduce the external and internal egg quality as well as affects all phase of semen production in breeder cocks. Hatchability is lower in case of small eggs compared to medium and large eggs. Without this turning of eggs in setter of incubator also very important, if do not turn eggs in setter then the incubation length increase for few days (King'Ori, 2011). Hatchability is higher based on fertile eggs than that based on total eggs set (Murad *et al*., 2001). The fertility and hachabiity of birds and poultry mainly affected by nutrition, birds factor, natural or artificial incubation and environmental factors. Poultry and birds production at all scale of proportion is wholly dependent on supply of day-old chicks.

Fertility and hatchability are two major parameters that highly influence the supply of day-old chicks. Successful day-old chicks start with the proper selection and management of breeding stock, proper post-lay handling of fertile eggs and currect incubation process (King'Ori, 2011). Therefor, the propagation of peachicks maily increased by good fertility and hatchability rate as well as birds mangment propely in every steps. Captive breeding of Indian peafowl is common by pet rearers and zoo and safari park manager for propagation of this bird due to economic and conservation praspectives. Thus, the current study was designed to elucidate various breeding parameters of both male and female Indian peafowl under captive breeding conditions in Bangladesh National Zoo.

2. Material and Methods

2.1 Study site and period

The research work was conducted to determine the breeding parameters of Indian peafowl in Bangladesh National Zoo. The experiment was conducted for a period of 3 years and 9 months. The current research work was done in Bangladesh National Zoo, which is located in capital of Bangladesh and situated middle part of Bangladesh. The experimented period was between April, 2015 and December, 2018. Before starting the experiments, the researcher took a training class of the staffs about experiment for taking data properly on breeding parameters as well as reproductive parameters about Indian Peafowl. Then the present study was planned to investigate breeding as well as others related reproductive parameters of Indian peafowl's reared in captivity in Bangladesh National Zoo.

2.2 Breeding parameters

The breeding related data were collected by using questionnaire, weighting balance, measuring scale and directly by observation. A well-planed questionnaire was used to get information on Indian peafowl breeding as well as reproductive parameters added in appendix part of the thesis.

The appearance of male and female Indian peafowl of BNZ in breeding season was detected by several time keen close observations. The age at sexual maturity was selected based on questionnaire result as well as direct observation from the four year study period. Dimorphic male and female physical structure and sexual behavior of Indian peafowl was found by direct observation. The male and female sexual behavior was informed by close observation of several times. Without this the lek formaton with female by male were detected from the 20 lekking from the aviary and that was done by direct observation and counting female with single male. The sexual maturity age of male and female peafowls as day of hatched out chicks up to sexual maturity time of that birds which from physical and external appearanced of male and female peafowls. The month when the sexual matured birds appear the maturity activities that month considered the sexual maturity age. We considered 20 samples of both male and female Indian peafowls for presenting the current research findings. Then sexual maturity time presented as yearwise for Peacock and Peahen.

Breeding season considered the first egg laying time in the season and the last laying time in the season. In 2015, 1st egg laid in mid April and last egg laid in last week of August, in 2016, 1st egg laid in 1st week of March and last egg laid in last week of August, 1n 2017, 1st egg laid in 1st week of March and last egg laid in last week of August and in 2018, 1st egg laid in mid February and last egg laid in mid-August. Therefore, the breeding season was considered as February to August of the year. In case of detection of breeding season we considered the sample size of total adult peacock and peahen.

Egg colour, egg shape and egg size was detected by direct close keen observations of several time of the breeding season. Male and female ratio in breeding flock was also known by direct observation and by using questionnaire. Incubation period was calculated from the day of setting into incubator to hatching out of peachicks. Incubation temperature, incubation humidity, incubation of egg starting, egg storing time, turning of eggs, candling and transfer in hatcher from setter were known by using questionnaires as well as some times direct observations. Number of egg setting in natural broody peahen was known by direct observation and by using questionnaire.

Figure 2.1: Displaying and mating of Indian peafowl in Bangladesh National Zoo.

Figure 2.2: Egg weighting and measuring of Indian peafowl in Bangladesh National Zoo.

Figure 2.3: Incubator for artificial incubation of Indian pefowl eggs in BNZ.

The several type of displaying time was calculating by use of stopwatch for twenty displaying times of each displaying. The reproductive traits were recorded from peahens. Egg size (length and width) were measured with measuring scale and slide calipers for 50 eggs. Egg weight was measured with weighting balance as well as digital balance for 50 eggs. Clutch size was calculated from 20 peahen's clutch number by making average and standard deviation. The first laying time was considered as day of hatched out chicks up to first egg lay by that peahen. The first laying age also detected from 20 samples of peahens.The mean value of most of the parameters was presentd with standard deviation values of that parametes for finding the variation in individual level. Without this breeding and reproduction related others parameters were detected by using the well formed questionnaire.

Reproductive parameters of fertility and hatchability were calculated by using below formula.

2.3 Mathematical calculation and analysis

Fertility and hatchability of eggs was determined based on fertile eggs and hatched out chicks. Infertile eggs were detected by candling method. The eggs, which failed to develop embryo was regarded as infertile eggs. Candling to detect fertility was done after a week of incubation. Fertility of Indian peafowl's egg was detected by using the following formula.

$$\text{Fertility} = \frac{\text{No. of fertile eggs}}{\text{No. of total eggs}} \times 100$$

Poultry men in two senses use the term hatchability: i) hatchability based on total eggs and ii) hatchability based on the fertile egg. Hatchability was detected as the percentages of eggs hatched out. Then hatchability of the peachicks was calculated by using the following formulae.

$$\text{i) Hatchability/ total eggs} = \frac{\text{No. of hatched out peachicks}}{\text{No. of total eggs}} \times 100$$

$$\text{ii) Hatchability/ fertile eggs} = \frac{\text{No. of hatched out peachicks}}{\text{No. of fertile eggs}} \times 100$$

The data collection on setting eggs as well as fertility and hatchability for 2014 was done based on record book data and by direct questioning. Without this the natural breeding data was recorded and observed only for three years due to natural brooding occure in yrars (2015, 2016 and 2017).

2.4 Data collection and analysis

A 15 days interval was done for data collection, supervision and observation of management for clear conception. On the other hand one person was engaged in Bangladesh National Zoo to collect data continuously. The data generated from this experiment were entered in Microsoft Excel worksheet, organized and processed for further analysis. Two mean of male female parameters were compare by unpaired t-test also without this the uni-variate analysis have been done for separate single variable. The mean values presentd as Mean±SD and without this the range in individual level presented for finding the variation in individual level. On the oter hand, fertility and hatchability presented as percentage. The collected data were analyzed by using the Microsoft Excel, SPSS 16 and STATA 13.

3. Results and Discussion

3.1 Breeding parameters (Qualitative) of Indian peafowl in captivity

Male nature in breeding season was found walking, displaying and calling excitedly, but female nature in breeding season was found slowly walking beside the displaying male. The mate choice appeared to depend on attractiveness of the displaying male (Table 3.1).

Table 3.1: The peacock and peahen nature and appearance in breeding season in BNZ

SL No.	Breeding Parameters	Obseved appearances and nature
1	Peacock nature in breeding season	Walking, displaying and calling excitedly. In addition, more running and fighting. Lek formation with 3 or 4 female.
2	Peacock appearance in breeding season	Colourful body with glossy blue neck well arranged elongated train, Strong smooth tail and walking with upward tail.
3	Peahen nature in breeding season	Not eagerly ready to mate. Slowly walk beside the displaying male. Mate chooses based on attractiveness of Peacock.
4	Peahen appearance in breeding season	Shiny brown body with smooth shape.
5	Sexual behavior of peacock	Polygamous in nature
6	Sexual behavior of peahen	Polygamous in nature

Male appearance in breeding season was found colourful body with glossy blue neck well arranged elongated train, strong smooth tail and walking with upward tail but the female appearance in breeding season were found shiny brown body with smooth shape (Table 3.1).

Without this single male maintained a territory in breeding season with 3 or 4 female and male and female both was found polygamous in nature.

3.3 Breeding parameters (General) of Indian Peafowl in Bangladesh National Zoo

Breeding time was found in BNZ for Indian peafowl February to August. Indian peafowl breeds only once in a year in Bangladesh National Zoo (Table 3.2).

Table 3.2: Breeding parameters (General) of Indian Peafowl in Bangladesh National Zoo

SL No.	Breeding Parameters (N)	Results with Presentable Units
1	Breeding season (105)	February to August
2	Breeding intensity (105)	Single time in a year
3	Egg colour (50)	Brown, light brown , pale white and light creamy
4	Egg shape (50)	Oval shape, elongated oval and rounded oval
5	Egg size (50)	Larger than chicken egg
6	Male: Female	1:1, 1:2, 1:3 , 2:3 and 2:5
7	Incubation temperature	99- 100 ^{0} F
8	Incubation humidity	Not specifically maintained. Early stage low and late stage high
9	Turning eggs in incubator	3-6 times in setter/ day
10	Natural brooding	10-12 egg/Peahen

Egg colour variation was found which was brown, light brown, pale white and light creamy and the egg size was larger than the chicken egg . Egg shape was foun oval, elongated oval and rounded oval. The incubation temperature maintained by zoo authority was 99- 100 ^{0} F. The incubation humidity was not strictly maintained but at early stage of incubation low humidity and late stage of incubation high humidity maintained (Table 3.2).

Without this the eggs were turned in the setter 3-6 times/ day. In case of natural brooding generally 10-12 eggs were sated under a broody Peahen. In the present study, we reported that male: female ratio in breeding sheds were 1:1, 1:2, 1:3 and 2:5 and in aviary 2:3 (Table 3.2). Without these candling of incubated eggs were done at day 7, transferred of eggs in setter to hatcher at day 27. Indian Peafowl was found dimorphic, mature male and female can be easily differentiated properly by observing the physical structure.

3.4 Breeding parameters (quantitative) of Indian peafowl in captivity

Age at sexual maturity of peacock was estimated at 2.79±.20 years which ranged between 2.5-3.0 years (Table 3.3).

Table 3.3: Breeding parameters (quantitative) of Indian peafowl in captivity

Breeding Parameters	N	Mean±SD	Minimum	Maximum
Age at sexual maturity of peacock (year)	20	2.79±.20	2.5	3.0
Age at sexual maturity of peahen (year)	20	1.77±.19	1.5	2.0
General displaying time (minute)	20	3.30±.92	2	5
Courtship displaying time (minute)	20	14.60±2.1	10	18
Extremely egger to mate displaying time (minute)	20	27.20±3.6	23	35
First laying age (day)	20	675.45±65.74	553	751
Egg weight (gm)	50	107.84±6.27	90	118
Egg length (cm)	50	7.53±.50	6.4	8.2
Egg width (cm)	50	5.43±.24	4.9	5.8
Clutch size (number)	20	11.25±1.02	9	12
Incubation period (day)	20	29.45±.69	29	31

On the other hand age at sexual maturity was detected 1.77±.19 years which ranged with 1.5-2.0 years in case of peahen (Table 3.3). Displaying time was found 3.3±.92 minute that ranged with 2-5 minute in general condition, 14.6±2.1 minute that ranged with 10-18 minute at the time of courtship and 27.2±3.6 minute that ranged with 23-35 minute when extremely egger to mate (Table 3.3). First laying age was found 675.45±65.74 days, which range with 553-721 days.

Egg weight, egg length and egg width was found in the present study 107.84±6.27 gm that ranged to 90-118 gm, 7.53±.50 cm that ranged to 6.4-8.2 cm and 5.43±.24 cm that ranged to 4.9-5.8 cm. The clutch number was found 11.25±1.02 that raged with 9-12 (Table 3.3). High variation in the egg weight, egg size and egg shape were also found from SD vale as well as ranged values of that parameters. More over incubation period of eggs for hatching out was detected 29.45±.69 days which ranged from 29 days to 31 days (Table 3.3).

In the present study we found sexual dimorphism of male and female , the similar result also was found by (Sahajpal and Goyal, 2008), where they said that Indian peafowl, sexual dimorphism is a definite prerequisite for behavioral part of selection and directional selection, which selects evolution of such distinguishing characters as the peacock's tail. The evolution of sexual dimorphism applied to the forces of sexual selection acting upon both sexes of species. In male and female Indian peafowl, dimorphic plumage signals and the presence of crest are related to sex. On the other hand current study found that the nature of male in breeding season displaying and calling excitedly but the female nature was found walking slowly beside displaying male and mate choose based on attractiveness of Peacock. The past study findings also found near to similar agreement with current study findings which, was female choose for mates, and lay more eggs for, males with the largest trains (Ismail *et al.,* 2010). The peahen's discerning eye carefully selects the most glamorous and mature male, rejecting younger, less splendid birds (Takahashi and Hasegawa, 2008). El-Shahawy, (2010) did an experimental study and observed that males with maximum number of eyespots in their trains have greater rate of mating success and if the ocelli are experimentally removed from the trains, mating success rate decreases significantly. Similar findings were observed in the present study showing that greater the number of ocelli greater will be the mating success rate. Hence, there is direct correlation between number of ocelli and mating success rate. Another finding related to female sexual behavior was found that the peahen choose attractive male for mating which was also guessed by (Darwin, 1871) that females preferred more beautiful males for aesthetic reasons alone, although the great variety of male ornaments suggested to him that there could be mate choice for novelty's sake as well. More others results also supported this results also Peacocks (genus *Pavo*) are known for their highly elaborate train feathers displayed during courtship and assessed by females during mate choice (Petrie *et al*., 1999; Petrie and Halliday, 1994; Loyau *et al*., 2005a; Takahashi *et al*., 2008; Dakin and Montgomerie, 2011). Male nature in breeding season in current study was found walking, displaying and calling excitedly as well as male appearance in breeding season was found colourful body with glossy blue neck well arranged elongated train, strong smooth tail and walking with upward tail.

Based on dimorpism the past study results present the male appearance and nature but no appreance was presented for female. Its means the partial similarities for male apperences and nature but no results on female peafowl where as we presented the nature and appearance of female peafowl but in this study which was found shiny brown body with smooth shape and not eagerly ready to mate as well as slowly walk beside the displaying male. Earlier study also reported that Indian Peafowl are polygamous (Ali and Ripley, 1995), polyandrous (Lank *et al*., 2002) and have a *lek* like mating system, where males defend small and clumped territories in their breeding season (Hillgarth, 1984, Rands *et al*., 1984, Loyau *et al*., 2007b), which is also supported by result of present study where we found the male and female were polygamous in nature for mating. The elaborate train and its display of the male Indian peafowl, which is a visual signal, directed at female, has long been a subject of fascination and debate in the scientific world (Harikrishnan *et al.,* 2010). Peacocks are known for their highly elaborate train feathers, displayed during courtship and assessed by peahens during mate choice (Dakin and Montgomerie, 2011). According to sexual selection theory male with highly ornamented feather have greater reproductive success (Kodric-Brown and Brown, 1984). Mating success was normally more successful with the large number of eyespots also called ocelli on the train of the peacock (Parasharya and Mukherjee, 1999; Jaiswal *et al.,* 2013). The ornamentation of the peacock's train has been measured with the number of eyespots, train length and area of eyespots, density of eyespots, and proportion of feathers with eyespots, diameter of eyespots, and eyespot colour and iridescence. Currently, the consensus is that the peacock's train is a handicap but it is also considered an indicator of good genes (Araki *et al.,* 1989; Dutta *et al.,* 2013; Zhou *et al.,* 2015). The tail ornamentation is the most interesting factor among peacocks. It can merely be considered as a beneficial trait in intra-sexual selection but actually it is a poor weapon in maneuvering sexual copulate successfully (Hanotte *et al.,* 1991a).

Males with more extravagant secondary sexual characteristics, such as bigger, luminous trains tend to have better genes in the peahen's perspective. These genes will directly benefit the peahen's offspring, as well as the fitness and reproductive success. Females have often shown to distinguish among potential mates, and to prefer mating with individuals bearing the most exaggerated characters. In some cases, those males have shown to produce more successful, healthy and vigorous males (Jobson Christopher, 2016). According to Takahashi and Hasegawa, (2008) a variety of calls are given by peafowl of which seven are made only by males, out of which three call types are important for breeding; six alarm calls are uttered by both sexes. Present study was found similar result that was male peafowl calling excitedly in breeding season for attracting female peafowl. The present study also represented that the Peahen choose the mate for producing next generation with attractive and more displaying males which, have the more eyespots. Because that Peacock maintain many good genes which will transfer to their progeny and that peachicks will maintain very good health and more livability that result also supported by the past study where we found Peahen choose more attractive Peacock for their mating.

Indian peafowl is polygynous and generally has two to three breeding peahens in its harem (Roberts, 1992). These birds stay in small flocks of 1 peacock and 3-5 peahens and tend to remain closed together during breeding season (Mushtaq-Ul-Hassan, 2012; Grimmett *et al*., 1999). Peacocks are polygamous. They have a lek like mating system, where males defend small and clumped territories in their breeding season (Hillgarth, 1984; Rands *et al*., 1984; Loyau *et al*., 2007). A past study of a feral population suggests that peafowl does not defend its harem due to small breeding territory (Rands *et al*., 1984). Visiting peahens wander through several territories, sometimes making repeated visits, before selecting a peacock for mating (McGowan and Garson, 1995). Peafowl are polygamous. A polygamous family of a peafowl is made up of one adult male and 4 to 6 peahens. In a family, the group of peahens is called a harem Berman, (1996). The Indian Peafowl is a lek-breeding, dimorphic species, with males having an elaborate tail called the train. In the present study we also found that the Peacock makes the harem with 3 or 4 Peahen. Another past study was found the similar result that was being polygamous; a peacock can mate with 4-5 peahens during a breeding season (Santiapillai and Wijeyamohan, 2015). A recent study of a feral population suggests that Indian peafowl does not defend its harem due to small breeding territory (Landman and Gruys, 1998; Dakin, 2011; Dodia, 2011). A mature peacock in prime condition forms lek and perform courtship dance so that it can mate with as many as five peahens (Yasmin, 1995). In the current study detected the Pecock lekked with 3 to 4 Peahens which, supported by the most of past findings.

In the present study, we found the breeding seson for Indian peafowl was February to August. Although, the breeding season of the Indian peafowl is not fixed, it may breed throughout the year but animals prefer to breed during the rainy seasons (Naseer *et al.*, 2018c). The breeding season of the peafowl is spread out but it appears to be dependent upon the rains. In Southern India, the peak season of breeding is April to May, January to March in Sri Lanka and June in Northern India Petrie, (1999). The past finding observed that most of birds at Government Zoological Gardens breed in month of May on the other hand most of birds at Private Sectors breed in the month of August (Naseer *et al.*, 2018b). The peak breeding season in southern India is April to May, and June in northern India. Indian peafowl breeds from April through October. Adult males with a completely developed train establish display territories in mid-April, and maintain them until the end of the breedings season in September when molting of train feathers begins (Shahla and Yahya, 1996). Without these the males with short-train reached a maximum during the hottest time of the year, while those with long train reached their peak for breeding (Santiapillai and Wijeyamohan, 2015).

Breeding season starts around March and ends in August. Peahens sometimes start laying before they are bred with. Once the male has lost his tail train, egg production and fertility levels will drop noticeably (Mountain, 2014). On the other hand in Sri Lanka the breeding season commenced in December with the onset of the north-east monsoon and reached its peak in May with the start of the dry season (Santiapillai and Wijeyamohan, 2015). But from the several past studies results we found breeding season of Indian peafowl is not fixed but mostly it breeds in rainy season from April to August (Black *et al.*, 2010) in captivity. Satyanarayana and Rajadurai, (1989) reported that the nesting season of peafowl was from January to October and it usually coincides with monsoon. One of the pst study presented, late April to August was observed to be the breeding season for free ranging peahen at the Bankapura Peacockreserve. In Adichunchanagiri and Jogimatti region, the pre-breeding season of peafowl starts from March to June, followed by the breeding season from July to September and a non-breeding season from November to February. Yasmin and Yahya, (1996) stated that in southern India it usually coincides with the Northeast monsoon (October-December). Johnsingh and Murali, (1981) reported that the breeding period of peafowl in southern Tamil Nadu starts from August to October, followed by a post-breeding (nesting) period from November to March. Breeding seasons varied in several studies results compared with present study results. This variation may be due to the differences in climatic condition in different areas as well as based on starting rainy season as we know rain influenced the peafowl's for earlier mating. Without this the feeding and mangemental differences also make differencs in breeding seasons of peafowl. One of the past study also presented breeding season varied based on sex ratio which is also suppored by the present study results where a long breeding season was found February to August.

Without this past study finding also represented that the breeding season varied in semi-wild at Government Zoological Gardens breed in month of May on the other hand most of birds at Private Sectors breed in the month of August which, is also supported by the present study result. Wihout this wild condition and farm based rearing system the breeding season varied compared with zoo rearing in semi-wild rearing system. The present study found that the breeding season started with the rain starting season which is quite similar to those obtained Santiapillai and Wijeyamohan, 2015. The breeding season of peafowl, which commences in December with the onset of the north-east monsoon and reaches a peak in May with the start of the dry season, very much similar to the pattern reported from India (Santiapillai and Wijeyamohan, 2015). Peahens lay 6–12 brownish, buff coloured eggs from April to September (www.animalcorner.org, 2018). The fact that the breeding season of peafowl varied that may be due to the starting of rainy season as well as diffrerences coccurs due to differences in sex ratio in breeding flock. Prolong breeding season in present study may be due to the suitable environmental temperature and level of humidity suited for egg laying during February to August.

Although peacocks are capable of mating at the age of two, they reach sexual maturity a year later. Peacocks acquire their full trains when they are about 3 years old (Santiapillai and Wijeyamohan, 2015). Age at reproductive maturity of female Indian peafowl was 2.41±0.13 years and 2.26±0.12 years and of male was 2.65±0.65 years and 2.71±0.63 years, respectively at both government and private captivity sectors (Naseer *et al.*, 2018b). Peacocks are almost fully grown within a year. Two-year-olds resemble adult males but their tails do not have the characteristic eyes, or ocelli. They become sexually active at about 3 years of age. Peahens mature earlier than males and some mate when they are 1 year old. Others wait until the second year (Maria, 2018). Peahens generally reach breeding age at around 2 years, Peacocks at around 3 years (, April 2018). West and Zhoa, (1988) reported that Peafowl normally reach breeding age at two years. A mature male is a peacock which is at least three years old. Generally peacock will not have a full train until it is three years old. The tail train will lengthen and get fuller over the first two to three years. After the peacock is five or six years old, the tail train will remain consistent in length and quality for the rest of the bird's life as long as the bird remains healthy.

The tail train is very important to the breeding cycle of peafowl. The peacock will molt the tail in late summer and this is when the breeding season will end. A two year old peacock that has a one to two foot long tail train will be a better breeder at this age than a peacock of the same age that doesn't have a tail train of any size (Blau, 2004). Peafowl will start to lay their eggs when they are reached to 2-2.5 years of age (Sharma, 1973). The current study supported by the most of earlier studied findings which was found age of sexual maturity 1.77±0.19 years wich ranged 1.5-2.0 years for female and 2.79±0.20 years which ranged 2.5 -3.0 years for male Indian peafowl. Age at sexual maturity is influenced by genetic makeup of the individual and it also influenced by feed intake, lighting, increase and decrease of day length and other environmental factors (Morris and Fox., 1960; Wessels, 1962). Age at sexual maturity is an important trait from the economic standpoint. The age of days that laying commences is important with respect to its bearing on total first year lay (Lush, 1945). It is also important, because the earlier in life that a pullet commences laying, the sooner she produces revenue. Date of hatch has direct influences on age at sexual maturity (Weatherup *et al*., 1980). But past studied by Naseer *et al.,* (2018c) found that the female age of sexual maturity was more than 2 yers and male age of sexual maturity was more than 2.5 years. These results partially agreed with the current study findings this is may be due to the dfferent in rearing system, feeds supply, environmental condition and lighting expouser. The present study also revealed that female Indian peafowl take less time to mature than their males.

The finding of past study, egg weight was significantly correlated with egg length and egg width and the egg length was significantly correlated with egg width by Proudfoot and Hulan, (1981). That study also reported that positive correlation between size of hatching egg and body weight of chick in broilers and in other chicks. Without this another past study result found egg weight, egg length, egg width, incubation period, clutch size, and age at first egg were 104.85±21.93 gm, 7.34±0.19 cm, 5.71±0.06 cm, 29.4±0.13 days, 9.30±0.10 and 744.20±0.96 days, respectively (Talha, *et al.*, 2018). Clutch size varies between 4 -12 eggs with 6 being the average. Mean number of eggs per peahen laid were 0.71± 0.13, 1.63 ± 0.15 and 0.68±0.06, respectively, for 1:1, 1:2 and 1:3 sex ratios (Mushtaq-ul-Hassan *et al.,* 2012). When remove eggs while the peahen sits on them, she will continue to lay through the whole breeding season. Generrally the peahens will lay eggs in about three cycles during the season if you continually pick up the eggs daily. Pehens may lay for a month straight and then stop laying for seven to ten days before starting to lay again. Sometimes they don't stop laying altogether but will lay an egg every few days. Peahens will normally lay one egg every other day and in most cases they will be laid in the late afternoon or right before dark (Mountain, 2014). Another past study by Abrar *et al.*, (2017a), was estimated that the mean egg weight (95.98± 1.46) gm, (118.8 ± 1.43) gm and (97.79 ± 4.98) gm respectively in several groups based on cage space and during egg production time. The egg weight was found 49.87 ± 8.6 gm in male: female sex ratio 1:1, 92.46 ± 5.42 gm in male: female sex ratio 1:2 and 85.84 ± 4.99 gm in male: female sex ratio 1:3 (Mushtaq-ul-Hassan *et al.*, 2012).

Nevertheless, in the present study we found that egg weight, egg length, egg width, incubation period, clutch size, and age at first egg were 107.84±6.27 gm, 7.53±.50 cm, 5.43±.24 cm, 29-31 days, 11.25±1.02 and 675.45±65.74 days, respectively. Egg related most of present study results near to similar to past reported result but first laying age and clutch size differ highly, that may be due to different of rearing system, environmental condition and diet. Differnet in egg weight also found in different study results, this is is because of different in diet, rearing space as well as age of peafowl at the time of laying. Without this sex ratio of male: female also was found significantly effect on egg weight which also supported by the present study findings were we found variation in egg weight from several different sex ratio in different flock. The present study finding of egg weight also supported by the findings of Zou and Wu (2005), and Mushtaq-ul-Hassan *et al.*, (2012) they reported that less feed intake due to several reasons resulted in decreased egg weight and egg production in avian species as increase intake of feed increases the intake of protein and other ingredients of feed which resulted in increase in egg production. Wthout this egg weight and egg production differences due to the differences in male: female sex ratio. These results closely resembled those of Deeming and Wadland (2002) who observed the influence of mating sex ratios in commercial pheasant flocks and reported that egg production was significantly higher for the 8:1 mating ratio than that of 12:1. On the other hand, the results of the present study are also in close agreement with the findings of past researchers, who reported that food restriction significantly decreased egg production and egg weight (Lebbie *et al.*, 1981). Without this egg, weight is influenced by the total egg production per year, sequence of egg in the clutch, level of protein in ration, feed and drinking water, ambient temperature, stable type and disease (Darwati *et al*, 2010).

The Indian peafowls lay three to six buff white eggs on the nest. The peahen lays one egg in one day (Singh and Prasad, 1960). Males have no part in incubating or raising the chicks. However, an unusual instance of a male incubating a clutch of eggs has been reported (Shivrajkumar, 1957). The Peahen lays 3-5 brownish oval eggs and sometime up to 12 eggs (Jackson, 2006). The eggs are creamy buff, unmarked and the usual clutch is 4 to 6 eggs (Nakamura *et al.*, 2009; Mushtaq-ul-Hassan *et al.*, 2012). Peahens lay 6–12 brownish, buff coloured eggs from April to September (www.animalcorner.org, 2018). The clutch comprises of 4-8 fawn to buff white eggs which are incubated only by the female (Whistler and Hugh, 1949). The eggs are light brown in colour and are similar in size to turkey eggs (Virdi, 2008). Egg colour is influenced by genetic effect, housing system etc. reported by Samiullah *et al.*, (2015). The size of egg varies with female age, year, seasonal variations and laying order (Murphy, 1994). The current findings also supported that the colour and size of eggs of past found results. On the other hand, the present study finds that the egg colour is brown, light brown, light creamy and pale white. Above-mentioned result also supported by the present study results, some variation also found in few results this is may be due to most of results reported from natural range peafowl's but in captivity management, system was different. Mainly the feed igredients effect on egg colour significantly so in this study we found the several feed ingredients supplied to the captive breeding Indian peafowl of BNZ. The fact that the egg colour was also found differences in the present study that also supported by the past study results.

The female of peafowl normally layed clutches of six and often more than six eggs (Pabisch *et al.*, 2010). Clutch size of Indian peafowl is usually 4 to 9 eggs in natural habitat but in captivity the hen lays 8-20 eggs and the incubation period is about 28-30 days (Landman and Gruys 1998; Dakin, 2011; Anon., 2002). The eggs hatch after about 28 days (Whistler and Hugh, 1949). Time for hatching of eggs of Indian peafowl was observed to be 27.92±0.17 days and 27.96±0.12 days at the government and private sites, respectively (Naseer *et al.*, 2018b). It takes 27-30 days for peafowl eggs to hatch. Sometimes peahens will start sitting when may be only a few eggs are laid and then continue to lay eggs until she has several all of different ages. Her peachicks will start hatching around 28 days after incubation. If some of the eggs were laid six to seven days apart, much age difference between the first and last peachicks hatched (Mountain, 2014). The Peahen will sit upon the eggs and incubate them for 28 days (www.animalcorner.org, 2018). The female alone incubates the eggs, which hatch in 28-30 days. The eggs of peafowl have also been seen incubated by other birds such as hen (Singh and Prasad, 1960). Once mating has occurred, the peahen will lay a clutch of three to six eggs. She will incubate them for about 29 days with no help from the male (Maria, 2018). Clutch size differ highly when the peafowl lives in natural habitat which was found in past study 4-9 and was 4 to 6 eggs (Nakamura *et al.*, 2009; Mushtaq-ul-Hassan *et al.*, 2012). It was observed that the mean clutch size of Indian peafowl at one captive site, government zoological gardens, was 8.6±0.55 eggs and at the other captive site (private sectors) were 7.24±0.6 eggs (Naseer *et al.*, 2018b). On the othe hand, we found the clutch size in the study 11.25±1.02 which differed highly copared to past study most of the results, which was 4-9. This difference was found due to the earlier results presented mainly for wild condition breeding on the other hand the present result presented the captive breeding codition in BNZ. Without this the nutrient supply and weather condition are also major factors to get more or less eggs. Another important factor is natural brooding or machine brooding, in case of incubator settin generally get mor eggs in clutch compared to natural brooding which is supported by the current study finding. Grimmett (2011) mentioned that the mean number of eggs laid by peahen per season was 8.06 ± 0.32. Samour *et al*. (2010) observed the mean numbers of eggs per season were 6.99 ± 0.57 and a similar outcome was reported by Rao (1979); their documented mean number of eggs per season was 7.01 ± 0.69. Virdi (2008) opined, Peahens begin laying eggs in June-July and will lay eggs every other day until a clutch of seven to ten eggs is achieved. He also found that the eggs hatched after 27 to 30 days of incubation. The inubation period also increased if the turning of eggs in setter did not do properly (King'Ori, 2011).

The present study findings of eggs number in per clutch differed significantly with the above-given data. Moreover, mean number of eggs laid by peahen significantly increase under captivity conditions compared to their natural habitats. In this case the egg remove continuously from hatching in the incubator so the Peahens lay continue in the breeding seaseon. On the other hand if we remove the egg whole time in the breeding season the peahens may lay eggs for two or three clutch in breeding season therefore in captivity we get more eggs compared to wild condition clutch size. But one of the past study result presented a result with clutch size 8-20 in captivity present study result was 11.25±1.02 in zoo cptivity which supported to each other. Incubation period in the present study was found 29.45±.69 days and ranged 29-31 days where as in the past study was found 28-30 days and in some cases 27-30 days, which was more or less similar to present study. Incubation period mainly varied for differences in temperature and humidity in incubator machine as well as egg storing time. Without this turning of eggs in setter per day is an impotant factor for incubation period that was also reported by past study.

In the current study, we reported that male: female ratio in breeding sheds were 1:1, 1:2, 1:3 and 2:5 and in aviary 2:3. A previous study by Mushtaq-ul- Hassan *et al*. (2012) also found that 1:2 sex ratios showed better results in terms of egg production and egg weight and 1:3 sex ratios for more fertility and hatchability in peafowl. One peacock for every four peahens shoul be managed which will insure fertility and safety all around. If keep too many males than there will be fights and chaos in the coop. If you keep too many hens then you can't be sure that the one you want is fertile or not (Mountain, 2014). Without this the past findings of sex ratio 1♂: 2♀ can be used for the breeding of wild Indian peafowl under captive condition (Abrar *et al.,* 2017a) which is also supported by the present study finding where also mangae the same sex ratio in some cases. Another past finding in Sri Lanka the wild ranged peafowl was found in mixed groups where the average adult male: female ratio was 1:0.79 (Santiapillai and Wijeyamohan, 2015). Sundaramurthy *et al.* (2002) reported the sex ratio of adult male and female to be 1:0.72 in South India, while Solaiappan *et al.* (2002) have reported the sex ratio of adult male to female as 1:0.76 in wild ranging condition. The sex ratio can also vary due to the behavior of individuals during the breeding season which, was also supported by past study. As Yasmin (1997) argues, resource abundance may change with changing seasons and variation in group size is therefore expected between the seasons as well. Solaiappan *et al.,* (2002) have reported the sex ratio of adult male and female to be 1:0.79 based on their studies on the population and behaviour of Indian peafowl at Ketchilapuram village, Tuticorin district, Tamil Nadu. They also reported seasonal variation in group composition and grouping patterns of Indian Peafowl in three different seasons.

The present study also maintains the same ratio in most case but some case differed in sex ratio. This ratio mainly maintained for more fertility and hatchability as well as support for other managemental systems. Some past styudy result which, was not similar with present study results due to different species that were male to female ratios for optimum fertility and hatchability varies from species to species i.e. in chicken 8-9 males/100 females (Hazary *et al*., 2001; Lesson and Summers, 2001; Griskevicius *et al*., 2012), in ostrich 1 male: 3 females (Lambrechts *et al*., 2004) and 1 male: 2 females in quails (Shanaway, 1994). Male and female sex ratio maintain mainly based on speciecs, size and availability of male and female for maintain male and female number in the breeding flock. But the past study also found that sex ratio have no effect on egg production in domestic fowl by housing them at similar cage apacing Al-Rawi (1980).

One of the past study about temperature and humidity for Indian peafowl hatching in the incubator, the temperature maintained 99.5-100 degrees F and humidity not strictly maintain but they mange the humidity based on passive humidity control system. They maintain humidity mainly to add water daily to the water trough to ensure correct humidity levels (Mountain, 2014). In the present study we also maintaine the temperature 99-100 degrees F and humidity not maintain properly and maintained based on passive humidity control system. So the present study result about temperature and humidity management in incubator supported the past study result. If the temperature drops below even one degree the chicks probably will die. Check the temperature at least twice daily. As we know if the humidity in the incubator is too low or too high, the hatch will fail. When humidity is too low, the air cell will be too big at hatching time (Mountain, 2014). Therefore, temperature and humidity shoud maintain properly for getting more hatchability. Witout this the turning of peafowl eggs in incubator for proper hatching as well as the time of transfer of the egg from seter to hatcher is very important to know for getting more hatched out peachicks. Therefore, that results also presented in the present study which, was not found from the past study results.

On the other hand there was no finding about Peahen nature and appearance in breeding season as well as scattered finding of peacock nature and appearance in breeding season. However, in the present study we presented the nature of male and female peafowl appearance in breeding season properly. Without this there was no finding about displaying time of male peafowl from past finding but in the present study, we did it very specifically for general, courtship and eager to mate condition. In the present study, displaying time was found different general 3.3±.92 minute, courtship 14.6±2.1 minute and extremely eager to mate 27.2±3.6 minute. Many bird species engage in courtship rituals; in these rituals, when a male and female find each other, one or both of them puts on some sort of display. This often involves displaying plumage and performing some type of 'dance', or a specific set of movements. In some bird species, a male and female will perform a courtship ritual together. It is thought that this type of ritual helps create a social bond between the newly mated pair. In other bird species, only one bird – usually the male – displays. Such is the case with the Peacock (Maria, 2018). The behavior of Indian peafowl was strongly influenced by age and sex (Harikrishnan, *et al.,* 2010). This could be attributed to greater amount of time spent standing, displaying and preening by adult males than by females. Adult males spent significantly more time in preening than sub-adult males and females suggesting they incurred a high maintenance handicap because of the elaborate ornamentation (Walther and Clayton, 2005). Mating commenced when the male lunged forward after displaying, to mount the female once it crouched. The male dropped the train during copulation and held the crest plumes of the female with its beak. In this position, the male made a highpitched whistling call as reported by Galusha and Hill (1996). After copulation, which lasted a few seconds, adult males remained in their courts displaying to other females and never attempted to follow the female they mated (Harikrishnan, *et al.,* 2010). The most impressive characteristic of the blue and green peacock is their ability to raise their train feathers into a huge arc, 1.8-2.1 meters wide and walk around with this display, rattling and shimmerings the feathers. It is an attractive display for human viewers, although the behavior of peahen is somewhat different. She behaves as if she has seen this display many times before. The peahen carefully selects the more splendid and mature male (Jackson, 2006).

A mature peacock in prime condition forms lek and perform courtship dance so that it can mate with as many as five peahens. The egg fertility rate for each male should be monitored closely to determine how many peahens each male is capable of mating with successfully by a healthy male. A healthy bird will be active, have good feather quality, straight legs and toes, and clear eyes (Yasmin, 1995). The male peafowl display their magnificent trains and use loud calls to attract a harem of three to five females (Ali and Ripley, 1980a*)*. Males may display even in the absence of females. When a male is displaying, females do not appear to show any interest and usually continue their foraging (Johnsingh, 1976). Females do not appear to favour specific males (Rands *et al*., 1984). These results are also close agreement with the presnt study where we found that male were callng excitedly and displaying in breeding season. Whereas female did not appear to shown any interest to male and continued their feeding. Peacock also dropped the train during copulation and remained in their courts displaying to other females. It was found that adult males spend more time in displaying than sub-adult males whereas, females spend more time in feeding and roaming around displaying adult males (Dookia, 2015), which is partially supported by the present finding. The females most often mate with the males who have the most eyespots on their fans and the largest displays (Stokes *et al.*, 1971) that is also supported by the current study finding. Egg storing time is also very important factors which supported by past study fertile eggs should not be stored for more than 10-14 days, after 14 days of storage; hatchbility begins to decline significantly (King'Ori, 2011). In the current study the eggs also stored up to 10 days wich result agree with the past finding of 10-14 days.

3.5 Fertility and hatchability of Indian peafowl in captivity

The overall fertility of Indian Peafowl found in in Bangladesh National Zoo (45.61%; n=592) has shown in Table 3.4. Fertility rate was found the highest (49.13%; n=230) in 2015 and the lowest (40.80%; n=125) in 2017 (Table 3.4).

Table 3.4: Fertility of Indian Peafowl in Bangladesh National Zoo

Year	Total eggs	Fertile eggs	Fertility%
2014	120	49	40.83
2015	230	113	49.13
2016	27	13	48.15
2017	125	51	40.80
2018	90	44	48.89
Total	**592**	**270**	**45.61**

The fertility rates were detected at 40.83% (n=120), 48.15% (n=27) and 48.89% (n=90) in year 2014, 2016 and 2018. Fertility rate ranged from 40.80 to 49.13% in the years 2014 to 2018 (Table 3.4). The total egg numbers were the highest (n=230) in 2015 and were the lowest (n=27) in 2016 for setter of incubator for hatching purpose. Variation in fertility year wise was also found (Table 3.4). In the year 2015, the highest number (n=230) of eggs were setted in the incubator for the hatching of peachicks from those (n=113) were fertile. The number of fertile eggs were the lowest only (n=51) out of (n=125) incubator setted eggs in 2017.

Hatchability rate is the main target for peafowl owner or rearer for finding the newborn peachicks. The overall hatchability was found 40.20% (n=592) based on total eggs and 88.15% (n=270) on fertile eggs (Table 3.5).

Table 3.5: Hatchability of Indian peafowl in Bangladesh National Zoo

Year	Total eggs	Fertile eggs	Hatched out chicks	Hatchability based on total eggs	Hatchability based on fertile eggs
2014	120	49	43	35.83	87.76
2015	230	113	99	43.04	87.61
2016	27	13	11	40.74	84.62
2017	125	51	45	36.00	88.24
2018	90	44	40	44.44	90.91
Total	**592**	**270**	**238**	**40.20**	**88.15**

Hatchability rate was found the highest in 2018 and the lowest in 2014, which were 44.44% (n=90) and 35.83% (n=120), respectively (Table 3.5). Hatchability rate based on fertile eggs was found very well which were 87.76% (n=49), 87.61% (n=113), 84.62% (n=13), 88.24% (n=51) and 90.91% (n=44) in the respective years of 2014, 2015, 2016, 2017 and 2018. Variation in hatchability year wise was also found in the present study (Table 3.5). The number of total egg setting in the incubator also found varid yearwise where we found only 27 eggs in 2016 whereas 230 eggs in 2015. The egg number low only 27 in 2016 was setted in incubator because of that year the incubator was not functioning well. The fertility rate of Indian peafowl in natural brooding and machine brooding was found near to similar 45.46% (n=55) and 45.61% (n=592) in BNZ (Table 3.6 and 3.4).

Table 3.6: Fertility and hatchability in natural brooding of Indian peafowl in BNZ

Year	Total eggs	Fertile eggs	Hatched out chicks	Fertility	Hatchability based on fertile eggs
2015	24	11	11	45.83	100
2016	11	5	5	45.45	100
2017	20	9	9	45.00	100
Total	**55**	**25**	**25**	**45.46**	**100**

However, the hatchability rate based on fertile eggs was found high in natural brooding 100% (n=25) compared to machine brooding based on fertile eggs 88.15% (n=270) shown in Table 3.6 and 3.4. Fertility rate varied little bit yearwise but hatchability rate based on fertile eggs was 100% in all the three years (Table 3.6). The fertility rate were detected 45.83% (n=24), 45.45% (n=11) and 45.00% (20) in respective years 2015, 2016 and 217. The natural brooding result as presented only for three years (2015, 2016 and 2017) because of that three years only natural brooding occured.

The fertility of Indian peafowl from past finding was (%) was 33.65 ± 1.49 in male: female sex ratio 1:1, 65.05 ± 3.95 in male: female sex ratio 1:2 and 79.63 ± 4.27 in male: female sex ratio 1:3 (Mushtaq-ul-Hassan *et al.*, 2012). But in the present study male: femal sex ratio1:1, 1:2, 1:3 and 2:3 produced eggs, mixed and combined we found the overall fertility (45.61%) of Indian peafowl. The visitor disturbance in zoo may reduce fertility and survival rate of peachicks. On the other hand in the wild habitat the peafowl did not disturbed by visitors and increases the fertility rate as well as survival rate of peachicks (Agnes Deepa *et al.*, 2013). The present study result we were laso found that the fertility rate is low around (45%) only which was supported by the past study result.

In a past study hatchability in sex ratio 1:1, 1:2 and 1:3 was 24.76%, 40.39% and 61.59% was found by (Mushtaq *et al.,* 2012). The hatching percentage varied from 39% in 2009 to 64% in 2010, 69% in 2011 and 55% in 2012. Overall hatching of peafowl was found 58% (Tariq *et al.,* 2018). On the other hand present study with sex ratio 1:1, 1:2, 1:3 and 2:3 produced eggs mixed and combined and overall hatchability was found 40.20% and year wise hatchability was found 35.83% in 2014, 43.04% in 2015,40.74% in 2016, 36.0% in 2017 and finally in 2018, 44.44%. Low hatchability of Indian peafowl in the present study also supported by several past study reports which described that poor hatchability was linked with egg age (Tarongoy *et al.,* 1990*)* storage condition (Brah and Sandhu, 1989), age of flock (Brah and Sandhu, 1989; Buhr, 1995), system of husbandry and rearing technology (Weis, 1991), mating system (Gebhardt-Henrich and Mark, 1991), incubation relative humidity and eggs turning angle (Permsak, 1996). The poor hatchability in Bangladesh National Zoo, as reflected by several investigations might be associated with early embryonic death, rotten egg, broken yolk, dead-in-shell chicks, prolonged pre-incubation storage, poor breeder nutrition, breeder age, contamination, incubator and hatcher malfunctions were the main problems associated with poor hatchability (Deeming, 1995; Rosner and Van-Schalkwyk., 2000; Cabassi *et al.,* 2004; Hassan *et al.,* 2004; Ipek and Sahan, 2004; Malecki *et al.,* 2005; Tariq *et al.,* 2018).

There is a general hypothesis that fluctuating selection driven by sex ratio dynamics contributes to explain the maintenance of genetic variation in personality traits, so any change in the ratio exhibits a marked effect on fertility and hatchability of eggs (Newcombe, 1996; Kiers, 1997; Del Giudice, 2012). Male and female ratios for optimum fertility and hatchability varies from species to species that is in chicken 8-9 males/100 females (Hazary, *et al*., 2001; Lesson and Summers, 2001; Griskevicius *et al*., 2012), in ostrich 1 male: 3 females (Lambrechts *et al*., 2004) and 1 male: 2 females in quails (Shanaway, 1994). Sachdev *et al*., (1985) found fertility and hatchability higher in fertile eggs of Japanese quail (*Coturnix japonica*) in heavy eggs (10.1-11.00 g) than light eggs (7.01-8.90 g). Sarica and Soley, (1995) observed similarly, the highest fertility and hatchability rate in incubated eggs in Japanese quail having egg weight 11.6 g and over on the other hand the lowest level of fertility and hatchability rate was found of eggs that had a weight of 9.5 g and lower. Seker *et al*., (2004) reported, increase in hatchability rate with increase in egg weight in Japanese quail. Sex ratio 1:3 showed higher egg fertility (%) as compared to other ratios. In breeding flocks of birds, mating ratio of male to females plays a pivotal role in optimizing fertility and hatchability in the eggs produced by a flock (Altan and Oguz, 1993).

Fertility of the eggs is one of the most important factors determining hatchability of all egg set (Deeming and Wadland, 2002). Environment and management often influence the effect of breed on egg fertility and hatchability (Jayarajan, 1992). Without this fertility can affect hatchability during the process of incubation and hatching. Hatchability is reduced with reduction in fertility and hatchability is higher based on fertile eggs than that based on total eggs set (Murad *et al*., 2001). In the present study we also found a similar relationship between percent of fertile eggs and percent of hatchability that was recorded earlier, the higher the percent of fertile eggs the higher is the percent of hatchability.

There were two important factors, fertility and egg quality, which affect hatchability if management is not a limiting factor. Fertility can affect hatchability during the process of incubation and hatching. Hatchability is reduced with reduction in fertility (Farooq *et al*., 2001). The traits livability, fertility and hatchability are of paramount importance to poultry breeders, because they incur loss in breeding operations. Poor fertility, low hatchability and less livability significantly affect net returns (Azizul *et al*., 1980). Therefore, higher fertility of hatching eggs, higher hatchability of fertile eggs and lower mortality of birds should be of direct interest to the poultry and birds' breeders as well as the hatchery operations (Banerjee, 1993). Poultry breeders must look into these three traits of significance to overcome the problems of infertility, poor hatchability and low livability (Ahmed *et al*., 1982). The ratio of males to females in a population is an important factor in determining behavior in animals. Too many or too few males in a unit may lead to higher proportion of infertile eggs (Mushtaq-ul-Hassan *et al.,* 2013). The fertility depends on various factors such as breed, season, pre-incubation holding period, lighting, level of nutrition, mating and time of mating (Singh, 1975; Silversides *et al*., 2001). Temperature is a major factor for the production of the fertile eggs. It has been reported that fertility is affected badly during both hot and cold weather (Crawford, 1984). Hatchability of fertile eggs may be influenced by several factors such as genetic factor, care of hatching eggs, storage temperature, moisture, age of broody birds, quality of eggs, seasons, nutrition, etc. (Gringer, 1964; Kingan *et al.,* 1964; Kamphues *et al.,* 2001). Hatchability of eggs is to some extent heritable, but determined by a complicated genetic constitution. Factors that can cause the developing embryo to fail to get out of the shell are varied in nature (Cowan *et al.,* 1978). Both high and very low moisture contents in the weather badly affect the hatchability, but moderate moisture content of the air enhances better result (Das *et al.,* 2005). In the past study on chicken species, the overall fertility rate was 88.6 in Fayoumi and in Sonali chicken 89.8% and the overall hatchability rate was 86.0% in Fayoumi, which was lower than Sonali 87.5% (Miazi *et al.,* 2012). This result supported that the fertility and hatchability rate vary species to species and there rate is always higher in chicken species compared to Indian peafowl. On the other hand, we also found in that study hatchabilty based on fertile eggs was found higher (100%) in natural brooding compared to machine brooding (88.15%), which revealed that natural brooding is better compared to machine brooding. The fertility and hatchability rate was varied year wise because temperature humidity varied in several years. Hatchability mainly depen on male and female sex ration if we looked on past study results. The past studied results presented that hatchability low 24.76 % in male: female (1:1) and 40.39% in male: female (1:2) and the highest 61.59% in male: female (1:3) was found by (Mushtaq-ul-Hassan *et al.,* 2012). Mushtaq-ul-Hassan *et al.,* (2012) also repoted that the maximum egg fertility (79.63%) and hatchability (61.59%) was noted in the sex ratio 1:3. On the other hand, present study with sex ratio 1:1, 1:2, 1:3 and 2:3 produced eggs mixed, combined, and overall hatchability was found 40.20%. Therefore, for a strategic breeding program we should be considered male and female sex ratio properly, which may be 1:3 sex ratio and 1:1 sex ratio shoud be aboided.

Different ecological and social factors affect hatchability of eggs in different bird species. Significant relations among these factors and hatchability of eggs were obtained by Koenig (1982). Nwagu (1997) highlighted that optimum incubation conditions like the right temperature, humidity and ventilation during the setting and hatching stages are vital for best results. Without this the hatchability also depends on incubator in case of machine hatching and in natural condition brooding by peahens, so the differences in fertility and hatchability was found in present study compared to past study due to the male and female sex ratio, temperature, humidity, nutrition level, age of peahen and overall management system differences. Without this incubator, management and species variation also changes of hatchability to present and past study. In the past studied results they did not present the fertility results because they mainly emphasis on hatched out peachicks which was the final product we want. But in the present study we presented the fertility rate also based on total eggs because of we also emphasis of egg quality and egg storing time. In curent study stored egg generally for up to 10 days due to single incubator in BNZ that also effect on hatchability rate. Therefore, storing time should be low and better to use the fresh eggs for seting the egg in incubator.

Fertility and hatchablity rate is very important for getting pogeny from any specics. If the fertility and hatchability rate found more then the final production of progeny will get more. More progeny will give more economic return as well as easy to make conservation program for that species. Finally, we can be said that both fertility and hatchability rate should be considered for finding the perfect breeding results.

Most of the findings on breeding parameters in the past studies were not presented properly as well as research work done with few sample in natural breeding condition. However, in the present study we presented the most of breeding parameters with good sample size in captive breeding condition at BNZ. To know breeding parameters are very important for develop peafowl farm as well as design conservation plan of any species. As we know the Indian peafowl has extrincted from the wild area of Bangladesh. Therefore, the present studied elavorate results on breeding parameters will help to farm based rearing with breeding strategy as well as to make future plan for conservation of Indian pefowl in Bangladesh. The peafowl owners as pets also used these parameters to do smart breeding plan for getting more progeny and finally will get more economic return. The captive breeder as well as zoo rearer of peafowl also can be use the present study result for taking the breeding strategy as well as good management of their peafowl in captivity. The nature and physical appearance of Peacock and Peahen was found properly in the present study which, will help to identify male and female peafowl as in breeding or nonbreeding status. Finally, it could be said that the present study presented most of the paramteres related to breeding and reproduction of Indian peafowl in BNZ with good smple size. In conclusion it can be said that the breeding parameters were detected very good and the breeding strategy was also found well in case of Indian Peafowl in Bangladesh National Zoo. So this study results could be used for future breeding related research in zoo, safari park as well as farm for management of good strategic breeding plan of Indian peafowl.

4. Conclusion

Captive breeding is a unique process, through which endangered species being reproduce and maintained their progeny in human mediated controlled environment in different settings including zoos, wildlife sanctuary, and safari park. Interestingly, Indian peafowl in captivity specially the male attract the female counterpart by walking, displaying and calling excitedly but female slowly walk beside the displaying male and mate choose based on attractiveness. Male appearance in breeding season, colourful body with glossy blue neck well arranged elongated train, strong smooth tail and walking with upward tail but the female appearance in breeding season, shiny brown body with smooth shape. Besides this, a single male maintain a territory in breeding season with 3 or 4 female. Males' became sexually mature at the age of 2.79±0.20 years ranged with 2.5 to 3 years whereas females became sexually mature at 1.77±0.19 years ranged with 1.5 to 2 years of age. Breeding season also extended from February to August. Egg colour variation was found which was brown, light brown, pale white and light creamy and the egg size was larger than the chicken egg. The average egg weight is 107.84±6.27 gm of Indian Peafowl in Bangladesh National Zoo. In case of natural brooding generally 10-12 eggs were sated under a broody Peahen. The incubation temperature maintained by zoo authority was 99-100 ^{0} F but humidity not strictly followed. Incubation period was found 29.45±.69 days. In the present study, reported that male: female ratio in breeding sheds were 1:1, 1:2, 1:3 and 2:5 and in aviary 2:3. Fertility and hatchability rate was found normally 45.61% and 40.20%. But in natural brooding fertility rate was found 45.46% whereas hatchability rate was found 100% based on fertile eggs. The fertility and hatchability rate varied also year wise due to environmental impact, variation in temperature and humidity, nutrient status, egg storing time, activities of incubator machine and total management system.

In summary we could provide suggestions and necessary direction for successful breeding program of Indian peafowl based on their phenotypic and genotypic characteristic that showed in captive environment. The significant traits that determined the supreme quality of breeding stock are peafowl quality and age, sex ratio, egg storing time, incubation temperature and humidity, incubation system and fertility and hatchability rate. The propagation of day-old peachicks can be done properly with smart breeding plan which help to generate considerable economic return of pet bird rarer and conservation planners. The results of this study might be helpful especially to farmers and captive breeders for information concerning the breeding season, sex ratio, egg storing time, total management and behavioral activities of the Indian peafowl under captivity. Furthermore, breeders will be able to timely implement proper management practices before the onset of the breeding season of this bird in order to obtain more fruitful results in terms of their business and breeding management. Without this more propagation of peachicks by proper breeding plan in captivity also could be done. That enough numbers of day-old peachicks will help to do make conservation plan for Indian peafowl. By this way, initiatives can be taken to breed the species in captivity, systematically train them to survive in the wild, and release in safe wild habitats where the species once existed in the wild.

CHAPTER 4

Feed, Feeding Ecology and Habitat of Indian Peafowl in Captivity

Abstract

Feeding habit is an important biological characteristic widely practiced on animals, particularly on birds in aviary. Deficiencies in proteins and in certain nutrients resulted in retardation in growth, poor feathering and less resistant to drastic weather. As a result, peafowl in captivity provided with extra feed are bred and reared under controlled conditions. The Indian peafowl (*Pavo cristatus*) has been reared in a good feed, feeding and management system in the Bangladesh National Zoo (BNZ). The research importance is crucial since no published data on the feed, feeding and habitat of Indian peafowl in Bangladesh is available. Thus, the research has been carried out with Indian peafowl based on feed and feeding ecology, as well as habitat, under captive condition in BNZ. The study was performed from April, 2015, to December, 2018, in BNZ by direct interacting, observing, using structured questionnaire, and finally by taking record on data sheets. During the current study, feedstuffs, amount of feeds and the form of feeds for adult Indian peafowls in captivity was assessed. The feeds supplied for the adult Indian peafowls, in BNZ, were layer feed, spinach, cabbage, fruits, eggs and peanuts throughout the whole study period. Mango and water melon were supplied seasonally, but in most of the time the papaya was routinely supplied. Pellet form of layered feed, chopped spinach and pieces of fruits and boiled eggs were generally supplied. The bulk part of feed comprises with layer feeds, spinach and fruits. On a daily basis, 250 gm of daily and 25 gm of supporting feed, eggs and peanuts were given to per Indian peafowl. In addition, *ad libitum* clean water was also given every day. Gourd spinach was more common and sometimes mixed with two spinaches, which were also supplied,

whereas cabbage was supplied only in the season. No impact on feed intake was found in rainy season in the last three years. Nevertheless, in summer season, about 10 gm of layer poultry feed and in winter season, about 15 gm of fruit has not been consumed by the peafowl. However, the effect of feed intake was found in both high and low temperature only for few days in the last three years of study, which was not significant. The peachicks were fully free from feed and water at day 1 and adlibitum amount of crumble form feeds were supplied from the 2nd day of age. Apart from this, after the 3rd month, layer starter in the form of pellet has started to mix with the crumble. Spinach, fruits, eggs and peanuts were given as feed constituents after the 2nd weeks, 1.5 month, 2nd weeks and 4 months, respectively. Glucose mixed water was supplied from the 2nd day, and later from the 4th days, clean water was started to supply as the feed additives. A mixture of vitamin-mineral was also supplied from the 5th days of age. Adilbitum amount of layer feed was given after the 9th month of age. The Indian peafowls were found to become habituated to the feeds supplied by the authority of BNZ, which were layer starter, layer layer, spinach, fruits, eggs and peanuts. Feed and water were supplied in feeder and waterer, and peachicks have been fed on paper for the first few days in brooder house. The Indian peafowls, sometimes, were fed like omnivores, which was observed to take small pieces of sand, others odd materials and self-feathers roots. They were also habituated with the supplied feeds by the visitors, such as gram, puffed rice, puffed corn, several types of chips, cucumber etc. Therefore, the feeding environment of Indian peafowl in the BNZ was ecologically sated up for a long time to survive and express good performances. In the current study, we considered the habitat as aviary and house of Indian peafowl with the roosting site of those places in the BNZ.

1. Introduction

1.1 Feed and feeding

Feeding is an important biological characteristic as it is observed that supplementary feeding in hunting grounds may affect the number of certain bird species (Khulape *et al.*, 2014). Specific deficiencies in proteins and in certain nutrients result in retarded growth, poor feathering and less resistant to drastic weather (Hanotte *et al.*, 1991b; Gupta *et al.*, 2005; Ramesh and McGowan, 2009; Khulape *et al.*, 2014). As a result, pheasants in captivity provided with extra feed are bred and reared under control and are released into the wild after a specific time span, similar to broilers (Harikrishnan *et al.*, 2010). Most evidences supported that improved growth of Indian peafowl offspring with elaborated trains is related to higher amount of fat reserves in peacocks with longer trains (Miller *et al.*, 1998; Parasharya and Mukherjee, 1999; Nasser *et al.*, 2018b). Nutrition has played a dynamic role in the early development of the bird and supplementary diet is required for proper growth. Green feed stuff and grains are introduced in order to mimic natural feeding conditions. As Indian peafowl is omnivorous, so the protein content plays an important role in building different biological characteristics e.g. growth rate of the bird (Harihar and Fernandes, 2011). Expenditure of a lot of energy by male to produce and maintain elaborated good train conditions, will not only result in the form of a trade-off between a longer train but also avoid predators and search for food (Parasharya and Mukherjee, 1999; Jaiswal *et al.*, 2013). Bird is virtually omnivorous, feeding on a range of insects, reptiles, worms, seeds, grains and fruits (Loyau *et al.*, 2005b; Takahashi and Hasegawa, 2008; Harikrishnan *et al.*, 2010). Indian peafowl, *Pavo cristatus* is an omnivorous birds and resident breeder across the Indian subcontinent (Kushwaha and Kumar, 2016). This omnivore eats seeds, insects, fruits, small mammals and reptiles. Peafowl also feed on small snakes but keep their distance from larger ones (Johnsingh, 1976). Peafowl are generally believed to be virtually omnivorous (Baker, 1928; Ali and Ripley, 1974), eating everything from grain and green crops, plant parts, flower petals, seed heads, insects, small reptiles, mammals, and even small snakes. Berries, drupes (such as Carissa, Lantana, *Zizyphus*) and wild figs (*Ficus*) are apparently favoured foods where they are available. Johnsingh and Murali, (1981) found the birds feeding in cultivated fields and on an adjoining acacia plantation as well as in fallow lands and noted that three birds that were examined had primarily eaten plant materials such as leaves, grass seeds, flower parts, croton fruit, acacia seeds, cyperus rhizomes and rice. Invertebrates included various insects such as termites, grasshoppers, ants, beetles, scorpions and other arthropods. They also feed on reptiles, and amphibians. Foraging is usually done in small groups, which are primarily harem groups during the breeding season and are segregated parties of adult males and females with young outside the breeding season. In Gir forest of Gujarat, a large percentage of their food is made up of the fallen berries of *Zizyphus* (Trivedi and Johnsing, 1995). Indian peafowl feed on a wide range of crops such as groundnut, tomato, and paddy, chilly and even bananas in around cultivated areas (Johnsingh and Murali, 1981). Around human habitations, they feed on variety of food scraps and even human excreta. In the countryside, it is particularly partial to crops and garden plants (Ali and Repley, 1981). The plant matter constituted the bulk of the diet of Indian peafowl compared to low proportions of animal matter (Navaneethakannan, 1981).

Peafowl diet is mainly paddy, bajra, other grain seeds and partial to agricultural crops and garden plants a revealed by villagers and priests (Dookia, 2015). In the past study by faecal analysis technique showed that dietary components of Indian peafowl were covered by plant contents following by animal sources. The plants components constituents grass seeds were predominant followed by dicotyledon and fruits with least portion of monocotyledons .Whereas among animal components, ants, grasshopper, earthworms, spider and unidentified bones were present. Faecal analysis indicated the presence of some non-food items such as sand and gravel (Naseer *et al.*, 2018c). Seeds, grain, lentils, groundnuts, tender shoots of crops, flower-buds, berries and drupes, wild fiq, centipedes, scorpions, lizards, small snakes , insects (e.g. locust hoppers, beetles, caterpillars), worms and grubs have all been more or less regularly found in crop and stomachs (Samour *et al.*, 2010). In areas where it is semi-feral and abundant it is destructive to cereal and groundnut crops in the highest degree, and a veritable scourge to the small farmer, vying with the sacred monkeys in the work of devastation (Miller *et al.*, 1998). Peafowls are omnivores and eat mostly plant parts, actively hunting insects and other arthropods, reptiles and amphibians. Scratching through leaf litter is how wild peafowls find their food. They are not meticulous and will eat almost anything that can fit into their beak (Jobson and Christopher, 2016). The peafowls must also be supplied some minerals: oyster shells for healthy bones and thick eggshells, gravel bits for digestion and clean, fresh drinking water. Generally add vitamins and electrolytes to the peacocks' water, about .5 tsp per gallon, to look like lemonade. This helps the birds through times of stress and extreme heat or cold (Rowe, 2013).

The Indian peafowl is omnivorous and they feed on flesh and vegetative fare. However, grain is their staple; also, their diet includes fruits, seeds, plants, insects, fish, small reptiles and amphibians. Some owners of peafowl cultivate seeds, greens, carrots and alfalfa for their birds in their land. Make sure your peafowl have fresh water at all times (Valerie, 2017). The system of interval for feeding peacocks twice a day regularly maintained. If they were in a cage, it would probably go out more often with treats during the day. Basically they supplied dried cat food with 32% protein, turkey and game birds feed in crumbles forms, cracked corn or hen scratch, greens-unsprayed lawn clippings, weeds, sprouts, fruits and Veggies-strawberry bits, oranges, melons, tomatoes, treats- bread crumbs, bits of cheese, scrambled eggs, cottage cheese, crackers, worms etc. The cracked corn, game bird food and cat food are available at all times in a peacock ‘smorgy’ trough, located high enough that dogs can't get to it (Rowe, 2013). Peafowl should be fed two handfuls of mixed grain and access to fresh water every day. This grain can be purchased at most feed stores, and most game bird feed, like turkey, chicken, or pheasant feed, is also fine for half to two thirds of their diet. The peafowl's complete diet should consist of about 5-10% of peanuts or sunflower seeds, supplemented with green vegetables such as cabbage or kale. This can be fed bread or fruit as an occasional treat, but never give your peafowl bones, as they may choke. Another option for a higher protein diet would be to include some cat or plant-based dog food (Allie, 2017).

Moreover a variety of food is required in captivity for birds as recommended by Central Zoo Authority India for South Asia region (Raja, 2007) i.e. 30 gm feed breeder, 30 gm onions and garlic, 100 gm spinach and 60 gm oil seeds to be fed to peafowls per bird in captivity. 125 gm poultry feed breeder, 20 gm onions and garlic, 60 gm spinach, 30 gm Oil seeds to be fed to pheasants and 250 gm poultry feed, 100-50 gm Roasted grams, 100 gm Spinach and Chapatti to be fed to Turkey (Sikandar *et al*., 2015). Diet provided at Lahore zoo for Indian peafowl per bird in captivity was found 300-400 gm poultry feed, 100-200 gm of parched grams on the other hand the diet provided for pheasants and turkey were found 125-350 gm poultry feed, 50-150 gm of parched grams, 50-150 gm of bajra, 200 gm fruits and 200-300 gm of poultry feed, 100-200 gm of parched gram (Sikandar *et al*., 2015). A weighed quantity of breeder ration 200 gm/bird was offered to Indian peafowl in captivity for breeding performance study (Abrar *et. al.,* 2017b). Weighed quantity of breeder ration @200 gm/peafowl was offered to each replicate as per ration schedule of Punjab Wildlife Department (Mushtaq-ul-Hassan, *et. al.,* 2012). The ration per peafowl was supplied 250 grams each (Parveen *et al.,* 2018). Above descrived feeds ingredients as well as amount of feeds supplied to the peafowl were found for several purposes rearing of this bird. Therefore the current study considered the feeds and feeding ecology of Indian peafowl in BNZ.

1.2 Habitat

The habitat in ecological science states that a habitat is the type of natural environment where a particular species lives. An artificial habitat can be created for different plants and animal within your indoor space, so the consideration of habitat of Indian peafowl start with whole earth then continent, then subcontinent, then country, then natural living space of part of a country and finally the house, aviary and room where they live. Therefore, in our study we considered the habitat as aviary and house of Indian peafowl with the roosting site of that place in the BNZ.

Indian peafowl is inhabited in the dense forest of East Asia having two species, the Blue peacock (*Pavo cristatus*), and the Green peacock (*Pavo musticus*) peacocks. However, the Congo peacock (*Afropavo congensis*), is found recently in Africa (Ramesh and McGowan, 2009). At the start of the 20th century, green Indian peafowl (*Pavo muticus*) were widespread and common across much of South-East Asia (Saini *et al.*, 2007), so that they were considered the second most abundant game-bird in Indochina after the red jungle fowl *Gallus gallus* (Ramesh and McGowan, 2009). In the last few decades, green Indian peafowl numbers have declined dramatically (Nasser *et al.,* 2018a). They are now considered to be extinct in Malaysia (Somes and Burger, 1993) and restricted to isolated populations in India, Thailand, Laos, China and Indonesia (Hanotte *et al.*, 1991a; Landman and Gruys, 1998; Hart, 2002). The green peafowl (*Pavo muticus*) historically covers a large area in East and Southeast Asia, from India to Indo-China and Java and may be extinct in some places such as northeast India and Malaysia (Parasharya and Mukherjee, 1999), although it is protected by law in many countries like Burma, Indonesia, Malaysia and Thailand (Yasmin and Yahya, 1996;

Yorzinski *et al.*, 2015). Indian peafowl is a resident breeder across the Indian subcontinent (Kushwaha and Kumar, 2016). Indian peafowl inhabit areas near streams, open forest and grasslands in the outskirt of villages (Ramesh and McGowan, 2009). Roost selection is a vital component of the overall habitat selection process; therefore, information on roost selection by a species carries immense importance for assessing its conservation needs. Judicious selection of roosting sites also enhances the survival of birds by virtue of reduced heat loss, information sharing accountability of population and better protection from predators (Gadgil and Ali, 1975; Gadgil, 1972; Dodia, 2011). Peafowl roost at night in tall trees (Dakin, 2011). Indian peafowl is a bird of scrub-jungles and forest edges, showing affinity to moist, dry deciduous and semiarid biomes. It is also found in agricultural fields, along streams with good vegetation and close to human habitations in a semi-feral condition. It roosts on trees and also uses tall buildings where trees are scarce (Johnsgard, 1986).

Peafowl is a bird of scrub-jungles (McGowan and Garson, 1995) and forest edges; showing affinity to moist, dry deciduous and semiarid biomes (Brickle, 2002). In its native range, the Indian peafowl can typically be found inhabiting the undergrowth in open forest and woodland, usually near a river or stream (Burton and Burton, 2002). It is also found in agricultural fields (Sathyanarayana, 2004), along streams with good vegetation and close to human habitations in a semi-feral condition (Johnsgard, 1986). In its wild state in northern India, the favored habitats of this species consist of forests growing along hillside streams, in which the undergrowth consists of bar bushes (*Zizyphus*) and thorny creepers, the bushes growing some 10 or 12 feet apart, and spreading out to form table-shaped tops that meet one another to form a continuous mass, allowing the birds to move about easily underneath. Higher up in the hill country they are found in open oak forests, where tiny streams run between the hills and each stream-bank is well covered by bushes, brambles and reeds (Gadagkar, 2003). The Indian peafowl is also known to occur in farmland, villages, and increasingly, more urban areas (Sathyakumar and Kalsi, 2007). The roosting pattern reveals that the highest number of female peafowl roost together on the trees whereas males roost singly on the top of large trees (Dookia *et al*., 2015). Rroost selection by bird species is of great importance in planning for its conservation and management. In birds, the roost selection is a vital component in the overall habitat selection process (Trivedi and Johnsingh, 1996).

Two most significant functions of communal roosting in bird species are the communication of information about the location of food sources and avoidance of predation (Gadgil and Ali, 1975). Indian peafowl prefered open areas as sites for lekking and dust bathing (Yasmin and Yahya, 1996; Harikrishnan *et al*., 2010). Therefore, information on roost as well as habitat selection by a species carries immense importance for assassing its conservation need and to design effective management strategies (Kalaiselvan and Ramesh, 2014). In wild state affects moist- and dry-deciduous forest in the neighborhood of streams. Where semi-feral, found in the precincts of villages and cultivation, in close association with man (Samour *et al.*, 2010). Then room or habitat of peafowl should be at least 12 feet wide and 20 feet long, and 10 to 15 feet high, or even higher, with perches. Indian peafowl usually stay within 2 or 3 acres in the wild but they have wandered up to a mile away to check out their neighbors. With the males strutting around in the cage then the females need some room to get out of the way. The larger and taller cage is better for peafowl (Rowe, 2013). Peafowls require at least 25 square meters (or 80 square feet) per bird in their habitat. The availability of space in the house is important in order to prevent disease, as well as fighting among the birds. The peafowl's house should be at least 2.5 meters (7 feet 10 inches) in height so that peafowl can fly and fan their tails. If you keep a male peacock, the pen should be large enough for him to display his long tail feathers without injury (Allie, 2017). Usually 100 square feet space required for each bird and in case of domestic peafowl farming, you have to ensure adequate housing and good environment. The housing space should be adjusted according to the length of peacock's trains because we know generally peacock trains can be over 5 feet long. So their shed must have to be at least 8 feet tall. You can use chicken wire for the walls and roof. It can be provide also a wooden shelter similar to a small shed or barn. The house can be bed with straw and keep a warming light inside. Make the house suitable enough for preventing all types of predators, such as raccoon wild dogs or foxes (www.roysfarm.com, 2019).

In captivity, peafowls are usually kept in pairs or one cock to two or three hens. The larger the pens the better, 12 feet by 60 feet is recommended, although they can be kept in smaller areas, 24 feet by 30 feet. Peafowls can be kept with other avian species, but should be introduced at the same time and kept in a large enough 1ight to allow for individual territories, nesting sites and feeding areas (www.journals.tdl.org, 2019).

Peacock or peafowl, as the word 'peacock' only refers to the male of the species, are commonly seen in zoos, on ranches and on hobby farms in the United States and in Europe. However, peacocks are originally native to the forests of Asia. These birds are members of the pheasant family, and they exhibit many of the same behaviors as other pheasants. They are ground feeders, meaning that they spend most of the time searching for food on the ground (Maria, 2018). Finally its can be stated that small territory and sufficient food supply are the basic requirements of this bird (Kaliner and Miringa 1972; Krautwald and Schildger, 1986). The importance of habitats and its standard were found from past studied informations. Obliteration of natural habitats enforced an urgent need of hbitats or houses related studies to understand the requirements so that wild population may be conserved. Despite its wide distribution, little data on Indian peafowl feeds, feeding ecology and habitats are available. Therfore, the current study was done with objective of feed, feeding ecology and habitat of Indian peafowl in Bangladesh National Zoo.

2. Material and Methods

2.1 Study site and period

The research work was conducted to determine the feed, feeding ecology and habitat of Indian peafowl in Bangladesh National Zoo. The experiment of Indian peafowl was conducted for a period of 3 years and 9 months. The research work was done in Bangladesh National Zoo, which is located in capital of Bangladesh and situated middle part of Bangladesh. The Indian peafowl, being brilliantly coloured are often confined for pleasure in zoos, parks and even houses by many people. Though the feeding behavior of peafowls has been studied in the wild by many researchers, no study has been observed regarding the general feeds and feeding ecology and habitat of peafowls under captive conditions. The experimented period was between April, 2015 and December, 2018. At the time of starting the experiments the researcher took a training class of the staffs for taking data properly on feed, feeding as well as habitat of Indian Peafowl. Thus, the present study was planned to investigate feed, feeding ecology as well as habitat of Indian peafowl's reared in captivity in Bangladesh National Zoo.

2.2 Feed and feeding ecology

The nutrition section of the zoo send the feed to the birds section by calculating the amount of feed based on requirement of bird section. The information about supplied feed of the Indian Peafowl was collected by direct observation and by using formatted questionnaires. The feed was supplied were layer feed, fruits, spinach, egg, groundnut and water. The amount and form of feeds were known by direct observation, direct weighing and using questionnaire. The amounts of feeds were known by direct questioning and weighing by digital balance. Feeding time and feeding interval was also known by direct questioning and observation. The form of feeds was also known by direct observing. Feeding ecology was known by direct questioning and observation. The feed intake decrease or increase was calculated by the amount of feed found in the next morning. After weighting, those feed then divided by total number of peafowl in that house.

Figure 2.1: The feeds of Indian peafowl in Bangladesh National Zoo

Figure 2.2: Feeds on feeder and feeding ecology of Indian Peafowl in BNZ

Finally the proper amount of feed was selected for per mature Indian peafowl, when no feed found in the next morning. Seasonal effect on feed intake by Indian peafowl in Bangladesh after weighting those feed then divided by total number of peafowl in that house. The season considered as rainy season (June-July); summer season (April-May) and winter season (November-January). Then recorded amount of feed of several ingredients were tabulated properly based on specific date and looked on weather condition of that day. Feed ingredients and amount of feed for peachicks in Bangladesh National Zoo was also known by using questionnaire and direct observation. Starting time of several feed ingredients amount and form of several types of feeds were detected by direct observation, direct weighting and questioning. Adlibitum amount of layer starter feed and water supplies from the 2nd day of age of peachicks up to nine month of age.

Commercial pellet form layer, layer grower and crumble form layer starter feed poultry feed was supplied mature Indan peafowl in BNZ. A standard chemical composition of layer chicken feed which contains several nutrition levels in per kg was considered in result and discussion which added in appendix part of the thesis. Ecological setting for feed and feeding were observed properly by direct keen observation of several times. Without this collecting information by using questionnaire about adult and young peafowl habituation with the feeds also helped to detect feeds and feeding ecology of Indian Peafowl.

2.3 Habitat

The habit of the Indian peafowl was considered the total landscape of Bangladesh National Zoo. However, the zoo administration seated the houses for the peafowl, which was a large size aviary and one big house of 12 separated rooms. Therefore, the measurement of two houses/habitats of the peafowl was measured by measuring tape also by direct questioning and observation. Roosting matrials were detected by direct observation into the habitats. Without this resting and egg laying sites were also observed into the habitats. Others important things into habitats also observed properly for findings all informations about habitats. The internal setup of aviary and houses also observed for looking roosting, resting and egg laying sites.

Figure 2.3: Measuring of Indian Peafowl house in Bangladesh National Zoo

Figure 2.4: Aviary and the internal setup in aviary in Bangladesh National Zoo.

Figure 2.5: House and the internal setup of single room of the Peafowl habitat in BNZ.

Without this the space required for per adul peafowl were detectecd by using below formula.

$$\text{Required space per peafowl} = \frac{\text{Total space in the house}}{\text{Total number of peafowl in the house}}$$

On the other hand roosting materials were observed for detection roosting sites, roosting materials as well as availability of roosting material in any house or in aviary. Extra sheds in the aviary and basket for natural brooding nest were also detected by direct observation and questionnaire feed back. Although related more others information were collected by using well formed questionnaire added in appendix part of the thesis.

2.4 Data collection and analysis

A 15 days interval was done for data collection, supervision and observation of management for clear conception. On the other hand one person was engaged in Bangladesh National Zoo to collect data continuously. The data generated from this experiment were entered in Microsoft Excel worksheet, organized and processed for further analysis. Most of the results were presented in tabular form. In some cases, the uni-variate analysis has been done for separate single variable. The collected data were analyzed by using the, Microsoft Excel and STATA 13.

3. Results and Discussion

3.1 Feeds, feeding ecology of Indian peafowl in Bangladesh National Zoo

Feed is very important factor for all living being. Feeding materials and its set up is also very important things. Therefore, Indian peafowl feeds and its ecology should be known properly before rearing. Without this, the houses or areas for living of Indian peafowl should be considered properly.

3.2 Feeds of adult Indian peafowl

During the current study, feedstuffs, amount of feeds and the form of feeds for adult Indian peafowl's in captivity were assessed. The amount of several feeds supplied for adult Indian Peafowl were layer layer feed (120 gm), spinach/cabbage (80 gm), fruits (50 gm), eggs (15 gm) and peanuts (10 gm) in BNZ found throughout the period of study (Table 3.1).

Table 3.1: Types of feed ingredient with amount for adult Indian Peafowl in BNZ

SL No.	Feed Ingredients	Form of feed	Amount
1	Layer layer feed	Pellet	120 gm
2	Spinach/Cabbage	Chopped	80 gm
3	Fruits	Pieces	50 gm
4	Egg	Pieces	15 gm
5	Peanut	Inner seeds	10 gm
6	Water	Clean	*Ad libitum*

Mango and water melon were supplied seasonally but most of the time papya was supplied. Pellet form of layer feed, chopped spinach and pieces fruits and boiled eggs were generally supplied in BNZ (Table 3.1). Without this the inner seeds of peanuts were supplied to the adult Indian peafowl. Bulk part of feeds comprises with layer layer feeds, spinach and fruits which was 250 gm daily on the other hand 25 gm of supporting feed eggs and peanuts were given to the per Indian peafowl. Adlibitum clean water was also given every day for Indian Peafowl in BNZ in current study (Table 3.1). Gourd spinach was more common and sometimes mixed of two spinach were also supplied to the adult peafowl where as cabbage was supplied only in the season. The boiled eggs were broken and supplied to peafowl in pieces form. Without this one egg was supplied for three adult peafowls.

Animal body has to perform different mechanical activities for which they need energy derived from food (Machovsky *et al.,* 2016; Okoro *et al.,* 2016). To maintain the body structure and to support the growth, nutrients are required which are also provided by food (Elliott *et al.,* 2014). Invertebrates mostly of insects are good source of protein while plants are enriched in calcium level that is essential for egg production (Moorthi *et al.,* 2014; Charlton *et al.,* 2015; Nowak *et al.,* 2016). In the current study we also found that several types of feeds ingredients were supplied to their peafowl integrated with same objectives.

Layer poultry feed was supplied for the reason of intake of balance diet on the other hand fruit was supplied due to fruits contains many vitamins and minerals that are good for health. Without this spinach is the rich source of minerals, vitamins, pigments, and phytonutrients that help to protects several diseases generally skin care and increase capacity of digestive system. As we know, the egg is a super food and that food loaded with nutrients, some of which are rare in the modern diet. All the nutrients required to turn a single cell into a baby chicken that a whole egg contains. Eggs also contain decent amounts of fat, protein, vitamin A, vitamin B, vitamin D, vitamin E, vitamin K, phosphorus, selenium, calcium and zinc, which supply energy and prevent from vitamin-mineral deficiency. Peanuts are an excellent plant-based source of fat, protein and are high in various vitamins, minerals and plant compounds. The peanuts also can be useful as a part of a weight loss diet, work as antioxidant, anti allergic and may reduce the risk of both heart disease and gallstones. Peanuts are a high-calorie food and should not be eaten in excess due to high in fat. In the present study, Indian Peafowl were observed to feed on 120 gm layer layer poultry feed, 80 gm spinach, 50 gm fruits, 15 gm egg and 10 gm peanuts. But before study showed that a variety of food is required in captivity for birds as recommended by Central Zoo Authority India for South Asia region (Raja, 2007) i.e. 30 gm feed breeder, 30 gm onions and garlic, 100 gm spinach and 60 gm oil seeds to be fed to peafowls per bird in captivity. 125 gm Poultry feed breeder, 20 gm onions and garlic, 60 gm Spinach, 30 gm Oil seeds to be fed to Pheasants and 250 gm Poultry feed, 100-50 gm Roasted grams, 100 gm Spinach and Chapatti to be fed to Turkey (Sikandar *et al*., 2015). Diet provided at Lahore zoo for Indian Peafowl per bird in captivity was found 300-400 gm Poultry feed, 100-200 gm of Parched grams on the other hand the diet provided for Pheasants and Turkey were found 125-350 gm Poultry feed, 50-150 gm of Parched grams, 50-150 gm of Bajra, 200 gm fruits and 200-300 gm of Poultry feed, 100-200 gm of Parched gram (Sikandar *et al*., 2015). A weighed quantity of breeder ration 200 gm/bird was offered to Indian peafowl in captivity for breeding performance study (Abrar *et. al.,* 2017a). Weighed quantity of breeder ration @200 gm/peafowl was offered to each replicate as per ration schedule of Punjab Wildlife Department (Mushtaq-ul-Hassan, *et. al.,* 2012).

According to previous reports at site, the peafowls were preferred to poultry feed but in present research, the diet preference was in order of maize >millet >poultryfeed (Parveen *et. al.,* 2018). Chakravarthy and Thyagaraj, (2005) reported that although peafowls are an omnivore and adaptable feeder, they are mainly granivorous because in the agronomic ecosystem they mostly feed on paddy. The results obtained in the present study also indicate the preference of peafowls towards grains rather than other items such as meat and fish.

The variation in feedstuffs and amount of feeds in present study from the earlier studies is may be due to objectives of rearing peafowl, availability of feedstuffs as well as personal design for good diet. Without this BNZ, authority tried their best to supply the highest level of diet for the Indian peafowl to get the best performances from them. This adaptation of feeds items and amounts feeds was easy for the BNZ authority due to the Indian peafowl fed as omnivores. The omnivorous peafowl can eat any plant matter they can find as well as bugs, amphibians, and anything else alive that is small enough to fit in their beaks in the wild condition.

However, in captive condition, food should be provided fresh and any that smells off or is moldy should be thrown away to prevent occurrences of Coccidiosis (www.backyardchickens.com, 2018). Peafowl is generally believed to be omnivorous, large sized bird and it can eat everything from grain and green crops to insects, small reptiles and small mammals (Johansingh and Murali, 1981; Ali and Ripley, 1987; Sathyanarayana, 2005). Peafowl are generally believed to be virtually omnivorous (Baker, 1928; Ali and Ripley, 1974), eating everything from grain and green crops, plant parts, flower petals, seed heads, insects, small reptiles, mammals, and even small snakes. Berries, drupes and wild figs are apparently favoured foods where they are available. Johnsingh and Murali, (1981) found the birds feeding in cultivated fields and on an adjoining acacia plantation as well as in uncultivated lands and noted that three birds that were examined had primarily eaten plant materials such as leaves, grass seeds, flower parts, croton fruit, acacia seeds and rice. Invertebrates included various insects such as termites, grasshoppers, ants, beetles, scorpions and other arthropods. They also feed on reptiles, and amphibians. Foraging is usually done in small groups, which are primarily harem groups during the breeding season and are segregated parties of adult males and females with young outside the breeding season. One of the past finding from faecal analysis technique showed that dietary components of Indian peafowl were covered by plant contents following by animal sources. Among the plants components grass seeds were predominant followed by dicotyledon and fruits with least portion of monocotyledons. Among animal components, ants, grasshopper, earthworms, spider and unidentified bones were present. Faecal analysis indicated the presence of some non-food items such as sand and gravel (Naseer *et al.*, 2018c). Peafowl are omnivores and their diet consists of plants and flower petals, seeds, ants, termites, ticks and locust. They will also eat small reptiles such as young cobra snakes, arthropods and amphibians (www.animalcorner.org, 2018). Occasionally, peafowls were found to feed on harvested crop in agriculture fields as it contained cereals (Chopra and Kumar, 2014). The results obtained in the present study also indicate the preference of peafowls towards grains rather than other items such as meat and fish as well as the peafowl also intake sand, self feather roots and visitor supplied feeds.

Current study also found that feed choose bsed on plant material as well as animal source material for propely manage the feed quality. Poultry feed was found as popular feedstuffs in captive rearing system in most of the past studies, but in case of Indian peafowl as pet bird maize, wheat, paddy, millet etc. were also supplied to their peafowl. On the other hand one of the past study result was found peafowl choose maize and millet compared to animal and fish based feeds. In the presnt study we also found that peafowl choose the visitors supplied feed like grams and maize etc. compared to regular supplied poultry feed.

Past study was also reported that although peafowls are an omnivore and adaptable feeder, they are mainly granivorous because in the agronomic ecosystem they mostly feed on paddy and other grains. The results obtained in the present study also indicate the preference of peafowls towards grains rather than other items such as animal and fish based feeds. Therefore, the most of past studied results was also supported by the current stdudy findings. By this way we also found that the peafowl rearer do not give the feeds to their peafowl based on choosement they supplied the feeds based on nutrient status of feed stuff as well as objectives of the rearing. Finally, it could be said that feedstuffs supplied to the peafowl was based on availability, nutritional status as well as cheap price feed in the captivity. Without this routine supply of the fresh feed to the Indian peafowl of BNZ which was supported by past study results. The feedstuffs supplied by the zoo authority were found based on abilibility and nutritious condition of feed for managing the breeding status of Indian peafowl in BNZ. Adlibitum feed did not supply to the adult peafowl because of they will get more weight and later will become unfit for breeding. But the adlibitum water was supplied to the peafowl all time for properly activated the body physiology. The form of feedstuffs supplied were also considered in the present study because the peafowl choose the chooped, pieces or pellet form of feeds compred to bulk part of feeds. For this reason pellet form of layer feed, chopped spinach and pieces fruits and boiled eggs were generally supplied to the Indian peafowl in BNZ. According to zoo rearer site the preferable food of peafowl was found poultry feed which supplied balanced nutrients to their peafowl. Ealier most of the studies detectedted the diets of Indian peafowl from the natural range feeds. On the other hand the current study estimated the ingredients, amounts and form feeds of breeding purpose Indian peafowl in BNZ. Thus the present finding may be useful for provisioning of food choice for captive rearing peafowl in zoo. These findings may be useful to design the nutrition chart for captive breeding peafowl to avoid leftover feed.

There was no impact on feed intake was found in rainy season (June- July) in last three years (Table 3.2).

Table 3.2: Seasonal effect on feed intake of Indian Peafowl in Bangladesh National Zoo

Date	Highest temperature(^{0}C)	Lowest temperature(^{0}C)	Highest Humidity (%)	Feed intake
24 April/2016	36	29	89	Average 10gm Poultry feed not intake
11 May/2016	37	28	89	Average 10gm Poultry feed not intake
22 May /2017	37	28	94	Average 08gm Poultry feed not intake
25 April/2018	36	22	74	Average 10gm Poultry feed not intake
27 May/2018	36	27	94	Average 12 gm Poultry feed not intake
26 January/2016	24	08	93	Average 10 gm fruit not intake
14 January/2017	23	07	93	Average 15 gm fruit not intake
09 January/2018	23	07	100	Average 20 gm fruit not intake
29 December/2018	23	07	94	Average 15 gm fruit not intake

However, in summer season (April-May) about 10 gm of layer layer poultry feed was not intake by peafowl. On the other hand in winter season (November-January) abut 15 gm of fruit was not intake by peafowl (Table 3.2). The low feed intake in summer season may be due to heat stress in the summer where decrease more dried feed intake like poultry pellet. However, in the winter season only for 4 day in three years took decrease amount of fruits, this may be the cause of cool stress.

Abrar *et al., (*2017b) reported that statistically maximum feed consumption rate (29.80%) was observed during 1st week of study when the mean ambient temperature was recorded as 35.2°C. As the ambient temperature was decreased up to 26°C during the study period and the age was increased, there was significant decline was noted in feed consumption rate that was the minimum feed consumption rate at 9th week of study was found only 6.62%. Another study also supported by the findings of (Reece and Lott, 1983) who performed an experiment to find the effect of temperature and age on body weight and feed efficiency of broiler chickens and found the growth rate was declined with the decline of temperature i.e the growth rate at 26.7 °C were 6% less at 35th days and 10% less at 55th days than at 15.6 °C.

Statistically less feed was consumed by sex ratio 1:3 and better feed conversion was shown by sex ratio 1:1 (Mushtaq-ul-Hassan *et al.*, 2012). Peafowl are able to adapt too much colder climates than their native range. However, in areas that are both damp and cold, peafowl do not fare as well (Brickle, 2002; Jackson, 2006). Pheasants are regarded as the most distinctive bird family, perhaps, due to their charismatic features and also their significant role in the high altitude ecosystem (Thaker, 1963).

The results of the present study are agree with above mentioned study where we found high temperature reduced the feed intake for few days only. However, the feed intake effect was found in both high and low temperature only for few days from the three years, which is not significant. Due to this adaptability of Indian peafowl is very high in any aspects like those that habitat and feeding this bird easily take feed in any type of weather conditions. As we know the peafowl is very hardy and adapted to most of the environmental condition for this reason the feed intake effect was not found significant variation in several seasons. The weather codition of Bangladesh as well as Dhaka city is not tamparate so the feed intake condition in several seasons did not vary significantly. The male-female sex ratio in any flock is also very important for consumption of feeds which was found from the past study, where 1:1; male: female sex ratio consumed more feeds and 1:3; male: female sex ratio consumed less amount feeds. The present study presented male: female sex raton in several flocks were 1:1, 1:2, 1:3, 2:3 and 2:5. There fore the differencence in sex ratio of male: female also cause for differences in feeds consumption in current study findings.

As we know the Indian peafowl fed as omnivores and their adaptability is very good in all types of environment due to this no significant effect was found in feed intakes in several seasons, but little bit cool and heat stress was found only for few days in winter and summer season, because of as a living beings physiology do not functions sames in every day. Witout this in starting time of season the peafowl take few days for adaptation which also hamper on feeds intake. Finally it can be said that weather of Dhaka city and Bangladesh National Zoo is enough standard for managing feed and feeding of Indian peafowl.

3.3 Feeds of young Indian peafowl

The peachicks were fully free from feed and water at day 1 of age (Table 3.3). Without this it (Table 3.3) showed that *adlibitum* amount of crumble form feeds were supplied to the peachicks from the 2nd days of age. Without this after the 3rd month layer starter pellet form start mixed with crumble as a manner of in 1st week 1/3 pellet, 2nd week 1/2 pellet, 3rd week 2/3 pellet and finally in 4th week totally supplied pellet form of layer starter. Spinach, fruits, eggs and peanuts were given as feed constituents from 2 weeks, 1.5 month, 2 weeks and 4 months respectively (Table 3.3). Glucose mix water was supplied from 2nd days and later from 4th days clean water was supplied. Vitamin-mineral mixed also was supplied from 5th days of age (Table 3.3).

Table 3.3: Feed ingredients and amount of feed for young Indian Peafowl in BNZ

SL No.	Feed ingredients	Form of feed	Starting time	Amount
1	Layer starter	Crumble or mash	From 2nd days	*Adlibitum*
2	Spinach	Chopped Spinach	After 2weeks	Little amount
3	Fruit	Pieces	After 1.5 months	Little amount
4	Egg	Pieces	After 2 weeks	Little amount
5	Peanut	Inner seeds	After 4 months	10 gm
6	Water	Clean	From 4th day	*Adlibitum*
7	Glucose water	Clean	2nd day	*Adlibitum*
8	Free from feed	-	1st day	-
9	Pellet form layer starter	Pellet	After 3 months	*Adlibitum*
10	Layer layer	Pellet	After 9 months	*Adlibitum*
11	Vitamin-Mineral premix	Powder form	After 5 days	Required amount

Adilbitum amount of layer feed was given after the 9 month of age (Table 3.3). The BNZ authority did not supply the layer grower feed to the young Indian peafowl because of they did not want to get a heavier peafowl later; they want a smart strong Indian peafowl for their breeding purposes. They supplied the several feeds to their Indian peafowl with little amount in starting stage due to adaptation with that feeds properly. To protect from the deficiency of nutrients level, the BNZ authority managed a good numbers of feed stuffs in the Indian peafowl diet in several stage of their life which also supported by the past studied results. Specific deficiencies in proteins and in certain nutrients resulted in retard growth, poor feathering and less resistant to drastic weather (Hanotte *et al.*, 1991a; Gupta *et al.*, 2005; Ramesh and McGowan 2009; Khulape *et al.*, 2014). Nutrition has played a dynamic role in the early development of the bird and supplementary diet is required for proper growth. Green feed stuff and grains are introduced in order to mimic natural feeding conditions. As Indian peafowl is omnivorous, so the protein content plays an important role in building different biological characteristics e.g. growth rate of the bird (Harihar and Fernandes, 2011). Without this eggs and peanuts supplied good amount of fat which helps in good feathering and fat storing, one of the past study also supported that improved growth of Indian peafowl offspring with elaborated trains is related to higher amount of fat reserves in peacocks with longer trains (Miller *et al.*, 1998; Parasharya and Mukherjee 1999; Nasser *et al.*, 2018c). Peacock chicks should get a high protein diet for their first 3 months of life. We should look for a Game Bird feed crumble of about 25 to 30% protein (www.aboutpeafowl.com, 2018). In another past study also presented, peachicks can be fed medicated game starter or medicated chick starter mixed with gamebird/turkey starter (28-30% protein). Make sure to get the starter with amprolium for the prevention of coccidiosis or others medicine, which are considered, medicated due to the medication, included for other problems. Starter should have 28% protein, which is higher than chickens. After they are a week or two old you can introduce soft greens like baby spinach and kale (www.backyardchickens.com, 2018). Present study also support this system peachicks need more protein diet, due to this layer starter supplied in early stage of life which contain more protein around 20%. In the present study we also found that in the early stage sevral types of feeds supply small amount in sveral stage of life for propely adapted with that feeds. Without this we found that spinach supply start at the age of 2nd week which also supported by the past study result. On the other hand gloucose, vitmin-mineral and sometime antibiotic mixed water also suppied to the Indian peafowl of BNZ for preventing diseases as well as proper growth which is also supported by the past study results. Therefore, proper feed supply to young peafowl is very important for growth, disease prevation and adaptation with feedstuffs. On the other hand poultry feed choosed by the zoo authority for rearing peachicks because of this is available in market and supplied balanced nutritients to their birds. Others feeds ingredients also selected based on availability, nutrition requirement as well as proper body functioning of peachicks. Finally, it can be concluded that the current study findings may be useful to design the nutrition chart for captive growing young peafowl and for better management for the magnificent creatures. To analyze species-specific and age-specific diet preference more research is needed, as published literature in this regard is not available.

3.4 Feeding ecology of Indian peafowl

The Indian Peafowl were habituated to the supplied feeds by the authority of BNZ, which were layer starter, layer layer, spinach, fruits, eggs and peanuts (Table 3.4). Feed and water was supplied in feeder and waterer on the other hand Peachicks fed on paper for first few days in brooder house (Table 3.4). Egg, spinach and naturally found insects fed from the floor of houses but the Peafowl could not take their feed from roosting side. Feed supply to the Indian peafowl of BNZ every day single time at 10-12 am (Table 3.4).

Table 3.4: Feeding ecology of Indian Peafowl in Bangladesh National Zoo

SL No.	Adaptation	Feeds and feeding system
1	Habituated with feed	Fed layer starter , layer layer, eggs, spinach, peanuts and fruits
2	Peachicks fed on paper	Fed crumble form of layer feed at first 3 days
2	Habituated with feeder	Feed
3	Habituated with waterer	Water
4	Habituated with floor feeding	Egg, spinach and insects
5	Habituated with roosting site	They can not take feed from roosting site
6	Feed supply time	10-12 am
7	Feed supply interval	Every days single time
8	Feed as omnivores	Some time take small sand pieces, self feathers roots and odd materials also
9	Visitor supplied feeds	Visitors give several types of feeds like Gram, Pupped rice, Pupped corn, several types of Chips, Cucumber etc.
10	Free from feed	No feed and water supply at day 1
11	Supplied feeds form	Crumble and pellet form of layer feed, chopped spinach, pieces fruits and broken boiled eggs

Indian peafowl was observed to feed like omnivores, which was taken the small pieces of sand, others odd materials and also self feathers roots (Table 3.4). They were also habituated with supplied feeds by the visitors; the feeds were gram, uffed rice, uffed corn, several types of chips, cucumber, etc. (Table 3.4). Crumble and pellet form of layer feed, chopped spinach, pieces fruits and broken boiled eggs were supplied to peafowl. No feed and water was supplied to the peachicks at dya 1 of age (Table 3.4). Habituated with anything for living being is an important factor for ecological set up with that environment. Without making a good ecological set up with feed and habitat or any other things in the environment no species can be survived properly. Therefore, the feeding environment of Indian peafowlin BNZ was ecologically sated up for a long time to survive and produce good performances. Earlier sever studied result was also found that peafowl adaption with several types of feeds which results are given below.

The Indian peafowl is virtually omnivorous, feeding on a range of insects, reptiles, worms, seeds, grains and fruits (Loyau *et al.,* 2005a; Takahashi and Hasegawa 2008; Harikrishnan *et al.*, 2010). Peafowl is omnivorous and feed on flesh and vegetative fare. But the gain is their staple and their diet includes fruits, seeds, plants, insects, fish, small reptiles and amphibians. Peafowl owners sometimes also cultivate seeds, greens, carrots and alfalfa for their birds. Make sure your peafowl have fresh water at all times (Valerie, 2017). They are omnivorous and feed on a variety of animal and plant material (Kushwaha and Kumar, 2016). Earlier also, Johansingh and Murali, (1981) has also recorded that peafowls feed on plant materials such as leaves, grass seeds and flower parts, cotton fruits, *Acacia* seeds, *Cyperus rhizomes*, standing cereal crops and various insects (termites, grasshoppers, ants and beetles) in cultivated fields, adjoining *Acacia* plantation and fallow lands. It has also been reported that due to omnivorous nature, blue peafowl, they eat snakes and keep these venomous animals away from human communities. Indian peafowl can both be advantageous and detrimental for the crops, on one hand, functions as a biocontrol by feeding on harmful pests and on other hand it turns out to be a pest on crops (Drisdelle, 2007). Peafowl is omnivorous, feeds on everything from grain and green crops to insects, small reptiles and small mammals (Johansingh and Murali, 1981; Sathyanarayana, 2005). They forage in agricultural fields, parks, and forest outskirts in pair or small clusters. Berries and drupes of plants are apparently favoured foods of peafowl (Dilger and Wallen, 1966; Ali and Ripley, 1987; Johansgard, 1986). Peafowl are omnivorous and feed on insects, seeds, fruits, small mammals and reptiles. They feed on small snakes and stay away from the larger ones Johnsingh, (1976). In the Gir forest of Gujarat, the food of peafowl largely consists of fallen berries of Zizyphus (*Zizyphus spinosa)* Trivedi and Johnsingh, (1995). Around cultivated areas, they also feed on wide range of crops tomato, groundnut, paddy, chilly and even bananas Johnsingh and Murali, (1981). Around human habitation, they feed upon different food scraps and even human excreta Ali and Ripley, (1980b). Sathyanarayana and Veeramani, (1993) investigated the activity patterns, food habits and use of roost trees by the Indian Peafowl in Scrub jungle and Dry deciduous Forests of Mudumalai Wildlife Sanctuary, Tamil Nadu. They found that the Peafowl roosted in eight tree species which includes species such as *Acacia sundra, Cordia obliqua, Bombax malabaricum* and *Zizphus jujuba.* According to the study of Chopra and Kumar, (2014) Indian peafowl feed on flowers, leaves, fruits and parts of flowers and leaves of several trees. They feed on insects and on remains of the snake bodies as well.

These findings mainly collected from the wild ranged Indian peafowl. Rajaraman *et al.,* (1998) have carried out a preliminary work on the food preferences of the Indian Peafowl at Suriyur, Mathur, Vemmani and Neerpalani villages that fall under the Viralimalai Panchayat Union, Tamil Nadu. The diet analyses revealed that the plant matter constituted the bulk of the diet of Indian peafowl and the animal matter was found only in low proportions. Among the plant matter, paddy formed the major proportion. Saravanan *et al.,* (1997) have also reported that paddy comprised the bulk of diet. In the village of Viralimalai, Tamil Nadu, (Sathyanarayana, 2004) surveyed and recorded major crop patterns viz., paddy, pearl millet, finger millet, maize, ground nut, sesame, sugarcane, tomato, brinjal, lady's finger, capsicum, onion and cotton. The faecal analyses from his study revealed that the peafowl's consumed paddy, finger millet, pearl millet and groundnut. They also feed on tomato, brinjal, lady's finger, capsicum, onion and cotton. All the food items were found only in minimal quantity except paddy. The peafowl's prefer to feed on paddy mostly.

In captivity the feed was supplied to the peafowl twice a day regularly and in a cage, it would probably go out more often with treats during the day. Basically they get: (dried cat food with 32% protein), turkey and game feed in crumbles forms, cracked corn or hen scratch, greens- unsprayed lawn clippings, weeds, sprouts, fruits and Veggies- strawberry bits, oranges, melons, tomatoes, treats- bread crumbs, bits of cheese, scrambled eggs, cottage cheese, crackers, worms etc. The cracked corn, game bird food and cat food are available at all times in a peacock 'smorgy' trough, located high enough that dogs can't get to it (Rowe, 2013). After leaving the roosting areas the birds move into forest clearings, cultivated fields, or other areas for foraging in the early morning hours. In the mid day they spent their timer under shady trees often very close to the water sources, where the birds drink and preen at length. Late in the afternoon, they forage a second time, and return for another drink at dusk before going to roost in the evening (Ali and Ripley, 1974). Peafowl should have access to be fed two handfuls of mixed grain and adlibitum fresh water every day. This grain can be purchased at most feed stores, and most game bird feed, like turkey, chicken, or pheasant feed, is also fine for half to two thirds of their diet. The peafowl's complete diet should consist of about 5-10% of peanuts or sunflower seeds, supplemented with green vegetables also such as cabbage or kale. Peafowl's can be fed bread or fruit as an occasional treat, but never give your peafowl bones, as they may choke. Another option for a higher protein diet would be to include some cat or plant-based dog food (Allie, 2017). Moreover from several past study results showed that a variety of feeds and amount of feeds is required in captivity for birds as recommended by Central Zoo Authority India for South Asia region (Raja, 2007) i.e. 30 gm feed breeder, 30 gm onions and garlic, 100 gm spinach, and 60 gm oil seeds to be fed to peafowls per bird in captivity. 125 gm Poultry feed breeder, 20 gm onions and garlic, 60 gm Spinach, 30 gm Oil seeds to be fed to Pheasants and 250 gm Poultry feed, 100-150 gm Roasted grams, 100 gm Spinach and Chapatti to be fed to Turkey (Sikandar *et al*., 2015). Diet provided at Lahore zoo for Indian Peafowl per bird in captivity was found 300-400 gm Poultry feed, 100-200 gm of Parched grams on the other hand the diet provided for Pheasants and Turkey were found 125-350 gm Poultry feed, 50-150 gm of Parched grams, 50-150 gm of Bajra, 200 gm fruits and 200-300 gm of Poultry feed, 100-200 gm of Parched gram (Sikandar *et al*., 2015). Peacocks can fly quite well, but they find the majority of their food on the ground. They eat some plant material, but this isn't the favorite food of the species. Most of the time, peacocks are interested in eating insects. A peacock requires a high percentage of protein in its diet to stay healthy, and it gets most of that from insects (Maria, 2018).

From the above discussion we can say that Indian peafowl can be supplied several types of feed because they are considered as omnivores. We also found that in the past studies poultry feeds were supplied to their peafowl as well as several types of seeds also supplied that also selected for the Indian peafowl of BNZ and adapted this feeds properly in the feeding system. Various types of feeds were supplied to their peafowl in several past studies bsed on the availability of feedstuffs, feed choose by the peafowl owner and objectives wise feedstuffs choosements. However, in all cases the feeds were adapted properly for peafowl which was also supported by the present study results. The feeds supplied for peafowl in the present sudy were also furits, vegetables, peanuts and cabbage which also supported by the past syudies findings. The seeds amount in peafowl regular feeds should maintain 5-10% which is also similar to present finding where regularly 10 gm of peanuts to the Indian peafowl of BNZ.

When visitor supplied some feeds to the peafowl, they take this very quickly and competitively as well as same behaviour expressed when any insect or worm found suddenly. This means the peafowl choose exceptional types of feeds compared with routine supplied feed that was found in the present study. The peafowl do not choose to take whole formed feed so they were supplied crumble and pellet form of poultry feed , pieces form of fruits and broken boiled egg for easy intake. There were found mango trees in aviary and guava trees also, and sometime the whole mango and guava were found in floor of aviary but the peafowl did not intake that whole form of feeds. Therefore, the form of feeds is very important to supply for the peafowl for easy intake as well as for safety. They were also taken the odds materials as well as self feathers root. That result also agree with past studies findings that's are major diet portion of Indian peafowl is sand and gravel generally known as non-food materials. Like other birds, Indian peafowl also swallow sand and gravel for improvement of their digestive system. Small pieces of the gravel and sand were seen in the faecal matter (Naseer *et al.*, 2018c). Previous studies showed that more than 32% of faecal contents were composed of non-food items (Trivedi and Johnsingh, 1995). The wild ranged and caged peafowl most of cases take feeds two to three times a days current study also support this, though feed spplied single time in a day but they intake that feeds several times in a day.

The amount of feeds is also very important for Indian peafowl; fewer amounts feeds deterior healt condition on the othe hand more amount of feeds make the peafowl fatty. Therefore, perfect amount of feeds supplied to Indian peafowl is very important to manage health condition for breeding purposes. More over past study presented that the peafowl choose insects compared to others feeds current stduy also support this finding when the peafowl find some insects in aviary they intake that swiftly. Feedstuffs selection, feeding time and feed supply should be maintained properly for peafowl. The feederer and waterer also can be used for peafowl feed supply for sacking of wastage. The supplied time in a day and feeding place can be sated by any one based on their own choice. Finally, it can be said that the feeding ecology setting is very easy for the peafowl as we know this bird is omnivores in nature. By this way you can easily choose the feedstuffs which are available, cheap and nutritious for the Indian peafowl.

3.5 Habitat of Indian peafowl

In our study we considered the habitat as aviary and house of Indian peafowl with the roosting site of that place in the BNZ. There was a big 12th room round shape house where each room size was length 26-27 feet X width 10.5 to 17 feet X height 9 to 11 feet. They have also one big aviary for the Indian Peafowl, which was 115 feet length X 100 feet width X 50 feet height. Both habitats comprise of sanded and cemented floor and most part of ceiling was made by the wire net (Table 3.5).

Table 3.5: Habitats of Indian Peafowl in Bangladesh National Zoo

<table>
<tr><th colspan="3">Indian Peafowl house</th><th colspan="3">Aviary for Indian Peafowl</th></tr>
<tr><td colspan="3">Main peafowl house is rounded and was parted with 12 sub-houses.</td><td colspan="3">Big house for more than 100 peafowl, which was naturalized with several types of trees.</td></tr>
<tr><td>Length</td><td>Width</td><td>Height</td><td>Length</td><td>Width</td><td>Height</td></tr>
<tr><td>26-27feet</td><td>Outer part 17 feet
Middle part 13 feet
Inner part 10.5 feet</td><td>9-11 feet</td><td>115 feet</td><td>100 feet</td><td>50 feet</td></tr>
<tr><td colspan="3">Floor has sanded part and cemented part</td><td colspan="3">Most of the part of floor is sanded and little part cemented</td></tr>
<tr><td colspan="3">Cemented part ceiling with roof</td><td colspan="3">Cemented part ceiling with roof</td></tr>
</table>

Some small fruits tree are available in some houses	There are so many types of trees in the aviary
There is a resting as well as egg laying area in the house	There is a small resting as well as egg laying area in the aviary.
The most of the part of fence and roof made by metal wire.	The most of the part of fence and roof made by metal wire.
There is a gutter beside the house	There is a gutter beside the house
Available roosting sight in all houses	There are available roosting sights in aviary with so many types of trees.
Few types of roosting materials are available.	So many types roosting materials are available.
There are no extra shed for shadow in the houses	There are several extra small sheds for shadow in the aviary
No extra basket supply for laying	Extra basket supply for laying
No shooting space is in the house	One semi circle shooting space in the aviary
Only Peafowl live in the houses	Peafowl and Pigeon lives in the aviary

The big room and the aviary for the Peafowl comprises with resting and egg laying areas. Few types of roosting material in the room of the big house but several types roosting materials sated in the aviary. In the aviary, they supply the extra basket for egg laying as well as natural brooding for Indian Peafowl. In the big habitat every room well sated for Indian peafowl living but the aviary was well sated for living of Indian peafowl and Pigeon (Table 3.5). Both of the habitats in BNZ for Indian peafowl were enclosed with big sandy areas. Also profer drainaze system is available beside both of houses. Space requirement for single Indian peafowl was enough in both habitats which was more than 100 squire feet (Table 3.5).

The habitats of the current study in BNZ for Indian peafowl was found with good set up with several roosting sites which was supported by the past studied several results considering also space availability and height of Indian peafowl houses.

A captive animal is the wild animal, which is held under confinement and is dependent on humans for provision of all its needs, whereas captive wildlife facility is includes a sanctuary, an orphanage or a rescue centre that provides shelter and care to animals that have been abused, injured or sick, abandoned or orphaned, illegally held or are otherwise in need. Such a facility may be private, public or community owned (Audigé *et al.*, 2001). Indian Peafowl is natural bird of India and thought to inhabit throughout India and other parts of the subcontinent (Hanotte *et al.*, 1991a). Indian peafowl inhabit areas near streams, open forest and grasslands in the outskirt of villages (Ramesh and McGowan, 2009). It is also found in agricultural fields and close to human settlements in a semi-feral condition (Johnsgard, 1986) and in home gardens where it can be a serious pest (Santiapillai and Wijeyamohan, 2015). Indian blue peafowl do not travel or migrate widely (Brickle, 2002; Jackson, 206). That's were the natural habitat of wild ranged Indian peafowl. On the other hand in captivity, the room or house or habitat of Peafowl should be at least 12 feet wide and 20 feet long, and 10 to 15 feet high, or even higher, with perches. Peafowl's usually stay within 2 or 3 acres in the wild, but mine have wandered up to a mile away to check out my neighbors. Males strutting around in the cage due to this the females need some room to get out of the way. The larger and taller the cage, it will do the better for your peacocks (Rowe, 2013). Peafowl require at least 25 square meters (or 80 square feet) per bird in their habitat. Available space in the house is important in order to prevent disease, as well as fighting among the birds. Pens should be at least 2.5 meters (7 feet 10 inches) in height so that peafowl can fly and fan their tails. If you keep a male peacock, the pen should be large enough for him to display his long tail feathers without injury (Allie, 2017). It has to ensure adequate housing and good environment for domestic peafowl farming. Usually for each bird required 100 square feet in the pen. This housing space should be adjusted according to the length of peacock's trains. Generally, peacock trains can be over 5 feet long for the reason their shed must have to be at least 8 feet tall. Ensure well ventilation system. Make the house suitable enough for preventing all types of predators, such as raccoon wild dogs or foxes (www.roysfarm.com, 2019). In captivity, peafowl are usually kept in pairs or one cock to two or three hens. The larger the pens the better, 12 feet by 60 feet is recommended, although they can be kept in smaller areas, 24 feet by 30 feet. The Indian peafowls can be kept with other avian species, but should be introduced at the same time and kept in a large enough 1ight to allow for individual territories, nesting sites and feeding areas (www.journals.tdl.org, 2019).

Some past study results about Indian peafowl habitat was stated that, they do not migrate or travel widely. They are most common in deciduous, open forest habitats. Areas that had sufficient water sources and were relatively distant from any human presence were also preferred if given the choice in case of wild condition. However, in the captivity, their basic requirements include a suitable roost tree, a small territory, and sufficient food. Peafowl are able to adapt too much colder climates than their native range. However, in areas that are both damp and cold, peafowl do not fare as well. They are often kept in urban gardens and zoos (Brickle, 2002; Jackson, 2006). The preferred habitats of this pennant species are scrub jungles and forest fringes, dry deciduous and semiarid regions, agricultural fields, along streams and near human settlements (Kushwaha and Kumar, 2016). The Indian peafowl inhabits South Asia in the wild state. As a domesticated bird it is found in almost all parts of the world (Johnsgard, 1999). Essentially, all Indian pheasants are terrestrial forest dwellers, though the Indian peafowl is known to thrive also in the non-forest areas and even in urban places. The Indian peafowl prefers scrub forest for its habitat and is distributed widely through the country; it is the only pheasant species that is able to adjust easily to human beings and is at home near habitations and even in urban areas. This is another factor that has facilitated its long and intimate association with the people in India (Kushwaha, and Kumar, 2016). In south Asia, it is found mainly below an altitude of 1800 m and in rare cases seen at about 2000 m Dodsworth, (1912).

Peafowl prefers to live in hot places. However they can live in frosty cold weather too. Peafowl prefers to live in open areas like parks and grassy land with few trees and shrubs. Some even live in people’s backyards Berman, (1996). Its hardiness, beauty and adaptability has made it an inhabitant of our gardens and barnyards Jackson, (2006). Provision of sufficient habitat for the peafowl is a key component of management programmes (Satyanarayana and Veeramani, 1993) yet information is extremely limited on characteristics of tree selected by this species for roosting in the preferred study areas in Kamataka. In its wild state in northern India, the favored habitats of this species consist of forests growing along hillside streams, in which the undergrowth consists of bar bushes (*Zizyphus*) and thorny creepers, the bushes growing some 10 or 12 feet apart, and spreading out to form table-shaped tops that meet one another to form a continuous mass, allowing the birds to move about easily underneath. Higher up in the hill country they are found in open oak forests, where tiny streams run between the hills and each stream-bank is well covered by bushes, brambles and reeds (Gadagkar, 2003).

The peafowl roost high in the trees Berman, (1996). Trivedi and Johnsingh, (1996) reported that the roost of Indian Blue Peafowl gives us lot of management strategies to safe guard the trees in the relevant habitats. But information on the roost selection is a vital component in the overall habitat selection process. However, very limited information is available on the roost study of Indian Blue Peafowl. Ali and Ripley, (1983) have reported that large birds need tall trees and small birds need small trees for roosting. Roosting site selection plays a pivotal role in the nesting success of any species.Roost selection by bird species is of great importance in planning for its conservation and management. In birds the roost selection is a vital component in the overall habitat selection process (Trivedi and Johnsingh, 1996). Two most significant functions of communal roosting in bird species are the communication of information about the location of food sources and avoidance of predation (Gadgil and Ali, 1975). According to the observations of Chopra and Kumar, (2012) peafowl roost in their habitats during their inactive period (*i.e*., noon and in late evening hours) on dominant tree species. The roost comprises of adult males, females, sub-adults. The height of roost tree, roost height, canopy cover and habitat plays a vital role in choosing the roost trees by Peafowl (Gadgil and Ali, 1975).

According to Bergmann, (1980) and Johansgaurd, (1986) blue peafowl (*Pavo cristatus)* has been observed on the tall trees for roosting and nesting under dense bushes with open areas having feeding grounds. Johnsingh and Murali, (1981) found five banyan trees *(Ficus bengalensis)* served as the roosting site for about 100 birds. Roosting of the peafowls is very closely related with the sunset but temperature has no relation with roosting (Navatheekannan, 1981). During the night, peacocks do not typically stay on the ground. Instead, they fly up into the trees in the forest and roost there (Maria, 2018). Peafowl are mainly ground-dwelling birds preferring forests and farmland. They can also be found in bushlands and rainforests all the year round. But there were so many will nest on the ground while some will roost in trees (www.animalcorner.org, 2018).

Joshua and Johnsingh (1988) reported that roost selection is a vital component in the overall habitat selection process. Information on roost selection by a bird species is of great importance in plarming for its conservation. Navaneethakannan (1981) also suggested that it would be interesting to study the peafowl distribution related to the availability of suitable roosting trees. She further stated that the researcher must to know why the peafowl choose the trees they do i.e. is it coimected with height or lack of lower branches or restricted to certain species of trees. Roost site selection of pheasants directly reflects the suitability and preference of that particular habitat and selection is regulated by many factors. The roost site selection is regulated by many factors. The roost site selection has often been a focus of research on many birds (Zahavi, 1975). A perusal literature shows that no detailed information is available about roost selection by a species as it carries immense importance for assessing its conservation needs (Joshua and Johnsingh, 1988). The limiting factors controlling peafowl populations could be appropriate vegetative cover for roosting and nesting (Sharma, 1974). Therefore, it is pertinent to study whether the height of the tree is connected with the roosting tree preference by peafowl.

Enclosures must be designed to meet the full biological requirements of the animals they contain. In particular, the following are required; space for free movement and exercise; no undue domination by individuals within herds or groups; no unnatural provocation for public benefit; no stress caused by visibility of others in adjoining enclosures; to endeavour to simulate conditions of natural habitat; trees for shade and shelters to be constructed to merge with the environment. They must have resting and exercising facilities tailored to meet the biological needs of the species. They must also have proper ventilation and lighting. Animals must be kept in viable social groups. Facilities may not acquire a single animal of any species with an exception related to specific breeding issues (Bais *et al.,* 2017).

From the above studied result we found that the space requirement for a single Indian peafowl in house was minimum 80-100 squaire feet and height of the houses was found from 7 feet to 15 feet on the other hand our study was found that the space given to per peafowl was more than 100 square feet and height started with 9 feet to 50 feet. Without this in the present study, we found that the Indian peafowl houses of BNZ also were sated with several types of roosting and resting as well as egg laying sites. The aviary of the present study was sated up with several types of trees and small sheds for roosting and resting as well as also supply extra basket for egg laying and natural brooding. On the oter hand from the past study we found tha peafowl choose the forest or cultivated land areas were water is available. Peafowl can live in too cooler as well as dump areas so it means that the habitat better that this condition is good enough. The both habitats of the present study located in good area with good environmental condition, whrer available spce for live and well arrangement with resting, roosting and feeding space. Without these both of the habitat in BNZ for Indian peafowl well arranged with enough space for exercising and breeding group formation. The big sandy areas in both habitats also support for dust bathing and pit formation for resting. The big trees and several small sheds in aviary also support peafowl for roosting and resting into shadow. The basket supplied into the aviary for egg laying and natural brooding. Without this both habitats has the well drainage system for proper sanitation. The opening of the drain also protected by hardwires for protecting predators. The fancing wire also well fitted for protecting and entering predators in to the habitas. Detailed information on the habitat relations of peafowl is essential for any biologist to design effective management strategies. From the above discussion, it could be said that the habitat of Indian peafowl in BNZ is very good and smart enough for living.

The current study evaluated that the feedstuffs and feeding ecology as well as habitat or houses of Indian peafowl in BNZ that were found very smart and standard. Therefore, this feeding and habita system can be implemented in others zoological gardens, safari-parks and by peafowl owners.

4. Conclusion

Feed and habitat is very important for all livinf beings. The feed supplied to the peafowl in BNZ based on age and availability feedstuffs considere for proper rearing. Bulk part of supplied feeds for adult peafowl's comprises with layer layer feeds, spinach and fruits which was 250 gm daily on the other hand 25 gm of supporting feed eggs and peanuts were given to the per Indian peafowl. The sevreal form of feeds is also cosidarable for properly feed intake. Without this supply of adlibitum water for Indian Peafowl in Bangladesh National Zoo are available. The low feed intake in summer season may be due to heat stress in the summer where decrease more dried feed intake like poultry pellet. However, in the winter season only for 4 day in three years took decrease amount of fruits, this may be the cause of cool stress. The feed intake effect was found in both high and low temperature only for few days from the three years that was not significant. The peachicks were fully free from feed and water at day 1 of age and adlibitum amount of crumble form feeds were supplied to the Peachicks from the 2nd days of age. Spinach, fruits, eggs and peanuts were giving as feed constituents from 2 weeks, 1.5 month, 2 weeks and 4 months respectively. Glucose mix water was supplied from 2nd days and later from 4th days, clean water was supplied. Vitamin-mineral mixed also was supplied from 5th days of age. Adilbitum amount of Layer layer feed was given after the 9 month of age. The Indian Peafowl were habituated to the supplied feeds by the authority of BNZ, which were layer starter, layer layer, spinach, fruits, eggs and peanuts. Feed and water was supplied in feeder and waterer on the other hand Peachicks fed on paper for first few days in brooder house. Indian Peafowl some time fed like as omnivores and habituated with supplied feeds by the visitors also. Habituated with anything by living being is an important factor for ecological set up with that thing. Without making a goof ecological set up with feed and habitat or any other things in the environment no species can be survived properly. The feeds and feeding system was also smart enough for Indian Peafowl in Bangladesh National Zoo.

As we know peafowl do not migrate or travel widely so we can easily enclose them in a house in captive rearing system at zoo. the There was a big 12th room round shape house where each room size was length 26-27 feet X width 10.5 to 17 feet X height 9 to 11 feet. They have also one big aviary for the Indian Peafowl, which was 115 feet length X 100 feet width X 50 feet height. Both habitats comprise of sanded and cemented floor and the wire net made most part of ceiling. The big room and the aviary for the Peafowl comprises with resting and egg laying areas. Roosting space and instruments also were available in both peafowl habitat. Without this a good drainaze system was available beside both habitats. Space requirement for single Indian peafowl was enough in both habitats, which was more than 100 squire feet. Housing system of Indian peafowl in BNZ is standard enough for peafowl living. Hence the peafowls were usually being fed the items which were available more readily and were economic. It is recommended to provide feed to birds in less quantity to prevent the wastage of feed and manage good body condition for breeding purpose. Finally, it can be concluded that the feed, fedding ecology and habitat of Indian peafowl in BNZ was found smart enough for peafowl rearing. The findings of this study will be useful in improving the feeding and habitat management of the Indian peafowl in captivity, particularly in zoos, safari parks and farms. As we found adaptability of Indian peafowl in captive environment of zoo was very good. Without this the current study results may be useful in order to increase the information's regarding peafowl feeds, feeding ecology and habitat in Bangladesh.

Livability of Indian Peafowl up to Fledgling Age

Abstract

Livability is the potentiality of an individual to survive up to its normal life, which affects the productive and reproductive performance of poultry and other birds. The fledgling age considered in the present study was 3 months or 90 days, because by this time they grow full feathers. Therefore, this research was conducted with the aim to explore the livability and mortality up to fledgling age of Indian peafowl under captive condition in Bangladesh National Zoo (BNZ). The study was done from April 2015 to December 2018 in BNZ by direct interacting, observing, using structured questionnaire and finally taking records on the data sheets. During the study period we observed a very high livability of peachicks for all the year round. The overall livability was found 95.82% (*n*=263) up to fledgling age. Livability (97.5%; *n*=40) was the highest in 2018, whereas it was the lowest (93.75; *n*=16) in 2016. On the other hand, the mortality was found low in all the listed years; the average was found 4.18% (*n*=263) up to fledgling age. The mortality was the lowest (2.50%; *n*=40) in 2018, and the highest (6.25%; *n*=16) in 2016. The major infectious diseases that affected the peachicks were colibacillosis (46%; *n*=5) and salmonellosis (27%; *n*=3); other noninfectious accidental injury (27%; *n*=3) follows the most considerable death. In the early stage of life (1-15 days), the mortality rate was remarkably high (82%; *n*=9) than (18%; *n*=2) in the later stage of life (16-90 days). Considering the livability of the species in captivity, it is possible to acclimatize them in the semi-wild habitat and eventually release them in the wild in order to re-establish the wild population in Bangladesh.

1. Introduction

Livability means the percentage of live birds for a specified period, which affects the productive and reproductive performance of poultry and other birds (Singh and Kumar, 1994). Livability of chicks is a final measure of a bird's reproductive performance (Anisuzzaman, 1988). The peachicks can be moved to normal pens around 3 months of age in warm weather. By this time, they will have full feathers (except for their heads) and be better able to cope with any medical problems that may arise. Therefore, they need a heat lamp on them during winter, depending on where they live (Kedreeva, 2015). Peahens grant the peacocks with the most eyespots so her chicks might follow in the footsteps of the male's superior immune position and have a greater probability of survival (Ismail *et al.,* 2010). It is generally well known that chicks from certain mating are known to live well, while from different mating, have high mortality. It is a good practice to use only breeders whose progeny live well. The traits livability, fertility and hatchability are of paramount importance to poultry breeders, because they incur loss in breeding operations. Poor fertility, low hatchability and less livability significantly affect net returns (Azizul *et al*., 1980). Therefore, higher fertility of hatching eggs, higher hatchability of fertile eggs and lower mortality of birds should be of direct interest to the poultry and birds' breeders as well as the hatchery operations (Banerjee, 1993). Poultry breeders must look into these three traits of significance to overcome the problems of infertility, poor hatchability and low livability (Ahmed *et al*., 1982). Viability (also called livability) is the potentiality of an individual to survive up to its normal life. In chicken, life begins just after fertilization and continues until death (Khan *et al*., 2007). Survival percentage of peachicks might be varied from 35% in 2009 to 87% in 2010, 96% in 2011 and 95% in 2012, with an overall survival percentage of 81% (Tariq *et al.,* 2018).

Ornamentation in feather patterns is characteristic of Indian peafowl, high quality ornament signals at high levels of resistance and immunity. The expression of ornaments may be an indication of the ability of the bearer to its defense against disease causing pathogens (Somes and Burger, 1993; Stewart *et al.,* 1996; Takahashi and Hasegawa, 2008). Crossbreeding generally improves progeny and adult livability (Stanphone, 1961), but sometimes two comparatively low breeds may produce considerably higher livability. This is because of bringing together the favorable dominant genes in the crossbreed progeny from each of the pure breed parents (Aini, 1990). It has already been established that certain genetic groups differ from others with respects to their ability to withstand unfavorable conditions. Females are more viable than males (Bagust, 1999). It is also known that within sire's progeny, the pullets with relatively low egg production are more likely to die during the first laying year than with higher those with higher record (Tsarenko *et al*., 1986). It is possible to increase livability by breeding. A well-planned selection and breeding program offers the best hope for livability of birds (Yeasmin *et al*., 1992). Crossbreeding also reduces progeny mortality (Ghostaly *et al*., 1951; Knox, 1939). Once the fertile eggs hatch, place the peafowl chicks under a standard brooder lamp at 95 degrees F. Decrease the temperature of the brooder by five degrees each week until it is down to room temperature (Mountain, 2014). Temperature, light, diet, management and disease affect on livability (Wu *et al*., 1983; Reddy *et al*., 1965).

Peafowls are able to adapt too much colder climates than their native range. However, in areas that are both damp and cold, peafowl do not fare as well (Brickle, 2002; Jackson, 2006). Pheasants are regarded as the most distinctive bird family, perhaps, due to their charismatic features and also their significant role in the high altitude ecosystem (Thaker, 1963). Peahens grant the peacocks by the whole of the practically eyespots for her chicks will hopefully follow in the footsteps of the male's superior immune position and have a greater expose at survival (Ismail *et al.*, 2010). Chicks inherit strong immune system if peahens choose peacock with most number of ocelli (Kumar *et al.,* 2013; Saini *et al.,* 2007; Naseer *et al.,* 2018b). It is believed that peahens try to select a male with the brightest plumage possible because it is a sign of good health, which is a sign of good genetics. It stands to reason that if a female chooses a strong, healthy mate; her chicks will have a genetic advantage and be more likely to survive to adulthood (Maria, 2018). Food quality is an important factor for the growth of the immune system during the first weeks of post hatching period. Therefore, the good quality food is necessary for the growth of the immune system during the first week of post hatching period, because there is a need for proliferation of white blood cells (WBC) and seeding of lymphoid structures during this period. During this period, any deficiency (or an excess) of nutrients may abruptly affect the resistance of an individual in the later life (Yasmin, 1997).

Losses from diseases or any other causes in poultry stock or birds are of paramount importance. It has been established that certain breeds, varieties and strains differ from others with respect to their ability to withstand unsuitable environmental condition (Ketelaere *et al*., 2002). Common diseases were found to be salmonellosis, mycopplamosis, Newcastle disease, gumboro, coccidiosis, colibacillosis, gangrenous dermatitis, ascitis and omphalytis at the time of chicks rearing period (Saleque, 2003). In the wild, the common predators for the chicks are crows, fox, wildcat, mongoose, kite, rat, domestic cat, etc. (Saleque *et al*., 1996). The mortality rate was found to be more in case of Sonali than the Fayoumi, because the later is scattered reared in the scavenging system in Bangladesh for a long time (Fattah, 1999). The crossbred chicks (Sonali) suffered from various diseases such as pullorum, salmonellosis, gumbroo, ranikhat and coccidiosis from 2nd weeks of age. They were very much susceptible to diseases and their growth might be retarded (Frossido, 1986; Fattah *et al.,* 1999). Performances of different breed combinations under semi-scavenging conditions for mortality. In semi-scavenging condition, the mortality of Sonali and Deshi was 50% and 29% respectively (Amin *et al*., 1992). Without interventions, the mortality rate of poultry was reported to be 35-85% due to diseases and predators (Scott *et al*., 1976). One of the past studies about Indian peafowl mortality and diseases described that, most of the dead birds (46%) were found late and 7% deaths were not reported so in total 53% deaths were not investigated. Rest of the birds died of different diseases like NDV caused (25%), enteritis (11%), hemorrhagic enteritis (3%), hepatitis + NDV (2%), traumatic gizzard (2%), and one percent by each of enteritis + nephritis, coryza, liver intoxication and hepatic discolouration (Tariq *et al.*, 2018). Overall values of morbidity, mortality and case fatality were 45.2%, 27.1% and 60.0%, respectively due to avian pox. The chicks of 9 to 12 weeks of age showed a significantly ($P<0.001$) higher prevalence rate than other age groups. The morbidity and mortality due to avian pox in peafowl chicks was significantly ($P<0.001$) reduced when kept in mosquito-proof cages and hatched under broody chicken hens. Morbidity due to poxvirus infection on the peafowl farm was 82%, 26% and 12% in successive years. It was concluded that avian pox rendered high morbidity, mortality and case fatality in peafowl chicks (Khan *et al.*, 2009). Global biodiversity of birds has declined markedly over the past 40 years (Hanotte *et al.*, 1991b). The population of vertebrates in tropical regions specially in southeast Asia are considered to be decreased tremendously which may result in extinction of many species till next 50 years (Freeman and Hare, 2015). Very few studies have suggested the actual cause of decline in population of vertebrates; still a lot of work has to be performed to quantify the causes of declining the population of vertebrates (Harihar and Fernandes, 2011). Illegal trade for train-feathers and mass mortality due to indiscriminate application of pesticides and herbicides in crop-fields are major causes of the recent decline in peafowl numbers (Ramesh and McGowan, 2009)**.** Considering the need for conservation initiatives for peafowl, one must look beyond the ‘fire-fighting approach’ towards ‘keeping the common species common' in order to be efficient with conservation investments and instill greater public participation (Ramesh and McGowan, 2009). Many captive breeding programs for rehabilitation of endangered species are launched and coordinated internationally through different organizations such as Species Survival Commission (SSC) and International Union for the Conservation of Nature (IUCN). Many conservation programs now use captive breeding to support endangered and threatened species (ICBP, 1979). Presently, it is estimated that thousands of species will require captive breeding to prevent their extinction over the next 200 years (Allendorf and Luikart, 2007).

Peafowls raised in inadequate conditions, on poor quality feed and exposed to natural pathogens most frequently became victims of nutritional, viral, bacterial and parasitic diseases (Khan *et al.,* 2009). Avobe fidings most information about livability and mortality were found from the chicken species. Only few findings on mortality and cause of mortality of Indian peafowl were found from past studies. But no information about livability of peachicks was found from earlier results. Therefore, the current study selected the objective livability up to fledgling age for ex-situ conservation of Indian peafowl in BNZ.

2. Material and Methods

2.1 Study site and period

The experiment on Indian peafowl was conducted for a period of 3 years and 9 months. The Indian peafowl's were selected for this research work because the bird is already extinct from our wild areas and at the initiation time of this work a large number (214) of Indian peafowl in BNZ was available with a well-planned breeding strategy, so this bird has the potential for reintroduction and *in-situ* conservation. The research work was done in Bangladesh National Zoo, which is located in the capital of Bangladesh and situated middle part of Bangladesh. The experimental period was between April, 2015 and December, 2018. Before starting the experiment staffs participated in training about the experiment; via taking data properly on livability and mortality as well as other related parameters about Indian peafowl. Thus, the research work was done on livability up to fledgling age for ex-situ conservation of Indian peafowl in Banglades National Zoo.

2.1 Livability and mortality

Livability up to fledgling age was considered for this study because at the early stage mortality rate is high. Here fledgling age (3 month of age) was considered as at that age peafowl become in full finished plumage. The information about livability were collected mainly by observation, then by using questionnaire and finally from record book data. Properly brooding of Peachicks help to find more live birds and protect mortality of baby Peachicks.

Figure 2.1: Peachicks in brooding house in Bangladesh National Zoo

Mortality data were also collected by same ways. Information regarding the probable cause of mortality was collected by direct observation and using well formed questionnaire. The mortality data were collected from day 1 to 15 days old and then again on 16-90 days old and were calculated by below stated formula. The diseases and abnormalities were diagnosed by clinical sing and symptoms and some time by postmortem as required. For confirmatory diagnosis, some samples were also sent to diagnostic laboratory.

2.2 Mathematical calculation and analysis

The livability of peachicks from day-old to up to 3 months age was calculated by using the following formula:

$$\text{Livability} = \frac{\text{No. of live peachicks up to specified time}}{\text{Total peachicks}} \times 100$$

The mortality of peachicks was determined by using the following formula:

$$\text{Mortality} = \frac{\text{No. of dead peachicks up to specified time}}{\text{No. of total peachicks}} \times 100$$

The data about livability and mortality of peachicks for 2014 was collected from record book aw well as by direct questioning.

2.3 Data collection and analysis

Data collection, supervision and observation of management was performed in a 15 days interval for clear conception. On the other hand, one technical person was engaged in BNZ to collect data continuously. The data generated from this experiment were entered in Microsoft Excel worksheet, organized and processed for further analysis. Livability and Mortality was calculated as percentage and was presented with pie chart. The collected data were analyzed by using Microsoft Excel and STATA 13.

3. Results and Discussion

3.1 Livability of peachicks

Table 3.1 showed that the livability of Indian peachick was very high for all reported years up to fledgling age. The overall livability was found 95.82% (n=263) up to fledgling age for Indian peafowl at BNZ.

Table 3.1: Livability of Indian Peafowl in Bangladesh National Zoo up to fledgling age

Year	Hatched out peachicks	Dead peachicks	Live peachicks	Livability (%)
2014	43	2	41	95.35
2015	110	5	105	95.45
2016	16	1	15	93.75
2017	54	2	52	96.30
2018	40	1	39	97.5
Total	**263**	**11**	**252**	**95.82**

Livability (97.5%; n=40) was highest in 2018 where as the lowest (93.75%; n=16) was in 2016 (Table 3.1). On the othe hand livability were detected 95.35% (n=43) in year 2014, 95.45% (n=110) in year 2015 and 96.30% (n=54) in year 2017, respectively. More than 90% livability was found in all the years in the present study. The range of livability between 2014 and 2018 was found 93.75% to 97.5% in the present study (Table 3.1).

Habit destruction and other factors pose a severe threat to the survival of the Indian peafowl mainly in wild condition (Naseer *et al.*, 2018a). Judicious selection of the roosting site enhances the survival of birds, by virtue of reduced heat loss, information sharing, accountability of population and better production from predators (Gadgil 1972; Tast and

Rassi, 1973; Gadgil and Ali, 1975; Gyllin *et al.*, 1977). According to Baker and Inglis, (1930) peafowls preferably roost on high, open trees so that they could get vision from all directions; and they generally select the tallest trees for roosting in forests in order to protect themselves from the tree-climbing, night predators such as the leopard and other cats. Roosting site may enhance the survival of birds, by virtue of reduced heat loss, information sharing and better protection from predators (Gadgil and Ali, 1975).

In captivity, the survival percentage of Indian peafowl was varied from 35% in 2009, 87% in 2010, 96% in 2011 and 95% in 2012, with an overall survival percentage of 81% (Tariq *et al.*, 2018). Present study also found high livability based on several years; percentage varied from 95.35% in 2014 to 95.45% in 2015, 93.75% in 2016, 96.30% in 2017 and 95.82% in 2018, with an overall livable percentage of 95.82%, wich supported by the past findings, but in year 2009 only survival percentage 35% found from past study, whereas current study did not find any such type of abruption in the results from several years. This is may be due to that they presented survival perentage, on the other hand present study presented livability percentage. The hatching success of peahen is very low but survival rate is substantially high in captivity (Tariq *et al.*, 2018). Present study result also supports these results of that past study.

The livability was found high might be due to providing high quality feed, feeding management, peachicks rearing system as well as high profile management system that supported the good percentage of live peachicks up to fledgling age. Peachicks that are old enough (3-4 months at least) that they do not need the heat lamp can be moved to a larger space (www.backyardchickens.com, 2018), so in the early stage the pechicks supported by the brooding house which helps to develop proper physiological activities and reduced the chance of disease production in body system. Without this in this time the peachicks managed under a small confined house wich make easy for good management. On the other hand in case of chicken, previous studies found that livability of Sonali chicks in intensive system of rearing was 90.8% and 94.4% in case of semi-intensive system (Islam *et al.,* 2004), which is higher than the study on Aseel and Hilly in intensive system (88.89% and 46.15%). Livability of Hilly chicken under intensive management was found 96.67% (Khan *et al.,* 2007) and the egg production was 78 per year. The overall livability of Fayoumi and Sonali chicks after 8-week in scavenging rearing system was 58.2% and 49.4% respectively (Miazi *et al.,* 2015). It is generally well known that chicks from certain mating are known to live well, while from different mating, have high mortality. As we know, it is a good practice to use only breeders whose progeny live well. Generally, chick produced from good quality peacock which one has strong and beautiful train feather produced good quality chicks with desirable livability.

In addition, good quality feeds with proper nutrients and balanced diet could help the development of immune system adequately which gear up the livability of peachicks. Several earlier studies also support this argument, peahens grant the peacocks by the whole of the practically eyespots for her chicks will hopefully follow in the footsteps of the male's superior immune position and have a greater expose at survival (Ismail *et al.*, 2010). Without this it has been documented that males with more number of ocelli have greater energy; leading to female's first choice to copulate with them. Chicks inherit strong immune system if peahens choose peacock with most number of ocelli (Kumar *et al.,* 2014; Saini *et al.,* 2007; Naseer *et al.,* 2018a). When a male peacock finds a peahen that he hopes to mate with her. He then begins to shiver, causing his feathers to move rapidly back and forth. This reflects light off of the highly iridescent feathers, making him seem even more brightly coloured. If the peahen is impressed with his display, she will approach and mimic his movements for a few moments, before mating with him. However, most peacock displays end up being rejected by peahens, which seem to be highly picky. It is believed that peahens try to select a male with the brightest plumage possible because it is a sign of good health, which is a sign of good genetics. It stands to reason that if a female chooses a strong, healthy mate; her chicks will have a genetic advantage and be more likely to survive to adulthood (Maria, 2018).

The peahen mates with the favored male produced large eggs with more testosterone hormone deposited in egg yolk. The Peachicks hatched from the mating who has the largest and more eye-spots tend to grow faster and have better survival rate (Petrie and Williams, 1993). Ornamentation in feather patterns is characteristic of Indian peafowl, high quality ornament signals at high levels of resistance and immunity. The expression of ornaments may be an indication of the ability of the bearer to its defense against disease causing pathogens (Somes and Burger 1993; Stewart *et al.,* 1996; Takahashi and Hasegawa, 2008). Good quality food is necessary for the growth of the immune system during the first week of post hatching period, because there is a need for proliferation of white blood cells (WBC) and seeding of lymphoid structures during this period. During this period, any deficiency (or an excess) of nutrients may abruptly affect the resistance of an individual in the later life (Yasmin, 1997).

Generally, peahens choose the peacocks with the most eyespots because her chicks will hopefully inherit the male's superior immune system and have a greater chance at survival (Dakin, 2008). The Peafowl prefers and it is very active in domestic habitat compaired to wild habiata. The death rate also recorded low, during study period only one death occured in domesticated habitats (Deepa *et al.,* 2013). The visitor disturbance in zoo may reduce fertility and survival rate of peachicks. On the other hand in the wild habitat the peafowl did not disturbed by visitors and increases the fertility rate as well as survival rate of peachicks (Deepa *et al.,* 2013).

In case of chicken livability as found around 90% in intensive rearing system which also supported by the current study where found more than 90% livability of peachicks in all the studied years. Present study also support the result of that past study because of most of our studied peacock were ornamented with more eyespots in their train feathers. Without this from the past study in captivity death rate reduced due to not predation by predators as well as well management. But the past study result presented a contradictionary result also where we found visitor disturbance reduce the survival rate, this is may be in case of adult peafowl in zoo but peachicks did not keep in front of visitors. As we know most of case peafowl prefer domestic habitat and survival rate more in this condition. Livability rate also can be increased by developing proper breeing policy in case of poultry. In this case we also practiced good strategy for breeding of peafowl based on male female ratio and selection of good and mature male for breeding purposes. By these ways livavility rate can be increased in captive peafowl.

Without this in early stage several vitamin and minarel suppied to the water frequently and sometime used antibiotic in water for protecting diseases. Therefore, the livability percentage was found high in peachicks. Adequate amount of balanced feed along with high quality management system, low diseases outbreak in the intensive cages are the major cause of better livability of Indian peafowlin in BNZ. In summary, the livability of peachicks was found optimum in this study which highlights the importance of good quality peacock, balanced diet, proper brooding and vaccination. Generally brooding of peachick's stongly maintained because of in cool environment pachicks suffer from differentnt diseases and increase the mortality rate. Without this more protein percentage based feeds help to activate and develop immune system properly, that protect fom several diseases and increase livability. On the other hand the proper housing system protects the peachicks from predation by predators and by this way increase the livability percentage. Past study reported that most of the peafowl are reported to exist in areas 900-1200 meter above sea level. This bird has the ability to adapt according to variations in weather conditions and can survive well in both hot and cold climates (Kaliner and Miringa, 1972; Krautwald and Schildger, 1986). When the precocial chicks hatch, they are well developed and able to leave the nest within a few hours to follow the female, and are able to feed themselves from birth (Whistler, 1949). The newly hatched chicks are born with flight feathers and are able to fly short distances within three days of hatching (Maria, 2018). Which are laso supported by current study, the livability was high in Indian peafowl for their ability to cope with environment as they reared in BNZ as semi-wild condition for a long period of time. In captivity, peafowl can live for about 23 years but it is estimated that they live only for about 15 years in the wild Flower, (1938).

The death toll of Peafowls in captivity at breeding center was further supported by Khan *et al.,* (2009) who reported that peafowls raised in inadequate conditions, on poor quality feed and exposed to natural pathogens most frequently became victims of nutritional, viral, bacterial and parasitic diseases. On the other hand peachicks in the current study reared with adequate nutrition and proper brooding as well as standard management system, due to these the peachicks of current study did not suffered from several diseases and increased livability percentage. The lifespan of peafowl detected more in captivity than wild ranged peafowl which also support for more lvability of pachicks in captivity. Without this as precocial chick they can manage themselves properly; intake feeds as well as escape from ground predators by flying. Without this they have the potentiality for adapting in harsh environment through gene introducing. The weather condition in Bangladesh National Zoo area was found very good for present studied years that also support for more livability of peachicks. Finally it can be said that the strong, strout and more eye spoted male mate with female peafowl produced highly immnued peachicks which, help to find more livability of peachicks in Bangladesh National Zoo.

3.2 Mortality of peachicks

They have very low mortality rate, just only 4.18% (n=2630), (Table 3.2) which is the representation of their higher livability percentage in this facility.

Table 3.2: Mortality of Indian peafowl in Bangladesh National Zoo up to fledgling age

Year	Hatched out peachicks	Dead peachicks	Mortality%
2014	43	2	4.65
2015	110	5	4.55
2016	16	1	6.25
2017	54	2	3.70
2018	40	1	2.50
Total	**263**	**11**	**4.18**

Mortality was recorded lowest (2.50%; n=40) in 2018, whereas highest (6.25%; n=16) in the year of 2016. Overall, the mortality rate was found low in all year round. However, the mortality rate were found 4.65% (n=43) in year 2014, 4.55% (n=110) in year 2015 and 3.70% (n=54) in year 2017, respectively. The ranges of mortality rates 2.5% to 6.25% between years 2014 and 2018. Colibacillosis and salmonellosis were the major infectious diseases that contribute his mortality percentage for the peachicks (Table 3.3).

Table 3.3: Causes of mortality of Indian Peachick in BNZ up to fledgling age

Year	Hatched out peachicks	Dead peachicks	Causes of moratlity
2014	43	2	Collibacillosis
2015	110	5	3-Collibacillosis+2-Salmonellosis
2016	16	1	Leg’s squamashing
2017	54	2	Accidental injury
2018	40	1	Salmonellosis

Mortality ranges 2.5 % to 6.25% from year 2014 to 2018. Highest death of peachicks (5) was observed in 2015 and lowest (1) in 2016 and 2018. The pathogens isolated from dead peachicks were *E. coli* species, *Salmonella* spp. species and accidental case was found leg's squamashing and others accidental issues (Table 3.3).

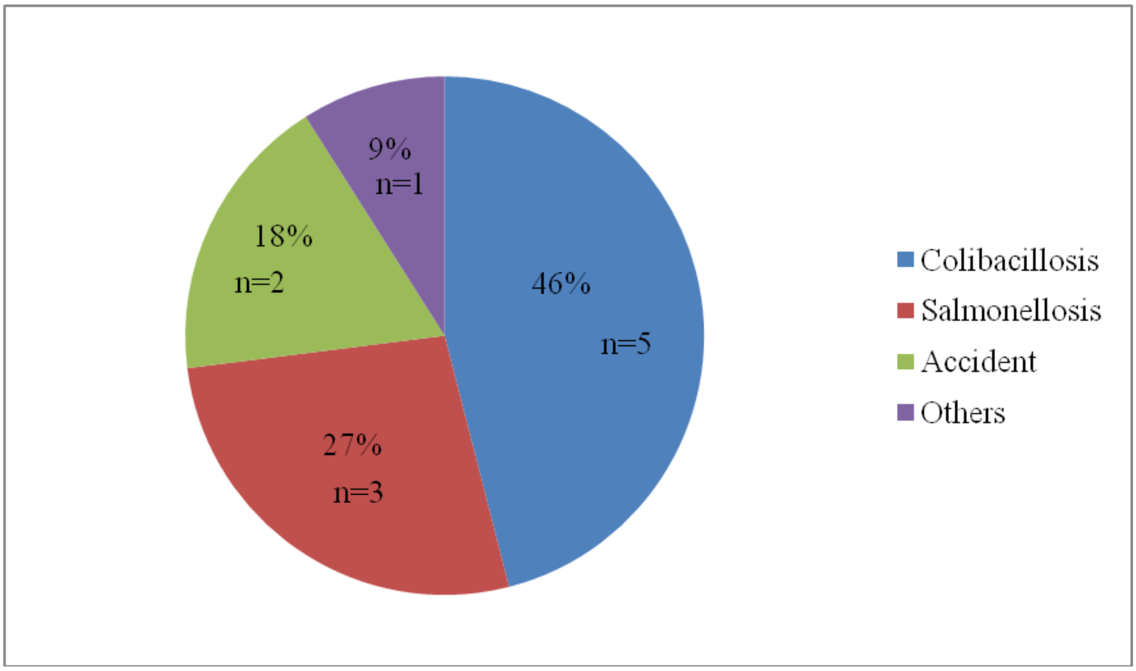


Figure 3.1: Mortality rate by several causal agents of Indian Peafowl in BNZ up to fledgling age.

Figure 3.1 showed that colibacillosis might have caused (46%; n=5) mortality, and salmonellosis caused (27%; n=3), but accident caused (18%; n=2) mortality and finally other caused only (9%; n=1) mortality. Colibacillosis was the main causes of death (46%; n=5) of Peachicks on the other hand the second highest cause was found the salmonellosis (27%; n=3), so the disease colibacillosis and salmonellosis caused most part of mortality compared to others.

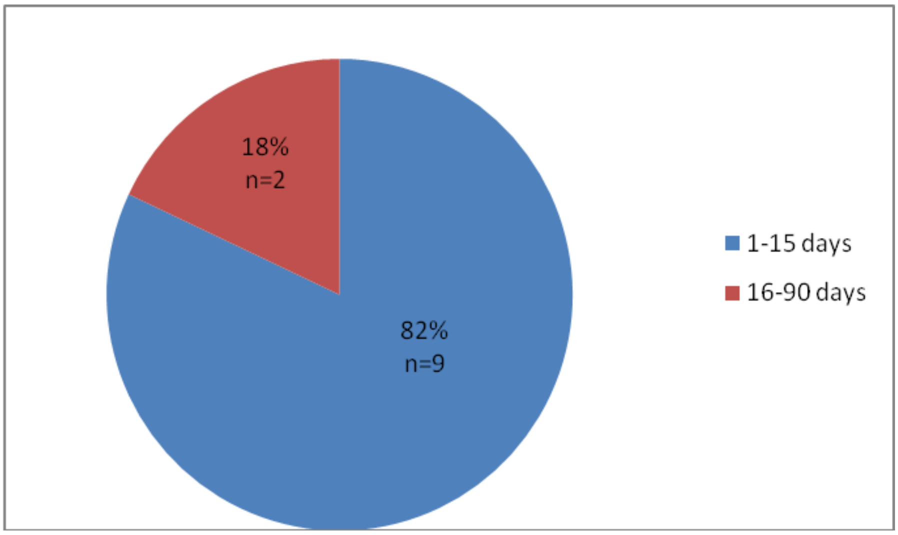


Figure 3.2: Mortality rate based on age group of Indian peafowl in BNZ up to fledgling age

In early age between 1-15 days most of the death occurred (82%; n=9) and during 16-90 days only (18%; n=2) death occurred (Figure 3.2). In the early life, the peafowl mortality rate was higher compared to their later part of life, might be due to the not development of immune systems. In a separate study, mortality was caused mainly due to Newcastle diseases (ND) (25%) as well as nteritis (11%), hemorrhagic enteritis (3%), epatitis with ND, traumatic izzard (2%) (Tariq *et al.*, 2018). The death toll of Peafowl in captivity at breeding center was further supported by Khan *et al.* (2009) who reported that Peafowl's risen in inadequate conditions, on poor quality feed and exposed to natural pathogens most frequently became victims of nutritional, viral, bacterial and parasitic diseases. In the present study, we found mortality percentage was low all over the years and disease variation also low which suggested good management and proper caring of peachicks in BNZ. It has been established that certain breed, varieties and strains differ from others with respect to their ability to withstand adverse environmental condition (Ketelaere *et al.*, 2002). The common diseases of chicken were found to be salmonellosis, mycoplasmosis, newcastle disease, gumboro, coccidiosis, colibacillosis, gangrenous dermatitis, ascitis and omphalitis at their entire life cycle (Saleque, 2003). The common predators for the chicks are crows, fox, wildcat, mongoose, kite, rat and domestic cat as well (Saleque *et al*., 1996). The mortality rate was found to be more in case of Sonali than the Fayoumi, because the later is scattered reared in the scavenging system in Bangladesh for a long time (Fattah, 1999). The Sonali breed is also less alert and it cannot easily take feed from the scavenging area, so suffers from nutritional deficiency and more prone to victimized by the predators (Miazi *et al*., 2015). For lack of nutrition, they also suffer from several diseases.

The crossbred chicks (Sonali) suffered from various diseases such as Pullorum, Salmonellosis, Gumbroo, Ranikhat, and Coccidiosis from 2nd weeks of age. They were very much susceptible to diseases and their growth might be retarded (Frossido, 1986; Fattah *et al.,* 1999). In semi-scavenging condition, the mortality of Sonali and Deshi was 50% and 29% respectively (Amin *et al*., 1992). Without any interventions or preventive measures, the mortality rate of poultry was reported to be 35-85% due to diseases and predators attack (Scott *et al*., 1976). Several vehicles on the roads inside the park and in adjoining villages' roads also could be the reason of their mortality because they used to cross the roads. Due to their heavy long train feathers weight unable them to fly very soon and leads to death by accident. One of the important reasons could be the poisoning to counter crop damage and villagers add more amounts of fertilizers in their crops for high yielding and resistance to diseases. When peafowl eat that agricultural crops as food grains and it leads to their mortality rate higher. Their call activity during roosting is the most negative aspects and get more prone to predation. As, state forest department revealed that peafowl mortality rates is mostly through predators like wild cats, jackal, python and many more. The other reason could be the poisoning to counter crop damage and villagers add more amounts of fertilizers in their crops for high yielding and resistance to diseases but as peafowl eat the agricultural crops as food grains and it leads to their mortality rate higher (Dookia, 2015).

Chicks are somewhat more prone to predation than adult birds. Adults living near human habitations are also sometimes hunted by domestic dogs (Gurjar et *al.,* 2013). The veracity about Peacocks is loss and destruction of habitats due to urban sprawl that result in shrinking of the natural habitats (Kushwaha and Kumar, 2016). Threats include, increasing poaching for feathers and meat, habitat destruction, mortality due to chemical fertilizers and pesticides, poisoning by farmers to prevent crop damage and extraction of various parts for traditional medicines (Kushwaha and Kumar, 2016). The results of the present study we find low mortality rate in adlibitum feed supply, are also in close agreement with the findings of those of some researchers (Lebbie *et al.,* 1981) they reported that food restriction significantly increased mortality. The Indian peafowl is under threat from various quarters that include the demand for feathers and wild meat, conflict with farmers during cropping season, increased use of chemical fertilizers and pesticides, and habitat degradation (Sharma, 1974; Ali and Ripley, 1980a). Other threats include habitat degradation and loss more significantly from conversion of their habitat to agriculture, habitation and industrial growth, poisoning to counter crop damage, consumption of eggs and fat extracts for alleged medicinal values, and killing for wild meat (Del Hoyo *et al.,* 1994; Chakkaravarthy, 2002).

Illegal trade for train-feathers and mass mortality due to indiscriminate application of pesticides and herbicides in crop-fields are major causes of the recent decline in peafowl numbers. Though there has been increasing concern over the declining peafowl population, it is difficult to arrive at a realistic plan unless the current population size, the rate of decline and the causes of decline are scientifically quantified (Ramesh and McGowan, 2009). While the species is becoming locally extinct from several parts of its former range due to habitat conversion and changes in the cropping pattern, (Imam, 2005) poaching, and pesticide-related issues, there is no estimate of the size of surviving populations and the rate of loss from the entire country. Although these threats are believed to be causing an alarming decline in populations, but the magnitude and pattern of the mortality in peachick are yet to be quantified in captibity at zoological garden.That past studies result presented for peafowl mainly in case of wild ranged, but present study considered the captive rearing in zoo and only on peachicks at age 3 months. There fore the most of the past fidings did not support the current study results. Past recording result about mortality was Newcastle diseases (ND) (25%) as well as enteritis (11%), hemorrhagic enteritis (3%), hepatitis with ND (2%), traumatic gizzard (2%) (Tariq *et al.*, 2018). Which result did not support by the current study because peachicks vaccinated properly in the present study for ND.

On the other hand enteritis concurrent coli-enteristis (11%) and hemorrhagic enteritis (3%), wich is supported by present study where found colibacillosi caused mortality in early stage of peachicks, but past finding in case of chicken within 2 weeks age suffered from several diseases which also supported by current study in early stage, (1-15days) peachicks suffered from several diseases and more death occurred. Salmonellosis and colibacillosis were also recorded in case of chicken which also supported by the current study results about peachicks. On the other hand from the above past studies information about chicken species means that chicks mortality mainly caused by the diseases, predators and some time accidental cases. In the current study we also found that peachicks mortality mainly caused by diseases and some cases by accident but not by predators. Accidentals cage occurred some time due to more instruments in houses which fall down on peachick's bodies. One rare accidental cases also found in this present study which was dead by leg's squamashing. Predator occurred mortality did not find in current study because of protection of peachicks from predators by proper housing system. Without this we found that mortality rate is high in early stage of peachicks this is because of immune system was not active properly in the early stage due to this they can not proctect from diseases.

Livability up to fledgling age is very important because if the more live bird was found in early stage then we will get more mature bird later for producing next generation. Therefore, good managemenent system should be developed for finding more livable bird in early stage. In the late stage of life immune system develops properly to protect many diseases. Peafowls adapted with their environment for living properly. In this time, mortality also should be reduced by using medicated feed and water as well as supply balanced nutritious feeds to the peachicks. Peachicks also save from predation from predators to support with good houses. Diseased peachicks can be properly medicated by using veterinary doctor prescription by the way we can protect mortality and increased livability percentage. Good male selection for breeding purpose also one of the important factor for finding more peachiks live in early stage. In present study, we found that most of the Peacock was very good health condition and attractive looking with good train feathers arrangement.

The progeny from that healthy, attractive and well-arranged trained Peacock will become with good health and strong immune system, which help to get more livability in Peachicks in early stage. In the breeding season extra supply of vitamin and mineral which help to maintain proper breeding stage for male displaying and sperm production and female good ova formation and that help to produce more healthy progeny of peafowl. The current study also showed more livability and less mortality of peachiks in BNZ. For this reason we can easily do ex-situ conservation and reintroduction plan of Indian peafowl in Bangledesh.

4. Conclusion

Livability affects the productive and reproductive performance of poultry and other birds.The overall livability up to fledgling age was found 95.82%. Livability (97.5%) was highest in 2018 where as the lowest (93.75) was in 2016. On the other hand mortality was also found low in all the listed years, the total average was found only (4.18%) in BNZ up to fledgling age. Mortality was the lowest (2.50%) in 2018, where as the highest (6.25%) in 2016. The main cause of peachick mortality was found colibacillosis and salmonellosis and in sometime accidental causes in early stage of life. In early age between 1-15 days most of the death occurred which was 82%, later during 16-90 days only 18% death occurred. In early stage mortality rate was found high compared to late stage because of immune system was not actived in the early stage. Perfect male and female with good helth for breeing should be slected. Balnced and nutritious feeds and good housing system needs for protecting from diseases and preadotrs. Finally, the good management of peachicks rearing and proper care of pechicks in early stage helps to get more live peachicks in early stage. Livability percentage up to fledgling age is very important because by this time development of immune system in poultry and bird. Without this livability and mortality data is very important for taking decision about conservation plan of any species. Therefore, more livability and less mortality rate of peachicks is final target to a breeder and peachicks rearer. There was no past study result about livability and mortality of peachicks in Bangladesh contex which are very important parameters to take plan for conservation stratagey. So this result will help to future researcher as well as coservator planner to do their work properly and perfectly. In conclusion it could be summarized that the livability of Indian peachick of Bangladesh National Zoo was detected high up to fledgling age, which might help ex-situ conservation and reintroduction of Indian peafowl in Bangladesh.

CHAPTER 6

Disease Conditions and Different Abnormalities of Indian Peafowl and its Management in Captivity

Abstract

The wild and domesticated peafowls are prone to many bacterial, viral and parasitic infectious diseases. Various factors are contributing to infections in peafowls. However, there is very little published data on disease conditions and abnormalities of Indian peafowl and its prevention and control measures. Therefore, we aim to identify the disease conditions and different abnormalities as well as its management in captivity. The research was done from April 2015 to December 2018 in Bangladesh National Zoo (BNZ) by direct interacting, observing, using structured questionnaire and taking data from recordbook. The main causes of death in early stage were peachicks, colibacillosis and salmonellosis. The total calculated death due to diseases was recorded only 8 in early stage of Indian peafowl from 2014 to 2018. Out of the total recorded death, the highest rate 62.5% (*n*=5) was recorded due to colibacillosis disease and the salmonellosis disease rate was 37.5% (*n*=3). On the other hand, the common diseases were recorded in adult Indian peafowl were coccidiosis and parasitic infestations. The disease omphalyitis was also found in day old peachicks. Moreover, Newcastle disease, fowl pox, avian cholera, rickets, and enteritis were reported in the past time, as documented from record book and questionnaire survey.

The common abnormalities, which were counting in the last four years, were curled toes, bumble feet, wing injury and lameness. A total of 61 cases of common abnormalities were recorded, out of that the highest rate 54.1% (*n*=33) was curled toes and the lowest recoded case was 6.6% (*n*=4) wing injury. On the other hand, the case of lameness was found (29.5%; *n*=18) and bumble feet was observed (9.8%; *n*=6). Moreover, other abnormalities,

like weakness, gout in hock joint, heat stress, cool stress, visitor stress, nervous disorder and coprology were also recorded through the questionnaires answer session as well as by direct observation. Fighting was found very common in breeding season by male to male and cannibalism found in rare case in early stage of life due to mineral deficiency in Indian peafowl. There were several types of predators and disturbing animals like rats, mice, cats, dogs, crows, monitors and kites available in the premises of BNZ. Vaccine against ND, fowl pox and avian influenza were used for Indian peafowl in BNZ for combating against those diseases.

The vaccines were administrated based on the direction of vaccine company. Medication against parasitic infestation was started from 4 month of age and later continued regularly in a six-month interval. Some vitamin mineral and nutrient substances are also being used regularly for preventing several abnormalities and diseases. Amino acid solution was supplied at the time of growing stage, as well as train feathers initiation stage. In the breeding season, extra supply of vitamin AD_3E, calcium, vitamin E and selenium, multivitamin and mineral and vitamin AD syrup are ensured, which help to maintain proper breeding stage for male displaying and healthy sperm production and female good ova formation. A well management system has developed in relation with feeds, feeding system, and habitats for making protection against abnormalities, diseases and predators of Indian peafowl. A veterinary hospital in the BNZ premises provides regular monitoring of their health status and suggests good quality management practices for all animals including Indian peafowl.

1. Introduction

The wild and domesticated peafowls are prone to many bacterial, viral and parasitic infectious diseases (Hopkins, 1997). Various risk factors are contributing for developing infectious diseases in peafowls (Perrins,1990). There were approximately 80 infectious diseases that are encountering the peafowl regularly. The diseases and health of peafowl are very similar to turkeys among the domestic poultry of the world (Schwartz, 1997). Many of these diseases recommend wire-bottom brooders because many diseases that will easily kill peachicks are found in the soil. It should be considered that the peachick's is to keep them off natural ground, watch for signs of illness closely and do not use anything slippery for bedding- newspaper, bare plastic, metal, etc. Improper footing can lead to spraddle-leg. The brooder should be free of drafts and kept clean (Kedreeva , 2015).

Peafowl's diseases were found almost identical to those of its New World counterpart, the turkey. The peafowl's was responded to medications that were known to be effective for the turkey. Peafowl's infectious diseases cross the whole spectrum of etiological or causative agents including virus, virus-like bacteria, fungi, protozoan, worms, and external parasites. Approaches to study diseases of peafowl's were considered specific to infections, regardless of causative agent by systems such as the respiratory, digestive, immune, reproductive, circulatory, renal and nervous systems. The most common approach was to study the disease agent by its manifestations, clinical signs, systems affected and control (Schwartz, 1997). The common viral diseases of peafowl were listed as Newcastle disease, fowl pox, hemorrhagic enteritis and mycoplasmosis, but bacterial diseases were pullorum and fowl typhoid, paratyphoid, staphylococcus, fowl cholera (FC), avian tuberculosis and the protozoal disease were coccidiosis, histomoniasis, trichomoniasis, leucocytozoonosis. The parasitic disease was observed as ascaridia, cecal worms, gapeworms, capillaria worms, tapeworms and external parasite lice, mites etc. However, the nutritional related diseases were found rickets, curled toe paralysis, nutritional roup, perosis, crazy chick disease and gizzard myopathy (Schwartz, 1997). Hamilton and Zuk, (1982) opinioned that Indian peafowl females select the males by assessing the quality of their ornamentation since these characters were good indicators of parasitic load and that indirectly revealed the health status of the male. Peafowls were found susceptible to enteric parasites like all gallinaceous birds; notably the protozoa called *Histomonas meleagridis* that causes the disease popularly known as black head. This is passed from bird to bird by an intestinal worm *Heterakis gallinae*, which live in the caeca (Harper, 1995).

Lice are common external parasites in outdoor birds and birds in the wild. Lice are insects that spend their entire life cycle on the host. Lice feed on skin, scales and feather debris. Poultry lice have chewing mouth parts. Lice spread bird to bird as body contact is made by birds. Mites are common to all avian species. The northern mite is the most prevalent and troublesome of the mites in poultry and other birds. Mites are members of the spider family. They spend their entire life cycle on the bird and tend to be more resistant than lice to pesticides. Mites spread from bird to bird as flock members make body contact. The life cycle of mites is 7 to 14 days (Schwartz, 1997). Mixed infections were found frequently in few peacocks particularly, *Eimeria* spp with *Ascaridia* spp and *Eimeria* spp with *Strongyles* spp (Kathiravan1 *et al.,* 2017). Earlier several finding also revealed that birds are more prone to mixed parasitic infections (Muraleedharan *et al.,* 1990; Reddy *et al.,* 1992; Titilincu *et al.,* 2009; Jaiswal *et al.,* 2013). The prevalence percentage of gastro-intestinal helminths was 56.32% in peafowls and these were found positive for *Heterakis gallinae* (18 birds; 36.73%), *Ascaridia galli* (13 birds; 26.53%), *Daveniapro glottina (*03 birds; 6.12%), *Capillaria columbae* (09 birds; 18.37%) and *Acuria spiralis* (06 birds; 12.24%). Basit *et al.,* (2014) directed, Peafowl owner should also check for external parasites like mites, lice, and chiggers. As we know peafowl are not common pets or farm animals, there is no established vaccine schedule for them, but avian pox, blackhead disease, and coccidiosis is always a concern (Allie, 2017).

Parasitic infections that often goes unnoticed due to lack of investigation studies of in Indian peafowl, regarding the presence of parasites, will serve as an eye opener for the academicians, field veterinarians as well as researchers that will further help in investigation of these parasitic infections and their impact on health of the birds (Jaiswal *et al*., 2013). The most common disease that affects the peafowl is caused by internal parasites. Generally, parasitic infestation in birds is not acute in nature rather produce chornic and sutained economic losses. Peafowl's gastro-intestinal tract harbors a wide variety of helminthes as such nematodes, trematodes and cestodes are the most deleterious parasites and are responsible for clinical and sub clinical parasitism. Birds that are housed outdoor are invariably infested by nematode sometime, which was roundworms *Ascardia galli* and *Capillaria sp*. infections (Darrel, 1996). Ascaridia, common round worms, are prevalent in many species of fowl. *Ascarid species* are essentially host specific in that each has its preferred bird species. The ascarid life cycle is egg-larva-adult. The worm egg is passed in the feces, germinates on the environment, and is then eaten by a susceptible host which provides opportunity to complete the life cycle. The larva migrates extensively in the intestinal lining causing much tissue damage, blood loss, intestinal lesions with complications. Cecal worms, *Heterakis gallinea*, are tiny worms that live in the ceca (blind pouches) of the birds.

These worms cause little damage or discomfort to the bird but are important because they serve in the perpetuation of histomoniasis. The dormant histomonad has been shown to exist from one season to the next in the egg of the cecal worm. Gapeworms, *Syngamus trachea*, are worms that localize in the trachea (windpipe) of birds. Heavy infections cause respiratory distress in young birds with their small trachea being mechanically blocked which plugs the passage of air. Infective *Syngamus sp.* eggs apparently winter over in worm-contaminated pens. It is also thought that earthworms are an intermediate host of this parasite. Capillaria worms, *Capillaria sp.* are parasites of the gastro-intestinal tract. At least two capillaria species are known to infect the crop, esophagus and mouth while other species (4 or 5) localize in the intestine and ceca. Each species tend to have its preferred location in the digestive tract. Capillaria cause a general unthriftiness, paleness and rough feather coat in the infected birds. Tapeworms are known to parasitize fowl. It is assumed that only those species common to the peafowl and/or turkeys would be involved. Tapeworms have a two-stage lifecycle with the bird being the second stage or the primary host. The first stage occurs in insects, arthropods, and crustaceans called secondary hosts. Peafowl become infected from feeding on infected secondary host. Symptoms usually depend on finding tapeworm segments in the bird feces (Schwartz, 1997).

Peafowl also usually suffer from parasitic infections, which are among most common sanitary problems affecting wild birds, occurring mostly as subclinical conditions but may also cause mortality. Amongst parasitic diseases, protozoan diseases especially coccidiosis enlist as the leading parasites affecting birds worldwide, resulting in poor growth, diarrhoea and high mortality, particularly in young birds (Freitas *et al.*, 2002). Parasitic infestations are chronic in nature, causing anorexia, malnutrition that makes the birds to immune-compromised, and prone for viral and secondary bacterial infections (Steiner and Davis, 1981). The gastro-intestinal tract of the bird generally infested by endo-parasite and infected birds may develop enteritis, emaciation, depression, anorexia, anemia and finally death (Forrester *et al.*, 1978). Parasites also damage the health of host by consuming nutrients and vitamins, decreasing feed utilization by the host causing intestinal obstruction and producing toxins resulting in progressive loss of condition of the host birds. Moderately infected flock of peafowl, the overall production may drop by 25% (Urquhart *et al.*, 1996). Several parasitic species in the wild free ranging peafowl's showed that *Eimeria* spp were the most common (43%) particularly *E. mayurai* and E. *pavonis.* The other detected worm species and their respective frequencies were *Hymenolepis* spp (4.16%), *Ascardia* spp (6.9%), *Strongyloides* spp (4.16%) and *Strongyles* spp (2.77%).

The past study revealed the high prevalence of coccidial infections in Inidan peafowl besides other helminthes (Kathiravan1 *et al.,* 2017). Besides the coccidiosis, there has also been a report of single cestode species in peacocks (Sloss *et al.*, 1994). Coccidiosis is known to cause serious mortality in galliform birds in captivity (Rommel, 2000). Coccidia, gastro-intestinal nematodes and cestodes are major endoparasites infecting peafowls (Titilincu *et al.,* 2009; Jaiswal *et al.,* 2013). Coccidiosis is an infection caused by one or more species of coccidia. Avian coccidia protozoan organism belongs to the genus *Eimeria*. Coccidiosis is a disease primarily of young birds 3 to 12 weeks of age. Coccidia are host specific; that is, coccidia does not cross infect from one bird species to another. Most bird species are subject to coccidial infection by 2 or more species (Schwartz, 1997). The parasites adversely affect the health of birds by reduce body weight, lowering the host resistance against other infections, retarded growth, unthriftiness, damage to the gut epithelium, reduced egg production, emaciation and death especially in younger birds during heavy infections (McSorley *et al.,* 2010).

Histomoniasis, commonly called 'blackhead' is an infectious intestinal disease caused by the protozoa *Histomonas meleagridis*. Birds are most susceptible between 6 and 14 weeks of age. Symptoms are watery, sulfur-coloured droppings, drowsiness, and weakness. The causative agent is shed in the feces of the infected birds and then contracted by susceptible birds as they feed from the floor and litter. Trichomoniasis is a disease found especially in young birds. There are two forms of this disease: (1) mouth, crop-esophagus infection or upper form caused by *Trichomonas gallinae*, and (2) intestinal or lower form caused by *Trichomonas gallinarum*. Birds with the upper form will be depressed, drool, have a sunken empty crop, swallow frequently and have a fetid odor. Many affected birds will maintain an upright penguin-like body posture. Signs of the lower form are depression, unthriftiness, loss of weight, and yellow-watery diarrhea (Schwartz, 1997).

Newcastle Disease (ND) is an acute rapid-spreading respiratory disease that is caused by a virus. ND can cause high mortality depending on the virulence or pathogenicity of the virus. The duration of ND is about 14 days. Since there is no effective medication against ND, it must be prevented or controlled by vaccination accompanied by excellent husbandry at all times (Schwartz, 1997). ND cause high mortality in early stage and as well as late stage of life. There is no effective medication for this disease. Only the vaccination is the only preventive measures of this disease. The duration of ND is about 14 days. Loss of appetite, coughing, sneezing, loss of feathers, drooping neck, depression, Nausea, Whirling and spinning are the main sign and symptoms of this disease. In 2011 total 180 peafowl dead by ND in Tharparkar district of Sindh but in Pakistan there were so many death of Indian peafowl occurred due to ND (www.youtube.com, 2019).

Fowl pox (FP) is a relatively slow spreading disease caused by a virus that is transmitted primarily via the bite of infected mosquitoes. The pox virus replicates or reproduces in the epithelial tissue; hence lesions are confined to unfeathered areas of the skin, conjunctiva of the eye and throat area. FP is a true pox in that the lesions are raised, scabby and crater-like with the scab firmly attached until the lesion is healed. Treatment would include vaccination of flock before or during an outbreak, mosquito control, and topical treatment of pox lesions with a skin antiseptic (Schwartz, 1997).

Pullorum and fowl typhoid are acute diseases caused by bacteria of the genus *Salmonella* — *S. pullorum* and *S. gallinarum*, respectively. These two bacteria are antigenically related. Both are spread from infected breeder birds to the progeny in the egg. To control these diseases, blood test the parent birds before the breeding season and eliminate the Pullorum-positive birds. If all pullorum-positive birds are destroyed, all progeny would be pullorum and typhoid free (Schwartz, 1997). Disease caused by one of the two poultry-adapted strains of *Salmonella* bacteria, *Salmonella pullorum*, this usually only cause of mortality in birds up to 3 weeks of age. Sometimes it can cause losses in adult birds, usually brown-shell egg layers. This bacterium affects chickens most frequently, but also infects turkeys, game birds, guinea fowls, sparrows, parrots, ringdoves, ostriches and peafowl. It has been demonstrated in non-commercial poultry but in few occasions may occured in commercial poultry. Morbidity is around 10-80% and the mortality is higher in stressed or immunocompromised flocks and sometimes up to 100%. Transmission may be transovarian or horizontal mainly in young birds and occasionally been seen through cannibalism (www.thepoultrysite.com, 2018). Paratyphoid is an acute septicemic and intestinal disease caused by a bacterium of the genus Salmonella. There are at least 2000 serotypes in this bacterial group which makes control by testing of the parent bird unfeasible. Paratyphoid causes high mortality in young birds from 8 to 28 days. After that, infected birds are chronically ill with many becoming stunned and unthrifty. Like pullorum and fowl typhoid, paratyphoid is spread from the infected hen to the chick. Chicks become infected at hatching as they come in contact with bacterial on contaminated egg shells (Schwartz, 1997).

Peafowl health deterioutes by disease like mycoplasmosis in breeding pens, wildlife parks and zoos (Nadeem *et al.*, 2014). *M. gallisepticum* (MG), *M. synoviae* (MS), and *M. meleagridis* (MM) are micoplasma diseases with MG and MM being the most serious and prevalent. Both MG and MM produce respiratory illness often diagnosed or reported as ‘sinusitis’, swelling of the eye sinuses, and ‘air sacculitis’, air sacs or air reservoirs of the respiratory system are enflamed and contain exudates or pus. MS infections are seen as arthritic and joint infections (Schwartz, 1997). As a bacterial diseases, mycoplasmosis caused by *Mycoplasma gallisepticum* (MG), *M. synoviae* (MS), *M. meleagridis* (MM) and *M. iowae* (MI) is reported to be one of the most highly infectious and prevalent diseases which can spread to a number of avian species including ducks, partridges, sparrows, quails, geese, pheasants, pigeons and peafowl (Bencina *et al.,* 1987; McMartin *et al.,* 1996; Ley and Yoder, 2008; Bradbury, 2001). Mycoplasma was first isolated in peafowl by Wills, (1955) and reported to have similar characteristics to causative organisms of chronic respiratory disease (CRD) in chickens and infectious sinusitis in turkeys. Mycoplasmosis is quite common in birds kept in zoos. In the United States, prevalence rates of 38.7% and 3.2% have been reported for MS and MM, respectively in peafowl (*Pavo cristatus*) kept at three Michigan zoos; whereas, the peafowl’s in all of these zoos were sero-negative for MG (Hollamby *et al.,* 2003).

Fowl cholera (FC) is an acute septicemic infection caused by the bacterium *Pasteurella multocida.* The disease is characterized by a rather sudden onset, high mortality with extensive hemorrhages in affected birds (Schwartz, 1997). Staphylococcus is an infectious non-contagious disease caused by a bacterium *Staphylococcus aureus*. The disease is characterized by septicemia, bumble foot and/or arthritis. Staphylococci are ubiquitous with most infections contracted by birds individually from the environment (Schwartz, 1997). Avian tuberculosis (TB) is a slow spreading disease of adult birds, probably 3 to 4 years of age in peafowl. The disease is caused by the bacterium *Mycobacterium avian*, an acid-fast organism. TB is characterized by gradual emaciation with the development of Tubercles (granulomas) in the viscera and is contracted by the bird from the infected environment. Infected premises remain infected for long periods unless there is a deliberate decontamination program developed. To confirm a diagnosis, the acid-fast staining technique is used (Schwartz, 1997).

Captive condition paves the ways for bacterial, viral, nutritional and parasitic diseases among Peafowl (Hollamby *et al.*, 2003). Without disease, peafowl also suffer from several types of abnormalities. Most of the abnormalities like curled toes, lameness etc. was found due to lack of vitamins or minerals (Schwartz, 1997). In addition, abnormalities occured due to accidental causes are very common (Hopkins, 1997). The common predators like coyotes, dogs, and foxes are the main concern for peafowl owners, especially those that are free-range. Tree houses are the best way to protect them from predators, and peafowl love to roost up high (Allie, 2017). Peacocks are quick to detect the presence of the larger cats on the prowl and herald the marauders' progress through the forest with loud warning alerts, which are taken up by other cocks and by langur monkeys (Black *et al.*, 2010). Shrub cover decreases the chances of nest predation by ground dwelling predators, so Indian Peafowl favours high shrub cover during its breeding period (Budgey, 1994). The Indian peafowl is under threat due to heavy demand for feathers and wild meat, during cropping season a source of conflict, advancement in green revolution such as chemical fertilizers and pesticides and habitat destructions (Samour *et al.*, 2010). In spite of the immense protection in India and wide distribution, the species is becoming locally extinct from several parts of its former range due to habitat conversion and changes in the cropping pattern (Imam, 2005), human interference (Shahabuddin and Kumar, 2007), poaching and pesticide-related issues (Jain and Rana, 2013). The Indian peafowl has been negatively affected by an unprecedented increase in the human population, large-scale clearance of forest for extensive agriculture, rapid industrialization and fragmentation and reduction in forest cover. This has not only led to a serious decline in abundance of peafowl, and other flora and fauna, but also excessive depletion in the resources of protected areas (Yasmeen, 1995).

Incidences of mortality of Indian peafowl, the national bird (Schedule I Indian Wild Life Protection Act 1972), are rampant in India (Kanthan *et al.,* 2013). The high demand of its train feathers, it is presently under threat (Johnsgard, 1986). The adult Indian peafowl can usually escape ground predators by flying into trees. Leopards are able to ambush them but in some areas such as the Gir forest, peafowl are the common prey of Lion too (Parashrya and Mukerjee, 1999). Though in Keoladeo National Park, there is a complete lack of large predators, but Jackals prey upon adults, young ones as well as on eggs, chicks are highly prone to predation. The mature peafowl's living near human habitations is sometimes hunted by domestic dogs or by humans in some areas (southern Tamil Nadu) for folk-remedies involving the use of peacock oil (Johnsingh and Murali, 1981). Several vehicles on the roads inside the park and in adjoining villages' roads also could be the reason of their mortality because they used to cross the roads. Due to their heavy long train feathers weight unable them to fly very soon and leads to death by accident. Their heavy loaded weight of their train-feathers could be the reason of their death, as they cannot fly as soon as possible at the time of predators catching.

One of the important reasons could be the poisoning to counter crop damage and villagers add more amounts of fertilizers in their crops for high yielding and resistance to diseases. When peafowl eat that agricultural crops as food grains and it leads to their mortality rate higher. Their call activity during roosting is the most negative aspects and get more prone to predation. As, state forest department revealed that peafowl mortality rates is mostly through predators like wild cats, jackal, python and many more (Dookia, 2015). Above mentioned information gave the data about diseases, abnormalities and predators of Indian peafowl, reared in captivity as well as wild ranged. But no data were found in Bangldesh contest about diseases, abnormalities and predators of Indian peafowl.

1.2 Prevention and control of diseases and abnormalities

Restricting the free movement of visitors in wildlife parks as well as zoos and adopting the proper bio-security measures is vital to minimize the risk of infectious diseases in Galliformes (Nadeem *et al.*, 2014). Most of the commonly occurring infections caused by MG and MS in captive peafowl and pheasants are associated with respiratory diseases and are characterised by foamy eyes, swollen infra-orbital sinuses, respiratory distress and death, but in peafowl its mechanism of transmission is unknown (Cookson and Shivaprasad, 1994; Hollamby *et al.,* 2003). Transmission may be associated with infected hosts at shared feed stations or shelter areas in the winter season (Hollamby *et al.,* 2003). Other avian species, including turkeys, chickens and bantams, may be the cause of transmission of MG in peafowl maintained in cages, and further transmission of the disease may occur by farm-to-farm movement of workers, visitors and other personnel on farm (Mason and Maiers, 1984). Christensen *et al.,* (1994) reported that MG remained alive in human hair for up to three days and MS up to eight hours, and on the nose and clothes MG and MS survived 12-24 hours and two to four days, respectively. Avian mycoplasmosis may be transmitted vertically through the eggs, or horizontally by direct contact between sick or unaffected carriers and susceptible animals. Indirect transmission via people, wild birds, drinking water, litter or breeding material may play a major role in the initiation of MS outbreaks because of the possible persistence of *Mycoplasma* spp. in the environment (Marois *et al.,* 2000). MG and MS infections were frequently found in game birds where multiple housing of different avian species was practiced (Reece *et al.*, 1986a; Cooksoon and Shivaparasad, 1994; Hollamby *et al.,* 2003; Nadeem, 2010).

Bencina *et al.,* (2003) reported that addition of new birds within the flocks, without serological screening, could be a possible cause of infection in pheasants and peafowl. The best control is prevention of the introduction of Pasteurella into the flock from new birds, sick birds, or contaminated materials and equipment. Vaccines are commercially available but are only marginally successful. Outbreaks can be brought under control by flock medication with sulfa drugs and antibiotics. Premises will remain infected following a FC outbreak unless a thorough decontamination program is conducted. Incase of typhoid the birds shoul be eradicated from flocks. Losses from paratyphoid can be reduced by medication, neomycin or nitrofuran, in the chick starter feed. Outbreaks of staphylococcosis do respond to antibiotic therapy that can be administered to birds individually or to the flock in the feed or water. Improved sanitation of the housing environment and better flock management will help control staphylococcosis. There is no treatment against TB. Improved management, better sanitation of the environment will help to prevent the introduction of the disease (Schwartz, 1997).

Control of lice is established by initiation treatment for all birds in the flock on a periodic basis with an approved safe pesticide. Treatment is not recommended unless lice are present on the birds. The life cycle of mite is 7 to 14 days so control requires treatment at 10 day intervals for 3 to 4 treatments and monthly thereafter of all birds in the flock with an approved safe pesticide (Schwartz, 1997). Modern anthelmintics generally have a wide range of safety, considerable activity against immature larval and mature stages of helminths, and a broad spectrum of activity. Nonetheless, the usefulness of any anthelmintic is limited by the intrinsic efficacy of the drug itself, its mechanism of action, its pharmacokinetic properties, characteristics of the host animal, and characteristics of the parasite whether it has developed anthelmintic resistance. The ideal anthelmintic should have a broad spectrum of activity against mature and immature parasites (including hypobiotic larvae), be easy to administer, have a wide margin of safety and be compatible with other compounds and be cost effective. Generally the broad range of anthelmintics have been used against helminths such as albendazole and fenbendazole for their effectiveness in the treatment and prevention of histomoniasis (black head) in turkeys by Hegngi *et al.,* (1999), levamisole against gastrointestinal nematodes in common peafowl by Ashraf *et al.,* (2002) in different climatic areas. Coccidiosis is best controlled by preventative medication in the feed during the susceptible age of the birds. Coccidiostats (preventive drugs) are available commercially with Amprolium and Rofenaid being the most prominent two. If a coccidiostat cannot be obtained, any good sulfa drug can be substituted in the feed. When outbreaks occur, birds can be treated with sulfa drug in the drinking water. All drugs should be used in accordance with the label instructions (Schwartz, 1997). Histomoniasis can be controlled by specific medication of a bird or flock at the onset of an outbreak or prevented with the use of a histomonastat, drug specific from Histomoniasis, in the feed. Presently there are no Food and Drug Adminitration (FDA) approved histomonastats. Currently, Metronidazole (Flagyl), copper sulfate, and Histostat are the medications used for the treatment of Blackhead. The symptoms are similar to histomoniasis with treatment and control the same as for histomoniasis (Schwartz, 1997). In the treatment of avian mycoplasmosis, antibiotics are frequently used in naturally infected birds (Hamdy *et al.,* 1982; Glisson *et al.,* 1989; Charleston *et al.,* 1998; Hannan, 2000), but various scientists have reported the development of resistance against various antibiotics across the globe (Bradbury *et al.,* 2001; Gautier-Bouchardon *et al.,* 2002; Pakpinyo and Sasipreeyajan, 2007). Tripathy *et al.,* (1972) treated the infra-orbital swelling of peafowl with vitamin A and terramycin (intramuscular; I/M) and terramycin (0.5ml) infused into the swelling after removal of exudate. Clinical signs disappeared within ten days and birds resumed their normal feeding. The signs did not reappear until after the six months of therapy. Reece *et al.* (1986b) reported that treatment with sulphonamide did not reduce the number of new cases within the flock, and so tylosin was recommended in infectious sinusitis associated with MG in peafowl, turkeys and other game birds. Reece *et al.* (1986a) successfully treated mycoplasmosis in racing pigeons with tylosin followed by oxytetracycline or chlortetracycline at a dose rate of 0.2-0.5 g per litre of drinking water for five days, bird health improved gradually. Wissman and Parsons, (1996) treated MS infection in the common rhea (*Rhea americana*) by injecting long acting doxycycline at a dose rate of 20 mg/kg of body weight (I/M) and tylosin at the dose rate of 250 g/8 ounce in drinking water, with the addition of vitamin A, D3 and B-complex (thiamine) as supportive therapy. All of the birds rapidly responded to this therapy and complete resolution of ocular and nasal lesions was observed. Fiorentin *et al.,* (2003) reported the eradication of mycoplasmosis by oral administration of oxytetracycline, enrofloxacin and norfloxacin in feed and drinking water of broiler breeding flocks. Roussan *et al.,* (2006) demonstrated that administering tilmicosin at a dose rate of 30 mg/kg of body weight for three successive days and repeated every five weeks for four months in Galliformes successfully controlled the infection of MG in eight flocks. Charleston *et al.,* (1998) reported the effectiveness of tilmicosin towards air sacculitis caused by MG in avian species at the dose rate of 50 mg/l in drinking water for three to five days. In a therapeutic trial, Nadeem (2010) reported a 75% recovery rate in captive peafowl by using tylax (tylosin) oral powder at the dose rate of 200 mg, and a 100% recovery rate by the use of oxytet (oxytetracycline) at the dose rate of 1 gm in two litres of drinking water for five days every two weeks. Clinical signs disappeared after seven to nine days, and birds improved their feed consumption. Forrester *et al.,* (2011) treated infectious sinusitis associated with MG in pheasants with tylvalosin (TVN; aivlosin, a macrolide) at a dose rate of 25 mg/kg of body weight for three consecutive days. There are no absolute cures for micoplasma infections but several antibiotics are effective as treatment and control of the infections. Recovered peafowl remain carriers and the disease is transmitted from the hen to the chick in the egg. Therefore, it is best not to save any micoplasma postive birds for breeding purpose since this would be perpetuating the disease year after year (Schwartz, 1997).

Infectious diseases of peafowl cross the whole spectrum of etiological or causative agents including virus, virus-like bacteria, fungi, protozoan, worms, and external parasites. Similarly, all systems of the bird are affected by these infections. The approaches to study diseases are to consider specific infections, regardless of causative agent by systems such as the respiratory, digestive, immune, reproductive, circulatory, renal, and nervous systems. The more common approach is to study the disease agent by its manifestations, clinical signs, systems affected and control. In case of dead peafowl, it should be done postmortem for diagnosis diseases, but in some case for confirm diagnosis needs laboratory diagnosis also. All bird fanciers are encouraged to familiarize themselves with necropsy (post-mortem) procedures and should routinely necropsy freshly dead or sick birds at the onset of a disease outbreak. Even if you contact your veterinarian or birds are submitted to a diagnostic laboratory, you need to be in position to describe the lesions you found in the birds. Important points to observe are the attitude of the bird, feathering, fleshing, colour of flesh, scaly legs, crusts on beak or eyelids, internal lesions by organ, i.e. heart liver, lungs, spleen, intestine, gonads, and kidney (Schwartz, 1997).

In summary, the diseases and health of peafowl are about the same as those in domestic poultry, especially turkeys. The experienced peafowl and poultry breeder become familiar with diseases endemic on their farm, locality or state. Since many of the avian diseases do cross species line, the mingling of peafowl with other menagerie birds or domestic poultry will increase the chance of becoming infected with diseases that are endemic. There was no study about Indian peafowl diseases and abnormalities and its management procedure earlier in Bangladesh context. Therefore, the present study was done with objective disease conditions and different abnormalities of Indian peafowl and its management procedure.

2. Material and Methods

2.1 Study site and period

The research work was conducted to determine the disease condition and abnormalities as well as its prevention and control methods of Indian peafowl in Bangladesh National Zoo (BNZ). The curren study was done in BNZ, which is located in capital of Bangladesh and situated middle part of Bangladesh during April 2015 and December 2018. Before starting the experiments, the researcher took a training class of the staffs about experiment for taking data properly on disease condition and abnormalities as well as prevention and control methods of that diseases and abnormalities which, casuse suffering of Indian Peafowl. Therefore, the current study was done to inform about disease conditions and different abnormalities of Indian peafowl and its management procedure.

2.2 Diseases and abnormities with prevention measures

Disease and abnormality data were collected by using questionnaire and direct observation.

Figure 2.1: Sowing curled toes and bumble foot in Indian Peafowl of BNZ

The predator list was calculated by direct observation and listing in own recording data sheet and later presented in tabular form. The diseases and abnormalities which were recording in current study time by own observation as well as informing from hospital authority; listed to my own record book data and then analysed the results, prepared all the figures and tables.At first the zoo stuff who engaged with peafowl rearing generally knocked the veterinary dotor about the primary disease condition and abnormalities. Then the disease diagnosis mainly had done by the veterinary doctor of hospital in BNZ. Generally in live condition diseased were diagnosed by clinical sign and information history but in case of death peafowl diseases were diagnose mainly by postmortem analysis. In some confused cases, the dead sampled also sent to the central diseases diagnostic laboratory (CDIL) for specific diagnosis.

Later on, the preventive measure and treatment schedule were collected from registrar book of the veterinary hospital and direct observation as well as using questionnaire. The extra information related to disease conditions and abnormalities were collected by using questionnaire and by direct observation. A well formed questionnaire with disease condition, abnormalities, predators and its management procedure in BNZ were used for data collection properly. Without this, data for finding disease condition and abnormalities in 2014 were collected from the record book as well as direct questioning. After confirmation about disease, the veterinary doctor was given the proper prescription as well as management of that disease condition properly. The prescription generally done based on avilable important medicine. But the vaccine schedule was made for the Indian peafowl based on important diseases. The administration of vaccine to peafowl was done as per rules of vaccine producing company.

In some cases small surjery was also done like the case of wing injury as well as some cases done dressing like bumble feet and others wounds. In these cases the peafowl were separated and keep in isolated houses up to recovery. The injetable form of antibiotics also administered for 4 to 5 days as well as extra care also taken in these cases.

On the other hand most of medication done flockwise and medicine and vitamin-mineral were mixted with supplied water as per requirements. The schedulic medication was done based on well planned schedule information sheet. Without this some common medicine kept all time in the hospital for common diseases like parasitic infestation and coccidiosis. In some serious case also medical board was also arranged for taking decision. On the other hand some sudden cases in any time, veterinary doctor was taken decision based on problems. Finally, most of management data were taken from direct observation and by using questionnaires.

2.2 Data collection and analysis

A 15 days interval was done for data collection, supervision and observation of management for clear conception. On the other hand one person was engaged in Bangladesh national Zoo to collect data continuously. The data generated from this experiment were entered in Microsoft Excel worksheet, organized and processed for further analysis. The most of the diseases and abnormalities presented the percentage-based results also pie chart was used for presenting results. On the other hand managemental information data were presented in tabular form for informing easily. The collected data were analyzed by using the, Microsoft Excel, SPSS 16 and STATA 13.

3. Results and Discussion

3.1 Diseases and abnormalities of Indian peafowl

The total calculated diseases case was recorded only 8 in early stage in Indian peafowl from 2014 to 2018 (Table 3.1). Only 5 cases of colobacillosis and 3 cases of salmonellosis was recorded from which the highest colibacillosis case 60% (n=3) was recorded in 2015 whereas no colibacillosis recoded from 2016 to 2018.

Table 3.1: Diseases of Indian peafowl in Bangladesh National Zoo in early stage

Year	Colibacillosis (%; 95%CI)	Salmonellosis (%; 95%CI)
2014	2(40; 5.27-85.34)	0(0; 0-70.76)
2015	3(60; 14.66-94.73)	2(66.67; 9.43-99.16)
2016	0(0; 0-52.18)	0(0; 0-70.76)
2017	0(0; 0-52.18)	0(0; 0-70.76)
2018	0(0; 0-52.18)	1(33.33; .84-90.57)
Total	**5(100;47.82-100)**	**3(100;29.24-100)**

Also the highest salmonellosis case 66.67% (n=2) was found in 2015 but no case of salmonellosis was found in yeas 2014, 2016 and 2017 (Table 3.1). Without this in 2014, 40% (n=20) of the colobacillosis was occurred whereas in 2018, 33.33% (n=1) of the salmonellosis was occurred in peachicks.

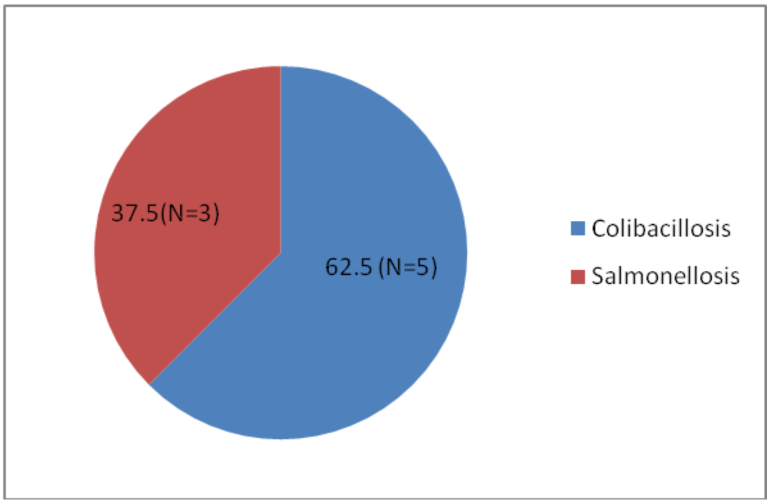


Figure 3.1: Diseases rate in early stage of Indian Peafowl in Bangladesh National Zoo

A total of 8 cases of common diseases in early stage of Indian peafowl were recorded in BNZ from 2014 to 2018, which were colibacillosis and salmonellosis. Out of the total recorded death case of diseases, the highest rate 62.5% (n=5) was recorded colibacillosis and the salmonellosis rate was 37.5% in BNZ (Figure 3.1).

The disease omphalyitis was also found in day old peachicks moreover ND, foowl fox, avian cholera, rickets, and enteritis reported in past time from record book and by questionnaire results. Mycoplasmosis is one of the most important diseases of Indian peafowl in BNZ. The common considerable disease, which was counted salmonellosis and colibesillosis in early stage of life of Inian peafowl. On the other hand, the inconsiderable but commonly found diseases were recorded in adult Indian peafowl was coccidiosis and parasitic infestation. The main causes of death were found in early stage of peachicks was found colibesillosis and salmonellosis. The others diseases did not causes more death in Indian peafowl of BNZ. One of the mature peacock dead by heat stroke in 2016, in summer season and that was diagnosed by postmortem analysis of the dead bird. Another adult peacock died by combined effect of coli-enteritis and Ascaris parasitic infestation in 2017, which was also diagnosed by postmortem analysis of the dead bird.

The common abnormalities, which were counting in last four years, were curled toes; bumble feet wing injury and lameness (Table 3.2). The total cases counting in last four years was found 61 from where the highest was recorded curled toes (n=33), then lameness (n=18), then bumble feet (n=6) and the lowest was recorded (n=4) wing injury (Table 3.2).

Table 3.2: Year wise counting of abnormalities of Indian Peafowl in BNZ

Year	Curled toes (%; 95%CI)	Bumble feet (%; 95%CI)	Wing injury (%; 95%CI)	Lameness (%; 95%CI)
2015	9 (27.27; 13.29-45.52)	2 (33.33;4.33- 77.72)	2 (50; 6.76-93.24)	5 (27.78; 9.69-53.48)
2016	12 (36.36; 20.4054.88)	0 (0; 0-45.93)	0 (0; 0-60.24)	3 (16.67; 3.58-41.42)
2017	7 (21.21; 8.98- 38.91)	1 (16.67; .42-64.12)	1 (25; .63-80.59)	7 (38.89; 17.30-64.25)
2018	5 (15.15; 5.11- 31.90)	3 (50; 11.81-88.19)	1 (25; .63-80.59)	3 (16.67; 3.58-41.42)
Total	**33** **(100; 89.42-100)**	**6** **(100; 54.07-100)**	**4** **(100; 39.76-100)**	**18** **(100; 81.47-100)**

In 2016 the highest numbers of curled toes (36.36 %; n= 12) were recorded but the lowest number 15.15 % (n=5) was recorded in 2018. Bumble feet was recorded the highest number 50 % (n=3) in 2018 on the other hand no case was found in 2016. No wing injury was recorded in 2016 but recorded wing injury was the highest 50% (n=2) in 2015. Lameness was recorded the highest 38.89 % (n= 7) in 2017 but the lowest recoded 16.67% (n=3) in 2016 and 2018 (Table 3.2). Curled toes also recorded 27.27% (n=9) in 2015 and 21.21%

(n=7) in 2017. Lameness was recorded 27.78% (n=5) and bumble feet was recorded 33.33% (n=2) in 2015. Wing injury reported 25% (n=1) in both year 2017 and 2018. But the bumble feet reported 16.67% (n=1) in year 2017.

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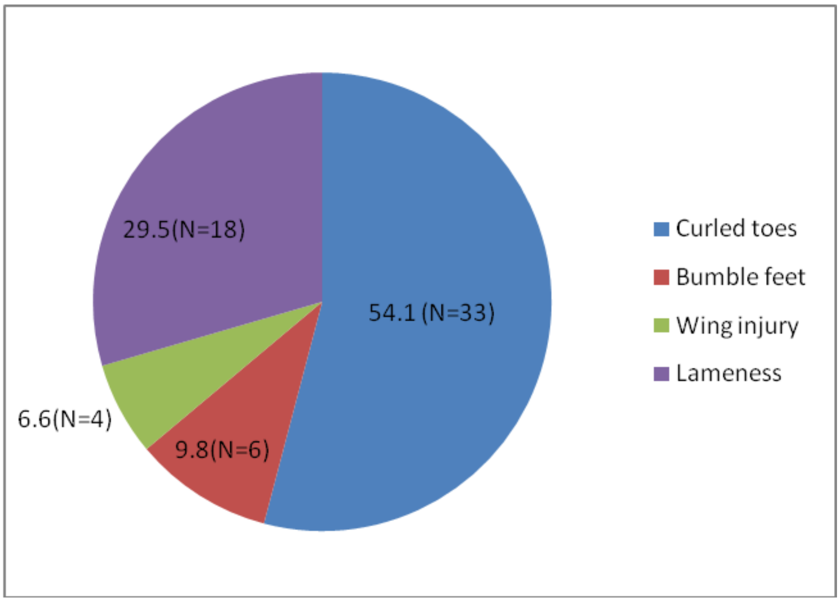

Figure 3.2: Rate of several abnormalities of Indian Peafowl in Bangladesh National Zoo

A total of 61 cases of common abnormalities were recorded in BNZ from 2015 to 2018, which were curled toes, lameness, bumble feet and wing injury. Out of the total recorded abnormalities, the highest rate 54.1% (n=33) was curled toes and the lowest recoded case rate was 6.6% (n=4) wing injury (Figure 3.2). On the other hand, the 2nd highest case rate was lameness (29.5%; n=18) and the 2nd lowest case rate was bumble feet (9.8%; n=6) in BNZ (Figure 3.2).

However, other abnormalities, which were listed, gout in hock joint, heat stress, cool stress, visitor stress, nervous disorder and coprophagy/autocoprophagy that were recorded from questionnaires answer and sometime from observation. Fighting was found common in breeding season by male to male and cannibalism found in rare case in early stage of life due to mineral deficiency in India peafowl. The most of the abnormalities was mainly cause by vitamin-mineral deficiency and by environmental factors. Without this several type of stress like heat, cool and visitors were also observed in the present study of Indian peafowl. As we know peafowls are omnivores in nature due to these self-feces as well as self infested parasites were also intake by Indian peafowl.

The common diseases of Indian peafowl was found in past study enteritis, nephritis, haemorrhagic enteritis, coryza, liver intoxication, traumatic gizzard, hepatic discolouration, Newcastle, and putrefied (Tariq *et al.*, 2018). Without this in another past study the common diseases was found based on infectious agents were viral diseases of peafowl listed were Newcastle disease, fowl pox, hemorrhagic enteritis and mycoplasmosis, but bacterial diseases were pullorum and fowl typhoid, paratyphoid, staphylococcus, fowl cholera (FC), avian tuberculosis, etc., and the protozoal disease were coccidiosis, histomoniasis, trichomoniasis, leucocytozoonosis. The parasitic disease was observed, internal parasitic - ascaridia, cecal worms, capeworms, capillaria worms, tapeworms and external parasitic lice, mites, etc. (Schwartz, 1997). Past studies described that the peafowls were found prone to many bacterial, viral and parasitic infectious diseases (Hopkins, 1997). On the other hand, the risk factors were recorded for developing infectious diseases in peafowls including unnatural habitat, the human encroachment, and deforestation and fragmented forest lands (Perrins, 1990), availability of vectors and intermediate hosts and urbanization. There were approximately 80 infectious diseases that are encountering the peafowl regularly. The diseases and health of peafowl were reported very similar to turkeys and the domestic poultry (Schwartz, 1997).

One of the past study by (Khan *et al.*, 2009) who reported that peafowls raised in inadequate conditions, on poor quality feed and exposed to natural pathogens most frequently became victims of nutritional, viral, bacterial and parasitic diseases. Peafowl health deterioutes by disease like mycoplasmosis in breeding pens, wildlife parks and zoos (Nadeem *et al.*, 2014). Captive condition paves the ways for bacterial, viral, nutritional and parasitic diseases among peafowls (Hollamby*et al.*, 2003). The past study by (Saleque, 2003) the common diseases were found to be salmonellosis, mycopplamosis, Newcastle disease, gumboro, coccidiosis, colibacillosis, gangrenous dermatitis, ascitis and omphalytis at the time of chicks rearing period. Due to the common diseases of chicken and peafowl, in the present study we observed the diseases were found near to same in peafowl also. The crossbred chicks (Sonali) suffered from various diseases such as pullorum, salmonellosis, colibacillosis, gumbroo, ranikhat, and coccidiosis from 2nd weeks of age. They were very much susceptible to diseases and their growth might be retarded (Frossido, 1986; Fattah *et al.*, 1999). The diseases of the first few weeks were found in peachicks like colibacillosis and salmonellosis were similar like the past study by (Frossido, 1986; Fattah *et al.*, 1999). In the present study, we also found same type of diseases in Indian peafowl but diseases number as well as variation was found few because of good management and proper care was taken by the BNZ authority to prevent and control diseases of Indian peafowl.

In the present study we also found one of the cause of mortality in early stage was salmonellosis which also supported by the below stated past study result. Disease caused by one of the two poultry-adapted strains of *Salmonella* bacteria, *Salmonella pullorum*, this usually only cause's mortality in birds up to 3 weeks of age means the early stage of age. Sometimes it can cause losses in adult birds, usually brown-shell egg layers. Salmonellosis affects chickens most commonly, but also infects turkeys, game birds, guinea fowls, sparrows, parrots, ringdoves, ostriches and peafowl. This disease still occurs worldwide in non-commercial poultry but is now rare in most commercial systems. Morbidity is 10-80%; mortality is increased in stressed or immunocompromised flocks and may be up to 100%. The route of infection is oral and via the navel or yolk. Transmission may be transovarian or horizontal mainly in young birds and may sometimes be associated with cannibalism. The bacterium is fairly resistant to normal climate, surviving months but is susceptible to normal disinfectants (Crespo and Maria, 2014). The present study also agreed with past study result in early age due to immunocompromised condition the peachicks died compared to adult stage in case of salmonellosis.

Parasitic infestation in birds is a common problem. The parasitic diseases in peacocks are less known, but it is an accepted fact that the most diseases resemble the ones that are encountered in turkeys Titilincu *et al.*, (2009). Birds in captivity are highly susceptible to parasitic infestation including both ecto-parasites and endo-parasites. This may due to high stocking density, hygiene practices, and poor sanitation and non-eliminating of infected individuals in free ranging condition (Khursheed *et al.,* 2014). Peafowls, as pheasants and chicken, belong to the family Phasianidae. The genus has its origins in Asia and can be found in India, Myanmar, Java, and the Malay Peninsula. Birds are usually very hardy and the most common diseases that afflict them are caused by internal parasites. *Ascaridia* spp. are nematode parasites found throughout the globe, which possess a wide host range, infecting the small intestines of chickens, turkeys, geese, pigeons, partridges, guinea fowl, and a number of wild birds, including peafowl (Balicka-Ramisz *et al.,* 2007; Bean *et al.,* 2005; Costa, 1970; Camacho-Escobar *et al.,*2008; Freitas and Ibanez, 1965). Although numerous reports describe occurrences of the genus Ascaridia around the world, species identification can be difficult (Ashraf *et al.,* 2002; Avcioglu *et al.,* 2008; Balicka-Ramisz *et al.,* 2007; Leal *et al.,* 2007; Marietto-Goncalves *et al.,* 2009).

Chickens are presumed to be the main host and infections usually lead to weight loss, bad feed efficiency, and low mortality. However, severe disease with clinical signs and high mortality can occur in young birds (Avcioglu *et al.,* 2008; Rao *et al.,* 1981; Rao and Hafeez, 2006). Rao and Hafeez (2006) reported that the peachick may have died due to peritonitis caused by rapture of the small intestine with heavy number of Ascaridia worms. Lapage (1956) mentioned that the young birds may be heavily infected when they are 3-4 weeks old and they may die at an early age. Regrettably, like other captive birds, they are also suffering from potential stress and frequent cases of parasitic infections, which are among the most prevailing diseases that affect them (El-shahawy, 2010). The major stress factor that can lead to lowered performance and malnutrition is intestinal parasitism (Badran and Lukesova, 2006). Several parasitic species in the wild free ranging peafowl's showed that *Eimeria* spp were the most common (43%) particularly *E. mayurai* and *E. pavonis* (Kathiravan *et al.*, 2017). Ascarid infection occurs in the small intestine of fowl, guinea fowl, turkey, goose and various wild birds (Soulsby, 1982) and the incidence of ascarid infection in peafowls was earlier reported by Rao *et al.* (1981) and Muralidharan *et al.* (1990). In past study the data on parasitic infestation in peafowl of Bahawalpur zoo were collected. Mixed types of ectoparasites were found in all infested peafowl's (Khursheed *et al.*, 2014).

The most common disease was found in present study in Indian peafowl in whole time was parasitic infestation and coccidiosis, the past studies also supported that parasitic infestation was more common then coccidiosis compared to others disease. Basit*et al*. (2014) reported that the prevalence percentage of gastro-intestinal parasites was 56.32%. The samples were found positive for *Heterakis gallinae* (18 birds; 36.73%), *Ascaridia galli* (13 birds; 26.53%), *Daveniapro glottina* (03 birds; 6.12%), *Capillaria columbae* (09 birds; 18.37%) and *Acuria spiralis* (06 birds; 12.24%). Peafowls are hosts for a wide range of ectoparasites such as ticks, mites, lices, fleas and trombiculid and certain endoparasites such as nematodes and insect larvae. These parasites mainly found on feathers and body, intestines, lungs and in blood (Mitchell *et al.*, 1975; Ashraf *et al.*, 2002). About 30.7% of peafowls were infected with external parasitic infestation. *Menacanthus stramineus* 12.19% was found to be high prevalent. It was revealed that Indian peafowl was mostly 36.66 % suspected to parasitic infestation followed by green peafowl (*Pavo muticus*) 29.26 %. Mixed parasites were found in majority of peafowl but louse were highly prevailed (Khursheed *et* *al.*, 2014). The parasites increase the body temperature of peacock, respiratory distress, Lateral recumbence and inability to fly (Ponnudurai *et al.*, 2011). Parasitic infestation is one of the major problems causing mortality in wild animals in captive form (Rao and Acharjto, 1984). Zoo birds under captivity suspected to anemia reduce growth, weight loss, illness and skin damage due to ectoparasites. Heavy infestations sometimes cause death of host (Arnall and Keymer, 1975). Parasitic infections in Indian peacock, that often goes unnoticed due to lack of investigation studies regarding the presence of parasites, will serve as a revelation for the academicians, field veterinarians as well as researchers that will further help in investigation of these parasitic infections and their impact on health of the birds (Jaiswal *et al*., 2013). Peafowl are susceptible to enteric parasites like all gallinaceous birds; notably the protozoa called *Histomonas meleagridis* that causes the disease commonly known as black head. An intestinal worm *Heterakis gallinae* passes this from bird to bird, which live in the caeca (Harper, 1986).

The gastro-ntestinal tract of peafowl harbors a wide variety parasites, of which nematodes, trematodes and cestodes are the most deleterious parasites and are responsible for clinical and sub clinical parasitism. Nematode infections are sometime found in birds that are housed outdoor are invariably roundworms *Ascardia galli* and *Capillaria sp*. infections (Darrel, 1996). They usually suffer from parasitic infections, which are among most common sanitary problems affecting wild birds, occurring mostly as subclinical conditions but may also cause mortality. Amongst parasitic diseases, protozoan diseases especially coccidiosis tops the list of parasites affecting birds worldwide, resulting in poor growth and high mortality, particularly in young birds (Freitas *et al.*, 2002). Mixed infections frequently were found in few peafowls particularly, *Eimeria* spp with *Ascaridia* spp and *Eimeria* spp with *Strongyles* spp observed by (Kathiravan *et al.*, 2017). Earlier several finding also revealed that birds are more prone to mixed parasitic infections (Muraleedharan *et al.,* 1990; Reddy *et* *al.,* 1992; Titilincu *et al.,* 2009; Jaiswal *et al.,* 2013). The nature of parasitic infections are chronic which causing anorexia, malnutrition related diseases, which makes the birds immune-compromised that make prone for viral and secondary bacterial infections (Garnett *et al.,* 1981). The endoparasites mainly infest the gastro-intestinal tract of the bird and infected birds may develop enteritis, emaciation, depression, anorexia, anemia and death (Forrester *et al.,* 1978). Coccidia, gastro-intestinal nematodes and cestodes are major endo-parasites infecting peafowls (Titilincu *et al.,* 2009; Jaiswal *et al.,* 2013). Parasitic infections are among the most common sanitary problems affecting wild birds and become either a sub clinical condition or even a cause of death, they have attention only when they have threatened agriculture or human health. Among parasitic diseases caused by protozoa, coccidiosis, is common and causes the most rigorous health and economic problems throughout the world (El-Shahawy, 2010). Besides the coccidiosis, there has also been a report of single cestode species in peacocks (Sloss *et al.,* 1994). These parasites infect the intestinal tracts of animals and birds. These are obligatory parasites that are characterized by the presence of apical complex in the free stages of cycle (sporozoites and merozoites) which invade the epithelial cells. *Eimeria* have direct life cycle (only one host), they are very site specific with reference to the development (intestine) and to cell types (epithelial cells of the intestinal villi or cells of the crypts) (Badran and Lukesova, 2006).

Though India, is the area with the highest diversity of Indian peacock species, only five species of *Eimeria* have been described so far from their faeces in this region (Banik & Ray 1961, 1964). Coccidiosis is known to cause serious mortality in galliform birds in captivity (Rommel, 2000). The average prevalence of the coccidiosis was reported to be 22% from January to June and was found to be more prevalent during the month of June (30%). Male samples showed higher prevalence of coccidiosis (28.57%) than female samples (20%). The disease was found more prevalent (26%) in peacocks of University of Veterinary and

Animal Sciences, Lahore and Household peacocks (Fiaz, 2013). The prevalence of infection with the parasite is as follows: (*E. pavonina* 48.3%); (*E. pavonis* 16.7%); (*I. mayurai* 3.3%) Titilincu *et al*., (2009). The symptoms of the disease include unthriftiness, loss of appetite, greenish or reddish diarrhea, huddling together, heads drawn in and ruffled feathers. In addition to weakness inability to stand and emaciation were also recorded at three out of twelve farms. The infected birds showed their comb and wattles pale and anaemic. Histological evidence revealed oedema, necrosis, leakage of blood, disruption and loss of villi. Severe unclotted blood may be observed in acute form (Soomro *et al.,* 2001). Coccidiosis is still the major disease problem of poultry in spite of advances that are made in control and prevention through chemotherapy, nutrition and management (Garbi *et al*., 2015). Seven species of *Eimeria* (*E. mayurai* from *P. cristatus, E. mayurai* from *P. muticus, E. pavonina* from *P. cristatus, E. pavonina* from *P. muticus, E. Pavonis* from *P. cristatus, E. pavonis* from *P. muticus, I. pellerdyi* from *P. muticus*) are identified as infecting peacocks (Al-Yousif and Al-Shawa, 1999). *E. arabica, E. mandali, E. patnaiki* and *E. riyadhae* from *Pavo cristatus* as well as *E. kharjensis n.sp.* and *E. mutica* from *Pavo muticus* are also reported (Al-Yousif and Al-Shawa, 1998). Although this disease is known for many years, it is still considered as the most economically important parasitic condition affecting poultry production throughout the world. These infections result in diarrhea, poor growth and eventually high mortality particularly in young birds (El-Shahawy, 2010).

Coccidiosis is considered to be a commonest depreciator or even a potential cause of death of poultry (Jadhav *et al*., 2012). It is a disease which develops within the intestine of most domesticated and wild animals and birds (Badran and Lukesova, 2006). The coccidia comprise of a large variety of unicellular parasitic organisms in the subkingdom protozoa of the phylum Apicomplexa (Conway and McKenzie, 2007). One of the past study repoted after examination, 8 of 12 samples (66.6%) presented single or mixed nematode infection and ascarid eggs were the most frequent finding on fecal examination in Indian peafowl. Adult peafowl did not present clinical signs even when positive after fecal exam (Teixeira *et al.,* 2012). Therefore, we found that the past studied result also agreed with the present study about parasitic infestation and coccidiosis. The several types parasitic infestation were found from the past findindgs but very common was ascarid infection which result also close agreement with current study finding in 2017 one of peacocks died from combined effect of ascariasis and coli-enteritis.

One of the common disease also reported in idian peafowl of BNZ, mycoplasmosis that was also supported by past study by Nadeem *et al.*, 2014, the paefowl can be hampered by the disease mycoplasmosis in breeding pens, wildlife parks and zoos. In the captivity high incidence of diseases of bacterial, viral, nutritional and parasitic origin of peafowls (Hollamby *et al.,* 2003). Mycoplasmosis caused by *Mycoplasma gallisepticum* (MG), *M. synoviae* (MS), *M. meleagridis* (MM) and *M. iowae* (MI) is reported to be one of the most highly infectious and prevalent disease. This disease can spread to a number of avian species including ducks, partridges, sparrows, quails, geese, pheasants, pigeons and peafowl (Bencina *et al.*, 1988; McMartin *et al.*, 1996; Ley and Yoder, 2008; Bradbury, 2001). Mycoplasma was first isolated in peafowl by Wills (1955) and reported to have similar characteristics to causative organisms of chronic respiratory disease (CRD) in chickens and infectious sinusitis in turkeys. Mycoplasmosis is quite common in birds kept in zoos. In the United States, prevalence rates of 38.7% and 3.2% have been reported for MS and MM, respectively in Indian peafowl kept at three Michigan zoos; whereas, the peafowl's in all of these zoos were sero-negative for MG (Hollamby *et al.*, 2003). One of the past study about the common organisms were found in peafowl in three zoos were *Bordetella avium*, *Mycoplasma synoviae Clostridium perfringens* and *Escherichia coli*. Some of those organisims was always found in the peafowl as commensalisms but some times they produced diseases wehen immune ystems do not functioning well (Stewart *et al.,* 1996). The current study also reported the case of mycoplasmosi in Indian peafowl of BNZ which result also supported by the past studied results.

The death toll of peafowls in captivity at breeding center was further supported by (Khan *et al.,* 2009) who reported that peafowls raised in inadequate conditions, on poor quality feed and exposed to natural pathogens most frequently became victims of nutritional, viral, bacterial and parasitic diseases. Present study results also supported by the above described past study results where we find the most common disease in early stage is salmenellosis and colibacillosis but in late stage coccidiosis and parasitic infestation. Without this one of the most important disease is mycoplasmosis which was also found in past study result.

Bacterial culture and nucleotide sequencing of the inflammatory specimens identified the causative agent as *Serratia marcescens*, an uncommon bacterium in birds. Sudden death of an Indian peafowl due to *S. marcescens* infection was rarely seen in animals (Lee *et al.,* 2015). Generally, gram-negative bacteria are not considered normal flora in an avian species (Saidenberg *et al.,* 2007). However, several previous studies by (Bailey *et al.,* 2002; Radwan and Lampky, 1972; Work and Rameyer, 1999.) have reported isolation of *S. marcescens* with or without clinical symptoms in birds, including houbara bustards (*Chlamydotis undulata macqueenii*), brown-headed cowbirds (*Molothrus ater*), raptors (Falconiformes), parrots and wedge-tailed shearwater chicks (*Puffinus pacificus*). The opportunistic infection of *S. marcescens* in the right eye of the bird attributes to the immunosuppression or liver damage, because the bacterium is not considered normal flora in avian species. These symptoms may in turn have been the result of old age, as well as the stress of being kept in a closed aviary (Yan *et al.,* 2014). Therefore, zoo veterinarians should be aware of *S. marcescens* infection in captive birds (Lee *et al.,* 2015). This past result was presented as an exceptional infection by causative agent *Serratia marcescens* which, generally do not infectect the bird but in this case infected peafowl and occurred death. Without this in current study we found a case deah of adult Peacock in 2016 due to heat stroke. That was also an exceptional case of India peafowl which, not recorded in earlier studies. So zoo veterinarians should be aware from those types of exceptional cases which may be occurred any time in Indian peafowl and also in other birds.

Newcastle disease (ND) is a highly contagious and fatal disease affecting poultry and a wide range of wild birds worldwide (Miller *et al.,* 2010; Dimitrov *et al.,* 2016). The Newcastle disease and fowl pox (FP) disese were recoded in past time in BNZ when no ND vaccine was administered in peachicks and adult peafowl routinely. Now the Newcastle dises and FP not break down in the peafowl flock because of routine vaccination maintained properly. There was no break down of avian influenza (AI) in peafowl of BNZ though one case sent to CDIL to diagnosis for AI, but it was found negative result. Science the AI vaccine also administered routinely to Indian peafowl to prevent this disease. In adult peafowl most of the diseases were treated by proper medication and finally recovered from the diseases. However, in early stage before starting treatment some peachicks was found death because of immune system do not activated in peachicks. The parasitic infestation as well as coccidiosis case, the routine administere of drugs was found in BNZ and due to this that caseses were recovered properly. One of the important diseases was found mycoplasmosis, peafowl was suffered by this disease for long time. This disease management and treatment is very tough for zoo people and in this case, they treated the peafowl with two combined antibiotics as well as suppottive medicine for long time.

The nutrition related diseases were found as rickets, curled toe paralysis, nutritional roup, perosis, crazy chick disease and gizzard myopathy (white muscle disease). Other than the diseases, peafowls also suffer from several types of abnormalities like curled toes, lameness, wing injury etc. were found due to lack of vitamins or minerals (Schwartz, 1997). In addition, abnormalities occured due to accidental causes are very common (Hopkins, 1997). There were not many chances for a peachick in a brooder to injure itself. More commonly you may see chicks bullying one another - picking head feathers, grabbing wings, pecking at exposed feet. Some of this is them exploring, sometimes it is something into which you need to intervene. If anyone draws blood, they should be separated. If you notice a chick is being kept away from food or water, it should be separated (Kedreeva, 2011). That result also supported by present study where we found cannibalism in peachicks due to mineral deficiency. Only few results of nutritiona deficiency diseases and abnormalities were recorded in the past studies and most of which also supported by the present study. The current study also found same type of abnormalities in Indian peafowl but abonormalities number as well as variation was found more in present study. This is because of current study considered so many things as abnormalities though past study overlooked that science of these abnormalities recovered automatically or medicated with vtamn-mineral mix for few days. On the other hand, most of the abnormalities mainly caused from vitamin-mineral deficiency and environmental factors. Therefore, these were easily recovred from supply of specific vitamin-mineral and remove the environmental factors properly. As we know peaowl prefer to live in captivity and due this suffer from low number of diseases. The diet is very important for suffering from several types of diseases, because from the past sudy by Norris, (1999) was found that the peafowl did not burn their excess protein and calcium by walking more and they will suffer from gout and kidney failure. In the present study we also found good number of gout cases, this is because in captitivity not burning protein and calcium properly due to not walking more in captivity.

Without this from the past stuy results we know the peahen mates with the favored male produced large eggs with more testosterone hormone deposited in egg yolk. The peachicks hatched from the mating who has the largest and more eye-spots tend to grow faster and have better survival rate (Petrie and Williams, 1993). Most of the peacocks were found with good and large numbers of eye-spots whcich help to initiate more immunity in peachicks and suffers from low numbers of diseases in early stage. We also found that some time commensalism microorganism like *E. coli* also do dieases in peachicks because in early stage immune systems did not functioning well. From the above discussion, we can say that the Indian peafowl was suffered from the diseases like the diseases of chicken species as well as turkey bird species. Therefore, it is easy to diagnosis and treatment of peafowl diseases and abnormalities for management people. Without this available vaccine and medicine can be found easily from the market due to same type of disese like chicken and turkey species.. Therefore, diseases and abnormalities diagnosis as well as treatment procedure can be maintained easily. By this way management people of BNZ for Indian peafowl properly identified the diseases and abnormalities as well as can be taken the next steps of management perfectly.

3.2 Predators and disturbing animals for Indian peafowl

There were several types of predators like rats, mice, cats, dogs, crows, monitors and kites available in the premises of Bangladesh National Zoo (Table 3.3).

Table 3.3: Predators and disturbing animals for Indian peafowl in Bangladesh National Zoo

SL No.	Predators
1	Rats
2	Mice
3	Cats
4	Dogs
5	Mongooses
6	Bengal Monitors
7	Yellow Monitors
8	Crows
9	Kites
10	Snakes

Without these, few numbers of Bengal Monitor, Yellow Monitor and Mongoose were found of premises of Bangladesh National Zoo. Moreover some cats and dogs were also recorded during current study (Table 3.3). The crow sometime entered in aviary and predated on Peachicks. Without this, Rat and Mice sometime entered in the houses and bite the Peafowl's. The snake is the predator mainly for peachicks but on the other hand adult peafowl predate the snake as like as predator. Nevertheless, the protection systems of habitats were very good for preventing them to those predators.

The common predators for the chicks are crows, fox, wildcat, mongoose, kite, rat, domestic cat, etc. (Saleque *et al*., 1996) which is also supported by the present study result where we found the common predators were Rat, Mice, Cat, Dog, Crow, Monitor , Mongoose, Kites etc. available in the premises of Bangladesh National Zoo.

The natural enemies' Indian peafowl was found large cats like civets, tigers, leopards. Some cases also by wild dogs like dholes and jackals are also considered to be main predators. But the peafowl can run fast to escape from their attract but suddenly in accidental case they were predated by those animals (Jackson, 2006). In case of free-range peafowl's, predators like coyotes, dogs, and foxes are the main concern for peafowl owners. Tree houses are the best way to protect them from predators, and peafowl love to roost up high (Allie, 2017). Peacocks are quick to detect the presence of the larger cats on the prowl and herald the marauders' progress through the forest with loud warning alerts, which are taken up by other cocks and by langur monkeys (Black *et al.,* 2010). Shrub cover decreases the chances of nest predation by ground dwelling predators, so Indian peafowl favours high shrub cover during its breeding period (Budgey, 1994). This bird has lengthy and robust legs that are equipped with brush for their protection from predators (El-Shahawy, 2010). The nest is a depression scratched out in the ground and lined with grass. Nests in such locations are many times destroyed by snakes, mongoose, and jungle cats which will eat the eggs. Peahens that are sitting on these nests are vulnerable to attack by jackals, fox, and stray dogs which will kill the peahen Virdi, (2008).

Incidences of mortality of Indian peafowl, the national bird (Schedule I Indian Wild Life Protection Act 1972), are rampant in India (Nambirajan *et al.*, 2018). The high demand of its train feathers, it is presently under threat (Johnsgard, 1986). The adult Indian peafowl can usually escape ground predators by flying into trees. Leopards are able to ambush them but in some areas such as the Gir forest, peafowl are the common prey of Lion too (Parashrya and Mukerjee, 1999). Chicks are more susceptible to predation than adult peafowl. The adults are sometimes hunted by the humans and domestic dogs in some human nearby areas. In some areas like Southern Tamil Nadu the "peacock oil" is used for folk remedies Johnsingh and Murali, (1981). Adult peafowl usually escape ground predators by flying into the trees. In some regions such as Gir forest, peafowl are common prey for large predators like leopards, tigers and dholes Parasharya and Mukherjee, (1999). The peafowl are provided with more safety when they forage in groups as there are more eyes to look for predators Yasmin and Yahya, (2000). Sometimes large birds such as Crested Hawk-Eagle and Rock Eagle-owl also hunt them (Dhanwatey, 1986; Tehsin and Tehsn, 1990). Though in Keoladeo National Park, there is a complete lack of large predators, but Jackals prey upon adults, young ones as well as on eggs, chicks are highly prone to predation. The mature peafowl's living near human habitations is sometimes hunted by domestic dogs or by humans in some areas (southern Tamil Nadu) for folk-remedies involving the use of peacock oil (Johnsingh and Murali, 1981). Their heavy loaded weight of their train-feathers could be the reason of their death, as they cannot fly as soon as possible at the time of predators catching. Their call activity during roosting is the most negative aspects and get more prone to predation. As, state forest department revealed that peafowl mortality rates is mostly through predators like wild cats, jackal, python and many more ((Dookia, 2015). Jackal (*Canis aureus*), feral dogs, python (*Python molurus)* and Common Indian Monitor Lizard (*Varanus bengalensis*) are the common Predators (Kushwaha and Kumar, 2016). Their loud calls make them easy to detect, and in forest areas often indicate the presence of a predator (Gurjar *et al.*, 2013).

Peafowl is regarded as one of the serious pests of agriculture. The use of pesticides in agriculture also poses a threat especially to the chicks (McGowan and Garson, 1995). Illegal trading of train-feathers for selling in the local markets is still being done in most of the places. Around KNP, the mortality records of peafowl are very high and this is because of trading of train-feathers mostly. The reasons of their mortality could also be human intervention in their habitat patterns (Dookia, 2015). Peacocks are also caught for their magnificent tail feathers, and also for making 'peacock oil'. In agricultural areas and in home gardens, peafowl are also attacked by dogs (Santiapillai and Wijeyamohan, 2015). Adult peacocks living near human habitations are sometimes hunted by domestic dogs (Sabesh, 2010). Which is also supported by the present study where we found dog in the premises of BNZ that has the chance to predate peafowl when escape from houses.

Above mentioned most of the past studied results about predators presented for the wild ranging peafowl. For this reason though some predators were found available in premises of BNZ for Indian peafowl but they did not do predation due to properly enclousyed the peafowl in enclousers. On the other hand the present study result represented the semi-wild rearing of peafowl in captivity of BNZ.

One of the past finding said you need to be aware of predators. Allowing them the ability to free range can provide you with many enjoyable hours of entertainment by coyotes, bobcats, raccoons, foxes, domestic dogs along with other large animals will all enjoy having your peas for dinner. Free from danger of peafowl make sure there are no holes or gaps in the lower part of your fencing and chicken wire or hardware cloth is best for covering up holes. Make sure you lock all doors at night for protecting peafowl from predators. Latches, carabineers and even deadbolts are all great to use depending on the door type.

Remember, roofs should be sturdy and under good condition so that no predators can enter (www.backyardchickens.com, 2018). The present study result also supported by above mentioned study result that was be carefulness of all ways to prevent predators. As we know predator is always a important factor for considering more live peachicks finding so it is very important to prevent predation by predators. The peachicks generally reared very protectively in good houses in early stage. That brooding house was fanced properly in quarantine shed. Without this the adult peafowl house or habitat was made with strong wirenet and comprises with several resting and roosting sites. The opening of the drainage system also protected by hardwire to prevent enter predators. Witout this in the aviary there were found several types of big trees as well as small sheds, which help to roosting properly. As we know in the late evening, the peafowl roosing in the upper branches of trees for protecting them from predators. The adult peafowl, sometime fight against predators by using their spurs and wings and protected them from predators. On the other hand if an adult peafowl scape out fom its enclouser in BNZ they will find available tall trees in the zoo for roosting and can save themselves from predators. Without this if any peachick escape out from its enclouser, they can not go out from the building of quratine shed because the brooding house maintain in the quarantine building shed. Thereore, we found that the zoo management authority was taken prevention measures propely by several ways to protect peafowl from predators. Finally, it can be said that mainly the peafowl habitats should be managed properly to protect from predators. So the peafowl house in the BNZ was ensuring proper enclosures, which minimize the risk of entering predators as well as visitors.

3.3 Preventive measures against Disease conditions and Abnormalities

Vaccine against Newcastle disease (ND), owl pox (FP) and avian influenza (AI) were used for Indian peafowl in Bangladesh National Zoo to protect those diseases. The vaccines were administrated based on the vaccine production company direction (Table 3.4). Vaccine against ND was given usually at 5 days and 21^{st} days, 2 month, 4 month then regular yearly, but vaccine against avian influenza H5N1 strain @ .5ml in the adult peafowl yearly and then vaccine against fowl pox was supplied at the age of 30 to 31 days, single dose.

Table 3.4: The most important preventive measures against disease conditions and abnormalities of Indian peafowl in Bangladesh National Zoo

SL No.	Preventive measures
1	Vaccination against ND
2	Vaccination against fowl pox
3	Vaccination against avian influenza
4	Anti-parasitic drugs start from 4 month of age
5	Routine anti-parasitic medicine supply
6	Glucose water supply in early stage
7	Antibiotic water supply in early stage for preventing omphalytis
8	Routine check-up
9	Routine multivitamin and mineral supply in winter season
10	Routine electrolyte solution and vitamin –C supply in summer season
11	Vitamin-mineral supply also in other time when need
12	Amino-acid solution supply at the growing stage and molting stage
13	Calcium supply in breeding season
14	Vitamin-E and Selenium supply in breeding season
15	Routine multivitamin and mineral supply in breeding season
16	Vitmin AD_3E supply in breeding season
17	Vitamin AD syrup supply in production season
18	Quarantine shed for diseased or newly arrived Indian peafowl
19	Properly maintain hygiene of Indian peafowl enclosure
20	Available space for dust bathing
21	Maintain a veterinary hospital

Without this medication against parasitic infestation was started from 4 month of age and later continued regularly six months interval. Some vitamin mineral and nutrients substances also used regularly for preventing several abnormalities and diseases. Amino acid solution supplied at the time of growing stage as well as train feathers initiation stage. To prevent of heat stress in summer electrolyte and vitamin-C supply in the water and in case cool stress in winter supply multivitamin and mineral in the water routinely. In early stage glucose water as well as some time antibiotic water supply for more energy and to prevent omphalytis of peachicks (Table 3.4). In the breeding season extra supply of vitamin AD_3E, calcium, vitamin-E and selenium, multivitamin and mineral and Vitamin AD syrup which help to maintain proper breeding stage for male displaying and sperm production and female good ova formation and egg laying (Table 3.4). Routine checkup was also found to prevent disases, abnormalities. Without this dust bathing space and quarantine shed as well as veterinary support was found available in BNZ for Indian peafowl (Table 3.4).

Vaccination programs for carnivores, nonhuman primates, equids, artiodactylids, and birds should be developed. Vaccination of zoo carnivores is essential because of their susceptibility to various diseases such as feline panleukopenia, feline rhinotracheitis, feline calicivirus, rabies, canine distemper, and canine parvovirus. But in case of birds, most of time used only ND vaccine. Previously, only killed virus vaccines were recommended, but recent studies have shown that some modified live vaccines are safe for use in selected species. The decision to vaccinate zoo animals for less common diseases for which a vaccine is available should be made on an individual basis. Newer recombinant and subunit vaccines are being developed for a variety of infectious diseases for domestic animals and humans. These vaccines should be used with caution until safety and efficacy studies have been completed for zoological species (Miller and Fowler, 2014). However, unless something worse is going on immediately, or your flock has had a previous infection of something and become carriers, most would advise against giving vaccines to your chicks. If your flock is clean and unvaccinated, and you vaccinate a chick, it can actually contract what you were vaccinating against and become a carrier. When it comes to vaccinations in birds, it is usually the whole flock or none of the flock (Kedreeva, 2011).

Wihout this we found that the dust-bathing of Indian peafowl is one of the most ommon behavior which prevent bacteria and other external parasites infestation. That result supported by the past finding as Ramesh and McGowan, (2009) point out, ‘dust-bathing’ is important to get rid of the feather-degrading bacteria and other external parasites another past finding was found by Santiapillai and Wijeyamohan, (2015) also similar result. Many of the jurisdictions we examined have implemented thorough requirements with respect to the care that must be given to captive wildlife and the safety of the people who come into contact with them. Most significantly, it is clear from an enforcement perspective that emphasis on a stringent, preventative application process is desirable (Bais *et al.,* 2017).

Most of the past study about prevention of diseases and abnormalities gave emphasis on control parasitic infestation, which make hazard in whole life of Indian peafowl. The past study result described the worms live in the intestine and they shed eggs in feces to re-infect the same bird or other birds by direct contact with the feces or by an intermediate host. When infected with these worms a bird can show a variety of signs from a poor health to diarrhea and ultimately to death. Endo-parasites in birds produce pathogenic conditions ranging from dilations of gut and nodule formation to severe enteritis. The parasites adversely affect the health of birds during the time of heavy infestation with loss in body weight, lowering the host resistance against other infections, retarded growth, unthriftiness, damage to the gut epithelium, reduced egg production, emaciation and death especially in younger birds (McSorley *et al.,* 2010). The parasites also damage the health of host by consuming nutrients and vitamins, decreasing feed utilization by the host causing intestinal obstruction and producing toxins resulting in progressive loss of condition of the host birds. The overall production may drop by 25% when moderately infected flock by parasites (Urquhart *et al.,* 1996). The parasitic infection transfer from infected to healthy birds by arthropod vectors, bird lice species and ectoparasites such as lice and ticks in peafowl's (Ponnudurai *et al.,* 2011). Young animals and those stressed by shipment, disease, or injury are the most likely to be adversely affected by parasites. At these times, commensal parasites (especially protozoa) can cause disease. Acute diarrhea can result from massive infections of Coccidia, Trichomonas, Giardia, or *Balantidium* spp. Amebiasis, which is fairly common in primates and reptiles, can be fatal in a compromised animal. Intestinal parasites may be a major, continuous problem in species kept in naturalistic exhibits or on dirt substrate or pasture, especially in young, newly introduced, or stressed individuals (Scott, 1988). Modern anthelmintics generally have a wide range of safety, considerable activity against immature larval and mature stages of parasites and a broad spectrum of activity. The "ideal" anthelmintic should have a broad spectrum of activity against mature and immature parasites (including hypobiotic larvae), be easy to administer, have a wide margin of safety and be compatible with other compounds and be cost effective.

A broad range of anthelmintics such as Hegngi *et al.,* (1999), has used albendazole and fenbendazole for their effectiveness in the treatment and prevention of histomoniasis (black head) in turkeys. Ashraf *et al.,* (2002), used Levamisole against gastrointestinal nematodes for common peafowl in different climatic areas. Parasitic infestation also cause of a potential health problem of animals including birds. Parasites invariably affect host production performance and resulted into great economic losses. The trickiest thing about worming your birds is going to be picking the wormers and the schedule for worming. Some wormers work by adding them to the birds water, some are injections, some can be mixed with their food or given orally. The method you have to use is going to determine which wormer you use. The schedule is going to be what you consider to be appropriate, but should be at least twice a year, though some people do this more often and of course you would treat if you noticed symptoms of your birds having an infestation. The twice a year worming is preventative and "house cleaning" in nature, not a restriction. It is usually recommended that you alternate wormers so that no worm builds a tolerance and so that you are sure to get all the kinds of worms you bird may be subjected to. If worming only twice a year, most people will do this at the start of the breeding season (spring) and at the end of the breeing season late summer/ fall (Kedreeva, 2011). Current study findings also supported by this pas study results where we found antiparasitic drugs used twice yearly and using patten was found very tricky. Combined used of safe drugs also used in present study for killing worm properly which is also supported by past study findings. Modern broad spectrum and safe antiparasitic drugs were used in BNZ in case of Indian peafowl for properly killed all of parasite and no more side effect, which was also supported by earlier study. Without this, one of the past studies suggested that regular check your peafowl for external parasites like mites, lice, and chiggers. Since peafowl are not common pets or farm animals, there is no established vaccine schedule for them, but avian pox, blackhead disease, and coccidiosis is always a concern (Allie, 2017). The foundation of a medical program for zoo animals is preventive medicine. Preventive medical programs should be adaptive and include attention to individual specimens as well as the herd, troop, or flock. Components of the program include quarantine of new arrivals, periodic fecal examinations and treatments for parasites, booster vaccinations, and health screening procedures, nutrition evaluation, necropsy examination of deceased specimens, and a comprehensive pest control program (Bais *et al.,* 2017). That past findings also supported by the current study where quarantine shed maintain properly.

Routine checkup is one of the mos important things for preventing diseases properly which is also supported by past findings of (Kedreeva, 2011). He described an unhealthy chick may be lethargic, not just sleepy. Where a healthy chick will perk and begin to be active if you disturb the brooder, an unhealthy chick may remain lethargic after waking. You may notice a chick walking funny. You may notice their stool is consistently watery, loose, or bloody. It may be lacking or overly heavy in white matter (urates). Your chick may sneeze or ‘gape’ its mouth and may have runny discharge from the nasal cavity or mouth. You may notice chicks huddling under the heat lamp if they are getting too cold (which can kill them). You may notice them avoiding the light and/or panting if they are too hot. If you see any form of injury or missing feathers in undue amounts (more than one or two in a patch may be the chick getting picked on). There should never be blood. Any wound that is any colour other than red or clear may be infected- especially if you see yellow, white, green, or black discharge. Skin around wound sites may be red or swollen if there is infection. Unhealthy chicks may not be eating or drinking properly. If you see any of these signs, or anything not mentioned but which does not resemble a healthy chick, there may be something wrong (Kedreeva, 2011).

Past of the most studies did not intensively consider vaccination schedule for their peafowl but in some cases they only considered about the ND vaccination schedule. Without this past studies also emphesis on, parasitic control of birds. On the other hand present study considered the vaccination properly for important dieases ND an FP as well as for AI also. On the other hand the good schedule for control parasite by using safe an broad spectrum drugs routinely.

Animals entering a collection must undergo quarantine. Quarantine facilities should be designed to allow handling of animals and proper cleaning and sanitizing of enclosures. Shipping crates should be cleaned and disinfected before they leave the quarantine area, and the crates’ contents disposed of appropriately. Quarantine facilities require barriers against ingress of potential vectors and vermin. Separate keepers who are skilled at recognizing signs of stress and disease and who will carefully monitor feed intake and fecal characteristics should care for quarantined animals. Quarantine entry should be strictly controlled. Only essential personnel should be allowed into the quarantine facility. Individuals leaving the quarantine facility should not return to other animal areas without showering and changing clothing. The duration of quarantine should be appropriate to ensure that infectious diseases are not introduced into the permanent collection when the quarantined animals are released to exhibits. Quarantine facilities should follow the "all-in/all-out" principle, i.e., if additional animals are added to an ongoing quarantine, the quarantine period should be restarted. During quarantine, animals should receive appropriate vaccinations and diagnostic testing (eg, tuberculosis, heartworm). They should be examined and treated for ecto- and endoparasites and screened for enteric bacterial pathogens. Before release, animals should receive physical and laboratory examinations, which may include radiographs, serology, hematology, and clinical chemistries. Serum should be frozen for future reference and possible epidemiologic studies (Martin *et al.,* 1987). There for screening of bird health bfore entering new shed should be done. That was done in quarantine shed and kept the peafowl minimu 30 days before releasing in new shed. Therefore, these findings also supported by the present study result.

It can be conclude that vaccination and antiparasitic drugs were commonly used by most of the peafowl caretaker from earlier study and present study findings from avobe discussion, but present study also took more preventive measures based on several stage of life of Indian pefowl. Without this quarantine shed and hygienic condition of enclosure of Indian pefowl is very important issue for prevention disease and abnormalities. On the other hand vitamin-mineral supply is one of most important factor for preventing several abnormalities like lameness and disease like rickets were maintained by most of the peafowl owners which also supported by the present study results. Routine checkup help to know about diseases and abnormalities about early stage which help to take preventive measures rapidly that protected from big loss. Without these measures, a well sated veterinary hospital for taking all measures to prevent diseases and abnormalities of Indian peafowl in BNZ.

3.4 Management against diseases and abnormalities of Indian peafowl

There was a big management system developed relation with feeds, feeding system and habitats for making protection against abnormalities, diseases and predators of Indian peafowl in Bangladesh National Zoo (Table 3.5).

Table 3.5: Most important management systems against disease conditions and abnormalities of Indian peafowl in Bangladesh National Zoo

Serial no.	Management systems
1	Predator control
2	Control of external feed supply
3	Control to enter outer person in the houses
4	Fresh water supply
5	Spinach supply
6	Fruit supply
7	Peanuts supply
8	Balanced feed supply
9	Adlibitum fresh water for all time
10	Supply the fresh feeds
11	Feed supply regularly
12	Cleaning regularly
13	Sanitation Properly

14	Take initiative quickly in any case
15	Wire netting properly into the houses
16	Brooding properly
17	Give enough space in houses
18	Clean feeder regularly
19	Clean waterer regularly
20	Proper management of litter in brooding house
21	Hardwire netting in drainage openeing

The house was made with good protection system for entering predators and also the visitors which help to protect predation and disturbing of visitors. Without this cleaning regularly, proper drainage system , controlling for entering predators and enough spaces in houses also help in protection against abnormalities, diseases and predators of Indian Peafowl in Bangladesh National Zoo (Table 3.5). Feeds and feeding system was also found very good like regular fresh feed supply, balanced feed supply and nutrias feed supply all the year round to their peafowl's in BNZ. Without this properly brooding of peachicks also, help to prevent many diseases as well as express good growth performance (Table 3.5).

Management of animals in captivity poses serious challenges that range from animal welfare considerations, space requirements, human skills, veterinary care and visitor satisfaction to financial requirement (Audigé *et al.*, 2001). Management of captive wildlife is broad and specialised. Whilst there are many examples of good practice, some captive wild animals suffer because of poor welfare standards. Compounding this is that some animal facilities are unregulated and uncontrolled. Some of these are poorly designed, managed and maintained and are unable to provide the barest essentials necessary for the health and psychological well-being of the animals under their care. The most common shortcomings in captive facilities are: undersized and ‘barren’ cages and enclosures, unsuitable floor surfaces that can be injurious to the animals and also difficult to clean to maintain good hygiene, poor quality feed and nutrition, inadequate veterinary/health care and insufficient expertise in appropriate animal care and in some instances ignorance of legal provisions (Woodroffe, 1999). One of the past study result reported restricting the free movement of visitors in wildlife parks as well as zoos and adopting the proper biosecurity measures is vital to minimize the risk of infectious diseases in Galliformes (Nadeem *et al.*, 2014). A successful control program is continuous and requires a concerted effort by zoo staff to minimize harborage and food for pests, in addition to the use of mechanical and chemical control methods. Choice of agent, method of use, and storage may minimize zoo animals’ access to pesticides and the risk of secondary poisoning. Common zoo pests may serve as important disease vectors. For example, cockroaches are intermediate hosts for Gastro- Intestinal (GI) parasites of primates and birds; rodents can harbour and spread Listeria, Salmonella, and *Leptospira* spp and *Francisella tularensis*. Pigeons, geese, ducks, and starlings are potential reservoirs for avian diseases; they consume or contaminate animal food and deposit droppings everywhere. Arthropod vectors can transmit pathogens such as West Nile virus (Leighton, 2002).

Dehydration can occur in chicks which are shipped or which haven't figure out how to drink quite yet, or which are afflicted by some other problem. You will most likely not be able to tell by the amount of water difference in the waterer. If you think your chick may be dehydrated, you can attempt to pull a flap of skin away from the body (pinch a little bit of skin, over the shoulder perhaps) and observe how quickly it returns to the original form. When properly hydrated, the skin will return to normal almost instantly. In a dehydrated bird, the skin will sink slowly back to place, or maintain the pinched form briefly in severe cases. Dehydrated birds may appear lethargic, wobbly, or be cold to the touch. When you receive new birds through hatching or shipping or pick up, ensure that they are drinking before leaving them alone, even if it means sitting by the brooder for a while or "pecking" at the water with your fingers to help them. You can also provide electrolyte water (such as Pedialyte) to new birds (Kedreeva, 2011). The management practices (feeding, housing, productive and reproductive performance) used for rearing the peafowls in captivity was different in different breeding centers in Pakistan (Ali *et al.,* 2011). Husbandry and nutrition Nutrition standards speak to the basic need to nourish the animals in a manner that ensures their continued physical health. Access at all times to clean water, for example, is essential. Equally important, however, and widely acknowledged, is the requirement that a diet be tailored to the species and include a broad variety in the types of food provided to enhance the captive animal's quality of life. A zoo veterinarian has to evaluate and approve husbandry and assist in developing nutrition programs for each species within a collection. Each animal must receive a timely supply of wholesome and unadulterated food insufficient quantity, according to the requirement of each individual. Potable water must be available around the clock in each enclosure (Ahl *et al.,* 1993).

The basic safe care of any peachick should ensure that they are not exposed to environmental issues that would put them in harm's way. Their food should be kept dry and clean, including the feeder. Any food that is not dry should be dumped and fresh food should be added- damp food can mold or rot and kill your chicks. Water should be provided fresh daily as needed and should be provided away from the food to prevent them from wetting the food. Their bedding should also be clean and dry, and should be replaced if it is not. Their bedding or brooder bottom should be such that they can get a grip to stand properly but cannot get their claws/toes stuck in anything. There should be no sharp objects in the brooder (including wire ends if you have a wire bottom brooder) or on the walls/ceiling where they might injure themselves. You will want to avoid housing your chicks where they can catch drafts that might cool them, and ensure that their heat lamp is both hot enough and that there's space to get away from it if needed (Kedreeva, 2011).

A well-defined personnel health policy is also an important part of a preventive health program. Several infectious diseases of humans, such as tuberculosis, measles, and amoebic dysentery, can be acquired by captive wild mammals, especially primates. Pre-employment screening and proper training, plus periodic tuberculin testing and health monitoring during employment, will minimize the potential for disease transmission from caretakers to animals (Bais *et al.,* 2017).

The management of the most common found infectious disease mycoplasmosis was done properly by drinking water, litter management properly. Which was also supported by past study result, most of the commonly occurring infections caused by MG and MS in captive peafowl and pheasants are associated with respiratory diseases and are characterized by foamy eyes, swollen infraorbital sinuses, respiratory distress and death, but in peafowl its mechanism of transmission is unknown (Cookson and Shivaprasad, 1994; Hollamby *et al.,* 2003). Transmission may be associated with infected hosts at shared feed stations or shelter areas in the winter season (Hollamby *et al.,* 2003). Other avian species, including turkeys, chickens and bantams, may be the cause of transmission of MG in peafowl maintained in cages, and further transmission of the disease may occur by farm-to-farm movement of workers, visitors and other personnel on farm (Mason and Maiers, 1984). Christensen *et al.,* (1994) reported that MG remained alive in human hair for up to three days and MS up to eight hours, and on the nose and clothes MG and MS survived 12-24 hours and two to four days, respectively. Avian mycoplasmosis may be transmitted vertically through the eggs, or horizontally by direct contact between sick or unaffected carriers and susceptible animals. Indirect transmission via people, wild birds, drinking water, litter or breeding material may play a major role in the initiation of MS outbreaks because of the possible persistence of

Mycoplasma spp. In the environment (Marois *et al.,* 2000), MG and MS infections were frequently found in game birds where multiple housing of different avian species was practiced (Reece *et al.,* 1986b; Cooksoon and Shivaparasad, 1994; Hollamby *et al.,* 2003; Nadeem, 2010). Bencina *et al.,* (2003) reported that addition of new birds within the flocks, without serological screening, could be a possible cause of infection in pheasants and peafowl. Christensen *et al.,* (1994) reported that MS and MG survived in the feathers of birds up to three or four days, respectively, which showed that newly introduced birds may act as carrier for MG and MS infection within flocks. The death of Peafowl's in captivity at breeding center was further supported by (Khan *et al.* ,2009) who reported that Peafowl's raised in inadequate conditions, on poor quality feed and exposed to natural pathogens most frequently became victims of nutritional, viral, bacterial and parasitic diseases. Based on this above mentioned past study the present study result was found good management against several diseases and abnormalities as well as control predators which helped prevent diseases , abnormalities and control predators of Indian peafowl in BNZ. Animals should be evaluated to ensure their health complies with local, state, and federal health requirements before shipment to other zoos or before release in managed reintroduction programs. Preshipment evaluations can also be used as an opportunity (Bais *et al.,* 2017). Captive animal facilities become the homes for these individuals for purposes of nurturing them. The welfare of each individual animal in these facilities is of primary concern (Audigé *et al.,* 2001). Witout this transmission of several diseases also stated in past study which also supported by present study, quarantine of diseased peafowl and treated properly. Without this transfering fom brooding sheds to growing sheds the peachicks kept in quarantine shed for adapting properly and by this way diseases transmission can be prevented. External supply of feeds by visitors sometime cause food poisoning as well as chocking which is very dangerous situation for peafowl therefore, the zoo authority tried their best to prvent supply of any feeds by visitors.

Without this several types of feeds supply based of important nutrients compositions which help to maintain proper health of peafowl. Litter management in brooding house also very important, because of more weted and dried litter cused several diseases to peachicks. Entring visitors as well as predators both cuses the chances of zoonotic diseases breakdown as well as predation peafowls by prdators. After hatched out of birds at zoo should be examined to check their health, to give those vitamins, their first vaccinations and some kind of individual identification. The signs of hungry status are frequent making of sound but in case of full stomach, the baby bird's looks with normal and sound health appearance (Kleiman, *et al.*, 2010). In case of peachicks of BNZ the authority supplied adlibitum amount of feed and clean water so that they can intake as their requirement. Above findings most of the past results as well as management systems were similar to current study management systems.

The summarized management systems involved in Indian peafowl rearing in BNZ were found all time supplied of fresh and required amount feeds routinely which saved peafowls from several diseases and nutrient difeciency. Adlibitum water for peafowl was supplied which was liked by peafowl and those maintained physiological activities properly. Without this, a good number of husbandry people are available in BNZ for taking any managemental decision for well being of Indian peafowl. Finally, we concluded that welfare of Indian peafowl in BNZ, which was maintained properly freedom from injury and disease and pain by prevention of rapid diagnosis of diseases and treatment perfectly. The enclosure design also has done which minimize the risk of injury and ensured animal could get away from each other, as well as mixed species could not injure each other. Providing correct diet and suitable hygienic environment by BNZ authority prevented and controlled diseases.

3.5 Treatment for Disease conditions and different Abnormalities

Antibiotics used mainly for infectious diseases and the most common antibiotics were Oxy-tetracycline ad Gentamicine. Without this anticoccidial drugs used against coccidiosis which was also a common disease of Indian peafowl in BNZ (Table 3.6).

Table 3.6: Treatment of disease conditions and abnormalities of Indian Peafowl in BNZ

SL No.	Treatment
1	Antibiotics
2	Anticoccidial drugs
3	Antihistaminic
4	Antiparasitic drugs
5	Anti mycoplasmal drug
6	Sulfar drug
6	Vitamin-mineral
7	Vitamin B-complex
8	Vitamin-C
9	Saline solution
10	Antiseptic uses in injury
11	Surgery

Antibiotics, anti-coccidial drugs, antihistaminic, anti-parasitic drugs, anti-mycoplasmal drug, vitamin-mineral premix, vitamin B-complex, vitamin-C and saline solution were found mainly used drugs (Table 3.6). Without this in case of injury antiseptic as well as surgery was used and then other supportive drugs also used (Table 3.6).

Several types of medication based on diseases were maintained properly by Physician prescription. A veterinary hospital is sated in the BNZ for treating and preventing several types of abnormalities and diseases. The most common medication based on diseases was implemented is as follows: In case of omphalytis- oxytetracycline, 5-7 days; weakness – multivitamin and mineral solution, 5-7 days; parasitic infestation- piperazine citrate/ albendazole/ fenbedazole / single dose or some time double doses; coli-enteritis - doxicycline+colestin; salmonellosis- oxytetracycline, 5 days; mycoplasmosis/infectious bronchitis- tylosin/ doxicycline+colestin, about one week; coccidiosis-sulfa drug /sulphaclozine sodium monohydrate, 3-5 days; bumble feet - iodine swabbing and oxy tetracycline, 5 days and wound – iodine or potassium permanganate solution as antiseptic, up to required time. However, in case of surgery – inject 0.5 ml oxtetracycline for 4-5 days and dressing properly by antiseptic and supportive treatment by antihistaminic drugs. Without this for curled toes treatment was done only for few days by Vitamin $B_{126.}$ On the other hand specific treatment and others supportive treatment with vitamin mineral and antihistaminic drugs were used for rapid recovery and proper cure of the diseases and abnormalities of Indian peafowl in BNZ. Many medications can be obtained through your vet if you know the name of the medication. Some case of infection in early stage peachicks should be on some form of medicated starter (Kedreeva, 2011). This also supported by the present study where in case of omphalytis the peachicks were supplied with oxytetracycline added water in first few days.

Dehydration can occur in chicks which are shipped or which haven't figure out how to drink quite yet, or which are afflicted by some other problem. You will most likely not be able to tell by the amount of water difference in the waterer. In a dehydrated bird, the skin will sink slowly back to place, or maintain the pinched form briefly in severe cases. Dehydrated birds may appear lethargic, wobbly, or be cold to the touch. When you receive new birds through hatching or shipping or pick up, ensure that they are drinking before leaving them alone, even if it means sitting by the brooder for a while or "pecking" at the water with your fingers to help them. You can also provide electrolyte water (such as Pedialyte) to new birds (Kedreeva, 2011). This finding also supported by the prent study, dry weather condition when birds were in painting and dehydrated they supply electrolyte in water for 3-5 days.

In general, vaccination and treatment will be most valuable in tiny populations facing very high extinction risks (Woodroffe, 1999). In the course of wildlife conservation and management, some individual animals get orphaned, sick, injured or otherwise incapacitated necessitating interventions to assure them of a life. In many cases during the course of treatment and care, these animals get habituated making it extremely difficult if not impossible to rehabilitate them back to the wild (Audigé *et al.*, 2001). Like domestic animals, zoo animals are vulnerable to a wide variety of ecto and endoparasites, and similar drugs are used for treatment. Care must be exercised in the choice of medications due to species-specific sensitivities to some drugs. Of most concern are parasites with direct life cycles. Incorporating anthelmintics directly into the feed is helpful. As in domestic species, anthelmintic resistance may develop and necessitate rotating medication. Parasites with indirect life cycles are less frequently a problem if the exhibit area is free of intermediate host (Scott, 1988). The best control is prevention of the introduction of Pasteurella into the flock from new birds, sick birds, or contaminated materials and equipment. Vaccines are commercially available but are only marginally successful. Outbreaks can be brought under control by flock medication with sulfa drugs and antibiotics. Premises will remain infected following a FC outbreak unless a thorough decontamination program is conducted (Schwartz, 1997). In case of typhoid the bird's shoul be eradicated from flocks. Losses from paratyphoid can be reduced by medication, neomycin or nitrofuran, in the chick starter feed. Outbreaks of staphylococcosis do respond to antibiotic therapy that can be administered to birds individually or to the flock in the feed or water. Improved sanitation of the housing environment and better flock management will help control staphylococcosis. There is no treatment against TB. Improved management, better sanitation of the environment will help to prevent the introduction of the disease (Schwartz, 1997). Control of lice is established by initiation treatment for all birds in the flock on a periodic basis with an approved safe pesticide. Treatment is not recommended unless lice are present on the birds. The life cycle of mite is 7 to 14 days so control requires treatment at 10 day intervals for 3 to 4 treatments and monthly thereafter of all birds in the flock with an approved safe pesticide (Schwartz, 1997). Modern anthelmintics generally have a wide range of safety, considerable activity against immature larval and mature stages of helminths, and a broad spectrum of activity. Nonetheless, the usefulness of any anthelmintic is limited by the intrinsic efficacy of the drug itself, its mechanism of action, its pharmacokinetic properties, characteristics of the host animal, and characteristics of the parasite whether it has developed anthelmintic resistance. The ideal anthelmintic should have a broad spectrum of activity against mature and immature parasites (including hypobiotic larvae), be easy to administer, have a wide margin of safety and be compatible with other compounds and be cost effective. Generally the broad range of anthelmintics have been used against helminths such as albendazole and fenbendazole for their effectiveness in the treatment and prevention of histomoniasis (black head) in turkeys by Hegngi *et al.,* (1999), levamisole against gastrointestinal nematodes in common peafowl by Ashraf *et al.,* (2002) in different climatic areas. Coccidiosis is best controlled by preventative medication in the feed during the susceptible age of the birds. Coccidiostats (preventive drugs) are available commercially with Amprolium and Rofenaid being the most prominent two. If a coccidiostat cannot be obtained, any good sulfa drug can be substituted in the feed. When outbreaks occur, birds can be treated with sulfa drug in the drinking water. All drugs should be used in accordance with the label instructions (Schwartz, 1997). Amprolium is one of the most used medicines against coccidiosis. Coccidia are single-celled protozoa which act as parasites and which infect the intestinal tract of some animals, including birds. Young birds, especially new chicks, are most susceptible to death from this infection because their digestive systems are not strong enough to combat it. Adults which carry the protozoan are usually strong enough and will not show symptoms even if they are infected. The symptoms include lethargy, loss of apatite, dehydration, loss of balance, and blood in the stool. Coccidiosis is common enough that most medicated starters include amprolium, a preventative medication. When purchasing a medicated starter, always check the back for the ingredients as some starters do not include this, but can still be considered medicated because they have other medications in them (Kedreeva, 2011). Histomoniasis can be controlled by specific medication of a bird or flock at the onset of an outbreak or prevented with the use of a histomonastat, drug specific from histomoniasis, in the feed. Presently there are no Food and Drug Adminitration (FDA) approved histomonastats. Currently, metronidazole (flagyl), copper sulfate, and Histostat are the medications used for the treatment of blackhead. The symptoms are similar to Histomoniasis with treatment and control the same as for histomoniasis (Schwartz, 1997). The diseases of peafowl are almost identical to those of its New World counterpart, the turkey.

Likewise, peafowl will respond to medications that are known to be effective for the turkey. This is to say that anyone experiencing illness in peafowl can consider it a turkey in seeking diagnosis and establishing a treatment (Schwartz, 1997). In case of injury peafowl was injected oxytetracycline, 0.50 ml/IM, finding of current study. If you must give an injection to one of your peafowl, unless specifically directed to be a veterinarian, do not inject into the breast muscles of your bird. If possible, subcutaneous injections should be given, and the best spot for this is between their wings along their back (Kedreeva, 2011). Treatment requires the correction of the deficiency in the feed plus a short period of vitamin-electrolyte supplementation in the water (Schwartz, 1997), that also supported by the current study.

**A standard disease based treatment for several diseases schedule by (Kedreeva, 2010) was found as follows:

Tylan 200 (Trade name-NOT 50) - Used typically for respiratory infections/problems

Ivermectin - Wormer

Duramycin - Antibiotic

Fenbendazole - Wormer (found in safe guard for goats)

Wazine - Wormer (for roundworms only)

Meloxicam (Trade name-Metacam) - Anti-inflammatory/Pain medication (Non-steroidal, most steroidal anti-inflammatory medications are only given in the event of emergency, as in cases where birds have gone into shock)

Ammoxicillan - Anti-biotic

Baytril - Strong Anti-biotic

**Another standard disease based treatment for several diseases schedule by (Kedreeva, 2011) was found as follows:

Tylan 200 (Tradename-NOT 50) - Used typically for respiratory infections/problems. Available without prescription.

Ivermectin - Wormer (Ivomec brand name wormer for goats). Available without prescription.

Duramycin - Antibiotic. Available without prescription.

Fenbendazole - Wormer (found in safe guard for goats). Available without prescription.

Wazine - Wormer (for roundworms only). Available without prescription.

Meloxicam (Metacam) - Anti-inflammatory/Pain medication (Non-steroidal, most steroidal anti-inflammatory medications are only given in the event of emergency by a vet, as in cases where birds have gone into shock) Prescription needed.

Ammoxicillan - Anti-biotic (usually oral). Prescription needed.

Baytril - Strong Anti-biotic (usually oral). Prescription needed.

Flubenvet – wormer

Solubenol - wormer roundworms, cecal, capillary

Corid – Coccidiosis. Available without prescription.

Sulmet - Coccidiosis. Available without prescription.

Amprolium - found in medicated starter, preventative for coccidosis. Available without prescription.

Valbazen- wormer

Levamisole- wormer

The ailing pea fowl chicks were treated with Albendazole oral suspension @ 5mg/Kg body weight. No Ascaridia eggs could be detected on the examination of faecal samples of the treated pea fowl chicks on 7th and 14th day post treatment and the birds recovered (Rao and Hafeez, 2006). The parasites production can be controlled by mixing of sulpha quinoxaline and diaveridine in the drinking water (Williams, 1978). Peafowl should be treated with metronidazole, tetracyclines, fenbendazalo, manually removed and to prevent from Ectoparasites birds treated with malathrin-piperonyl butoxide, carbaryl malathion, screen enclousers, Pyrethrin carbaryl powder (Stadler and Carpenter, 1996).

There are so many effective treatment for mycoplasmosis was reported several past studies which were in the treatment of avian mycoplasmosis, antibiotics are frequently used in naturally infected birds (Hamdy *et al.,* 1982; Glisson *et al.,* 1989; Charleston *et al.,* 1998; Hannan, 2000) but the development of resistance against various antibiotics has been reported by various scientists across the globe (Bradbury *et al.,* 1994; Gautier-Bouchardon *et al.,* 2002; Pakpinyo and Sasipreeyajan, 2007). Tripathy *et al.,* (1972) treated the infraorbital swelling of peafowl with vitamin A and terramycin (intramuscular; I/M) and terramycin

(0.5ml) infused into the swelling after removal of exudate. Clinical signs disappeared within ten days and birds resumed their normal feeding. The signs did not reappear until after the six months of therapy. Reece *et al.*, (1986b) reported that treatment with sulphonamide did not reduce the number of new cases within the flock, and so tylosin was recommended in infectious sinusitis associated with MG in peafowl, turkeys and other game birds. Reece *et al.*, (1986a) successfully treated mycoplasmosis in racing pigeons with tylosin followed by oxytetracycline or chlortetracycline at a dose rate of 0.2-0.5 g per litre of drinking water for five days. These avobe described treatment schedules helped to improve bird health gradually.

Wissman and Parsons, (1996) treated MS infection in the common rhea (*Rhea americana*) by injecting long acting doxycycline at a dose rate of 20 mg/kg of body weight (I/M) and tylosin at the dose rate of 250 g/8 ounce in drinking water, with the addition of vitamin AD3 and B-complex (thiamine) as supportive therapy. All of the birds rapidly responded to this therapy and complete resolution of ocular and nasal lesions was observed. Fiorentin *et al.*, (2003) reported the eradication of mycoplasmosis by oral administration of oxytetracycline, enrofloxacin and norfloxacin in feed and drinking water of broiler breeding flocks. Roussan *et al.,* (2006) demonstrated that administering tilmicosin (Provitil® powder) at a dose rate of 30 mg/kg of body weight for three successive days and repeated every five weeks for four months in Galliformes successfully controlled the infection of MG in eight flocks. Charleston *et al.,* (1998) reported the effectiveness of tilmicosin towards air sacculitis caused by MG in avian species at the dose rate of 50 mg/l in drinking water for three to five days. In a therapeutic trial Nadeem, (2010) reported a 75% recovery rate in captive peafowl by using Tylax (tylosin) oral powder (Routhas®UK) at the dose rate of 200 mg, and a 100% recovery rate by the use of Oxytet (oxytetracycline; The Russell® USA) at the dose rate of 1 gm in two litres of drinking water for five days every two weeks. Clinical signs disappeared after seven to nine days, and birds improved their feed consumption.

Forrester *et al.,* (2011) treated infectious sinusitis associated with MG in pheasants with tylvalosin (TVN; aivlosin, a macrolide) at a dose rate of 25 mg/kg of body weight for three consecutive days. They reported that TVN had better efficacy over other macrolides (tylosin and tilmicosin) because of its high absorption from the alimentary tract from where it entered the lungs, especially the epithelial lining of the respiratory tract. If your bird is gasping, wheezing, has a swollen face, has nasal discharge or discharge in their eyes, is coughing, or sneezing, it may be in some sort of respiratory distress ("gaping" as opposed to gasping may be a result of worms, specifically gapeworm, see below). Most of these symptoms can be treated with Tylan 200. A 1cc dose can be injected subcutaneously (under the skin, above muscle) between their shoulders. Give this dose once a day for three days. Pneumonia is usually put into the same category as respiratory illness, as it presents with a lot of the same symptoms. They may sneeze, cough, shake their heads, produce fluid/discharge from the nostrils or mouth, breathe with their beak open, or you may hear a rattle in their breathing. Vets may sometimes recommend this be treated with a regimen of Baytril (an antibiotic) tablets. For one of the members here, a vet prescribed precisely: Keep bird indoors for 7 days, give three 22.7mg tablets of Baytril twice a day for seven days (Kedreeva, 2011). Mycoplasmosis of birds is most complicated disease for treating properly needs several types of strong antibiotics, single antibiotic dose or combined doses also need. This is one of the most important diseases of Indian peafowl, which mainly affect on respiratory tract of birds some time refers by the inexpert people “coolness”. Several types of treatment schedule mainly usd of combined antibiotics and supportive drugs also used for mycoplasmosis of Indian peafowl in BNZ which also supported by the past study.

Without this one of the past study result found Piperazine and Ivermectin used for treating endo and acto- parasitic disease and used sulfa drug for coccidiosis (www.wikihow.com, 2018). Ivermectin, levamisole hydrochloride and flubenvet 5% also used for parasite killing also be used and sulfa drug used as a coccidiostalt in one of the past used treatment (www.browfarm.co.uk, 2018). The line of treatment and several drugs used for parasitic infestation and coccidiosis was also suppoted by the present treatment schedule of treating of those diseases. Medication flowed by Brow farm in website (www.browfarm.co.uk, 2018) is given below to compare with present treatment schedule.

Table 3.7: The medication dose rates shown below for both peafowl and game birds in Brow farm

Product Name **Active ingredient in product** **Product Use**	**Dose Rate**
Amoxinsol 100 75g Active ingredient: Amoxicillin trihydrate Treatment of pasteurellosis and colibacillosis	16 gm/ 100 litre drinking water
Baycox 2.5% Oral Active ingredient: Toltrazuril Treatment coccidiosis in young, growing birds	2 ml / litre or as advised
Baytril 10% Oral Active ingredient: enrofloxacin Treatment of (e.g. pasteurellosis,	50 ml per 100 litre drinking water of day olds for 24 hours

mycoplasmosis, coli-bacillosis, coli-septicaemia and salmonellosis)	
Denagard 12.5% Active ingredient: (tiamulin) Treatment of infectious sinusitis and air sacculitis	2 ml per litre
Octacillin 100g Active ingredient: Amoxicillin Treatment of primary infections and secondary infectio	22g per 100 litre
Panacur 2.5% /10% Active ingredient: fenbendazole Treatment of roundworms, some tapeworms and lungworms.	100 ml treatment dose or 25ml preventive dose per 100 litre for 2 to 3 days. Then repeat in 10 days
Solubenol 100g Active ingredient: flubendazole Treatment of Ascaridiagalli, Heterakisgallinarum and Capillariaspp in adult stages	10 g per 100 litre
Soludox 1kg Active ingredient: doxycycline reduce lesions due to Pasteurellosis caused by Pasteurellamultocida or to reduce morbidity and lesions in respiratory infections caused by Ornithobacteriumrhinotracheale (ORT)	30 g per 100 litre
Solulyte Active ingredient: Sodium Chloride, Potassium Chloride Liquid condition to replace body salts	200 ml per 100 litre

Tetsol 2kg Activeingredient: tetracycline Treatment of diseases caused by Clostridium perfringens	55 g per 100 litre
Flagel / Flagyl / Fishzole / Active ingredient: metronidazole Treatment of Blackhead disease	400 mg per litre of drinking water for 5 days
Tylan Activeingredient: Prevention of necrotic enteritis, necrotic enteritis	0.5g per litre of drinking water for 5 days

Fenbendazole, Tramisol, Ivermectin and Levasole were used for parasite killing and several antibiotic like Tylan powder (100 g)-Effective for respiratory illnesses in peafowl, Baytril Tablets-Effective for treating peafowl with swollen sinuses,Corid-Effective for treating coccidiosis in peafowl, Flagel-Effective for treating Blackhead in peafowl for treating several diseases (www.backyardchickens.com, 2018).

The susceptibility of the isolated microorganisms to antibiotics was determined using the disc diffusion method, as previously described (Kim *et al.,* 2015). The *S. marcescens* strain isolated in this study was sensitive to amikacin, chloramphenicol, ciprofloxacin, colistin, gentamicin, kanamycin, enrofloxacin, norfloxacin and trimethoprim-sulfamethoxazole. Conversely, it was resistant to ampicillin, bacitracin, cephalotin, cefazolin, erythromycin, novobiocin, penicillin, streptomycin, oxytetracycline and vancomycin (Lee *et al.*, 2015).From above discussion about treatment schedule of Indian peafowl, we found most treatment schedule for parasitic infestation, Coccidiosis and Mycoplasmosis present study also found the same pattern for treatment of diseases. There are basically two means of prevention of coccidiosis: chemoprophylaxis and vaccination. Chemoprophylaxis using so-called anticoccidial products (ACP) or anticoccidials in the ration is by far the most popular.

It is estimated that 95% broilers produced receive anticoccidials Chapman, (2005). Generally two groups of anticoccidial drus are used namely 'ionophores' (ionophorous) and 'chemicals' (synthetically produced drugs). In 1948, sulphaquinoxaline was the first drug administered in the feed (Chapman, 2003); (McDougald and Reid, 2003). Other chemicals followed in the years after, allowing the poultry industry to expand and upscale production (McDougald *et al*., 1987; Peek and Landman, 2003; Naciri *et al.*, 2004). The antimicrobial susceptibility test indicated that the *S. marcescens* isolated in this study was resistant to penicillin, cephalosporin, macrolides, tetracycline and vancomycin. A study reported that all *S. marcescens* isolates of human origin were resistant to ampicillin, cefotaxime and gentamicin (Sung *et al*., 2006). Because many *S. marcescens* strains have shown resistance to multiple antibiotics, it represents a growing public health concern (Kim *et al.*, 2015; Sung *et al.*, 2006). This case was exceptional for peafowls. However, other exceptional or rare diseases also treated properly by veterinary surgeon of BNZ.

In case of a wound becoming infected, you may see green, yellow, orange, or red discharge, or reddened skin around the site of the injury. White discharge is normal and usually indicates healing. Black usually indicated necrotic skin or flesh, and should be removed before it can infect surrounding area. You can re-clean the wound with fresh water and a soft cloth. While peroxide is safe to use in diluted form (30% diluted from the bottle), be aware that peroxide will also cause skin/flesh to become necrotic as it fights infection, and so should be avoided for any major infection. Neosporin (or other triple anti-biotic) without painkillers should be safely used in small wounds to keep them from becoming infected (Kedreeva, 2011). Abrasions or injury are also called scrapes as well as the skin has become roughed up across a surface and may be bleeding. These are usually shallow and easy to treat. You can clean the wound with fresh water and a soft cloth, running water over it and brushing softly until any contaminants (dirt, plant matter, insects, skin flakes) are washed away. You can apply a thin coat of a topical gel antibiotic like Neosporin- but do not use that kind with painkillers. Any plain triple anti-biotic should do. In the case of most abrasions, due to their shallow nature, they should air dry and heal fairly quickly. For deeper abrasions, a dressing may be used (Kedreeva, 2011). This result also suppoted by the present study in case of one injured peahen by rate bite, the abrasion area was cleaned properly. Then inject .5 ml oxtetracycline for 4-5 days and dressing properly by antiseptic and supportive treatment by antihistaminic drugs. In case of win inury or any surgery – the injured area was cleaned properly and then injects .5 ml oxtetracycline for 4-5 days and dressing properly by antiseptic and supportive treatment by antihistaminic drugs. A dressing for birds can usually be made using gauze and brown cling gauze/vet wrap. Brown cling gauze sticks to itself but is not very absorbent. They will pick at anything on their bodies, so you may have to replace the wrapping daily. Make sure that any time you dress a wound that the binding is secure/firm. It should not be tight enough to inhibit circulation but should also not be loose enough that the bird will wiggle out of it (Kedreeva, 2011).

Two big treatment schedules was presented from Kedreeva, 2010-11 and Brow farm both of the scheduled developd mainly based on farm rearing conditions of peafowl. Without this in Brow farm the treatment schedule managed for both pet birds and peafowl due to this the prescribed medicine were more compared to BNZ treatment schedule. As we know in case of farm based treatment schedule farmers always maintain big prescription for preventing all of the problems as well as getting more production. On the other hand in case of semi-wild reaing condition in zoos and wildlife parks used mainly few treatment schedules for importantant as well as severe disease condition. They mainly develop poper management system to prevent diseses and some time waits for recovering some minor important diseases automatically, so the farm based past treatment schedule did not supported mostly by the present study treatment schedule because of in BNZ the peafowl is rearing in semi-wild condition and no need to get more production.

Several disease conditions, drugs and doses were selected based on severity of diseases. There is a programmed, which was developed for preventive and curative veterinary care and nutrition for all animals as well as Indian peafowl of BNZ. In addition, the veterinary service of BNZ designed based on animal health and welfare, which was preferred by expert veterinarian. Without this continuous veterinary education exposed by wild animal's problem help to veterinarian for proper and perfect medication schedule for important case management. All of the important veterinary drugs available in the veterinary hospital of BNZ. On the other hand the equipments for restraining, control, medication as well as an operation theater for surgery is available in BNZ for properly management of all diseased wild animals. There are a group of good skilled veterinary surgeon are available in BNZ for making decision about diagnosis of diseases of Indian peafowl and their treatment properly. On the other hand postmortem analysis also was done by veterinary surgeon for diagnosis diseases properly. If in any case they fail to diagnosis disease of wild animals they sent the specimen to national laboratory of Bangladesh which is called Central Disease Diagnosis Laboratory for specific diagnosis of diseases. Finally, it can be concluded that the control, management, diagnosis and treatment plan wsas found very smart and standard in BNZ compared with past study results.

4. Conclusion

The common diseases of Indian peafowl in BNZ were salmonellosis and collibacillosis in early age but in adult stage were parasitic infestation and coccidiosis. But the common abnormalities were found weakness, bumble feet, curled toes, lameness and wing injury. There were also found several types of predators and disturbing animals like rats, mice, cats, dogs, crows, monitors and kites available in the premises of BNZ. The general prevention and control methods of above-mentioned thing were vaccination, management and treatment. The prevention and control methods were found very high quality for diseases, abnormalities and predators in Bangladesh National Zoo for Indian peafowl. There was a big management system developed relation with feeds, feeding system and habitats for making protection against abnormalities, diseases and predators of Indian peafowl. The house was made with good protection system for entering predators and also the visitors which help to protect predation and disturbing of visitors. Without this cleaning regularly, proper drainage system , controlling for entering predators and enough spaces in houses also help in protection against abnormalities, diseases and predators of Indian peafowl in BNZ. Feeds and feeding system was also found very good like regular fresh feed supply, balanced feed supply and nutrias feed supply all the year round to their peafowl’s in BNZ.

Without this properly brooding of peachicks also, help to prevent many diseases as well as express good growth performance. Antibiotics used mainly for infectious diseases and the most common antibiotics were Oxy-tetracycline ad Gentamycine. Moreover anticoccidial drugs used against coccidiosis which was also a common disease of Indian peafowl in BNZ. Several types of medication based on diseases were maintained properly by Physician prescription. A veterinary hospital is sated in the Bangladesh National Zoo for treating and preventing several types of abnormalities and diseases. The most common medication based on diseases was implemented in BNZ by using available medicine of the market of Bangladesh. Without these specific treatment others supportive treatment with vitamin mineral and antihistaminic drugs were used for rapid recovery and proper cure of the diseases and abnormalities of Indian peafowl. Perfect diagnosis of diseases and abnormalities were done by the official veterinary physicians based on clinical signs and postmortem analysis, which was followed by treatment as prescribed by the physicians. Vaccine against Newcastle disease, fowl pox and avian influenza were used to combat those diseases. Moreover, medication against parasitic infestation was started from four month of age and later continued regularly in six months interval. Some vitamins, minerals and nutrients were used regularly for preventing several abnormalities and diseases.

Finally, we concluded that welfare of Indian peafowl in BNZ, which was maintained properly by providing curative and preventive medicine for the treatment of diseased peafowl's. Proper diagnosis of diseases and abnormalities were done by the official veterinary physicians based on clinical signs and postmortem analysis, which was followed by treatment as prescribed by the physicians. This present study results on disease condtions, abnormalities and its management proceduers can be used for future research in these fields. Without this this important findings on diseases and abnormalities of peafowl and its prevention and control measres can be used by several zoos, wildlife parks and farms for their management purposes.

CONCLUSION AND RECOMANDATIONS

Conclusion

The research was conducted on the breeding and feeding of Indian peafowl in Bangladesh National Zoo from April 2015 to December 2018. Other than the breeding the parameters like weight-gain, phenotypic characteristics, livability and preventive and curative measures of diseases and abnormalities were studied. Present study results revealed that body weight increase when age increase. The average body weight of day old peachick was found (65.7±3.00) gm and that body weight gain at age 180 days was found (19,982.05±38.58) gm. Individual level variation in weight of same age group was found in the present study. Individual level variation in same age group support that the Indian peafowl maintain semi-wild management system for growing wildlife as wildlife style. The overall comparison of weight-gain of male and female Indian Peafowl have been revealed that the male gain better weight in all stage of development compared to the female peafowl's 's from 210 days to up to 365 days and the differences of male and female peafowl weight was highly significant means $P<.001$. In the one year of age, male peafowl gain 3266.2 gm weight where as female peafowl gain 2830.4 gm at the same age. So weight-gain up to one year of age was found very well. Most of the phenotypic quantitative characteristics differ significantly for peacock and peahen. However, in case of colour neck and upper barest was found glossy blue for peacock but in case of peahen neck and upper breast colour was found metallic green.

On the other hand, white variety of peafowl both peacock and peahen plumage colour is white. peacock has the train feather but peahen has no train feather. The peacock is more beautiful than peahen respect to colour and attractiveness. In breeding season male walking, displaying and calling excitedly but female slowly, walk beside the displaying male and mate choose based on attractiveness. Male appearance in breeding season, colourful body with glossy blue neck well arranged elongated train, strong smooth tail and walking with upward tail but the female appearance in breeding season, shiny brown body with smooth shape. Without this single male, maintain a territory in breeding season with 3 or 4 female. Male become sexually matured at 2.79±.20 years where as female become sexually matured at 1.77±.19 years of age. Breeding season also extended long period February to August. Egg colour variation was found which was brown, light brown, pale white and light creamy and the egg size was larger than the chicken egg. The average egg weight is 107.84±6.27 gm of Indian peafowl in Bangladesh National Zoo. In case of natural brooding generally 10-12 eggs were sated under a broody Peahen. The incubation temperature maintained by zoo authority was 99-100 ^{0} F but humidity not strictly maintains. Incubation period was found 29.45±0.69 days. In the present study, we reported that male: female ratio in breeding sheds were 1:1, 1:2, 1:3 and 2:5 and in aviary 2:3. Fertility and hatchability rate was found normally 45.61% and 40.20%. Therefore, the breeding strategy was very good for Indian Peafowl in BNZ. Bulk part of supplied feeds for adult peafowl's comprises with layer layer feeds, spinach and fruits which was 250 gm daily on the other hand 25 gm of supporting feed eggs and peanuts were given to the per Indian peafowl. Moreover, all time supply of adlibitum water for Indian peafowl in BNZ. The feed intake effect was found in both high and low temperature only for few days from the three years, which is not significant.

The peachicks were fully free from feed and water at day 1 of age and adlibitum amount of crumble form feeds were supplied to the Peachicks from the 2nd days of age. Spinach, fruits, eggs and peanuts were give as feed constituents from 2 weeks, 1.5 month, 2 weeks and 4 months respectively. Vitamin-mineral mixed also was supplied from 5th days of age. Adilbitum amount of Layer layer feed was given after the 9 month of age. The Indian Peafowl were habituated to the supplied feeds by the authority of BNZ, which were layer starter, layer layer, spinach, fruits, eggs and peanuts. Feed and water was supplied in feeder and waterer on the other hand Peachicks fed on paper for first few days in brooder house.

Indian Peafowl some time fed like as omnivores, which was taken the small pieces of sand, others odd materials and self-feathers roots. They were also habituated with supplied feeds by the visitors; the feeds were Gram, Pupped rice, Pupped corn, several types of Chips, Cucumber etc. Habituated with anything by living being is an important factor for ecological set up with that thing. Without making a goof ecological set up with feed and habitat or any other things in the environment no species can be survived properly. The feeds and feeding system was also smart enough for Indian peafowl in BNZ. There was a big 12th room round shape house where each room size was length 26-27 feet X width 10.5 to 17 feet X height 9 to 11 feet. They have also one big aviary for the Indian Peafowl that was 115 feet length X 100 feet width X 50 feet height. Both habitats comprise of sanded and cemented floor and the wire net made most part of ceiling. The big room and the aviary for the peafowl comprises with resting and egg laying areas. Few types of roosting material in the room of the big house but several types roosting materials sated in the aviary. Space requirement for single Indan peafowl was enough in both habitats, which was more than 100 squire feet. The habitats of the present study in BNZ for Indian peafowl was found with good set up comprises with several roosting sites, enough space and desired height.

The livability up to fledgling age was found 95.82%. Nevertheless, mortality was also found low in all the years round in this study. The main cause of peachick's mortality was found colibacillosis and salmonellosis. In early age between 1-15 days most of the dead occurred which was 82% later 16-90 days only 18% dead occurred. Mortality rate of peachick was found high in early stage compared to late stage because of immune system did not active in the early stage. Out of the total recorded death case due to diseases during the study, the rate 62.5% was recorded colibacillosis and the salmonellosis rate was 37.5%. The common diseases were salmonellosis and colibasillosis in early stage and coccidiosis and parasitic infestation in adult stage. Moreover, omphalytis was reported in day old peachicks and Newcastle disease, fowl pox, avian cholera, rickets, and enteritis were reported in past time, but not during this study. The common visible abnormalities were curled toes, bumble feet, wing injury and lameness. The highest recorded (54.1%) was curled toes and the lowest recoded was (6.6%) was wing injury. Other rarely observed abnormalities included gout in hock joint, heat stress, cool stress, visitor stress and nervous disorder. There were several types of predators and disturbing animals like rats, mice, cats, dogs, crows, monitors and kites available in the premises of BNZ. Proper diagnosis of diseases and abnormalities were done by the official veterinary physicians based on clinical signs and postmortem analysis, which was followed by treatment as prescribed by the physicians. Vaccine against Newcastle disease, fowl pox and avian influenza were used to combat those diseases. Moreover, medication against parasitic infestation was started from four month of age and later continued regularly in six months interval. Some vitamins, minerals and nutrients were used regularly for preventing several abnormalities and diseases. Finally, it can be concluded that prevention and control methods maintained strictly and properly for diseases, abnormalities and predators of Indian peafowl in BNZ.

Therefore, it can be said that the present study provides a benchmark for the breeding and feeding as well as other related parameters of Indian peafowl in Bangladesh. As we know the Indian peafowl is wild bird as well as this is also raised as ornamental bird therefore, this is very important for conservation as well as recreation purposes. Thus, the present study results will be useful in for breeding and feeding management of the Indian peafowl in captivity, particularly in zoos, safari parks and farms. Moreover, initiatives can be taken to reintroduction and ex-situ conservation of Indian peafowl in Bangladesh.

Recommendations

The following have been recommended based on the present study:

- Indian peafowl chick has some good characters such as more livability, easily habituated with food and habitat, so the peafowl can be easily reared in captivity.
- The weight-gain was found very good which support that the Indian peafowl can be reared in farm for producing meat.
- The findings on feeds and feeding ecology may be useful to design the nutrition chart for captive peafowl to avoid leftover feed and for better management.
- Peachicks should be protected to prevent mortality during the first two weeks after hatching, when they might die due to bad weather and diseases.
- Routine vaccination should be administered regularly against common diseases like Newcastle and fowl pox, and prophylaxis against coccidiosis and helminths.
- Keeping in view the reproductive performance in captivity, the staff of the breeding centers should be trained on regular basis regarding different aspects of rearing of captive peafowls.
- Breeding, feeding and management systems of Indian peafowl in BNZ can be implemented in other national and international zoos as well as by peafowl owners.
- The high percentage of livability also helps to *ex-situ* conservation policy, so we can captive populations of the species in Bangladesh.
- Reintroduction of Indian peafowl can be implemented in Bangladesh, provided that standard procedure of acclimatization and protection and monitoring are done.

Reintroduction of Indian peafowl in the wild can be considered following the steps mentioned below -

A) Area selection for reintroduction.

B) Feasibility study of the area.

C) Importance of reintroduction of Indian eafowl to be communicated to the local people, and also nationally.

D) Peachicks collection and special rearing.

E) Growing stage peafowls should be selected for easily adaptation .

F) A good number of peafowls not less than 50 should be released for social group and breeding group formation.

G) Before releasing, the health and genetic screening should be done.

H) Before releasing training and acclimatization should be practiced for p.eafowl

I) Release the peafowls in selected area and ensure protection from people.

J) Pre- and post-release monitoring should be continued for long time.

K) Post release survival and breeding should be monitored for long period of time.

REFERENCES

Abrar, M., Ahmad, Q. A., Ali, Z., Iqbal, M. A., Altaf, S., Sagheer, A., & Khan, L. (2017a). Effect of cage spacing on production, fertility and hatchability of eggs in Indian peafowl at wildlife breeding center (Gatwala), Faisalabad-Pakistan. *J Ent Zool Stud*, *5*(4), 354-360.

Abrar, M., Naz, S., Ahmad, Q. A., & Malik, K. (2017b). Effect of temperature on growth and feed consumption rate of Korean ring-necked pheasant (*Phasianus colchicus*). *J Ent Zool Stud*, *5*(3), 103-106.

Agnes Deepa, A., Gunasekaran, C., Mohana, P., Lena, M., & Elanchezhian, M. (2013). Survival strategy, population and habitat utilization (Domesticated and Captive) Indian peafowl (*Pavo cristatus*) in Bharathira University Campus and V.O.C. Park (Mini Zoo) the Western Ghats, Tamil Nadu, South India. *International journal of Recent Scientific Research, 4*(6), 787-789.

Ahl, A. S., Acree, J. A., Gipson, P. S., McDowell, R. M., Miller, L., & McElvaine, M. D. (1993). Standardization of nomenclature for animal health risk analysis. *Rev. sci. tech. Off. int. Epiz., 12* (4), 1045-1053.

Ahmed, N. U., Amin, R., Magor, N. P., Miah, N. I., Islam, N., Saha, A., & Ali, H. (1991). Livestock related FSR [Farming Systems Research] activities of the Bangladesh Rice Research Institute. In *Workshop on Livestock Development in Bangladesh. Savar, Dhaka (Bangladesh). 16-18 Jul 1991.*

Aini, I. T. (1990). Indigenous chicken production in South-east Asia. *World's Poultry Science Journal*, *46*(1), 51-57.

Ali, S., & Ripley, S. D. (1969). Handbook of the Birds of India and Pakistan*: Stone curlews to owls (Vol. 3).* Oxford University Press.

Ali, S., & Ripley, S. D. (1974). Handbook of the Birds of India and Pakistan, together with those of Bangladesh, Nepal, Sikkim, Bhutan and Srilanka, *(Vol. 1-10)*. Oxoford University Press, Bombay, pp. 2989.

Ali, S., & Ripley, S. D. (1980). Handbook of The Birds of Magapodes to Crob Plover. Oxford University Press, New Delhi, pp. 347.

Ali, S., & Ripley, S. D. (1980). Handbook of the birds of India and Pakistan, together with those of Bangladesh, Nepal, Bhutan, and Sri Lanka. Oxford University Press.

Ali, S., & Ripley, S. D. (1981). Handbook of the birds of India and Pakistan. Vol (1), Oxford University Press, New Delhi.

Ali, S., & Ripley, S. D. (1983). Handbook of the birds of India and Pakistan (Compact Edition). Oxford University Press and BNHS, Mumbai.

Ali, S., & Ripley, S. D. (1987). Handbook of the birds of India and Pakistan. (2nd Edn.), New Delhi: Oxford University Press.

Ali, S., & Ripley, S. D. (1989). Handbook of the birds of India and Pakistan. Vol. 1. Divers to Hawks.

Ali, S., & Ripley, S. D. (1995). The Pictorial Guide to the Birds of Indian Sub-continent. Oxford University Press and BNHS, Mumbai.

Ali, Z., Bibi, F., Mahel, A. Q., Firdous, F., & Zamaan, S. U. (2011). Captive Breeding Practices in Pakistan: A Review. *J. Anim. Plant Sci*, *21(2)*, 368-371.

Allendorf, F. W., & Luikart, G. (2007). Conservation and the genetics of populations Blackwell. *Malden, MA*. Publishing Oxford; (UK), pp. 279-287.

Allie, L. (2017). 5 Essential Tips for Keeping Peacocks as Pets. WOS, INC.https://www.wideopenpets.com/5-essential-tips-for-keeping-peacocks-as-pets/; Accessed on 09 April, 2019.

Al-Rawi, B. A. (1980). Sex ratio effects on egg production. *Poultry Science, 59*(7), 1546-1547.

Altan, O., & Oguz, I. (1993). Bildiricinlarda *(Coturnix coturnix jqaponica)* yasin ve erkek disi oranininkulucka ozellikleri ve dollu sure uzerine etkileri (Turkish of: Effect of mating ratios and parental are onfertility, hatchability duration and recovery of fertilityin Japanese quail *(Coturnix coturnix jqaponica)* E.U. *Zir. Fak. Derg*., 30, 57-64.

Alyousif, M. S., & Al-Shawa, Y. R. (1998). Two new coccidia (Apicomplexa: Eimeriidae) from the green peacock (*Pavo muticus*) from Saudi Arabia. *Parasitology international*, *47*(4), 301-306.

Alyousif, M. S., & Al-Shawa, Y. R. (1999). Coccidian parasites of the green peacock (*Pavo muticus* L.) in Saudi Arabia. *Saudi. J. Bio. Sci*, *6*(1), 111-117.

Amber, AJ (1994). Research on establishing, appropriate breed for rural poultry production, Directorate of Livestock Service. Report the ongoing result in BLRI seminar, held on February 27-28. Savar. Dhaka.

Amin, M. R., Hoque, M. M., Islam, Q. M. S., & Khan, M. M. R. (1992). The performance of crossbred and indigenous chicken under scavenging system in Bangladesh. *Bangladesh Journal of Animal Science*, *21*(2), 77-88.

Amoudi, M. A. (1988). Two New Species of Eimeria from Peacocks (*Pavo cristatus*) in Saudi Arabia. *The Journal of protozoology*, *35*(4), 546-548.

Anisuzzaman, M., & Wahid, M. A. (1988). A study on growth rate, feed efficiency and livability of Fayoumi chicken under Bangladesh condition. Unpublished M. Sc. thesis, Bangladesh Agricultural University, Mymensingh.

Anon, M. J. (2002). Social citizenship: The fight for social rights. Electronic notebooks of philosophy of law, 6, 1-15.

Ansari, M. (1957). A note on the mensuration of an ischnoceran Mallophaga, *Goniodes pavonis* (Linnaeus), infesting the Indian common pea-fowl (*Pavo cristatus Linnaeus*). *Pakistan journal of health*, *6*(4), 243-269.

Araki, T., Kudo, K., Kuramoto, M., & Torikata, T. (1989). The amino acid sequence of Indian peafowl (*Pavo cristatus*) lysozyme and its comparison with lysozymes from phasianoid birds. *Agricultural and biological chemistry*, *53*(11), 2955-2962.

Arnall, L., & Keymer, I. F. (1975). Bird disease; an introduction to the study of birds in health & disease. Bailliere Tindall, London, T.F.H. Publication, pp.528.

Ashraf, M., Waraich, F. N., Ahmad, I. G., & Pervez, K. (2002). Chemotherapy of gastro-intestinal namatodes in common peafowl (*Pavo cristatus*). *Pakistan Veterinary Journal*, *22*(2), 91-93.

Asmare, B. (2014). Biotechnological advances for animal nutrition and feed improvement. *World Journal of Agricultural Research*, *2*(3), 115-118.

Athar, M., Shakoor, A., Muhammad, G., Sarwar, M. N., & Chaudhry, N. I. (1996). Clinical perspectives of intravenous ketamine anaesthesia in peafowl (*Pavo cristatus*). *Acta Veterinaria Hungarica*, *44*(3), 357-361.

Audigé, L., Doherr, M. G., Hauser, R., & Salman, M. D. (2001). Stochastic modelling as a tool for planning animal-health surveys and interpreting screening-test results. *Preventive veterinary medicine*, *49*(1-2), 1-17.

Avcioglu, H., Burgu, A., & Bölükbaş, C. S. (2008). Ascaridia numidae in rock partridge (*Alectoris chukar*) in Turkey. *Parasitology research*, *102*(3), 527-530.

Azizul, H. D., & Reza, A. (1980). A comparative study of the performances of exotic breeds and indigenous birds under Bangladesh condition (M. Sc. Thesis, Department of Poultry Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh).

Badran, I., & Lukeshova, D. (2006). Control of coccidiosis and different coccidia of chicken in selected technologies used in tropics and subtropics. *Agricultura tropica et subtropica, 39*(1), 39-43.

Bagust, A., Place, M., & Posnett, J. W. (1999). Dynamics of bed use in accommodating emergency admissions: stochastic simulation model. *Bmj*, *319*(7203), 155-158.

Bailey, T. A., Silvanose, C., Manvell, R., Gough, R. E., Kinne, J., Combreau, O., & Launay, F. (2002). Medical dilemmas associated with rehabilitating confiscated houbara bustards (Chlamydotis undulata macqueenii) after avian pox and paramyxovirus type 1 infection. *Journal of wildlife diseases*, *38*(3), 518-532.

Bais, B., Tak, L., & Mahla, S. (2017). Study of preventive health measures for wildlife in captivity a review of management approaches. *International Journal of Avian & Wildlife Biology*, *2*(2), 73-75.

Baker, E.C.S. (1928). The Fauna of British Indian, Including Ceylon and Burma, Birds. Volume 5 (2 ed.). Taylor and Francis, London, pp. 282-284.

Baker, H. R., & Inglis, C. M. (1930). Birds of Southern India including Madras, Malabar, Travancore, Cochin, Coorg and Mysore. Superintendent Government Press, Madras.

Balicka-Ramisz, A., Tomza-Marciniak, A., Pilarczyk, B., Wieczorek-Dabrowska, M., & Bakowska, M. (2007). Intestinal parasites of parrots. *Wiadomosci parazytologiczne*, *53*(2), 129-132.

Banerjee, G. C. (1993). A Text Book of Animal Husbandry. Seventh Edition. Poultry, pp. 722-793.

Bangladesh, I. U. C. N. (2015). Red List of Bangladesh Volume 3: Birds. *IUCN, International Union for Conservation of Nature, Bangladesh Country Office, Dhaka, Bangladesh, xvi+ 676pp*.

Banik, D. C., & Ray, H.N. (1961). On a new coccidium, *Eimeria pavonina n. sp*. from peacock (*Pavo cristatus* Linn). *Bull Calcutta Sch Trop Med*, *9*, 61.

Banik, D. C., & Ray, H.N. (1964). On a new coccisium *Eimeria mandali n. sp.* from the Indian peacock. *Bull Calcutta Sch Trop Med*, *12*, 27.

Barbieri, N. L., Tejkowski, T. M., de Oliveira, A. L., de Brito, B. G., & Horn, F. (2012). Characterization of Extraintestinal Escherichia coli Isolated from a Peacock (*Pavo cristatus*) with Colisepticemia. *Avian diseases*, *56*(2), 436-440.

Basit, A., Ali, A. A., Malik, M. S., Malik, A. N., Iftikhar, M., Haq, H. M. A., & Nadeem, S. M. (2014). A study of gastrointestinal helminths in native peafowl and comparative efficacy of Albendazol and a Pyrantel pamoate against the helminth parasites. *Journal Infection and Molecular Biology*, *2*(2), 22-25.

Bean, D. L., Rojas-Flores, E., Foster, G. W., Kinsella, J. M., & Forrester, D. J. (2005). Parasitic helminths of Eurasian collared-doves (*Streptopelia decaocto*) from Florida. *Journal of Parasitology*, *91*(1), 184-187.

Bencina, D., Mrzel, I., Rojs, O. Z., Bidovec, A., & Dovc, A. (2003). Characterisation of *Mycoplasma gallisepticum* strains involved in respiratory disease in pheasants and peafowl. *Veterinary record*, *152*(8), 230-234.

Bencina, D., Mrzel, I., Tadina, T., & Dorrer, D. (1987). Mycoplasma species in chicken flocks with different management systems. *Avian Pathology*, *16*(4), 599-608.

Bencina, D., Tadina, T., & Dorrer, D. (1988). Natural infection of ducks with *Mycoplasma synoviae* and *Mycoplasma gallisepticum* and Mycoplasma egg transmission. *Avian Pathology*, *17*(2), 441-449.

Bergmann, J. (1980). The peafowl of the world, Saiga Publ. Co. Ltd.

Berman, R. (1996). Peacock. Lerner Publication Company, pp. 8-13.

Bhanja, S. 1., Mandal, A. B., & Goswami, T. K. (2004). Effect of in ovo injection of amino acids on growth, immune response, development of digestive organs and carcass yields of broiler. *Indian Journal of Poultry Science*, *39*(3), 212-218.

Bhowmik, N., Mia, M. M., & Rahman, M. A. (2014). Morphometric measurements, productive and reproductive performance of Jalali pigeon. *International Journal of Development Research*, *4*(4), 908-911.

Black, P. A., Cox, S. K., Macek, M., Tieber, A., & Junge, R. E. (2010). Pharmacokinetics of tramadol hydrochloride and its metabolite O-desmethyltramadol in peafowl (*Pavo cristatus*). *Journal of Zoo and Wildlife Medicine*, *41*(4), 671-676.

Blanford, W.T. (1898). The Fauna of British Indian, Including Ceylon and Burma.Birds 4. Taylor and Francis, London, pp. 432-468.

Blau, S. K. (2004). Light as a feather: Structural elements give peacock plumes their colour. *Physics Today*, *57*(1), 18-18.

Bradbury, J. M., Yavari, C. A., & Dare, C. M. (2001). Mycoplasmas and respiratory disease in pheasants and partridges. *Avian Pathology*, *30*(4), 391-396.

Brah, G. S., & Sandhu, J. S. (1989). Preincubation storage of guinea fowl eggs in cooling cabinet vs. room: Effect on hatchability components. *Trop. Agric*, *66*, 265-268.

Brickle, N. W. (2002). Habitat use, predicted distribution and conservation of green peafowl (*Pavo muticus*) in Dak Lak Province, Vietnam. *Biological Conservation*, *105*(2), 189-197.

Budgey, H.V. (1994). Parental strategies of Indian Peafowl. Thesis submitted to Dept. of Biology, Open University, California (Unpublished).

Buhr, R. J. (1995). Incubation relative humidity effects on allantoic fluid volume and hatchability. *Poultry science*, *74*(5), 874-884.

Burton, M., & Burton, R. (2002). International wildlife encyclopedia (Vol. 22). Marshall Cavendish.

Cabassi, C. S., Taddei, S., Predari, G., Galvani, G., Ghidini, F., Schiano, E., & Cavirani, S. (2004). Bacteriologic findings in ostrich (*Struthio camelus*) eggs from farms with reproductive failures. *Avian diseases*, *48*(3), 716-722.

Camacho-Escobar, M. A., Arroyo-Ledezma, J., & Ramirez-Cancino, L. (2008). Diseases of backyard turkeys in the Mexican tropics. *Annals of the New York Academy of Sciences*, *1149*(1), 368-370.

Cencek, T., Ziemko, I., Kuczynska, E., & Tomezyk, G. (1992). Amidostomum ansers in geese efficacy of anthelmintic drugs. *Medycyna Weterynaryjna*, *48*(9), 421 – 423.

Chakkaravarthy, Q. A. (2002). Call to save our national bird, Indian Peafowl (Pavo cristatus). In Proceedings of the National Symposium on Galliformes, Division of Wildlife Biology, AVC College, Bharathidasan University, Tamil Nadu, pp. 77-78.

Chakravarthy, A. K., & Thyagaraj, N. E. (2005). Feeding behaviour of peacocks (*Pavo cristatus*) on cultivated crops in Coastal Karnataka. *Indian Bir*, *7*, 126.

Chambers, J. R. (1990). Genetics of growth and meat production in chickens. In: Crawford RD, editor Poultry breeding and genetics. Netherlands: Elsevier Science Publisher, BV, pp. 599-643.

Chapman, H. D. (2003). Origins of coccidiosis research in the fowl-the first fifty years. *Avian diseases*, *47*(1), 1-20.

Chapman, H. D. (2005). Perspectives for the control of coccidiosis in poultry by chemotherapy and vaccination. In Proceedings of the IXth International Coccidiosis Conference, Foz de Iguassu, Parana, Brazil. Apinco Foundation of Poultry Science and Technology, Campinas, São Paulo, Brazil, pp. 99-103.

Charleston, B., Gate, J. J., Aitken, I. A., & Reeve-Johnson, L. (1998). Assessment of the efficacy of tilmicosin as a treatment for *Mycoplasma gallisepticum* infections in chickens. *Avian pathology*, *27*(2), 190-195.

Charlton, A. J., Dickinson, M., Wakefield, M. E., Fitches, E., Kenis, M., Han, R., & Bruggeman, G. (2015). Exploring the chemical safety of fly larvae as a source of protein for animal feed. *Journal of Insects as Food and Feed*, *1*(1), 7-16.

Cheng, H. W. (2010). Breeding of tomorrow's chickens to improve well-being. *Poultry science*, *89*(4), 805-813.

Chhbara, A. D., & Sapra, K. L. (1973). Growth, mortality and carcass quality traits of indigenous and exotic pure-breds and their crosses. *Indian veterinary journal*, pp. 1007-1013.

Chopra, G., & Kumar, T. (2012). Study of roosting sites of Blue Peafowl (*Pavo Cristatus*) Linnaeus, 1758 In District Kurukshetra, Haryana (India). *Journal of Biological and Chemical Research*, *29*(2), 273-282.

Chopra, G., & Kumar, T. A. (2014). Study of Food and Feeding Habits of Blue Peafowl (*Pavo Cristatus)* Linnaeus, 1758 in District Kurukshetra, Haryana (India). International Journal of Research Studies in Biosciences (IJRSB), *2*(6), 11-16.

Christensen, N. H., Yavari, C. A., McBain, A. J., & Bradbury, J. M. (1994). Investigations into the survival of *Mycoplasma gallisepticum*, *Mycoplasma synoviae* and *Mycoplasma iowae* on materials found in the poultry house environment. *Avian Pathology*, *23*(1), 127-143.

Chumbe, A., Izquierdo-Lara, R., Tataje-Lavanda, L., Figueroa, A., Segovia, K., Gonzalez, R., & Icochea, E. (2015). Characterization and sequencing of a genotype XII Newcastle disease virus isolated from a peacock *(Pavo cristatus*) in Peru. *Genome Announc.*, *3*(4), 792-815.

Conway, D. P., & McKenzie, M. E. (2007). Poultry coccidiosis: diagnostic and testing procedures. John Wiley & Sons.

Cookson, K. C., & Shivaprasad, H. L. (1994). *Mycoplasma gallisepticum* infection in chukar partridges, pheasants, and peafowl. *Avian Diseases*, pp. 914-921.

Costa, J. O. (1970). Effects of experimental *Ascaridia galli* inoculation in chickens. *Arquivos da Escola de Veterinaria*, *22*, 11-31.

Cowan, I. R. (1978). Stomatal behaviour and environment. In *Advances in botanical research* . Academic Press, 4, 117-228.

Crawford, T. J. (1984). The estimation of neighbourhood parameters for plant populations. *Heredity*, *52*(2), 273-283.

Crawshaw, G. J., & Boycott, B. R. (1982). Infectious laryngotracheitis in peafowl and pheasants. *Avian Diseases*, pp. 397-401.

Crespo, R., & Maria, D. (2014). Salmonella and Campylobacter Transmission Routes in Breeder Turkeys, pp. 1-20.

Crowe, T. M., Bowie, R. C., Bloomer, P., Mandiwana, T. G., Hedderson, T. A., Randi, E., & Wakeling, J. (2006). Phylogenetics, biogeography and classification of, and character evolution in, gamebirds (Aves: Galliformes): effects of character exclusion, data partitioning and missing data. *Cladistics*, *22*(6), 495-532.

Dakin, R. (2011). The crest of the peafowl: a sexually dimorphic plumage ornament signals condition in both males and females. *Journal of avian biology*, *42*(5), 405-414.

Dakin, R., & Montgomerie, R. (2013). Eye for an eyespot: how iridescent plumage ocelli influence peacock-mating success. *Behavioral Ecology*, *24*(5), 1048-1057.

Daniels, R. R. (1992). Geographical distribution patterns of amphibians in the Western Ghats, India. *Journal of Biogeography*, pp. 521-529.

Darrel, K. S. (1996). Antimicrobials commonly used in avian medicine Part 4: Antifungals, anthelmintics, and antiprotozoals. Old World Aviaries Antimicrobial. Hill Country Aviaries, LLC, pp. 33-34.

Darwati, S., Martojo, H., Sumantri, C., Sihombing, D. T. H., & Mardiastuti, A. (2010). Productivity, repeatability of productive and reproductive traits of local Pigeon. *Journal of the Indonesian Tropical Animal Agriculture*, *35*(4), 268-274.

Darwin, C. (1871). *The descent of man, and selection in relation to sex*. 1st edition. John Murray, London, UK.

Das, C, Ranvig, H, Riise, JC, Chowdhury, SD (2005). Performance of laying chicken in cafeteria and balanced feeding under semiscavenging condition. Proceedings of the third annual scientific conference. Chittagong Government Veterinary College.14-15 February. pp 18-29.

Deeming, D. C. (1995). Factors affecting hatchability during commercial incubation of ostrich (*Struthio camelus*) eggs. *British poultry science*, *36*(1), 51-65.

Deeming, D. C., & Wadland, D. (2002). Influence of mating sex ratio in commercial pheasant flocks on bird health and the production, fertility, and hatchability of eggs. *British poultry science*, *43*(1), 16-23.

Del Giudice, M. (2012). Sex ratio dynamics and fluctuating selection on personality. *Journal of Theoretical Biology*, *297*, 48-60.

Del Hoyo, J., A. Elliot & J. Sargatal (1994). Handbook of The Birds of The World. New World Vultures to Guineafowl - Volume 2. Lynx Edicions, Barcelona, pp.434-552.

Delacour, J. (1977). Pheasants of the world. Spur Publications.

DeMarco, M. A., Delogu, M., Catelli, E., Terregino, C., & Guberti, V. (2002). Seroprevalences against *Mycoplasma gallisepticum* and *Mycoplasma synoviae* detected in free-living and reared pheasants in Emilia Romagna region. *Large Animals Review*, *8*(6), 105-106.

Dhanwatey, A. S. (1986). A Crested Hawk-Eagle *Spizaetus cirrhatus* (Gmelin) killing a Peafowl (*Pavo cristatus* Linnaeus). *Journal of the Bombay Natural History Society*, *83*(4), 202.

Dharmakumarsinhji, R.S., and Lavkumar, K.S. (1981). Indian peafowl, Sixteen Indianbirds, Publication Division, Ministry of information and broadcasting, Government of India, pp. 24-28.

Dilger, W. C., & Wallen, J. C. (1966). The pecking responses of peafowl chicks. *The Living Bird*, *5*, 115-125.

Dimitrov, K. M., Ramey, A. M., Qiu, X., Bahl, J., & Afonso, C. L. (2016). Temporal, geographic, and host distribution of avian paramyxovirus 1 (Newcastle disease virus). *Infection, genetics and evolution*, *39*, 22-34.

Dodia, P. P. (2011). Roost tree selection by the common Indian Peafowl (*Pavo cristatus*) at Bhavnagar district, Gujarat (India). *Life Sci Leafl*, *11*(2), 346-354.

Dodsworth, P. T. L. (1912). Occurrence of the common peafowl (*Pavo cristatus Linnaeus*) in the neighbourhood of Simla, NW Himalayas. *J. Bombay Nat. Hist. Soc*, *21*(3), 1082-1083.

Dookia, S. (2015). Ecology and Behaviour of Indian Peafowl (*Pavo cristatus*) in Keoladeo National Park, Bharatpur, Rajasthan, India. *International Journal of Fauna and Biological Studies*, 2, 97-103.

Drisdelle, G. (2007). Living with peafowl, dedicated to quality service. *City of Dunedin, Florida*. file:///G:/Review%20on%20Peacock/Peacocks/national bird.asp.html.

Dutta, S., Goyal, A., & Kumar, M. (2013). Top quark physics in the vector colour-octet model. *Physical Review D*, *87*(9), 094016.

Elliott, K. H., Le Vaillant, M., Kato, A., Gaston, A. J., Ropert-Coudert, Y., Hare, J. F., & Croll, D. (2014). Age-related variation in energy expenditure in a long-lived bird within the envelope of an energy ceiling. *Journal of Animal Ecology*, *83*(1), 136-146.

El-Shahawy, I. S. (2010). *Eimeria pavoaegyptica sp. nov.* (Apicomplexa: Eimeriidae) in faeces of Indian peacocks (*Pavo cristatus)*Linnaeus, 1758 (Galliformes: Phasianidae) from Egypt. *Memórias do Instituto Oswaldo Cruz*, *105*(8), 965-969.

FAO (Food and Agricultural Organization) (2010). Draft guidelines for molecular characterization of animal genetic resources for food and agriculture. Rome: FAO.

Farooq, M., Durrani, F. R., Aleem, M., Chand, N., & Muqarrab, A. K. (2001). Egg traits and hatching performance of Desi, Fayoumi and Rhode Island Red chicken. *Pakistan J. Biol. Sci*, *4*(7), 909-911.

Fattah, K.A. (1999). The Danish human resource base in agricultural research for development. Poultry as a tool in poverty eradication and promotion of gender equality. Proceedings of a workshop. Held on March 22-26, pp. 21.

Fiaz, M. (2013). Prevalence of Coccidiosis in Peacock at Lahore-Pakistan. *Biological Society of Pakistan*, *59*(1), 57-68.

Fiorentin, L., Soncini, R. A., da Costa, J. L. A., Mores, M. A., Trevisol, I. M., Toda, M., & Vieira, N. D. (2003). Apparent eradication of *Mycoplasma synoviae* in broiler breeders subjected to intensive antibiotic treatment directed to control *Escherichia coli*. *Avian Pathology*, *32*(2), 213-216.

Flower, M. S. S. (1938). The duration of life in animals-IV. Birds: special notes by orders and families. In Proceedings of the Zoological Society of London, pp. 195-235.

Forrester, C. A., Bradbury, J. M., Dare, C. M., Domangue, R. J., Windsor, H., Tasker, J. B., & Mockett, A. A. (2011). *Mycoplasma gallisepticum* in pheasants and the efficacy of tylvalosin to treat the disease. *Avian pathology*, *40*(6), 581-586.

Forrester, D. J., Carpenter, J. W., & Blankinship, D. R. (1978). Coccidia of whooping cranes. *Journal of Wildlife Diseases*, *14*(1), 24-27.

Forssido, T. (1986). Studies on the meat production potential of some local strains of chickens in Ethiopia (Doctoral dissertation, University of Giessen).

Freeman, A. R., & Hare, J. F. (2015). Infrasound in mating displays: a peacock's tale. *Animal behaviour*, *102*, 241-250.

Freitas, J. F., & Ibáñez Herrera, N. (1965). Fauna helmintológica do Peru: nova espécie do gênero Ascaridia Dujardin, 1845 (Nematoda, Ascaridoidea). *Memorias do Instituto Oswaldo Cruz*, *63*, 51-58.

Freitas, M. F. L., Oliveira, J. B., Cavalcanti, M. D. B., Leite, A. S., Magalhaes, V. S., Oliveira, R. A., & Evencio-Sobrino, A. (2002). Gastrointestinal parasites of captive wild birds in Pernambuco state, Brazil. *Parasitol Latinoam*, *57*(1-2), 50-54.

Friend, M., & Franson, J. C. (1999). Field manual of wildlife diseases. General field procedures and diseases of birds (No. ITR-1999-001). Geological Survey Madison Wi Biological Resources Div.

Fuller, R. A., & Garson, P. J. (2000). Pheasants: status survey and conservation action plan *2000-2004* (Vol. 51). IUCN.

Gadagkar, R. (2003). Is the peacock merely beautiful or also honest?. *Current Science*, *85*(7), 1012-1020.

Gadgil, M. (1972). The function of communal roosts: relevance of mixed roosts. *Ibis*, *114*(4), 531-533.

Gadgil, M., & Ali, S. (1975). Communal roosting habits of Indian birds. *J. Bombay Nat. Hist. Soc*, *72*(3), 716-727.

Galusha , J.G., & Hill , L.M. (1996). A study of the behavior of Indian peacocks (*Pavo cristatus*) on protection island, Jefferson County. Washington, USA, 34, pp. 23-31.

Garnett, W. R., Davis, L. J., McKenney, J. M., & Steiner, K. C. (1981). Effect of telephone follow-up on medication compliance. *American journal of hospital pharmacy*, *38*(5), 676-679.

Gautier-Bouchardon, A. V., Reinhardt, A. K., Kobisch, M., & Kempf, I. (2002). In vitro development of resistance to enrofloxacin, erythromycin, tylosin, tiamulin and oxytetracycline in *Mycoplasma gallisepticum, Mycoplasma iowae* and *Mycoplasma synoviae*. *Veterinary microbiology*, *88*(1), 47-58.

Gebhardt-Henrich, S. G., & Marks, H. L. (1991). Research Note: The effects of switching males among caged females on egg production and hatchability in Japanese quail. *Poultry Science, 70*(8), 1845-1847.

Ghostley, F., & Nordskog, A. W. (1951). Hybrid vigor in strain crossing and breed crossing. In *Poultry Science 30*(6), 914-914.

Gill, F.B. (1994). Ornithology, 2nd Edition. Oxford University Press, New York, pp. 117.

Glisson, J. R., Cheng, I. H. N., Brown, J., & Stewart, R. G. (1989). The effect of oxytetracycline on the severity of airsacculitis in chickens infected with Mycoplasma gallisepticum. *Avian Diseases*, 750-752.

Grimmett, R., Inskipp, C. & Inskipp, T. (1999). Birds of India: Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka, and the Maldives. Princeton University Press. ISBN 0-691-04910-6.

Gringer, P. (1964). The effect of vitamin K nutrition of the on hatchability and prothrombin levels with offering. *Poultry Science*, *43*, 289.

Griskevicius, V., Tybur, J. M., Ackerman, J. M., Delton, A. W., Robertson, T. E., & White, A. E. (2012). The financial consequences of too many men: Sex ratio effects on saving, borrowing, and spending. *Journal of personality and social psychology*, *102*(1), 69-80.

Gupta, S. K., Verma, S. K., & Singh, L. (2005). Molecular insight into a wildlife crime: the case of a peafowl slaughter. *Forensic science international*, *154*(2-3), 214-217.

Gurjar, R. L., Singh, R. P., & Mishra, A. (2013). Density of the Indian Peafowl (*Pavo cristatus)* in Satpura Tiger Reserve, India. *Journal homepage: www. wesca. net*, *8*(1), 12-18.

Gyllin, R., Källander, H., & Sylvén, M. (1977). The microclimate explanation of town centre roosts of jackdaws *Corvus monedula*. *Ibis*, *119*(3), 358-361.

Hamdy, A. H., Saif, Y. M., & Kasson, C. W. (1982). Efficacy of lincomycin-spectinomycin water medication on *Mycoplasma meleagridis* airsacculitis in commercially reared turkey poults. *Avian diseases*, *26*(2), 227-233.

Hamilton, W. D., & Zuk, M. (1982). Heritable true fitness and bright birds: a role for parasites? *Science*, *218*(4570), 384-387.

Hammond, J. (1947). Animal breeding in relation to nutrition and environmental conditions. *Biological Reviews*, *22*(3), 195-213.

Hannan, P. C. (2000). Guidelines and recommendations for antimicrobial minimum inhibitory concentration (MIC) testing against veterinary mycoplasma species. *Veterinary research*, *31*(4), 373-395.

Hanotte, O., Burke, T., Armour, J. A. L., & Jeffreys, A. J. (1991a). Cloning, characterization and evolution of Indian peafowl (*Pavo cristatus)* minisatellite loci. In DNA Fingerprinting: Approaches and Applications (pp. 193-216). Birkhäuser Basel.

Hanotte, O., Burke, T., Armour, J. A., & Jeffreys, A. J. (1991b). Hypervariable minisatellite DNA sequences in the Indian peafowl (*Pavo cristatus)*. *Genomics*, *9*(4), 587-597.

Harihar, A. B. I. S. H. E. K., & Fernandes, M. E. R. W. Y. N. (2011). Estimating the seasonal densities of Indian Peafowl (*Pavo cristatus)* and Red Junglefowl (*Gallus gallus)* in the northern Indian deciduous forests of Chilla Range, Rajaji National Park. *International Journal of Galliformes Conservation*, *2*, 31-35.

Harikrishnan, S., Vasudevan, K., & Sivakumar, K. (2010). Behavior of Indian peafowl (*Pavo cristatus* Linn*).* 1758 during the mating period in a natural population. *The Open Ornithology Journal*, *3*(1), 13-19.

Harper, D. (1995). *Keeping pet birds: a practical encyclopedia*. Blitz Editions.Printed in Slovak Republic, pp 174-175.

Harrison, J., & Worfolk, T. (1999). A Field Guide to the Birds of Sri Lanka. Oxford University Press, Oxford.

Hart, N. S. (2002). Vision in the peafowl (Aves: *Pavo cristatus*). *Journal of Experimental Biology*, *205*(24), 3925-3935.

Hassan, S. M., Siam, A. A., Mady, M. E., & Cartwright, A. L. (2004). Incubation temperature for ostrich (*Struthio camelus*) eggs. *Poultry science*, *83*(3), 495-499.

Hazary, R. C., Staines, H. J., & Wishart, G. J. (2001). Assessing the effect of mating ratio on broiler breeder performance by quantifying sperm: egg interaction. *Journal of Applied Poultry Research*, *10*(1), 1-4.

Hegngi, F. N., Doerr, J., Cummings, T. S., Schwartz, R. D., Saunders, G., Zajac, A. & Pierson, F. W. (1999). The effectiveness of benzimidazole derivatives for the treatment and prevention of histomonosis (blackhead) in turkeys. *Veterinary parasitology*, *81*(1), 29-37.

Hillgarth, N. (1984). Social organization of wild peafowl in India. *World Pheasant Assoc J*, *9*, 47-56.

Hollamby, S., Sikarskie, J. G., & Stuht, J. (2003). Survey of peafowl (Pavo cristatus) for potential pathogens at three Michigan zoos. *Journal of Zoo and Wildlife Medicine*, *34*(4), 375-379.

Hopkins, C. (1997). Peafowl Husbandry. *Game Bird and Conservationists Gazette*, 6, 37-39.

Hoyo, J., Elliot, A., & Sargatal, J. (1994). Handbook of the Birds. of the the world. New World Vultures to Guineafowl- Volume 2 Lynx Edicions, Barelona, pp. 434-552.

ICBP (1979). Red Data Book-2. In Warren, B.K.K. RED Data Book. Editor: Warren BKK. Vol. 2: Aves.2nd ed. Part 1. IUCN, Morges, 1980.

Imam, E. (2005). Population status and conservation of Indian Peafowl (*Pavo cristatus)* in Aligarh, northern India. In Galliformes 2004. Proceedings of the 3rd International Galliformes Symposium. World Pheasant Association, Fordingbridge, United Kingdom, pp. 191-193.

Ipek, A., & Sahan, U. (2004). Effect of breeder age and breeding season on egg production and incubation in farmed ostriches. *British poultry science*, *45*(5), 643-647.

Islam, M.A., Ranving, H. & Howlider, M.A.R. (2004). Incubation capacity of broody hens and chick performance. Proceedings of the second annual scientific conference. Chittagong Government Veterinary College held on 25-26 February 2004, pp. 3-19.

Islam, S., Uddin, M. S., Sarker, N. R., Faruque, S., & Khatun, R. (2003). Study on the productive and reproductive performance of 3 native genotype of chickens under intensive management Executive summaries of research report. In Ann. Res. Rev. Workshop, pp. 11-12.

Ismail, M. M., Khan, O. A., Cattoli, G., & Lu, H. (2010). Isolation and identification of highly pathogenic avian influenza virus subtype H5N1 in peafowl (*Pavo cristatus*). *Avian diseases*, *54*(1), 357-360.

Jackson, E.C. (2006). Peacock. Published by Reaktion Books Ltd. 33 great Sutton street, London, U.K. Publication Date: November 30, 2006 | ISBN-10: 1861892934 | ISBN-13: 978-1861892935, pp. 07-16.

Jadhav, B. N., Nikam, S. V., Bhamare, S. N., & Jaid, E. L. (2012). New species of genus Eimeria *(Eimeria shivpuri*) in Broiler chicken (*Gallus gallus Domesticus*) from Aurangabad (MS) India. *International Multidisciplinary Research Journal*, *2*(3), 6-8.

Jain, D., & Rana, S. (2013). Population indices and habitat association of Indian Peafowl (*Pavo cristatus*) in Haryana using line transect and call count method. *Indian J. Animal Research*, *47*(2), 152-155.

Jaiswal, A. K., Sudan, V., Shanker, D., & Kumar, P. (2013). Endoparasitic infections in Indian peacocks (*Pavo cristatus*) of Veterinary College Campus, Mathura. *Journal of parasitic diseases*, *37*(1), 26-28.

Jayarajan, S. (1992). Seasonal variation in fertility and hatchability of chicken eggs. *Ind. J. Poult. Sci.*, 27, 36-39.

Jobson and Christopher. (2016). "The Extraordinary Iridescent Details of Peacock Feathers Captured Under a Microscope." Colossal. Colossal, 30 Mar.. Web. 30 Nov. https://lucvertebrates.wordpress.com/2016/12/01/indian-peafowl-where-beauty-is-more-than-skin-deep.

Johnsgard, P. A. (1986). The pheasants of the world. Oxford University Press.

Johnsgard, P. A. (1999). Pheasants of the World. Smithsonian Institution Press.

Johnsingh, A. J. T. (1976). Peacocks and cobra. *J. Bombay Nat. Hist. Soc*, *73*(1), 214.

Johnsingh, A. J. T. and Murali, S. (1981). The ecology and behaviour of the Indian peafowl (*Pavo cristatus*) Linn. of Injar. *J. Bombay Nat. Hist. Soc*, *75*, 1069-1079.

Jordan, F., Pattison, M. A., & Faragher, T. (2001). Poultry Diseases. 5" Edition.

Joshua, J., & Johnsingh, A. J. T. (1988). Observations on birds on Mundanthurai Plateau, Tamil Nadu. *J. Bombay Nat. Hist. Soc*, *85*(3), 565-577.

Jull, M. A. (1958). Considerable progress achieved in breeding for increased egg production in Egypt. *World's Poultry Science Journal*, *14*(3), 200-202.

Jull, M.A. (1952). Poultry breeding. 3rd edition: John Wiley and sons. New York., 325.

Kalaiselvan, K., & Ramesh, N. (2014). Studies on roost and characteristics of roosting tree utilized by Indian Peafowl *(Pavo cristatus)* at Musiri area, Trichy District, Tamil Nadu, India. *International Research Journal of Natural and Applied Sciences*1(7), 171-178.

Kaliner, G., & Miringa, E. N. (1972). Malignant lymphoid neoplasia in a peahen (*Pavo cristatus)*. *Avian diseases*, pp. 1115-1117.

Kamphues, J.C., Ring, G., Glunder, C., Ahlers, I., Sander, U.N., Distl, O. (2001). Analysis of genotype–environment interactions between layer lines and hen housing systems for performance traits, egg quality and bone breaking strength.2nd communication egg quality traits. Zuchtungskunde. 73, 308-323.

Kannan, R. & D. A. James (1998*).* Indian Peafowl *(Pavo cristatus)*, version 2.0. In the Birds of North America (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.https://doi.org/10.2173/bna.377.

Kathiravan, R. S., Ramachandran, P., Shanmuganathan, S., Karthikeyan, A., Sathiyamoorthy, N., Gollapalli, S. K. & Madesh, E. (2017). Prevalence of Endoparasitic Infection in Free Ranging Peacocks of Southern Tamil Nadu, India. *Int. J. Curr. Microbiol. App. Sci*, *6*(10), 366-371.

Kedreeva, (2010). Peafowl 101: Basic care, genetics, and answers. https://www.backyardchickens.com/threads/peafowl-101-basic-care-genetics-and-answers.388465/; Accessed on 12 April, 2019**.**

Kedreeva, (2011). Peafowl 103: Illness, Injury, Medication and Care. https://www.backyardchickens.com/threads/peafowl-103-illness-injury-medication-and-care-in-progress.542109/; Accessed on 12 April, 2019**.**

Kedreeva, (2015). Peafowl 101: Basic Care, Genetics, and Answers. Introduction to peafowl. The basics, caring for peafowl, genetics and more https://www.backyardchickens.com/articles/peafowl-101-basic-care-genetics-and-answers.67744/; Accessed on 12 April, 2019**.**

Ketelaere, B. D., Govaerts, T., Coucke, P., Dewil, E., Visscher, J., Decuypere, E., & Baerdemaeker, J. D. (2002). Measuring the eggshell strength of 6 different genetic strains of laying hens: techniques and comparisons. *British poultry science*, *43*(2), 238-244.

Keymer, I. F. (1958). A survey and review of the causes of mortality in British birds and the significance of wild birds as disseminators of disease. *Vet. Rec, 70*, 713-720.

Khan, A., Yousaf, A., Khan, M. Z., Siddique, M., Gul, S. T., & Mahmood, F. (2009). Cutaneous form of pox infection among captive peafowl (*Pavo cristatus*) chicks. *Avian pathology, 38*(1), 65-70.

Khan, M. K. I. (2003). Crossing Hilly with RIR and Fayoumi for the Deveopment of Layer Chicken Suitable for Semi-scavenging System with Sonali and Nera as Control. An applied research project, pp. 25-29.

Khan, M. R., & Roy, P. C. (2003). Credit policy; disbursement and its impact on poultry industry in Bangladesh. In Third International Poultry Show and Seminar Dhaka Bangladesh, pp. 43-51.

Khan, M.K.I., Debnath, N.C., Bhuiyan, M.S.A., Khatun, M.J., Karim, M. R., & Dey, B. C. (2007). Development of crossbred chickens for semi-scavenging system by the crossing of Hilly (native) with Rhode Island Red and Fayoumi. *Indian Journal of Animal Sciences*, *77* (3), 257-261.

Khan, M.M.H. (2018). Photographic Guide to the Wildlife of Bangladesh. Arannayk Foundation, Dhaka, Bangladesh, pp. 18.

Khawaja, T., Khan, S. H., Mukhtar, N., Ali, M. A., Ahmed, T., & Ghafar, A. (2012). Comparative study of growth performance, egg production, egg characteristics and haemato-biochemical parameters of Desi, Fayoumi and Rhode Island Red chicken. *Journal of applied animal research*, *40*(4), 273-283.

Khulape, S. A., Gaikwad, S. S., Chellappa, M. M., Mishra, B. P., & Dey, S. (2014). Complete genome sequence of a Newcastle disease virus isolated from wild peacock (*Pavo cristatus)* in India. *Genome Announc.*, *2*(3), 495-514.

Khursheed, A., Sial, N., Malik, S., & Lashari, M. L. (2014). Parasitic infestation in Peafowl of Bahawalpur Zoo, Punjab, Pakistan. *Standard Sci Res Essays*, *2(9)*, 401-405.

Kiers, R. W. (1997). Assessing and achieving fertility: The role of male management. Rosstech, December edition. Ross Breeders Ltd., Newbridge, Midlothian, UK, 1-6.

Kim, K. T., Lee, S. H., & Kwak, D. (2015). Prevalence, biochemical characteristics, and antibiotic susceptibility of aeromonads, vibrios, and plesiomonads isolated from different sources at a zoo. *Journal of zoo and wildlife medicine*, *46*(2), 298-305.

King'Ori, A. M. (2011). Review of the factors that influence egg fertility and hatchability in poultry. *International Journal of Poultry Science*, *10*(6), 483-492.

Kingan, J. R., & Sullivan, T. W. (1964). Effect of high levels of alfalfa meal on egg production, yolk colour, fertility and hatchability. *Poultry Science*, *43*(5), 1205-1209.

Kleiman, D. G., Thompson, K. V., & Baer, C. K. (Eds.). (2010). Wild mammals in captivity: principles and techniques for zoo management. University of Chicago Press.

Knox, C. W. (1939). Crossbreeding in the domestic fowl. Proc. 7th World's Poult. Congr., Cleveland, pp. 58-61.

Kodric-Brown, A., & Brown, J. H. (1984). Truth in advertising: the kinds of traits favored by sexual selection. *The American Naturalist, 124*(3), 309-323.

Koenig, W. D. (1982). Ecological and social factors affecting hatchability of eggs. *The Auk*, *99*(3), 526-536.

Krautwald, M. E., & Schildger, B. (1986). Foreign-body related esophagus obstruction in a peacock (*Pavo cristatus* L. 1758). *Tierarztliche Praxis*, *14*(4), 491-494.

Kumar, A., & Aggarwal, S. G. (2014). Ecology and Biodiversity Status of Sachin Gidc and Its Surroundings with Special Reference to Conservation Measures for Indian Peafowl (*Pavo Cristatus*) Schedule-I Bird Species. *Octa Journal of Environmental Research*, *2*(1), 82-100.

Kumar, A., Maan, S., Mahajan, N. K., Rana, V. P., Jindal, N., Batra, K., & Maan, N. S. (2013). Detection and molecular characterization of Newcastle disease virus in peafowl (*Pavo cristatus*) in Haryana State, India. *Indian Journal of Virology*, *24*(3), 380-385.

Kumar, J., Aggarwal, C. K., & Acharya, R. M. (1976). Collecting and evaluation of native germplasm part 11. Efficiency of fowl conservation, egg production, and egg size in Deshi Rhode Island Red and their crosses. In *Anim. Breed. Abstr* , *40*, 581-586.

Kushwaha, S., & Kumar, A. (2016). A review on Indian peafowl (*Pavo cristatus*) Linnaeus (1758). *J Wildl Res*, *4*(4), 42-59.

Lambrechts, H., Swart, D., Cloete, S. W. P., Greyling, J. P. C., & Van Schalkwyk, S. J. (2004). The influence of stocking rate and male: female ratio on the production of breeding ostriches (*Struthio camelus* spp.) under commercial farming conditions. *South African Journal of Animal Science*, *34*(2), 87-96.

Landman, W. J. M., & Gruys, E. (1998). Amyloid arthropathy in an Indian peafowl. *Veterinary record*, *142*, 90-90.

Lank, D. B., Smith, C. M., Hanotte, O., Ohtonen, A., Bailey, S., & Burke, T. (2002). High frequency of polyandry in a lek mating system. *Behavioral Ecology*, *13*(2), 209-215.

Lapage, G. (1956). Ascaridia galli. Veterinary Parasitology, Oliver and Boyd, London, pp. 175.

Larson, C. (2018). Common Diseases and Ailments of Turkeys and Their Management. Published by the American Livestock Breeds Conservancy PO Box 477 Pittsboro, NC 27312 USA phone (919) 542-5704 fax (919) 542-0022 albc@albc-usa.org www.albc-usa.org © 2007 American Livestock Breeds Conservancy ISBN # 978-1-887316-08-8.https://livestockconservancy.org/images/uploads/docs/ALBCturkey-5.pdf;/ Accessed on 11 December, 2018.

Laun, G.F., & Costa, D.A. (1962). Appraisal of meat production capacity in the New Hampshire, Rhode Island Red, White American and Leghom breed and some of their crosses. *Production lmtilvte Zootee*, 43, 20-25.

Leal, J. L. P., Payan, M. M., & Sandoval, J. A. P. (2007). Prevalencia de parásitos gastrointestinales en las aves de los ordenes galliformes y columbiformes mantenidas en el parque zoológico nacional de Cuba. *REDVET. Revista Electrónica de Veterinaria*, *8*(12), 1-21.

Lebbie, S. H. B., Benyi, K., & Ademosun, A. A. (1981). The effects of feeding regime and stocking rate on the performance of medium-bodied layers in the humid tropics. *British Poultry Science*, *22*(5), 415-421.

Lee, S. H., Park, S. J., Kwak, D., & Kim, K. T. (2017). Sudden death of an Indian peafowl (*Pavo cristatus*) at a zoo due to non-pigmented Serratia marcescens infection. *Journal of Veterinary Medical Science*, 799(2017), 2048-2051.

Leeson, S., Summers, J. D., & Moran Jr, E. T. (1976). Avian water metabolism—A Review. *World's Poultry Science Journal*, *32*(2), 185-195.

Leighton, F. A. (2002). Health risk assessment of the translocation of wild animals. *Revue scientifique et technique-Office international des épizooties*, *21*(1), 187-216.

Leiper, R. T. (1908). An account of some Helminthes contained in Dr. Wenyon's Collection from the Sudan. Third Rep Welc Res Lab Gordon Mem Coll Khartoum, pp. 187-199.

Lepage, D. (2008). Avibase-Birds checklists of the World. http://avibase.bscoc.org/checklist.jspregion=afr&list=howardmoore&lang=EN/; Accessed on 12 April, 2018**.**

Lesson, D., & Summers, J.D. (2001). Male fertility. In: Broiler breeder production. Ist International Book Distribution Company, Lucknow, India, pp. 37.

Ley, D. H., & Yoder Jr, H. W. (2008). Mycoplasma gallisepticum infection. *Diseases of poultry*, *12*, 807-834.

Ley, D. H., Saif, M., Barnes, H. J., Glisson, J. R., Fadly, A. M., mcDouglad, R., & Swayne, D. E. (2003). *Mycoplasma gallisepticum*. Infection. Ames: Iowa State Press.

Linnaeus, Carl. (1758). Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus I. Editio decima, reformata. Holmiae. (Laurentii Salvii).

Lint, K.C. (1975). Acclimation of birds in captivity. *AFA Watchbird*, 2, 6-7.

Liu, S., Chen, J., Chen, J., Kong, X., Shao, Y., Han, Z., & Liu, M. (2005). Isolation of avian infectious bronchitis coronavirus from domestic peafowl (*Pavo cristatus*) and teal (Anas). *Journal of General Virology*, *86*(3), 719-725.

Liu, Y. U. E. Q. I. A. N. G., Han, L. I. A. N. X. I. A. N., Xie, Y. I. C. H. A. N. G., Wen, Y. U. N. Y. A. N., & Zhang, R. E. N. G. O. N. G. (2009). The status and habitat use of Green peafowl (*Pavo muticus)* in Shuangbai Konglonghe Nature Reserve, China. *Int. J. Galliform. Conservat*, *1*, 32-35.

Loyau, A., Gomez, D., Moureau, B., Théry, M., Hart, N. S., Jalme, M. S., & Sorci, G. (2007a). Iridescent structurally based colouration of eyespots correlates with mating success in the peacock. *Behavioral Ecology*, *18*(6), 1123-1131.

Loyau, A., Jalme, M. S., & Sorci, G. (2005a). Intra-and intersexual selection for multiple traits in the peacock (*Pavo cristatus*). *Ethology*, *111*(9), 810-820.

Loyau, A., Saint Jalme, M., & Sorci, G. (2007b). Non-defendable resources affect peafowl lek organization: a male removal experiment. *Behavioural processes*, *74*(1), 64-70.

Loyau, A., Saint Jalme, M., Cagniant, C., & Sorci, G. (2005b). Multiple sexual advertisements honestly reflect health status in peacocks (*Pavo cristatus*). *Behavioral ecology and Sociobiology*, *58*(6), 552-557.

Lukanov, H. (2013). Peafowl's species and their mutations. https://www.researchgate.net/publication/274070223_peafowls_species_and_their_mutations.,/; Accessed on 12 April, 2018**.**

Lukert, P. D., & Saif, Y. M. (1997). Infectious bursal disease virus. In "Disease of Poultry", (BW. Calnek, *et al.,* ed.), pp. 721-731.

Lush, J.L. (1945). Animal Breeding Plans. 3rd edition. Iowa state University Press., pp. 316.

Machovsky-Capuska, G. E., Senior, A. M., Zantis, S. P., Barna, K., Cowieson, A. J., Pandya, S., & Raubenheimer, D. (2016). Dietary protein selection in a free-ranging urban population of common myna birds. *Behavioral ecology*, *27*(1), 219-227.

Maharani, D., Hariyono, D. N., Putra, D. D., Lee, J. H., & Sidadolog, J. H. (2019). Phenotypic characterization of local female duck populations in Indonesia. *Journal of Asia-Pacific Biodiversity*, *12*(4), 508-514.

Malecki, I. A., Horbanczuk, J. O., Reed, C. E., & Martin, G. B. (2005). The ostrich (*Struthio camelus*) blastoderm and embryo development following storage of eggs at various temperatures. *British Poultry Science*, *46*(6), 652-660.

Malony, M.A., Gyilbreath, J.C., Robert, D., & Morrison, D. (1963). Two any selection for body weight in chicken. *Poultry Science*, 42, 32-36.

Mandal, A. K. (1965). Studies on some aspects of avian coccidia (Protozoa: Sporzoa). 3 Five new species of the genus *Eimeria schnedier*, and a new subspecies of *Eimeria roscoviensis* (Labbe). *Proc Zool Soc (Calcutta)*, *18*, 47-57.

Maria, C. (2018). Characteristics of a Peacock Bird. https://sciencing.com/characteristics-peacock-bird-6155098.html/ ; Accessed on 21 April 2018.

Marias, C.L. (1965). Influence of crossbreeding on fertility hatchability and growth rate of chicks. Animal Breeding Abstract, 34, pp. 266.

Marietto-Gonçalves, G. A., Martins, T. F., de Lima, E. T., de Souza Lopes, R., & Andreatti Filho, R. L. (2009). Prevalência de endoparasitas em amostras fecais de aves silvestres e exóticas examinadas no Laboratório de Ornitopatologia e no Laboratório de Enfermidades Parasitárias da FMVZ-UNESP/Botucatu-SP. *Ciência Animal Brasileira*, *10*(1), 349-354.

Marois, C., Oufour-Gesbert, F., & Kempf, I. (2000). Detection of *Mycoplasma synoviae* in poultry environment samples by culture and polymerase chain reaction. *Veterinary microbiology*, *73*(4), 311-318.

Martin, S. W., & Meek, A. H. (1987). P. Willeberg-Veterinary Epidemiology principles and methods. USA: Iowa State University Press, pp. 343.

Mason, S. J., & Maiers, J. D. (1984). An epornitic of *Mycoplasma gallisepticum* in turkeys. *Avian diseases*, *28*(3). 751-757.

Mbap, S. T., & Zakar, H. (2000). Characterization of local chickens in Yobe state, Nigeria. In The role of Agriculture in Poverty Alleviation (Abubakar MM, Adegbola TA and Butswat ISR, eds.*)*. Proceedings of the 34th Annual Conference of the Agricultural Society of Nigeria (ASN*)*, pp. 126-131.

McDougald, L. R., & Reid, W. M. (2003). Coccidiosis In: Diseases of Poultry (11th edn). Iowa State University Press, Ames, IA, USA.

McDougald, L. R., Da Silva, J. M. L., Solis, J., & Braga, M. (1987). A survey of sensitivity to anticoccidial drugs in 60 isolates of coccidia from broiler chickens in Brazil and Argentina. *Avian diseases*, *31*(2), 287-292.

McGowan, P. J. K. & Garson, P.J. (1995). Status survey and conservation action plan 1995-99. Pheasants. (Vol. 24). *IUCN, Gland, Switzerland.*

McGowan, P., & Madge, S. (2010). Pheasants, Partridges & Grouse: Including buttonquails, sandgrouse and allies. Bloomsbury Publishing.

McMartin, D. A., DaMassa, A. J., McKeen, W. D., Read, D., Daft, B., & Lam, K. M. (1996). Experimental reproduction of *Mycoplasma gallisepticum* disease in chukar partridges (*Alectoris graeca*). *Avian diseases*, *40*(2), 408-416.

McSorley, H. J., Grainger, J. R., Harcus, Y., Murray, J., Nisbet, A. J., Knox, D. P., & Maizels, R. M. (2010). daf-7-related TGF-β homologues from trichostrongyloid nematodes show contrasting life cycle expression patterns. *Parasitology*, *137*(1), 159.

Miazi O.F., Miah G., Momin M.M., Hassan M.M., Uddin M.M., Hossain, M.E., Mahmud M.S. and Ahsan M.F. (2015). Liveability of Fayoumi and Sonali Chicks in Scavenging Rearing System. *Scientific Research Journal (SCIRJ*), *3*(12),15-19. www.scirj.org © 2015, Scientific Research Journal.

Miazi, O. F., Miah, G., Miazi, M. M., Uddin, M. M., Hassan, M. M., & Ahsan, M.F. (2012). Fertility and hatchability of Fayoumi and Sonali chicks. *Scholarly Journal of Agricultural Science*, *2*(5), 83-86.

Miazi, O. F., Miah, G., Uddin, M. M., Hassan, M. M., & Ahsan, M. F. (2011). Effects of environment and genotype for the expression of weight gain of Fayoumi and Sonali chicks. *International Journal of Natural Sciences*, *1*(1), 22-24.

Miller, P. E., Paul-Murphy, J., Sullivan, R., Cooley, A. J., Dubielzig, R. R., Murphy, C. J., & Fadly, A. M. (1998). Orbital lymphosarcoma associated with reticuloendotheliosis virus in a peafowl. *Journal of the American Veterinary Medical Association*, *213*(3), 377-380.

Miller, P. J., Decanini, E. L., & Afonso, C. L. (2010). Newcastle disease: evolution of genotypes and the related diagnostic challenges. *Infection, genetics and evolution*, *10*(1), 26-35.

Miller, R. E., & Fowler, M. E. (2014). Fowler's Zoo and Wild Animal Medicine, Volume 8-E-Book (Vol. 8). Elsevier Health Sciences.

Mitchell, R. M., & Dick, J. A. (1975). Ectoparasites from Nepal birds. *J, Bombay Natural. Hist. society*, *74*, 264-274.

Mohamed, N., Azzam, A. A., Mohammed, S., & Yousif, A. (2015). Identification key for chewing lice (Phthiraptera: Amblycera, Ischnocera) infesting the Indian Peafowl (*Pavo cristatus*) with one new country record and new host record for Saudi Arabia. *Turkish Journal of Zoology*, *39*(1), 88-94.

Moorthi, R. N., Armstrong, C. L., Janda, K., Ponsler-Sipes, K., Asplin, J. R., & Moe, S. M. (2014). The effect of a diet containing 70% protein from plants on mineral metabolism and musculoskeletal health in chronic kidney disease. *American journal of nephrology*, *40*(6), 582-591.

Morris, T. R., & Fox, S. (1960). The use of lights to delay sexual maturity in pullets. *British Poultry Science*, *1*(1-3), 25-36.

Mountain, P. (2014). Peafowl 101: Breeding, Hatching and Raising Peafowl. https://www.backyardchickens.com/articles/breeding-hatching-and-raising-peafowl.67360/; Accessed on 12 Ocotober, 2018.

Muhammad, M. H., Shabana, N., Muhammad, A., Sultan, M., Zahid, A., Faiza, M.& Muhammad, S. (2013). Assessing the Effects of the Mating Sex Ratios on

Reproductive. Performance of Indian Peafowl (*Pavo cristatus). Pakistan J. Zool., vol. 45(*6), 1623-1627.

Mulotwa, M., Louette, M., Dudu, A., Upoki, A., & Fuller, R. A. (2010). Congo Peafowl use both primary and regenerating forest in Salonga National Park, Democratic Republic of Congo. *Ostrich*, *81*(1), 1-6.

Munir, M., Shabbir, M. Z., Yaqub, T., Shabbir, M. A., Mukhtar, N., Khan, M. R., & Berg, M. (2012). Complete genome sequence of a velogenic neurotropic avian paramyxovirus 1 isolated from peacocks (*Pavo cristatus*) in a wildlife park in Pakistan. *Journal of Virology,* pp. 13113-13114.

Murad, A., Farooq, M., Mian, M. A., & Muqarrab, A. K. (2001). Hatching performance of Fayumi eggs. *Sarhad J. Agric*, *17*(1), 1-6.

Muraleedharan, K., Iswaraiah, V., Ziauddin, S.K. & Srinivasan, K. (1990). A survey of gastrointestinal parasites of mammals of zoological gardens at Mysore. *Mysore J. Agri. Sci*., 24, 250-526.

Murari, S. K., Frey, F. J., Frey, B. M., Gowda, T. V., & Vishwanath, B. S. (2005). Use of *Pavo cristatus* feather extract for the better management of snakebites: neutralization of inflammatory reactions. *Journal of Ethnopharmacology*, *99*(2), 229-237.

Murphy, M. T. (1994). Breeding patterns of Eastern Phoebes in Kansas: Adaptive strategies or physiological constraint? *The Auk*, *111*(3), 617-633.

Mushtaq-ul-Hassan, M., Ali, Z. A. H. E. D., Arshad, M. I., Mahmood, S., & Mahmood-ul-Hassan, M. (2012). Effects of mating sex ratios in Indian peafowl (*Pavo cristatus*) on production performance at Wildlife Research Institute, Faisalabad (Pakistan). *Iranian Journal of Veterinary Research*, *13*(2), 143-146.

Mushtaq-ul-Hassan, M., Naz, S., Abrar, M., Mahmood, S., Ali, Z., Mahmood, F., & Sarwar, M. (2013). Assessing the effects of the mating sex ratios on reproductive performance of Indian peafowl (*Pavo cristatus)*. *Pakistan Journal of Zoology, 45*(6), 1623-1627.

Naciri, M., Chaussé, A. M., Fort, G., Bernardet, N., Nérat, F., & De Gussem, K. (2004). Value of anticoccidial sensitivity tests (ASTs) in the prevention of chicken coccidiosis. In XXII World's Poultry Congress. Istanbul: Word's Poultry Congresses. Istanbul June, pp. 8-13.

Nadeem, M. (2010) Prevalence, antibiotic sensitivity profiles and treatment trial of mycoplasmosis in captive peafowl maintained at selected government wildlife parks of Punjab. M.Phil. Thesis, Dept. of Clinical Medicine and Surgery, Univ. Agri., Faisalabad, Pakistan.

Nadeem, M., Yousaf, A., Iqbal, Z., Awais, M. M., & Pervez, B. A. (2014). Prevalence, diagnosis and treatment of mycoplasmosis in game birds. *World's Poultry Science Journal*, *70*(1), 69-80.

Nakamura, A. A., Simões, D. C., Antunes, R. G., da Silva, D. C., & Meireles, M. V. (2009). Molecular characterization of *Cryptosporidium* spp. from fecal samples of birds kept in captivity in Brazil. *Veterinary Parasitology*, *166*(1-2), 47-51.

Nambirajan, K., Muralidharan, S., Manonmani, S., Kirubhanandhini, V., & Ganesan, K. (2018). Incidences of mortality of Indian peafowl Pavo cristatus due to pesticide poisoning in India and accumulation pattern of chlorinated pesticides in tissues of the same species collected from Ahmedabad and Coimbatore. *Environmental Science and Pollution Research*, *25*(16), 15568-15576.

Naseer, J., Anjum, K. M., Khan, W. A., Imran, M., Ishaque, M., Hafeez, S., & Nazir, M. A. (2018a). Phylogenetic analysis based studies on genetic variation of Cytochrome b gene of Indian peafowl (*Pavo cristatus*) in Pakistan. *Indian Journal of Animal Research*, *52*(3), 343-346.

Naseer, J., Anjum, K. M., Khan, W. A., Imran, M., Yaqub, A., Munir, M. A., & Nazeer, A. (2018b). Observations on the Reproductive Behavior of Indian peafowl (*Pavo cristatus*) Under Captivity. *JAPS, Journal of Animal and Plant Sciences*, *28*(2), 515-519.

Naseer, J., Anjum, K. M., Munir, M. A., Nazir, M. A., Yousaf, M. Z., Naseer, O., & Akbar, M. T. (2018c). A study on Indian peafowl (*Pavo cristatus*) emphasising breeding season and feeding behaviour in captivity. *Indian Journal of Animal Research*, *52*(11), 1664-1666.

National Geographic. (2016). Peacocks," *National Geographic*. National Geographic Partners, 28 Nov. 2016. Web. 30 Nov. 2016.

Navneethakannan K (1981). Activity patterns in a colony of peafowl (*Pavo cristatus*) in nature. *Journal Bombay Natural History Society*, *81*(2), 387-393.

Newcombe, M. (1996). Managing broiler breeder males in production. *Shaver focus*, pp. 1-5.

Norris, T. 1999. Captive Bird Diets vs Wild Bird Diets. http://www.peafowl.org/articles/captive-bird-diets-wild-bird-diets/; Accessed on 12 April, 2019.

Nowak, V., Persijn, D., Rittenschober, D., & Charrondiere, U. R. (2016). Review of food composition data for edible insects. *Food chemistry*, *193*, 39-46.

Nwagu, B. I. (1997). Factors affecting fertility and hatchability of guinea fowl eggs in Nigeria. *World's Poultry Science Journal*, *53*(3), 279-286.

Oates, E. W., & Blanford, W. T. (1889). The Fauna of British India, Including Ceylon and Burma: Birds (Vol. 1). London: Taylor & Francis.

Ohta, Y., & Kidd, M. T. (2001). Optimum site for in ovo amino acid injection in broiler breeder eggs. *Poultry Science*, *80*(10), 1425-1429.

Okoro, V. M. O., Nwokeocha, A. C. C., Ijezie, C. O., Mbajiorgu, C. A., & Mbajiorgu, E. F. (2016). Effect of varying dietary supplemental inclusion levels of onion and garlic on semen quality characteristics of Hubbard white breeder broiler cocks aged 35–41 weeks old. *Indian Journal of Animal Research*, *50*(6), 922-929.

Pabisch, S., Puchegger, S., Kirchner, H. O. K., Weiss, I. M., & Peterlik, H. (2010). Keratin homogeneity in the tail feathers of *Pavo cristatus* and *Pavo cristatus mut. alba*. *Journal of structural biology*, *172*(3), 270-275.

Pakpinyo, S., & Sasipreeyajan, J. (2007). Molecular characterization and determination of antimicrobial resistance of *Mycoplasma gallisepticum* isolated from chickens. *Veterinary microbiology*, *125*(1-2), 59-65.

Parasharya, B. M., & Mukherjee, A. (1999). Roosting behaviour of Indian peafowl (*Pavo cristatus). Journal-bombay natural history society*, *96*(3), 471-472.

Parveen, Z., Sidra, S. and Khan, B.N. (2018). Diet preferences and general behavior of peafowls in captive environment. *Punjab University Journal of Zoology*, 33(1), 16-21. http: dx.doi.org/10.17582/pujz/2018.33.1.16.21.

Payne, R. B., (2010). Handbook of the birds of the world. Wilson J. Ornithol., 122, 627-629.

Peek, H. W., & Landman, W. J. M. (2003). Resistance to anticoccidial drugs of Dutch avian *Eimeria* spp. field isolates originating from 1996, 1999 and 2001. *Avian Pathology*, *32*(4), 391-401.

Permsak, S. (1996). Effect of water spraying and eggs turning angle to efficiency of duck hatchability. In *Proceedings of the 34 th Kasetsart university annual conference, Bangkok (Thailand)* (Vol. 517, pp. 22-26).

Perrins, C. M. (1990). Conseil international pour la protection des oiseaux. *The illustrated encyclopaedia of birds: the definitive guide to birds of the world*. Headline.

Petrie, M., & Halliday, T. (1994). Experimental and natural changes in the peacock's (*Pavo cristatus*) train can affect mating success. *Behavioral Ecology and Sociobiology*, *35*(3), 213-217.

Petrie, M., & Williams, M. (1993). Peahens lay more eggs for pecocks with larger trains. Proceedings: Biological Sciences, *251*(1331), 127-131.

Petrie, M., Krupa, A., & Burke, T. (1999). Peacocks lek with relatives even in the absence of social and environmental cues. *Nature*, *401*(6749), 155-157.

Petrie, M., Tim, H., & Carolyn, S. (1991). Peahens prefer peacocks with elaborate trains. *Animal Behaviour*, *41*(2), 323-331.

Pienkowski, M. W., & Minton, C. D. T. (1973). Wing length changes of the Knot with age and time since moult. *Bird Study, 20*(1), 63-68.

Ponnudurai, G., Rajendran, K., Rani, N., Harikrishnan, T.J. (2011). A note on parasitic infestation in Indian peacock. *Zoo's Print*, 27(4), 1-32.

Proudfoot, F. G., & Hulan, H. W. (1981). The influence of hatching egg size on the subsequent performance of broiler chickens. *Poultry Science*, *60*(10), 2167-2170.

Radwan, A. I., & Lampky, J. R. (1972). Enterobacteriaceae isolated from cowbirds (*Molothrus ater*) and other species of wild birds in Michigan. *Avian diseases*, *16*(2). 343-350.

Raghavendra, G. (2001). Survival Strategies - Cooperation and Conflict in Animal Societies. Harvard: Harvard University Press. pp. 212. ISBN 978-0-674-00611-9.

Rahman, M., Sorensen, P., Jensen, H. A., & Dolberg, F. (1997). Exotic hens under semi scavenging conditions in Bangladesh. *Livestock Research for Rural Development*, *9*(3), 1-11.

Raja, A., (2007). Zoos in India. Central Zoo Authority, India.Peacock Farming | Modern Farming Methods - Roy's Farmhttps://www.roysfarm.com/peacock-farming/; Access on 12 April, 2019.

Rajaraman, S.K., Rajkumar, K., & Ramesh, C. (1998). Food Items Preferred by the Indian Blue Peafowl (*Pavo cristatus*). B.Sc. Dissertation. A.V.C. College, pp. 12.

Ramesh, K., & McGowan, P. (2009). On the current status of Indian peafowl (*Pavo cristatus)* (Aves: Galliformes: Phasianidae): keeping the common species common. *Journal of Threatened Taxa*, *1*(2), 106-108.

Rands, M. R. M., Ridley, M. W., & Lelliott, A. D. (1984). The social organization of feral peafowl. *Animal Behaviour*, *32*(3), 830-835.

Rao, A. T. (1979). Intussusception of proventriculus in a common pea fowl (*Pavo cristatus*). *Vet Rec*, *104*(4), 76.

Rao, A. T., & Acharjyo, L. N. (1984). Diagnosis and classification of common diseases of captive animals at Nandankanan zoo in Orissa, India. *Indian Journal of Animal Health1*, *23*(2), 147-152.

Rao, A. T., Acharjyo, L. N., & Patnaik, M. M. (1981). Pathology of ascariasis in a pea fowl (*Pavo cristatus*) caused by Ascaridia perspicillum Rudolf 1803. Note. *Indian Veterinary Journal*, *58*(7), 585.

Rao, T. B., & Hafeez, M. (2006). Ascariasis in Indian peafowl (*Pavo cristatus)* chicks. *Zoos PJ*, *21*(8), 2377.

Rauw, W. M., Kanis, E., Noordhuizen-Stassen, E. N., & Grommers, F. J. (1998). Undesirable side effects of selection for high production efficiency in farm animals: a review. *Livestock production science*, *56*(1), 15-33.

Ray, H. N. (1966). Remarks on *Eimeria pavonis n. sp.* from Indian peacock (*Pavo cristatus*). *Indian J Microbiol*, *6*, 51-52.

Reddy, N.R., Jaya Gopala, Jagannath, M.S., D'souza, P.E., Rahman, A. & Basavarajappa. (1992). Prevalence of gastrointestional parasites in wild mammals and captive birds at Bannerghatta National Park, Bangalore. *Indian J. Anim. Sci. 62*(11), 1046-1048.

Reddy, V. B., Sharma, P. L. M., & Varadarajulu, P. (1965). The effect of breed, preincubation storage time and egg weight on hatchability of poultry eggs. *Indian vet. J*, *42*, 438.

Reece, F. N., & Lott, B. D. (1983). The effects of temperature and age on body weight and feed efficiency of broiler chickens. *Poultry Science*, *62*(9), 1906-1908.

Reece, R. L., Ireland, L., & Barr, D. A. (1986a). Infectious sinusitis associated with *Mycoplasma gallisepticum* in game-birds. *Australian veterinary journal*, *63*(5), 167-168.

Reece, R. L., Ireland, L., Scott, P. C., Pang, V. F., Adams, J. H., Beasley, V. R., & Haschek, W. M. (1986b). Mycoplasmosis in racing pigeons. *Australian veterinary journal*, *63*(5), 166-167.

Rees, P.A. (2011). An introduction to zoo biology and management. Wiley Blackwell West Sussex UK, pp. 151-172.

Rezaei, M., Yngvesson, J., Gunnarsson, S., Jönsson, L., & Wallenbeck, A. (2018). Feed efficiency, growth performance, and carcass characteristics of a fast-and a slower-growing broiler hybrid fed low-or high-protein organic diets. *Organic Agriculture*, *8*(2), 121-128.

Ridley, R. K., Terhune, K. S., & Granstrom, D. E. (1991). The efficacy of pyrantel pamoate against ascarids and hookworms in cats. *Veterinary research communications, 15*(1), 37-44.

Roberts, T. J. (1992). Birds of Pakistan, the: passeriformes: pittas to buntings (Vol. 2). Oxford University Press.

Rodenburg, T. B., & Turner, S. P. (2012). The role of breeding and genetics in the welfare of farm animals. *Animal frontiers*, *2*(3), 16-21.

Rommel, M. (2000). Parasitosen des Nutzgeflügels (Huhn, Truthuhn, Gans, Ente, Taube). *Veterinärmedizinische Parasitologie. Parey Buchverlag, Berlin*, 673-774.

Roque, L., & Soares, M. C. (1994). Effects of eggshell quality and broiler breeder age on hatchability. *Poultry science*, *73*(12), 1838-1845.

Rösner, T., & Van Schalkwyk, A. (2000). The environmental impact of gold mine tailings footprints in the Johannesburg region, South Africa. *Bulletin of Engineering Geology and the Environment*, *59*(2), 137-148.

Roussan, D. A., Abu-Basha, E. A., & Haddad, R. R. (2006). Control of *Mycoplasma gallisepticum* Infection Ạn Commercial Broiler Breeder Chicken Flocks Using Tilmicosin (Provitil Powder) Oral Formulation. *International Journal of Poultry Science*, *5*(10), 949-954.

Rowe, S. (2013). The More Peacock Page. http://www.boxess.com/wppg2.htm/; Accessed on 09 April, 2019.

Sabesh, R. (2010). The Peacock-Our national bird. *Eco News*, *16*(2), 5-7.

Sachdev, A. K., Ahuja, S. D., Thomas, P. C., & Agarwal, S. K. (1985). Effect of egg weight and duration of storage on the weight loss, fertility and hatchability traits in Japanese quails. *Indian journal of poultry science*, *20*(1), 19-22.

Sahajpal, V., & Goyal, S. P. (2008). Identification of shed or plucked origin of Indian Peafowl (*Pavo cristatus*) tail feathers: Preliminary findings. *Science & Justice*, *48*(2), 76-78.

Saidenberg, A. B., Teixeira, R. H., Astolfi-Ferreira, C. S., Knöbl, T., & Piantino Ferreira, A. J. (2007). *Serratia marcescens* infection in a swallow-tailed hummingbird. *Journal of wildlife diseases*, *43*(1), 107-110.

Saini, M., Das, D. K., Dhara, A., Swarup, D., Yadav, M. P., & Gupta, P. K. (2007). Characterisation of peacock (*Pavo cristatus*) mitochondrial 12S rRNA sequence and its use in differentiation from closely related poultry species. *British poultry science*, *48*(2), 162-166.

Saleque, M. A., & Mustafa, S. (1996). Landless women and poultry: the Brac model in Bangladesh. In Integrated Farming in Human Development. Proceedings of a workshop, pp. 18.

Saleque, M. A., Rahman, M. H., & Hossain, M. I. (2003). Seasonal variation in the prevalence of poultry diseases in Bangladesh. In 9th BSVER Annual Scientific Conference held at BAU, Mymensingh on, pp. 6-7.

Samiullah, S., Roberts, J. R., & Chousalkar, K. (2015). Eggshell colour in brown-egg laying hens—a review. *Poultry science*, *94*(10), 2566-2575.

Samour, J., Naldo, J., Rahman, H., & Sakkir, M. (2010). Hematologic and plasma biochemical reference values in Indian peafowl (*Pavo cristatus*). *Journal of avian medicine and surgery*, *24*(2), 99-107.

Santiapillai, C., & Wijeyamohan, S. (2015). The indian peafowl (*Pavo cristatus*) in the Vicinity of the Giant's Tank in Mannar District, Sri Lanka. *Ceylon Journal of Science (Biological Sciences)*, *44*(1), 61-66.

Saravanan, K., Saravanan, P., & Senthil, T. (1997). Diet of the Indian Blue Peafowl (*Pavo cristatus)*. B.Sc. Dissertation A.V.C. College, Mayiladuturai, pp. 12.

Sarica, M., & Soley, F. (1995). The effect of hatching egg weight on the hatchability, growing and egg production traits of Japanese quail (*Coturnix coturnix japonica*). *Journal of Agriculture Faculty of OMU*, *10*(3), 19-30.

Sathyakumar, S., & Kalsi, R. S. (2007). Partridges, quails, francolins, & snowcocks. Galliformes of India. *Envis Bulletin: Wildlife and Protected Areas*, *10*, 3-32.

Sathyanarana, M. C. (2005). Impact on the Indian peafowl (*Pavo cristatus*) on agricultural Ecosystems. *Envis Bull. Wildlife Prot. Areas*, 175-176.

Sathyanarayana, M. C. (2004). Bird pest management with special reference to Indian peafowl (*Pavo cristatus*) in Tamilnadu, India. In Galliformes 2004. Proceedings of the 3rd International Galliformes Symposium. Fordingbridge, UK: World Pheasant Association.

Sathyanarayana, M. C., & Veeramani, A. (1993). Activity Patterns and feeding ecology of blue peafowl (*Pavo cristatus*) in Mudumalai Wildlife Sanctuary, Tamil Nadu. *Zoo's Print*, 13-15.

Sathyanarayana, M.C., & Rajadurai, T. (1989). Preference of roosting trees of Indian Peafowl (*Pavo cristatus*). National Symposium on Natural Resources and their Conservation, A.V.C. College, pp. 15-17.

Schalkwyk, S. V., Cloete, S. W. P., Brown, C. R., & Brand, Z. (2000). Hatching success of ostrich eggs in relation to setting, turning and angle of rotation. *British Poultry Science*, *41*(1), 46-52.

Schrank, F. V. P. (1788). Verzeichniß der bisher hinlänglich bekannten Eingeweidewürmer: nebst einer Abhandlung über ihre Anverwandtschaften. Strobl, pp. 1-12.

Schwartz, D.L. (1997). Disease of Peafowl. Issue of The UPA Newsletter. © 1997 The United Peafowl Association. https://unitedpeafowlassociation.org/page/1/?s=health/; Accessed on 19 December, 2018.

Scott, M. E. (1988). The impact of infection and disease on animal populations: implications for conservation biology. *Conservation biology*, *2*(1), 40-56.

Scott, M.L., Nesheim, M.C. & Young, R. J. (1976). Nutrition of the chicken (2nd Edtion). M.L Scott Associate Ithaca New York, pp. 236.

Seker, I., Kul, S., & Bayraktar, M. (2004). Effects of parental age and hatching egg weight of Japanese quails on hatchability and chick weight. *International Journal of Poultry Science*, *3*(4), 259-265.

Shahabuddin, G., & Kumar, R. (2007). Effects of extractive disturbance on bird assemblages, vegetation structure and floristics in tropical scrub forest, Sariska Tiger Reserve, India. *Forest Ecology and Management*, *246*(2-3), 175-185.

Shanaway, M. M. (1994). Quail production systems: a review. FAO, Rome (Italy). *Animal Production and Health Division*.

Sharma, I. K. (1973). Ecological studies of biomass of the Peafowl (*Pavo cristatus*). *Japanese Journal of Ornithology*, *22*(93-94), 25-29.

Sharma, I. K. (1974). Ecological studies of the plumes of the peacock (*Pavo cristatus*). *The Condor*, *76*(3), 344-346.

Shivrajkumar, Y. S. (1957). An incubating Peacock (*Pavo cristatus* Linn.). *J. Bombay Nat. Hist. Soc*, *54*(2), 464.

Siddiqui, K. U., Islam, M. A., Kabir, S. M. H., Ahmad, M., Ahmed, A. T. A., Rahman, A. K. A. & Khondker, M. (2008). Encyclopedia of flora and fauna of Bangladesh. Vol. 26 Birds. Asiatic Society of Bangladesh, Dhaka, Bangladesh.

Sikander, S. K., Ali, Z., Nemat, A., Ahmad, S., Hussain, Z., Saleem, K., & Khan, M. N. (2015). Diet Provision for Zoo Animal in Captive Conditions of Lahore Zoo. *Pakistan journal of animal and Plant Sciences*, *25*(3), 493-499.

Silversides, F. G., & Scott, A. T. (2001). Effect of storage and layer age on quality of eggs from two lines of hens. *Poultry Science*, *80*(8), 1240-1245.

Singh, D (1975). Poultry breeding in India. Cited in: livestock breeding in India by Sunderesan, D. Vikash Publishing House. Delhi. pp 155-160.

Singh, N., & Prasad, R. (1960). Welcome to BJP Central Library. BJP e-Library. · URI: http://library.bjp.org/jspui/handle/123456789/423. Appears in Collections: Books – Manthan and other. Files in This Item: File, Description, Size, Format. bihar-ka Gaourv.pdf, 10.84 MB, Adobe PDF, View/Open.

Singh, R. P. & Kumar, J. (1994). Biometrical Methods in Poultry Breeding (No. Ed. 1). Kalyani Publishers 1/1, Rajinder nagar, Ludhiana-141008, India.

Siriwan, P. (1996). Effects of water spraying and eggs' turning angle to efficiency of ducks' hatchability. In 34. Kasetsart Univ. Annual Conference, Bangkok (Thailand), 30 Jan-1 Feb 1996. 517, 22-26.

Skoglund, W. C., Seegar, K. C., & Ringrose, A. T. (1952). Growth of broiler chicks hatched from various sized eggs when reared in competition with each other. *Poultry Science*, *31*(5), 796-799.

Sloss, M. W., & Kemp, R. L. (1978). Veterinary clinical parasitology (No. Ed. 5). Iowa State University Press.

Sloss, M. W., Kemp, R. L. & Zajac, A.M. (1994). Veterinary clinical parasitology. 6. Lucknow: International Book Distribution Co., pp. 85.

Solaiappan, A., Karuppasamy, S. and Murali, S. (2002). A study on the Population and Behaviour of Indian Peafowl (*Pavo cristatus*) in Ketchilapuram Village, Tuticorin District, Tamilnadu. Proceedings of the National Symposium on Galliformes. A.V.C.College, pp. 86.

Somes, J. R. G., & Burger, R. E. (1993). Inheritance of the white and pied plumage colour patterns in the Indian peafowl (*Pavo cristatus*). *Journal of Heredity*, *84*(1), 57-62.

Soomro, N. M., Rind, R., Arijo, A. G., & Soomro, S. A. (2001). Clinical, gross and histopathological studies of coccidial infection in chicken. *Int J Agric Biol*, *3*(4), 426-427.

Soulsby, E. J. L. (1982). Helminths. *Arthropods and Protozoa of domesticated animals, 291*.

Stadler, C. K., & Carpenter, J. W. (1996). Parasites of backyard game birds. In *Seminars in Avian and Exotic Pet Medicine*, *5*(2), 85-96. WB Saunders.

Stanphone, W. (1961). Crossbreds as layers. Animal Breeding Abstract 30, pp. 244.

Steiner, C. V., & Davis, R. B. (1981). *Caged bird medicine: selected topics*. Iowa State University Press.

Stewart, I. R., Clark, F., & Petrie, M. (1996). Distribution of chewing lice upon the polygynous peacock (*Pavo cristatus)*. *The Journal of parasitology*, *82*(2), 370-372.

Stokes, A.W. and Williams, H. Warrington. (1971). "Courtship Feeding in Gallinaceous Birds". *The Auk*, *88*(3), 543-559.

Stuart-Baker, E. C. (1927). The fauna of British India including Ceylon and Burma. Birds IV.

Sudhahar, S. (2003). Studies on roost count and characteristics of roosting trees utilized by peafowl (Pavo cristatus) in Viralimalai area, Tamilnadu, Southern India. M.S., thesis submitted to A.V.C. College, Mannampandal, Tamilnadu.

Sun, L., Zhang, G. H., Jiang, J. W., Fu, J. D., Ren, T., Cao, W. S., & Liu, W. J. (2007). A Massachusetts prototype like coronavirus isolated from wild peafowls is pathogenic to chickens. *Virus research*, *130*(1-2), 121-128.

Sundaramoorthy, T. (2018). Indian peafowl. C.P.R. Environmental Education Center. http://cpreec.org/01.htm/; Accessed on April, 2019.

Sundaramurthy, K., Moorthy, K. and Murali, S. (2002). A study on the Ecology (Population) and Behaviour of the Indian Peafowl (*Pavo cristatus*) in Vembakkotai, Virudhunagar

District, Tamilnadu. Proceedings of the National Symposium on Galliformes. A.V.C.College, pp. 86.

Sung, M. J., Chang, C. H., Yoon, Y. K., & Park, S. E. (2006). Clinical aspects of an outbreak of Serratia marcescens infections in neonates. *Korean J Pediatr*, *49*(5), 500-506.

Takahashi, M., & Hasegawa, T. (2008). Seasonal and diurnal use of eight different call types by Indian peafowl (*Pavo cristatus*). *Journal of Ethology*, *26*(3), 375-381.

Takahashi, M., Arita, H., Hiraiwa-Hasegawa, M., & Hasegawa, T. (2008). Peahens do not prefer peacocks with more elaborate trains. *Animal Behaviour*, *75*(4), 1209-1219.

Talha, M. M. H., Mia, M. M., & Momu, J. M. (2018). Morphometric, productive and reproductive traits of Indian peafowl (*Pavo cristatus*) in Bangladesh. *International Journal of Development Research*, *8*(02), 19039-19043.

Tareq, M. K. (1992). The performance of exotic breeds under scavenging cum supplementary feeding in rural condition of rearing (M. Sc. Thesis, Bangladesh Agricultural University, Mymensingh).

Tariq, M., Butt, N. S., Mansha, M., & Bhinder, M. A. (2019). 34. Breeding performance and disease profile of six peafowl species in captivity at Jallo breeding center, Lahore. *Pure and Applied Biology (PAB)*, *8*(1), 312-320.

Tarongoy Jr, J., Eduave, F., & Gemota, E. K. (1990). Egg age as a factor of hatchability. *SWUCA-J. Agric Res* 5, 22-26.

Tast, J. O. H. A. N., & Rassi, P. E. R. T. T. I. (1973). Roosts and roosting flights of wintering jackdaws *Corvus monedula* at Tampere, Finland. *Ornis Fenn*, *50*, 29-45.

Tehsin, R., & Tehsin, F. (1990). Indian Great Horned Owl (*Bubo bubo* Linn.) and Peafowl, (*Pavo cristatus* Linn). *J. Bombay Nat. Hist. Soc*, *87*(2), 300.

Teixeira, M., Monteiro, J. P., Catenacci, L. S., de Azevedo Rodrigues, M. D. L., & de Carvalho, M. (2012). Ascaridiasis in peafowl (*Pavo cristatus,*Phasianidae) due to *Ascaridia galli* Schrank, 1788. *Journal of Zoo and Wildlife Medicine*, *43*(3), 585-587.

Thakar, J. P. (1963). Peacock: the national bird of India. *Journal of the Oriental Institute*, 425-446.

Thapar V (1998). Land of the Tiger: A natural history of the Indian subcontinent. University of California Press.

Titilincu, A., Mircean, V., Bejan, A., Iovu, A., Ungureanu, R., & Cozma, V. (2009). Prevalence of endoparasites in peacocks (*Pavo cristatus*). *Revista Scientia Parasitologica*, *10*(1/2), 101-105.

Travassos, L. (1913). Sobre as especies brazileiras da subfamilia Heterakinae Railliet & Henry. *Memorias do Instituto Oswaldo Cruz*, *5*(3), 271-318.

Tripathy, S. B., Acharjyo, L. N., Singh, U., Ray, S. K., & Misra, S. K. (1972). Studies on an outbreak of Mycoplasma gallisepticum infection among peafowls (*Pavo cristatus*). *British Veterinary Journal*, *128*(8), 428-431.

Trivedi, P., & Johnsingh, A. J. T. (1995). Diet of Indian Peafowl (*Pavo cristatus* Linn*)*. Gir Fores*t, Gujarat. Journal of Bombay Natural History Society*, *92*(1-3), 262-263.

Trivedi, P., & Johnsingh, A. J. T. (1996). Roost selection by Indian Peafowl (*Pavo cristatus*) in Gir Forest, India. *Journal-Bombay Natural History Society*, *93*, 25-29.

Tsarenko, P., & Karaseva, Z. H. (1986). Ways of improving egg quality. In *Poultry Abstract* , 12(5), 129.

Urquhart GM, Armour J, Duncan IC, Dunn AM, Jennings FW (1996). Vet Para. In: 2 nd. Ed, Blackwell Science, Inc, pp 276 – 278.

Valerie, A. M. (2017). How to care for Peacocks. https://animals.mom.me/how-to-care-for-peacocks-8447134.html/; Accessed on 11 December, 2018.

Verma, N., Bhatnagar, P. K., & Banerjee, D. P. (1991). Comperetive efficacy of 3 Broad--Spectrum Anthelmintics against *Ascaridia galli* in Poultry. *Indian Journal of Animal Sciences*, *61*(8), 834-835.

Vigran, N. (2016). Peafowl in the Aviary. *AFA Watchbird*, *22*(2), 31-33.

Vijayarani, K., Muthusamy, S., Tirumurugaan, K. G., Sakthivelan, S. M., & Kumanan, K. (2010). Pathotyping of a Newcastle disease virus isolated from peacock (*Pavo cristatus*). *Tropical animal health and production*, *42*(3), 415-419.

Virdi, M. (2008). Mobilizing grassroots action for the conservation of galliformes in the Gori river basin of Pithoragarh district of Uttrakhand, India. Report submitted to WPA/PSG.

Walther, B. A., & Clayton, D. H. (2004). Elaborate ornaments are costly to maintain evidence for high maintenance handicaps. *Behavioral Ecology*, *16*(1), 89-95.

Warren, D. C. (1953). Practical poultry breeding. Macmillan: New York.

Weatherup, S. T. C., & Foster, W. H. (1980). A description of the curve relating egg weight and age of hen. *British Poultry Science*, *21*(6), 511-519.

Weis, J. (1991). Analysis of fertility, hatchability and egg quality indices in reproduction breeding of guinea fowls. *Acta Zootechnica Universitatis Agriculturae. Nitra (CSFR)*. 47, 5-15.

Weiss, I. M., & Kirchner, H. O. (2010). The peacock's train (*Pavo cristatus* and *Pavo cristatus mut. alba*) I. structure, mechanics, and chemistry of the tail feather coverts. *Journal of Experimental Zoology Part A: Ecological Genetics and Physiology*, *313*(10), 690-703.

Wessels, J. P. H. (1962). Relationships between weight increase, feed intake, age at sexual maturity and early egg production in New Hampshire pullets. *South African Journal of Agricultural Science*, *5*(3), 427-431.

West, B., & Zhou, B. X. (1988). Did chickens go north? New evidence for domestication. *Journal of archaeological science*, *15*(5), 515-533.

Whistler, H. (1949). Popular handbook of Indian birds. Gurney and Jackson, London. ISBN, 1406745766, pp. 354-356.

Whistler, H.F., & Hugh L. (1949). Popular handbook of Indian birds (4th ed.). Gurney and Jackson, London, pp. 401-410.

Wieliczko, A., Tomanek, B., & Kuczkowski, M. (2003). Prevalence of infectious diseases in ring-necked pheasant flocks in Poland. *Polish journal of veterinary sciences*, *6*(3), 177-182.

Williams, R. B. (1978). Notes on some coccidia of peafowl, pheasants and chickens. *Veterinary Parasitology*, *4*(2), 193-197.

Wills, F. K. (1955). Isolation of pleuropneumonia like organism from a peacock. *Southwest Veterinary*, *8*, 258-259.

Wissman, M. A., & Parsons, B. (1996). Mycoplasmosis in the common rhea (*Rhea americana*). *Journal of Avian Medicine and Surgery*, *10*(1), 28-30.

Woodroffe, R. (1999). Managing disease threats to wild mammals. *Animal conservation*, *2*(3), 185-193.

Work, T. M., & Rameyer, R. A. (1999). Mass stranding of wedge-tailed shearwater chicks in Hawaii. *Journal of Wildlife Diseases*, *35*(3), 487-495.

Wu, C. K., & Han, Y. W. (1983). Feeding efficiency and utilization of energy and protein of broiler and different Diets. *Journal of Northeast Agricultural University*, *2*, 16571.

Yan, J., Li, S., & Li, S. (2014). The role of the liver in sepsis. *International reviews of immunology*, *33*(6), 498-510.

Yasmin, L., Hossain, M. A., Miah, M. A. M., & Rahman, M. M. (1989). Characteristics of backyard poultry farmers affecting their knowledge on poultry production in Bangladesh. *Bangladesh Journal of Training and Development, 2*(1), 22-30.

Yasmin, S. (1995). Ecology and biology of the Indian peafowl *(Pavo cristatus)* in the Aligarh region (Doctoral dissertation, Aligarh Muslim University).

Yasmin, S. (1997). Group size and composition of Indian Peafowl (*Pavo cristatus*) in an agro-ecosystem at Aligarh, Uttar Pradesh. *Journal of the Bombay Natural History Society*, *94* (3), 478-482.

Yasmin, S., & Yahya, H. S. A. (1996). Correlates of mating success in Indian peafowl. *The Auk*, *113* (2), 490-492.

Yasmin, S., & Yahya, H. S. A. (2000). Group size and vigilance in Indian peafowl (*Pavo cristatus* Linn.), Family: Phasianidae. *Journal-BombayNatural Histoy Society*, *97*(3), 425-427.

Yeasmin, T. (2000). Effects of incorporating dwarf gene from indigenous (desi) to exotic breeds of chicken (Doctoral dissertation, Ph. D. Thesis, Department of Poultry Science, Bangladesh Agricultural University, Mymensingh).

Yeasmin, T., & Howlider, M. A. R. (1998). Comparative physical features, egg production and egg quality characteristics of normal and dwarf indigenous (Deshi) hens of Bangladesh. *Journal of Applied Animal Research*, *13*(1-2), 191-196.

Yeasmin, T., Husain, M.A. & Hamid, M.A. (1992). Investigation and the quality of eggs of Different genetic group of birds in different seasons. *Bangladesh Journal of Animal Science*, 21 (1-2), 29-35.

Yorzinski, J. L., Patricelli, G. L., Platt, M. L., & Land, M. F. (2015). Eye and head movements shape gaze shifts in Indian peafowl. *Journal of Experimental Biology*, *218*(23), 3771-3776.

Zahavi, A. (1975). Mate selection—a selection for a handicap. *Journal of theoretical Biology*, *53*(1), 205-214.

Zarate, A.V. (1996). Breeding strategies for marginal regions in the tropics and subtropics. *Anim. Res. Dev.,* 43, 99-118.

Zhou, T. C., Sha, T., Irwin, D. M., & Zhang, Y. P. (2015). Complete mitochondrial genome of the Indian peafowl (*Pavo cristatus*), with phylogenetic analysis in phasianidae. *Mitochondrial DNA*, *26*(6), 912-913.

Zou, S. G., & Wu, Y. Z. (2005). Effects of protein and supplemental fat on performance of laying hens. *Int. J. Poult. Sci*, *4*(12), 986-989.

http://www.aboutpeafowl.com/feeding-peacocks-and-peahens-peafowl-food-how-to-feed-peafowl-to-keep-the-birds-healthy/; Accessed on 11 December, 2018.

https://www.animalcorner.org/animals/peafowl/;Peafowl Peacock/; Accessed on 21 April, 2018.

https://www.animals.fandom.com/wiki/Indian_Peafowl/; Indian Peafowl. Animal Database. ; accessed on April, 2019.

https://www.avianreport.com/bird_habitats/; Accessed on 11 December, 2018.

https://www.backyardchickens.com/articles/caring-for-peafowl.67363/; Accessed on 11 December, 2018.

https://www.backyardchickens.com/threads/peafowl-101-basic-care-genetics-and-answers.388465/; Accessed on 12 Ocotober, 2018.

http://www.browfarm.co.uk/peafowl/illness-treatments/; Accessed on: 11 December, 2018

https://www.hyline.com/aspx/redbook/redbook.aspx?s=2&p=17.Monitoring Body Weights in Grow/; Accessed on 11 December, 2018.

https://www.journals.tdl.org/watchbird/index.php/.../861/; Accessed on 12 April, 2019.

https://www.roysfarm.com/peacock-farming/;Accessed on 12 April, 2019.

https://www.thepoultrysite.com/disease-guide/salmonella-pullorum-pullorum-disease-bacillary-white-diarrhoea/; Salmonella Pullorum, Pullorum Disease, 'Bacillary White Diarrhoea/; Accessed on 12 october, 2018.

https://www.timeanddate.com/weather/bangladesh/dhaka/historicAccessed on 21 April, 2018.

http://www.torontozoo.com/IndianPeafowl.ExploretheZoo/AnimalDetails.asp?pg=590/; Accessed on 12 April, 2019.

https://www.wikihow.com/Care-for-Peacocks#Health_sub/; Accessed on 11 December, 2018.

https://www.worldweatheronline.com/dhaka-weather-averages/bd.aspx Accessed on 21 April, 2018.

https://www.wunderground.com/history/airport/VGTJ/2018/3/1/DailyHistory.html?req_city=&req_state=&req_statename=&reqdb.zip=&reqdb.magic=&reqdb.wmo= Accessed on 21 April, 2018.

https://www.youtube.com/watchtv,BaRyfXWtKI4/; Diseases of Peafowl. Accessed on May, 2019.

LIMITITIONS OF MY STUDIES

Indian peafowl reared in captivity in Bangladesh National Zoo but rearing and management system was found semi-wild in nature. In sampling wild birds, selection bias might have been introduced as convenient sampling was performed. However, in contrast samples taken from domestic birds, random sampling of wild birds was not possible perfectly. Thus, this selection bias may, at least in theory, have influenced the weight and Phenotypic characteristics of Indian Peafowl in Bangladesh National Zoo. The convenient sampling protocol also affected the health condition of Indian peafowl due to the transferring time from one house to another house. Without this we did catches the peafowl based on age by fishing net, therefore, health problem arises in peafowl mainly capture myopathy. Due to this, not all peafowl considered for research. However, sample size was good enough for present research finding.

Although random sampling techniques were applied for sampling but some time selection based on houses, which made biased however, the rate of non-participation house was low and could easily be compensated for by including neighbouring houses on consultation with peafowl management people. The peafowl management people were sometimes also found very busy with their tightly scheduled activities. In these circumstances, a convenient time for all parties was set for the sampling and interview to take place. In summary, for the sampling of captive peafowl in Bangladesh National Zoo, I am confident there were no sampling biased that could have affected any of the conclusions drawn from these data in the present study.

Diagnostic errors could potentially have occurred for diseases and abnormalities, despite using published diagnostic tests based on clinical sign and post mortem analysis. However, throughout, we maintained proper data collection schedule and appropriate sample size and well formatted questionnaire.