STATUS AND MANAGEMENT PRACTICES OF ROYAL BENGAL TIGER IN BANGLADESH NATIONAL ZOO

FOWZIA BAHAR

DEPARTMENT OF ANIMAL PRODUCTION AND MANAGEMENT

SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA -1207

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By

FOWZIA BAHAR

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Approved By:

Professor Dr. Md. Jahangir Alam Professor & Chairman Department of Animal Production and Management **Supervisor**	**Golam Azam** Upazilla Livestock Officer Carnivorous Section, Bangladesh National Zoo **Co-Supervisor**

Professor Dr. Md. Jahangir Alam
Chairman
Examination committee
Department of Animal Production and Management
Sher-e-Bangla Agricultural University
Dhaka-1207

DEPARTMENT OF ANIMAL PRODUCTION AND MANAGEMENT
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka – 1207

CERTIFICATE

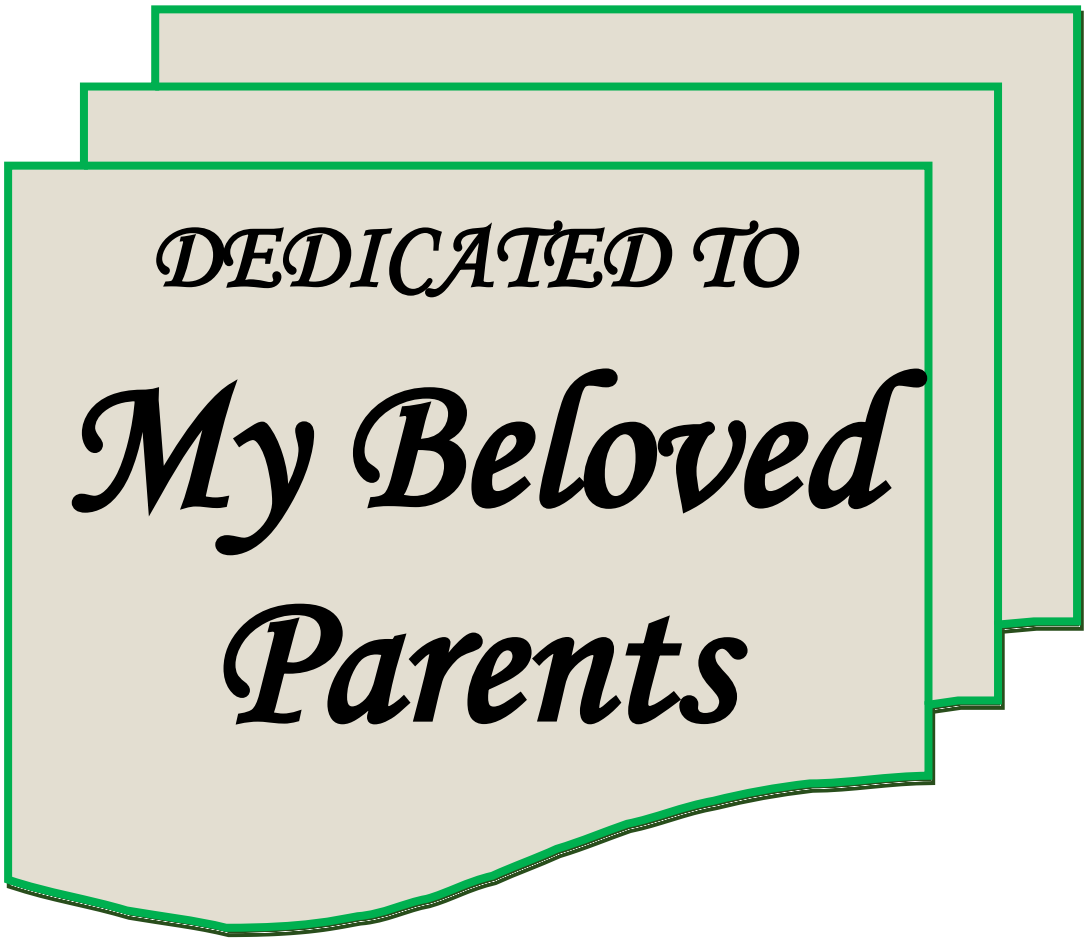
This is to certify that the thesis entitled ***STATUS AND MANAGEMENT PRACTICES OF ROYAL BENGAL TIGER IN BANGLADESH NATIONAL ZOO*** *submitted to the Department of Animal Production and Management, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE (MS) in ANIMAL SCIENCE****, embodies the results of a piece of bona fide research work carried out by* ***FOWZIA BAHAR,*** *bearing Registration No.****18-09201*** *under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma in any other institution.*

I further certify that any help or sources of information received during the course of this investigation has duly been acknowledged.

Dated:

Dhaka, Bangladesh

Professor Dr. Md. Jahangir Alam
Supervisor
Professor & Chairman
Department of Animal Production and Management
Sher-e-Bangla Agricultural University
Dhaka-1207


DEDICATED TO
My Beloved
Parents

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The Author

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LIST OF ABBREVIATIONS AND SYMBOLS

>	=	Greater than
%	=	Percentage
<	=	Less than
±	=	Plus minus
ANOVA	=	Analysis of Variance
B.C.	=	Before Christ
BAU	=	Bangladesh Agricultural University
BBS	=	Bangladesh Bureau of Statistics
BW	=	Birth weight
Ca	=	Calcium
cm	=	Centimeter
CV %	=	Percent Coefficient of Variation
DF	=	Degree of freedom
DLS	=	Department of Livestock Services
e.g.	=	exempli gratia (L), for example
et al.,	=	And others
etc.	=	Etcetera
FAO	=	Food and Agricultural Organization
g	=	Gram (s)
i.e.	=	id est (L), that is
Kg	=	Kilogram (s)
LSD	=	Least Significant Difference
m^2	=	Meter squares
mg	=	Milligram
ml	=	Milliliter
MS	=	Mean Square
No.	=	Number
NS	=	Non-significant
^oC	=	Degree Celsius
SAU	=	Sher-e-Bangla Agricultural University
WHO	=	World Health Organization
µg	=	Microgram

STATUS AND MANAGEMENT PRACTICES OF ROYAL BENGAL TIGER IN BANGLADESH NATIONAL ZOO

ABSTRACT

The Royal Bengal Tiger (*Panthera tigris tigris*) is the national animal of Bangladesh as well as of India. This most majestic mammalian cats are found in Sundarban mainly. It is globally endangered and nationally critically endangered species that is conserved by Convention on International Trade in Endangered Species (CITES). The current study was done to know the status and management practices of tiger in Bangladesh National Zoo. Different data was collected and feed samples were tested in Central Disease Investigation Laboratory (CDIL). There were 9 tigers including 5 male and 4 female in the study tenure. Beef was supplied every day except Sunday at 8.47±2.36 kg beef and 0.35±0.14 kg liver per animal per day whereas only 1.56±0.53 kg of broiler was allowed on Sunday. The zoo experienced born of several cubs in the last 10 years and 75% of them are male. However, unfortunately some of the cubs were died due to cold stress, inbreeding, trypanosomiasis and renal failure. Though zoo is very nice place for breeding, conservation of endangered animals but due to lack of proper breeding policy, many problems are faced. Housing and other management facilities were recorded good but not internationally standardized. Feed samples were tested negative on the day of feeding whereas all were infected by *Escherichia coli* on the third day. Finally, it can be concluded that Bangladesh National Zoo is a good place for tiger conservation beyond some limitations.

CHAPTER I

INTRODUCTION

The Royal Bengal Tiger, binomially named as *Panthera tigris tigris* (Linnaeus, 1758), is the National Animal of both Bangladesh and India. The tiger is admired, feared and respected by humans for its beauty, grace, strength, ruthlessness and other natural and supernatural attributes (Tamang, 1993). The tiger is the largest of the cats (Sunquist and Sunquist, 2002) and is one of the world's most magnificent animals. Of eight sub-species of the tiger, the Bengal tiger mainly occurs in India, Bangladesh, Nepal and Bhutan. From the 100,000-150,000 tigers that might have existed 150 years ago, we are left with 5,000-7,000 animals today (Thapar, 1996; WWF, 1999). At present, more tigers exist in captivity than in the wild (Nowell and Jackson, 1996; Karanth, 2001). There are eight species of wild cats found in Bangladesh (Khan, 2004a; Khan, 2004b), of which five are globally threatened (IUCN, 2003) and six nationally (in Bangladesh) threatened (IUCN Bangladesh, 2000). According to IUCN Criteria, the Bengal tiger has been categorized as globally Endangered (IUCN, 2003) and nationally Critically Endangered (IUCN Bangladesh, 2000). Fifty years ago tigers were found in all the forested areas of Bangladesh, but today the only stable population is in the Sundarbans. Large carnivore species occur at naturally low densities, which make them particularly susceptible to extirpation and extinction (Lande, 1988; Caughley, 1994). The tiger is the pride of the fauna of the Sundarbans. Since the tiger is at the top of the ecological pyramid of the mangrove ecosystem, it is also considered as the Flagship or Umbrella Species to conserve the unique biodiversity of the Sundarbans.

Bangladesh National Zoo is a zoo located in the Mirpur section of Dhaka, the capital city of Bangladesh. The zoo contains many native and non-native animals and wild life, and hosts about three million visitors each year. The name of zoo has been changed from 5 February 2015 from Dhaka Zoo to Bangladesh National Zoo. Established in 1974, the 186-acre (75 ha)

Bangladesh National Zoo is the largest zoo in Bangladesh, and is operated by the Ministry of Fisheries and Livestock. The zoo attracts around 10,000 visitors every day with the number increasing during the weekends and holidays. The Royal Bengal tiger is an excellent indicator species for the health of the Sundarbans (Ali Reza *et al.,* 2000). It is a solitary animal that inhabits in thorny, dry or moist, deciduous, semi-evergreen, mangrove, swamps, grassland etc. In a group, one tiger 'owns' the territory, 1 or 2 are extremely low ranking and the rest share a central social position (Fraser *et al.*, 1991).

In Bangladesh National Zoo, various animals exist here and all are well fitted. Among them Royal Bengal tiger is very important for its beauty and also tiger is the pride of the fauna of the Sundarbans. Since the tiger is at the top of the ecological pyramid of the mangrove ecosystem, it is also considered as the Flagship or Umbrella Species to conserve the unique biodiversity of the Sundarbans. Zoo is an important practice to observe animal beauty practically. In most of the cases, it is impossible to observe animal beauty in the forest. Due to some practical limitations, the study has covered within a short duration. During this period, population was very healthy. Information at present revealed that the tigers in the Bangladesh National Zoo had good birth rate with are total of 9 (5 female and 4 male) tigers (on June 2019). One female recently had died and the record of causes of death was collected. The report from CDIL (Central Disease Investigation Laboratory), Department of Livestock Services, Dhaka and IPH (Institute of Public Health), Mohakhali, Dhaka confirmed the causes of death.

Feeding of Royal Bengal Tiger is the most important cases to conserve tiger in zoos. Feeding habit is also another consideration. Daily requirement of meat depends on its body weight. Generally tiger intake feed (meat) of 5-7% of its body weight. In Bangladesh National Zoo, a tiger intake 7-12 kg beef per day. Unique nutritional requirements of felids must be recognized in feeding captive tigers, including the need for high protein and fat diets, inclusion of dietary vitamin A (as retinol), arachadonic acid, taurine, and niacin. Bush *et al.,* (1987)

points out that exact nutritional requirements for all nutrients are not known specifically for tigers; therefore, requirements are extrapolated from data on domestic felids (NRC, 1984). Diets are formulated, prepared, and fed; some meet dietary needs while others do not and result in tigers with nutritionally related medical problems (e.g., chronic disease, nutritional disorders or poor reproductive performance).

To conserve tiger population as management purpose, it is very important to protect them from disease. Trypanosoma is a protozoan blood parasite of mammals which is transmitted mechanically by biting of flies of the genera Tabanus, Lyperosia, Stomoxys and Atylotus (Brun *et al.,* 1998). People of every age and race could be infected by Trypanosomiasis same the way. Trypanosoma is pathogenic in most domesticated animals and some wild animals, including deer, elephants, capybara, jaguars (Choudury *et al.,* 1972) and tigers (Manohar *et al.,* 2003). Carnivores may also get affected after feeding on infected meat (Raina *et al.,* 1985). A large number of Tigers has died in different zoos of the world due to Trypanosomiasis.

Reproductive success is a key to survival and continued existence for any species, and understanding species' reproductive parameters (e.g., age at first reproduction, reproductive rate, liter size, interbirth interval, and breeding period) is critical to developing effective conservation strategies (Carter *et al.,* 1999). Reproductive parameters are important to determine population turnover, potential growth rates, and are important indicators to detect the lineage persistence in a population (i.e., lineage loss, individual fitness, population viability [Kelly, 2001; Holt *et al.*, 2003]), population viability (Kelly, 2001; Balme *et al.*, 2012), and to examine meta-population dynamics (e.g., determining the reproductive output of source populations) (Chapron *et al.*, 2008). In the wild Royal Bengal Tiger, sexual maturity is attained at three to four years in females, and four to five year in males (Mazak, 1979). In captivity, maximum age of tiger has been recorded twenty to twenty six years; this may also be near about their age in the wild (Mazak, 1979). Tiger mating

may occur throughout the year; however this is most likely to occur from November to April (Kaplanov, 1948; Geptner and Sludskij, 1972).

Habitat is also an important factor for tigers for proper management in zoo. It includes food, feeding, reproduction, good health, reduction of disease infection etc. for successfully done of these issues. The habitats of Tigers are tropical dry forests and mangroves, tropical moist evergreen forests, sub-tropical and temperate upland forest, Subtropical moist deciduous forest, Alluvial Grassland, temperate broadleaf mixed Conifer forest and Boreal Taiga (WWF, 1999). In the zoos, habitat should be reserved which facilitate feeding and reproduction advantages and this will help them to keep proper management.

Therefore, the present study was conducted at Bangladesh National Zoo with the following objectives.

General Objectives

- To study the management practices of Royal Bengal Tiger at Bangladesh National Zoo

Specific Objectives

- ✓ To find the feeding schedule (feeding schedule and materials, security)
- ✓ To find the habitat situation
- ✓ To find the security situations
- ✓ To examine what practical action could be taken to improve their management
- ✓ To explore the production profile of the Royal Bengal Tiger at Bangladesh National Zoo
- ✓ To know the reproduction profile of the Royal Bengal Tiger at Bangladesh National Zoo
- ✓ To know the bacterial contamination of meat allowed for Royal Bengal Tiger supplied from the authority of Bangladesh National Zoo

CHAPTER II

REVIEW OF LITERATURE

The review of literatures on status, management practices and feed contamination for Royal Bengal Tiger is presented in this chapter. The parameters includes are: overview on tiger, feeds and feeding, production and reproduction profile and feed contamination.

2.1 Overview on Royal Bengal Tiger

The Royal Bengal tiger *(Panthera tigris tigris)* is one of the 9 known subspecies of tiger *(Panthera tigris),* which is found in four countries of the Indian subcontinent namely India, Bangladesh, Nepal and Bhutan.

Tigers are usually territorial and solitary animals, except for females with cubs (Nowell and Jackson, 1996). Though they are solitary, they are not anti-social. Males have been spotted with females, when feeding their cubs or at resting (McDougal, 1977). Their social system is connected through visual signals, scent marks and vocalizations. There have been few instances in which tigers hunt or move together like a pride of lions (Wright, 1989)

2.2 Feeds and Feeding

Unique nutritional requirements of felids must be recognized in feeding captive tigers, including the need for high protein and fat diets, inclusion of dietary vitamin A (as retinol), arachadonic acid, taurine, and niacin. General reviews of felid nutrition (Scott, 1968; MacDonald *et al*., 1984), a more specific review applying these data to captive tiger management (Dierenfeld, 1987), and a summary of digestion studies conducted on captive tigers (Hackenberger *et al*., 1987) provide evidence that the domestic cat remains the best model for establishing dietary composition parameters (National Research Council, 1984) for the tiger.

Bush *et al.* (1987) point out that exact nutritional requirements for all nutrients are not known specifically for tigers; therefore, requirements are extrapolated from data on domestic felids (NRC, 1984). Rations are formulated, prepared, and fed; some meet dietary needs while others do not and result in tigers with nutritionally related medical problems (e.g., chronic disease, nutritional disorders or poor reproductive performance). Fortunately, most nutritional disorders are of only historical significance due to improved nutritional management (Slusher *et al.,* 1965).

Adult tigers are fed to maintain body condition, with general maintenance energy requirements = 140 kcal (body mass in kg). 75 (Kleiber, 1964). Thus a female averaging 123 kg requires 5170 kcal/day, whereas a 160 kg male requires 6300 kcal. Metabolizable energy (ME) requirements can be met by daily feeding 3.1 and 4.1 kg respectively, of commercial diets containing about 2.00 kcal/kg (as fed basis) daily, with a digestibility coefficient of 0.84. Most management programs have found that tigers' appetites and body conditions improve if they are fasted one to two days a week. Either no food is fed on these days or shank or other large bones are fed. Feeding bones (femur bones, oxtails, rawhide) has an additional function in promoting periodontal health and provides an opportunity to exhibit more natural feeding behaviors, and presumably is enriching to the animals. One fast day per week is recommended, which increases the meal sizes to 3.6 and 4.8 kg for Bengal tiger females and males respectively (Sumatran tigers less; Siberian tigers more). Ration quantities should be increased 10-20% in animals housed outdoors during winter months, and decreased by the same amount during summer months when appetite drops. Increase diet to ad libitum during lactation. Commercially prepared feline diets or properly supplemented carcass meat should be considered the dietary staple for tigers. Composition should closely adhere to nutrient specifications as outlined above.

Recent studies with zoo felids have reported excesses of vitamin A and phytoestrogens, and deficiencies of taurine in various commercial preparations. Responsive manufacturers are correcting these potential health problems by reducing retinol to levels of approximately 15,000 IU/kg (dry basis), minimizing the addition of estrogenic plant materials, and increasing the addition of taurine, particularly in heatprocessed meat products. No vitamin supplements should be necessary with properly formulated and stored commercial diets.

The advantage of the commercial diets is that they are readily available, require little or no labor in preparation, and are assumed to be formulated with a sound nutritional basis. The disadvantage is that it does not resemble a tiger's natural diet and disallows "hunting" as seen in captive tigers fed whole or partial carcasses. Some managers consider commercial feline diets very boring for the cat and unavailable to Southeast Asian zoos. For example, Indonesian zoos feed their tigers kangaroo meat and Chinese zoos feed mostly chicken. Economics determine the components of these diets as the ingredients vary with the change in cost of produc ing the diet. Thus, the guaranteed analysis remains the same, but the diet may vary in raw ingredients. The guaranteed analysis label does not guarantee that the ingredients of the diet are actually utilized or available for utilization by the tiger (Bush *et al*., 1987).

Lindburg (1988) presented excellent arguments for the augmentation of prey items to animal exhibits to enhance natural behaviors, as well as health effects previously discussed. While zoos cannot recreate a completely natural existence, there are points at which nature's ways can guide management in improving the quality of life for zoo animals. Equating an adequate diet with good nutrition leads to dietary substitutions which ignore non-nutritive requirements.

These requirements include substitute activities, oral health in relation to food texture, and the psychological aspects of feeding. While psychological well-being remains an elusive concept regarding "pleasure" in feeding, the difficulties encountered in its measurement do not render it unimportant. Until more refined techniques for assessing the mental state of animals in feeding are developed, we may be guided by the fact that the behaviors commonly associated with feeding in nature lead to the conclusion that much of their pleasure centers around food.

Markowitz (1982) described an elaborate system of behavioral enrichment installed to promote displays of hunting and jumping ability of the tiger. Certainly obesity due to lack of activity in captivity is a major problem for zoo carnivores, including tigers. Both of the above suggestions require commitment in terms of labor and/or capital investment, but may prove valuable.

2.3 Reproduction status of Royal Bengal Tigers

Tigers (*Panthera tigris*) are endangered throughout their range (Mills and Jackson, 1994; Nowell and Jackson, 1996), and understanding their reproductive parameters is critical for developing sound conservation strategies. For example, an understanding of reproduction and recruitment rates is needed to estimate what human-induced mortality rates a population can sustain (Ahearn *et al.,* 2001; Kenney *et al.,* 1995), to examine metapopulation dynamics (e.g., determining the reproductive output of source populations), and for population modeling and estimating minimum viable population size (Smith and McDougal, 1991). Yet, reproductive parameters of wild tiger populations are poorly known. The majority of information comes from captive animals (Seal *et al.,* 1987) and 1 wild population of Bengal tigers (Sunquist, 1981). Because tigers are widely distributed across Asia (Nowell and Jackson, 1996), reproductive parameters may vary between the 5 extant subspecies in response to different climates, habitats, prey densities, and other environmental parameters. Information on how reproductive parameters vary between

different areas and subspecies is essential for range-wide conservation planning.

Reproductive success is a key to survival and continued existence for any species, and understanding species' reproductive parameters (e.g., age at first reproduction, reproductive rate, liter size, interbirth interval, and breeding period) is critical to developing effective conservation strategies (Carter *et al.,* 1999).

Reproductive parameters are important to determine population turnover, potential growth rates, and are important indicators to detect the lineage persistence in a population (i.e., lineage loss, individual fitness, population viability [Kelly, 2001; Holt *et al*., 2003]), population viability (Kelly, 2001; Balme *et al*., 2012), and to examine meta-population dynamics (e.g., determining the reproductive output of source populations; Smith and McDougal, 1991; Chapron *et al.,* 2008). Reproductive data are available for some long-lived carnivores (i.e., lions *Panthera leo*; Packer *et al*., 1988), cheetahs (*Acinonyx jubatus*; Kelly *et al.,* 2001); leopard (*Panthera pardus*; Balme *et al.,* 2012), and pumas (*Puma concolor*; Logan and Sweanor, 2001). Yet reproductive parameters of wild tiger (*Panthera tigris*) populations are sparsely available and may vary over their global range. The limited information on reproductive parameters has been obtained from studies in India (Schaller, 1967; Sankhala, 1978; Chundawat *et al.,* 2002; Singh *et al*., 2013a), Nepal (Sunquist, 1981; Smith and McDougal, 1991; Smith, 1993), and the Russian Far East (Smirnov and Miquelle, 1999; Kerley *et al*., 2003). Reproductive parameters may vary among the subspecies of the populations because of the different climatic conditions, habitats, prey densities, and other environmental parameters (Kerley *et al.,* 2003). Information on how reproductive parameters vary among subpopulations of the same subspecies surviving in different habitats is essential for range-wide conservation planning (Kerley *et al*., 2003).

The population in RTR represents a unique gene pool (Sharma *et al*. 2008), which is adapted to survive harsh and inclement weather conditions during summer. The open, thorny, deciduous forest with scanty vegetation and a good road network in RTR provided ideal conditions for tiger sightings (particularly in the valley and other low-lying areas).

The Amur tiger (*P. altaica*), the northernmost subspecies, is faced with harsh environmental conditions including severe winters and low prey densities (Miquelle *et al*., 1999b). Current information on reproductive parameters of Amur tigers is based on snow tracking (Matyushkin *et al*., 1999; Salkina, 1994), which has limited applications because individuals cannot be positively identified or monitored over extended or snowfree periods. We analyzed data collected during a 9-year period on and near the SikhoteAlin Biosphere Zapovednik in the Russian Far East, using a combination of radiotelemetry, live capture, and conventional tracking, to describe reproductive parameters of Amur tigers in the wild. We compare our findings with existing information on Amur tigers (much in Russian sources) and Bengal tigers in Nepal, where prey densities are much higher and tiger home-range sizes much smaller than those in the Russian Far East (Goodrich *et al*., 1999; Miquelle *et al*., 1999a).

2.4 Basic Status and Characteristics of Zoo Royal Bengal Tigers

The Bengal tiger's coat is yellow to light orange, with stripes ranging from dark brown to black; the belly and the interior parts of the limbs are white, and the tail is orange with black rings. The white tiger is a recessive mutant of the Bengal tiger, which is reported in the wild from time to time in Assam, Bengal, Bihar and especially from the former State of Rewa. However, it is not to be mistaken as an occurrence of albinism. In fact, there is only one fully authenticated case of a true albino tiger, and none of black tigers, with the possible exception of one dead specimen examined in Chittagong in 1846 (McDougal, 1977). Male Bengal tigers have an average total length of 270 to 310 cm (110 to 120 in) including the tail, while females measure 240 to 265 cm

(94 to 104 in) on average (Mazak, 1981). The tail is typically 85 to 110 cm (33 to 43 in) long, and on average, tigers are 90 to 110 cm (35 to 43 in) in height at the shoulders (Karanth, 2003). The weight of males ranges from 180 to 258 kg (397 to 569 lb), while that of the females ranges from 100 to 160 kg (220 to 350 lb) (Barlow *et al.*, 2010). The smallest recorded weights for Bengal tigers are from the Bangladesh Sundarbans, where adult females are 75 to 80 kg (165 to 176 lb) Bengal tigers have exceptionally stout teeth, and the canines are the longest among all living felids; measuring from 7.5 to 10 cm (3.0 to 3.9 in) in length (Sunquist, 2002). Bangladesh is having 6 zoos and 2 safari parks.

One reason for the shift to "naturalistic" exhibition styles was an increased public concern for animal welfare. Many animals in captivity perform abnormal behaviors known as "stereotypes'" (Carlstead, 1996). Stereotypic behavior can be described as a pattern of movement such as pacing and head bobbing that is performed repeatedly, is relatively invariant in form, and has no apparent function or goal (Carlstead, 1996). Such behaviors are rarely seen in wild animals; therefore they are considered an indication of stress. Stereotypes' occur in many species and are thought to have a variety of causes. For example, they may arise when animals are consistently unable to reach a goal, such as natural feeding behavior (Carlstead, 1996; Rushen and Passille, 1992; Shepherdson *et al*., 1993). Shepherdson et al. (1993) found that captive felids often spent the time prior to feeding performing stereotypic pacing behaviors. Duckler (1998) found that the skulls of captive tigers had distinctively malformed external occipital protuberances that are not found in wild specimens. These were caused by excessive grooming behavior in the captive tigers and a reduction in the jaw muscles due to eating processed food (Duckler, 1998). 13 Stereotypic behavior may also appear when an animal is physically restrained from moving to a desired place.

For example, Meyer-Holzapfel (1968) found that a dingo (Canis familiaris dingo) separated from its pack, paced in a figure-eight pattern along the separating barrier. Stereotypes' may also develop from other behavioral and

physiological stresses, such as boredom, physical restraint, fear, or frustration (Carlstead, 1996). The limitation of space is thought to be another cause of stereotypic behavior. In most cases, the smaller the enclosure, the more likely the animal will display stereotypes' (Carlstead, 1996). However, it would be difficult to determine the exact amount of space that an animal needs to avoid developing stereotypic behaviors. Draper and Bernstein (1963) found that changes in the physical dimensions of the captive environment were often accompanied by a marked change in behavior. Lyons et al. (1997) studied the behavior pattern of 19 captive felid species and found that the cats in relatively larger enclosures had a higher level of exploratory behavior. Low stimulus diversity is yet another factor influencing stereotypic behavior. In sterile environments, captive animals often appear to be "bored" or lethargic due to a lack of stimulation. Carlstead (1996) reports two ways that captive animals adapt to low stimulus environments: (1) they decrease the stimulus-seeking behavior (lethargy), or (2) they attempt to satisfy the stimulus-seeking behavior through other means (stereotypes'). Common stereotypes' in felids include pacing, head-twisting, tail and toe sucking, and fur plucking (Wooster, 1997). Mellen *et al*. (1998) found that the relationship between pacing and several variables that characterize the physical and social environment was a useful measure of well being in small captive felids. Preventing Stereotypic Behavior Through Environmental Enrichment According to Shepherdson *et al*. (1993) environmental enrichment "is an animal husbandry principle that seeks to enhance the quality of captive animal care by identifying and providing the environmental stimuli necessary for optimal psychological and physiological well-being". Environmental enrichment includes a wide variety of techniques. For instance, food can be 14 hidden throughout exhibits to entice animals to perform hunting behaviors; wood blocks or logs can be given to satisfy felid scratching behavior when trees are not available; stimulating scents can be spread throughout enclosures; and sterile concrete enclosures can be replaced with natural substrate and vegetation. Environmental enrichment programs are important in that they provide for the well being of the animals, allow the

animals to display “natural” behaviors to the public, and increase reproductive success (Shepherdson *et al*., 1993). Adding natural substrate, vegetation, water features, rocks, and other features not only makes the environment more pleasant for the animals, but it also increases the educational value of zoo exhibits for visitors. Poole (1998) explains that the captive environment should be sufficiently complex to allow a full range of locomotors activities, including walking, climbing, swimming, or burrowing as appropriate to the species concerned. In the wild, a mammal chooses a living area that offers suitable facilities for its needs, so the zoo manager should do the same for those in his care. Carlstead (1996) illustrates that making the environment more complex and unpredictable can reduce stereotypic behavior; by providing stimuli, you reduce the tiger’s desire to perform a negative behavior (Carlstead, 1996).

2.5 Significance for Conservation of Royal Bengal Tiger

The tiger is the biggest (Sunquist and Sunquist, 2002), the most iconic, and one of the most endangered of all cats (WWF-UK, 2014). Tigers occupy an important place in the Indian culture (Thapar, 1992) and revered as cultural icon by the people (Weber and Rabinowitz, 1996). Since ages, it has been a symbol of magnificence, power, beauty and fierceness and has been associated with bravery and valour. It is admired by the people for these natural and supernatural attributes (Tamang, 1993). The tiger also has a significant place in Hindu mythology in association with Goddess Durga (WWF-INDIA, 2014). When Buddhism evolved from Hinduism and spread through Asia, the tiger came as spiritual and cultural images, which adorn splendid murals in temples in India, Bhutan, China, Thailand and Tibet (Jackson, 1999). Tiger is the national animal of both India and Bangladesh.

In addition to the cultural significance, they are very significant in ecological point of view. Tiger is the top predator, which is on the apex of food chain. Therefore, tigers can be an important indicator of the health of an ecosystem. Protection of tigers indirectly protects habitats and health of the forest. It is an

umbrella species, whose conservation leads to the conservation of various other species, which are directly or indirectly part of the tiger's food chain (WWF-INDIA, 2014). Tiger is also an endangered species, world tiger population reduced from 100,000 in 1900s to 3,600 adults in 2010 (Wikramanayake *et al*., 2010). Some studies state that more tigers exist in captive than in the wild (Nowell and Jackson, 1996; Karanth, 2001).

2.6 Distribution and Population Status

The tiger is originated in eastern Asia (Kitchener, 1999). The oldest fossil remains of tigers were found in northern China and Java (Hemmer, 1987). Many tiger fossils were found in China, Sumatra and Java, which dated from the end of pilocene to late Pleistocene (Hemmer, 1987). The tiger fossils found in Indian subcontinent are dated back to late Pleistocene (Hemmer, 1987). Nowell and Jackson (1996) claims that tigers moved to India from the eastern part of the continent about two million years ago. The late arrival of tigers to India is supported by the fact that tigers are absent in Sri Lanka, which was cut off from India due to rising sea levels during that period (Kitchener, 1999). So, tigers entered India either through north-west or through north-east (Heptner and Sudskii, 1992).

Now, there are 9 subspecies around the continent and the Royal Bengal tiger is the most numerous of subspecies. The tigers are found in 13 countries of Asia called as tiger range countries namely China, Vietnam, Myanmar, Indonesia, Malaysia, India, Bhutan, Bangladesh, Cambodia, Russia, Nepal, Lao PDR and Thailand (Stoner and Pervushina, 2013). The Bengal tiger is found in four countries of the Indian subcontinent namely India, Bangladesh, Nepal and Bhutan. India is home for more than half the population of wild tigers (Mondol et al., 2009), with about 1410 individuals estimated in 2006 excluding the population in Indian sunderbans (Jhala *et al*., 2008). The recent surveys conducted on 2010, shows wild tiger population in India to be 1706 with a range of 15711875. Tigers are found in the forests, all throughout India in

different types of habitats ranging from tropical Western Ghats in the south to mangrove Sunderbans and Himalayan foothills (Ranganathan *et al*., 2008).

Humans maintain wild animals in zoological parks for the purposes of education, conservation, research, and recreation. However, abnormal behaviors may develop in animals housed in human-made environments, if those environments do not allow them to carry out their natural behaviors (such as swimming, climbing, stalking, and predation). The Bengal tiger, also called the Royal Bengal tiger (*Panthera tigris tigris*), is the most numerous tiger subspecies.

Royal Bengal Tiger is the national animal of both India and Bangladesh (Chundawat *et al*., 2011) by 2011; the total population was estimated at fewer than 2,500 individuals with a decreasing trend. None of the *Tiger Conservation Landscapes* within the Bengal tiger's range is considered large enough to support an effective population size of 250 adult individuals. Since 2010, it has been classified as endangered by the IUCN (Lytton, E. 1841). Presently, five sub-species of tigers have been recognized as existing in the world. Bengal tiger (*Panthera tigris tigris*) is one of the most beautiful sub-species for its royal beauty, for which it is called Royal Bengal tiger (distribution specially in Sundarban of Bangladesh & India, also few area in Nepal, Bhutan & North-west of Myanmar).

The Royal Bengal tiger is an excellent indicator species for the health of the Sundarbans (Ali Reza, *et al.* 2000). It is a solitary animal that inhabits in thorny, dry or moist, deciduous, semi-evergreen, mangrove, swamps, grassland etc. In a group, one tiger ‘owns’ the territory, 1 or 2 are extremely low ranking & the rest share a central social position (Fraser, *et al.* 1991). The population of free ranging Bengal tigers in Bangladesh (Sundarban) by 2016 was about 106.

2.7 Present Threats

The most obvious direct threats for the tigers in the wild are conflict with humans, prey depletion, habitat loss and habitat fragmentation (Ramakrishnan *et al*., 1999). Historically, human- tiger conflict has been one of the big sociological and conservation concern in tiger range countries. The poaching is fueled by demand for tiger body parts in china for traditional Chinese medicine and other practices (Kenney *et al*., 1995). Tigers are highly sensitive to poaching, which may lead to extinction (Chapron *et al*., 2008). Tiger population directly depends on prey density (Karanth *et al*., 2004). Prey reduction is caused mainly by local communities depending on the forest for their livelihoods (Madhusudhan, 2004). Domestic livestock of local villagers are known to ecologically compete with ungulates, affecting ungulate population (Carbone and Gittleman, 2002). Habitat depletion and fragmentation is caused by increasing demand and consumption of natural resources from forest by the increasing human population (Vitousek *et al*., 1997). Other causes are changing land use patterns around the forest and urbanization, which disconnect and isolate habitat (Barbier, 2001). All the above discussed threats are directly or indirectly related to socio-political issues. The tiger is a dangerous predator found in parts of the world with some of the highest density and poorest populations (Dinerstein *et al*., 2006). In this context legally protecting tigers by establishing protected areas involve significant political challenges involving historical, legal, livelihood and management issues (Rastogi *et al*., 2012).

2.8 Food Contamination

The primary goal from an animal health perspective is to provide a good diet formulation based on sound nutritional concepts and quality sources of dietary components. Other contributors have pointed out the value of attempting to meet the environmental and behavioral needs of captive tigers. One of the ways to meet these needs is to devise a weekly diet that would provide commercially

prepared diets, bones and whole or partial carcasses. Care must be taken that animals euthanized with barbiturates are not fed, as this is the most common type of poisoning in large captive felids. Felids feeding on such carcasses may show varying signs from mild ataxia to general anesthesia that may last for days. The liver from such carcasses are especially high in barbiturate levels and cause more severe signs (Bush *et al*. 1987). In addition, communication between the source of the diets, the veterinary and nutrition staff, and the keepers will allow monitoring of health status, early evidence of nutritional deficiencies, or potential toxic problems. Only then can dietary inadequacies be assessed.

Sometimes Bengal tigers are affected through food contamination affected by *Escherichia coli* which is Gram-negative, facultative anaerobic, rod-shaped and highly motile bacteria. There are *E. coli* strains that are harmless commensals of the intestinal tract and others that are major pathogens of humans and animals. The pathogenic *E. coli* are divided into those strains causing disease inside the intestinal tract and others capable of infection at extra-intestinal sites (Kaper *et al*., 2004). The spread of *E. coli* in North America coincided with the importation of infected cattle from Argentina, where the rates of human infection were previously about three times higher than those found in North America (McMichael, 2001). The first outbreaks caused by *E. coli* occurred in Oregon and Michigan, USA, in 1982, when it was isolated from individuals who developed bloody diarrhea and severe abdominal cramps after eating hamburgers (Besser *et al*., 1999). The first published study on the prevalence in meats of EHEC strains was that of Doyle and Schoeni in 1987, who tested for *E. coli* and found this strain in 3.7% of 164 cattle, 1.5% of 264 pork, 1.5% of 263 poultry, and 2.0% of 205 lamb samples (Doyle and Schoeni*et al*., 1987). Tiger may affected by ***Escherichia coli*** through feeding of these meat if it is contaminated.

CHAPTER III

MATERIALS AND METHODS

3.1 Study Design

3.1.1 Study place

The data on Royal Bengal Tiger was collected from Bangladesh National Zoo situated at Mirpur, Dhaka and some chemical analysis of meat samples collected from tiger cave were done at Central Disease Investigation Laboratory (CDIL) situated at Gulistan, Dhaka under the supervision of the Department of Animal Production and Management, Sher-e-Bangla Agricultural University, Dhaka-1207.

Plate 3.1: Map of Bangladesh National Zoo.

3.1.2 Study period

The study was carried out from January to December 2019.

3.1.3 Study population

The necessary data for this experiment was collected from total Royal Bengla Tigers including adult male, adult female, juvenile, infant at Bangladesh National Zoo.

Plate 3.2: Royal Bengal Tiger at Bangladesh National Zoo.

3.1.4 Environmental condition of the study area

The production of Royal Bengal Tiger in a Zoo, tourist and their interaction are greatly influenced by the local environmental condition. Therefore, environmental condition of the study area is overviewed. Maximum and minimum temperatures as observed in May and January ranged between 34°C and 15-20°C. Summer season continued from April to June 24- 32°C and winter lasted from December to February. Rainfall started in May and continued up to September. About 92% of the annual rainfall occurred during the monsoon. The maximum humidity was observed 86% from July to September and the minimum about 47% from January to April (BBS, 2019).

3.2 Parameters Studied

The present study covered the following aspects of Royal Bengal Tiger such as feeds and feeding, production and reproduction profile and herd management as well as qualitative assessment of beefed to them.

3.2.1. Feeding Requirements

Tigers, and all cats, are obligate carnivores, meaning that they must eat meat and only meat. Meat is much easier to digest than plant matter, so the tiger's system is simpler. Herbivore and omnivore digestive system is longer, and has a transverse colon to facilitate plant digestion. The tiger's colon is shorter, and has no transverse colon. There are certainly differences in the gut flora and in the enzymes that are produced, between tiger and herbivores.

The process of digestion for a tiger starts at the mouth. Here the tiger uses its canines and molar teeth to break down food. The mouth also has salivary glands which serve just to lubricate food. The saliva does not contain enzymes so it does not help to actually break down the food. Next the food goes through the esophagus and into the stomach. In the stomach the food is liquefied. The stomach contains a concentrated solution of hydrochloric acid which dissolves the food. After the stomach the liquified food enters the small intestine. This is the most important part of the tiger digestive system. In the small intestine the liquefied food or chyme is digested and the nutrients are absorbed and they enter the bloodstream. The different enzymes that help to break down the food are called Amylases, Protease and Lipases. Amylases splits up the carbohydrates into monosaccharides. Protease splits proteins into amino acids. Lastly Lipases splits lipids or fats into fatty acids and glycerol. All of these enzymes are supplied to the small intestine by the pancreas and liver. This digestion occurs as the food moves through the small intestine. After the small intestine the food goes through the large intestine caecum whit is a small appendage that connects the small and large intestine. In the large intestine the food is already mostly digested to the main job of the large intestine is to allow

water to escape and to compact what's left into a small compact mass that is then expelled through the anus.

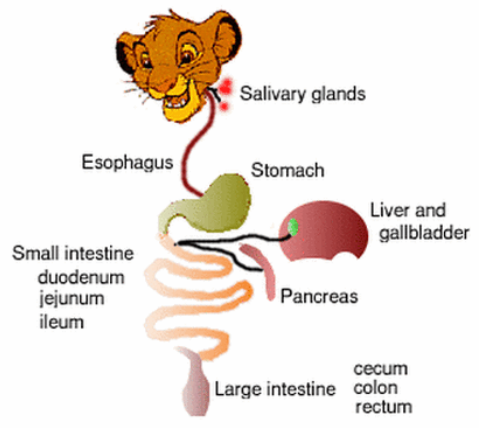


Plate 3.3: Digestive System of Royal Bengal Tiger.

3.2.2 Feeds and feeding

This part covered feed sources, chemical composition of feed, water sources, supplemental feeding and seasonal effect on feed intake.

Tigers are carnivores. They prefer hunting large ungulates such as chital, sambar, gaur, and to a lesser extent also barasingha, water buffalo, nilgai, serow and takin. Among the medium-sized prey species they frequently kill wild boar, and occasionally hog deer, muntjac and grey langur. Small prey species such as porcupines, hares and peafowl form a very small part in their diet. Because of the encroachment of humans into their habitat, they also prey on domestic livestock (Andheria, 2007). Generally in Bangladesh National Zoo, feeding of tigers relies on beef and chicken.

3.2.3 Production profile

This part covered mainly the following aspects-

- Birth weight of male and female
- Adult weight to female

- Weaning weight of male
- Weaning weight of female
- Weaning age
- Length of estrous
- Age at first pregnancy
- Gestation length and
- Sex ratio

3.2.4 Herd Management

This part covered mainly the following aspects such as capturing procedure and provision for shelter.

Plate 3.4: Herd Management of Bangladesh National Zoo.

A. Housing Requirements

Exhibit/Enclosure Design

All large cats including tigers are territorial and require their own space. Enclosures should therefore be as large as possible. Tigers are generally solitary animals preferring to live alone. They are large, powerful land-living

species. They do not need trees or high walkways in their enclosures, however elevated resting platforms should be provided in their outdoor enclosure and in the den area.

They may be given free access to an indoor den and outdoor enclosure, but must be shut in during the night for security reasons. They do best when maintained in outdoor, spacious and well planted enclosures.

The tiger are a flighty animal and need a large flight distance. The exhibit should have tall fences with a perimeters fencing along with gutter surrounding the area.

Plate 3.5: Housing of Bangladesh National Zoo

Spatial requirements

It is recommended that single animals should have at least 37m² floor space and the enclosures should be at least 3.5m high. The minimum space provided should be increased by 50% for each additional cat in the enclosure.

Weather protection

The enclosure needs to have a sheltered area for the tiger to retreat to in poor weather. There are no size requirements but will need to protect the total number of tigers within the exhibit.

Temperature requirements

Tigers are incredibly adaptable animals that can be found in a variety of climates and habitat types across Asia. They can survive in extreme temperatures: from -40°c (Russia) to +40°c (India).

Bengal tigers like the constant shade that the forest floor guarantees with the understory's leaves leaving the tigers cool. The tropical rainforest temperature never falls below 18 degrees celsius and can reach up to 33 degrees celsius and over.

B. General Husbandry

Record Keeping

All animals should be individually identifiable, with the use of name and identification number. Each animal should have its own file which contains the following information:

- ✓ Identification numbers or name of animals
- ✓ Health problems
- ✓ Veterinary examinations
- ✓ Veterinary treatments
- ✓ Behavioral data
- ✓ Reproductive stages, condition and behaviors
- ✓ Gene pool information
- ✓ Parents
- ✓ Birth dates
- ✓ Changes in diet
- ✓ Movements within and between institutions

- ✓ Body mass and measurements.
- ✓ History of animal
- ✓ Enrichment behaviors and reactions.
- ✓ Transfer details
- ✓ Individual characteristics

ISIS (International species inventory system) uses the basic biologic information (age, sex, parentage, place of birth, circumstance of death, etc.) to manage genetic and demographic programs for their animal collections. ARKS (Animal record keeping system) are used by zoo's in the Australasian region and information is available to all zoo's. Information such as age, parents, genetics are available.

Routine data collection

Information that may be acquired for long term studies include

- ➢ Weights/growth – development charts
- ➢ Contraception/genes/parenting behaviors
- ➢ Blood biochemistry
- ➢ Clinical sign/symptom

C. Breeding

The tiger in Bangladesh has no definite mating and birth seasons. Most young are born in December and April. Young have also been found in March, May, October and November. In the 1960s, certain aspects of tiger behavior at Kanha National Park indicated that the peak of sexual activity was from November to about February; with some mating probably occurring throughout the year Males reach maturity at 4–5 years of age, and females at 3–4 years. A Bengal comes into heat at intervals of about 3–9 weeks, and is receptive for 3–6 days. After a gestation period of 104–106 days, 1–4 cubs are born in a shelter situated in tall grass, thick bush or in caves. Newborn cubs weigh 780 to 1,600 g (1.72 to 3.53 lb) and they have a thick wooly fur that is shed after 3.5–

5 months. Their eyes and ears are closed. Their milk teeth start to erupt at about 2–3 weeks after birth, and are slowly replaced by permanent dentition from 8.5–9.5 weeks of age onwards. They suckle for 3–6 months, and begin to eat small amounts of solid food at about 2 months of age. At this time, they follow their mother on her hunting expeditions and begin to take part in hunting at 5–6 months of age. At the age of 2–3 years, they slowly start to separate from the family group and become transient — looking out for an area, where they can establish their own territory. Young males move further away from their mother's territory than young females. Once the family group has split, the mother comes into heat again (Sanderson, 1912).

D. Vaccination

In captive condition only Tryphanosomiasis Vaccine is given to the tiger at early age of 6 month.

E. Deworming

In carnivores commonly Anthelmentics were used because they are highly susceptible to gut acting parasites

F. Habitation

Due to some practical limitations, the study has covered a period of 3 months duration. During this period, population was very healthy and good birth rate with is total of 9 tigers. At present (on October 2020) the population is 9 in Dhaka zoo. One female had died and the record of causes of death was collected.

G. Restraint systems

Restraint is the restriction of movement of any Sanctuary animal and may vary from simply confining the animal in an enclosure, small space, box, or crate, to completely restricting its muscular activity (immobilization). Where possible, handling should be avoided at all by using shifts.

Psychological restraint

Understanding certain biological characteristics of the animal(s) involved in a restraint procedure enables the Keeper to utilize behavior in control of the animal. Behavior patterns can be predicted and allowed for. Each species has its own behavior patterns and the keeper can counteract or incorporate these into restraint practices.

Voice is a tool which can be very effective; emotional states are reflected in the voice. Wild animals perceive fear or lack of confidence in the Keepers' body language – the way the hands are held, posture and general stance can all influence the success of a restraint procedure. Contact with the animal may be by voice or sight initially to avoid startling it.

Confinement

By reducing the size of the enclosure, an animal's confinement may be intensified. The smaller the area an animal has to move around in, the easier it may be for the Keeper to check wounds, sores, injuries etc. Closer confinement often involves special cages or crates for transferring an animal from one area to another, a night or nest box, a shipping crate or a squeeze cage. The latter is an invaluable kind of restraint tool, and may be portable or built into an area frequently used by the animal, such as a chute or passageway (for example, between indoor and outdoor cages).

Physical barriers

Physical barriers can be used to protect the Keeper from the animal, or to get close to the animal without it being alarmed. Shields of plywood or Plexiglas with handles are useful.

Chemical restraint

Chemical restraint has become increasingly important in the last few years with the development and understanding of new drugs and new delivery systems. It

is not used without much consideration. Pole syringes, blow guns, blow pipes, dart pistols and rifles are all utilized at Big Cat Rescue, along with drugs put in the food and water. It should be realized that considerable research has been carried out at Big Cat Rescue, and much information read by our staff, on the chemical restraint of sanctuary animals. The drugs, charts and transfer equipment is all kept locked in the office. Upper level staff has keys.

However, the Keeper should not assume that chemical restraint is always the easiest, safest and preferred method; this simply isn't so and each method, physical, chemical or mechanical has to be considered in light of individual circumstances.

H. Health management

Whether in the wild or held in captivity, tigers (like all animals) are susceptible to certain illness and disease. Of course, these diseases are more likely to claim the life of the wild cat in their natural habitat (as opposed to in captivity), since they do not have access to medical care. Tigers suffer from many of the same illnesses that are experienced by domestic cats and treatment may be similar (if not exactly the same), depending on resources and experience. However, in order to treat wild tigers, sophisticated tracking technology is required to be able to determine when the animal becomes ill. Still, even the most sophisticated equipment does not guarantee quick diagnosis.

Some of the most common illnesses experienced by tigers (as well as other wild and domestic cats) include:

Rabies

Rabies is a virus that is usually fatal to the animal once contracted. It is transmitted through the bites of other infected animals, which are made all the more vicious as a result of their illness. The incubation period generally lasts for a few weeks, but can extend to several months in some cases. Once the tiger has been bitten by another infected animal, the virus is carried through the

bloodstream to the spinal cord. It moves through the nervous system and causes major neurological damage. Initially, the cat will begin to act abnormally. It may have a fever and will lick its wound. During the second phase of the illness, the victim will begin to act unpredictably. It will be vicious and restless, but may at times be rendered paralysed. The final stage is one of major nerve damage, which then prevents the animal from being able to swallow anything (including water and its own saliva). Excessive drooling occurs as a result and has become the tell-tale sign of an animal with advanced rabies. The animal is likely to go into a coma before it dies. Euthanasia is usually the kindest, most dignified option. Rabies can be prevented by vaccinating the animals as soon as possible. Domestic cats should be kept away from others that may be infected, but this is not possible with wild tigers.

Feline AIDS or FIV (Feline Immunodeficiency Virus)

This virus is a disorder that affects the immune system of the cat. However, it is completely curable, unlike HIV or AIDS in human patients. If left untreated, though, this virus makes the tiger extremely susceptible to other illnesses and infections that it may otherwise have been able to overcome. Notably, feline AIDS and feline leukaemia are often found in the same animal. FIV is usually spread through direct bites, since it dies as soon as it leaves the body. In addition, an infected mother can pass it on to the foetuses she carries. The virus is carried in the blood, saliva and cerebrospinal fluid. Humans cannot catch it from cats. After a bite from an infected animal, it takes just four weeks for the victims white blood count to drop dramatically. This leaves the animal susceptible to any number of illnesses and diseases, which it does not have the resources to fight against.

Feline Leukaemia Virus (FeLV)

This virus is responsible for more feline deaths than any other known illness. It is contagious, but can lie dormant in the bone marrow for a long period of time. It is responsible for cancerous as well as non-cancerous diseases, but is not

transmissible from cats to human beings or other animal species. This virus is killed quite easily by exposure to oxygen as well as any and all detergents. Therefore, the cat would require close, moist contact with another infected tiger in order to contract FeLV. This is usually achieved when cats groom, lick or bite each other. Kittens and cubs may also be infected by their mothers during her pregnancy or while they drink milk from her. FeLV produces a number of associated diseases and symptoms. These include anaemia, liver disease, intestinal disease, reproductive complications, lymphosarcoma, full-blown cancerous leukaemia, chronic respiratory infections, chronic gingivitis, stomatitis, feline infectious peritonitis, poor healing of wounds and abscesses, and chronic generalised infections.

Tigers can be vaccinated against FeLV to prevent them from succumbing to this virus. Once an unvaccinated tiger has contracted it, though, it needs to be removed from the wild and treated by doctors. It needs a nutritious diet, other necessary vaccinations (since its immune system will be severely compromised as a result of the FeLV), reduced stress, and prompt treatment of any other illnesses that may arise. Should the FeLV develop into a full-blown cancer, the survival rate is not good, and many animals are euthanised at this point to prevent further suffering.

Other common illnesses that afflict tigers are Tick bite fever, Distemper and Tuberculosis.

Table 3.1: Common parasites and diseases reported in Tiger

Parasites	**Diseases**
1. *Toxocara cati,* 2. *Toxascaris leonine* 3. *Paragonimus westermani* 4. *Leptospira interroganss* 5. *Bartonella henselae* 6. *Rickettsia conorii* 7. *Toxoplasma gondii* 8. *Candidatus* 9. *Mycoplasma haemominutum* 10. *Hepatozoon canis* 11. *Bartonella* spp 12. *Diphyllobothrium* 13. *Taenia* sp.	1. Distemper, 2. Mange, 3. Anthrax, 4. Rinderpest 5. Tick bite fever 6. Distemper 7. Tuberculosis 8. Feline Leukaemia Virus (FeLV) 9. Feline AIDS or FIV (Feline Immunodeficiency Virus) 10. Rabies

3.3 Nutritional Status and Bacterial Contamination

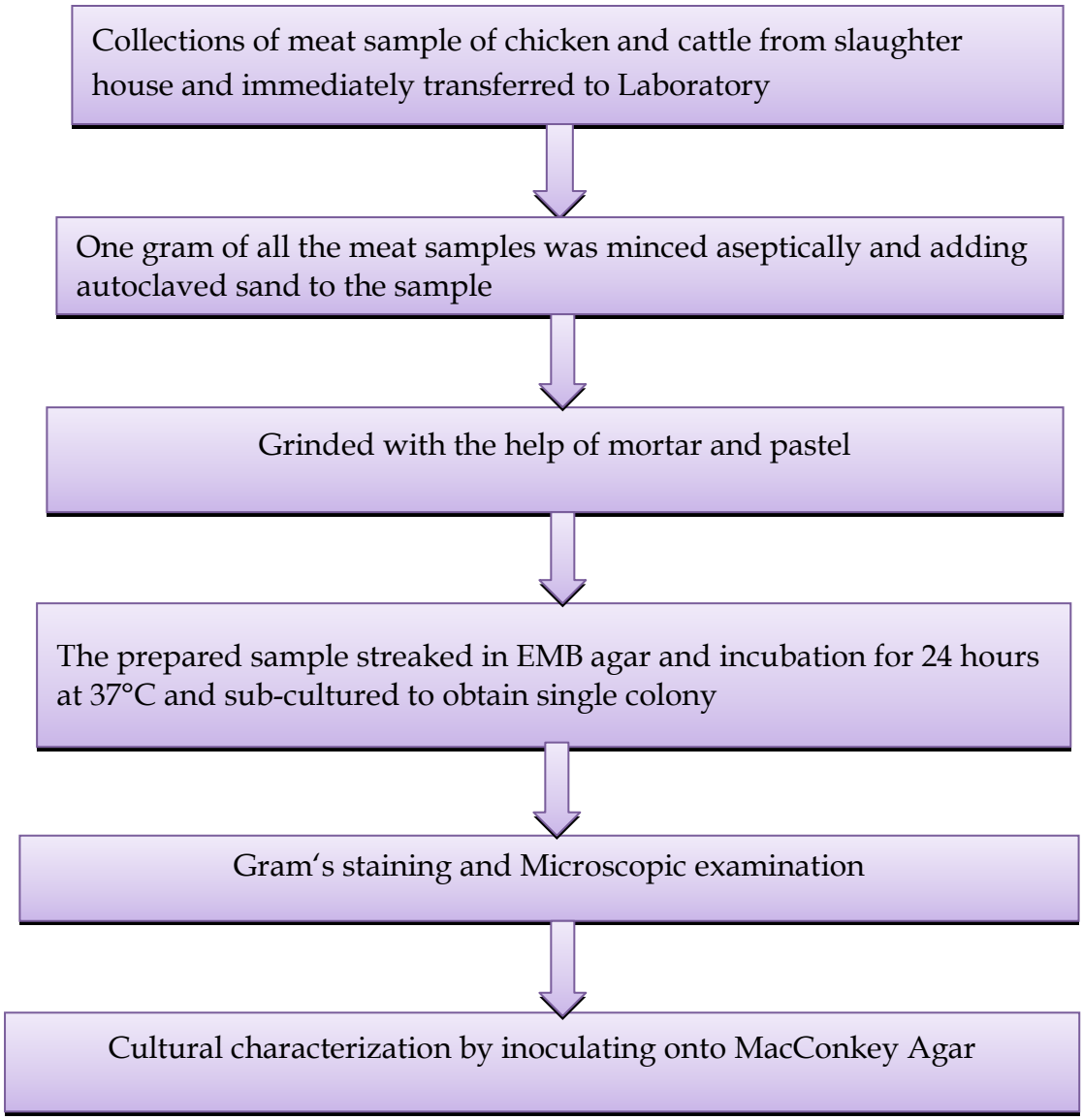
Feed samples (beef and chicken) were collected from Bangladesh National Zoo. Beef and chicken that were remained after feeding of tigers were considered as feed samples. Samples were collected to observed nutritional status and bacterial contamination. Each sample was collected separately in a separate Zip lock bag. Then the samples were taken in icebox. Finally, the samples were transported from the study area to the laboratory of CDIL to isolate *E. coli.*

3.3.1 Processing of sample

On the day of arrival at the laboratory, 5 gms of meat from each sample was taken by using sterile forceps. Then it was grinded with the help of mortar and pestle and a swab was taken by using cotton bud. Then the bud was transferred immediately into autoclaved nutrient broth and incubated at for 24 hours. After 24 hours incubation at 37°C, each tube were examined for the satisfactory growth of organisms and then subsequent streaking on various agar media such as EMB and McConkey agar media.

3.4 Experimental Design

The study design and experimental procedures are shown in Figure 05.



3.4.1 Study materials and reagents

3.4.2 Materials

- Cotton buds
- Test tube
- Tube stand
- Cooling box
- Measuring cylinder
- Conical flask
- Petri dishes
- Gas burner
- Mask
- Hand gloves
- Tissue Paper
- Autoclave
- Incubator
- Refrigerator
- Laminar air flow cabinet
- Inoculating loop
- Glass beads
- Slides
- Microscopes

3.4.3 Reagents

- Nutrient broth
- Nutrient broth
- EMB agar media
- MacConkey agar media

3.4.4 Preparation of culture media

All the media used in this experiment were prepared according to the manufacturer‘s instructions.

3.4.4.1 Nutrient broth

Nutrient broth (NB) was prepared by dissolving 13 grams of dehydrated nutrient broth (Hi media, India) into 1000 ml of distilled water and was sterilized by autoclaving for 15 minutes. Then the broth was dispended into the tubes (5 ml/tube) and stored at 4°C in the refrigerator until used. The media was used to grow the organisms from the samples.

3.4.4.2 Eosin Methylene Blue agar

Thirty eight grams of Eosin Methylene Blue agar (EMB) (Hi-media, India) was added to 1000 ml of distilled water in a flask and heated until boiling to dissolve the medium completely. The medium was then sterilized by autoclaving at 121°C. After autoclaving, the medium was put into water bath of 45°C to decrease its temperature. After solidification of the medium in the petri dishes, these were allowed for incubation at 37°C for overnight to check their sterility and then stored in a refrigerator for future use. This medium was used as a selective medium for the identification of *E. coli.*

3.4.4.3 MacConkey agar

Fifty grams powder of MacConkey agar (MC) agar base was added to 1000 ml of distilled water in a flask and heated until boiling to dissolve the medium completely. The medium was then sterilized by autoclaving at 121°C maintaining a pressure of 15 lb/sq. inch for 15 minutes. After autoclaving, the medium was put into water bath of 45°C to decrease its temperature. After solidification of the medium in the petri dishes, the petri dishes were allowed for incubating at 37°C for overnight to check their sterility and then stored in a refrigerator and were used for the identification of *E coli.*

3.5 Processing of the Samples

3.5.1 Primary culture on nutrient broth

The nutrient broth containing the swab sample was incubated for 24 hours at 37°C for primary growth. Growth of the organism is indicated by the development of turbidity of the broth.

3.5.2 Culture on nutrient agar

With the help of sterile inoculating loop culture from nutrient broth were inoculated into nutrient agar and incubated at 37°c for 24 hours. The inoculated media were then examined for growth of bacteria. Smooth, glistening and opalescent colony were found on nutrient agar.

3.5.3 Culture on Eosin Methylene Blue (EMB) agar

EMB agar plates were streaked separately with the organism and incubated at 37°C for 24 hrs. The growth was indicated as smooth, circular, black color colonies with metallic sheen. EMB agar is used to differentiate coliform enteric bacteria from other enteric bacteria due to production of acid. In acidic conditions the dyes produce a dark purple complex which is usually associated with a green metallic sheen which is an indication of growth of *E. coli*. Other non-lactose fermenters appear as translucent or pink on EMB agar.

3.5.4 Culture on MacConkey agar

MacConkey agar plates were streaked separately with the organism and revealed the growth of bacteria after 24 hrs of incubation at 37°C aerobically and were indicated by the growth of bright pink to red colored colony due to fermentations of lactose by *E. coli.* Other gram negative enteric bacteria that do not ferment lactose appeared colorless on MacConkey agar and the agar surrounding the bacteria remained relatively transparent.

3.6 Statistical Analysis

Data recorded for different parameters were compiled and tabulated in proper way for statistical analysis. Analysis of mean, standard error of mean, standard deviation and variance was done with the help of SPSS (Version 20.0).

CHAPTER IV
RESULTS AND DISCUSSION

The present work on Royal Bengal Tigers at Bangladesh National Zoo was conducted under the Department of Animal Production and Management, Sher-e-Bangla Agricultural University, Dhaka. Current status of the tiger including feeding and management practices of Royal Bengal Tiger along with feed contamination test were performed in the study. This chapter deals with the results from collected data which are presented below.

4.1 Status of Royal Bengal tiger at Bangladesh National Zoo

4.1.1 Population size

At present in Bangladesh National Zoo; production and conservation status of from 2010 to 2020 presented in Table 4.1 and Figure 4.1. It was found that Royal Bengal Tigers in Bangladesh National Zoo was decreasing day by day. For this reason in 2020 four Royal Bengal Tigers had been imported from South Africa.

Table 4.1: Population size of tiger in Bangladesh National Zoo

Year	Number of tigers	Male (No.)	Female (No.)	Death (No.)
2010	9	6	3	1
2011	10	7	3	1
2012	9	6	3	-
2013	9	6	3	-
2014	9	6	3	-
2015	9	6	3	3
2016	8	6	2	2
2017	7	5	2	1
2018	6	4	2	-
2019	6	4	2	1
2020	9	5	4	-

The result indicated an undulating curve of population size of Royal Bengal Tiger at Bangladesh National Zoo. But the recent year, it was found positive. The result was more or less similar to the Rangpur Zoo and Chottogram Zoo. It is also supported by the tiger population in the country.

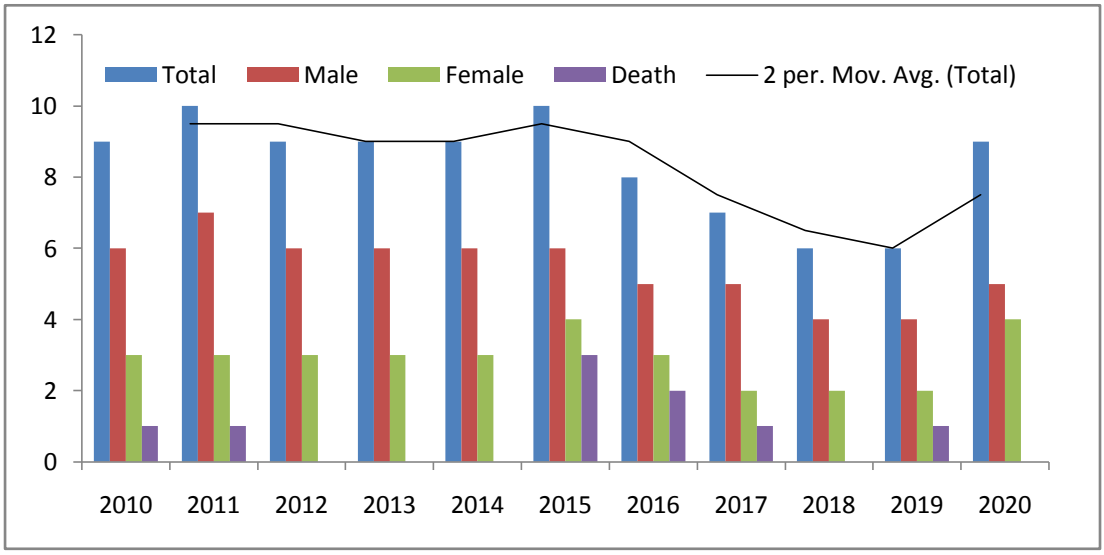


Figure 4.1: Population size of tiger at Bangladesh National Zoo

Currently, the total population size of tigers is estimated at 3,159 animals based on field data from 2009-2014 and at 4,240 individuals according to official government estimates published in 2011 in the Global Tiger Recovery Program. Besides this the population of free ranging Bengal tigers in Bangladesh (Sundarban) by 2016 is about 106 (Tiger census though pug mark). But previously the population of Royal Bengal Tiger was about 445 in the year of 2005 (Tiger census by IUCN and UNDP). It indicates that the tiger population in free range decreasing day by day. Now in captivity total population of Royal Bengal tiger is 25.

4.1.2 Sourcing of Royal Bengal Tiger at Bangladesh National Zoo

Record book of Bangladesh National Zoo showed that, there were a total of 4 cubs born including 3 male and 1 female in the zoo from the tenure of last ten years (2010 to 2020). The zoo was enriched with one male cub in the year of

2010, 2015 and 2016. A female cub was also born in 2010 along with her male sibling (Table 4.2).

Table 4.2: Sourcing record of tiger in Bangladesh National Zoo

Year	Number of tigers born			Number of tigers donated/bought			
	Male	Female	Total	Male	Female	Total	Source
1990	3	3	6				
1991	1	2	3				
1992	2	2	4				
1995	3	1	4				
1998	3	1	4				
2003	2	2	4				
2004	3	1	4				
2007	2	1	3				
2008	1	1	2				
2010	1	1	2				
2015	1	0	1	0	1	1	Forest dept.
2016	1	0	1				
2019				2	2	4	Bought

The graph of the birth record showed a negative trend (Figure 4.2). Most (58%) of the cubs were male and rest (42%) were female. There was no new cub since 4 years. Chottogram Zoo was enriched with some cubs including a rear white tiger in the mean time.

However, Bangladesh National Zoo bought 2 male and 2 female tigers in 2019 and Department of Forest donated 1 female tiger in 2015.

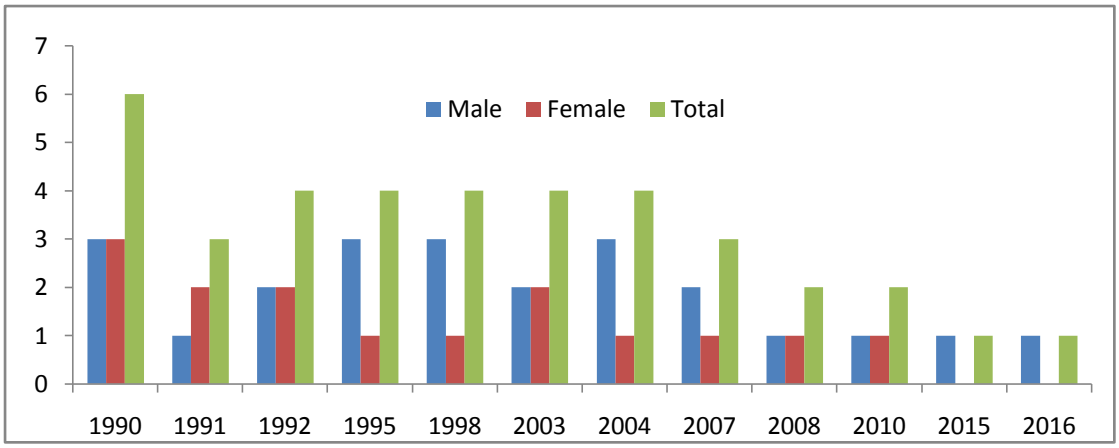


Figure 4.2: Birth record of tiger at Bangladesh National Zoo

According to Carter *et al.* (1999) reproductive success is a key to survival and continued existence for any species, and understanding species' reproductive parameters (e.g., age at first reproduction, reproductive rate, liter size, inter birth interval, and breeding period) is critical to developing effective conservation strategies. Since conservation of species is the first goal to set up a zoo, it should get higher importance to make more cubs as tiger is marked as globally Endangered (IUCN, 2003) and nationally Critically Endangered (IUCN Bangladesh, 2000).

4.1.3 Death of Royal Bengal Tiger at Bangladesh National Zoo

Record book of Bangladesh National Zoo showed that, there were a total of 9 deaths occurred in the zoo from the tenure of 2010 to 2020. One tiger died in 2010, 2011, 2017 and 2019; two of them died in 2016 and 3 died in 2015 (Table 4.1).

Causes of death were recorded in the zoo record book as per standard method. The causes of death since last ten years was illustrated in Table 4.3.

Table 4.3: Causes of death of tiger in Bangladesh National Zoo

Year	No. of Death			Causes of Death
	Male	Female	Total	
2010	1	0	1	One cub was died due to diaphragmatic hernia
2011	1	0	1	Kidney failure
2015	1	2	3	2 for senility and 1 for acute renal failure
2016	0	2	2	Trypanosomiasis
2017	1	0	1	Senility
2019	1	0	1	Trichomoniasis

Most of the death of tiger in Bangladesh National Zoo was due to Senility (34%) followed by renal/kidney failure (22%), trypanosomiasis (22%) trichomoniasis (11%) and diaphragmatic hernia (11%). The number of death was found lower in recent years that indicated the better cub health management practices in the zoo.

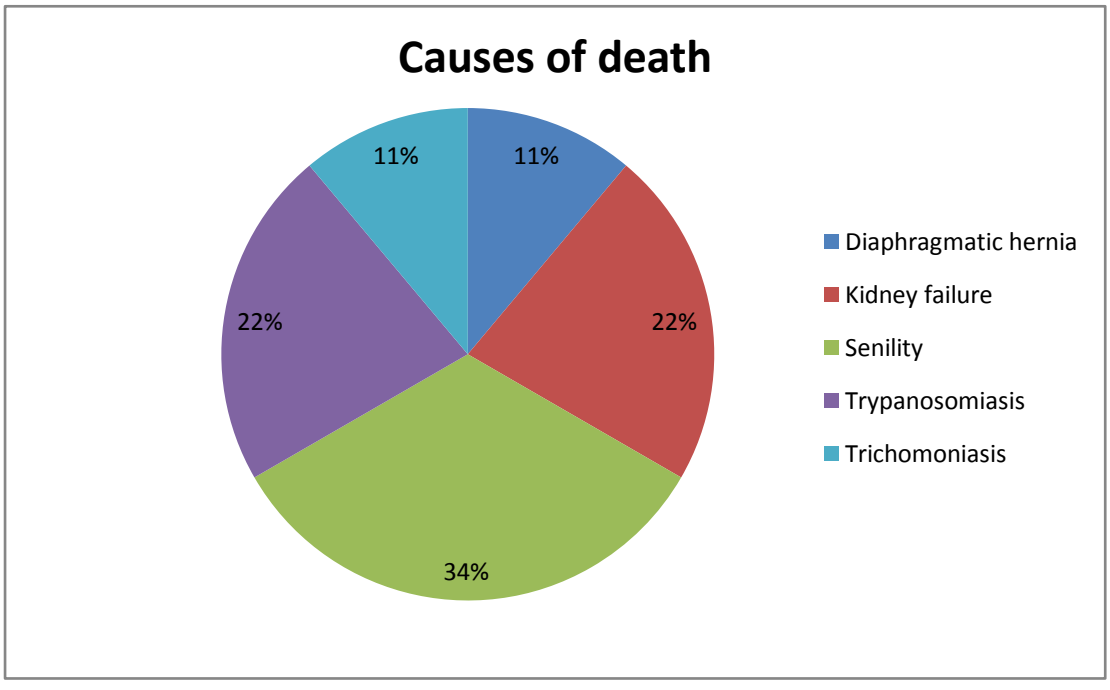


Figure 4.3: Causes of death of tiger at Bangladesh National Zoo

4.1.4 Body Weight of Royal Bengal Tiger at Bangladesh National Zoo

Record book of Bangladesh National Zoo showed that, there were a total of 9 tigers having mean body weight of 136.44±16.62 kg. Five males were having mean body weight of 140.00±15.00 kg and 4 female having 132.00±19.73 kg.

4.2 Management Practices of Tiger in Bangladesh National Zoo

Management of tiger includes feeding, housing, breeding, biosecurity and health care.

4.2.1 Feeding and Nutrition

Healthy and balanced diet is compulsory for better health. Tigers are obligatory carnivores. Bangladesh National Zoo provides a balanced diet for the tigers. Here, at Bangladesh National Zoo offered 8.47±2.36 kg of beef and 0.35±0.14 kg liver for per tiger per day in the study period. Sunday was termed as off day considering the tiger's health condition. Every tiger was allowed to 1.56±0.53 kg of broiler on Sunday (Figure 4.4 and Table 4.4).

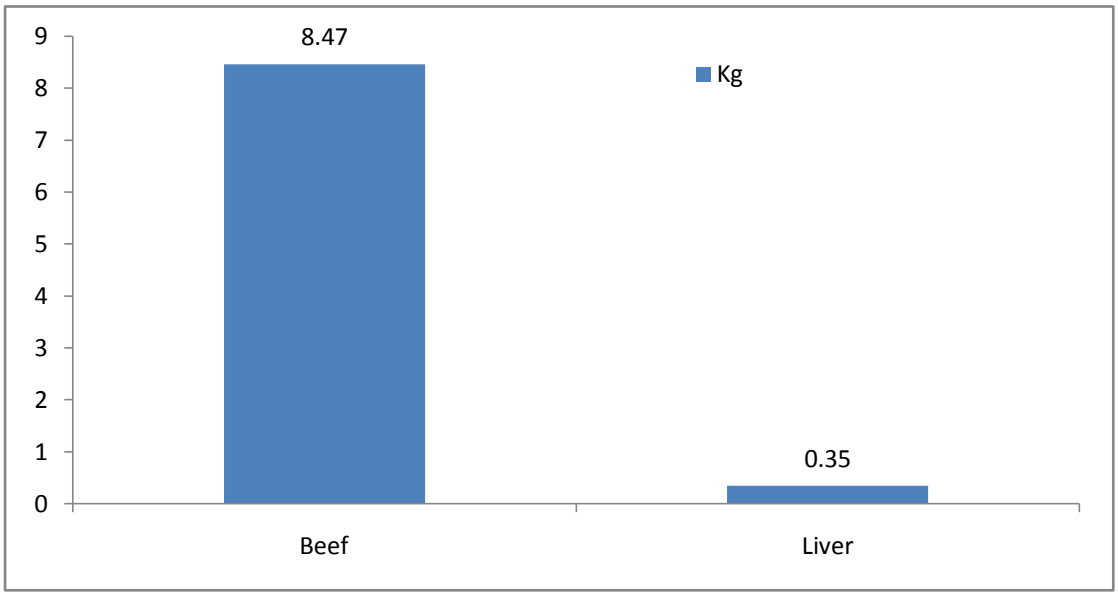


Figure 4.4: Regular diet of tiger at Bangladesh National Zoo

Table 4.4: Feeding practices of Royal Bengal Tiger at Bangladesh National Zoo in Bangladesh

Days of a week	Types of meat	Amount (kg)/tiger
Saturday	Beef	8.47±2.36
	Liver	0.35±0.14
Sunday	Chicken	1.56±0.53
Monday	Beef	8.47±2.36
	Liver	0.35±0.14
Tuesday	Beef	8.47±2.36
	Liver	0.35±0.14
Wednesday	Beef	8.47±2.36
	Liver	0.35±0.14
Thursday	Beef	8.47±2.36
	Liver	0.35±0.14
Friday	Beef	8.47±2.36
	Liver	0.35±0.14

During the study period, it was found that, the feed was weighed and daily records kept as to how much was offered to each individual tiger and how much was consumed (Plate 4.1).

A healthy cattle was slaughtered after inspection of a veterinary officer in the early in the morning on every week days. After processing, it was transferred to the enclosure at required amount.

Determination of ration amounts is a dynamic process to meet changes in metabolic needs, such as in seasonal needs, illness, pregnancy, lactation and growth. Proper body weight was maintained to avoid obesity by diet alterations. These changes were reflected not only energy but also vitamin and mineral needs. Records of stool consistency assisted in determining if the diet was poorly digested or possibly inducing diarrhea indicative of enteric disease.

The food was offered on a non-contaminated surface. In most situations feeding was done on the enclosure floor.

A. Processing of beef

B. Sanctioning for an enclosure

C. Supply of beef into enclosure

D. Feed intake on floor

Plate 4.1: Processing and supply of beef to tiger

Changes in ration in off day played a vital role to keep the tiger healthy and to give them another taste.

Bush *et al.* (1987) point out that exact nutritional requirement for all nutrients are not known specifically for tigers; therefore, requirements are extrapolated from data on domestic felids (NRC, 1984). Rations are formulated, prepared, and fed.

Kleiber (1964) recommended that, adult tiger requires 140 kcal of energy per kg to maintain body condition. Thus a tiger averaging 123 kg requires 5170 kcal/day, whereas a 160 kg male requires 6300 kcal.

Ration quantities was increased 10-20% during winter months, and decreased by the same amount during summer months when appetite drops. Increase diet to ad libitum during lactation and pregnancy.

Considering nutrient status of supplied food for Royal Bengal Tiger from Bangladesh National Zoo; was nutritionally rich (Table 4.5).

Table 4.5: Nutrient status of supplied beef and chicken

Nutrients	**Beef**	**Chicken**
Crude protein	17.24%	19%
Crude fat	11.03%	0.6%
Crude fibre	1.26%	1.20%
Minerals	0.52%	0.8%

Here, supplied beef contained 17.24% Crude protein, 1.13% Crude fat, 1.26% Crude fibre, 0.52% minerals, 7500 IU/lb Vitamin A and 842 IU/lb Vitamin D. On the other hand, white meat or broiler fed on off day contained 19% Crude protein, 0.6% Crude fat, 1.20% Crude fibre and 0.8% minerals. Moisture content of beef and chicken were 79.82 and 76 per cent respectively (Figure 4.5).

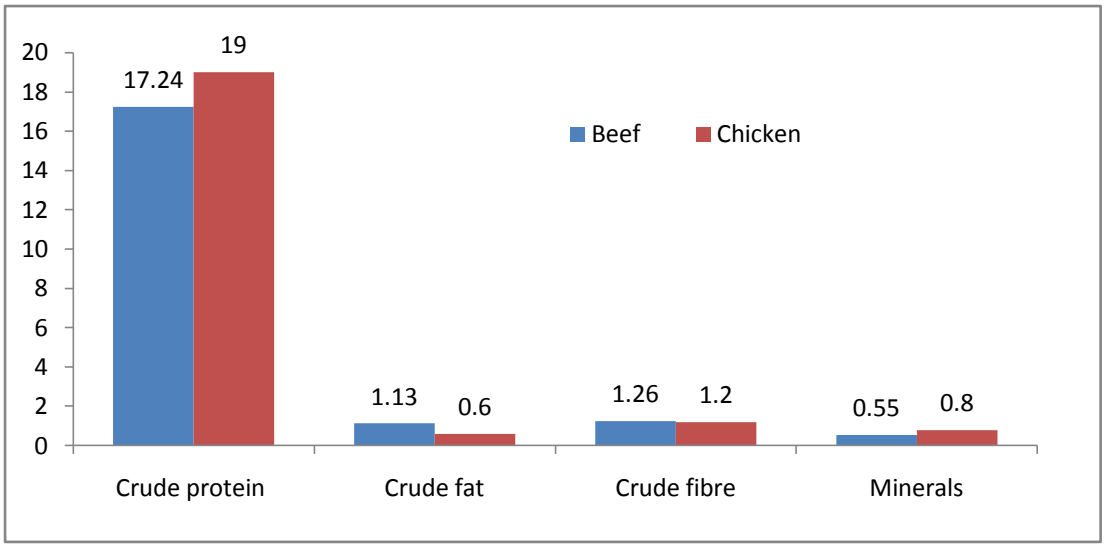


Figure 4.5: Nutrient status of supplied beef and chicken

4.2.2 Habitat of Royal Bengal Tiger

During the period of 1986-1989, the Bengal tiger's sheds were established in Bangladesh National Zoo, Bangladesh. To study the habitat status, an observation of was done. Condition of the shed, water house, space measurement, quality of protection net and bar were observed (Figure 4.6). Excluding the moat, all the sheds were not so naturalistic and had no privacy for the animals from visitors.

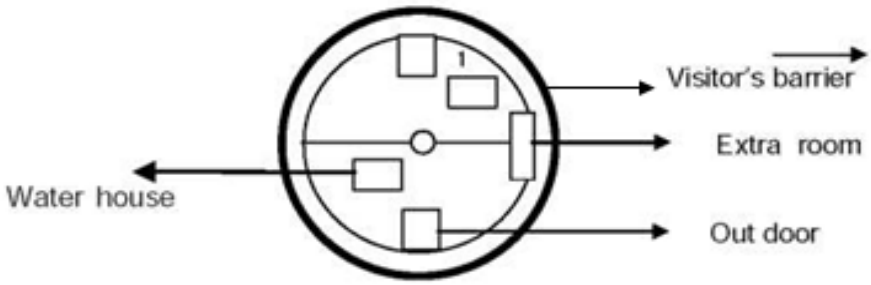


Figure 4.6: Shed of tiger in Bangladesh National Zoo

The sheds are almost round shaped, divided in two parts having 18-20 feet space from the middle point of the shed. In each part there is a small extra room and device of suitable locking and opening (squeezing device). There is a water house of 8 feet length and 6 feet breadth with 5 feet deep in each shed.

Also a facility for climbing up and down is there. Some portions have non concreted floor and there is a wooden post inside each part of the shed (Figure 4.6). One moat has one indoor house, small bush, 25 sq. feet land with grass and a water house of 80 feet length, 11 feet breadth and 8 feet deep for swimming. Here, there are also stairs for climbing up and down. Also there is a water house in the two blocks of the moat.

Scottish Govt. (2019) recommended that single animals should have at least 37m² floor space and the enclosures should be at least 3.5m high. The minimum space provided should be increased by 50% for each additional cat in the enclosure.

4.2.3 Reproductive feature

The observed ratio in 2006 (male:female) was 8:4, which was very difficult to manage. Three male tigers were in the moat and it was not possible to free them all at a time because of dominant behaviors. The zoo caretaker's psychological signals helped to manage them. In this stipulated time one pair was donated to the Dulahazra Safari Park, Cox's Bazar, Bangladesh, another pair was donated to the Jahanabad Cantonment Zoo, Khulna, Bangladesh and one male tiger was donated to Rangpur Zoo, Bangladesh. The visual body condition of the tigers was good. Stool samples were collected from all the sheds and moat. The samples were examined regularly for detecting major parasitic infestations. Other preventive measures (vaccine, deworming etc.) were taken properly.

At present (2020) male: female ratio is 5:4 in Bangladesh National Zoo. According to zoo officials, all the animals are sexually mature. All nine animals are between 2 to 3 years old and were bred in captivity. Reproductive parameters are important to determine population turnover, potential growth rates, and are important indicators to detect the lineage persistence in a population (Holt *et al.* 2003), population viability (Kelly 2001; Balme *et al.* 2012), and to examine meta-population dynamics (Chapron *et al*. 2008). It is

reported from zoo authority, Dhaka, Bangladesh that breeding rate is higher in winter than summer.

Kerley *et al.* (2003) stated that reproductive parameters may vary among the subspecies of the tiger populations because of the different climatic conditions, habitats, prey densities, and other environmental parameters. Information on how reproductive parameters vary among subpopulations of the same subspecies surviving in different habitats is essential for range-wide conservation planning (Kerley *et al*., 2003).

Table 4.6 showed that the key reproductive features Royal Bengal Tiger in Bangladesh National Zoo and revealed that winter is the most favorable time for tiger reproduction.

Table 4.6: Key reproductive features of Royal Bengal Tiger in Bangladesh National Zoo

Breeding interval	Breeding season	Range number of offspring	Average number of offspring	Average gestation period
Royal Bengal tiger in Bangladesh National Zoo	Generally breeding occurs in November and December (winter) but in summer it is also happened	1 to 2	1	8 Month

4.2.4 Herd management

Tiger rapidly adapt to the presence of man and machinery when they are noticed with palatable feeds. There are some squeeze cage and other facilities to handle the tiger or giving feed or vaccination or medication.

A daily, weekly or monthly routine was maintained to make the hard management easier. The routine works was presented in the Table 4.7.

Supervisor of the carnivores department maintained and regulated the schedule whether the responsible laborers done their works or not.

Table 4.7: Schedule of day to day operations on tiger premises

Time	Farm operations
7:00-9:00 A.M	✓ Cheek all over the enclosure of tiger ✓ Find out or observe if any mortality occurred ✓ Inspection within the area if any hazard happened atsight ✓ Clean out the dumping wastage material such as cons, bottle or any plastic product which was thrown by visitors ✓ Cleaning all the equipment's such as feeder, waterer ✓ Cleaning the entire feed supply zone ✓ Arrange the necessary vehicle to transport feed or other's ✓ Cleaning farm premises
9:00-12:00 P.M	✓ Feeding of beef/chicken ✓ Isolation of sick tiger ✓ Treating sick tiger
12.00-3.00 P.M	Lunch cum rest period for laborers
3.00-4.00 P.M	Miscellaneous jobs of tiger premises such as, periodical vaccinations, Repair of enclosure, Fittings and repair of equipment, weekly scrubbing and white washing of drinking water tank, periodical spraying of tiger premises with suitable antiseptic.
4.00 P.M-7.00A.M	A Night watchman on duty.

Date: Signature

Concerned Zoo Officer

4.2.5 Health care

Observation in Bangladesh National Zoo reveals that the visual body condition of the tigers were good. Stool samples were collected from all the sheds and moat. The samples were examined regularly for detecting major parasitic infestations. Other preventive measures (vaccine, deworming etc.) were taken properly. It was reported from zoo authority that in the year 2020, death of a female tiger was occurred due to cause of Tryphanosomiasis disease. So, at present zoo authority is very careful about vaccination and other visual health check up.

Table 4.8: Health status of tiger

Gender	Number	Case No.	Healthy	Sick	Remark
Male	1	C3	✓		
	2	C4	✓		
	3	C9	✓		
	4	C11	✓		
	5	C21		☒	Senility
Female	1	C3	✓		
	2	C4	✓		
	3	C11	✓		
	4	C21	✓		

During the examination period, no tiger was sick in the Bangladesh National Zoo except senility of 1 male. The tiger we identified did not see any disease in the year (Table 4.8). But we tried very well to observe it clearly. Here we have learned from past history that due to the absence bacteria, viruses, parasites and nutrition there usually diseases. However, during the examination, we did not use any medicines in tiger.

4.2.6 Vaccination and deworming

Prevention is better than cure. Bangladesh National Zoo is maintaining the following vaccination schedule for tiger.

Table 4.9: Vaccination schedule for tiger

Sl No.	Name of Disease	Name of Vaccine	Dose
1	Feline panleukopenia	Quadricat or Novivac	One ample per animal
2	Feline calicivirosis		
3	Feline viral rhinotracheitis		
4	Feline chlamydiosis		
5	Rabies	Rabis/Rabison	

Deworming was done by applying Albendazole tablet at every 3 months interval. Number of tablet varied between 1 and 2 according to the body weight of the tiger.

4.2.7 Factors affecting the management

Bangladesh National Zoo is a very nice place for breeding, conservation of endangered animals but due to lack of proper breeding policy, many problems were faced. Squeeze cage facility with proper equipments eases managing the animals during medical problems.

4.3 Food Contamination

5 samples were collected after eating of Royal Bengal Tiger in Bangladesh National Zoo. All samples were tested for bacterial contamination (*Escherichia coli*). All supplied current meat showed no bacterial contamination (*Escherichia coli*) but 3 days old meat showed the presence of *Escherichia coli.*

Table 4.10: Bacterial contamination (*Escherichia coli*) of supplied feed sample

Samples	**Detection of** *Escherichia coli*		
	Day 1	**Day 2**	**Day 3**
Sample -1	Not detected	Not detected	Detected
Sample -2	Not detected	Not detected	Detected
Sample -3	Not detected	Not detected	Detected
Sample -4	Not detected	Not detected	Detected
Sample -5	Not detected	Not detected	Detected

Food preparation and handling is an area of special concern. If the diet is mixed within the institutions, all ingredients should be scrupulously maintained free of contamination from chemicals, pests or microorganisms. Avoid allowing raw diets to warm to room temperature for long periods of time prior to feeding. Commercial diets are thawed under clean conditions, free from external contamination, and fed immediately after thawing. Some institutions actually feed the diet while still frozen allowing tigers to eat as it thaws.

4.3.1 Result in nutrient broth

The nutrient broth containing the swab sample was incubated for 24 hours at 37^{o}C for primary growth. Growth of the organism was indicated by the development of turbidity of the broth (Plate 4.2).

4.3.2 Result in nutrient agar

With the help of sterile inoculating loop culture from nutrient broth were inoculated into nutrient agar and incubated at 37°C for 24 hours. The inoculated media were then examined for growth of bacteria. Smooth, glistening and opalescent colony were found on nutrient agar.

4.3.3 Result in Eosin Methylene Blue (EMB) Agar

EMB agar plates streaked separately with the organism revealed the growth of bacteria after 24 hours of incubation at 37°C aerobically and were indicated by

the growth of smooth, circular, black color colonies with metallic sheen (Plate 4.2)

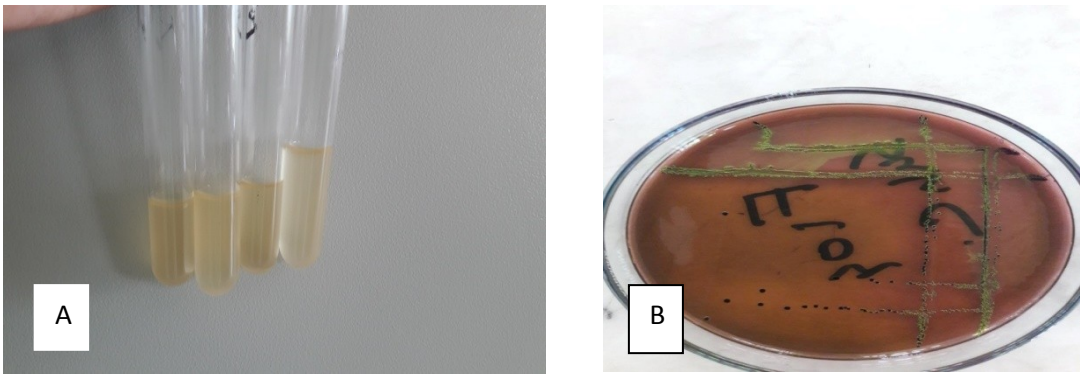


Plate 4.2: Cultural and microscopic examination of E. coli (A) Nutrient broth, (B) EMB agar

4.3.4 Result in MacConkey (MC) agar

MC agar plates were streaked separately with the organism and revealed the growth of bacteria after 24 hours of incubation at 37°C aerobically and were indicated by the growth of bright pink to red colored colony due to fermentations of lactose by *E. coli*. But other gram negative enteric bacteria do not ferment lactose appear colorless on MC agar and the agar surrounding the bacteria remains relatively transparent.

4.3.5 Results of Gram's Staining

The microscopic examination of Gram's stained smears from EMB agar revealed Gram-negative, pink colored, small rod shaped organisms arranged in single, pairs or short chain (Plate 4.3).

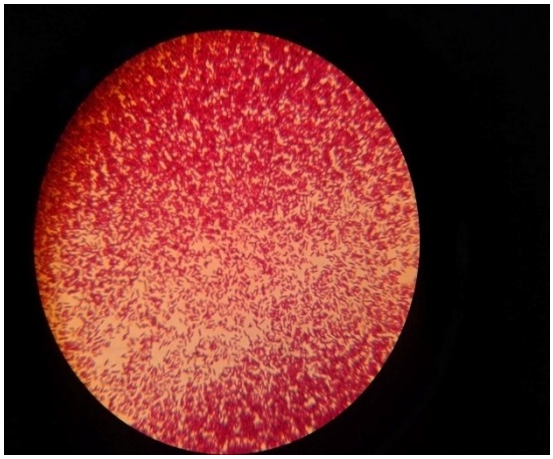


Plate 4.3: Gram negative, pink colored, long rod shape *E. coli* under light microscope. (100x)

CHAPTER V
SUMMARY AND CONCLUSION

Bangladesh National Zoo is the largest zoo in Bangladesh. The present study was conducted at Bangladesh National Zoo, Bangladesh to know the status, reproductive characteristics, and bacterial contamination of meat for Royal Bengal tigers at National Zoo in Bangladesh. This study was carried out during January to December 2019.

During the period of 1986-1989, the Bengal tiger's sheds were established in Bangladesh National Zoo, Bangladesh. Condition of the shed, water house, space measurement, quality of protection net and bar were observed. The sheds are almost round shaped, divided in two parts having 18-20 feet space from the middle point of the shed.

At present Bangladesh National Zoo is conserving 9 tigers (5 male and 4 female). Among them 4 tigers are recently imported from South Africa. Every day for each adult tiger, 8.47±2.36 kg beef and 0.35±0.14 kg liver were supplied. Once a week, 1.56±0.53 kg of broiler was provided per tiger. Samples of provided food was collected and analysis. No bacterial contamination was found at current condition but at 1, 2 and 3 days after sample collection, presence of *Escherichia coli* was found.

At present (2020) male:female ratio is 5:4 in Bangladesh National Zoo. According to zoo officials, all the animals are sexually mature. All nine animals are between 2 to 3 years old and were bred in captivity.

Zoo is very nice place for breeding and conservation of endangered animals but due to lack of proper breeding policy, many problems are faced. Due to inbreeding effects, weak cubs with various nervous syndromes, developmental anomalies occur and many unnatural behaviors are observed. Male and females were kept in pair.

Recommendation

1. Animal exchange program should be strengthened.
2. Adequate laboratory facilities and a complete veterinary unit should be developed in Bangladesh National Zoo, Bangladesh.
3. Print and audio-visual media should take active part with positive reporting.
4. Regular training, workshop and seminars should be arranged to identify, solve the problems and related matters.
5. This will improve research also.
6. Zoo legislation or act should be prepared at the earliest.

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