PRODUCTION AND MANAGEMENT OF RHESUS MONKEY UNDER CAPTIVE CONDITION AT BANGLADESH NATIONAL ZOO

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PRODUCTION AND MANAGEMENT OF RHESUS MONKEY UNDER CAPTIVE CONDITION AT BANGLADESH NATIONAL ZOO

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CERTIFICATE

*This is to certify that the thesis entitled, "**PRODUCTION AND MANAGEMENT OF RHESUS MONKEY UNDER CAPTIVE CONDITION AT BANGLADESH NATIONAL ZOO**" submitted to the Faculty of Animal science & Veterinary Medicine, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF ANIMAL SCIENCE**, embodies the result of a piece of bona fide research work carried out by **MD. JAHIDUR RAHMAN**, Registration No. **17-08241** under my supervision and my guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Date: December,2019
Place: Dhaka, Bangladesh

Dr. Md. Jahangir alam
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Dedicated To
My Beloved Parents

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ACRONYMES AND ABBREVIATIOM

ABBREVIATION		FULL MEANING
BBS	=	Bangladesh Bureau of Statistics
ARKS	=	Animal Record Keeping System
FAO	=	Food and Agriculture Organization
BNZ	=	Bangladesh National Zoo
WHO	=	World Health Organization
DLS	=	Department of Livestock Service
et al.	=	And others
Ft	=	Feet
Kg	=	Kilogram
Gm	=	Gram
Kcal	=	Kilo calorie
Cm	=	Centimeter
IUCN	=	International Union for Conservation of Nature
ISIS	=	International Species Inventory System

Etc	=	Etcetera
e.g	=	For example
Ed	=	Edited
Eds	=	Edition

LIST OF SYMBOL

SYMBOL		FULL MEANING
@	=	At the rate of
^{o}C	=	Degree Celsius
^{o}F	=	Degree Fahrenheit
%	=	Percentage
&	=	And
/	=	Per
>	=	Greater Then
:	=	Ratio

PRODUCTION AND MANAGEMENT OF RHESUS MONKEY UNDER CAPTIVE CONDITION AT BANGLADESH NATIONAL ZOO

BY

MD. JAHIDUR RAHMAN

ABSTRACT

The production and reproduction profile, feeds and feeding and troop management of Rhesus Monkey studied in captive condition at Bangladesh National Zoo in this experiment. For these purposes, 48 Rhesus monkey were parted with 2 troop and each troop contain 24 of monkey of 18 female and 6 male monkey were used during June 15th to August 15th, 2019 for a period of 3 month. Require amount of balance food that supplied to the Rhesus Monkey contain boiled egg, bread, banana, apple, papaya, pine apple, ground nut, cucumber and gram But we had made little change the food component for observing their health condition and breeding performance. We had replaced pine apple to mango and added Citrus food such as orange. From the study it was followed by Prevalence rate of cage(1) was 33.33% and Prevalence rate of cage(2) was 20.83%. The infection of virus not found, infection rate of bacteria was 4.16%, parasite was 12.5% and fungal was 14.58%. The average length of estrous cycle was 26.9 day for cage(1) and 29.8 day for cage(2) also include the average

duration of gestation length was 157.10 days for cage(1) and 164.5 days for Cage(2). It is concluded and recommended that a balance ration used to be fed with proper management systems to keep unique health status along with productive and reproductive well-being of the Rhesus Monkey at Bangladesh National Zoo.

CHAPTER-I

INTRODUCTION

Monkeys are tree-dwelling (arboreal) simians. They are in the primate order. Monkeys are intelligent, social animals. Most monkeys have a tail, even if it is a short one (Groves, 2008). The word "monkey" is a common-language term which is not used in taxonomy. It includes two rather different groups of primates. Some examples of monkeys are macaques, baboons, guenons and marmosets (Dawkins, Richard, 2004). The non-human primates are represented with 63 genera and about 600 species and sub species in 92 countries (Chopra et al; 2013). They are often included with Apes but they are very different. The main different is that the Apes don't have a tail. There are seven species (14 subspecies) of macaques are known in South Asia and five species of them found in Bangladesh. These are Rhesus macaques (*Macaca mulatta*), Pig-tailed macaques (*Macaca leonina*), Cynomolgous macaques (*Macaca fascicularis*), Assamese macaques (*Macaca assamensis*), and stump-tailed macaques (*Macaca arctoides*) [Feeroz, 2001; Feeroz et al; 2011; Hasan, 2003; Khan, 1982]. The latter four macaque species are distributed only in the north eastern and south eastern hill areas of the country and their population density is very low (Islam et al.; 2000). Rhesus macaques are found throughout the country except for the north eastern part where no primate species lives (Hasan et al; 2013; Khan, 1982). This species is found in all types of natural forest, tea gardens, planted forests, and human settlement areas and is the only primate species found in the Sundarbans mangrove forest in the south west of the country [Hasan et al; 2013].

Rhesus macaque populations in natural habitats of the country can be divided into the three major sub-populations defined by geographic and anthropogenic barriers shown in south western. The eastern sub-population is connected by forest that traverses the state of Tripura in North east India, which are borders of Bangladesh

to the north, south, and west, and the Indian state of Mizoram to the east, dividing eastern Bangladesh into a north east and south east sector. Approximately 5000 individuals of monkeys was estimated to engage with business which is the largest captive stock of monkeys in Bangladesh. As the Wildlife (Conservation and Security) Act, 2012 does not allow keeping any monkey individual in captivity; a separate management plan is required to conserve this captive population as well as our centuries' old tradition of monkey performance. The rhesus macaques are distributed throughout the country. They are synanthropic, thriving in human-altered environments, including urban areas, and plays a significant role in the culture and tradition of some communities. Overall Monkey are non-seasonal breeders and although some have labeled them "weed species" in recognition of their ability to live in densely populated urban areas. (Teas et al; 1980, Richard et al; 1989, Southwick et al; 2005). Primate populations are being reduced or eliminated in many parts of the world due to habitat destruction, competition for food and space, bush meat hunting, biomedical research, and the pet trade (Mittermeier et al; 1986). Published data detailing the distribution and population composition of rhesus macaques in Bangladesh is very limited (Green, 1978; Gittins , 1980) and largely limited incidental or discontinuous observations in the early 80's (Khan and Ahsan, 1981). Intensive surveys, which covered 17 primate habitats in the north eastern and south eastern part of the country (Feeroz et al; 1995). Primate populations are being reduced or eliminated in many parts of the world due to habitat destruction, competition for food and space, bushmeat hunting, biomedical research and the pet trade (Wolfheim, 1983).

The Sundarbans forest, hilly area are highly fragmented and disturbed forest in Bangladesh. It is under high pressure for fuel wood, fallen dry leaves for cooking, grazing, illicit felling and fire used hazards (Khan, 2010). The forests are being destroyed at an unprecedented rate to clear land for pineapple (Ananus comosus), banana (Musa spp.) and kachu (Colocasia spp.) cultivations and human settlement

(Khan, 2010). Large number of human population (about60,000) of this area, with its increasing need for fuel wood, timber, building material and cultivable land exert heavy pressure on the remaining forest area (Hossain et al; 2004). On the other hand, natural Shal stock has lost its vigorous coppicing ability to a great extent, bole becomes malformed, and the growth of the trees seems to be stunted (Hossain et al; 2004). A recent estimate reveals that over 70% of the Shal forest area is either degraded or encroached by this time (Nishat et al; 2002). Thus the most important underlying causes of this destruction are high population pressure and weak forest management system. Several researchers worked on distribution and population composition of Rhesus Macaques in Bangladesh (Green 1978, Gittins 1980, Khan and Ahsan 1981, Hasan et al; 2013, Sultana 2012).

General Objectives

- To study the management practices of Rhesus monkey at Bangladesh National Zoo.

Specific Objectives

- ✓ To find the feeding practices of Rhesus monkey (feeding schedule and materials, security).
- ✓ To find the habitat situation at the zoo.
- ✓ To find the funding of Rhesus monkey (*Macaca mulatta*) Research in Bangladesh National Zoo.
- ✓ To examine what practical action could be taken to improve their management.
- ✓ To know the prevalence rate of the Rhesus monkey at Bangladesh National Zoo.
- ✓ To explore the Reproduction profile of the Rhesus monkey at Bangladesh National Zoo.

CHAPTER-II

REVIEW OF LITERATURE

The review of literatures on production and management of Rhesus monkey is presented in this chapter. The parameters includes feeds and feeding, production profile and troop management state of captive condition.

2.1. GENERAL INFORMATION OF RHESUS MONKEY

2.1.1: Scientific classification of Rhesus monkey

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Mammalia
Order	:	Primates
Family	:	Cercopithecidae
Genus	:	Macaca
Species	:	*Macaca mulatta*

2.1.2: Other Common Names

- Macaque rhesuss - French
- Mono resus- Spanish
- Rehesusapa or rhesusmakak- Swedish
- Macaca mulatta lasiota- West Chinese rhesus macaque
- Macaca Mulatta sanctijohannis- Insular Chinese rhesus macaque or south Chinese rhesus macaque
- Macaca Mulatta vestita- Tibetan rhesus macaque

2.1.3: Geographic Distribution and Habitat

Rhesus macaques are Old World monkeys from Asia that range in geographic distribution from Afghanistan to the Pacific coast of China--, including India, Bhutan, Laos, Nepal, Bangladesh, Thailand, Vietnam, and Pakistan.

In Bangladesh Rhesus macaques are found in Sylhet, Chittagong and Sundarbans(IUCN Redlist Volume-2). They boast the largest native range of any other nonhuman primate species. Rhesus macaques are extremely adaptable monkeys that can be found in elevations ranging from sea level to as high as 13,123 ft (4,000 m). They dwell in tropical and temperate habitats including deciduous, semi desert, mixed deciduous, bamboo, temperate, and tropical forests, as well as mangroves and swampland.

Introduced colonies of rhesus macaques are also found in the United States, specifically in Florida and South Carolina, as well as the U.S. territory Puerto Rico. As a way to gain a larger tourist population, six rhesus macaques were introduced to Florida's Silver Springs State Park in the 1930s; another six were introduced in 1948. Being the excellent swimmers that they are, they quickly made their escape from Silver River Island by swimming into neighboring forests, and eventually into human developments. Morgan Island, a Sea Island in South Carolina, is also home to a sizable colony of introduced rhesus macaques. They were imported in the 1970s for the purposes of biomedical research in local laboratories. In addition, the tiny Caribbean island of Cayo Santiago, Puerto Rico, houses approximately 1,000 rhesus macaques that have been studied in a free-range colony since they were introduced in the 1930s.

Fig 01: Worldwide geographical location Rhesus monkey

2.1.4: Size and Weight

Rhesus macaques are medium-sized monkeys. Gender dimorphism is present in this species; males and females display differences in body size.

- Males measure on average 1.7 ft (53 cm) and weigh, on average, 17 lb (7.70 kg),
- Females have an average height of 1.5 ft (47 cm) and an average weight of 11.8 lb (5.34 kg).
- Their medium-length tails average between 8.2 and 9 in (21–23 cm).

2.1.5: Lifespan

The lifespan of a rhesus macaque is between 25 and 30 years. They live between 20 and 40 years in captivity; their lifespan is smaller in the wild due to fights, predators, and humans.

2.1.6 Appearance

Rhesus macaque is charismatic monkeys that range in color from pale brown to auburn with intertwined streaks of gray hair. Their underbellies are a faded brown color. Their

expressive faces are hairless and reddish-pink in tone, a color that matches that of their bottoms. Their pink ears appear large and pointed.

Underneath their protruding eyebrows, their eyes are almond-shape and yellowish-brown in color. Their nose bone is narrow and rather flat, and ends with slanted nostrils. Their mouth protrudes out and their lips are thin.

Babies don't have as much hair as adults; their face and the top of their head is bare, pink, and wrinkled. Their ears appear larger and more pointed than those of their adult counterparts. The hair on the inside of their arms and legs and on their chest is very light, exposing large patches of pink skin. Their hair thickens as they age. Their large cheek pouches are used to store food while foraging through their surroundings.

Fig 02: Physical appearance of Rhesus Monkey

2.1.7: Diet

Rhesus macaques are omnivorous. They consume a large number of plants, roots, seeds, bark, and fruit. They also eat insects, eggs, and chicks. Groups that live closer to human communities glean a considerable amount of their diet from human activities. They raid crops, snack on leftover food from garbage cans, and even steal directly from people they encounter. Up to 93% of their diet can come directly from humans, whether as handouts or from foraging in their crops and farms. Human-provided food typically includes

bananas, bread, peanuts, fruits, and vegetables. Because their palate is so extensive, rhesus macaques tend not to have any issues finding sustenance. Rhesus macaques that live in forested areas forage for their food. Everyone in the group that discovers any food is expected to vocalize and call out, so others can partake of the feast. However, generally speaking, females call out to signal the location of a good food source more frequently than males.

2.1.8: Behavior and Lifestyle

Rhesus macaques are highly adaptable to coexisting with humans, which is most commonly seen in India, where the monkeys are considered to be sacred creatures and are left undisturbed. While they are predominantly quadrupedal (that is, they walk on all fours), they can be both arboreal and terrestrial, depending on the habitat in which they are located.

They are active both during the day and at night, and are considered to be boisterous creatures. Feeding, resting, traveling, grooming, and playing encompass the majority of day-to-day activities. Climate and weather affect the types of daily activities that the rhesus macaque partakes in. The hotter the season, the lazier and more inactive they are, as opposed to their more active temperate months.

Rhesus macaques are gregarious and live in groups with several adult males and many more females of all ages and their offspring. These females and their young belong to different matrilines, which can include up to six generations. Group size varies depending on whether they live in urban or forested habitats. A study conducted in Bangladesh, for instance, revealed that urban groups include between 22 and 90 individuals, whereas forest groups include between 10 and 78 individuals, for an average of 30 individuals in most places. These are bold, extremely curious, and adventurous monkeys. Their society is based on a strong hierarchical system in which high-ranking individuals behave like despots and subordinates are at their mercy.

Males disperse away from their native group at adulthood and have to work hard at establishing friendships throughout their lives. All females in a group, however, are related to one another (grandmother, mother, sisters, daughters, and cousins) and form a strong

and supportive social network. They only allow a few selected adult males to stay in the group in exchange for protection against other macaques and predators.

2.1.9: Gestation period and Family

Males reach puberty at 4 or 5 years old. All males have great sexual appetite; this is why, as soon as they become successful with females, the older fellows in the group kick them out. These young studs have no alternative but to find a new group. Some do not make it, starving in the transition or getting eaten by predators. If they manage to find a new group, it is best for them to keep a low profile and use any opportunity to work their way up the ranks overtime provided females like him.

Females become fertile at 3 or 4 years old. At that age, the skin on their face and genitalia becomes redder. They decide the type of relationship they want. Sometimes they choose a passing fling with a seemingly random outsider; other times, they opt for a long-term arrangement with a male from the group in exchange for protection. They communicate their intentions by following a male around, sitting next to him, and presenting their behind to him. They are insistent and sometimes even slap males who do not respond to their advances. They go into estrus during the rainy season when food is most abundant, and give birth to a single offspring after 165days of gestation(Animal diversity web). Interestingly, there are usually about the same number of male and female infant births, but mortality is high, especially for males.

2.2: Feeding and watering management

2.2.1: Feeding management

Rhesus Macaque (*Macaca mulatta*) is the most common non-human primate in the forested and urban areas of Asia (Hasan et al; 2013). It is found throughout India in its peninsular (Madhya Pradesh, West Bengal, Assam and Bangladesh), northern (Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Uttar Pradesh, Rajasthan, and Gujarat) (Seth et al; 2001), and northeastern (Assam, Meghalaya, and Arunachal Pradesh regions (Molur et al; 2003). Information on the feeding ecology of a species provides the detailed dietary specialization necessary for its survival and is an important part of its natural life history (Harcourt et al; 2002). Flexibility

in diet patterns plays a pivotal role in the survival of non-human primate species in urban and peri-urban ecosystems through resource sharing and competition and has evolutionary implications in the long-term. Primates are known to adopt several foraging strategies (Fleagle & Gilbert, 2006). Natural diet of forest Rhesus Macaques includes fruits, seeds, inflorescences, flowers, buds, leaves, young shoots, twigs, barks, roots, and pith and resin of gymnosperms, angiosperms, and fungi (Fooden, 2000). Macaques are also known to consume animal food items that such as insects, spiders, worms, termites, grasshoppers, lizards, ants, beetles, molluscs, crayfish, shellfish, honeycombs, crabs, and bird eggs (Mandal, 1964; Lindburg, 1971; Malik, 1983). In marine coastal areas, the species is mostly known to rely on seeds and fruits (Hanya et al; 2003) and also catch live fish as in the sundarban (Majumder et al; 2012). In forested habitats, primates consume 25% to 40% of the total frugivore biomass (Chapman et al; 1995). Ingestion of fruits or young leaves with sugar and insects with protein content help to balance their diet (Janson & Chapman, 1999). Feeding patterns are also associated with human-macaque conflict—crop raiding by macaques in villages near forest areas has increased the level of negative association of the species by farmers (Air, 2015). The dependency of urban macaques on anthropogenic food resources and their behaviors associated with food utilization from urban areas often increase the risk of undesirable interactions with human beings (Sha & Hanya, 2013).

Photograph-1: Different type of fresh fruits supplied for Rhesus monkey at Bangladesh National Zoo.

In urban landscapes, the nutrition required for primates becomes highly questionable. Urban macaques largely share human food resources (Gupta, 2001) and depend on cultivated crops, plants, and even garbage (Lee et al; 1986). In some cases, macaques depend on humans for being fed (Strum, 1994). The feeding patterns of primates that live in tourist sites and temples are often influenced by provisioning of food by humans. Urban macaques have also acquired behavioral adaptations in food-acquisition techniques (Mangalam & Singh, 2013). Urban

habitats, in contrast to natural ones, have a more direct influence on primate behaviours associated with competitive resource utilizations and foraging techniques. Several anthropogenic barriers and disturbances interfere with the feeding ecology of primates in urban environments.

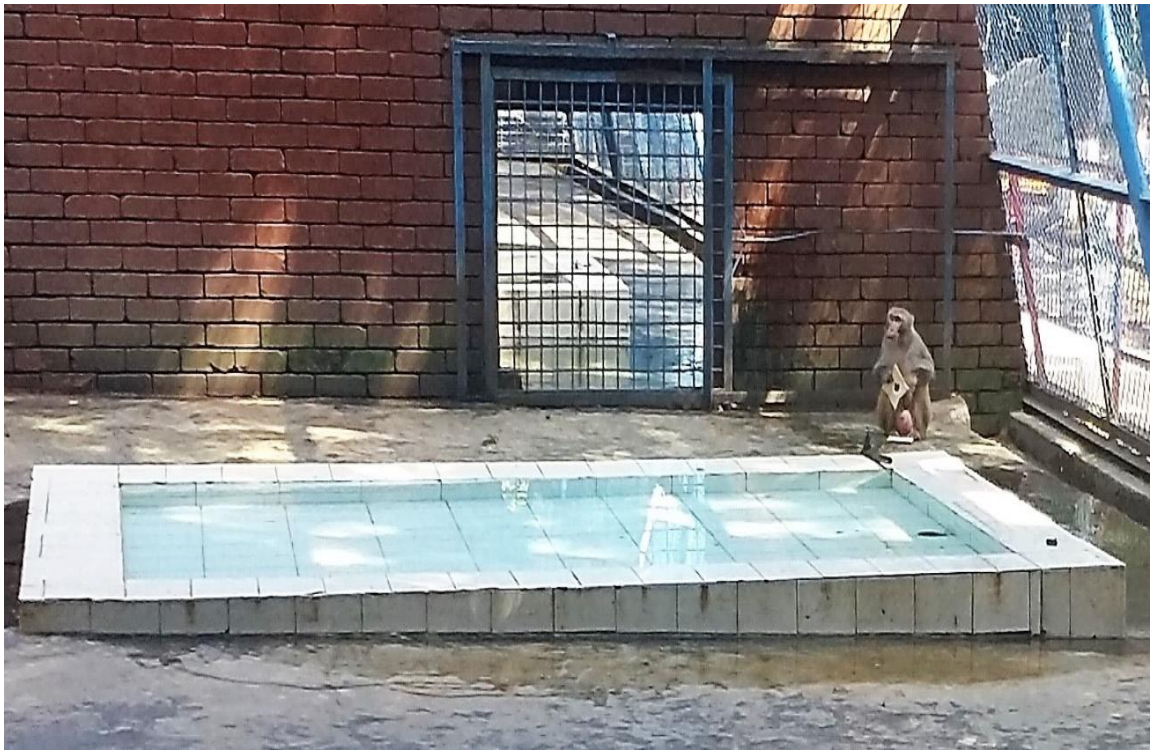
Although Rhesus Macaques were assessed as a Least Concern (LC) species by IUCN (2018), primates are threatened globally by human-wildlife negative interactions, habitat loss and fragmentation, and several other anthropogenic factors (Strum 1994, 2001; Mittermeier & Konstant, 1996, 1997; Kemf & Wilson 1997; Cowlishaw & Dunbar, 2000; Peterson, 2003; Hill, 2005). The Negative interactions between humans and macaques due to food provisioning and other anthropogenic drivers possess major challenges for the survival and persistence of the species. The need for translocation of rhesus macaques and the consequences were due to its proliferation in urban areas of India was suggested and studied earlier (Malik & Johnson, 1991, 1994; Southwick et al; 1998). Translocation or relocation is a widely used conservation tool but it is known to induce stress, as evident in the higher level of stress hormones in females of the species during the translocation process (Aguilar-Cucurachi et al; 2010).

The reproductive capacity, inter-birth interval, and the size of social groups in primates are often determined by the amount of food they consume (Air, 2015). Again, the availability of different food resources can reduce seasonal fluctuations in diet and provisioning of food regularly to urban primates may have adverse effects on their behavior, social organization, and conservation (Sinha, 2017).

2.2.2: Water Requirement

In general, NHPs fulfill their daily water requirements (sensible and insensible losses) with 20ml/kg body weight. UCAR requires that each NHP either earns or is supplemented to no less than 20ml/kg/day of mean body weight from the previous calendar month. Water equivalents of fruit or vegetables may be used to partially

meet the NHP's fluid requirements. As identified in people, 20% of the daily water intake is generally obtained from food (Food and Nutrition Board 2004). Water equivalents can be found in Bowes and Church's Food Value of Portions Commonly Used (18th edition, Pennington JAT and Douglass JS, ed., Lippincott, Williams and Wilkins: Philadelphia, 2005). Therefore, no more than 20% of the minimum daily water requirements may be provided in the form of fruits/vegetables.



Photograph-2: Watering management of Rhesus monkey at Bangladesh National Zoo.

2.3. Captive management

2.3.1: captive feeding management

In general, primates can be fed a diet based on commercial monkey biscuits or canned primate diet. Marmosets should be fed a marmoset diet. Moderate amounts of assorted carrot, sweet potato, apple, banana, and orange also can be offered; however, it is advised to feed greens and green vegetables, which are more

comparable to the natural diet. Monkey biscuits and the canned products should comprise 20% of the dry-matter intake of Gorilla and Orangutan diets; fruits and treat items should comprise ≤20%. Green vegetables and browse should be at least 40% of the diet, depending on the species. (International Primatological Society, 1993).

Feeding only greens and vegetables, with vitamin and mineral supplements, is being tested in several species of primates. Diets should be developed and offered in such a way that enrichment is supported.

Photograph-3: Captive Feeding management of Rhesus monkey at Bangladesh National Zoo.

Dietary crude protein ranges for Pongidae such as Gorillas are 14%–16% and for New World primates such as pinches 18%–22%. For all primates, the diet should contain 0.8% calcium and 0.6% phosphorus. Primate diets should contain 5,000–8,000 IU vitamin A and 800–1,500 IU vitamin D, except diets for Squirrel monkeys and Marmoset/Tamarin should contain 2,400 IU vitamin D. The vitamin C level

should be at least 200 mg/kg dry matter. The maintenance metabolic rate (kcal/day) is for Pongidae (gorillas, orangutans), 3,621; Baboons, 1,099–1,324; Langurs, 632–637; Rhesus macaques, 567–1146; Marmoset, 31–76; and Tamarin, 57–105. Obesity should be prevented; therefore, it is important to weigh animals regularly or to perform body condition scoring (Shimoji et al; 1993).

Monkey biscuits containing high-quality protein (18%–22.5% crude protein) should be fed to New World primates to ensure that their higher protein requirements are met. Regular monkey biscuits can be fed to Old World species depending on other components in the diet, although many larger Old World species such as Gibbons, Orangutans, Chimpanzees, and Gorillas also need high-fiber products. Laboratory primate biscuits are typically formulated with very low fiber levels (eg, 5%). Because many of the natural foods consumed by these species appear to contain very high fiber levels (e.g.>20%), increasing the dietary fiber intakes of larger primate species is widely practiced. High-fiber biscuits should comprise at least 50% of the dietary dry matter, and browse should be at least 40% of the diet fed. Most of the time, however, these amounts are not available, and greens and vegetables can be a replacement for the browse.

Commercial, preferably gluten-free, high-fiber monkey biscuits (25%–50% neutral detergent fiber and up to 15%–35% acid detergent fiber) have been developed to feed captive colobines. A diet consisting of 30% of a palatable high-fiber biscuit and ≥70% green vegetables and fresh browse is recommended for most colobines. Only a high-fiber primate biscuit and browse is the preferable food for colobines. If the biscuit is not readily accepted, adding a limited amount of applesauce or banana flavor can increase palatability. Also, alfalfa pellets and a good-quality alfalfa hay can be provided in limited quantities. If a gluten-sensitive enteropathy is suspected, any product that contains wheat, barley, rye, or oats should be removed from the

diet. In colobines, dietary changes always should be made gradually to allow their gastric microflora time to adapt. (Nutrition in Primates, Joeke Nijboer, 1994).

2.3.2: Cage Space Requirement

Primatologists agree that adequate cage space is a key factor for a monkey's well-being. (Bayne 1989) asked 56 investigators of 10 laboratories in the United States what they thought could be done to improve their animals' well-being. The most frequent recommendation was for larger cages (National Institutes of Health, 1991). Despite this apparent awareness that non-human primates in the US deserve larger cages than those currently used, there is a strong reluctance to increase cage sizes because of the perceived costs (Bowden, 1988; Holden, 1988; Line et al; 1989a, b; 1991; Mason, 1989; Woolverton et al; 1989; Erwin, 1991; Wolfle, 1991; American Medical Association, 1992; Crockett, 1993), and because of recent studies which support the status quo by demonstrating that the quantity of cage space is not an important factor in the promotion of primate well-being. The present report reviews these studies and evaluates the usefulness of their methodologies in determining species-adequate cage space standards for non-human primates. Space requirements of some countries, such as Great Britain (Home Office, 1989) and Switzerland (Der Schweizerische Bundesrat, 1981) exceed the EEC standards.

Table 1: Minimal cage space requirements for the most common laboratory non-human primates in Europe* (European Economic Community Council 1986) and in the USA (National Institutes of Health 1985; United States Department of Agriculture 1991)

Gender	Floor area (m^2)	Height (m)
Female macaques (5-7kg)	0.70 (Europe) 0.40 (USA)	0.85 (Europe) 0.76 (USA)
Male macaques (10-15kg)	1.10 (Europe) 0.56 (USA)	1.25 (Europe) 0.81 (USA)

2.4: Behavioral disorder

It was examined the effect of cage space on the expression of behavioral disorders. The above long-tailed and pig-tailed macaques were videotaped in a familiar environment (Crockett et al; 1993a) when being single-housed for two weeks, each in five different-sized barren cages (largest cage: 0.61m2x0.84m; smallest cage: 0.05m2x0.36m). Smaller cages failed to trigger an increase in abnormal behaviors. These findings are in line with those of Bayne and McCully, (1989) and Line et al; (1989a; 1990a; 1991): six and ten adult single-housed rhesus macaques were tested in small and moderately enlarged barren cages (0.40m2 versus 0.57m2 versus 0.63m2). No reduction in stereotypical behaviors was seen in the larger cages. It was concluded that increasing cage size does not lead to improvements in well-being (Crockett & Bowden, 1994).

It would be surprising if intelligent animals such as primates could be cured from ingrained behavioral disorders by simply being provided with more empty space. Even a manyfold enlargement of unstructured cage space will not change this circumstance (Goosen, 1988). The situation is different when increased space also implies more complexity (Leu et al; 1993) for example, noted a significant decrease in stereotypical activities in 20 single-housed long-tailed macaques transferred daily from barren home-cages to large multi-compartmentalized cages. Exploring the various compartments of the larger cage probably distracted the animals sufficiently to override the urge for stereotyped movements.

The predominant importance of the quality rather than quantity of cage space for the behavioural health of non-human primates is underscored by the fact that 'pathologic behaviour' (Brent et al; 1989), especially stereotypies, is ameliorated or even eradicated when no extra space is provided, but suitable stimuli added to counteract 'boredom' (Whitney & Wickings, 1987; Vandenbergh, 1989; Wemelsfelder, 1994) in a hitherto barren cage environment (Reinhardt et al; 1987b;

Goosen, 1988; Brent et al; 1989; Line et al; 1989c, 1990b; Meunier et al; 1989; Weld et al; 1989; Weld & Erwin, 1990; Bayne et al; 1991; Lam et al; 1991; Bayne et al; 1992a, b; Nadler et al; 1992; Perkins et al; 1992; Eaton et al; 1993; Phillippi-Falkenstein 1993; Shimoji et al; 1993; Boinski et al; 1994; Brent & Long, 1995).

While behavioral disorders are not significantly affected by the actual cage size, sporadic disorders may be triggered in an animal when the cage becomes too small for normal 'distancing responses' (Hediger, 1955) during an alarming situation. The confined subject is quasi cornered in such a circumstance and experiences higher tension (Berkson et al; 1963) than in a large cage with adequate options for flight. (Draper and Bernstein, 1963) noticed that rhesus macaques resort to stereotyped activities in an unfamiliar, potentially alarming environment when being confined in small cages (0.64m2x0.80m) but not when being confined in much larger cages (3.84m2x1.60m) with enough space for escape. The authors hypothesized that the stereotyped movements served the subjects as substitute actions for inhibited flight responses to the fear-inducing, unfamiliar environment. This inference is in line with the commonly made observation that caged primates afflicted with gross behavioral pathologies such as self-biting or self-clasping, predictably display these reactions when being approached or looked at by a fear-provoking person (Reinhardt, 1995; Slides 34-36; cf. Berkson, 1968; Fittioghoff et al; 1974; Fritz et al; 1992).

2.5: Reproduction Profile

Females reach puberty around age three while males are sexually mature by age four (Rawlins & Kessler, 1986b). The ovarian cycle lasts for 28 days and is characterized by the darkening of the skin surrounding the anogenital region accompanied by menstruation (Catchpole & van Wagenen, 1975). Estrus lasts for eight to 12 days, with the day of ovulation occurring at the midpoint of the estrus period. Females have increased sexual activity during ovulation, exhibiting the highest number of

copulations seen during the ovarian cycle (Fooden, 2000). Females reproduce from three until about 20 years of age (Rawlins & Kessler, 1986b). Males reach puberty between three and 3.5 years of age but do not reach adult body size until about eight years old (Dixson & Nevison, 1997; Bercovitch et al; 2003). Though males are capable of reproducing by age four, they are not reproductively successful until after age eight, or when they reach adult size. During this time between becoming sexually mature and when they begin to mate, young rhesus macaques are learning the social skills, including fighting ability, that will influence their success throughout their lives (Bercovitch et al; 2003). Both males and females reach sexual maturity sooner in captivity (Catchpole & van Wagenen, 1975).

There is marked birth seasonality in rhesus macaques, with the majority of mating occurring in October through December and birth coinciding with the end of the rainy season, or during the period of highest food abundance (Lindburg, 1971; Qu et al; 1993). At Cayo Santiago, the mating season is much longer and begins in July and lasts until December (Chapais, 1986). High-ranking males have more opportunities to mate with females than low-ranking males, but do not always sire a disproportionate number of infants. Lower-ranking males may have similar reproductive success compared to high-ranking males because they are new immigrants and are more attractive to females because of this (Berard, 1999). From one breeding season to the next, females will drastically reduce the amount of mating they do with familiar males and over a period of three years, they try not to mate with any familiar males given the opportunity to mate with unfamiliar males (Bercovitch, 1997; Berard, 1999).

During the breeding season, females enter into consortships with one or more males. An individual female will spend longer amounts of time in contact with, grooming, and mating with these males. Males and female rhesus macaques are promiscuous breeders, mating multiple times with multiple mates (Lindburg, 1971). Both males and females initiate these consort relationships and competition for access to mates

is related to the high levels of aggression seen in rhesus macaque groups during this time of year. Gestation lasts 164 days in rhesus macaques and the inter-birth interval is between 12 and 24 months (Fooden, 2000). If a female does not have a successful pregnancy or her infant dies in the first year of life, she is more likely to give birth the following season than a female who successfully rears an infant (Seth, 2000).

CHAPTER-III

MATERIALS AND METHOD

Materials and method used to conducting the present research are described in this chapter under different sub-titles.

3.1: Study Area

The experiment was conducted with selected Rhesus monkey (*Macaca mulatta*) at the Bangladesh National Zoo, Mirpur, Dhaka, Western area of the Capital city.

Photograph-04: Map of the Bangladesh National Zoo, Mirpur, Dhaka.

3.2: Study period

The experiment was carried out from June 15th to August 15th 2019 for a period of 3 months.

3.3: Environmental condition of the study area

Environmental condition of the study area is over viewed. Maximum and minimum temperatures as observed in May and January ranged between 33°C and 15-20°C. Summer season continued from may to september 25- 30°C and winter lasted from December-to February. Rain falls started in May and continued up to September. About 95% of the annual rain fall occurred during the monsoon. The maximum humidity was observed 96% from July to September and the minimum about 45% from January to April (BBS, 2000).

3.4: Study population

The necessary data for this experiment was collected from 48 Rhesus monkeys in the National zoo. The monkey are parted with 2 troop. Each troop contain 24 number of monkey.

3.5: Age of the study population

The monkeys are used for this research that are above 3years and above 4 years of age.

Table 2: Age and ratio of male and female Rhesus monkey

Cage	No of monkey	Age of the monkey	Ratio
Cage 1	24	>4years	Male: Female- 1:3
Cage 2	24	>5yaers	Male: Female- 1:3

3.6: Space requirement for the population

We have provided sufficient space for monkey because its possibly effect on their health, feeding and production. In several time we noted that monkey are those type of animal which need to free space for their natural movement.

Table 3: Space Requirement for Rhesus Monkey

Types of measurement	Area
Length of the total experimental cage	110ft
Width of the total experimental cage	32ft
Height of the total experimental cage	24ft
Area of the total experimental cage	96600cft
Space per monkey	1932 cft

3.7: Feeds and feeding

This part covered the following aspects-

- ❋ Feed sources
- ❋ Water sources
- ❋ Supplemental feeding and
- ❋ Seasonal effect on feed intake

3.8: Feed Requirements

Feeding time is one of the most important moments for monkey in a day. The type of ingredient depends on the species. For most Monkeys fruit is the primary food that they consume. They often spread seeds too from the fruits as they move along. Feeding is a very important aspect of the social life for Monkeys too.

When food is plentiful they are usually timid and get along well within their groups. A scarcity of food can create high levels of stress.

Sometimes the groups that are large will have to break down into smaller ones. That will allow them to venture out and to find food so that they can survive. Some of the monkeys will get on the ground and eat dirt if there is absolutely no food for them to consume. Mating will come to a halt as well when there isn't adequate food supplies. We provided several types of fruits, bread and vegetable also. Balance diet is very essential to monkey for proper growth and sound health. But we have little change the food item for follow difference of their health condition and breeding performance.

Photograph-5: Food preparation for Rhesus monkey at Bangladesh National Zoo.

Photograph-6: Feeding management of monkey at Bangladesh National Zoo.

Table 4: Item of food supplied daily per monkey (Cage 1)

No of component	Amount (gm)
Boiled egg	50
Bread	90
Banana	900
Apple	90
Papaya	100
Pine apple	100
Ground nut	15
Cucumber	150
Gram	30

But we have little change the feed ingredient for following their health condition and breeding performance. We have replace pine apple by mango and added citrus food as orange for selected experiment monkey of cage no.2

Table 5: Item of food supplied daily per monkey (Cage 2)

No of component	Amount (gm)
Boiled egg	50
Bread	90
Banana	900
Apple	90
Papaya	100
Mango	200
Citrus food (Orange)	120
Ground nut	15
Cucumber	150
Gram	30

3.9: Production profile

This part covered mainly the following aspects-

- ❋ Birth weight of male and female
- ❋ Weaning weight of male
- ❋ Weaning weight of female
- ❋ Length of estrous

- ❋ Breeding performance
- ❋ Gestation length and
- ❋ Sex ratio

3.10: Troop management

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

Photograph-7: Structural design of Rhesus monkey cage of Bangladesh National Zoo, Mirpur, Dhaka.

3.10.1: Exhibit/Enclosure Design

There are no EAPA spatial requirements set in NSW for ungulates in the captive environment. Monkey are a flighty animal and need a large flight distance. The exhibit should have tall fences with a perimeters fencing.

3.10.2: Holding Area Design

In designing holding yards for monkey there are factors to be considered:

- A design that be easy to separate into small groups or individuals with many pen areas.
- Monkey like to move around the whole area.
- Ideally the main area should have concrete floors that are sloped to allow drainage and ease of cleaning.
- A set of scales is essential and can often be incorporated into a crush.
- The design must provide adequate ventilation and air movement without drafts.
- The design must allow adequate lighting.
- The site should have electric power and running water.
- Gate latches should be designed to minimize opportunity for injury to stock.

3.10.3: Position of Enclosures

The position of the enclosure is front side of the zoo because primates have stress absorbing capacity. They are not frightened when the visitor comes near to the enclosure.

3.10.4: Weather Protection

The enclosure needs to have a safety isolated area for the monkey to retreat in poor weather.

3.10.5: Enclosure Furnishings

Enclosure furnished with long chain link cage which are about 110ft length, 32 ft width and 24ft Height.

3.11: General Husbandry

3.11.1: Hygiene and Cleaning

Daily cleaning tasks:

- Spot cleaning feces
- Cleaning drinking water trough.

- Removing old browse and left over foods

Weekly cleaning tasks:

- Complete change of waste material

Monthly cleaning tasks:

- Scrub any cement areas

Half yearly

- New substrate – mulching

Cleaning agents suitable:

Animal house washed by 5% bleaching agent overall and chain link area.

Photograph-8: Cleaned Rhesus monkey cage of Bangladesh National Zoo, Mirpur, Dhaka.

3.11.2: Pest control

Pest control boxes should be placed in areas around enclosure and checked weekly and are refilled any pest removed. Disposing of pests – follow intuitions procedure. Taranga's – all dead animals are to be taken to VQC for post mod

3.11.3: Record Keeping

All animals should be individually identifiable, with the use of coloured or numbered ear tags. Each animal should have its own file which contains the following information:

- ✓ Identification numbers or tags of animals
- ✓ ARKS number
- ✓ 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 behaviours 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) is used by zoo's in the Australasian region and information is available to all zoo's. Information such as age, parents, genetics are available.

3.12: Routine Data Collection

Most information is on monkey management. Some of this information does work for monkey in captive intuition. There have many studies on monkey and its management. Information that may be acquired for long term studies include

- Weights/growth – development charts
- Contraception/genes/parenting behaviors
- Blood biochemistry

3.13. Rhesus Monkey Available at Bangladesh National Zoo

Table 6: Number of Rhesus Monkey at the zoo

Month	Male	Female	Died	Total
July	47	41	1	87
August	47	40	-	87
September	47	40	2	85

3.14: Reproduction

Females reach puberty around age three while males are sexually mature by age four (Rawlins & Kessler, 1986b). The ovarian cycle lasts for 28 days and is characterized by the darkening of the skin surrounding the anogenital region accompanied by menstruation (Catchpole & van Wagenen, 1975). Estrus lasts for eight to 12 days, with the day of ovulation occurring at the midpoint of the estrus period. Females have increased sexual activity during ovulation, exhibiting the highest number of copulations seen during the ovarian cycle (Fooden, 2000). Females reproduce from three until about 10 years of age (Rawlins & Kessler, 1986b). Males reach puberty between three and 4 years of age but do not reach adult body size until about eight

years old (Dixson & Nevison, 1997; Bercovitch et al; 2003). Though males are capable of reproducing by age four, they are not reproductively successful until after age eight, or when they reach adult size. During this time between becoming sexually mature and when they begin to mate, young rhesus macaques are learning the social skills, including fighting ability, that will influence their success throughout their lives (Bercovitch et al; 2003). Both males and females reach sexual maturity sooner in captivity (Catchpole & van Wagenen, 1975).

3.14.1: Reproduction and selection

The current reproduction system may be defined as a controlled, single-sire and natural mating.

3.14.2: Mating system (polygynous)

The breeding season (rut) of Rhesus monkey takes place from October through December. Following the breeding season there is a 165 day gestation period, with births in February and April. (Whitehead, 1993)

3.14.3: Controlled mating

The researcher knows precisely when the male will mate the female because he separates the sexes outside the appropriate time.

3.14.4: Single –sire mating

The researcher knows precisely which monkey is the parents of each baby monkey.

3.14.5: Natural mating

No artificial reproduction for the time being

3.14.6: Parental investment

Precocial, pre-fertilization (provisioning, protecting: female) pre-hatching/birth(provisioning female protecting: female) pre-weaning/fledging(provisioning female protecting: female)

3.14.7: Lifespan/Longevity

It is not known how long monkey live. Related Rhesus monkey can live a maximum of 30 years in the wild and 26 years in captivity (Animal diversity web).

3.14.8: Key Reproductive Features

Table 7: Reproductive feature of Rhesus Monkey

Breeding interval	Breeding season	Range number of offspring	Average number of offspring	Average gestation period
Rhesus Monkey breed once yearly	Breeding occurs in October to December	1-4	1	165 days

3.15: Health Management

Health indicators Information from routine health management, including coat and body condition as well as physical values such as longevity, growth rate, susceptibility to disease, reproduction and infant care, individual nutritional requirements and wound healing, can be used to assess the welfare of macaques.

It is not possible to provide a complete summary of health management requirements in this fact sheet. Contact a veterinarian for answers to specific questions. A reference list for further reading is provided in this fact sheet.

One key component of troop management is disease control. It is the responsibility of each researcher to manage his animals in such a manner that they are found healthy and in good condition because it makes the animals more resistant to infections and disease.

Prevention of disease is better than any possible cure. It is important to establish a good working relationship with a veterinarian. Together, the researcher and the veterinarian can work out a program tailored for any individual place to control disease and to maximize the health and productivity of animals.

Well-fed animals, with minimum stress during handling will be healthier and more disease-resistant. The causes of diseases can be categorized as:

3.15.1: Viral Disease

- **Rabies**

Rabies in primate is rarely reported in various country and with one exception has always occurred in animals that were recently imported from rabies endemic areas. The one exception occurred after a dog bit.

- **Simian Immunodeficiency Virus (SIV)**

SIV is closely related to HIV-1 and HIV-2 (causes of AIDS) and causes an AIDS-like illness in macaque monkeys; it may be asymptomatic in other species. There have been no reports of human illness, but there are research workers who developed antibodies to SIV after handling laboratory specimens.

- **Ebola disease (Filoviruses)**

The Ebola viruses from the Sudan and Zaire have not been isolated from monkeys. A different Ebola virus was discovered in 1995 in West Africa Chimpanzees when a researcher became infected. The Ebola virus that caused an outbreak in a Reston, Virginia monkey quarantine facility, did not cause illness in any humans, but four animal handlers developed antibodies to the virus. These incidents remind us of the potential for as yet undiscovered human pathogens to be introduced by wild caught monkeys.

3.15.2: Bacterial disease

- **Tuberculosis**

Primates are very susceptible to infection from Mycobacteria tuberculosis (TB) and can Contract it from humans or other animals. Primates from environments where human TB is prevalent are at greatest risk for having the disease. Clinical signs are not a reliable indication of the severity of tuberculosis in monkeys. A monkey that appears healthy may have extensive miliary disease involving thoracic and abdominal organs; signs of debilitation may appear only shortly before death. However, advanced tuberculosis should be suspected in animals that cough; lose appetite or weight; and/or have enlarged or draining lymph nodes, skin wounds that

fail to heal, or abdominal masses. Illegally imported monkeys and those raised and sold as pets in the US may not be appropriately tested and could be infected.

- **Pneumonia**

Upper respiratory diseases of bacterial origin can cause widespread illness, and bacterial pneumonia is associated with increased mortality, particularly in newly imported or immature nonhuman primates. Causative agents include Streptococcus pneumoniae, pneumoniae, Bordetella, bronchiseptica, Haemophilus influenzae, and various species of streptococci, staphylococci, and pasteurellae. Infant primates are highly susceptible to cross-species transfer from people Pneumonia may accompany or follow other primary diseases (eg, dysentery or respiratory viral infection). Clinical signs may include coughing, sneezing, dyspnea, mucoid or mucopurulent nasal discharge, pyrexia, lethargy, anorexia, and weight loss.

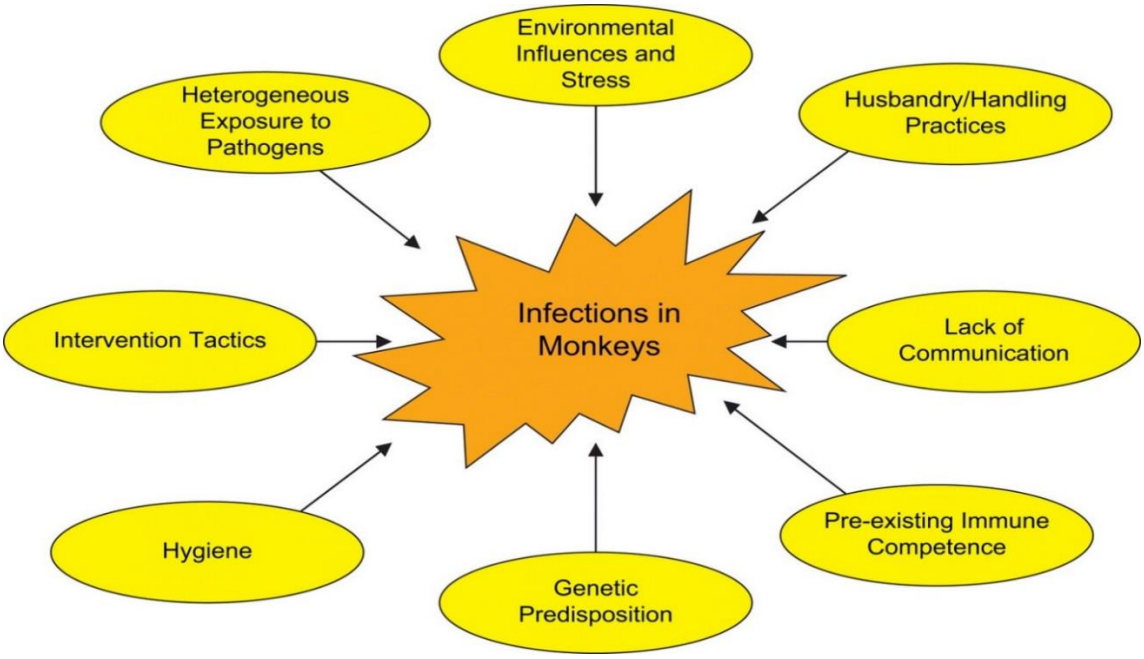


Figure-1: Factors contributing to variable rates of bacterial infection in monkeys and correlation to human risk assessment.

3.15.3: Parasitic disease

Non-human primates are also susceptible to parasitic infections from other animals and humans, although they are not the primary host. These usually do cause disease and may be more difficult to diagnose and treat. Parasites may influence their hosts in different ways. They may cause the death of the host due to a direct lethal effect or an indirect effect. Direct lethal effects may occur if killing is a part of the life cycle of the parasite or if hosts and parasites have not developed an equilibrium. Parasites may also influence the behaviour of their hosts. If the hosts are intermediate hosts in the life cycle of the parasites, the alterations in behavior may make them an easier prey for their predators, the final hosts.

Table 8: Common parasitic disease of Monkey

Disease	Agent	Location of host	Transmission	Diagnosis
Stomach worm	Physaloptera	Stomach	Oral, intermediate host: cockroach	Fecal flotation, repeated
Hydatid disease	Echinococcus, Taenia	Muscle, organs, body cavities (aberrant host)	Canid host, ingestion ova from feces	Radiography, ultrasound, aspiration
Toxoplasmosis	Toxoplasma gondii	Systemic, multiple organs, nervous system	Ingestion ova from feline feces	Serology, cerebrospinal fluid tap, histopathologic examination
Filariasis	Dipetalonema (presumed)	Peripheral blood	Bite from mosquito	Blood smear
Cerebral larval migrans	Baylisasaris procyonis	Brain	Ingestion of ova from raccoon feces	Usually postmortem histologic examination of brain

3.15.4: Fungal Infection

- **Cutaneous mycosis**

Mycoses that cause superficial infections of the epidermis, hair, and nails, are called cutaneous mycoses**.** Its very common fungal disease in primates family caused by Trichophyton, Epidermophyton, and Microsporum. Tineas on most areas of the body are generally called ringworm.

- **Alopecia**

Alopecia, or hair loss, is common among captive nonhuman primates. While the exact welfare implications of alopecia are not clear, its high prevalence is of concern to behavioral managers, veterinarians and regulatory agencies. Several factors have been implicated as contributing to alopecia including compromised immune function, dermatological pathologies, and environmental factors.

Helminth and Protozoal Disease:

Protozoan infections are parasitic diseases caused by organisms formerly classified in the Kingdom Protozoa. Protozoa are among the most important causes of disease in Non-human primates.

Table 9: Common helminth and protozoal disease of Monkey

Disease	Agent	Location of host	Transmission	Species
Entamoeba	Entamoeba histolytica	Intestine	eggs hatching in intestine	Rhesus macaques, squirrel monkeys
Cryptosporidium	Cryptosporidium Sp	Intestine	Indirect, snail ingestion	Macaques
Balantidium	Balantidium coli	Human liver fluke	Indirect, snail ingestion	Macaques
Giardia	Giardia lamblia	small intestine/ jejunum	Direct ingestion	All

3.16: Disease that we found at the Zoo

1) Bacterial Pneumonia
2) Enteritis
3) Giardiasis
4) Stomach worm infection
5) Ascariasis
6) Cutaneous mycosis
7) Dermatitis
8) Alopecia

3.17: Tuberculin Test

- **Procedure:**

The TB skin test is also called the Mantoux tuberculin skin test (TST). A TB skin test requires two visits with a health care provider.

- The TB skin test is performed by injecting a small amount (01ml) of fluid (called tuberculin) into the skin on the lower part of the arm of Monkey.
- A person given the tuberculin skin test must return within 48 to 72 hours to have a trained health care worker look for a reaction on the arm.

- **Result:**

The result depends on the size of the raised, hard area or swelling.

Positive skin test:

If the swelling in large size in the body, this means the Animal was infected with TB bacteria. Additional tests are needed to determine if the person has latent TB infection or TB disease.

Negative skin test: If there is no swelling in body where injected, this means the animal body did not react to the test, and that latent TB infection or TB disease is not likely.

We are performed tuberculin (TB) Test of the study 48 monkey but we got negative result of all. That means the monkey with in the zoo are completely free from tuberculosis disease.

3.18 General appearance of Rhesus Monkey at zoo

Health Condition:

Information from routine health management body condition as well as physical values such as growth rate, susceptibility to disease, reproduction and infant care, their activities show that they so much active and due to supply a balance diet their appearance are increase redoubtable.

Movement:

It is notable that they are much cautious about each other and their movement is cerebral. They are always hang up with the fence, around the fence they make auspicious environment movement is just like affable to each other.

Coat Color:

The rhesus macaque is brown or grey in color and has a pink face. Male are darker the female. The hairy part are brown to blackish glossy in appearance.

Production Rate:

The production rate is constant in that period. Only one or more infant are produce birth during the consequent pregnancy period. Assume that November to January they are delivered the infant. Typically a single infant is born, usually at night. At 4 weeks infant weight is around 0.65 kg (rhesus), and by 6 weeks the infant is able to move independently and starts to explore away from the mother. Nutritional weaning begins gradually at 4 months.

Mortality rate:

No monkey are found dead in that experimental period.

3.19 Statistical analysis:

The results were presented as the means and the standard deviation of the means. Data were statistically analyzed by one- way analysis of variance (ANOVA) using the compare means procedure (SPSS 7.5., 1999 software for windows, SPSS Inc., Chicago, IL, USA). $p<0.05$ will be considered to be statistically significant

3.20 Daily troop management Schedule

Table- 10: Schedule of day to day operations on Rhesus Monkey premises

Approximate time(hours)	Research work operations
7.00 – 9.00 A.M Schedule of daily working premises on Rhesus monkey shed	➢ Cheek all fences of monkeys shed. ➢ Count the total numbers of monkey and adjust previous numbers ➢ Find out if any mortality occurred ➢ Clean out the dumping wastage material such as banana ,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 shed premises
9.00-12.0 A.M	➢ Supply all the feed supplement in one time daily allocated for the monkeys ➢ Isolation of sick monkey ➢ Treating sick monkey
12.00-3.00 P.M	➢ Lunch-cum-rest period for attendants
3.00-4.00 P.M	➢ Miscellaneous jobs such as, periodical vaccinations, Repair of shed fences, Fittings and repair of equipment, weekly scrubbing and white washing of drinking water tank.
4.00 P.M —7.00A.M	➢ A night security person respective on duty.

Signature of
Concerned Zoo

Officer

CHAPTER-IV

RESULTS AND DISCUSSION

The results of following parameters such as feeds and feeding, production and reproduction profile of troop. Management practices have been presented in this chapter.

4.1: Protein and Calorie Requirements of Rhesus monkey from supplied Food

Table 11 Protein and calorie of supplied food (cage 1)

No of component	Protein(gm/day)	Calorie(Kcal/day)
Boiled egg	6.3	155
Bread	4	214.28
Banana	9.81	901.1
Apple	0.26	52
Papaya	0.47	43
Pine apple	0.54	75
Ground nut	1.2	85
Cucumber	1.30	32
Gram	2.9	165
Total	26.78	1722.38

Table 12: Protein and calorie of supplied food (cage 2)

No of component	Protein(gm/day)	Calorie(Kcal/day)
Boiled egg	6.3	155
Bread	4	214.28
Banana	9.81	901.1
Apple	0.26	52
Papaya	0.47	43
Mango	1.65	120
Ground nut	1.2	85
Cucumber	1.30	32
Gram	2.9	165
Orange	0.94	47
Total	27.89	1814.28

Calorie requirements of infant to adult rhesus monkeys for weight maintenance,growth, and reproduction have not been determined and it is doubtful,except under the most highly standardized conditions, whether this would be possible. The observation shows that restriction of monkey calorie need for 500gm body weigt monkey need 150kcal/day. It is well known that expression of

food intake data on a per kg basis instead of metabolic body size may lead to highly variable results, especially in comparing small to large animals, or those with different body composition (Brody, 1945; Ausman et al; 1972, 1981). In addition, animal activity, markedly influenced by cage size, socialization, and other factors, will affect the calorie needs of the animal.

Although juveniles and adults could be maintained on diets containing a minimum of 8-9% protein (as percent of calories), doubling this amount would allow for individual variance, stress, illness, pregnancy, or other mediating factors. Thus, it has been our practice to maintain nonpregnant animals on dietscontaining approximately 18% protein (as percent of calories). Protein requirement for 500gm/day body weight monkey is 2.17gm/day. (Kerr, 1972; Ausman et al; 1979; Ausman and Gallina, 1979).

The food chart we mentioned experiment to the for study monkey maintain this above this requirement. The protein we supplied is 22.19% as percent of calories cage (1) and 23.39% as percent of calories cage (2). Age of the experiment monkey is above 4 years and all are adult and average weight is 6kg of age. That's why they need 150×12= 1800kcal/day and 2.17×12=26.04gm/day.

We fulfill the protein and calorie requirement, at this observation period we supplied per day 26.78gm protein, 1722.38kcal calorie for cage (1) Rhesus monkey and 27.89gm protein, 1814.28kcal calorie for cage (2) Rhesus monkey.

4.2: Prevalence Rate

Prevalence is the proportion of persons in a population who have a particular disease or attribute at a specified point in time or over a specified period of time.

$$\text{Prevalence rate} = \frac{\text{Number of affected animal}}{\text{Number of animal}} \times 100$$

Table 13: Affected Rhesus monkey with infectious disease

Name of the Disease	Number of affected monkey Cage (1)	Number of affected monkey Cage (2)
Tuberculosis	_	_
Pneumonia	1	_
Stomach worm	1	1
Giardia	1	1
Ascariasis	1	1
Enteritis	-	1
Cutaneous mycosis	2	-
Dermatitis	1	
Alopecia	1	1
Total	8	5

Prevalence rate cage (1): 8/24×100= 33.33%

Prevalence rate cage (2): 5/24×100= 20.83%

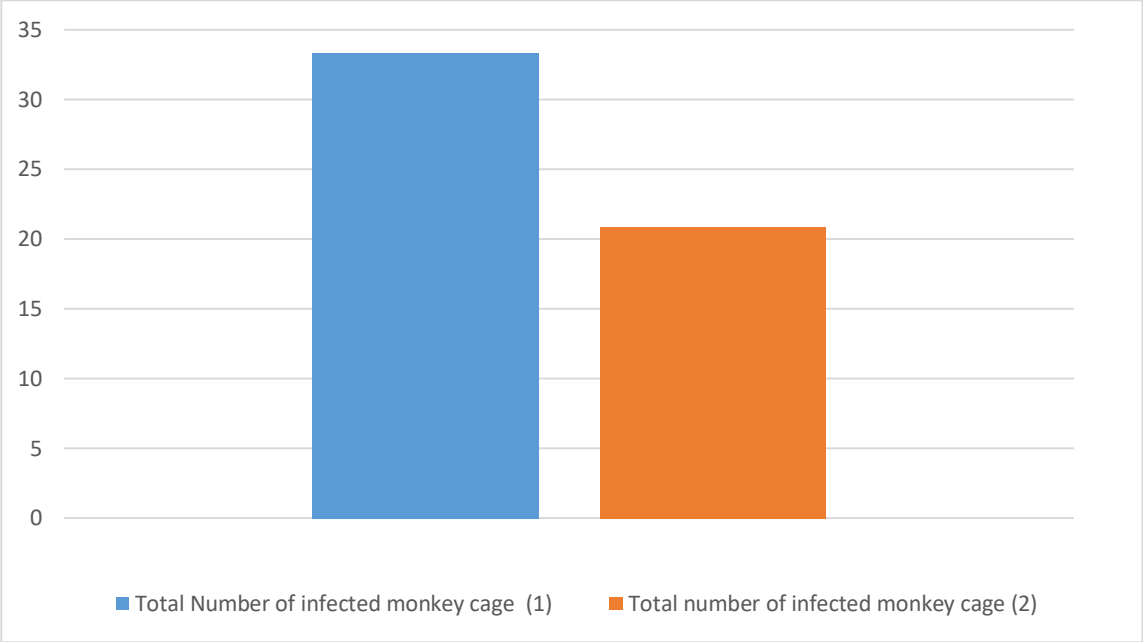


Figure-2: Graphical presentation on prevalence rate of Rhesus monkey at Bangladesh National Zoo.

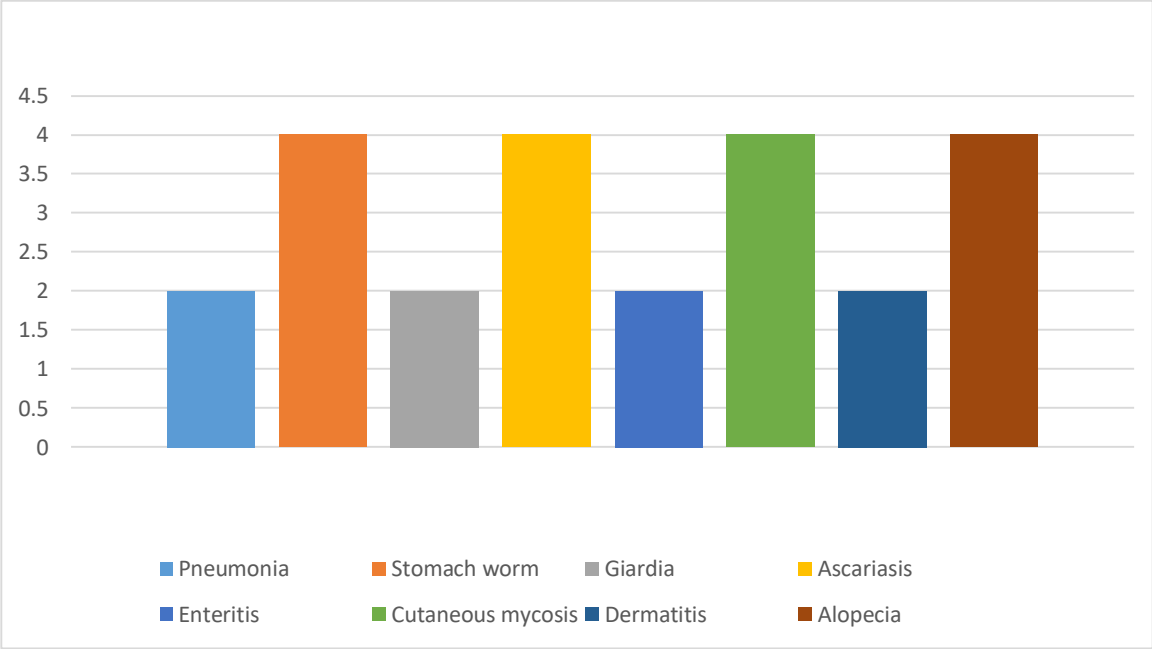


Figure-3: Graphical presentation on Disease rate of experiment Rhesus monkey at Bangladesh National Zoo

The pathogens that can be passed from nonhuman primates include bacteria, fungi, parasites, and viruses. They may be spread by bites, scratches, handling animals or their tissues, airborne transmission of aerosols and droplets, ingestion, and arthropod vectors. We maintain the animal so preventive measures that's why the infection rate in first cage is 33.33% in 1st cage and 20.83% in 2nd cage. There is some difference between in diet consumption. In the 2nd cage we provide them extra food mango and orange. Mango contain lots dietary fiber, vitamin A,C,K,B5, potassium, copper and orange contain vitamin C,B12,sugar,protein,potassium that are gets extra benefit and protection to disease. Both vitamin C and citric acid can increase body's absorption of iron from the digestive tract. We have also found that the disease rate of monkey where monkey affected with pneumonia 2%, stomach worm 4%, giardia 4%, ascariasis 4%, enteritis 2%, cutaneous mycosis 4%, dermatitis 2%, alopecia 4%. The rate of disease is constant with parasite and fungal infection. The infection of virus is totally free. Bacteria are also in less amount of infection is 4.16% only, the parasitic infection rate is 12.5% and fungal infection rate is high 14.58%. Fungal infection are associated with several factor vitamin deficiency, fighting, environment etc. Fungal is much sensitive disease then other.

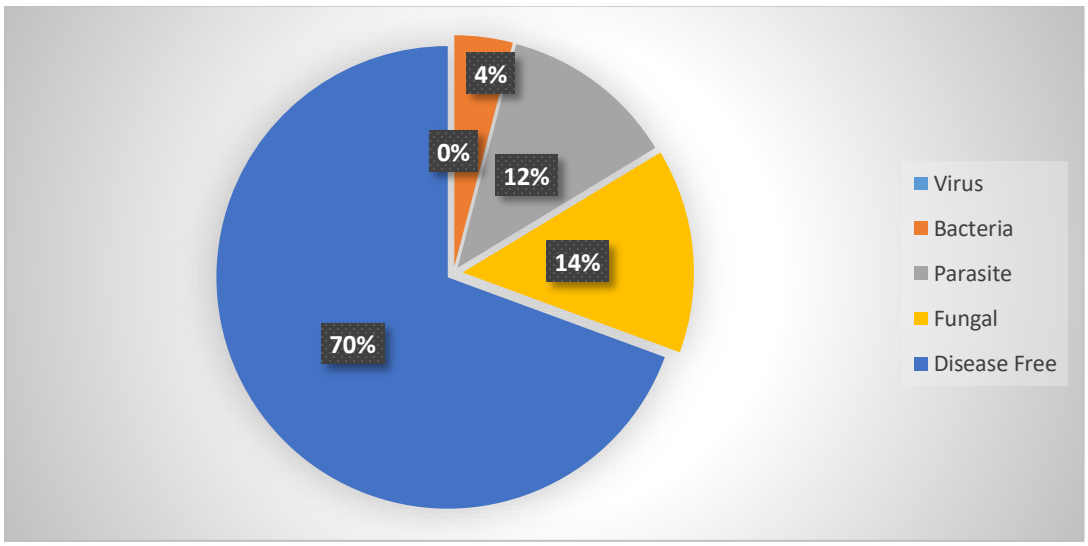


Figure-4: Graphical presentation on present Disease status of Rhesus monkey

4.4: Reproduction profile of Rhesus monkey

4.4.1: Body weight of Rhesus monkey at Bangladesh National zoo

Table 14: Body weight of Rhesus monkey at Bangladesh National zoo

Traits	No of animal	Mean	Standard error of mean (SEM)	Standard deviation(SD)
Male birth weight(kg)	**10**	**0.325**	**0.17**	**0.57**
Female birth weight(kg)	**10**	**0.296**	**0.17**	**0.55**
Adult male weight	**12**	**7.53**	**2.17**	**8.40**
Adult female weight(Kg)	**36**	**5.97**	**1.60**	**6.24**
Meal weaning weight(Kg)	**10**	**1.10**	**0.60**	**2.96**
Female weaning weight(Kg)	**10**	**1.01**	**0.22**	**2.40**

Body weight of Rhesus monkey at BN Zoo is presented in table 4.4.1. The average birth weight of males and females were 0.325±0.17 kg and 0.296±0.17 kg. In the present study, the adult males and females weights were 7.53±2.17 kg and 5.97± 1.70 kg respectively. Table showed that the average males and females weaning weights were 1.10±0.60kg and 18.49±0.22 kg respectively.

4.4.2Mortality Rate

$$\text{Prevalence rate} = \frac{\text{Number of died animal}}{\text{Number of animal}} \times 100$$

Total 48 number of animal we observed and only 3 of them are died, that means mortality rate was 6.25%

4.4.3: Reproduction profile (cage-1)

Table 14: Reproductive performance of monkey (cage 1) at Bangladesh National Zoo, Mirpur, Dhaka.

Traits	Number of monkey	Mean	Standard error of mean (SEM)	Standard deviation (SD)	Maximum	Minimum
Length of estrus (Days)	18	26.9	0.36	1.30	29.8	24.4
Gestation period (Days)	18	157.10	0.85	4.45	164.4	148.8

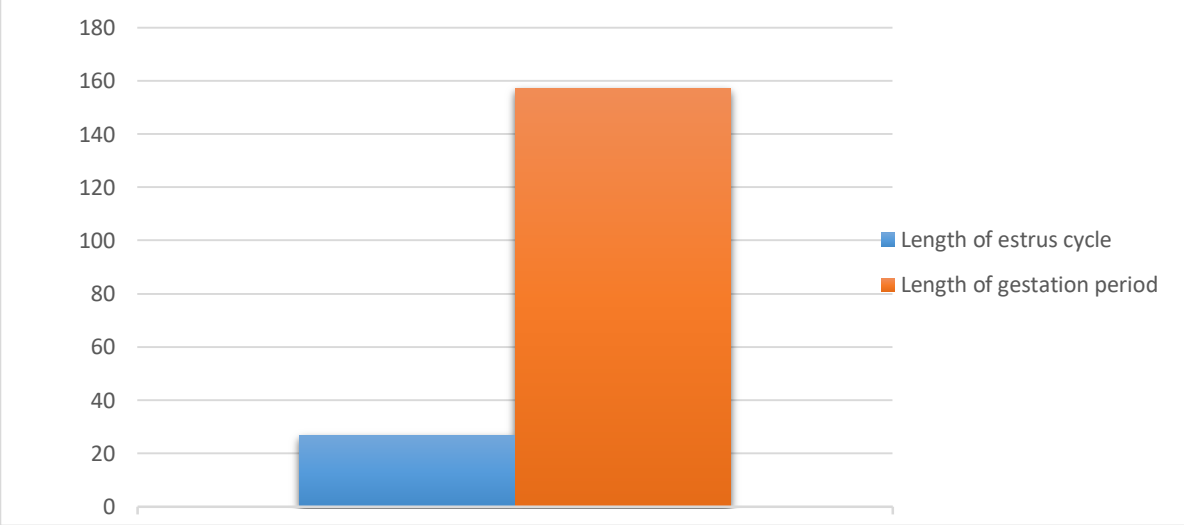


Figure -5: Graphical presentation on Reproductive performance of (cage 1) Rhesus monkey at Bangladesh National Zoo, Mirpur, Dhaka

4.4.4: Reproduction profile (cage-2)

Table 15: Reproductive performance of monkey (cage 2) at Bangladesh National Zoo, Mirpur, Dhaka.

Traits	Numner of monkey	Mean	Standard error of mean (SEM)	Standard deviation (SD)	Maximum	Minimum
Length of estrus (Days)	18	29.8	0.44	1.73	32.7	27.8
Gestation period (Days)	18	164.5	0.74	3.27	169.3	156.9

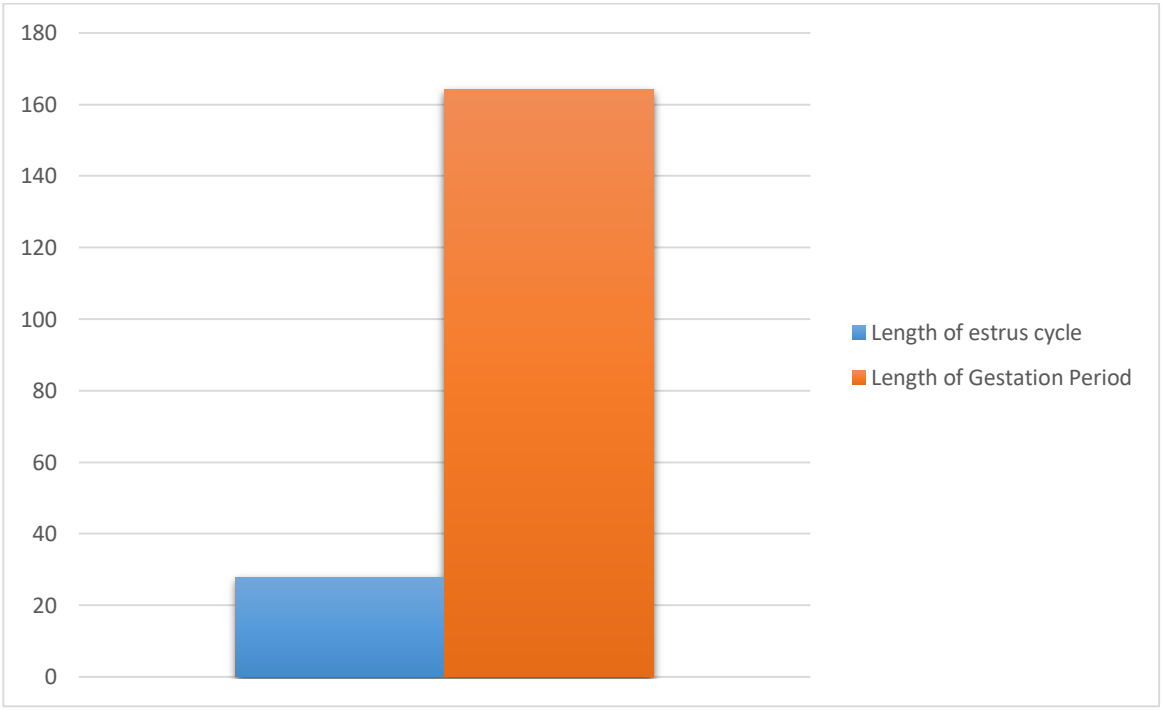


Figure-6: Graphical presentation on Reproductive performance of (cage 2) Rhesus monkey at Bangladesh National Zoo, Mirpur, Dhaka

In the present study of Cage(1) , the average length of estrous cycle was 26.9±0.36 day. The highest and lowest lengths of estrous cycle were 29.8 day and 24.4 day respectively.

The average length of estrous cycle was 29.8±0.44 day of Cage(2). The highest and lowest lengths of estrous cycle were 32.7.8 day and 27.8 day respectively.

Females reach puberty around age three while males are sexually mature by age four (Rawlins & Kessler 1986b). The ovarian cycle lasts for 27-30 days and is characterized by the darkening of the skin surrounding the anogenital region accompanied by menstruation (Catchpole & van Wagenen, 1975). Estrus lasts for eight to 12 days, with the day of ovulation occurring at the midpoint of the estrus period. Females have increased sexual activity during ovulation, exhibiting the highest number of copulations seen during the ovarian cycle (Fooden, 2000). Females reproduce from three until about 20 years of age (Rawlins & Kessler, 1986b).

From the Table 14 showed that the average duration of gestation length was 157.10 days for cage(1). The highest and lowest lengths of gestation period were 164.4days and 148.8 days.

From the Table 15 showed that average duration of gestation length 164.5 days for Cage(2). The highest and lowest lengths of gestation period were 169.3 days and 156.9 days.

Information about approximately 700 pregnancies that resulted in spontaneous vaginal deliveries of live born young is presented. The average length of these pregnancies was 166.5 days (Hrdy and Whitten, 1987).

CHAPTER-V

SUMMARY AND CONCLUSION

The study was conducted at the Bangladesh National Zoo, Mirpur, Dhaka, to find and evaluate the following parameters such as feeds and feeding, production profile and troop management of monkey (Rhesus) from june 15th to august 15th 2019 for a period of 3 months. The collected data were compiled, tabulated and analyzed systematically.

The supplied food fulfill the requirement of the proper calorie and protein. The ration contain protein 26.78gm/day, calorie 1722.38kcal/day for (cage1) and protein 27.89gm/day, calorie 1814.28kcal/day for (cage2). Where as the average requirement of protein for adult monkey is 26.04gm/day and 1800 kcal/day . Now we could say that we fulfill the experimental monkeys feeding component. The appearance of their body condition, coat color, movement are redoubtable for proper care.

The disease prevalence rate of monkey cage(1) is 33.33% and cage(2) 20.89%. There was much difference of this rate because of supplied extra food mango and orange in cage(2).This small amount of food can supply extra nutrient that can improve immunity for the cage(2) monkey. Overall the 4.18% of monkey were infected by bacteria, 12.5% of monkey are infected by parasite and 14.89% of monkey were infected by fungal disease. That's why we say that the parasite and fungal effect are auspicious for monkey but we must take extra care about fungal disease.

The average length of estrous cycle was 26.9 day for 1st cage and 29.8 days for 2nd cage. The average age at estrus was 27-30 days. The average duration of gestation length was 157.10 days for 1st cage and 164.5 days for 2nd cage. The gestation period

is 3-4 months of age and average is 166.5days. The estrus cycle and gestation period is maintain in control.

We observe that there is a small difference between two cages in case of estrus cycle and gestation period. Because of there is change of feeding and also age difference between two cages. The 1st cage monkey are above 4 years of age and 2nd cage monkey are above 5 years of age that's why the difference we get. The cage(1) monkeys were just initial stage of estrus cycle where cage (2) monkeys were adapted with it.

From the above results it might be say that supplied balanced nutritive food along with the management system for Rhesus Monkey at the Zoo is well.

If we supplied this type of ration that can promote healthy monkey production as well as infant. It will also help contribute to our national economy. It is concluded that if recommended rations could be fed with proper management procedures the balanced nutritive conditions along with productive and reproductive well-being may achieved of the Rhesus Monkey at Bangladesh National Zoo.

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APPENDICES

Appendix 1: Disease status of Rhesus monkey at National Zoo

Name of the disease	Number of affected animal	Percentage of infectious disease (%)
Virus	0	0
Bacteria	1	4.16
Parasite	5	12.5
Fungal	7	14.58
Total	13	70.89

Total Number of Rhesus Monkey = 48

Total Number of Affected Monkey= 13

Disease free Monkey= 35

Disease Free Monkey in Percentage = 70

Appendix 2 : Data Collected During Research work for (Cage 1)

Reproduction Traits Cage (1)

Traits	**Monkey**																
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**XIII**	**XIV**	**XV**	**XVI**	**XVII**	**XVIII**
Length estrous (Day)	25.2	27.8	24.6	25.3	28.3	27.5	27.3	24.8	24.4	29.8	29.2	26.3	26.9	27.4	29.5	25.6	26.5	28.8
Gestation length (Days)	148.8	159.5	154.9	155.4	158.9	155.3	150.2	153.8	164.4	161.8	156.7	154.3	151.4	155.4	160.4	158.3	160.9	156.7

Appendix 3 : Data Collected During Research work for (Cage 2)

Reproduction Traits Cage (2)

Traits	**Monkey**																	
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**XIII**	**XIV**	**XV**	**XVI**	**XVII**	**XVIII**
Length estrous (Day)	28.9	30.5	32.7	29.4	27.8	30.9	29.2	28.4	31.5	30.8	27.9	31.7	28.5	30.6	27.9	29.6	29.8	30.3
Gestation length (Days)	160.7	169.3	161.7	163.4	157.4	164.5	161.8	162.2	158.1	163.5	159.7	156.9	167.1	164.2	166.2	159.5	163.3	159.9