HAND REARING OF WILD MAMMALS IN CAPTIVITY




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NANDANKANAN BIOLOGICAL PARK, ODISHA

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PREFACE

Recognition of Zoo Rules, 2009 emphasizes the need of 'Nursery for Hand Rearing of Animal Babies' in recognized zoos. Zoos in India also function as Rescue Centres for rehabilitation of many orphaned wild infants. Many Indian zoos have hand reared wild animals in different situations with varied success rate. However documentation of such experiences is far from desired level.

The authors have attempted to compile information on more than 50 case reports of hand rearing on 25 species of mammals in Indian condition. Information on general hand rearing processes including initial care, dietary requirements, general husbandry, sanitation and common health problems encountered are also discussed in addition to the case reports. This publication is a result of an extensive literature survey, gathering of data recorded during hand rearing of different mammals at Nandankanan Zoological Park and collection of information on hand rearing of mammals carried out at some other Indian zoos.

The book is a humble effort to disseminate the learning during hand rearing of wild animals under Indian conditions. The authors hope this book will be an important tool for wildlife conservationists, zoo managers, biologists and veterinarians. The authors have given their best possible efforts to bring out details correctly. Suggestions from readers are also invited for further enrichment and improvement of this book and same may be communicated to the publisher in the address given on the back cover.

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FOREWORD

Nandankanan Biological Park is the only large zoo of our state Odisha. Since its inception on 29th December 1960, it has been progressively emerging as centre for *ex-situ* conservation, education and research. As a premier large zoo of India, it has spearheaded in many significant improvements to provide highest standards of housing, husbandry and health care to captive wild animals. It has immensely contributed towards enriching our knowledge on biology of endangered species. Nandankanan has also served as a centre for rehabilitation for many orphaned/injured wild mammals of the state, many of them received as young and successfully hand reared. The book has presented many examples of the same.

The publication titled '**Hand rearing of wild mammals in captivity**' being released on the occasion of the celebration of "Wildlife Week-2019" on 4th October 2019 is an attempt to bridge the information gap for rehabilitation of orphaned wild animals. The authors have attempted to document hand rearing cases of 25 mammals in Indian zoos.

The efforts taken by Nandankanan Biological Park to document these studies are indeed praiseworthy. I am sure the book will help generating awareness and compassion for wildlife among readers. It will also highlight the need for protection and conservation of these enigmatic species.

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GOVERNMENT OF INDIA
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MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
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Central Zoo Authority
केन्द्रीय चिड़ियाघर प्राधिकरण

MESSAGE

The Central Zoo Authority (CZA) is a Statutory Body of Ministry of Environment, Forest and Climate Change, Government of India constituted in the year 1992 under provision of the Wildlife (Protection) Act, 1972 to oversee the functioning of zoos in India. It is facilitating the improvement and management of the zoos in the country since its inception.

The National Zoo Policy, 1998 stated in one of its objectives that, the zoos shall continue to function as rescue centres for orphaned wild animals, subject to the availability of appropriate housing and upkeep infrastructure, supporting their rehabilitation and conservation when they have no chance of survival if left as such. Recognition Zoo Rules, 2009, made under Wildlife (Protection) Act, 1972 emphasizes the need of nursery for hand rearing of animal babies in recognized zoos.

Hand rearing mammals is probably more art than it is science. Very less information is available on the subject as these incidences are less frequent and rarely reported. Besides, the procedure of rearing may vary with location, condition and resource available. The CZA as a part of its endeavor for scientific management of zoos in the country, published 'Standardization of Animal Diet in Indian Zoos' in collaboration with Indian Veterinary Research Institute. It includes a Chapter on hand rearing of orphan neonates.

The publication titled 'Hand Rearing of Wild Mammals in Captivity' is an attempt to compile valuable information on the need, procedure and skill required for hand rearing in case of emergencies with case reports of infant mammals in Indian zoos. I am sure that this handbook will be an important reference source for the managers of the Indian zoos in rehabilitation of rescued or orphaned infants. I appreciate the hard work done by the authors in compiling the information for this publication.

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Authors

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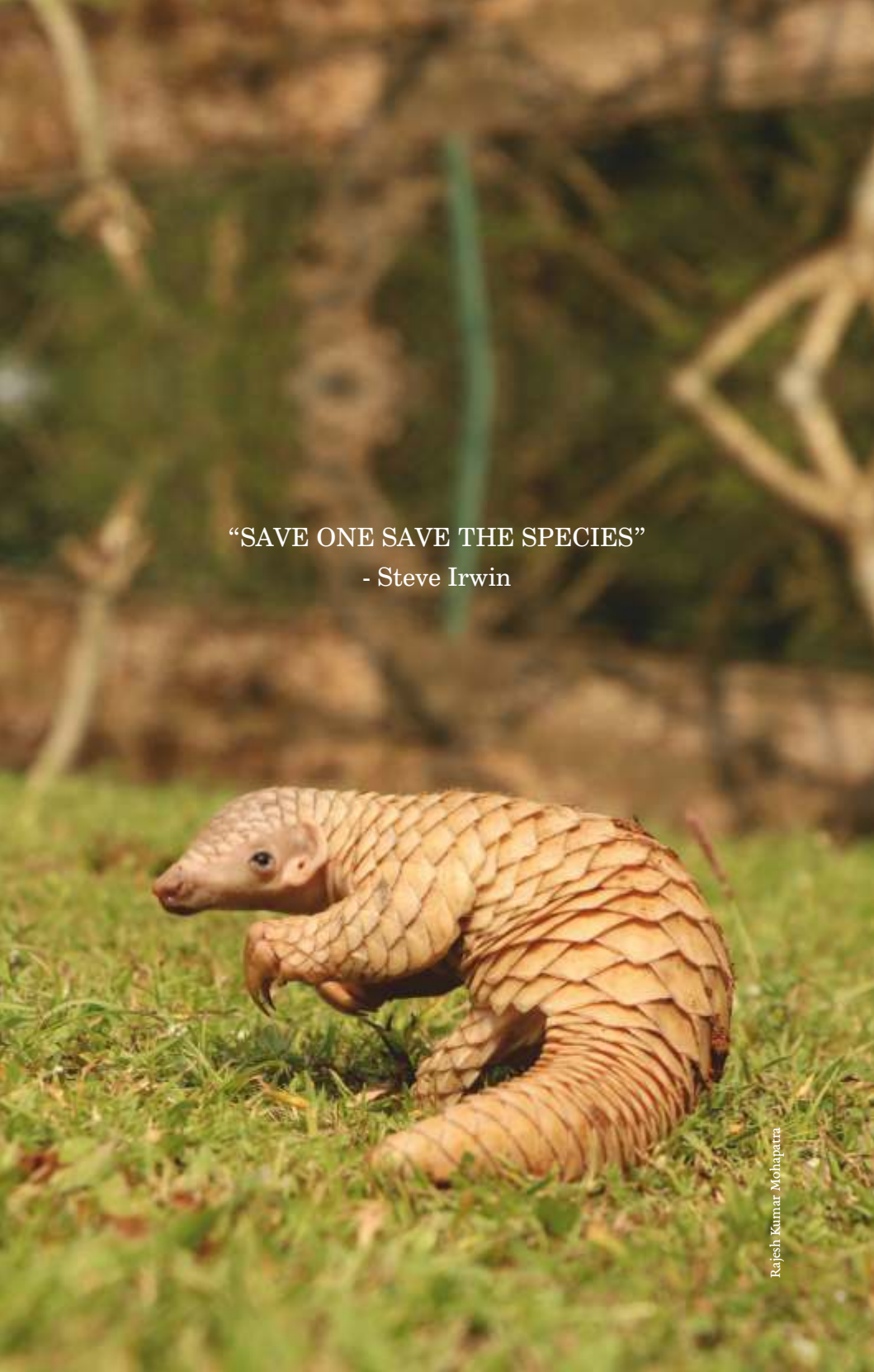
“SAVE ONE SAVE THE SPECIES”
- Steve Irwin
Rajesh Kumar Mohapatra

Introduction

Mammals are among the most interesting classes of vertebrates since it includes many familiar domesticated species, charismatic wild animals as well as our own species *Homo sapiens*. There are 5488 distinct mammals in the class Mammalia (Menon, 2014). All Mammals share some common characteristics which distinguish them from other animals. These characters include the presence of hair, mammary glands, a hinged jaw, external ears and three tiny middle ear bones. Mammals are found in every continent in a wide variety of habitats ranging from dense forests, deserts, deep seas, highest mountains, tropics and polar ice caps. There is a high variability in their size ranges from tiny bumblebee bats to giant blue whales. They are among the most adaptable animals, some live on land (terrestrial) some live in water (aquatic) and some even fly (aerial). Most of the mammals are warm-blooded i.e., they maintain a constant body temperature (naked mole is an exception to this). Based on their feeding habits, they can be grouped into carnivore (feed on flesh), herbivore (feed on plant matters) and omnivore (feed on both).

Only mammals can feed their young with milk produced by their mammary glands. The female may have two mammary glands or as many as a dozen or more. Being highly nutritious and immediately available, mammalian milk provides key nourishment as well as immunity to infant which helps to fight against infections and diseases. Some of the mother's antibodies cross placenta and enter the blood circulation of the offspring, but most antibodies are provided in the first milk or colostrum.

Most of the Indian zoos exhibit one or more species of native or exotic mammals. Zoos play a crucial role in *ex-situ* conservation, education and research. Zoos often receive rescued and injured animals including young mammals and serves as a centre for rehabilitation. The 'Recognition of Zoo Rules, 2009' emphasizes the need of 'nursery for hand rearing of animal babies' in the recognized zoos to support their rearing and rehabilitation during emergencies.

Need of Hand Rearing

Infants may require hand rearing on death of their mother, in poor mothering ability that occurs with primiparous mammals (mammals with first litter) that do not rear or take care of their infants properly. Also, discovery of orphan, feral, sick and injured or rescued animal babies need intervention if they fail to be with their mother. There is no “right way” to successfully raise any species like their mother. The orphaned or rescued babies should be tried first for reintroduction to its mother failing which hand rearing may be resorted to as the ultimate step. Hand rearing is intended to keep and look after the young by someone other than its mother. The goal of hand rearing is for saving the vulnerable newborns and infants those can't be taken care of by their mother. It requires a lot of time, effort and patience. The period of rearing may include late night feeding activities for many days by dedicated care takers. Hand rearing practice generally includes some basic arrangement like provision of sanitation, warm environment, a suitable feeding regimen, attention to excretions (emptying of the bowels) and general health. Success in hand rearing is varied and may not be specific to any standard protocol followed.

Hand reared hyena cub playing with wooden ball at Nandankanan zoo.

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Alternatives to Hand Rearing

There is a need to hand rear the infants in case of death of mother, maternal abuse, neglect or illness. There are some alternatives to hand rearing. There are cases of reintroduction of infants to their biological mother after a short period of hand rearing, e.g. Keiter et al. (1983) in orangutan and Wilson (1993) in aardvark. In one case, an infant giant panda was reintroduced to its mother after observing maternal response towards a stuffed panda toy soaked with infant's urine that was presented before mother for several weeks (Zhang et al., 2000). At times, it is possible to give supplementary feed to the infants without breaking their mother-infant bond i.e., mother can be trained to tolerate infant feeding sessions by care taker (Fortaine, 1979) and/or infants can be trained to approach a caretaker for feeding in presence of their mother (Thompson et al., 2010). At Nandankanan Biological Park/ Nandankanan Zoological Park, Bhubaneswar (Nandankanan zoo) in two instances, one in 2016 and another in 2018, two weak Nilgai fawns were provided with supplemental feed for a few days after birth without removing from mother for hand rearing. They responded well to this gradually by become active and started suckling from their mother. During April, 2018 one jackal cub was provided with supplemental feed without removing from its mother. In absence of the real mother to feed the infants, an alternative is to provide a lactating foster mother of same or related species e.g. a bitch for the tiger cub rearing (Sharma and Singh, 2008). The risk of injury to infant and the intervention by zoo staff always need to be evaluated before practicing any reintroduction or supplemental feeding .

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Supplemental feeding at Nandankanan zoo: A) Jackal cub under supplemental feeding, B) Nilgai fawn became active after supplemental feeding (the fawn standing away from mother).

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Hand reared elephants playing in a water pool at Nandankanan zoo.

Biological and Behavioural Considerations

Information on the biology of the species is crucial for its hand rearing. Each taxon has some physiological and anatomical uniqueness which may be considered while rearing and taking care. Knowing their breeding season, body measurement at birth, growth rate, behaviour and tooth eruption help to predict the age of the infant in some mammals and also in selecting a suitable diet for its rearing.

Infants usually have limited strength to maintain their constant body temperature. Therefore, they cling to the body of their mothers or other group members for obtaining additional heat. Hence, while hand rearing, a suitable environment need to be created to facilitate maintenance of constant body temperature of infant by artificial heat source such as by incubator, heating lamp, heating pad or surrogate companion. A digital thermometer with a minimum-maximum temperature alarm may be used to ensure suitable temperature and heat source be adjusted accordingly. The heat source should preferably be placed on the outside of the cage or have towels wrapped around it to prevent the animal from coming into direct contact. The zone of coverage of the heat source should partly cover the resting area of the infant so that it can seek for a

cooler zone in need. Ear suckling was observed among littermates kept in the same box and this could be due to the instinct of sucking their mothers' teat (Matthew, 1990). At times, such behaviour become injurious and warrants segregation. Mother licks the infants body parts to stimulate blood circulation, bowel movement and the ano-genital region to facilitate defaecation and urination (Alexander, 1988). The same can be stimulated by gentle massage in anogenital region by cotton cloth soaked in lukewarm water.

The primary objective of hand rearing is to keep the infant alive. The major emphasis to keep the hand reared animals in a sterile and sanitary environment often lead to a socially isolated environment, if the behavioural aspects are not looked into. Provision to play, display of species specific behaviour, socialization opportunities with adult groups promote their physical and psychological well-being. During the process of hand rearing different behavioural and biological aspects of infants e.g. tooth eruption, growth rate etc. can be recorded, which commonly go unnoticed when reared by mother. These information prove vital in captive management of these animals.

Young animals sleep a lot, at times they get asleep while feeding. The care taker should be able to distinguish between weakness and sleep. An animal's best indicator of well being is its appetite. If the infant is accepting proper food and taking rest, then it may be considered as healthy. The infant should be provided with undisturbed time to rest and uninterrupted sleep to grow and develop its natural instincts.

Suckling of body part of littermate observed in hand reared individuals when housed in group.

Initial Care and Stabilization

The initial care depends on whether the neonate/young has been removed from or rejected by its mother. The latter will require physical check up for any bleeding, breathing difficulties, broken bones, hyperthermia, hypothermia, parasites and shock or injuries. After given first aid, veterinary assistance should be sought right away.

Neonatal mammals are very susceptible to hypothermia. Rapid warming of these animals may result in fatal metabolic changes. It is important to note that, warming the animal exacerbates dehydration. Fluid therapy should be considered after warming. If the animal requires more than oral hydration, subcutaneous or intravenous injections of a balanced electrolyte solution (lactated Ringer's or normal saline) can be used as per the prescription of veterinarians. If the animal is weak and hypoglycemic, dextrose in lactated Ringer's solution (LRS) may be substituted.

It is important for neonate to receive colostrum during first 24 hours of birth as this is the main period when antibodies are absorbed from the gut into the blood circulation and protect the infant from infectious diseases. If not received, its immunity is seriously compromised and chance of survival is greatly reduced (Das et al., 2013). Care required for infants deprived of colostrum are discussed in detail in 'Common health problems' section.

Sarat Kumar Sahu

Emaciated elephant calf received for hand rearing.

Physical examination of elephant calf on receipt at Nandankanan zoo.

Physical examination

There is a need to physically examine the infant on receipt. The infant should be checked for external injury, hydration status, body temperature and response to handling. Puncture wounds from animal bites may be difficult to locate in hairy mammals and are frequently fatal. Infection of rabies virus should be considered as a contaminant of bite wound unless the neonate is bitten by a known vaccinated animal. Body fluids and faecal matter need to be collected for examination.

Nursing Procedure

Infant mammals feed on mother's milk. As hand rearing deals with the infants not under maternal care, there is limited chance to provide mother's milk. Therefore, a suitable milk replacement in form of reconstituted milk or foster mother is used for rearing.

Knowledge of milk composition of the species or taxon gives proper information to choose appropriate milk replacement for hand rearing. The milk-replacement formula should be as close as possible to the natural milk composition of the species. Excesses of fat or sugar may cause diarrhoea. Animals with milk low in lactose only produce small amounts of lactase to digest the milk. If high-lactose milk, such as cow milk, is fed to such animals, severe gastro-intestinal problems and diarrhoea may occur (Fraser et al., 1991; Gage, 2002).

Fat globule size should also be considered while selecting the replacement formula. Even though elephant milk contains two times higher fat than cow milk, elephant calf cannot tolerate cow milk because of the fat droplet size of elephant milk is much smaller than that of cow milk. In addition, predominant fatty acids in elephant milk are capric acid and lauric acid (32%) which is only 5% in case of cow milk. Palmitic acid and stearic acid are predominant fatty acid in cow milk (Das et al., 2013). Excess protein also causes bacterial overgrowth and kidney problem (Trendler, 2005). There are instances, where cow milk was used with varied dilution to successfully rear leopard, jackal, lagomorphs, giraffe (Dhoot et al., 2000, 2003; Mohodaya,1990a; Ashraf et al., 1997; Khadri and Valandikar, 2002) in spite of the difference to its natural milk composition. However, to obtain best results, infants should be fed with formula similar to mother's milk.

Probiotic, vitamin, mineral and calcium supplementation should be used whenever possible but never in excess. Calculation of feeding formula and frequency of feeding are given in the 'Recommendation' section in detail. Milk composition of some mammals in Indian zoos and some domestic mammals whose milk are used for hand rearing are given in Table 1.

Table 1. Milk composition of some mammalian species.

S.N.	Species	Solids%	Fat%	Protein%	Carbohydrate%
01.	Red kangaroo[a]	24.1	6.1	7.2	-
02.	Red necked wallaby[a]	25	7.2	6.8	10.9
03.	Brown lemur[a]	9.6	0.9	1.3	8.5
04.	Ruffed lemur[a]	14	3.2	4.2	7.7
05.	Slow loris[a]	16.3	7	3.9	6.6
06.	Red slender loris[b]	16.5	7.9	4.0	7.1
07.	Golden lion tamrin[a]	19.4	10.2	3	6.8
08.	Tufted capuchin[c]	16.48	5.22	2.40	6.94
09.	Common squirrel monkey[d]	-	5.1	3.5	6.3
10.	Common marmoset[e]	12.7	2.3	2.2	8.0
11.	Crab eating macaque[f]	12.2	5.2	1.6	-
12.	Rhesus macaque[g]	15.2	5.4	1.8	7.5
13.	Chimpanzee[h]	11.8	2.2	0.9	7.4
14.	White handed gibbon[i]	-	2.4	1.3	8.3
15.	Baboon[a]	14	4.5	1.5	7.8
16.	Cheetah[j]	23.7	9.5	9.4	3.5
17.	Leopard[k]	-	6.5	11.1	4.2
18.	African lion[a]	26.8	8.7	11.8	3.2
19.	Cat[a]	-	10.8	10.6	3.7
20.	Dog[a]	22.7	2.5	7.5	3.8
21.	Wolf[l]	23.4	9.6	92	3.4
22.	Jackal[l]	24.7	10.5	10.0	3.0
23.	Red fox[a]	18.1	5.8	6.7	4.6
24.	Otter[m]	-	24	11	0.1
25.	Brown bear[a]	31.9	17.1	9.2	2.2
26.	Black bear[a]	37.6	25.1	7.0	3.0
27.	Asian elephant[a]	17.7	7.5	4.5	5.2
28.	African elephant[a]	17.3	5.0	4.0	5.3
29.	Himalayan thar[a]	-	7.9	5.4	3.1
30.	Goat[m]	-	3.8-4.08	3.71-3.8	2.9-4.3
31.	Cow[m]	-	3.7	3.2-3.3	4.6-4.8
32.	Asian water buffalo[m]	-	6.5	4.3	4.9

33.	Blackbuck [n]	20.5	9.3	6.9	4.3
34.	Chinkara [l]	36.1	19.0	12.4	3.3
35.	White rhinoceros [o]	-	7.4	16.2	76
36.	Indian rhinoceros [p]	9.81	1.4	1.39	7.6
37.	Black rhinoceros [a]	8.8	0.2	1.4	6.6
38.	Mountain zebra [q]	10.0	1.02	1.6	6.9
39.	Plains zebra [q]	11.3	2.2	1.6	7.0
40.	Asiatic wild ass [q]	10.8	1.8	1.7	5.9
41.	Giraffe [r]	22.9	12.5	5.8	3.4
42.	European brown hare [a]	32.5	15.6	10.0	1.5

Data from the following sources:

a-Oftedal and Iverson (1995), b-Tilden and Oftedal (1997), c-Milligan (2010), d-Buss and Cooper (1972), e-Power et al. (2008), f-Nishikawa et al. (1976), g-Hinde (2007), h-Milligan (2007), i-Osthoff et al. (2009), j-Grant (2005), k-Livers (1973), l-Das et al. (2013), m-Trendler (2005), n-Dill et al. (1972), o-Osthoff et al. (2008), p-Nath et al. (1993), q-Oftedal and Jenness (1988) and r-Aschaffenburg et al. (1962)

Milk replacers represent a great advance in zoo husbandry techniques. Prior to their introduction, a mixture of one part of evaporated milk and two parts of water were the standard diet, varied in specified cases, for hand-rearing mammals in zoos (Crandell, 1964). Now there are several commercial brands of milk replacers available to meet the specific needs of different mammals (Table 2).

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Feeding bottles/accessories for hand rearing.

Table 2. Composition of commercially available milk replacers (Manufacturer's information).

S.N.	Brand name	Fat (%)	Protein (%)	Carbohydrate (%)	Water
1	Pet lac kitten milk replacer	18	33	Not mentioned	-
2	Petlac puppy milk replacer	28	29	Not mentioned	-
3	KMR kitten milk replacer	25	42	Not mentioned	-
4	Royal canin baby cat milk	39	33	18.5	-
5	Royal canin baby dog milk	39	33	18.5	-
6	Esbilac puppy milk replacer	40	33	16	-
7	Fawnlac deer milk replacer	30	29	Not mentioned	-
8	Lactogen 1	23	10.5	59.5	-
9	Lactogen 2	19.5	14.2	59.3	-
10	Cerelac	9	15	67	-
11	Amulspray milk powder	18	22	68	-
12	Beaphar lactol puppy milk	24	24	Not mentioned	-
13	KMR liquid	4.5	7.5	4.5	82
14	Esbilac liquid	6	4.5	3.4	85

Materials required for hand rearing:

All materials to be used for hand rearing should be clean and disinfected.

I) Feeding bottle: For preparation of the feed and to feed the animal. Feeding tube/dropper may be used wherever necessary. The bottle should be of appropriate size with suitable nipple.

ii) Towels/wipe: Used for wrapping, mopping and bedding.

iii) Enrichment item: As a provision to exhibit naturalistic behaviour and fulfillment of biological needs.

iv) Heating equipment: For thermoregulation.

v) Thermos flask: To keep hot water for many uses like feed preparation, cleaning etc.

vi) Thermometer: Ambient temperature should be monitored closely as overheating may be fatal and under-heating may cause problem. An internal and an external thermometer are good to monitor the temperature without disturbing and stressing the animal.

vii) Weighing balance: To weigh the animal regularly.

viii) Measuring cylinder: For taking measurement of liquids.

ix) Apron, mask and gloves: To prevent transmission of zoonotic and other diseases.

x) Disinfectant/Sanitizer: For sanitation of the hand rearing enclosure and also cleanliness in handling.

xi) Register: To record details of hand rearing.

While feeding, the infant should be allowed to rest in the cradle of caretaker's arm at about a 45-degree angle. The nipple may be placed gently into the infant's mouth. Rubbing its chin will stimulate it to take the nipple if it doesn't accept initially. It will probably have several short suckling spurts of a few seconds each during each feeding for the first week. It is important to allow the infant to have rest periods for a few minutes between the suckling attempts until it develops a strong suckling reflex. Before feeding, infant should be massaged around its ano-genital area with a cotton ball moistened with lukewarm water in order to stimulate urination and defaecation.

Housing: Infants under hand rearing need to be housed in well ventilated, hygienic and secure place free from disturbances. For neonates, the enclosure may be of plastic, wooden or cardboard boxes with a cut out entry hole or commercially available plastic pet houses with Igloo-type gate. The floor may be covered with newspaper, dressing gauze sheet or napkins for easy cleaning and disposal. Depending on the species, their size and growth rate, the animal should be transferred to a bigger cage or enclosure to provide more space. In case of cages, the wire mesh size should be suitably small. Part of the floor area may be covered with bedding material to provide a resting area. The housing area should be easily cleaned and with good access for feeding and treatment. It should have provision for external heat source if the animal is young, weak and not thermoregulating well. Once the animal started drinking consistently, handling of the animal should be made to its minimum. If group housing creates problem like infighting, suckling of body parts of litter mates, then cubs should be housed individually.

Rajesh Kumar Mohapatra

Housing hand reared: A. Lion cub in wooden box. B. Igloo box for marmoset.

Provision for exposure to the sunlight should be made for the infants under hand rearing as it helps in synthesis of the Vitamin-D in their body. Exposure to harsh sunlight or exposure for longer duration should be avoided.

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Morning sun exposure to hand reared bonnet macaque and sloth bear at Nandankanan zoo.

Sanitation and waste disposal

Hygiene and sanitation are crucial for successful hand rearing. Personal hygiene of the care taker is also important and need to be assessed before engaging him/her in the hand rearing activity. If the care taker has domestic animals at home then he/she should take precaution in this regard as there is a potential risk of infection and disease transmission. The utensils, feeding bottle and their nipples used for preparation of feed and feeding the infants need to be cleaned before and after every feeding with warm water and mild detergent.

The objective of cleaning is to remove harmful substances from the surface. Water with increased temperature and addition of proper cleaning agents give a better result. The cleaning agent should have water softening properties, be quickly and completely dissolved in water, non-corrosive, non toxic, stable and do not produce dust in storage and use. The purpose of disinfection is to kill pathogens and reduce their number below the infecting level. Heat is a non selective killer which acts by inactivating the protein of the microorganism. Proper disposal of leftover feed, solid and liquid waste including faecal material of the hand reared animal in regular basis significantly reduce the rate of pathogen proliferation.

Common Health Problems

During the process of hand rearing of an infant mammal one may come across with some health problems summarized below. These problems need to be addressed promptly with sincere efforts, as a little delay can prove detrimental to the life of these infants.

1. Gastro-intestinal disturbances: Common signs of gastro-intestinal disturbances are diarrhoea, constipation, reduced feed consumption, dullness, bloated or distended abdomen. The causes behind these problems may be due to:

- Consumption of inappropriate milk formula/ excess consumption of milk/ sudden change in milk formula.
- Non maintenance of proper hygiene or cleanliness of feeding bottle and utensils which leads to bacterial, viral, fungal or parasitic infections.

To reduce risk of development of gastro-intestinal disorders, it is recommended that before starting the selected milk formula, infant may be fed with electrolyte solution at least for the first feed followed by a gradual change over to the selected milk formula. Also, any essential change in milk formula or introduction of a new diet be done gradually. At least one feed of electrolyte solution should be given between two different formulations.

2. Aspiration pneumonia: Aspiration pneumonia frequently follows inhalation or aspiration of milk. The foreign matter (milk) causes inflammation of lungs. Common signs of aspiration pneumonia are wheezing or coughing, rapid breathing, difficulty in breathing, rapid heart rate, dullness, lethargy, fever etc. The causes behind this condition may be due to:

- Inappropriate feeding technique/ wrong nipple size and inexperienced care taker.

There is an increased risk of aspiration during first few feeds, as an orphan infant which has already suckled its mother, will resist to accept artificial teat in place of mother's nipple. It takes a few attempts to get accustomed to the feeding bottle and care taker. Hence to reduce the risk, it is suggested to give oral electrolyte solution or 10% glucose solution for initial 1 or 2 feeds rather than milk formula.

3. Hypothermia and Hyperthermia: Hypothermia (chilling) is not uncommon among orphaned infants rescued in winter months. If deserted for a long period, non-feeding will reduce body temperature (hypothermia). This will further predispose to disinclination to feed

that can lead to a cycle of deterioration in health condition and the infant may soon go to recumbency. In hypothermia, fast heating of the body should be avoided as it may prove fatal due to further desiccation leading to dehydration. Slow intravenous administration of luke warm fluid along with provision of external heat can raise the body temperature.

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Different health and management issues during hand rearing. A. Diarrhoea, B. dehydration C. human imprinting, D. Anal stimulation with lukeworm water E. X-ray examination for diagnosis.

Similarly, hyperthermia (overheating) poses a particular risk for very young infants which are unable to regulate their body temperature efficiently.

Hence to deal with extreme weather conditions, the rearing box or cell should contain one thermometer to record maximum and minimum temperatures daily.

4. Human imprinting: Some orphaned infants develop extreme inclination towards its care taker during the process of hand rearing. This may lead to serious behavioural difficulties and an inability of the animal to interact normally with members of its own species. Such incorrectly imprinted individuals are often become unsuitable for release into the wild or use in breeding programme.

To avoid such type of strong bonding between the infant and the care taker, handling of the infants should be restricted to its minimum. The duty of the caretaker be limited only to feeding the infant, cleaning and sanitation of the box/cell.

5. Suckling/ biting on litter mates: In case where a litter (with more than one infant) is rescued and hand reared together, the infants may suckle the ears, tail and penis of each other and this misdirected behaviour may cause injury to the stated organs which in turn get infected. These vices can be avoided only by continuous monitoring and immediate intervention e.g. segregation and individual housing.

6. Infants deprived of mother's colostrum: Orphaned infants prematurely separated from their dam may not have received adequate colostrum. Thus they have a risk associated with reduced immunity to infectious diseases. To gain the passive immunity in such infants, it is possible to milk the mother to feed colostrum to infant in some non-ferocious animals (Das et al., 2013). Also, intravenous serum transfusion from an adult of the same species can be used as a substitute for providing antibodies (see case report of lion hand rearing of Kanpur zoo). Alternatively, fresh or frozen colostrum (e.g. cow's or goat's colostrum) may be used as a substitute for natural colostrum intake. Commercial colostrum substitutes and immuno-stimulants available in the market may also be used as viable options.

Record Keeping

Good record keeping is vital for the success of hand rearing activity. Date and time of receipt/procurement and location from where the infant was collected i.e., rescued from the wild or from captive mother, need to be recorded. Exact date if date of birth is known or approximate age at the time of receipt are also important as the feed is prescribed to the infant accordingly. Keeping records of body temperature is necessary.

Body weight and measurement are the most important aspect of keeping records, because it helps to determine the growth rate; gain or loss of weight. Besides, health record describing interventions, schedule of activities for the day and feeding patterns need to be recorded. Observation on excreta with respect to consistency needs to be noted on a daily basis as any deviation gives indication to stomach upset or other clinical conditions. Periodic faecal examinations should be done for parasitic load. The natural orifices of animals should be observed daily to detect respiratory and gastrointestinal disorders.

Measuring body weight elephant calf under hand rearing.

Case Reports

Zoos also serve as centres for rehabilitation for many orphaned infants. Many Indian zoos have hand reared variety of wild animals in different situations with varied success rate. Unsuccessful cases of hand rearing are rarely published. Besides, published case reports on successful hand rearing practices also scanty and some reports are with limited information on details of dietary husbandry, growth rate etc. Sound knowledge on biological parameters like morphology, distributional range, age at first reproduction, litter size, neonatal measurements and weaning are crucial for hand rearing of animal(s) as these help identification of species, estimation of age of the rescued/seized infants received for rearing. A note on species biology with case reports on hand rearing of different mammalian species carried out in India, is briefly described.

Common marmoset,
Nandankanan Zoological Park.

Rajesh Kumar Mohapatra

Indian Mammals

Rajesh Kumar Mohapatra

Sloth bear, Nandankanan Zoological Park.

Tiger

Tiger (*Panthera tigris*) is an endangered species belonging to the family: Felidae. In India tigers are distributed along the Terai foothills of the Himalayas, North-East India, Central India, Eastern Ghats and the Western Ghats including the Nilgiri plateau (Menon, 2014). The female and male tiger become sexually mature at the age of 3 and 4 years, respectively (Acharjyo and Misra, 1975a). They breed throughout the year. Singh et al. (2013) reported the mean age at first reproduction (impregnation leading to cubs) as 51.3±4.5 months in wild. The litter size usually varies from 1-5 (Acharjyo and Mishra, 1985). Cubs measured 49-58 cm tip to tip in length and 0.920kg to 1.45kg in weight at birth (Acharjyo and Misra, 1972a). Eyes were closed at birth and opened between 7-12th day (Acharjyo and Mishra, 1985).

MC Zoological Park, Chhatbir: A day-old white tiger cub was hand reared after maternal rejection at MC Zoological Park, Chhatbir, Punjab in 2007 (Sharma and Singh, 2008). It was fed with goat milk in a feeder bottle (initially 4 times with 35ml each that gradually increased to 50ml as the cub grew) and changed to milk of a bitch (the foster mother for the cub) twice a day. As the cub was deprived of colostrum, an antibacterial drug containing Trimethoprim 40mg and

Mother tigress holding cub from nape, Nandankanan zoo.

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Sulphamethoxazole 200mg/5ml were fed to ward off any possible infection. Besides the feed was supplemented with vitamin, gripe water and calcium, intermittently. The cub started accepting chicken soup from 67th day and on completion of 12 weeks, it started accepting chunks of boiled chicken, mutton and buffalo meat in subsequent stages (Sharma and Singh, 2008). The tiger cub was housed in wooden box floored with foam and blanket in an ambient room temperature around 28°C. The cub measured 23.5"(59.69cm) in length from tip to tip and weighed 1.400kg on 7th day, 2'6" (76.2cm) in length and 3.840kg on 2 months of age and 2'10" (86.36cm) and 5.710kg at about 3 months of age.

Nawab Wazid Ali Shah Prani Udyan, Lucknow: A pair of rescued wild tiger cubs (one male and one female) were hand reared at Lucknow zoo in 1989 (Shukla, 1990). The cubs were abandoned by their mother due to human interference. The cubs were fed 6 times a day with goat milk diluted in a ratio of 1:1 with water for 6 days, then in 2:1 ratio for 4 days and pure milk of 1/20th of body weight, thereafter. The feed was supplemented with vitamins, minerals and protein. Minced liver (100g) was given at the age of 2 months in addition to the milk. The cub started accepting half boiled goat meat (1/10th of body weight) from 5 ½ months onwards. Subsequently, it started accepting boiled buffalo meat and raw buffalo meat at the age of 7 months. On receipt (approximately about age of 1 month) the female and male cub weighed 3.5kg and 3.3kg, respectively. At about 2 months of age they weighed 4.5kg and 4.1kg, respectively. After 1 ½ months of hand rearing the female cub became sick and died. The male cub weighed 11.5kg at 5 months of age and 34.5kg at 10 months of age.

Nandankanan Zoological Park, Bhubaneswar: One tiger cub was hand reared at Nandankanan zoo during January, 2018 after maternal rejection. The tiger cub was fed with 'Royal Canin baby dog milk' reconstituted in its recommended dilution (i.e., 10g in 20ml of lukewarm water) at the rate of 240ml per day divided in 12 feeds at 2 hours interval, which is increased to 360ml, 600ml, 700ml, 800ml and 900ml per day on third day, one month, 2nd month, 3rd month and 4th month of hand rearing, respectively. From 2nd month onwards number of feeding was reduced to 10 feeds per day avoiding night feeding. Solid food (Royal Canin starter feed) at the rate of 50g per day was introduced in 3rd month of rearing which was replaced by minced chicken meat in 4th month. After introduction of minced chicken meat, milk feed was reduced gradually to 600ml per day divided in 6 feedings. Milk diet was completely discontinued from

10th month of rearing. A multivitamin liquid preparation was added to the milk. Immunization of the cub was done against feline rhinotracheitis, calici, panleukopenia and rabies with killed multivalent vaccine (Biofel-PCHR; Bioveta, Czech Republic) administered subcutaneously at 8 weeks of age followed by boosters on 12th week, 16th week, 6months and then annually. As a preventive measure against Trypanosomiasis, the cub was administered with chemoprohylactic drug (Triquin; Vetoquinol, India) at the age of 7months which was repeated in every 4months interval.

The cub weighed 1410g, 1740g, 2150g, 2810g at 1st, 2nd, 3rd and 4th week of age, respectively. As the cub grew, it weighed 5320g, 9750g, 12500g, 14570g, 18420g during 2nd, 3rd, 4th, 5th and 7th month of age, respectively.

Milan Kumar Panda

Hand rearing of tiger cub at Nandankanan zoo.

National Zoological Park, New Delhi: One male tiger cub of 1.449kg and one female cub of 1.300kg weight and about one week of age were hand reared at Delhi zoo following maternal rejection and incidences of injury during May, 1964 (Husain, 1966). The hand rearing formula consisted of a mixture of powdered milk, lime water, multivitamin drops, antibiotic and hot water. Initially, the cubs were fed 1 oz (~30ml) every four hours, between 09:00 hours and 22:30 hours. Besides, the cubs were suckling from a lactating goat between 17:30 and 20:00 hours. From second week chicken essence was added to the milk formula. From 4th week they started accepting 2.5 to 3 oz of

milk feed and suckling from goat three times daily. Besides, egg yolk and calcium supplements were added to the milk feed. During 9th week the cubs started receiving 150g of goat meat and the suckling of goat milk reduced to once a day. Suckling from goat was stopped at four months of age, when each cub ate 1kg of goat meat. The male and female cub weighed 9.04kg and 6.94kg, respectively on four months of age.

Sri Chamarajendra Zoological Garden, Mysore: One white tiger cub was hand reared during 1991 at Sri Chamarajendra Zoological Garden, Mysore due to maternal rejection and cannibalism instances (Mugdur, 1991). The cub was fed with goat milk (50ml each) in six feedings per day. Milk was supplemented with multivitamins. Feed was subsequently increased to 150ml at about 1 ½ month of age. The cub weighed 4.75kg at 46 days of age.

Another rescued tiger cub of an estimated age of 2½ months was received on 28.10.2008 in critical condition at Mysore zoo. It was hand reared with reconstituted milk and beef.

Photo courtesy: Mysore zoo.

Hand reared tiger cub at Mysore zoo.

Lion

Lions (*Panthera leo*) are large carnivorous mammals belonging to the family: Felidae. Lions are the most social among the big cats and live in groups, called pride. African lions inhabit the Savannah grasslands. However, Asiatic lions are found in the dry deciduous forests located in the Gir National Park, Gujarat, India. Lions have no fixed breeding season although higher parturition rate have been recorded between February and July in Africa and between January and February in India (Prater, 2005).They have a gestation period of 100-120 days. Estrus in lions lasts for 4-7 days, with variable intervals and copulation occurs up to 100 times per day. Litter size is 1-3 (Acharjyo and Mohapatra,1980). Eyes are open at birth or shortly thereafter. Mean weight at birth was 1,650 g and cubs gain about 106 g per day in the first 4 weeks of life (Hemmer 1979b; Oftedal and Gittleman 1989). Newborn cubs are marked with spots that persist on belly and legs until adulthood and may remain throughout life. Cubs may begin walking within 2 weeks of birth. Eruption of milk teeth begins at 3 weeks of age, allowing the young to take solid foods at about 5-8 weeks (Schaller, 1972; Oftedal and Gittleman 1989). Cubs weaned at about 8 months and eruption of permanent teeth begins between 9th and 12th months (Grzimek, 1975). African lions become sexually mature at 2 years and 7 month of age (Acharjyo and Misra, 1971).

Nandankanan Zoological Park, Bhubaneswar: One lion cub was hand reared at Nandankanan zoo during July, 2015 following sickness of its mother. The cub was rescued at age of 5 days and fed with reconstituted dog milk formula 'Royal Canin baby dog milk' @ 20ml per feed and 12 feedings per day. After one month of hand rearing, the night feeding was discontinued and 11 feedings were given. In 9th week of rearing, minced chicken meat was introduced @ 100g per day and seven feedings of reconstituted milk was given in three hours interval. Minced chicken diet was gradually increased to 400g in 4th month of rearing and simultaneously the milk diet gradually decreased to 300ml per day in three feedings. The milk diet was completely replaced with meat diet at 6 month of age. Faecal sample was collected and examined regularly after four weeks of age. Deworming was carried out at 3 months age with Albendazole @ 20mg/kg body weight. Immunization of the cub was done against feline rhinotracheitis, calici, panleukopenia and rabies with killed multivalent vaccine (Biofel-PCHR; Bioveta, Czech Republic)

administered subcutaneously on 8th weeks followed by booster on 12th week, 16th week and 6 months then annually. The cub was administered with chemoprophylactic drug against Trypanosomiasis (Triquin; Vetoquinol, India) at the age of 7 months and repeated in every 4 months interval. The cub weighed 1.390kg at the time of rescue (5 day old) and consistent growth was recorded during hand rearing e.g. 3.250kg, 10.250kg and 20.200kg at 1 month, 3 months and 6 months of age, respectively.

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Hand rearing of lion cub at Nandankanan zoo.

Kanpur Zoological Park, Kanpur: A zoo born lion cub was hand reared at Kanpur Zoological Park during April, 2017 as its mother didn't fed even after 24 hours of birth. The body weight of the cub was 840 g at the time of rescue. Mother serum was administered orally and subcutaneously for first few days to improve immunity as the cub has not consumed colustrum. It was reared with PetAg KMR kitten milk replacer. As per recommendation (i.e., one scoop or 2.9 g of KMR milk powder for 57g body weight per day) the number of scoops required per day was calculated. Reconstituted milk of 80ml was prepared using 3.5 scoops of milk powder. Milk was fed 10 times a day during first 10 days of rearing, followed by 8 times a day and 5 times a day from 11-20th day and 21-30th day of rearing, respectively.

Calcium and multivitamin preparations were added to the reconstituted milk once daily. The cub started accepting meat based diet (30ml meat broth) from 38th day onwards. The cub weighed 1255g in 2nd week, 3730g in one month and 7700g in 2 months of age.

Photo courtesy: Kanpur Zoological Park, Kanpur

Hand rearing of lion cub at Kanpur Zoological Park, Kanpur.

Zoological Garden, Alipore, Kolkata: Alipore zoo has hand reared one lion cub in August, 1991 following maternal rejection and cannibalism of its littermate (Saha et al., 1992). It was fed with Lactogen 2. Initially ½ spoon (spoon supplied with the packet) of Lactogen 2 diluted in 60ml of water and fed to the cub, which gradually increased to 2 spoons in 90ml during 3rd week, 3 spoons in 120ml during 4th week, 4 spoons in 150ml of water during 5th and 6th week of age. The cub was fed 6 times a day during 2nd and 3rd week of age, which gradually reduced to 5 times a day in 6th week of age. Solid food in the form of chicken meat with bone was introduced at the 6th week of age which went upto 750g in 2 ½ months of age. The cub weighed 1080g on 9th day, 1320g on 27th day and 1830g on 45th days of age, respectively. At the age of the 4 ½ months, the cub was sifted to exhibit.

Leopard

Leopards (*Panthera pardus*) or the panthers belonging to family: Felidae are most widely distributed big cat species of the world. They have yellow coat marked with black rosette which are unique to each individuals like stripes of tigers (Menon, 2014). They breed all the year round (Desai, 1975; Prater, 2005). Female become sexually mature between two and half years to four years of age (Desai, 1975). Gestation period varies from 84-98 days (Desai, 1975). Longest gestation period of the species was recorded as 112 days at Prague zoo (Dobroruka, 1968). The litter size varies from 1-6 cubs (Desai, 1975; Acharjyo and Mohapatra, 1980; Prater, 2005). Neonates weigh between 0.500kg to 1.00kg and measures 360mm to 483mm from tip of nose to tip of tail. All cubs were born with their eyes closed (Desai, 1975). Eyes open between 4th and 8th day after birth. They wean at about four months of age (Prater, 2005).

Maharajbag Zoo, Nagpur: One leopard cub was hand reared at Maharajbag zoo in 1999 after maternal rejection (Dhoot et al., 2000). The cub was fed with lukewarm cow milk through feeding bottle. Feed was supplemented with multivitamins, iron and calcium. Initially, the cub was fed six times a day, 200 ml in total, avoiding night time feeding. Chicken soup was introduced in fifth week and gradually increased in quantity up to 12th week. Besides, boiled eggs were given from 8th to 10th week, and afterwards raw eggs were given. The cub gradually accepted boiled beef (during 10th and 11th weeks) and raw beef (13th week onwards). The quantity of milk was gradually reduced from 8th week onwards and stopped after 12th week. The cub weighed 0.650kg on 7th day, 2.450Kg on 35th day, 6.230kg on 70th day and 8.550kg on 84th day of age.

Kamala Nehru Zoo, Indore: One leopard cub was hand reared at Kamala Nehru Zoo, Indore in 1990 (Mahodaya, 1990a). The cub was separated for hand rearing during the 2nd week of birth as mother's milk was observed insufficient for the cub. Initially, the cub was fed with 20-30ml of goat milk per feed with multivitamins, iron and calcium supplementation at 3 hours interval. The quantity of milk was gradually increased to 600-700ml per day in one month of age. The cub started accepting chicken soup at about one month of age. The cub started accepting boiled chicken liver, boiled goat meat and boiled eggs subsequently.

Nandankanan Zoological Park, Bhubaneswar: On 19.10.2014, Nandankanan zoo had received one female leopard cub rescued from Titllagarh Forest Range of Bolangir Forest Division. The cub was about 3 months old with body weight of 2.9kg. At the time of arrival the cub was weak, anaemic and pot bellied. It was fed with 'Royal Canin baby dog milk' reconstituted as per recommendation i.e., 10g in 20ml of water. A multivitamin preparation along with calcium suspension was added to the milk. Carminative drugs and *Lactobacillus* preparations were added whenever necessary. Within a week minced chicken meat @ 50g/day was provided which was readily accepted. The quantity of meat was increased every week @ 50g to make 300g on 6th week. The milk diet was completely stopped at 6 weeks of rearing. Immunization of the cub was done against feline rhinotracheitis, calici, panleukopenia and Rabies with killed multivalent vaccine (Biofel-PCHR; Bioveta, Czech Republic) administered subcutaneously after two weeks of hand rearing followed by booster after four weeks. The cub was administered with chemoprohylactic drug against Trypanosomiasis (Triquin; Vetoquinol, India) at the estimated age of 7 months.

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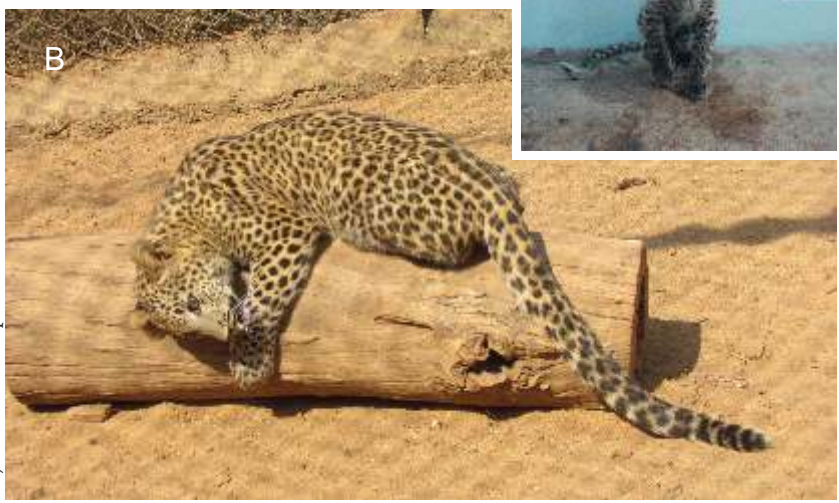
Hand rearing of leopard cub at Nandankanan zoo:
A: health condition during receipt.
B: leopard cub after two months of hand rearing.



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Jungle cat

Jungle cats (*Felis chaus*) are most common wild cats in India. They have a grey brown coat with faint red strips on forehead, two black stripes on forelegs and black rings on tail. Kittens have marking all over the body and dark rufus ears (Menon, 2014). Female become sexually mature at an age of 11 months (Schauenberg, 1979). Gestation period is about 2 months (Heptner et al., 1956). They give birth to 3-5 kittens in a litter and the neonates weighted between 83-125g (Acharjyo and Misra, 1974; Acharjyo and Mohapatra, 1977). Eyes are closed at birth and open between 11-15 days of age (Acharjyo and Mohapatra, 1977).

Nandankanan Zoological Park, Bhubaneswar: One rescued jungle cat kitten with an estimated age of 7-8 days weighing 130g on receipt, was hand reared at Nandankanan zoo in January, 2016. The infant was hand reared with reconstituted 'Royal Canin baby dog milk' as feed. Initially it was fed 5-6ml of feed 10 times a day, with a total quantity of 50-60ml/day. The milk feed was increased gradually to 100ml/day on 4th week, 180ml/day on 8th week and 240ml on 12th week of rearing. Total feed was divided into 10 feedings per day till 4th week and then into 6 feedings till 12th week. It started accepting minced chicken meat provided along with milk feed from 11th week. By 12th week it was accepting feed provided in a flat plate on its own. The number of feeding per day was reduced to two times a day (one with milk feed and other with meat feed) from 16th week onwards. Milk diet was completely stopped from 20th week. The kitten weighed 475g, 780g, 1015g and 1310g, 1825g on 4th, 8th, 12th, 16th, 24th week of rearing, respectively.

Sri Chamarajendra Zoological Gardens, Mysore: Two jungle cat kittens of about 10 days of age rescued and handed over to zoo by public were hand reared at Mysore zoo in November, 2008. The kittens weighed 150g on receipt. The kittens were fed with cow milk and water in ratio 1:1, 5 times in a day. Gradually, they started accepting adult diet i.e., minced chicken meat mixed with milk. They weighed 1.9 kg at four years of age.

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Hand rearing of jungle cat at Nandankanan zoo

Striped hyena

Striped hyena (*Hyaena hyaena*) is considered to be exclusively nocturnal and solitary (Prater, 2005; Menon, 2014). It is a classic scavenger, feeds on prey killed by other animals (Prater, 2005). Gestation period is 90-91 days. There is no apparent seasonal pattern (Pocock, 1941; Wagner, 2006). Litter size in captivity ranges from 1-5 cubs (Rieger, 1981). Weaning in captivity takes place after eight weeks and sexual maturity is reached at 2-3 years. Intense digging behaviour in the females announces parturition and cubs are reared in dens (Rieger, 1979).

Sanjay Gandhi National Park, Mumbai: One week-old female and two one month old male cubs were hand reared at Sanjay Gandhi National Park, Borivili, Mumbai during 1985 and 1986, respectively (Batwe, 1987). Toned milk having 3% fat and 8.5% SNF was used as feed with vitamin and calcium supplementation. Initially, 1:1 proportion of milk to water was fed till 30 days which gradually changed to 3:1 and 5:1 at the end of 45th and 60th day respectively. The cubs accepted 50g goat meat at the age of 90 days that gradually increased to 1kg with bones. The cubs were given solid food (1 teaspoon FAREX) on 30 days which increased to 4 teaspoon on 60

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Hand reared hyena cubs at Nandankanan.

days . The beef diet was given at 6 months of age. They were consuming about 2kg of beef (with bones) when they were 9 months old. The teeth like incisors, canines, premolars and molars were observed to erupt between 16-20, 31-45, 46-60, 61-75 days, respectively.

Nandankanan Zoological Park, Bhubaneswar: In November, 2015, four hyena cubs received at Nandankanan zoo were rescued from Phulnakhara area of City Forest Division, Bhubaneswar in dehydrated condition. The cubs were about one week old with partially open eyes and sluggish movement. They were reared with reconstituted 'Royal Canin baby dog milk'. On the first day the milk was mixed with glucose and electrolyte to restore energy and electrolyte balance. Each one was fed at rate 120ml per day divided in 12 feedings at 2 hours interval. On 3rd week of rearing, the night feeding was discontinued and 10 feedings were given in a day. Gradually, the milk quantity per day was increased to 450ml/ day and number of feedings per day was reduced to 6 feedings/day on 7th week of rearing. Solid food (minced chicken meat) was introduced at 2 months @ 50gm per head and gradually increased to 200gm in 4 months of rearing. With the introduction of solid food in 2 months, milk consumption was reduced gradually to 150ml/day in 4 months of rearing. Milk was completely withdrawn at 6 months age and replaced with chicken meat @ 500g per head per day. Average weight of hyena cubs was 593g at the time of receipt (about one week old)

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Photo courtesy: IGZP, Visakhapatnam

Hand rearing of hyena cubs: A. At Nandankanan zoo, Bhubaneswar;
B. At Indira Gandhi Zoological Park, Visakhapatnam.

and subsequently recorded as 1720g, 3576g, 7195g, 14280g at 4,8,12 and 16 weeks of rearing, respectively.

One female hyena cub was hand reared at Nandankanan zoo during May, 2017. The cub was rescued by the villagers in deserted condition and handed over to the Forest Department. It was weighing 815g and fed with reconstituted 'Royal Canin baby dog milk' 30ml/feed for 7 feedings a day during hand rearing. Minced chicken meat was introduced in 2nd month @50g/day and was gradually increased to 500g/day at 7th month. Thereafter, quantity of reconstituted milk was gradually reduced and completely with drawn by 9th month of age. The cub weighed 2300g, 4370g, 5750g, 9960g, 12370g and 14250g on 4th week, 8th week, 11th week, 4th month, 5th month and 6th month of rearing, respectively.

Indira Gandhi Zoological Park, Visakhapatanam: One-day old hyena cubs (one male weighing 450g and one female of 400g) were brought for hand rearing on 25-02-2017 following maternal rejection. The cubs were fed with 'Beapher lactol milk formula' reconstituted as per manufacturer's recommendation. In the 1st week of hand rearing the cubs were fed 15 times a day which gradually reduced to 8 times a day by 5th week and to 6 times a day by 8th week. The quantity of milk consumption increased gradually from 2ml per feed in 1st week to 30ml in 4th week and 75ml in the 8th week. From 10th week onwards the cubs started accepting 25g of minced chicken meat once a day with 100ml of milk feed 5 times a day. Gradually, the amount of feed increased to 250g of minced chicken twice a day with 200ml of milk feed twice a day. The cubs started accepting beef from 18th weeks onwards. They were accepting 500ml of milk feed once a day and 500-750g of beef in two times between 22nd and 25th weeks of rearing. From 26th week the milk feed was stopped and the cubs were given only beef (1kg meat and100g liver) as feed which increased with their age. The feed was supplemented with multi vitamins (ABDEC syrup from 1-30days, Vimerol from 45 days onwards) and calcium (Calsakthi syrup form 35 days of age). Initial average weight of the cubs was 425g (one-day old) and subsequently recorded 625g on 1st week, 1250g on 4th week, 3400g on 8th week of rearing. They weighed 4200g when they started accepting minced chicken meat.

Sri Chamarajendra Zoological Gardens, Mysore: The zoo had hand reared one hyena cub in March, 2013 using pasteurized cow milk and water in 1:1 ratio with need based vitamin and mineral supplementation. The cub weighed 600g initially, 900g and 1900g after first and second weeks of rearing.

Jackal

Jackals (*Canis aureus*) are medium sized canid with grey coat interspersed with black hair and make a characteristic eerie howling sound at dusk and just before dawn. Males are about 15% larger than females and the female have 4 pairs of mammae. They are distributed throughout India except high Himalayas (Menon, 2014). They become sexually mature at 11 months (Moehlman, 1983). Gestation lasts about 63 days (Moehlman, 1983). The litter size varies from 3 (Acharjyo and Mohapatra, 1980), 4 (Manimozhi et al., 2000) to 8 (Moehlman and Hofer, 1997). Pups are born blind and their eyes open at approximately nine days and their teeth erupt at 11 days after birth (Moehlman and Hofer, 1997). Lactation usually lasts for 8–10 weeks. Females attains sexual maturity at 11 months, while males become so after one year (Kingdon, 1977).

Arignar Anna Zoological Park, Chennai: Manimozhi et al. (2000) reported the hand rearing of jackal in 1995. The pups were fed boiled cow milk 6 times a day in lukewarm condition. The feeding frequency was gradually reduced to 3 times a day with acceptance of solid food. The pups first accepted beef when they were 45 days old. They were housed in a caged box with wooden floor covered with hay. The average weight, body length and tail length of hand reared jackal pups were 0.988kg, 34.25cm and 9.25cm on 43 days of age; 1.138kg, 42cm and 10.75cm on 61 days of age; 2.225kg, 45.5cm and 14.5cm on 91 days of age and 3.975kg, 57.55cm and 19.85cm on 181 days of age, respectively. The average weight, body length and tail length of mother reared jackal pups are 2.050kg, 45.25cm and 14.5cm on 61 days of age and 5.475kg, 65.75cm and 22.25cm on 181 days of age, respectively.

Maharajbag Zoo, Nagpur: Dhoot et al. (2003) reported hand rearing of four jackal pups (2 male and 2 female) in 2001. The pups were considered for hand rearing due to large litter size (8 pups) of the mother jackal. Each pup was fed with 30ml of lukewarm cow milk per day in 6 feedings during first week of hand rearing. Feed was supplemented with multivitamins, iron and calcium. Gradually, the frequency of feeding was reduced from 6 times a day on 1st week to once a day on 12th week. The quantity of milk feed was gradually increased up to 4th week and reduced from 6th week onwards. Chicken soup was offered on 3rd week and its quantity increased gradually up to 9th week. The pup was provided with boiled egg from 4th to 7th week and boiled beef from 5th to 7th week and raw egg

and raw beef (8th week onwards) which were readily accepted. The average body weight of the pups was 107.5g on 3rd day, 206.25g on 35th day, 622.5g on 70th day and 996.25g on 90th day of age.

Nandankanan Zoological Park, Bhubaneswar: One two-month old zoo born jackal pup raised by its mother was observed weak with retarded growth in April, 2014 at Nandankanan zoo. On close observation, both mother and pup were found to be infested with fleas. They were successfully treated with topical acaricide application. Considering poor health of the pup, supplemental feeding to the pup was initiated without removing it from the mother. Reconstituted 'Royal Canin baby dog milk' @ 30ml per day was given in a flat bottom bowl that was readily accepted by the pup. The milk was added with multivitamins and calcium syrup. The pup accepted minced chicken meat from 3 months onwards. Afterwards, the meat quantity was gradually increased with gradual reduction in milk diet. The pup showed improvement in health condition, weighing 1.7kg on 90 days and 3.5kg on 120 days age. .

Supplemental feeding of jackal pup without separating from mother for hand rearing.

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Asiatic wild dog

Asiatic wild dogs (*Cuon alpinus*) are social animals living in packs of 5-12 individuals (Ravi et al., 2015). They are found in Tibet, Ladak, Kasmir, with range extending to desert zones and dry open plains of peninsular India (Prater, 2005). They breed once a year. Mating recorded between September and January in wild (Prater, 2005) and between August to November at Arignar Anna Zoological Park, Chennai (Manimozhi, 2010). Sosnovskii (1967) reported gestation period of 60–63 days whereas Manimozhi (2010) reported a period of 59–62 days in the species. Each litter had average 4–6 pups (Sosnovskii, 1967). Ravi et al. (2015) reported the litter size of 7 and 10 at Mysore zoo. Parents and siblings in the group help to rear the pups (Durbin et al., 2004; Maisch, 2010). Cannibalism was reported in this species (Ravi et al., 2015).

Sri Chamarajendra Zoological Gardens, Mysore: Four Asiatic wild dog pups were hand reared following cannibalistic incidence of litter mates, maternal rejection and declining health condition in February, 2013 (Ravi et al., 2015). The pups were housed in wooden box with towel as bedding material and were fed with milk blended with chicken after initial rejection of minced meat. The feed was supplemented with multivitamins and liver stimulants twice daily. After 15 days of hand rearing the pups started consuming small pieces of meat voluntarily. The pups were dewormed and vaccinated against rabies, distemper, hepatitis, parvo and para influenza. At about six month of age the pups were shifted to day kraal to give more space for their physical activity and providing visual and auditory interaction with

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Adult Asiatic wild dog at Nandankanan zoo

their parents and older siblings. For individual identification, the pups were implanted with transponders and also ear notched at about six month of age.

In another incidence, three one-day old Asiatic wild dog pups were hand reared from 25.11.2018 at Mysore zoo following maternal rejection. The pups were weighed 150g each initially. They were allowed to be fed by a lactating bitch up to one and half months, after which pasteurized cow milk and water in ratio 1:1 was bottle fed by keepers. In the second month of rearing, the pups started accepting chicken meat mixed with milk. The pups weighed 650g and 3500g on after one month and three months of rearing, respectively.

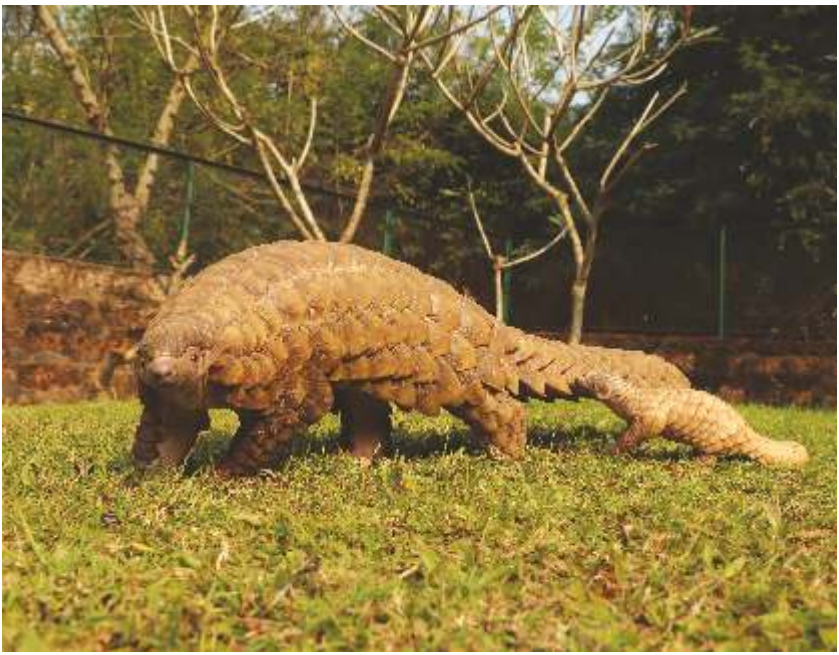
Photo courtesy: Mysore zoo.

Wild dog pups feeding on a lactating bitch as their foster mother, Mysore zoo.

Pangolin

Pangolins are toothless mammals belonging to the family: Manidae. Illegal trade of pangolin body parts for use in traditional medicine has made them the most trafficked mammals of the world (Mohapatra et al., 2015). Out of eight species of pangolins, two species of pangolins namely, Indian pangolin (*Manis crassicaudata*) and Chinese pangolin (*Manis pentadactyla*) are found in India. They live in burrows and feed on ants and termites (Mohapatra and Panda, 2013). Births have been recorded throughout the year except May and June. Usually one and rarely two young are born in a litter after a gestation period of 251 days (Mohapatra, 2016). Pangolin neonate weigh 235g and measure 30cm in length including 12.5cm tail (Acharjyo and Misra, 1972). Eyes are open at birth (Acharjyo and Misra, 1972). Instances of maternal rejection in captive Indian pangolins have been reported (Mohapatra and Panda, 2014). Young Indian pangolins become independent at 5-8months of age (Mohapatra ad Panda, 2014).

Nandankanan Zoological Park, Bhubaneswar: Mohapatra et al. (2013) reported hand rearing of one rescued Indian pangolin of about 4 weeks of age at Nandankanan zoo in July, 2012. The pangolin was kept in a well ventilated box of 60 X 40 X 30cm dimensions with



Mother and young Indian pangolin at Nandankanan zoo.

ambient temperature and humidity 21-30ºC and 55-89%, respectively. The baby was fed with 'Royal Canin baby dog milk' powder up to 29th week of age. The powder was reconstituted @ 1.5g in 20ml of water on the 1st week which was gradually increased to 4gm in 20ml of water on 15th week that continued till 29th week. Initially, it was provided 5-6 feeding/day which was gradually reduced to 2 feedings/day from 23rd week onwards and stopped after 29th week. The young pangolin started feeding ant diet from 108th day of rearing. At the time of receipt (about 4 weeks of age) it weighed 410g and measured 36cm in length. It was 1350g in weight and 53.5cm in length on 15th week, when it first accepted ant diet, and 1550g in weight and 59.5cm in length on 30th week.

Biological Park, Itanagar: One rescued Chinese pangolin baby was hand reared in January, 2014 at Biological Park, Itanagar. The baby weighed 500g and measured 40cm in length with 14cm tail. The baby was fed with reconstituted 'Royal Canin baby dog milk' with difficulties as the pangolin was hesitant to accept the feed. Unfortunately, the baby died within a month.

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Sorang Tadap

Hand rearing of Pangolins: A. hand rearing of Indian pangolin at Nandankanan zoo. B. hand rearing of Chinese pangolin at Itanagar Biological Park.

Otter

Otters are amphibious mammals belonging to the family: Mustelidae. They have thick and waterproof fur, webbed paws, flattened head, small ears and stiff whiskers well suited to foraging in aquatic habitat (Prater, 2005). Out of 19 species of otters, 3 species namely Eurasian otter (*Lutra lutra*), Asian small clawed otter (*Amblonyx cinerea*) and smooth-coated otter (*Lutrogale perspicillata*) are found in India. Otters are voracious feeders feeding on fish, frogs, turtles and aquatic invertebrates (Walker, 1964). They have a gestation period of 60-63 days (Yadav, 1967; Desai, 1974). Cubs are born blind. Weaning takes place about 130 days (Desai, 1974).

Sri Chamarajendra Zoological Garden, Mysore: Ben Shard (1963) reported hand rearing of otter at Mysore zoo. The otter was hand reared by feeding 1 ounce (2 tablespoons) buffalo milk mixed with 1 ounce (2 tablespoons) of water and 1 teaspoon of glucose four times a day till one month. The feed was supplemented with 1 teaspoon shark liver oil and 1 yeast tablet once a day. After 1 month of rearing the quantity of buffalo milk and water was increased by ½ ounce (1 tablespoon). The infant was given with 10 small live fishes per day in addition to the above feed. The number of feed of buffalo milk with water was reduced from 4 times to 2 times at 3 month of rearing. In addition, 0.25kg of live fish was given as feed which continued and increased with growth of the animal.

Pulari

Otters at Museum and zoo, Trivendrum.

Museum and Zoo, Trivendrum: Two wild caught otter cubs of 1-2 month of age were hand reared at Museum and zoo, Trivendrum (Ben Shard, 1963). They were fed with 2 ounce (4 tablespoon) of liquid made from boiled mackerel in water mixed with 1 ounce (2 tablespoon) of milk in not less than five feeding per day for four months. The cubs started eating small raw fish at about 6 month of age.

Vikramshila Gangetic Dolphin Sanctuary: Dey et al. (2018) reported hand rearing of a month-old male smooth-coated otter cub rescued from poachers in January, 2000 near bank of river Ganga at Vikramshila Gangetic Dolphin Sanctuary area, Bihar in collaboration with Sanjay Gandhi Zoological Park, Patna and Department of Environment and Forests, Bihar. The cub had an injury at tail tip at the time of rescue. It was housed in an enclosure room of 3.65m x 3.05m (12' x 10') dimensions. A water pool was constructed for the otter to play, eat and rest. The otter cub comfortably lived in this enclosure and showed no signs of ill health or stress. Every day it was allowed to play in a large terrace and verandah for 1-2 hours. For one year during 2000-2001, it was fed about 1.2 kg of fish, over two feeds per day. From 2001 onwards, the daily intake increased to approx. 1.5 kg of fishes per day. Small fishes were fed to it in the first year, and bigger sizes were introduced later. The fishes mainly included pond-cultured carps *Hypopthalmichthys molitrix*, *Catla catla*, and *Cirrhinus mrigala* (80%) and the catfish *Clarias batrachus* (20%). Occasionally, river fishes or chicken meat were provided. Deworming was conducted and vitamin supplements were fed once a year. It was returned to the wild in May, 2008.

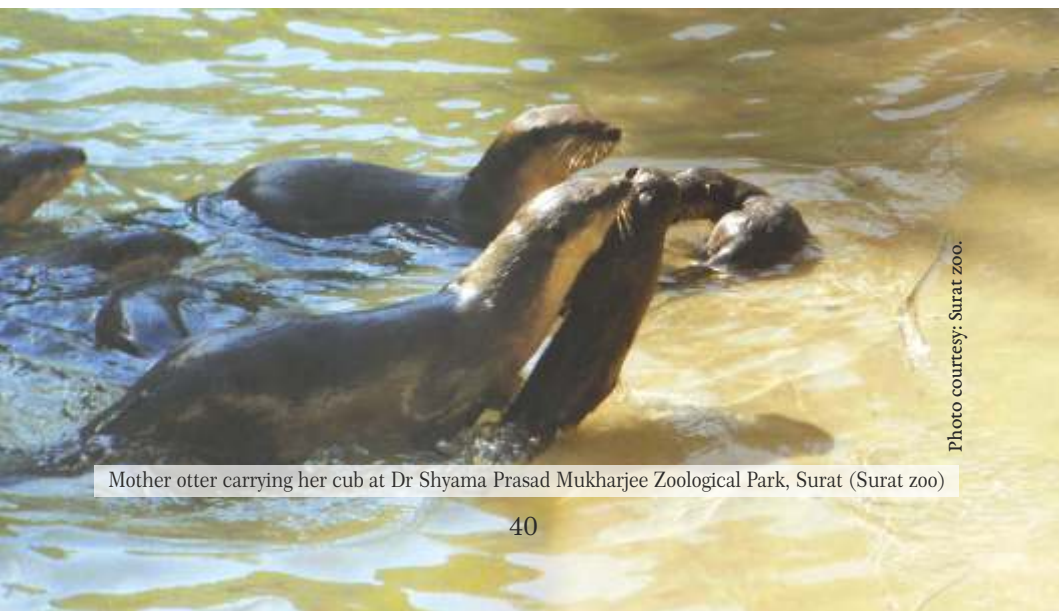

Photo courtesy: Surat zoo.

Mother otter carrying her cub at Dr Shyama Prasad Mukharjee Zoological Park, Surat (Surat zoo)

Common palm civet

Common palm civets (*Paradoxurus hermaphroditus*) are black or brownish-black civets with long coarse hair and three longitudinal stripes on their back (Prater, 2005; Menon, 2014). They are very common and found in most of the non-Himalayan India except the arid west (Menon, 2014). They breed throughout the year and the usual litter size varies from 2-4 (Prater, 2005). Young civets are born with eye closed that open between 6th-11th days postpartum (Acharjyo and Misra, 1973; Acharjyo and Mohapatra, 1978). At birth the young weighed 69-120g and measured 28-30.5cm in length (Acharjyo and Tripathy, 1974; Acharjyo and Mohapatra, 1978). The male civets become sexually mature at about 11 months of age (Acharjyo and Misra, 1975) whereas the female at 10 months (Acharjyo and Mishra, 1980). Cannibalism by mother was reported in common palm civet (Acharjyo and Tripathy, 1974).

Nandankanan Zoological Park, Bhubaneswar: During May, 2016, one orphaned common palm civet rescued from wild was hand reared at Nandankanan zoo. It was weak and weighed 70g at the time of receipt. The infant was having partially open eyes that got opened completely on 4th day of rearing. Based on observation of Acharjyo and Misra (1973) the age was estimated to be of one week. The infant was reared with reconstituted 'Royal Canin baby dog milk' powder, 1g diluted in 10ml of water. Initially it was fed 50ml of milk per day in 10 feedings by using plastic dropper. From 3rd week onwards it accepted bottle feeding. The quantity of milk feed was gradually increased to 120ml/day in 8 feedings during 2nd month, 180ml/day in 6 feedings during 3rd month, 200ml/day in 4 feedings during 4th month and then gradually reduced to 100ml of milk twice a day till 6th month of rearing. It started accepting small pieces of banana and grape from 5th week onwards and minced chicken meat from 10th week. After completion of 3rd month the civet was feeding on fruits, small pieces of chicken meat and small fishes with the existing milk feed. It weighed 325g, 570g and 920g on 4th, 8th, 12th week of rearing, respectively.

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Hand rearing of common palm civet at Nandankanan zoo.

Sloth bear

Sloth bears (*Melursus ursinus*) are endemic to the Indian subcontinent and Sri Lanka. They are distinguished by their elongated muzzle and lower lip, long unkempt hair, short hind legs and whitish V-shaped breast patch. Mating time is usually in hot weather and most of the young are born seven months later between December and January (Prater, 2005). Litter size varies from 1-2 (Laurie and Seidensticker, 1997). Weaning occurs at 2-3 months of age (Dunbar-Brander, 1931). The cubs live 2-3 years with mother till they attain maturity (Prater, 2005).

Nehru Zoological Park, Hyderabad: Two bear cubs were hand reared during 1992 at Nehru Zoological Park (Pillai, 1992). The cubs were bottle fed six times a day for 25 days later they started licking milk from the bowl. Initially, they were fed with 40ml of milk per feeding that gradually increased to 100ml during 2nd month of rearing. Same quantity of milk continued till six months. In addition, bread was given from one month of rearing, quantity of which was increased gradually with age. The male and female cub weighed 2kg and 1.8Kg after 2 days of receipt, 2.38 and 2.25kg at about 1 month of age and 4.75kg and 3.75kg when they are about 3 months old.

Nandankanan Zoological Park, Bhubaneswar: Three sloth bears cubs of age within one month, rescued during December, 2013, January, 2014 and December, 2017 from different parts of Odisha were hand reared at Nandankanan zoo. Initially, the cubs were fed with 'Royal Canin baby dog milk' powder reconstituted in its recommended

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Sloth bear with its cub at Nandankanan.

dilution @ 280ml per day divided in seven feeds at three hours interval without night feeding. They were housed in a 4'×4'×2' box made up of plywood with proper bedding materials and provision for temperature regulation. The dog milk formula continued up to 10th week of age after which human infant food 'Cerelac-1 (Nestle)' was introduced to add bulk to feed, which was increased gradually in quantity to completely replace Royal Canin Baby dog milk in two weeks. During 5th month of rearing Cerelac-1 was gradually replaced with Celerac-4 and the quantity being increased proportionate to its body weight. Adult diet e.g. boiled rice, vegetables and honey was introduced at 6th month @ 50g per day. With introduction of adult diet, the frequency of feeding was reduced to 4 feeds per day and further to two feeds per day during 8th month of rearing with increased in quantity of feeds. The cubs weighed 1.246kg, 1.615kg, 2.100kg, 2.822kg, 3.009kg, 4.893g, 7.330kg, 35.400kg in average on 2nd, 4th, 6th, 8th, 10th, 12th, 16th and 30th week of age, respectively. They were shifted to bigger kraals after 6 month of rearing for more space and to facilitate better husbandry.

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Hand rearing of sloth bear at Nandankanan zoo.

Indian hare

Indian hares (*Lepus nigricollis*) are herbivorous mammals feed on grass, vegetables and crops. They have reddish brown fur mixed with black hairs, large ovate ears and hind limbs larger than forelimbs. They are distributed from foothills of Himalayas through peninsular India and North East India except Sundarban mangroves (Menon, 2014). They breed throughout the year with a peak in monsoon (Prater, 2005). They give birth to 1-4 leverets (youngs) after a gestation period of 42-44 days (Roberts, 1977). Females become sexually mature at 6 months of age (Phillps, 1935).

Coimbatore Zoological Park, Coimbatore: Three rescued Indian hare leverets were hand reared at Coimbatore zoo in July, 1994, January and March, 1995 (Ashraf et al., 1997). They are hand reared using undiluted pasteurized cow milk. Milk consumption increased from 12ml/day on 2nd day to 187ml/day on 43rd day. They were fed 3-4 times a day using plastic syringe. Weaning took place at about 40 days of age. The mean growth rate reported was 19g per day. Though leporid's milk is composed of high fat, high protein and low sugar (Oftedal, 1980) the hare were hand reared with cow milk in this case because of non availability of suitable substitute (Ashraf et al. 1997).

Nandankanan Zoological Park, Bhubaneswar: One rescued female Indian hare leveret was hand reared in October, 2013 at Nandankanan zoo. On receipt the leveret weighed 170g. Assuming the weight of the *Lepus* spp. 120g at birth (Flux and Angermann, 1990) the age of the leveret was estimated as 5-7 days. It was initially fed with 30ml of reconstituted 'Royal Canin baby dog milk' per day divided into three feedings. The quantity of milk gradually increased to 45ml, 75ml, 105ml and 120ml on 2nd, 3rd, 4th and 5th week of rearing, respectively. On 38th day the leveret started nibbling grass, a sign of weaning. Milk feed was reduced and stopped after 6th week. The leveret weighted 280g, 400g, 540g, 700g and 850g on 2nd, 3rd, 4th, 5th and 6th week of age, respectively.

Hand rearing of hare leveret at Nandankanan zoo.

Asian elephant

Elephants are the largest land mammals. India has the largest surviving population of the Asian elephant (*Elephas maximus*), approximately 50 % of the total world population of the species (Daniel, 1996). The neonates weigh 70-133kg (Reuther, 1969).the litter size is usually one (Krisne Gowda, 1969) but twining in a litter also recorded with one male and one female calf (Yin, 1962). Asian elephant female gave birth for the first time at 15-16 years of age while male sired for the first time at 14-15 years of age (Flower, 1943). The gestation period of the species is 644 days in average (range 628-668 days) (Dittrich, 1966). The calf starts taking solid food at 4-5 months of age (Maberry, 1962), but weaning takes around 18 months (Shoshani and Eisenberg, 1982).

Nandankanan Zoological Park, Bhubaneswar: Nandankanan zoo has successfully hand raised six elephant calves during the period 2009 to 2018. These calves were rescued from different parts of the state of Odisha in injured and/ or abandoned condition, and then brought to the zoo for hand rearing and rehabilitation. They were of about one month to five months of age at the time of receipt. Upon arrival the calves were examined for their hydration state and naval condition apart from other physical examinations. They were fed with human baby milk formula 'Lactogen-I' (Nestle) diluted as per the recommendations and a total volume of one tenth of the weight of the calf was fed in a day divided in seven feeds at an interval of three hours. On first day of receipt the milk was given in more diluted form added with electrolytes and glucose so that the calf gets energy and gets accustomed to feeding bottle. Gradually, the night feeding was discontinued. The reconstituted milk was added with carminative drugs initially for few days, then with calcium, multivitamin

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Hand rearing of elephants at Nandankanana zoo.

preparations daily. The said feed (Lactogen-I) was increased with body weight and continued up to 3months (approx.) of age, then Lactogen-II was introduced to replace Lactogen-I gradually. From 6 months onwards another human baby food formula 'Cerelac' (Nestle) was introduced to increase bulk and nutrition in feed. At the age of one year (approx.) semi cooked grains like rhagi, wheat, rice were given. Green leaves with branches were also provided after one year and all the milk and milk based diets were gradually reduced and completely withdrawn within few months. Soaked grains and grasses were provided from 1½ years of age and gradually increased in quantity in proportion with body weight of the calf. Incidences of diarrhoea and other digestive disturbances are not uncommon. In such cases the quantity of milk was reduced from diet and electrolytes, *Lactobacillus* were provided with other therapy. In an incidence, one of the calves developed intolerance to Lactogen which was then reared successfully with 'Zerolac' (Raptakos), a lactose free milk substitute. Average body weight of the hand reared calves were recorded as 120kg,130kg, 150kg, 190kg, 250kg, 330kg and 400kg at age of 2, 3, 6, 9, 12, 18 and 24 months, respectively.

Assam State Zoo, Guwahati: Thakuria et al. (1996) reported hand rearing of five elephant calves at Assam State Zoo, Guwahati during 1988 to 1991. The calves were of 2-3months age when they were rescued from flood waters from different areas of Assam and handed over to zoo for care and rehabilitation. Infants of 0-3 months age group are fed with Lactogen milk powder (500g per day) mixed in lukewarm water at least seven times a day at two hours interval. One conical glass bottle attached with a piece of bicycle tube as nipple was used for feeding. During 3-6 months age, they were fed with Lactogen powder- 1kg, boiled rice- 500g and sugar- 50g per day mixed and divided equally in seven feeds. After 6months age 250g horse gram and *athia* (without seeds) banana were added to feed with boiled rice 1kg and lactogen 1 kg per day. Soaked Bengal gram was introduced at the age of 12 months and 1 kg was given in two feeds every day along with other ongoing feeds. At 15 months of age the calves were provided with one banana tree with leaves, 50 kg grasses and natural grazing. When the calves attained an age of two years, powder milk and sugar were withdrawn from the diet schedule and replaced by soaked gram whole-2kg, sugar cane-1kg, *athia* banana-10 numbers, molasses- 200g, garlic- 25g, turmeric (green) – 20g, black salt- 250g, common salt- 25g, grasses –100kg, banana tree with leaves-2 to 3 numbers apart from daily grazing of natural vegetation for two to three hours.

Great Indian one-horned rhinoceros

Great Indian one-horned rhinoceros (*Rhinoceros unicornis*) are the second largest mammals of India, best recognized by their large bulk and single horn. In India, they are distributed in Assam, West Bengal, Bihar and Uttar Pradesh. They occur in tall alluvial grassland and riverine forest grassland mosaics with swamp patches in the Gangetic and Brahmaputra river system in foot hills of the Himalaya. They are solitary animals and associated with other individual usually for breeding activities (Menon, 2014). They breed throughout the year (Laurie, 1982; Lang et al., 1977). Females become sexually mature at 4 year of age whereas males at 7 years. They usually give birth to one offspring after a gestation period of 462-489 days (Lang et al., 1977). Male neonates weighed 40-74kg and female 55.7-81kg (Lang et al., 1977). Though they started accepting solid food at 2-3 month of age weaning takes 12-18 months (Laurie, 1982).

Centre for Wildlife Rehabilitation and Conservation (CWRC), Assam: The rhinoceros calves about one to five months of age, swept away by

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Great Indian one horned rhinoceros- mother and calf at Sanjay Gandhi Zoological Park, Patna.

flood water from Kaziranga National Park were rescued and hand reared at the CWRC with the aim of releasing them into their natural habitat (Barman et al., 2014). At CWRC, the calves were reared at nursery enclosures (~5 m x 5 m). They were fed diluted human baby milk formula that was available in the market (brand name: Nestogen, make: Néstle) with a special 2-litre bottle with a long rubber nipple. For the first three to four days, they were given milk at one-hour intervals, although this frequency was reduced during the night. Once they were accustomed to drinking this milk, were less stressed and had stabilized, they were allowed to use a paddock (~10 m x 10 m) next to the nursery. After three to four months, varying with the individual, the calves were fed concentrates with mineral supplements and vitamins. From the age of 6 months, they were introduced to fresh greens, mainly grass, and continued with concentrates and milk. They were weaned at two years and fed a diet of greens from then on.

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Hand rearing of Great Indian one horned rhinoceros at CWRC, Assam.

Chinkara

Chinkara or Indian gazelle (*Gazella bennettii*) is found in the arid and semi-arid parts of western and central India from Punjab and Rajasthan, eastward through Gangetic valley and southward to the Deccan Plateau (Menon, 2014). Outside India, they are found in Pakistan, Afghanistan and Iran (Gaikwad and Narwade 2016). They breed thoughout the year with two birth peaks, the major one in the April and the minor one in autumn. Gestation period is 5 1/2 months (Prater, 2005). Sexual maturity was recorded at 12 months by Baharav (1974) and 18-24months by Baharav (1983a) in the subspecies Gazella gazella gazella. Litter size in the same subspecies is one and rarely two (Baharav, 1983a; Baharav, 1983b).

Kamala Nehru Zoo, Indore: One orphaned chinkara fawn at an approximate age of 2-3 weeks was hand reared at Kamala Nehru Zoo, Indore (Mahodaya, 1990b). The fawn lost her mother and came to village along with goat herd and subsequently brought to the zoo. The fawn was bottle fed with 200ml of diary milk with vitamin B complex syrup 3 times a day. After 1 ½ months the hand reared fawn started eating gulal leaves (*Ficus* sp.) and wheat bran.

Harpal Singh

Chinkara, MC Zoological Park, Chhatbir, Punjab.

Four-horned antelope

Four-horned antelopes or Chausingha (*Tetracerus quadricornis*) are distinguished by presence of four horns which are keeled in front and not ringed as in true antelopes. Females are hornless. They are distributed in India and Nepal. Age at sexual maturity of captive females is 21 months (Acharjyo and Misra, 1975b). Breeding season is in the hot weather and rains and young are born from October to February (Prater, 2005). Usually 1-2 fawns are born in a litter after a gestation period of 228-243 days. (Acharjyo and Misra, 1975b; Shull, 1962). Neonates weighed 0.74-1.1kg at birth and measured 42-46cm in total length, with shoulder heights of 24.0-27.5cm (Acharjyo and Misra 1975b; Acharjyo and Mishra, 1981).

Nandankanan Zoological Park, Bhubaneswar: On 16.02.2016, Nandankanan zoo received three Chausingha fawns (one female and two males) rescued from Dhama Forest Range of Sambalpur Forest Division, Odisha for hand rearing. The fawns were 1215g (female), 955g (male) and 950g (male) in body weight at the time of receipt. Considering the neonate weight between 0.75kg to 1.2kg (Acharjyo and Mishra, 1981) the age of the fawns were estimated to be about 7-10days. Preliminary physical examination revealed that the fawns were moderately dehydrated and lethargic in gait. They were fed with oral electrolyte solution added with glucose for rehydration. Then they were housed at 'Hand Rearing Centre' of the zoo in a well ventilated wooden box of 4'×4'×3' size with cotton carpets on the floor. The carpets were changed regularly to keep it dry. Every day in the morning, fawns were allowed to move freely inside the paddock area attached to the centre to get sunlight. They were fed with 'Lactogen-1' (Nestle), human baby milk powder reconstituted in its recommended dilution @ 20ml per feeding, 7 feeds a day at three hours interval through a human baby feeding bottle. The feed was supplemented with calcium and multivitamin syrups once daily. Number of feedings per day was reduced to six feedings and five feedings during second and third month of hand rearing respectively. On 07.04.2016 (50th day) of hand rearing the fawns were observed nibbling grasses and small quantity of fine chopped vegetables. Quantity of milk was gradually reduced from 4th month and completely withdrawn after completion of six months of rearing. The average body weight of three fawns were recorded as 1568g, 2866g, 4256g and 5311g after one, three, four and five months, respectively. During rearing, after two months, one male fawn and the female

fawn suffered from moderate ascitis (fluid retention in abdomen) which was treated and they recovered uneventfully in two weeks.

Gulab Bagh Zoo, Udaypur: A female four-horned antelope fawn was hand reared in March, 2009 following death of its mother (Bhatnagar et al., 2010). It was bottle fed for initial few days but later it accepted suckling from a lactating female goat. The goat was selected on the basis of body colour similar to species, short height and thin tipped teats to facilitate suckling. The goat got acclimatized to the new environment in 4-5 days. Initially, the suckling was facilitated by the care takers by restraining the goat to a stand-still position followed by guiding the fawn to the teats to suckle. After one month the fawn was able to suckle on its own without the support of care takers and gradually grew to its adulthood with a sound health.

Karuna Wildlife Rescue Centre, Andhra Pradesh: Govindan (2018) reported hand rearing of one four-horned antelope fawn at Karuna Wildlife Rescue Centre during 2016. The fawn was rescued by the villagers and brought to the Rescue Centre on 11.12.2016 for hand rearing. It was fed with lukewarm cow's milk four times a day added with multivitamins. After a month of hand rearing, the frequency was reduced to three times in a day. The fawn began foraging at the age of 6th week and gradually consumed variety of plants, vegetables and fruits. At the end of 5th month, milk was completely withdrawn. Faeces were soft and yellowish during the 1st week which gradually became harder and darker pellets in 2-3 weeks. During the hand rearing period the fawn was kept in a separate enclosure and between four to six months of age it was gradually introduced to a group of four-horned antelopes (Govindan, 2018).

Rajesh Kumar Mohapatra

Hand rearing of four-horned antelope at Nandankanan zoo.

Barking deer

Barking deer or Indian Muntjac (*Muntiacus muntjak)* belonging to family: Cervidae, has a redish brown coat with gray or white underparts. Bony frontal ridges with two black line on its face distinguishes it from other deer species. When alarmed or in flight these deer gives short cackling barks (Prater, 2005). They are found in most of the peninsular India, Terai, North-Eastern India and the low Himalayas (Menon, 2014). Neonates weighed 1.554kg in average ranging from 1.2 to 2.01kg (Acharjyo and Mishra, 1981). Litter size is usually one (Acharjyo and Mohapatra, 1980). Female became sexually mature at 8 months of age whereas males became mature at 12 months of age (Barrette, 1997). They have a gestation period of 205 to 215 days (Fradrich, 1987). They breed throughout the year (Acharjyo and Padhi, 1972).

Assam State Zoo cum Botanical Garden, Guwahati: Rescued barking deer fawns of age below one month were hand reared at three different instances in 2005, 2008 and 2010. They were fed with diluted cow milk in 1:1 ratio at 5-7% of their body weight per day along with oral rehydration solution and feed supplements. In the first instance, the rescued fawn was in very critical health condition and was provided with treatment. Though it had shown slight improvement, its faeces were never normal and succumbed to death on 7th day of rearing. In other two instances the fawn responded well to the hand rearing with good growth rate. They

Pitambor Newar

Hand rearing of barking deer at Assam State Zoo, Guwahati.

started feeding on grass within one month of rearing. In the 2nd month, they were shifted to bigger enclosure and was allowed to live with other individuals of their species. .

Nandankanan Zoological Park, Bhubaneswar: One barking deer fawn was hand reared at Nandankanan zoo during 2016. It was received from Ghumsur South Forest Division, Odisha in April, 2016. This male fawn was estimated to be around one month old, weighing 2.5kg and apparently healthy at the time of receipt. The fawn was fed with Lactogen-I (Nestle), a human baby milk powder reconstituted in water as per recommendation of the manufacturer. After initial resistance, the fawn got acquainted with the feeding bottle. It was fed approximately 10% of its body weight in a day. 60ml milk was provided in every feeding four times a day. Calcium, multivitamins and herbal liver tonics syrups were supplemented in milk. After two weeks of hand rearing, it started taking vegetables (pumpkins, long beans, carrots) given to it in small quantity. Milk diet was completely withdrawn after 3 months. Body weight of the fawn was recorded as 3350g, 4470g, 5450g on completion of one, two and three months of rearing, respectively.

Mathur (1992) reported hand rearing of one barking deer fawn at Nainital area, Uttarakhand which was found abandoned at road side. As the young was very much emaciated, dehydrated fluid therapy was given along with antibiotics. The fawn was fed with 10ml of 50% diluted milk at an hourly interval. It was introduced to a lactating German shepherd (bitch) the same day during dark hours by smearing the milk from the bitch on it under close observation for any aggressive behaviour. The fawn was accepted by the bitch and reared. After 17 days, the fawn was put on bottle feeding with cow's milk supplemented with vitamins and minerals for 2 months of age. Subsequently, it started nibbling grass and at the age of 3 months and it was released to local forest area.

B K Gogoi

Hand reared barking deer with conspecifics at Assam State Zoo, Guwahati.

Mouse deer

Mouse deer or the Indian chevrotain (*Moschiola meminna*) does not belong to the deer family, rather to a distinct family Tragulidae. Unlike deer, it lacks antlers, facial scent glands and both sexes have canines. They are nocturnal and herbivorous. They breed throughout the year (Acharjyo et al., 2005; Swapna and Sandeep, 2013). Female mouse deer comes to oestrus at an age of 145 days. Gestation period varies from 150 to 163 days. Age at first fawning is 304 days. The litter size is one, but occasionally twins are born. Mean birth weight and mean height is 468.8 ± 63.3g and 10 ± 3.3cm respectively (Swapna et al., 2014). Acharjyo and Mishra (1981) reported neonates weighed 319g (288-382g) and measured 27.9cm (26.5-30.5cm) in length with 14.6cm (14-16cm) in shoulder height. Female mouse deer become sexually mature at 5-8 months of age (Swapna and Sandeep, 2013).

Nandankanan Zoological Park, Bhubaneswar: Nandankanan zoo received one rescued mouse deer fawn on 23.03.2013 from Ghumsara North Division. The fawn initially weighed 380g. Considering the birth weight between 300-350g the age was estimated to be 10-15 days. It was bottle fed with reconstituted Lactogen-I, diluted as per the manufacturer's description. Initially, the fawn was fed with 5-7ml of reconstituted milk, six times a day. The milk feed increased to 10ml and 15ml in 5 times a day on 2nd and 3rd week of rearing, respectively. From 4th week onwards the milk feed was gradually reduced and completely stopped at the end of 5th week. It started eating vegetables and grass from 19th day of rearing. At the time of weaning the fawn weighed 1.68kg.

Rajesh Kumar Mohapatra

Hand rearing of mouse deer at Nandankanan zoo.

Stump-tailed macaque

Stump-tailed macaques (*Macaca speciosa*) are the largest and heaviest macaque species of India, distinguished by its blotched reddish face and short tail from other macaques. They are restricted to only Assam hill forests in India (Kumar and Raghavaih, 1996). They breed throughout the year. A single young is born after a gestation period of 165-185 days (Gogoi 2006). They breed throughout the year in captivity (Nieuwehnuijsen et al., 1985; Kumar and Raghavaih, 1996). Female first conceived at 4.4 years of age (Estrada and Estrada, 1981) and male first sired at 3.25 years of age (Trollope and Blurton-Jones, 1972). The gestation period reported to be 178 days (Trollope and Blurton-Jones, 1970) and the neonates weighed 380-650g (Nieuwehnuijsen et al., 1987). The litter size was one (Estrada and Estrada, 1981). Weaning observed in 10-14 months (Trollope and Blurton-Jones, 1970).

Assam State Zoo cum Botanical Garden, Guwahati: A stump-tailed macaque baby was hand reared at Assam State Zoo in 2005 (Gogoi, 2006). The baby was fed with 25% diluted commercially available homogenized toned milk (3% fat and 8.5% solid not fat (hereafter SNF) for first 2 weeks and later on without any dilution. Initially the baby was fed 20ml of milk at an interval of 1 hour or more. Gradually, the number of feeding was reduced with an increase in the amount feed and feeding interval. It was fed 6 times a day with 50 ml each from 5th- 8th weeks and 5 times a day with 70ml each from 9th-12th weeks of hand rearing. Ultimately, the milk diet was reduced to once a day from 13th-16th weeks and stopped. Feed was supplemented with calcium, phosphorus, vitamins and protein twice a day during rearing. The baby started accepting solid food at the age of one and half months. The baby weighed 450g when it was five day old and gradually grew to 700g on 1st fortnight, 1100g on 3rd fortnight, 1500g on 6th fortnight and 1700g on 8th fortnight.

Hand rearing of stump tailed macaque at Assam state zoo.

Anupam Natha

Bonnet macaque

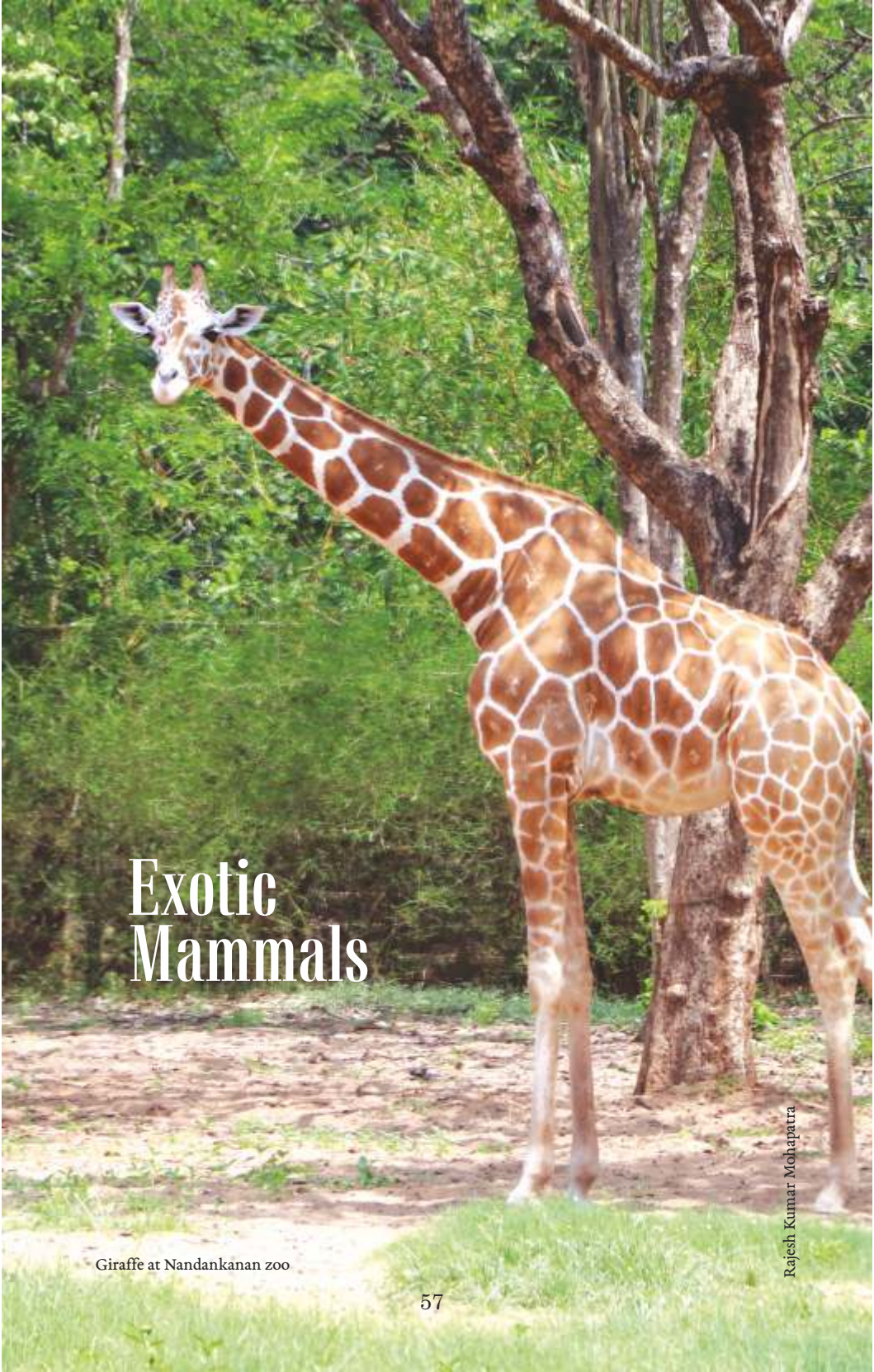
Bonnet macaques (*Macaca radiata*) are medium sized commensal macaques endemic to peninsular India. They are distinguished from other macaques by a cap or bonnet of long hair, arranged in a whorl and parted clearly and a very long tail that longer than its body (Menon, 2014). Female bonnet macaques become mature at 4 years of age and males at 6 years of age (Simonds, 1965). Births usually recorded in February & March (Simonds, 1965). Parturition in zoo housed bonnet macaques recorded from June to August (Acharjyo and Padhi, 1972). They have a gestation period of 162 days (Valerio and Dalgard, 1975). The litter size of one was recorded (Acharjyo and Mohapatra, 1980). The neonatal mass of female and male offspring recorded to be 388 ± 34g and 411± 50g (Valerio and Dalgard, 1975), respectively.

Nandankanan Zoological Park, Bhubaneswar: During May, 2017 one female bonnet macaque baby was hand reared at Nandankanan zoo following sickness of its mother. The baby was fed with human baby milk formula 'Lactogen-I' (Nestle) at its recommended reconstitution formula. It was fed @10ml per feed, 7 feedings per day at 3 hours interval. It was gradually increased to 70ml per feed in 6 months of hand rearing. Thereafter, milk provision was gradually reduced and withdrawn at 1 year age. It started eating fruits on 3 months age which gradually increased. It started taking pulses and leaves at about 6 month of age. On arrival the baby weighed 300g and it grew to 420g, 470g, 570g, 610g, 700g, 775g, 850g, 920g, 980g and 1075g in 1st to 10th weeks on age, respectively. It was of 820g weight when it started accepting fruits.

Rajesh Kumar Mohapatra

Hand rearing of bonnet macaque at Nandankanan zoo.

Exotic Mammals



Giraffe at Nandankanan zoo

Rajesh Kumar Mohapatra

Giraffe

Giraffe (*Giraffa camelopardalis*) is the tallest living land-animal. They are native to Africa, especially the savannas, grasslands and open forests of sub-Saharan regions (Muller et al., 2018). They breed throughout the year (Innis, 1951, Kingdon, 1979). Female becomes sexually mature at 6 year ± 3 months (Hall-Martin and Skinner, 1978) whereas male got sexual maturity at 7 years of age (Kingdon, 1979). Litter size is one but occasionally two are born (Innis, 1951). The gestation period recorded for the species is 462 days (range 459-465 days) (Savoy, 1966). The giraffe calf was 1.9m in height and weighed 45kg at birth (Khadri and Valandikar, 2002).

Photo courtesy: Mysore zoo.

Hand rearing of giraffe calf at Mysore zoo.

Shri Chamarajendra Zoological Garden, Mysore: The zoo had hand reared seven giraffe calves following maternal rejection (Khadri and Valandikar, 2002). The calves were fed with 1000ml of cow colostrum for first three days at every three hours interval. Next three days, they were fed with 50% of whole cow milk (500ml) and 50% of colostrum (500ml). Further three days, 75% of cow milk and 25% of cow colostrum were given. Milk feed was gradually increased to 1500ml in the 3rd month and 1600ml in the 4th month that continued till end of the 6th month. The feed was supplemented with vitamins and calcium from 3rd week onwards. From 7th month onwards, 100ml cow milk was reduced every month up to 9th month. Daily feeding of cow milk 6 times a day continued till 5th month. Number of feedings per day was gradually reduced from 6th month onwards (on 6th month-5 feedings/day, on 7th month-4 feedings/day, on 8th month-3 feedings/day, 9th month-2 feedings/day and discontinued thereafter). The calf was weaned by this stage. Browsing was practiced from 20th day onwards with *Acacia* leaves, grass, *Ficus*, Neem and Jamun leaves. From second month onwards the calves started accepting small quantity of vegetables and concentrates.

Jaguar

Jaguars (*Panthera onca*) are the largest felids of the American continent. They have pale yellow to reddish-brown fur with black spots, which on the sides change to rosettes; within these, there may be one or more small spots (Ceballos, 2014). They breed throughout the year, gestation lasts for 91-101 days (in captivity), after which the female gives birth to up to four cubs (Seymour, 1989; Quigley et al., 2017). The kittens are born with spots and eyes closed weighing around 800 g. They stay about 15 to 24 months with their mother and attain sexual maturity between 2 and 3 years (Seymour, 1989).

National Zoological Park, New Delhi : One jaguar cub was hand reared at National Zoological Park, New Delhi during 2013 after repeated death of three consecutive litters, due to cannibalism and other causes (Selvam et al., 2005). The jaguar cub was reared by a lactating foster bitch along with its own pups. The cub was kept in a wooden box of size 5.3X3.3X3.0 feet. During initial 2 weeks, the frequency of milk provided was 6 times/day an interval of 3 hours. From forth week onwards the frequency was reduced to 5 times/ day. The jaguar cub started accepting chicken soup on 47th day. From 71st day onwards,

M Sandeep

Adult jaguar at Nehru Zoological Park, Hyderabad.

it started accepting boiled chicken, beef and raw chicken and live fowl subsequently. Initially on day 1, the cub weighed 0.710kg. The cub weighed 1.300kg and measured 53.5cm in body length on 4th week, 2.340Kg and 64cm on 8th week and 3.400kg and 75cm on 10th week of age, respectively.

Nehru Zoological Park, Hyderabad: One day-old jaguar cub was hand reared at Nehru Zoological Park, Hyderabad due to maternal rejection. The cub weighed 750g and was shifted for hand rearing on 02.10.2014. It was fed with 'Royal Canin baby cat milk' powder with lukewarm water reconstituted as per manufacturer's recommendations. The cub was fed 7 times a day starting at 06:00 morning to 12:00 at night, at every 3 hours internal. Initially the cub was fed with 10ml of reconstituted milk during the first week of hand rearing. The amount of milk gradually increased by 5ml per week till 7th week and then by 10ml till 11th week. During 12th week cub was accepting 100ml of milk. The cub started accepting boiled chicken from 02-01-2015 (3 month of age) when it was 4.093kg in weight. The cub weighed 9.6kg on 02.03.2015 (5 month of age) when it was completely on meat diet.

Photo courtesy: Nehru Zoological Park, Hyderabad.

Hand rearing of jaguar cub at Nehru Zoological Park, Hyderabad.

Hamadryad baboon

Hamadryad baboons (*Papio hamadryas*) are old world monkeys found in northeast Africa, Saudi Arabia and Yemen. They have long and narrow snouts, a prominent ischial callosities or sitting pads. Females have brown fur with hairless faces and hindquarters of a similar color. Males are more colorful than females, with striking silvery fur that grows in a prominent mane around their heads and on their shoulders, emphasizing their pink faces (Butynski et al., 2013). They live in large troops but the troop is made of many stable groups or clans consisting of 1-4 polygynous single male harem units (Kummer, 1990). In wild female give birth to their first surviving infant at six years of age whereas male reproduce at nine years of age (Sigg et al., 1982). Gestation period is 178.6 ±15.5 days (Polo and Colmenares, 2016).

Indira Gandhi Zoological Park, Visakhapatnam: One-day old hamadryads baboon was hand reared from 28.02.3018 following maternal rejection. The baby was fed with 'Beapher lactol puppy milk'. The baby was initially fed with 5ml of milk, which gradually increased (~ 5ml/week) to 30ml on seven weeks of age. And, from 8-12 weeks 40ml milk was given. The frequency of feeding was 8 times a day till 5th week and 6 times a day from 7th–12th weeks. From 13th week the baby was fed with 2 spoon (25g) of Cerelac mixed in lukewarm water 5 times a day. The quantity of Cerelac gradually increased till 19th week to 5 spoon (62.5g), 4 times a day. From 20th week onwards 3 spoon of Cerelac was given as feed 3 times a day, in addition 100g of fruits were given once a day. The quantity of fruits gradually increased to 300g on 29th week and continued. Feed was supplemented with multivitamins as per requirement. On arrival the baby weighed 1100g and weighed 1650g, 2000g, 2250g, 2450g and 2850g on completion of 1st, 3rd, 5th,7th and 9th month of age, respectively.

Photo courtesy: IGZP, Visakhapatnam.

Hand rearing of Hamadryad baboon at IGZP, Visakhapatnam.

Chimpanzee

Chimpanzees (*Pan troglodytes*) are the closest living relative to humans, sharing more than 98% of our genetic blueprint. They inhabit tropical forests and Savannas of equatorial Africa. The male and female neonates weigh 1.35-2.2kg and 1.2-2.44kg and measured 37-44.5cm and 34.3-45.7cm in size, respectively (Keeling and Riddle, 1975). Usually one and occasionally two are born in a litter, (Peacock and Rogers, 1959). In females, swelling of vulva first observed in 6-8 years age (van Lawick-Goodall, 1969) and in males sexual maturity attained at 8 years of age (Yerkes, 1943). Gestation period varies from 202-261 days (Yerkes, 1943). They start accepting solid food at 4-6 months of age and weaning observed between 1.5-2.5 years of age (Goodall, 1965).

Kanpur Zoological Park, Kanpur: One male baby chimpanzee was hand reared at Kanpur Zoological Park during 1985 (Gairola, 1986). The baby was separated from its mother on 4th day of birth due to lack of nursing by the mother. On the 1st day of hand rearing, the baby was fed with 5ml of 5% dextrose solution 4 times a day. Thereafter the baby was fed with human infant formula (Lactogen). The feed was supplemented with vitamin and minerals. Quantity of the feed was gradually increased from 1g Lactogen in 10ml of water on 2nd day to 25g in 150ml on 8th week and finally to 35g in 210ml on five months of age. The baby was fed four times a day.

The body weight of baby was 1.700kg, 2.325kg, 3.475kg and 4.700kg on its 4th day, 1st month, 3rd month and 6th month of age, respectively. Commercially available solid feed like 'FAREX' was

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Chimpanzee- a family portrait, Nandankanan zoo.

introduced from 10th week and minced banana with orange juice started from 12th week onwards. Lactogen infant formula was replaced by full protein formula after completion of five months of age. Calcium was supplemented twice a day from 10th week onwards.

Nandankanan Zoological Park, Bhubaneswar: One baby chimpanzee was hand reared at Nandankanan zoo during 2009 as the mother chimpanzee did not show maternal instinct (Mishra et al., 2010). The baby was separated from his grandmother chimpanzee who was holding the baby just after birth. The baby was housed in a well ventilated nursery room of 2.30m X 2.30m size with provision of wooden cot, blanket and mosquito net. After separation 20 drops of dextrose solution was given to the baby. The proportion of reconstituted milk include 4.6g of Nestle's Lactogen-1 (infant formula) in 30ml of lukewarm water which had been maintained throughout the rearing period. The baby was fed 10ml of reconstituted milk at every hour on the 1st day and 30ml of milk at every 2 hours interval from 2-15 days of rearing. The feed was supplemented with multivitamins. Thereafter with the increased feed acceptance, the quantity of milk was gradually increased to 90ml at 71st day and onwards till 207th day, with an exception of reduced quantity of milk fed during 14th week as the baby was suffering from diarrhoea which was cured by administration of antibiotics. The frequency of feeding was reduced to eight feedings from 71st day onwards. The baby weighed 1655g in the one day of age, 2344g at four weeks of age, 3000g at 8 weeks of age, 3515g at 12 weeks of age and 4300g at 19 weeks of age, respectively. The baby started crawling in belly position at 95 days of age. It started responding to social interaction with his parent at 154th days of age (Mishra et al., 2010).

Satyanarayan Mishra

Hand rearing of chimpanzee at Nandankanan zoo.

Marmoset

Common marmosets (*Callithrix jacchus*) attain sexual maturity at around one year of age, but first successful reproduction occurs at about 1.5 years of age (Tardif et al., 2003). The average gestation period is estimated to be 143 to 153 days and soon after parturition (within 10 days), female marmosets begin to cycle again and shortly thereafter become pregnant (Tardif et al., 2003, Lunn and McNeilly 1982; Sussman, 2000). Marmosets produce more youngs per delivery compare to any other anthropoid primate and have more variation in litter size and triplets are the most common litter size (Tardif et al., 2003). Common marmosets exhibit a high degree of birth seasonality in the wild and have two birth peaks during the year; during September, October, and November as well as April, May and June (Stevenson and Rylands, 1988). Lactation lasts for 65-90 days and baby stops suckling in 8-10 weeks of age (Tardif et al., 2003) Weaning to solid food begins around 4th week and by about three months of age, the infants are almost completely weaned and are capable of self feeding (Tardif et al., 2003, Stevenson and Rylands, 1988). By 15 months, common marmosets attain their adult weight and are capable of reproduction (Yamamato, 1993).

Nandankanan Zoological Park, Bhubaneswar: During February, 2015, one new born marmoset was rescued for hand rearing as its mother died just after its birth due to dystocia. The baby was very small weighing 36.09g and measuring 19cm including 10.5cm tail. It was

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Housing of marmoset during hand rearing at Nandankanan zoo.

housed in chick brooder (Make-Brinsea) with heating element fitted inside. Gauge cloth and towels were used as bedding materials to give warmth as well as to simulate mother's lap. It was fed with human baby feed formula "Lactogen-1' (reconstituted 1g in 20ml water) added with one pinch glucose and 2 drops multivitamin syrup and one drop of CellPet immune booster. Gripe water @ 5drop along with *Lactobacillus* (Sporolac) was provided twice a day. It was fed through a dropper at every 1 hour interval 24 feedings per day. It was accepting only few drops of reconstituted milk in every feed. Multivitamins and calcium preparations were added to the milk. Number of feedings were reduced to 16 times per day after 1st week of rearing with no feeding during night. It was further reduced to 12 times per day at 2 hr interval after 3rd week; 6 times per day at 3 hours interval after 3rd month and from 8th month onwards feed was given four times a day. The infant started taking grass hopper from 10th week and fruit pulp from 13th week onwards. It weighed 47.5g, 64g, 125g, 230g and 430g on 14th, 26th, 53rd, 110th and 223rd day of rearing, respectively.

Prasant Gouda

Feeding of marmoset during hand rearing at Nandankanan zoo.

Recommendations

Criteria for selection: The animal should be selected for hand rearing under the following conditions: when the dam is injured, ill or dead, the dam rejected the infant, the infant is weak due to lack of nutrition and it was rescued or seized from wildlife crime committed. Priority be given to reunite with its dam after initial stabilization, if not succeeded; ultimately, long term rearing may be resorted to.

Initial care: Veterinary examination of the infant on arrival is highly recommended followed by treatment if necessary. If the infant is with umbilical cord attached, it should be tied and applied with mild antiseptic lotion. It should be monitored for subsequent signs of infection or swelling.

Body temperature: Normal body temperature ranges from 37.22 to 39.44 °C (99– 103 °F) for most mammals, depending on the species (Frazier et al., 2013). Recording of rectal temperature during initial days of hand rearing in case of hypothermic (low body temperature) infants is recommended until body temperature become normal. Placing the infant next to a covered hot water bottle or inside an incubator set at 26.67– 29.44 °C (80– 85 °F) for neonates will be helpful restoring normal body temperature. Similarly, hanging a heat lamp or using a ceramic brooder lamp larger infants helps (Frazier et al., 2013).

Housing: Nursery of the hand rearing infants should be in a clean, well ventilated area with minimum human interference. The housing facility and equipments should be sanitized between the cases. Group housing of hand reared infants often creates problems, e.g. sucking of body parts of housemate in an attempt to find nipples. At times suckling attempts concentrate on genital region and cause injury as the tissue is very delicate. Frazier et al. (2013) recommended application of "bitter orange" for temporary discouragement of this behaviour. In other instances, segregation and individual housing is required. Provision to express exploratory, playful behaviour and exposure to sunlight should be provided in a suitable outdoor facility. This is necessary for good muscle development, coordination, gastrointestinal tract functioning, temperature regulation, exhibition of natural behaviours and learning.

Feeding: The infants meant for hand rearing need to be checked for

proper hydration before giving any milk formula. Oral fluids should be avoided in case of hypothermia. Feed should be provided after bringing the body temperature to normal or near normal condition. In case of infant not able to suckle, very dehydrated and/or debilitated; alternative administration of fluid: oral with nasogastric tube, sub-cutaneous, intravenous or intraperitoneal may be opted under proper supervision during emergency. Choosing suitable milk formula is crucial for hand rearing. A formula similar in composition to mothers milk is the ideal option.

Formula calculation: The amount of feed given during hand rearing is crucial for the health and development of the infant. Total feed offered per day should be between 20-25% of the body weight for carnivores, 15-18% for primates and 15-20% for hoof stocks (Frazier et al., 2013). The total feed should be divided into number of feedings based on the gastric capacity (stomach capacity) of the infant. Frazier et al. (2013) suggested an infant of 1Kg body weight has approximately 50ml gastric capacity. The infant should not take feed more than its gastric capacity (Frazier et al., 2013). For example, one cub weighing 500g should be fed with 500(g)X20(% of feed)=100 (ml of feed) in a day. The gastric volume will be 50(ml)/1000(g)X500(kg)= 25ml per feeding. Number of feedings =100(ml)/25(ml)= 4 feedings per day. Increasing number of feedings more than the calculated values reduce further the quantity of feed per feeding and are helpful in proper digestion and assimilation. Over feeding should be avoided as it may cause gastric disorder, diarrhoea, blot etc.

Nipple shape and size: Shape of mouth of the infant and the shape of its mother's nipple should be considered to find out most suitable nipple for bottle feeding. It should have an appropriate sized hole in it as larger sized holes make the infant suckle very quickly and may inhale milk into its lungs, at times causing aspiration pneumonia. Selecting smallest possible hole in the nipple that allows the infant to suckle without frustration is helpful.

Sanitation: Neonates do not have adequate immunity for protection against infections and diseases, unlike adults. Therefore, precautions should be taken to avoid infections, which include provision of separate clothing for the personnel working in hand rearing, sanitation of hand before handling of the feeding bottles, feed and

measuring equipments. Preparation of fresh milk feed at each feeding is recommended. Storing the reconstituted milk feed even the meat pieces is not advisable as milk and meat form an excellent culture media for bacterial growth. The feed clinging near the mouth after feeding should be cleaned.

Observations and record keeping: Faecal consistency is a good indicator of the overall health of the infant. Variation in the same may be indicative of nutritional inadequacies or medical conditions. Some infants need manual stimulation for defaecation and urination. Gentle massage near ano-genital region with a cotton ball or clean cloth soaked in luke warm water is helpful for stimulation. It may be needed routinely until the infant does the same on its own consistently. On observation of diarrhoea, the formula should be diluted further (Acharjyo, 2002).

Keeping records of date of birth/acquisition, milk formula, frequency of feeding, quantity of formula consumed, day of solid food acceptance, amount of solid food eaten, change in body temperature, body weight measurement, eye opening, teeth eruption, other behavioural or biological information are useful and serves as references for future.

Identification: Individual identification is needed when more than one individual of the same species are hand reared together to avoid confusion during feeding and keeping records. For this, the infants may be marked tying with woolen threads of different colours, providing colour dots at visible body parts like ear tip, top of the head etc. Finally, permanent markers, like microchips and tags be used for their identification.

Weaning: The process of weaning (acceptance of feed other than milk, usually adult diet) is species specific and depends upon the body size, growth rate and lifespan of the species. Generally, species with larger body size have longer weaning period and species with smaller body size have a shorter period. Usually small portions of solid food mixed with the existing milk formula are given as feed to stimulate weaning. Weaning the infant too early may compromise its growth where as extended bottle feeding may develop human imprinting behaviours. Therefore, weaning should be made judiciously considering its natural history, e.g. the time that an animal would normally suckle in the wild (Trendler, 2005).

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