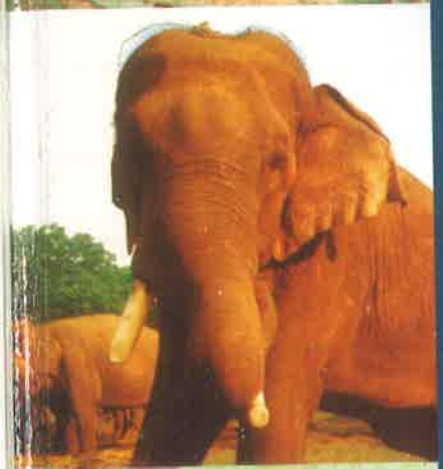

DIETARY HUSBANDRY OF WILD MAMMALIA

Dr. B. M. Arora

ASSOCIATION OF INDIAN ZOO AND WILDLIFE VETERINARIANS
&
CENTRAL ZOO AUTHORITY

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2001

वन महानिरीक्षक एवं विशेष सचिव
पर्यावरण एवं वन मंत्रालय
भारत सरकार
DIRECTOR GENERAL OF FORESTS & SPECIAL SECRETARY
MINISTRY OF ENVIRONMENT & FORESTS
GOVERNMENT OF INDIA

FOREWORD

Nature takes care of animals living in the wild. Their dietary requirements are met by the ecosystem to which the species belong. In fact, the availability of food material determines the movement pattern and abundance of the species in various wildlife habitats. However, when the animal is under the management of a zoo, the responsibility to provide food shifts from nature to the manager of these facilities. Since the range of food available to the wild animals in nature is varied, providing feed to the animals in the zoo similar to what it gets in nature is difficult and at times impossible. The management of the zoo has, therefore, to look for wholesome and unadulterated substitutes.

The need of a manual which can provide the zoo managers necessary scientific knowledge on the nutritional aspects of the zoo animals was felt for a long time. I am glad that Dr. B.M. Arora, former Director, National Zoolocial Park, New Delhi wildlife veterinary scientist of long standing has brought out a manual on Dietary Husbandry of Wild mammalia. The manual will provide the zoo managers an insight to the dietary needs of various species in their collection. I hope it spurts them to review the existing feeding schedules and revise them in such a manner that both their nutritional and physiological requirements are adequately met.

(C.P. Oberai)

ASSOCIATION OF INDIAN ZOO AND WILDLIFE VETERINARIANS

Reg. No. 1097/1999-2000

ACKNOWLEDGEMENTS

Directors and Veterinary Officers of the various captive and free wild animal facilities were kind to provide the animal diet schedules and their contribution in this respect is greatfully acknowledged. The help rendered by Dr. D.N. Kamara, Sr. Scientist (Nutrition) and Dr. N.S. Parihar, Former Head Division of Pathology, IVRI, Izatnagar (UP), and Mr. Bipul Charkarborty, Scientist, CZA, New Delhi for providing their critical views on the animal foods & feeding for the improvement of this publication deserve special thanks.

Last but not least I am thankful to Shri S.C. Sharma, Chairman, Members of Technical Committee and Member- Secretory of Central Zoo Authority for approval of the financial assistance to the author to bringout this publication.

B.M. Arora

[B.M. ARORA]
President

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I. INTRODUCTION

Food, water and shelter are three prime requisites for all living mammals on earth. Each mammalian species has its particular food requirements which are different not only in type but in quantity and quality also. The series of energy transfers have been called food chains because of the linkage of one with the others. Food chains rarely exceed four or five links and end in a predator. The top link in a food chain is generally controlled by territorial demands or requirements of space for the growth and prosperous development of the individuals of the species and this territorial demand is the strongest in the higher predators. In nature, several food chains in animal community constitute a food web.

The herbivores support themselves on the foraging matter-grasses, forbs, trees, shrubs and herbs. In captivity the diversity of dietary supplements in the case of herbivorous mammals is due to the variety of cultivated fodders offered. The diversity in supplied concentrate diets occur more by necessity and choice than by chance. The simple reason for diversity of diets of a species in captive facilities is that the same food commodity is not likely to be available in all seasons and in all parts of the country. The Veterinary Officers are, therefore, often left with no choice but to compute rations out of suitable substitutes much to the delight/palatability of the animals. For example, tender maize fodder remains available from February - November and berseem fodder from December - April in tropical regions.

Author has carried out survey to collect and collate information and data about food preferences of wild mammalian species in nature, and feeds and feeding regimens being followed in case of those very spercies in ex-situ facilities, and practice undertaken hand rearing of neonates. Mention has also been made about the nutritional studies carried out. The available case reports on diseases and disorders related to nutritional deficiencies are also included. After analysis of the entire information and data on these aspects following observations are indited.

(a) Most of our zoos have not yet formulated species specific dietary standards. In this respect certain examples are cited below.

i) Primates: At Biological Park, Patna (Bihar) both stump-tailed macaque (*Macaca speciosa*) and golden langur (*Presbytis geei*) are fed with the same type and quantity of diet. Zoological Garden, Mysore (Karnataka) feeds the same type and quantity of diets to Nilgiri langur (*Presbytis johni*), stump- tailed macaque(*Macaca speciosa*), lion-tailed macaque (*Macaca silensus*) and bonnet macaque (*Macaca radiata*). Zoological Park, Vandalur, Chennai (Tamil Nadu) feeds typical diet of same quantity to all its *Presbytis* species and rhesus macaque (*Macaca mulatta*), d) Zoological Garden, Guwahati (Assam) , and Zoological Garden, Itanagar (Arunachal Pradesh) have slated the same flat scale for both macaques and langurs. Further to their different exotic primate species, many captive facilities feed the same diet rather than diets formulated according to the species specific food preferences and requirements.

(ii) Large cats. Zoological Garden, Mumbai (Maharashtra) and Zoological Park, Kanpur (Uttar Pradesh) feed tigers (*Panthera tigris*) 12 to 16 kg beef per adult per day, whereas in other zoos the feeding scale of beef to tigers varies from 10 to 12 kg. Author's observation is that an adult tiger should be fed only 10 kg of beef having 25 to 30 per cent bone element six days in a week.

(iii) Ursids. To sloth bears (*Melurus ursinus*) Van Vihar, Bhopal (MP) and Zoological Park, Patna(Bihar) feed about 7.0 kg diet per adult per day, whereas it is about 5.0 kg in Zoological Park, Kanpur (UP).

(iv) Wild boar. In certain zoos ration to wild boar are @3 to 4 kg per adult per day and in others they are about 5 to 6 kg per adult per day.

(b) Allowances and supplementation for growth, reproduction, seasonal variation, stress, etc. are not being taken into consideration in the diet regimens for most of the endangered native species such as sangai deer (*Cervus eldi eldi*), chowsingha (*Tetracerus quadricornis*), rhinoceros (*Rhinoceros unicornis*), Lion-tailed macaque (*Macaca silenus*), golden langur (*Presbytis geei*), nilgiri langur (*Presbytis johni*), etc. Supplementation of foods for requirements of vitamins (particularly A, C and E) and minerals (particularly calcium and phosphorus) in the rations of certain captive mammalian species are required to be meticulously assessed. Synthesis of vitamin B_{12} in the gut with the blood plasma concentrations ranging from 16.94 µg/100 ml to 18.05 µg/ ml has been reported for the first time in growing and adult asian elephants (Ananthasubramanium,1989).

(c) Studies to determine food preferences in nature in case of many small native mammalian species such as mouse deer, pygmy hog, clouded leopard, caracal, binturong, golden cat, rusty spotted cat, marbled cat, hedgehog, hog badger, hoolock gibbon, slow loris, marmoet, marten, giant squirrel, pangolin, etc.are necessary, because difficulties are being faced in their long term survival and successful breeding in many zoos of the country.

(d) There are published reports about hand rearing of orphan neonates from the wild or those born in captivity by trial and error with their variable survival rates and breeding fates. There is urgent and express need to develop species specific standard guidelines on this aspect.

(e) Studies on digestion and metabolism in native wild mammals are almost negligible. The hydrolysis of ingesta by enzymes and microbial fauna in the gastro-intestinal tracts are yet not investigated, except in captive blackbuck (*Antilope cervicapra*) to some extent and detailed metabolic studies for certain foods in case of elephant (*Elephas maximus*). Hence, over all function of the various digestive processes to reduce food to molecular size or solubility that allows absorption and cellular utilization of the individual nutrients in the processes of metabolism in native wild mammals have to be established.

The Calgary Zoo Keeper Training lecture no 16 mentioned that in domestic animal for each m^2 body surface on 500 kg live weight(hypothetical basis) the amounts of carbohydrates (starch) required are: horse, 2.0 kg; cattle 2.4 kg; sheep,

5.8 kg and rabbit,14.4 kg. In general crude protein requirements are: herbivores, 12-18% ; omnivores, 20-25% ; carnivores 25-35% and fish eating animals over 35% on dry matter basis. The crude protein levels in the diets of grazing hooved stock are said to be 8-12% and in the diets of browsing hooved stock 12-16%. The proteins and carbohydrates are fed in proportions of 1:8-10 for domestic ruminants. This relationship changes for carnivores considerably. Total food caloric requirements (per kg body weight) in certain wild mammalian species mentioned are : hippopotamus 10 Kcal., elephant 13 Kcal., giraffe 20 Kcal and rhinoceros, 22 Kcal (Ingakrumbiegel,1987). Similar studies to establish food caloric requirements for most of the native mammalian species are required. (Note:The compact body of a hippo has less demand due to the surface to body weight ratio mentioned by Ingakrumbiegel, 1987).

(f) There is meager information on nutritional diseases and disorders in captive wild mammals and such information is almost lacking in free ranging populations of wild mammals. Species specific diet formulations for sick animals are also wanted.

(g) Explosion of human population has caused great devastating changes in the landscaping and topographic scenario of the wildlife habitats which have resulted definitely in adverse impact on the availability of foods to the species in nature. For example a habitat once having diverse vegetations and cover may be degraded to the extent that it is left only with bushes and shurbs. Therefore, regular studies on food ecology of the important mammalian species in various *in- situ* management facilities if carried out will enhance prospects of wildlife conservation.

This Publication on "Dietary Husbandry of Wild Mammalia" is a compilation embodying basic knowledge and information mainly on four aspects: i) Adaptive topographic anatomy and physiology of alimentary tracts, ii) Food availability to the mammalian species in nature, and food and feeding practices in various captive facilities iii) Hand-rearing of neonates, and v) Nutritional diseases and disorders. Appendix at the end encompasses guidelines for requirements of major nutrients,list of common trees and grasses, nutritive values of herbages and glossary of terms.

It is my sanguine hope that this compilation would serve as an useful guide to encourage and stimulate the animal nutritionists to undertake research in food ecology of free ranging wild animals and to evaluate specific dietary requirements of the counter species maintained in *ex-situ* facilities, which will certainly help Wildlife Veterinarians to formulate and compute suitable diets to meet their qualitative and quantitative requirements (The digestibility of dry matter, protein, fat, carbohydrate, ash, and energy has not been established for their diets so far. Likewise the caloric content of their diets remains unidentified).

The learned readers are welcome to draw the author's attention to any errors or scope for improvement in this review publication.

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II. GENERAL CONSIDERATIONS

Food is required for growth, subsistence and reproduction for all living beings. In nature such different needs are met by varying consumption. The caloric intakes are adjusted as per the needs of metabolism. The animal may be either hypermetabolic or hypometabolic. To determine caloric needs energy requirements are calculated on the basis of actual body weights. The energy needs for ectotherms (cold blooded) are about one eighth to one quarter of those of endotherms (warm blooded) and increase with warmer (but not cold) ambient temperatures. Energy equations vary with reference to basal metabolism. The latter may be free range or confinement based, for maintenance, activity or otherwise. For animals with diurnal activity cycles, the energy needs are for growth, maintenance of body temperature to adjust to ambient weather conditions, production, reproduction, and various other behavioural activities. There is now evidence that energy needs vary with breeds too. Pregnant females need increased calorific and protein intakes. Work on domestic species and on wild rodents (Sadleir, 1969) has shown that food intakes of upto four times than that of the maintenance are required during lactation. Thus, there are varying levels of nutritional requirements. Maintenance requirements include combination of nutrients necessary for body functioning (metabolism, maintenance of body temperature, weight gain and normal repair and replacement of cells and tissues). The production requirements could be for milk or hair coat production. The reproduction requirements meet the need for development of the foetus. Young animals consume greater quantities of food per unit of body weight. They utilize food more efficiently. Therefore have higher requirement for proteins, vitamins, minerals, and energy. They require more concentrated and more easily digestible foods. They are more susceptible to nutritional deficiencies. Special diets are required for assisted feedings of hospitalized animals and hand rearing of infants. To wild mammals both for prey and predator species in nature during the period of calamities such as wild fire, hail storms, drought, the animals have to exert much for search of food .

During recent past, studies on food ecology of wild mammals have progressed particularly in endangered artiodactylid and felid species, but mostly remained restricted to field gross observations on the type of foods and their availability in natural habitats for the species . While devising diets for wild mammals exhibited in *ex-situ* facilities, the knowledge about their natural diet and morphology and physiology of their digestive tracts is of utmost importance to determine the nature of foods and fodders that will meet their essential requirements. If the natural food of the species is not well known, comparison with known diets of similar species of domestic animals can be taken as guide for formulation of their diets. For example, order Artiodactylia, includes members of families *Bovidae* and *Cervidae*. Their nutritional requirements are generally comparable with domestic bovine, ovine and caprine species(i.e. cattle, sheep and goats). Similarly , the wild ass, and rhinoceros to some extent, can be compared with domestic equine species, the horse. In general, the nutritional requirement of certain species of non human primates such as colobus and langurs (leaves eating herbivores), though having four -

compartment - stomach but not-ruminating, are viewed well with those of human beings. Wild big cats have nutrient requirements of true carnivores. They require little carbohydrates but need high protein levels at all times. They may also require certain amino acids and fatty acids, not required by dogs or human beings, and they also require certain vitamins in greater amounts or in different forms. Ursids (sloth bear, Himalayan bear), Mustelids (ratels, otters), viverrids (civets), and procyonids (red panda) by taxonomic classification are carnivore but their requirements are not similar to that of true carnivores. They need fruits in their diets. Nevertheless it must be kept in mind that the captive wild species can differ widely from domestic species and it should not be assumed that diets of wild species would be identical to that of their counter domestic species under the same order. The anatomical and physiological distinguishing features of digestive tracts in different wild mammals develop and adapt to digestion of diverse dietary ingredients available in their ecosystem. Hence, there is always basic difference between the formulation of diets for wild mammals versus their domestic counter species. Further, the diets for domestic animals are generally compounded for maximum economic productivity, whereas long healthy reproductive successful life is the principal concern for wild mammals. To benefit the zoo and Veterinary / Biology Wildlife Conservationists available information on the various aspects of wildlife nutrition is is reviewed succinctly.

(A) Body weights: The standard publications on Indian wildlife mention data on live body weights of many species. On critical observation it is perceived that there is great variation in the body weight values of adult individuals of many species cited by different authors. Such discrepancies pose problems during computation of specific dietary requirements of a species. It is essential to establish nutritional requirements based on digestible coefficients of the nutrients which are always determined on the basis of metabolic body size, which is a major determinant of the energy requirements in ruminants. The energy requirements are proportional to body weight raised to the power of 0.75. The smaller ruminants have a higher requirements per unit body weight than larger species. Hence, establishment of specific average body weights and minimum and maximum ranges of body weights for all the species being maintained in the captive facilities is utmost important.

(B) Morphology of digestive tracts (alimentary canals): Animals are able to recognize which foods are suitable and which foods are not suitable after experience of countless generations and adaptation in nature. Accordingly, species have evolved many variations in their oral cavity and digestive tract that enable them to select and utilize foods of varying compositions. The general morphological variations of digestive tracts vis- a- vis food propensities of different orders of class Mammalia are mentioned briefly as under.

a) Insectivora : In the insectivorous species, the simple stomach is followed by a very short small intestine and usually no caecum as illustrated by *Potomogale*, which is adapted to feeding fresh water fish and crustaceans. In Sorex, the tract is only 2.6 times body length, and some faeces are reingested to permit a second opportunity for digestion. This phenomenon of reflection helps to explain the reduction in gut size as a physiological behavioural specialization. In one species

of Tenrec, which eats food other than insects, the tract may be seven times the body length. Morphology of the digestive system of long eared hedgehog (*Hemechinus collaris*) and pale hedgehog (*Paraecinus micropus*) is required to be studied to establish the food digestion values.

b) Chiroptera (bats): The smallest mammalian gut is found in the insectivorous bat, Rhinopome. Its tract is only four-fifth of its body length. Simplification of the gut is extreme in haemophagous bats, such as *Desmodus*, having the stomach as a blind-ending tube with a very short colon. There is no caecum. Such reductions are clearly adopted specializations rather than representing the primitive condition. In frugivorous bats, the stomach is relatively complex with distinct cardial region, a long pyloric diverticulum folded back on itself and a lateral caecum. The true caecum is also present in some genera. Some species have blind ending tubular stomach and also very short colon. By food habit, they are faunivores. They have relatively complex stomach with distinct cardiac region, long pyloric diverticulum and small lateral caecum (may be absent).

c) Primates : Frugivores species have C- shaped duodenum, small to large caecum and elongated folded colon. Lemurid and colobine species have simple saccular and tubular stomach, very short small intestine and elongated and coiled caecum. By food habit they are folivores and also caecotrophic. Faunivores have simple globular stomach, tortuous small intestine, short conical caecum and simple smooth walled colon. Tree shrews (Tupaia), which supplement their invertebrate diets with fruits, have a slightly larger colon but a small caecum.

d) Artiodactyla : Includes ruminant and non - ruminant species. The whole digestive tract in ruminant species may be about 20 times the body length. In adult male and female chitals (*Axis axis*) the maximum lengths of entire intestinal tract were recorded to be 1180 to 1347 cm (#4). Caecum length ranged from 38 to 72 cm. In one adult male sangai deer (*Cervus eldi eldi*) entire length of intestine measured 1540 cm (small intestine 875 cm, colon and rectum 575 cm and caecum 90 cm). Zheng and Pi (1979) mentioned the mean weights of the food contents of stomach chambers 557.9, 20.0 21.6 and 50.1 g in males (#5) and 779.0, 26.9, 25.1 and 74.1 g in female (#14) musk deer respectively for rumen, reticulum, abomasum and omasum and suggested that the omasum is larger than either the reticulum or the abomasum. Such a condition is unusual among the ruminants except in a few roughage feeders, e.g., buffalo and cattle (Hofman, 1973). In case of blackbuck (*Antilope cervicapra*) the entire intestinal length were found to be 1202.5 to 1950 cm (#6). Caecum length measured from 35 to 60 cm. In one captive adult female blackbuck that died due to impaction of stomach caused by polythene bags, caecum measured 75 cm. In the wild blackbuck specimen (#2) caecum measured comparatively less. Thus by food habits artiodactylids are folivores as well as frugivore. The mature artiodactylid ruminants are well known for their four-chambered stomach which is dominated by the vast rumen divided into dorsal and ventral sacs by muscular pillars and covered by keratinized squamous epithelium with papillae of varying size and shape. The oesophagus opens into a much smaller reticulum which has distinctive honeycomb pattern of ridges and is covered by small conical papillae. The rumen connects with the glandular part of the stomach

through the small ovoid omasum, which is partitioned by many leaves of varying size for water absorption. The glandular abomasum is thrown into folds throughout the fundic region. The small intestine is very long forming 3 distinct parts: duodenum, jejunum and ileum. Caecum is relatively short but colon is relatively long and elaborately flexed and coiled. Rectum is distinctly marked. Examples of true ruminants are in members of families *Cervidae* (chital, hog deer, barasingha, sangai) and *Bovidae* (blackbuck, nilgai, goral, wild buffalo). Fore - gut modifications are noteworthy in exotic species - hippopotamus (*Hippopotamus amphibius*), llama (*Lama glama*) and native species- camel (*Camelus demoderus*) and bacterian camel (*Camelus ferus*). The former two species are exotic to Asia. Camel has three chambered stomach. The two glandular sacs, the omasum and abomasum are merged into a single tube. The species show evolutionary convergence with ruminants in their adaptations of stomach structure for folivory. Hippopotamus (*Hippopotamus amphibius*) has similar evolutionary convergence with the ruminants in their adaptation of stomach structure for folivory. The hippopotamus has the oesophagus opening into a vestibule, with unequal diverticula leading into a third tubular chamber. All three chambers have stratified epithelium thrown into projecting folds with numerous papillae. There is a very long intestine but no caecum. The stomach of pigs and peccaries show some similarity to those of ruminants being three chambered but they do not ruminate. In pigs small intestine is comparatively long. The large intestine (caecum, colon and rectum) measures short in length but is appreciably larger in diameter than the small intestine. Caecum and colon are sacculated. The morphology of the gastric tract of pygmy hog (*Sus salvanius*) needs studies.

e) Proboscidea: There is only one species of elephant (*Elephas maximus*) found in India. It has simple large folded stomach. In adults it measures nearly 100 cm long. It has two extremities, the cardiac and the pyloric. The cardiac end is long and tapering. The anterior end is lined by mucous membrane and number of transverse nearly circular folds project inwards from the wall. When stomach is filled with ingesta they are invisible. Small intestine is about 18 to 20 metres long but capacious. The secretions poured in this portion are bile from the liver, pancreatic juice from the pancreas and from its own glands. The large intestine has huge saccular caecum and colon in large loops. Its total length may be about 13 to 14 metres. By food habit, elephant is classed as folivore.

f) Perissodactyla : Species (wild ass, rhinoceros) of the Order have simple stomach with cornified area. Small intestine is short. Caecum is huge and saccular and colon is capacious, has large loops.

g) Rodentia : Certain species have extensive cardial glands separated from fundus by folds and are frugivores. There are faunivorous species in which gastric glands are changed. In folivorous species stomach is cornified and caecum coiled and long. The members of families *Sciuridae* (squirrels, marmots) and *Hystricidae* (porcupines) are displayed in zoos.

h) Lagomorpha : Hares and rabbits have medium sized stomach, relatively short and simple small intestine, a longer sacculated and coiled caecum and a medium sized unsacculated large intestine. They have caecotrophic habit.

i) Carnivora : Have simple stomach, small intestine, 4 to 6 times of the body length, caecum very small or absent and reduced colon. By food habits the large felids are true carnivores. The ursids and civets are omnivores. Likewise other mammalia species dentition features and analysis of faecal matter (scats) provide great deal of information regarding the diet of various carnivorous species.

(C) Physiology : Food consists of proteins, carbohydrates, fats, vitamins, minerals and water (Fig. 1). Adopted from lecture notes of Calgary Zoo in varying proportions and is eaten for energy, growth and body repair, storage (especially in some species for hibernation), production and reproduction requirements. Modifications of alimentary tracts in different parts reflect adaptation to different foods differing in structure, chemical and nutritional values for meeting the species specific needs.

a) Food/Nutrients : As per Hofmann (1973) the digestive system of ruminants may be classified into 3 main categories: a) concentrate feeders, which feed mainly on the foliage of trees, shrubs, or forbs; b) bulk and roughage feeders, which feed predominantly on grasses; and c) intermediate or adaptable mixed feeders, which either browse or graze depending on what is locally available. The digestive strategies of browsers and grazers are different. Browse contains more indigestible material in the cell wall, mainly lignin and structural carbohydrates but more digestible material within the cell as compared to grasses. Little benefit is gained from retaining browse in the rumen for longer because lignin is highly indigestible. Browsers, therefore, maximize the extraction of the digestible cell contents by having a short period of digestion in order to process as much material as possible. Alternatively grazers have longer retention times to facilitate fermentation of the cellulose in the cell wall (Van Soest, 1980, 1982).

Crude protein or nitrogen and lignin levels in the faeces are probably the most reliable indices of the diet quality although cell soluble, hemi-cellulose, and cellulose contents provide useful additional information, particularly changes in chemical composition in regard to seasonal changes.

(i) Carbohydrates : The plant foods include young and mature leaves, grasses, stems, as well as barks and gums which contain carbohydrates (structural cellulose, hemicellulose, lignin and storage- starch and sugars). Long chain sugars require fermentation in an enlarged stomach or large intestine. Fruits including unripe and ripe (fleshy parts), seeds, and tubers containing mostly the reproductive parts of plants provide food containing short chain sugars that hydrolyze rapidly in large area of intestinal tracts for rapid absorption and immediate use. Cabohydrates are very important and major part of dry matter in plants. They are the major source of energy for mammals, being either primary or secondary users, e.g. carnivores feeding on herbivores. Carbohydrates are composed of C, H, and O with the H and O proportion same as in water. Some more details of the carbohydrates are given as under.

Simple Sugars : These are hexoses or pentoses according to the number of carbon atoms in each molecule. Pentoses are less important in nutrition. Hexoses are glucose, fructose and galactose. Glucose is the form of sugar in the blood.

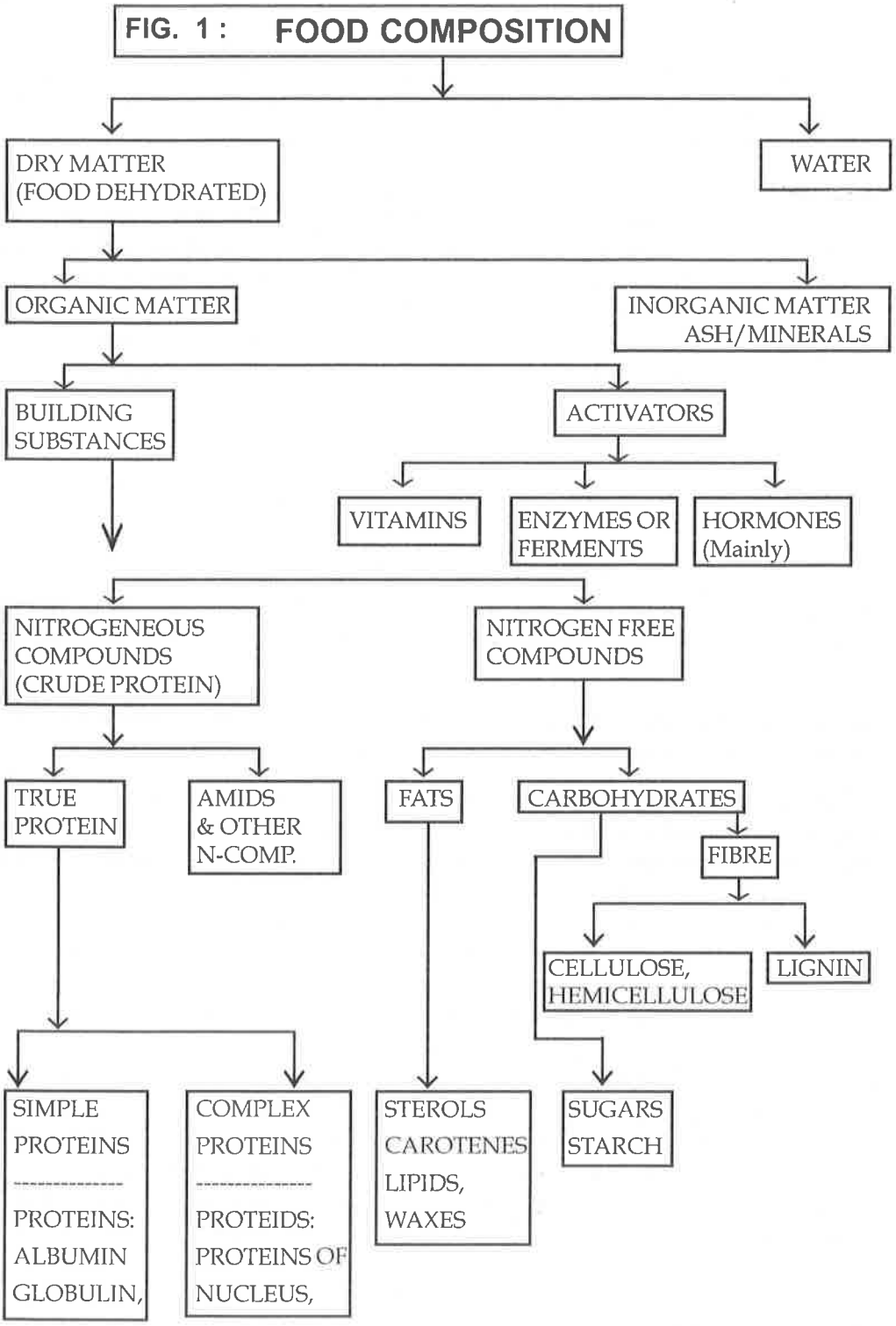


FIG. 1 : FOOD COMPOSITION
DRY MATTER (FOOD DEHYDRATED)
WATER
ORGANIC MATTER
INORGANIC MATTER ASH/MINERALS
BUILDING SUBSTANCES
ACTIVATORS
VITAMINS
ENZYMES OR FERMENTS
HORMONES (Mainly)
NITROGENEOUS COMPOUNDS (CRUDE PROTEIN)
NITROGEN FREE COMPOUNDS
TRUE PROTEIN
AMIDS & OTHER N-COMP.
FATS
CARBOHYDRATES
FIBRE
CELLULOSE, HEMICELLULOSE
LIGNIN
SIMPLE PROTEINS
PROTEINS: ALBUMIN GLOBULIN,
COMPLEX PROTEINS
PROTEIDS: PROTEINS OF NUCLEUS,
STEROLS CAROTENES LIPIDS, WAXES
SUGARS STARCH

Glucose is found in ripe fruits, sweet corn and honey. Fructose is found in ripe fruit and honey. Galactose forms part of the milk sugar. It does not occur free in nature.

Compound sugars : These are present in sugar beets and sugar cane, maltose in malt and as lactose the milk sugar. Malt is produced by germinating seeds from the starch they have stored.

Starch : Sugars are transformed into starch as food storage and energy reserves by plants. Starch in animals compares with glycogen produced by the liver as a form of stored sugar. Starch is composed of many glucose molecules (simple sugar) with the elimination of water. This process is reversed during metabolism where water is again added to form sugars. Special enzymes cause this during digestion of complex carbohydrates. If starch is acidified and heated, it will break down into sugars. Starch is not soluble in water and must be converted to sugar for transport in plants or animals.

Cellulose : Composes the plant cell walls. Cellulose is a very resistant and insoluble, complex chemical substance made of many glucose molecules. Cellulose can be broken down into sugars by heating it with acid. In animals, cellulose can only be digested with the action of bacteria. Only ruminants and herbivorous animals with special adaptations of their digestive tracts gain measurable food value from cellulose. The higher the cellulose content of a plant (in a grass it may be upto 1/3 of the total carbohydrate), the woodier it is and the less food value it presents to most animals.

Lignin : It is not a carbohydrate but associated with cellulose and hemicellulose in forming the cell wall matrix. However, it comes in the analysis of crude fibre.

(ii) Proteins : They have special function in animal nutrition as they are indispensable to maintain life and can not be replaced by other nutrients. Proteins always contain nitrogen, and most contain sulphur and some phosphorus. Each protein molecule is composed of many amino acids, 20 or more different kinds of amino acids are known which can be arranged in different combinations. Thus there are many kinds of proteins in plants and animals. Plants build complete protein molecules from inorganic nitrogenous salts like nitrates, absorbed from the soil through the roots. Animals can build (animal) protein from amino acids gained from digested plant protein as well as from proteins of animals, they feed. Animal matter including invertebrates, fish, and vertebrates provide sources of protein and fat to the carnivore species that are easily digested and, therefore, require relatively short and simple gut. In animal tissues proteins are found in protoplasm and in the nucleus. Animal cell walls are high in protein. Therefore, muscle tissue, internal organs and connective tissue, cartilage, skin, hair and horn all contain protein. Food containing complete proteins are milk, meat, fish, eggs, cheese, whole animals, and a few legumes. Fruits and vegetables contain many essential amino acids, minerals and vitamins but not all. Animals inherited with habits of consuming food of animal origin are the true carnivores and those consuming foods of animal as well as plant origin are omnivores.

The requirement of crude protein ascribed in herbivorous 12-18% (ratio of crude protein : carbohydrate 1:8-10),omnivorous,20-25%, carnivorous 25-35% (ratio of CP:Carbohydrate 1:2.0/2.5).

(iii) Fats : Fats are composed of C, H, and O as carbohydrates with C and H in much higher concentrations. Fat supplies, 2.25 times as much energy as carbohydrates per unit weight (Calgary lecture notes). Fat is formed by three molecules of various fatty acids and one molecule of glycerine (Glycerol). There are saturated and unsaturated fatty acids. Grains and seeds contain fats. Fat level in ruminant diets are normally restricted to less than 8 per cent of the dry matter. Higher levels tend to depress ruminal fermentation of fibers. Whether ruminal tissues can synthesize essential fatty acids is not certain. However, there is minimal dietary requirements in non - ruminants. Fats are mainly digested in the stomach of carnivores Fat soluble vitamins A,OD, and K combined with fat are available in food and there is hardly any fat free diet being supplied to any mammalian species in the zoos. Workers have recommended to provide 1 to 2 % of the metabolizable calories as essential fatty acids in the diets of certain wild mammal species in captivity. Carotenes are fatty substances converted into vitamin- A. Sterols including cholesterol are found in animal tissues. Ergosterol can be used to form vitamin -D by the animal with use of ultraviolet light. Phospholipids are found abundantly in blood, brain, liver and yolk.

(iv) Minerals : They are inorganic constituents of ash in food analysis (Fig.1). Their presence in food is related to the contents present in the soil,where plants have grown. Thus, mineral level in plants and animal food varies from region to region. Animals usually absorb minerals dissolved from mineral salts. Minerals are needed for the building of an organism and to regulate physiological functions such as osmotic pressure in cells and regulation of acid base concentrations. The minerals needed in large amounts are calcium (Ca), phosphorus (P), sodium (Na), potassium (K), magnesium (Mg), sulphur (S) and chlorine (Cl). Phosphorus and iron (Fe) are involved in formation of enzymes. 60 to 70 per cent of all minerals used for the body are found in the skeleton. The skeleton uses 90% of Ca and 85% of P. Growing, pregnant and lactating females have high requirements. According to one study lactating females and deer stags replacing antlers need 10 to 20 g calcium and 8 to 12 g phosphorus, otherwise normal requirement in deer is 4-8 g and 3-5 g, respectively. Both minerals are of great importance to the mammals receiving only flesh. Hence, there is always need for supplementation in their diets. For tusk growth 1.7 g / day of calcium is needed (Sukumar, 1985). McCallagh (1969) calculated that a 1000 Kg. male elephant needs 8-9 g of calcium per day. 3000 Kg pregnant or lactating cow elephant may require 60 g calcium per day. An elephant requires 75-100 g. sodium /day. Trace elements are: iron (Fe), manganese (Mn), copper (Cu), cobalt (Co), iodine (I), zinc (Zn) and selenium (Se), which can also be deficient in some soils and plants. Undissolved minerals are dissolved by the hydrochloric acid in the stomach. Others are freed by digesting organic substances which contain minerals in their composition. Minerals are chiefly absorbed by the small intestine. Iron (Fe), manganese (Mn), and cobalt (Co) are necessary for formation of haemoglobin in their blood. Manganese is required for bones and reproduction.

(iv) Vitamins : They are organic substances essential for body functions not to be considered as food. The body can not store vitamins sufficiently in the body, with the exception of vitamin-A. Fat soluble vitamins are A, D, E and K and water soluble vitamins are B - complex and C. Their requirements are met by various ways (Table 1 (a)). In ruminants ruminal fauna contribute in synthesis of vitamin B - complex. Certain foods are rich sources of vitamin - C. It is not synthesized by large non-human primates, carnivores, perissodactylids and suids. Vitamin - E is available in germinated grains, seeds and green plants. It is required in reproduction. Vitamin K is synthesized by intestinal bacteria, otherwise is also available in green plants, liver meal and fish meal. In body its presence is in the cells, muscles and blood.

Table 1 (a) : The principal nutrients and their functions.

Nutrient	Functions	Sources
Protein	Building and maintenance of all body tissues. Formation of substances essential to body functions, such as enzymes, antibodies, hormones, etc. Regulation of body processes.	Meat, fish, eggs, milk, gram, cheese, curds, ice-cream, pulses, soyabean, nuts, groundnuts, cereals.
Fat	Concentrated source of energy. Carriers of Vitamin A, D, E and K. Protection of the body.	Butter, ghee, vanaspati, vegetable oils, oilseeds and nuts, soyabean, and nuts, soya bean, avocado pear.
Carbohydrate	Main source of energy for the body functions sparing protein for its primary purpose. Providing fibre/roughage to aid in normal perist -active movements	Cereal grains, millets, pulses, legumes, roots and tubers (potatoes, sweet potatoes, yam, tapioca, etc.), sugar, jaggery, processed foods, noodles, jams, jellies, pastries, breads, cakes and candies. vegetables, fruits, condiments and spices are rich in fibre.
Vitamin A	Essential for healthy eyes and skin. Promotes growth maintains integrity of mucosal epithelium. Maintains visual acuity in dim light.	Fish liver oils, liver, butter, ghee, cream, whole milk, curd, cheese, egg yolk, green leafy vegetables (pumpkin carrots), yellow fruits (Papaya,mango) and fortified fats.
Thiamin (Vitamin B_1)	Part of enzyme system concerned with the proper utilisation of carbohydrates in the body. Maintenance of normal gastrointestinal tone and motility, normal heart action and nervous stability.	Unmilled cereals, wheat germ, whole wheat, parboiled rice, pulses and legumes, soyabean, nuts particularly groundnuts, dried yeast, liver, glandular organs, pork.
Riboflavin (Vitamin B_2)	Constituent of enzyme system, essential link in the metabolism of proteins and carbohydrates. Maintenance of normal skin tone, digestition and vision.	Milk and milk products (including skimmed milk, curds, cheese & whey), egg, liver, kidney, heart, meat, green leafy vegetables , dried yeast.
Nicotinic Acid (Niacin)	Essential component of enzymes for effective	Whole grain cereals, pulses, nuts particularly groundnuts, liver, meat, yeast.

	release of energy in the body. Maintenance of normal functioning of gastrointestinal tract, skin and nervous system.	
Pyridoxine (Vitamin B_6)	Constituent of enzymes which participate in amino acid metabolism. Participates in metabolism of unsaturated fatty acids.	Wheat germ, liver,kidney, meat,whole grain cereals vegetables.
Vitamin B_{12}	Essential for maturation of red blood cells in bone marrow. Involved in synthesis of nucleic acid.	Liver, kidney, milk, cheese, muscle meats.
Folic acid	Necessary for blood regeneration. Participates in nucleoprotein metabolism.	Liver, kidney, yeast, deep green leafy vegetables, pulses.
Ascorbic acid (Vitamin C)	Forms and maintains intercellular substance. Required for healthy gums and body resistance.	Fresh fruits particularly citrus fruits, guava, tomatoes, amla, raw vegetables, leafy vegetables, sprouted pulses.
Vitamin D	Promotes normal skeletal and tooth development. Regulates absorption and storage of calcium, phophorous.	Fish liver oils, exposure to sunlight, liver, egg yolk, butter, ghee milk.
Vitamin E:	Aerobic H transfer. Sexual function.	Germinated grains,seeds,green plants.
Vitamin K:	Facilitates blood clotting.	Green plants, liver, fish meal. Also synthesized by intestinal bacteria.

Table 1 (b) : Principal minerals and their functions

Nutrient	Function	Source
Calcium	Builds bones & teeth. Blood coagulation. Normal heart rhythm. Muscle contraction. Nerve irritability. Aids in use of iron. Activation of some enzymes.	Milk (including skimmed milk and butter milk), curds, gram, cheese, small fish, green leafy vegetables, tapioca, cereals (excluding rice) millets, ragi, gingelly seeds.
Phosphorus (P)	Builds skeleton and teeth. In soft tissues as an organic esters involved in energy transformation, cell division and reproduction	Meat, bonemeal, dicalcium phosphate, grains and vegetables
Sodium (Na)	Major extra cellular. Buffering osmotic pressures in blood , activates stomach fluids & amylase. 30to 40% found in bone.	
Iron	Constituent of haemoglobin which carries oxygen to the tissues. Constituent of bone.	Lean, red meats, liver, egg yolk, whole grain cereals and pulses such as wheat, bajra, bengal gram, green gram, soya bean; green leafy vegetables, nuts ,oilseeds, jaggery, dates, sprouted pulses.

b) Food Digestion : *Fig.2 and Fig.3* adopted from Calgary Zoo lecture notes. The existing animal species have evolved many variations in their digestive tracts (described above) that allow them to digest and absorb variety of food items which they are provided in their diets. The process of food digestion (preparation of food for absorption of nutrients) has been established and described at length in many text books and similar studies to establish standard values in wild mammalians are in fast progress. The available knowledge about the processes of food (carbohydrate, protein, fat) digestion in different terrestrial mammalian species are summarized briefly hereunder.

1. Pregastric fermentors :

i) All ruminants (cervids and bovids) and pseudo-ruminants (e.g. llama, camel) and non - ruminant (e.g. hippopotamus) artiodactylids.

ii) Selected herbivores: For example, colobus monkey, langur, hamster, vole, kangaroo, wallaby, three - toed sloth.

2. Post-gastric fermentors :

i) Caecal fermentors:For example, rat (rodentia-omnivore) and hare, rabbit (lagomorpha--herbivores)

ii) Colonic digesters with sacculated colon:For example, man, pig (omnivores), equine, rhinoceros (herbivores), New world monkey (selected herbivores).

iii) Unsacculated colon :For example, canids, felids and chiroptera (fruit eating bats).

Herbivores and Omnivores : The herbivorous mammals do not have enzymes responsible for digesting lignin-cellulose in feeds of plant origin. These animals depend upon symbiotic microbial fauna inhabiting certain parts of the gastro - intestinal tract (GI). The microbial fermentation sacs in GI tracts may either be pre - gastric or post - gastric (detailed below). The pre-gastric fermentors can be classified as ruminants and pseudoruminants. The ruminants which have well developed forestomach include species of families *Cervidae* and *Bovidae*. The pseudo-ruminants include, bacterian camel and llama (exotic species). The non ruminant herbivorous species which have simple stomach are (i) concentrate feeders like wild pig (omnivorous) (ii) medium roughage feeders like hare, rat (omnivorous) and (iii) high roughage feeders like elephant, rhinoceros, wild ass and zebra having post gastric fermentation.

Artiodactylids : Carbohydrates make the major portion of diets of artiodactylid ruminants. Their feeding habits depend to a large extent on the degree of preference for certain grasses and plants and their availability. Even during dry season when the choice of food is limited, different animal species retain particular feeding habits. Compared with grazers, the species feeding mainly on plant material other than grass, are characterized with smaller physiological capacities of the rumen, reticulum, higher counts of ciliate protozoa and large bacteria, higher levels of rumen ammonia and higher molar proportions of rumen propionate and valerate which facilitate

and enable them to meet their energy requirements from comparatively less amount of feed. The protein content of diet is lower in grazers. The number of protozoa and large bacteria differ according to animal species and diet. Animals with complex nutrient requirements depend on the availability of soluble carbohydrates and amino acids. High ammonia nitrogen level would be indicative of high protein and resultant high amino-acid content of the diet. At the maintenance diet in ruminants the principal end products are the volatile fatty acids- acetic, propionic and butyric acids. The pattern of volatile fatty acids vary with levels of fibrous carbohydrates in feed intake. The low levels of propionic acid suggest that a relatively high proportion of energy consumed was lost as methane (CH_4). The animal uses volatile fatty acids as sources of energy for life processes. This is in contrast to the situation in most other animal species in which the major product of carbohydrate digestion is glucose, the principal source of energy for cell metabolism. As long as there are no nutritional deficiencies this metabolic coupling will, with only lesser deviations, be maintained with constant turn over of micro - organisms and metabolites irrespective of animal species or diet in general. Smaller ruminants (deer, antelope) have greater turn over than large ones (barasingha, sambar, nilgai, wild buffalo). The organic substances which contain minerals in their composition, on digestion set free minerals, which are chiefly absorbed by the small intestine.

Non-ruminants : Artiodactylids have simple stomach, long small intestine, moderately large caecum and a sacculated large colon. Besides degradation of food in the stomach, enzymes secreted by pancreas and intestines of omnivores may also degrade stored carbohydrates into sugars which are absorbed and metabolized. The species of family *Suidae* have fermentation process for fiber contents both in the caecum and colon to a very limited degree. Physiology of digestion in case of pygmy hog (*Sus salvanius*) has not been studied completely.

Primates : Some of the primate species are predominantly folivorous and others frugivorous. Colobus monkeys and langurs, which have a four - compartment stomach, need dietary fiber for proper functioning of the pre-gastric fermentation chamber. However, they do not have benefit of bacterial assistance to the same degree (insufficient amount of animal protein is available) as of ruminants. They are therefore, not ruminants. Haldik (1977) (Primate Ecology. Academic Press London pp. 323-353) described that grey langurs (*Presbytis entellus*) are different in the proportion of leaves, flowers, and fruits they select than *Presbytis senex*. Certain macaque species are omnivorous too. Such animals, therefore, should not be fed on a strictly herbivorous diet, since animal proteins cannot be formed in their digestive tracts unless the entire range of essential amino acids is provided. Threfore their daily routine diets should always include animal proteins.

Proboscid : Length of the digestive tract per unit weight is less in the case of the elephants as compared with that in the other herbivores and as such, elephants eat incessantly throughout the 24 hours to satisfy their insatiable appetite which in turn is controlled to a certain extent by the caloric requirements and rate of passage of food through the intestinal tract (Benedict,1936). Enormous quantities of food pass through the alimentary canal and it is conceivable that the length of stay of food in the tract and the accompanying chemical transformation and absorption may not be the same as in other herbivora. Elephant (*Elephas maximus*) is hind gut fermentor.

FIG. 2 : Partition of Dietary Energy

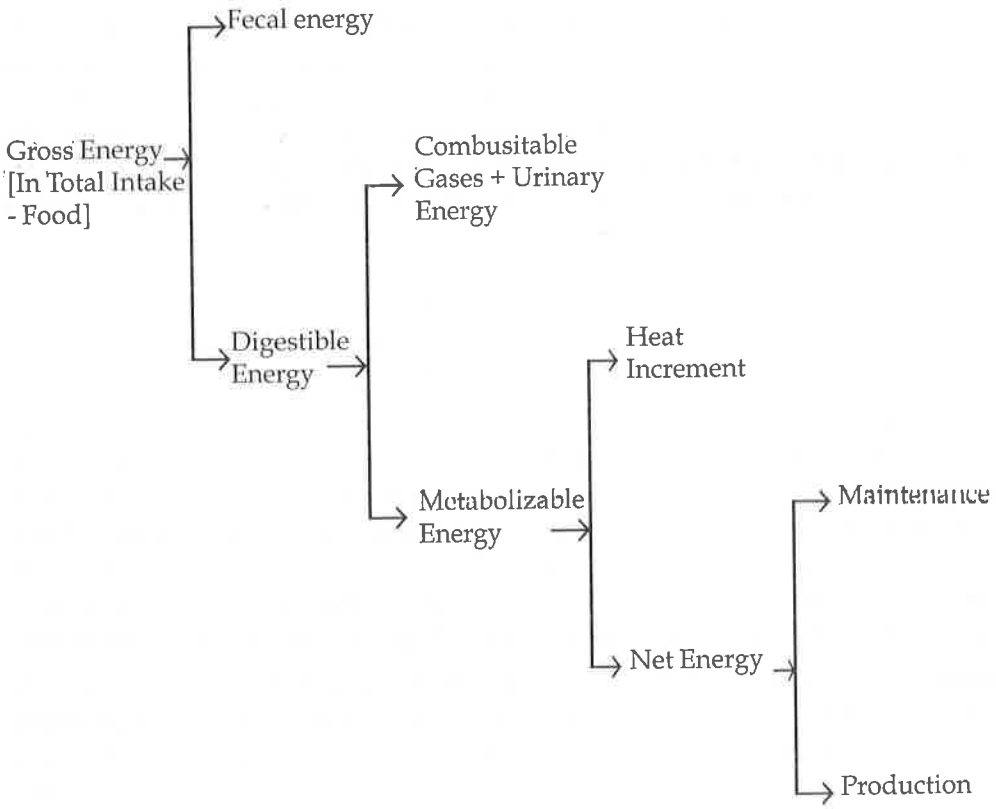
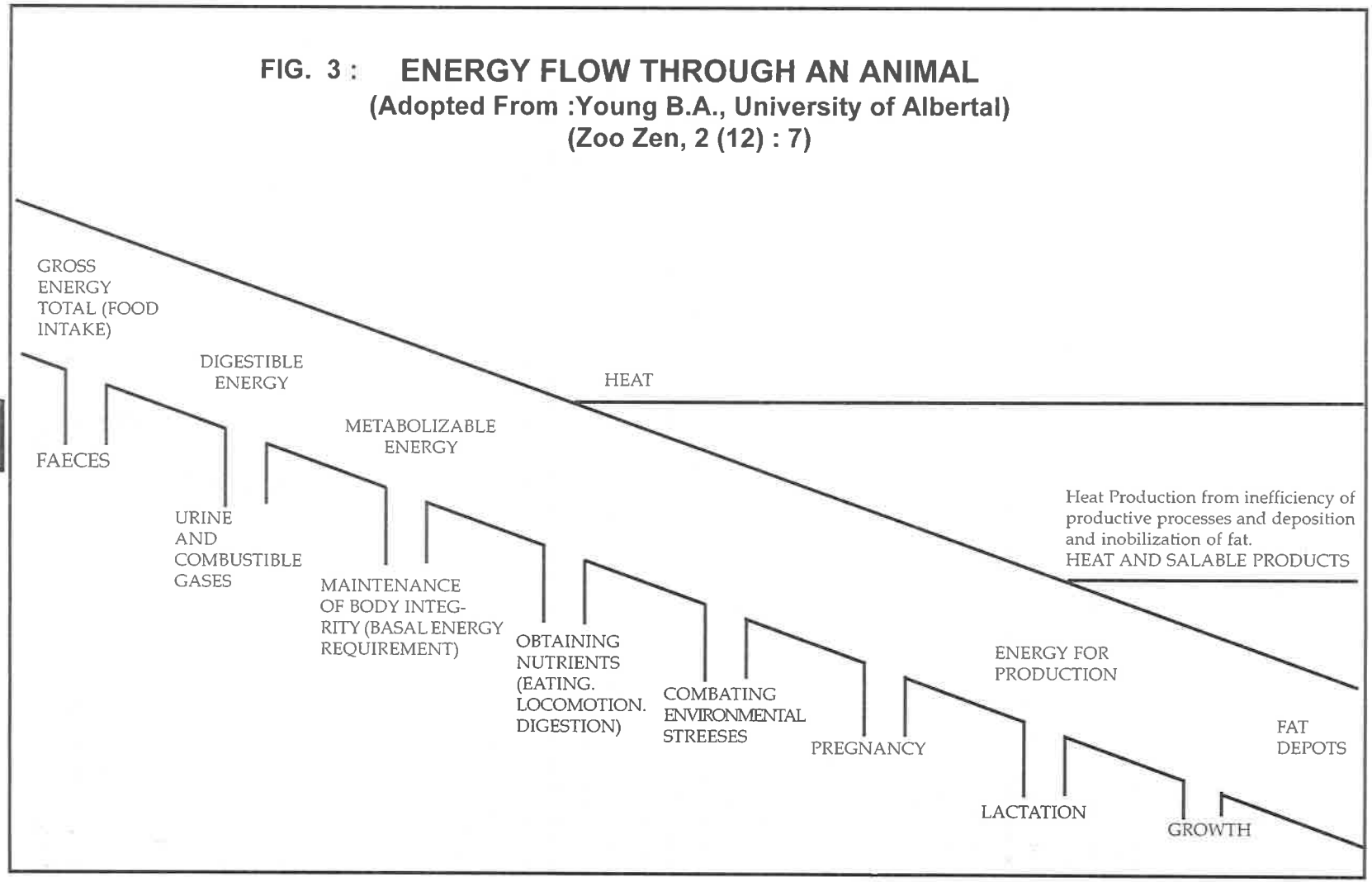


FIG. 3 : ENERGY FLOW THROUGH AN ANIMAL

(Adopted From :Young B.A., University of Albertal)
(Zoo Zen, 2 (12) : 7)



Perissodactylids : Both the native sub-species of the Order (*Equus hemionis khur, E.h. kiang* and *Rhinoceros unicornis*) are hind gut fermentors. The wild ass has very large caecum and large intestine relative to other segments of its gastro-intestinal (GI) tract. The caecum and colon are the vital intestinal parts in which microbial fermentation of food takes place.

In these species microbial digestion process has not been studied. The black African rhinoceros (*Diceros bicornis*) has pointed upper lip, hence its food habits are different from Indian rhinoceros.

Rodents and lagomorphs : Many rodents require some animal protein in their diet. Squirrels are not strictly herbivorous. In most rodents and lagomorphs hind gut fermentation occurs. Experimental studies on digestive enzymes in the various segments of gastro - intestinal tracts of hare (*Lepus sp.*) indicated that the enzymes responsible for the hydrolysis of fibrous feeds were located mainly in the caecum, colon and rectum. These enzymes are mainly of microbial origin in these segments. Amylase and protease have the highest activity in small intestine. Although in small quantities, the presence of all the enzymes was recorded in the stomach inspite of its lower pH. The presence of these enzymes is attributed to cecotrophy in hare and the source of these enzymes is the soft faces of hare which pass through the stomach (Agrawal *et al.*, 1993).

Carnivores : True carnivores have established food diets derived from animal sources. Those are readily digested and are high in protein and fat. This type of diet is suited to an alimentary tract which permits rapid passage through its length and is fitted with sturdy wall. The gastric part is simple stomach and intestinal part with separation into small intestine, large colon and reduced caecum. This type is found in all land carnivores. Thus, for true carnivores any amount of fiber consumed is of little importance as a source of nutrients. Tiger has no caecal capacity and unsacculated colon is not typically fiber-digester, though it is known that it eats grass for some specific needs. The fish eating carnivores (fishing cat, otters) have strong tubular intestine with almost no caecum.

(D) Diet formulation : The chemical composition of food is outlined in Fig 1. Food analysis is required to determine the nutritional composition but there are different ways to define food nutritive values. In many wild animals we do not know the exact requirements of proteins, carbohydrates, fats, vitamins and minerals. Therefore, zoo animals remain totally dependent upon the quantity and quality of food provided. The zoo Veterinarians should monitor all the purchased foods. Nutritional values for dry weight of food must be calculated per gram edible portion. The calculations must contain the variables of dry matter (DM), protein, fat, fiber, energy, vitamins A, D, E and C, calcium(Ca) and phosphorus (P), lysine and methionine in gram. The computations of diets meant for native wild mammalian species and presently being fed to them in captivity particularly to the endangered ones is yet to be reviewed to determine the actual needs for carbohydrates, proteins, fats, vitamins, and minerals to meet basal maintenance (i.e sufficient to maintain body temperature and yield energy for vital body physiological processes and nutrients for cell and tissue repair and replacement) and production (development

of foetus, milk for offspring) requirements. It is well established that animals consuming large amounts of roughage produce more heat than those animals which are on a high concentrate diet. This should be well taken care of while the diets for herbivore species are being prepared/procured.

(a) Artiodactylids. i) Ruminants : The zoo inmates inventory mainly includes deer and antelope species. In the wild, these animals forage in early morning and late afternoon. During periods of extreme deprivation they might graze during night hours also. Therefore, in the zoos such species are fed during morning and late afternoon hours. The ruminants are fed on good quality fresh fodder for maintenance. As a general rule non producing ruminants need 2 kg feed in dry matter for every 100 kg body weight (roughage feeding normally ranges 2 to 3 .5% of the body weight on dry matter basis). However, growing, pregnant or suckling dams with their offspring should also get concentrate mixture. Akin to domestic counter species concentrate mixture is fed at the rate of 5-10 g per kg body weight in maintenance diets. The grass hay used should contain at least 10% crude protein. Ruminants are fed with ration having crude protein 10 to 15% of dry matter and with protein to carbohydrate in proportion 1:8-10 (Calgary zoo lecture notes). Some workers have recommended that grazer hooved stock should get 8 to 12 per cent of crude protein in total diet and browser hooved stock 12 to 16% in the total diet. During lactation (in case of dams with their suckling offspring) the feed intake in terms of dry matter may go up to 3% or even 4% in certain species.

To provide 1-2% metabolizable calories essential fatty acids are required to be supplied through diet. However, in case of all ruminants fat must be restricted to less than 8% in the diet supplied.

ii) Non-ruminants : Their diets in general require 15 to 20 % crude protein in dry matter. The ratio of proteins to carbohydrates in pig diets should be 1:10 for maintenance.

(b) Carnivores. i) Felids : Generally an adult cat needs food quantity @ 4 to 8 % of its body weight daily. An adult tiger may need only 1.5 to 3.0 %. Young growing cats need 15-25% of their body weights. A pregnant female may need to consume 20-30% of her body weight. When nursing large litter this may have to be further raised (George Mahen, 1994). Thus, application of a thumb rule for determining the quantity of food to be given is meaningless as the body weights of wild felid species range from 1 kg to 240 kg and requirement of ration for each animal has to be fixed according to its need. The protein should be of high biological value. Appetite and body condition of tigers, lions and leopards are maintained well if they are fasted one day per week. Felids have only limited capacity to regulate transaminases and urea cycle enzymes and they eliminate higher quantities of nitrogen through urine. Therefore, their protein requirements are much higher than *canids*. Felids can utilize large quantities of animal and vegetable fats, up to two thirds of the dry weight of the diets. Felids can effectively utilize diets containing 30% or more of calories derived from proteins. When the protein source is lowered, providing less than 18% of caloric source, food intake is found to decrease with consequent weight loss. Essential fatty acid requirements of felids can be met when linolenic acid is

synthesized into arachidonic acid. The need for arachidonic acid arises when its availability from the animal products is not sufficient. Fats are energy dense-substances that improve diet palatability for many omnivorous and particularly carnivorous species. The metabolizable energy (Fig. 3) concentration of most fats is 2.25 times or more than that of carbohydrates and proteins. The cats (domestic) lack hepatic glycolytic enzyme (glucokinase) and they derive much of the glucose from amino acids by gluconeogenesis. Analogic state in wild felids should persist.George Mahen(1994) mentioned that: Felids utilize cooked starch. Dextrin is the most effectively used carbohydrate. When necessary carbohydrates are included in the diet of felids, the dietary requirement of B complex vitamins is to be increased three fold. Tiger weighing 123 -160 kg needs 5170 Kcal./day. Tiger needs about 7 kg meat per day and without bone, supplementation for vitamins and minerals is required. For every 2 kg meat 15 g of steamed bone meal and 15 g mixture of 1/3 part calcium carbonate and 2/3 parts dicalcium phosphate be supplemented. The lions need more or less the same quantity of food.

ii) Ursids : Despite being carnivore most bear species depend on energy rich diet of plant matter. The black bear (*Selenarctos thibetanus*) in the wild state hibernates during winter awakening for brief periods, if warm weather occurs. During spring they emerge from their dens and feed on available plant material, invertebrates including termites and ants, fruits and nuts. In Tibet, these bears are reported to kill domestic sheep and goats. In captivity black bear thrives on bread, milk, fruits and vegetables.

iii) Procyonids : The red panda is highly endangered species. It feeds on plants and insects; hence is omnivorous. But its staple food is bamboo. As a result of its such diet requirement, it has low metabolic rate, slow growth, late maturity, low survival of the young and low lactation. In captivity the diet, therefore, should be supplemented with essential amino acids, vitamins and minerals.

(c) Primates : In the zoos primates diets consist of fruits, nuts, vegetables, eggs, bread and milk. Free ranging monkeys are long period feeders. Such habit of monkeys, therefore, entail the zoo management that they should be fed at least 3 to 4 times in a day. The primates need 3-5% fat in the diet. Fruits and vegetables contain many essential amino acids but not all. Essential fatty acids are available in the diets of the primates. Old world primates need 15% protein and new world primates 25% protein in their diets. Hence, addition of animal protein in the diet of certain species is vital. In cases where caloric intake is found insufficient, glucose biscuits may be given in addition to bread. Very little is known about the actual needs of the various native species. Some studies have been carried out about nutritional requirements in rhesus macaque (*Macaca mulatta*) and common langur (*Presbytis entellus*). The energy requirements of primates vary as do their basal metabolic rates. A slender loris (*Loris tardigradus*) will need more energy than stump tailed / Assamese macaque. It is determined that in rhesus macaque, adult requirements are estimated at 100 kcal/kg, infant at 150 to 200 Kcal/kg, pregnant female at 175 Kcal/kg and lactating at 150 Kcal/kg (Gershoff *et al.* 1972). Similar studies are warranted in all other native primate species to establish their standard diets.

Proboscidea : Work undertaken at the College of Veterinary and Animal Sciences, Kerala Agricultural University, Thrissur culminated in the following important observations (drawn from the lecture of Ananthasubramaniam ,1989).

i) The nutritional requirements are to be assessed in terms of metabolic body size ($W^{0.75}$) per day .

ii) Palm leaves, even if fed *ad lib* form will not supply enough phosphorus either for maintenance or for growth. Whenever palm leaves form the sole source of feed for the elephant, there is need for phosphorus supplementation such as monosodium or disodium phosphate or other mineral mixture to supply 30 and 60 g phosphorus per day per animal for the young and the adult, respectively. The requirement for phosphorus appears to be greater in the elephants than in cattle.

iii) In the case of the elephant, Maynard's figure of 4409 Kcal/kg TDN seems to be more close to the determined value than Brody's (1945) figure of 4000 Kcal/kg TDN for calculating TDN from digestible energy (DE). 82% is accepted as the factor for conversion of DE into metabolic energy (ME) in the case of farm animals and has been found to be applicable in the case of elephants as well.

iv) The relationship of 2 mg endogenous N/Kcal basal energy has been found to be essentially the same in the case of the elephants.

v) Palm leaves, even if fed at a restricted level (75% of the ad lib intake), will provide adequate cobalt for vitamin B_{12} synthesis and for other metabolic processes.

vi) The synthesis of Vitamin B_{12} in the gut of the animal takes place and the concentration of Vitamin B_{12} in the blood plasma of elephants, ranged from 16.94 to 18.05 µg/100 ml for the growing and adult animals.

vii) Palm leaves diet, quality maintenance roughage for the elephants, was adequate and it was suggested that cereals could be safely omitted from the ration of adult idle elephants.

e) Perissodactylids : Studies have shown that in African rhinoceros daily intake in animal weighing 2000 kg to 3000 kg would be 30 to 40 kg of dry matter. The wild rhinos eat variety of plants and bushes for optimum fatty acid production. The Indian rhinoceros (*Rhinoceros unicornis*) is mainly grazer but also browses.

(D) Health problems :

(i) Deficiencies. (a) Herbivore ungulates : National parks, sanctuaries and bio-reserves are natural habitats and provide space, water, food, cover and ideal environment for flora and fauna flourishing together. Thus, soundness of the habitat in maintaining healthy wildlife biodiversity depends upon its physical and biological status. The most important biological parameter of a habitat is the vegetation which provides food as well as cover to its denizens. Food preferences of animals depend upon the food habits inherited and developed. The availability of forage areas for herbivorous species in a given habitat is important. On the other hand, zoological parks/zoological gardens exhibit greater number of species and safaris greater number of key species individuals in limited areas. Both sexes of the species need to be provided with healthy environmental conditions and insurance against diseases.

The shrinkage of the forest covers and natural grasslands not only affect the

perspective conservation wild fauna but their genetic diversity too. Most of the herbivores are susceptible to severe undernutrition during natural catastrophies such as flood, fire, drought, etc. In captive facilities, to ensure their supplies round the year, contract system is operated. However, supply of seasonal food commodities such as green fodders, vegetables, and fruits depends upon the weather conditions too.The ration supplied in zoos, therefore, does not generally vary in seasonal manner (except some green fodder supply), hence many animals maintain the same weight. Multivitamins and multimineral additives to obviate the deficiency problems are given mixed in their foods. Storage fat in the animals acts as an excellent insulator. At necropsy depletion of fat in debilitated animal is well marked in subcutaneous tissue, on the heart, around the kidneys and at other fat depots.

Non-availability of adequate balanced ration and unconducive environment cause repression of growth, delayed sexual maturity, low conception rate, increased prenatal (also perinatal) mortality, infertility and increased susceptibility to infectious diseases and even to its own carrier microbes. Minor dietary imbalances or deficiencies can lead to major physiological problems, if not corrected timely.

Artiodactylids : Cases of debility, bloat, impaction (including due to eating of foreign objects), excess wearing of teeth, deformity of antlers, overgrowth of hooves, pulmonary calcification and ossification. etc. have been encountered frequently in cervids and antelopes in captive facilities. Excess of concentrates forming the diet than the plants may create problem in tranquilization of deer and antelopes. Excessive fats in diet depress fermentation process in ruminants, hence will affect formation of vitamin B. Nitrogen(N), potassium(K) and calcium (Ca) are commonly replaced in soils when excess of chemical fertilizers are used. Consequently, the amount of these minerals vary in plants and may be lacking in supply through their feeding. On the other hand, in certain fodders calcium and phosphorus ratio are improper too. Calcium may be very much high in hay. Similarly, in grains the proportion of Ca: P is 1: 5 to 1: 10. Hence, undesirable ratios of vital minerals need to be corrected when grains and hay are fed together in proper ratio. Cervids replacing antlers need two to three times more than the regular amount of calcium.

Proboscids and perissodactylids : When some structural carbohydrates complexed with lignin escape degradation through the caecum and colon they constitute a bulky mass of undigested food and may cause obstruction in the large intestine. On the other hand, if diet of such species is very low in fibrous plants digestive disturbances such as colic and diarrhoea are likely to occur. Elephants like to roll on wet ground for skin conditioning. This can cause folding over of intestinal portions, telescoping, etc. if the animal is fed on concentrates lacking the fibrous bulk to fill out the digestive track. The food bulk keeps the organs in proper position.

(b) Carnivores : Excessive fat in the diet of carnivores may cause obesity, if there is no opportunity of excercise (particularly for the bears) in captivity. Zoo felids and canids are often fed on muscle meat which differ in composition (beef: moisture 60-64 %, protein 18.0 to 19.0%, fat 12-15%, and ash 4.4- 6.3%) from the whole prey. Muscle meat is deficient in calcium (has wide Ca: P= 1:15 to 1:26). Also sodium, potassium, iron, selenium and iodine are required. Some of the

vitamins, such as A, E and vitamin -B especially niacin, B_6 and B_{12} are required in monogastric species. Felids cannot use carotenes as source of Vitamin - A (liver is good source of vitamin A). Therefore, prolonged feeding of muscle meat without supplements leads to deficiencies characterised by alopecia, anorexia, follicular hyperdermatosis, general unthriftness, rickets, osteomalacia, osteoporosis, etc. It has become customary in most of the zoos to supplement muscle meat with vitamins and minerals. Felids are also sensitive to arginine deficiency which produces rapid elevation of ammonia level in blood resulting in ammonia toxicity. Felidae needs a dietary source of taurine as its ability to synthesize taurine from containing amino acids is limited. Taurine deficiency leads to retinal degeneration. In all animals tryptophane is converted to niacin but in felids tryptophane is a dietary requirement. This is of little consequence in the wild because the whole pray is rich in niacin.

In the zoos, otters' diet is always fish. When exclusively oil rich fish diet is fed, vitamin E deficiency may occur. It is also reported that thiaminase present in certain fish species increases during their freezing and then, on feeding, may cause deficiency of vitamin B_1 marked by paralysis. Such condition has to be looked into in our zoos.

(c) Primates : Ensley *et al.*(1982) described that *Acacia* fibers may cause impaction of the stomach in common langurs. Cases of death due to bloat as a result of excessive fermentation of the food causing distension and eventually rupture of stomach in langurs (*Presbytis entellus*) and bonnet macaques (*Macaca radiata*) are recorded in captive facilities (Arora *et al.* 1985). Certain important species diet must include animal protein. Excessive levels of fat in the diet may lead to diarrhoea and if extended for a prolonged time may end up in defective absorption, of vitamins and minerals especially calcium, selenium, iron and vitamin E. Deficiency of vitamins is not uncommon in primate species, particularly in new world species.

(ii) Disease susceptibility : Keusch and Farthing (1986) described the relationship as a triangle with infection, malnutrition and impaired host defense each occupying a corner. These corners (conditions) are interconnected with malnutrition resulting in impaired epithelial integrity, decreased secretion of lysozyme-containing secretions, compromised function of the immune system and impaired host defenses. Food allergy cases reported in monkeys and bears however condition(s) remained authenticated. It may result in neutropenia, immunosuppression and increased likelihood of infection. In the event of food deficiency and stress, immunity threshold is lowered and animals are susceptible to infectious diseases and may also be predisposed to own carrier micro-organisms such as *Pasteurella* sp., *E. coli*, *Staphylococcus, Actinomyces, Paramphistome* sp. influenza virus, hookworms, etc.). Contamination of water or infected fish with Aeromonas hydrophila can cause disease in otters. TB infected free ranging birds in the zoos may be source of disease in herbivores. Infected beef is more dangerous for the handlers besides to the animals that are fed. Infection of meat with harmful micro-organisms and toxic substances has to be cared for as per the specified quality control standards and regulations. Transportation stress and inadequate provision for housing to protect them from extreme weather (hot & cold) are also the important predisposing factors and need nutritional care.

5. Some tips for feeding in captivity.

(i) Animals must be fed fresh, palatable, uncontaminated and nutritionally adequate food according to the requirements of the species. The food must be having optimum taste, nutritional value, colour, etc. If advance storage of food is required proper guidelines for procurement and storage should be followed. Perishable food items are vegetables and fruits and they cannot be stored for prolonged duration. Vegetables are kept at 40-45°F (5-7°C), meat at 32-35°F (0-2°C) and fish between 0-10°F. Meat with its high level of proteins and water presents an ideal medium for decomposing organism and must be cooled quickly after the animal is slaughtered.The storage temperature should be just above freezing point for the meat to be used within a few days. For longer storage it must be frozen. Certain fruits are not required to be stored below 5°C.

(ii) After studying the digestive coefficient of various foods species requirement for the type, quantity and quality of food for species should be determined and provision be made accordingly.

(iii) Feeding timings should be strictly adhered to until and unless there is some emergency. Otherwise, the animals will pick up undesirable habits and vices.

(iv) Nutritional requirements and palatability are essential as animal's requirements change from season to season and with age too. Changes in diets or dietary manipulations if made in overcoming the problems, should be recorded with reason thereof. All the captive wild mammals require attention to stress because the benefits of nutritional support must be weighed against the duress suffered by wild animals under captive environment.

(v) Individual diets should be modified to match the changing physiological state of the animal i.e. new born, young, growing, pregnant, lactating, sick, recovering, etc. For the new arrivals and also in case of convalescent animals nutritional support is always started gradually, no matter what the final caloric goal may be. All are started at below maintenance levels for the first few days of refeeding and the total amount is increased gradually over time. If the nutritional support is started at the full amount, animals may have intestinal pain, regurgitation and diarrhoea. If the first few meals are started slowly and diluted, there will be fewer problems associated with refeeding. Starvation decreases metabolic rate producing a condition termed hypometabolism. Starved, moribund and other hypometabolic animals require fewer calories than usual. Any animal, rescued under extra - ordinary circumstances and placed in the zoo, has to be provided good nutritional support for better thriving and also for safe health and protection from many infectious and parasitic diseases of the resident population and even also from its own carrier infections which may flare up due to stress sustained due to change of the environment. There have been several occasions when offsprings/neonates of wild mammals have been collected from the wild and are subjected to hand-rearing.

Change in the diet may stimulate oestrus and solve nutritional infertility problem but it should not be taken for granted that a surge in nutritional intake will stimulate breeding in large mammals.

(vi) In summer, the carnivorous species such as lions and tigers may eat substantially less food (about 30% less). Food availablity to wild ruminants in high Himalayan environment consists of diverse and unusual plant species i.e. lichens, mosses, herbs, shrubs, hedges, grasses and woody perennials. Some of these plants, particularly lichens contain the unique polysaccharides, lichenea and isolichenea and are, in general, of poor nutritional quality. Additionally, during the 6 to 8 months winter, food is scarce and the animals are subjected to severe cold and environmental stresses.

(vii) Attention should be diverted to study abnormalities related to nutrition, metabolism, consumption of toxic substances, etc. Many disorders increase metabolic rate producing condition termed hypermetabolism. A vivid example is hyperthyroidism in cats. Occurrence of similar condition in large felids can not be ruled out. Other examples include fractures, infections, burns, etc. Animal with a disease that increases metabolic rate requires more calories than usual.

(viii) In case of deer, antelopes, wild asses and primates, to avoid conflicts and fightings among cage mates, the feed should be provided either on a long stretched platform or at several points so that each individual animal gets easy access to take its quota of ration. Trampling of weak neonates and intimidation of sub-adults by stronger ones must be. Aggressive individuals should be cared isolated immediately.

(ix) Big cats, canids and ursids, after weaning from their mothers, should be fed individually. Bears, apes and macaques are fed twice a day and small cats and puppies should be fed thrice a day. Never feed frozen cold meat until it is thawed to room temperature. The thawed meat, if not used, should not be refrozen to store.

(x) Water quality for turbidity, salinity, oxygen, minerals and its availability in the enclosures should be checked regularly. The water troughs/pots should be cleaned regularly to avoid formation of algae and collecting therein of any foreign matter. Female's suckling offsprings need more water. Water requirement also varies when there is change in the environment.

(xi) For hand rearing, special milk formulae have to be prepared which are different for each and every baby. Some animals need milk with low fat and high protein content while others require just the opposite.

Note: Ectotherms require attention to ambient temperature as food is digested incompletely. Reptlies such as python, king cobra, etc. are fed once a week. Most amphibians remain active and feed well at 20°C to 25°C. Snakes, turtles, crocodiles, lizards, etc. remain active and do well between 25°C to 35°C (77°to 95°F). However, diurnal lizards and crocodiles are given voluntary access to the higher temperatures between 32° to 37°C (89°F to 99°F). As the temperature goes down in winter, the metabolism of aquatic animals, reptiles, etc. is depressed and feeding requirements of many species are curtailed. In such cases force feeding should be avoided.

♦♦♦

III. FOOD & FEEDING

The physiological needs of the animals are difficult to measure and often it is also difficult to determine the foods eaten, though abundance of particular foods at particular times and food habits of the species may be known. Taste plays more important role in determining the eating habits of mammals than that of birds. The decrease in consumption of certain foods is due to many factors and not necessarily due to the quality of the available food. The readiness with which certain feeds are eaten indicates the animal's greater preference for them.

I. ORDER-ARTIODACTYLA

The Order has 9 living families in the world. Certain wild mammalian species of -*Cervidae Moschidae, Bovidae, Tragulidae, Camelidae* and *Suidae* families exist in the country and are of concern for our *in-situ* and *ex-situ* conservation and management facilities. All the species under the order are digitigrade (i.e. walk on their toes) and are referred to as even toed ungulate mammals.

Deer are members of family *Cervidae* and are animals of comparatively dense forests while antelopes are members of family *Bovidae* (also includes sub-family: *Antilopinae*) and are creatures of comparatively open areas. Mouse deer and suids are nocturnal feeders belonging respectively to families *Tragulidae* and Suidae.

I. Family *Cervidae* : It includes 6 native deer species, namely chital (*Axis axis*), hog deer (*Axis porcinus*), sambar (*Cervus unicolor*), barasingha/swamp deer (*Cervus duvauceli*), sangai/ Manipur deer (*Cervus eldi eldi*), hangul (*Cervus elaphus hanglu*), barking deer (*Muntiacus muntjak*). Himalayan musk deer (*Moschus chrysogaster*). is discurssed under separate family : *Moschidae.*

(1) Chital *(Axis axis)* : (A) Conservation: The chital (*Axis axis*) is main prey species in the tiger reserves of the country except in the high mountains about 2000 metres above sea level where the species is not found. Due to numerical superiority, prolific nature, comparative docility and greater ecological and aesthetic values, the species is being exhibited in the captive facilities to much greater extent.

(B) Food (a) Nature: They live in forests interspersed with open lands so that they can rest in the shady grooves and feed in the meadows. Schaller (1967) explicited more precisely that 'chitals are characteristically animals of the forest edge and of open glades and woodlands, with shade, water, and a good understory of tender grasses being requisites. These habitat preferences, together with an unbroken canopy , have hindered the expansion of the animal into much of the range occupied by the sambar and gaur.' In winter and summer months, the peak feeding activity is in the early dawn and in late dusky periods of the day. During rainy season feeding is also in the cool hours of the day. In the reserves during late night, the herds from various forest sites converge and concentrate around the official campus and the staff residential areas. Chitals feed mainly on short and tender grasses, herbs,

shrubs and fallen leaves and can stand on their hindlegs to pluck leaves and fruits from height of up to six feet from the ground.

The species consumes grasses the most. *Commelina*, *Desmodium*, *Pseudoarthria*, *Solanum*, and *Mimosa* are the preferred grass species. Schaller (1967) studied food habits and food preferences of the species in Kanha National Park (Madhya Pradesh). He mentioned eight species of grasses, eight species of grass-like plants, 32 browse species and 8 types of fruits consumed by the chitals. Details are presented in the **table 2 (a, b).**

Table 2 (a): Grass and grass like plants eaten and probably eaten by wild ungulates in Kanha Park (Schaller, 1967).

Species	Chital	Barasingha	Sambar	Gaur
Eaten:				
Bothriochloa odorata	x	-	-	-
Chloris dolicostachya	x	--	-	-
Chrysopogon fulvus	-	-	-	-
Coix lachrymajobi	-	-	-	x
Cyperus iria	x	-	-	-
Cyperus pangorei	x	-	-	-
Dendrocalamus strictus	x	-	x	x
Digitaria granularis	x	-	-	-
Echinochloa colona	x	-	-	-
Eragrostis gangetica	x	x	-	-
Fimbristylis dichotoma	x	-	-	-
Heleocharis fistulosa	-	x	-	-
Heteropogon contcrus	x	x	x	-
Imperata cylindrica	-	-	x	-
Oryza latifolia	x	-	-	-
Panicum miliare	x	-	-	-
Saccharum spontaneum	x	x	-	-
Setaria glauca	x	-	-	-
Themeda triandra	x	x	x	x
Thysanolaena maxima	-	-	-	x
Vetiveria zizanioides	x	x	-	x

Present and Probably eaten:

Andropogon brevifolius
Andropogon monticola
Andropogon serratus
Apluda mutica
Arthraxon ciliaris
Arundo donax
Cyperus exaltatus
Iseilema laxum
Lipocarpha argentea
Manisuris granularis
Oplismenus burmanii
Paspalum scrobiculatum
Pennisetum alopecurus
Pennisetum setosum

Cyperus paltestylis
Eragrostis unidoides
Fimbristylis ferruginea
Hemarthria compressa
Isachue albens
Scirpus capillaris
Scleria stocksiana
Spodiopogon rhizophorus
Sporobulus diander

Table 2 (b) : Browse species eaten by wild ungulates in Kanha Park (Schaller, 1967).

Species	Chital	Barasingha	Sambar	Gaur
Tree:				
Acacia torta	x	-	-	-
Bauhinea racemosa	x	x	-	x
Bombax malabaricum		x		
Bridelia squamosa	f	x	-	x
Casearia graveolens				x
Cassia fistula	x, f	-	x	f
Combretum flagrocarpum	-	x	-	-
Cordia myxa	-	-	-	x
Diospyros malanoxylon	-	-	-	f
Ehretia laevis	-	-	-	-
Emblica officinalis	x, f	-	-	x
Eugenia vulgaris	-	-	-	-
Ficus glomerata	f	-	-	x
Ficus gobosa	x	-	-	x
Gardenia latifolia	-	-	-	x
Gmelina arborea	-	-	-	x
Grewia abutilifolia	-	-	-	x
Miliusa tomentosa	-	-	-	-
Miliusa velutina	x	-	-	-
Mallotus philippinensis	-	-	-	x
Odina wodier	-	-	-	x
Shorea robusta	-	-	-	x
Stereospermum chelonoides	-	x	x	x
Syzygium cuminii	x, f	-	x	-
Terminalia alata	x	-	-	-
Terminalia arjuna	x	-	-	-
Terminalia chebula	x	-	-	-
Terminalia tomenlosa	x	-	x	-
Xeromphis uliginosa	-	-	-	-
Zizyphus xylophorus	-	x	-	x
Shrubs:				
Dalbergia rubiginosa	-	-	x	-
Diospyros tomentosa	x	-	-	-
Embelia tseriamcottam	x, f			

Kydia calycina	-	-	-	x
Moghania stricta	x, f	x	-	x
Ougeinia oojenensis	x	-	-	x
Pavetta indica	-	-	x	-
Phoenix humilis	x	x	-	x
Schrebera swientenioides	-	-	-	x
Sterculia foetida	-	-	-	x
Wrightia tinctoria	x	-	-	-
Zizyphus jujuba	x	x	-	-
Vines:				
Asparogus racemosus	-	-	-	-
Bauhinea vahlii	-	-	x, f	x
Cryptolepis buchanani				
Dioscorea bulbifera	x	-	-	-
Smilax seylanica	x	x	-	x
Forbs:				
Barringtonia acutangula	x	-	-	-
Blumea fistulosa	x	-	-	-
Blumea glomerata	x	-	-	-
Blumea virens	-	-	-	x
Crotalaria sericea	x	-	-	x
Curcuma ferruginea				
Elephantopus scaber	x	-	-	-
Laggera flava	x	-	-	-
Lepidagathis fasciculata				
Leucas mollissima	-	-	-	x
Naias sp.	-	-	x	-
Pimpinella heyneana	x	-	-	-
Pogostemon plectranthoides				
Triumfetta rhomboidea	x	-	-	-
Vernonia divergens	-	-	-	x

Note: x = Leaf eaten, f = Fruit eaten

Tak and Lamba (1984) observed that grasses grazed during January to June by chitals in and around Dhikala base camp of Corbett National Park, Uttaranchal included: *Aplude mutica, Arundinella bengalensis, Chloris delichostechya* (Pengi), *sopogon mantanus* (Genoria), *Chrysopogon serrulstus* (Bhuri), *Cynodon dactylon* (Dub), *Dendrocalamus strictus* (Bans), *Heteropogon contortos* (Kumeria, Girwala), *Imperata cylindrica* (Pula, Sirhi), *Saccharum bengalensis, Saccharum munja* (Munj), *Saccharum spontaneum* (Kans), *Setaria species* (Ballu), *Themeda arundinacea* (Serkanda, Ula) and *Vetiveria zizanioides* (Khas, Gamara). **Table 3** lists the main plant species browsed by the chitals in the park.

Table 3 : Plant species commonly browsed by the chitals in Corbett National Park (Tak and Lamba, 1984).

Species/ Local Name	Family	Plant parts eaten
Ageratum conyzoides	*Asteracea*	Leaves
Bombax ceiba (Semal)	*Bombacoceae*	Leaves,flowers, petals.
Cordia dichotoma (Libhera small tree)	*Ehretieceae*	Leaves
Cordia myxa (Lissora)	*Ehretiaceae*	Leaves
Ficus bengalensis (Bar, Barged)	*Moraceae*	Leaves
F. religosa (Pipal)	*Moraceae*	Leaves
F. ratusa (Lakar)	*Moraceae*	Leaves
F. rumphii (Pilkhan)	*Moraceae*	Leaves
Fimbristylis squarrosa (herb)	*Cyperaceae*	Leaves
Glynus lotides(Pilu herb)	*Aepoaceae*	Leaves
Glycosmis arbores (Phalse)	*Rutaceae*	Leaves
Grewia sapida (herb)	*Tiliaceae*	Leaves
Holarrhana antidysentrica (Safeda, Kura)	*Apocynaceae*	Leaves
Lantana camara (Lantana, Kuri)	*Verbenaceae*	Young shoots
Murraya koeniqii (Kari-patta, Jal neem)	*Rutaceae*	Leaves
Murraya paniculata (Kamini)	*Rutaceae*	Leaves
Nerium indicum (Kaner)	*Apocynaceae*	Leaves
Nerium odorum (Kaner)	*Apocynaceae*	Leaves
Philiostima malabaricum (Kachnar)	*Fabaceae*	Leaves , flowers
Polygonium polbsium (Kachnar)	*Polygonaceae*	Leaves
Solanum nigrium (Mukai-shrub)	*Solonaceae*	Leaves
Golanum varium (Jangli Began)	*Solonaceae*	Leaves
Shorea robusta (Sal)	*Dipterocarpaceae*	Leaves
Gyxyaium cumini (Jamun)	*Mystaceae*	Leaves
Terminalia alata (Asna)	*Combretaceae*	Leaves
T. belirica (Bahera)	*do*	Leaves
T. tomentosa (Asna)	*do*	Leaves

Food of chitals recorded in Betla, Palamau National Park (Mitra, 1983).

Trees

1. *Cassia fistula*, Leaves (June-Dec.); fruits (July-Aug.)
2. *Cardia myxo:* Leaves (round the year).
3. *Syzigium cumini:* Leaves (round the year).
4. *Shorea robusta:* Leaves (round the year); influorescence (Febuary-March).
5 *Terminalia tomentosa:* Leaves (round the year); fruit (January - February).
6. *Terminalia bellerica;* Leaves (round the year): fruit (January - February)
7. Terminalia chebula: Leaves (round the year); fruit (November - February)
8. Ageratum conyzoides : Leaves (December-January)
9. *Sterculia urens:* Leaves (October - December): fruit (March - April)
10. *Garuga pinata:* Fruit (June - August)

11. Bombax ceiba : Leaves (round the year).
12. Mallotus phillpinensis: Leaves (round the year)
13. Aegle mormelos: Leaves (round the year): fruit (March - April)
14. Ambellica sp.,: Leaves (round the year).

Grasses

1.*Chloris infortunata*	4. *Dendrocalamus strictus*
2. *Heteropogon contortus*	5. *Aplaudo mutica*
3. *Saccarum spontaneum*	6. *Chroysopogon sp.*

(b) Captivity : Diet of chitals consist of concentrate mash and green fodder. Table 12 includes types of diet being fed to chitals (*Axis axis*) in various captive facilities. Van Prani Udyan,I.V.R.I, Izatnagar (UP) regularly feeds seasonal fresh fodder-berseem, oat, maize, lobia and chari. Also concentrate goat ration (composition wheat bran 52 %, ground nut cake 25%, maize 20%, mineral mixture 2% and salt 1%) @ 1.0 kg per adult per day is given. Some feeding trials have also been conducted and are mentioned below.

Study 1 : Three feeding trials were conducted during 1995-96. In the first and second experiments intake digestibility of different nutrients were determined in two chitals. The animals were fed green fodders consisting of jowar (*Sorghum sinensis*) and maize (*Zea mays*). Digestibility of nutrients viz., DM, OM, CP, ADF and NDF were found higher in chitals as compared to sheep with both the fodders.In the 3rd experiment digestibility of nutrients was compared in swamp deer (*Cervus duvauceli*), hog deer (*Axis porcinus*), chital (*A. axis*) and blackbuck (*Antilope cervicapra*) fed with jowar fodder. Digestibility of all the nutrients (DM,OM and CP) we found to be the lowest in swamp deer and the highest in chitals (Garg *et al.* , 1996).

Study 2 : Gutel tree (*Trewia nudiflora*) is found bearing fruits from the last week of April. In about 60-70 days time the fruits become ripe in the second half of June. The fruit seeds are hard and blackish. The average weight of a ripe fruit is 21.73 grams. The leaf measures 23.5 cm in length and 18.6 cm in width. The nutritional analysis of fruit and leaf are furnished as below:

Chemical composition (%) of Gutel leaves & fruits

Nutrient	Leaf	Fruit
DM	19.96	31.04
OM	90.64	92.35
CP	19.75	04.46
EE	01.73	01.36
TCHO	69.16	79.53
ASH	09.36	07.65

Study No. 4 : Pattern of voluntary feed intake and digestibility of feeds in chital, hog deer and blackbuck of Van Prani Udyan, IVRI, Izatnagar (U.P) are mentioned in **table 5(a) and 5(b).**

Table 4 (a) : Voluntary feed intake in deer and antelope (IVRI).

Feed	Species	Dry matter intake	DM intake/kg kg W0.75
Mixed diet	Hog deer	2.52	60.6
Green oat	Blackbuck	3.27	79.9
Green maize	-do-	2.25	52.5
Maize grain & Berseem			
(a) 26:74	-do-	3.44	76.9
(b) 52:48	-do-	3.13	71.5
Green oat	-do-	2.2	50.3
Berseem	-do-	3.5	81.7
Green sorghum	Chital	1.77	50.3
Green maize	-do-	1.12	31.8

Table 4 (b) : Digestibility of feeds in deer and antelope (IVRI).

Species	Feeds	Digestibility coefficient				
		DM	CP	EE	NDF	ADF
Blackbuck	Maize fodder	69	72	64	71	56
	Berseem "	75	73	70	66	65
	Oat "	65	68	56	59	39
	Sorghum "	75	69	-	-	-
Hog deer	-do-	71	70	-	-	-
Chital	-do-	78	79	-	-	-
Swamp deer	-do-	56	43	-	-	-
Hog deer	Oat fodder	67	68	54	64	48
	Mixed diet	77	80	68	-	-

DM=Dry matter

The crude protein contents of fruit and leaves of gutel are as good as berseem and are considered sufficient to sustain the protein requirements of chitals (*A. axis*) Arora and Sahoo (1998 - 99). Effects of prolong feeding have to be studied.

(2) Hog deer *(Axis porcinus)*. (A) Conservation : It is found in the low grass plains of North India and its range extends to South East Asia. It was introduced in Sri Lanka long back and also in Australia.

(B) Food (a) Nature : Hog deer favours grassy jungles but not high and thick grasses. *Imperata cylindrica, Cynodon dactylon* and other species of *Graminae* are preferred. Fallen leaves of certain trees are also eaten well.

(b) Captivity : During 1986 at Van Prani Udyan, IVRI., Izatnagar (U.P.) we had conducted feed trials in respect of voluntary feed intake, dry matter digestibility, daily defaecation rate and pellet weights of two adult hog deer (*Axis porcinus*) of 33 kg average body weight. Diets offered were 500 g concentrate mixture for goat (Wheat bran 52%, Ground nut cake, 25%, Maize 20%, Mineral mixture 2% and Salt 1%) and ad libitum green maize chaff. Average dry matter digestibility was 76.51 % and DM intake and DDM intake per 100 kg body weight were 2.25 and 60.62 g/kg, respectively. Average defaecation rate was 15.92 times per day (range 10-24 times). Number of pellets per defaecation varied from 43 to 70 with an average of 61.3. The mean weight of an oven dried pellet was 203.6 mg. The various fresh green fodders such as berseem, oat, maize and lobia were fed at the rate of 5 to 7 kg per adult routinely.

Table 12 includes ration for hog deer prescribed by different zoos.

(4) Sambar *(Cervus unicolor).* (A) Conservation : The sambar the largest deer, is dweller of dry and moist deciduous forests of hill sides and is found in most of the tiger reserves.

(B) Food (a) Nature : It is a browser as well as a grazer. Hence, it has a wide range of food preferences including grasses, foliage of herbs, shrubs and trees and a number of seasonal fruits found in the forests. It can browse up to a height of 2.70 M (9 feet) when standing on its legs and can often clear up to 3.3 M (11 feet) to reach some particular fruit or forage of choice. It will wade through up to 2.10 M (7 feet) of water to feed on aquatic vegetation, especially lotus, water - lillies, trapha and algae. This range of feeding habit, both terrestrial and aquatic, explains the wide distribution of sambars throughout the country.Sambars mainly feed at dusk and retire into heavy cover at day break. The wild fruits (*Phyllanthur umblica, Ficus indica*) are very well liked (Brander, 1923) .Observations of Schaller (1967) about species food preferences are presented in table 3a. In Ranthambore National Park (Rajasthan) sambars have been observed to concentrate at the water ponds during the hard summer months for feeding , drinking and wallowing.

Sambars prefer grasses and forbs. The main grass species consumed are *Desmodium triangulare, Pseudodarthria viscida ,Bambusa arundinacea, Commelina, Cida rhombifolia , Mimosa pudica, Solanum forvum*, etc. Nagampongsai (1977) studied the food and feeding habits of sambar (*Cervus unicolor*) at Khao-yai National Park, Thailand and observed the main food of this species to be *Imperate cyllendrica*, which constituted 67% of the available forage.

(b) Captivity : In deer park of Forest Training Centre,Haldwani (Nainital) sambars are daily fed leaves of *Morusalba, Melia azederach, Holoptelia integrifolia* and *Dendrocalamus strictus*, besides concentrate ration @ 1.0 kg per adult. Nair and Jayson (1988) in their fodder (grass and forbs) feeding trials in sambars and chitals recorded the food preferences as **Table 5:**

Table 5 : Results of grass and forbs feeding trials in *C unicolar* and *A. axis.*

Name of plant	Sambar % diet	Chital % diet
1. *Grasses*	43.15	45.92
2. *Desmodium triangulare*	10.00	2.08
3. *Pseudarthria viscida*	8.60	8.40
4. *Mimosa pudica*	7.80	5.77
5. *Climber*	3.94	2.62
6. *Sida cordifolia*	3.50	2.00
7. *Solanum torvum*	3.16	6.70
8. *Sida rhombifolia*	2.76	4.96
9. *Commelina sp.*	2.76	7.78
10. *Bambusa arundinacea*	2.46	1.88
11. *Cyperus sp.*	2.02	-
12. *Xeromphis spinosa*	1.73	2.84
13. *Urena lobata*	1.63	0.52
14. *Chromolana odorata*	1.54	0.68
15. *Hemidesmus indicus*	1.27	0.40
16. *Herritia sublobata*	1.05	2.48
17. *Labiatae*	0.86	0.45
18. *Cassia hirsuta*	0.67	0.40
19. *Ipomea sp.*	-	0.28
20. *Diascorea sp.*	-	0.08
21. *Molinera finlaysonia*	-	0.60
22. *Urena labata (red)*	-	1.20
23. *Zizyphus oenoplia*	-	0.86
24. *Curcuma sp.*	-	0.08
25. *Scoparia dulcis*	-	0.52

Table 12 : furnishes the type of rations being fed to the sambars in different captive facilities.

(3) Barasingha / Swamp deer (*Cervus duvauceli*). (A) Conservation: Two sub-species known are *Cervus duvauceli duvauceli* inhabiting Tarai and *Cervus duvauceli branderi* inhabiting Central India. The total population of both the races presently is nearly 4000. The Tarai race is found in Uttar Pradesh (Dudwa National Park, Kishanpur and Katerniaghat Wildlife Sanctuaries, and Pilibhit and Hastinapur forests) and Assam (Manas and Kaziranga National Parks). The Central Indian race now is restricted to Kanha National Park in Madhya Pradesh.

The population of the species (*Cervus duvauceli duvauceli*) is around 80 animals in 6 zoos of the country and is likely to increase. In 1998 an unsuccessful attempt was made to release the species in Jaldapara Wildlife Sanctuary in West Bengal. Second time re-introduction is under consideration.

(B) Food (a) Nature : The species is Pure grazer. Observations of Singh (1982) on feeding behaviours are presented. Swamp deer are more diurnal. They feed till late in the morning and evening and between periods retire to safe places. In

summer the deer are active at night and during the day they spend the hot period lying on the open ground preferably under shady trees.This indicates that the species has high degree of heat tolerance. During the rainy season their activity is totally irregular. On the onset of rains the low lying areas are flooded and the animals move to upper forest areas and thus pass the unfavourable period. In winter the animals frequent in different areas, during night also visit cultivated crops to feed and in the mornings they revert back and retire.During winter season they also feed on aquatic vegetation.

Grasses preferred by both the races of barasingha have been studied and the observations are presented in table 6 (a) (Singh,1982) and table 6 (b) (Martin, 1975). In Kishanpur Wildlife. Sanctury and Dudwa National Park they also feed on floating as well as submerged aquatic vegetation. *Chara* and *Typha agustota* are found to be the main plants eaten throughout the year.During the dry season the deer feed on *Cynodon dactylon* existing at the banks of natural water bodies.

Table 6(a) : Grasses preferred as food by swamp deer(*Cervus duvauceli duvauceli*) in different seasons of a year in Dudwa National Park (Uttar Pradesh).

Sl. No.	Species of grasses	Cool Season	Dry Season	Rainy Season
1.	*Apluda mutica*	++	+	-
2.	*Bothriochloa odorata*	+++	++	++
3.	*Cymbopogon soanthus*	+	+	-
4.	*Cymbopogon warancusa*	+	+	-
5.	*Cynodon dactylon*	+	+++	-
6.	*Cyperus niveus*	++	++	+
7.	*Imperata cylindrica*	+++	+++	+++
8.	*Phragmites karka*	++	+++	+
9.	*Saccharum munja*	++	++	-
10.	*Saccharum spontanum*	+	++	-
11.	*Sclerostachya fusca*	++	+++	-
12.	*Themeda triandra*	++	++	++
13.	*Themeda aurdinacea*	+	++	++
14.	*Vetiveria zizanioidea*	+	+++	-

Table 6 (b) : Seasonal feeding of barasingha (*Cervus duvauce branderi*) on common grasses in Kanha National Park, Madhya Pradesh (Martin, 1975).

Species of grass	Cool and dry season 15 Dec.- 31 May	Early monsoon & early winter Ist June-14Dec.
Apluda mutica	+	++
Arthraxon quartinianus	-	+
Bothriochloa odorata	+++	+++
Chionachne koenigii	++(g)	?
Diandrochloa japonica	+	+

Digitaria stricta	+	+
Dimeria connivens	+	+
Eragrostiella bifaria	-	-
Eragrostis unioloides	-	-
Eulalia trispicata	++	++
Heteropogon contortus	++	++
Ischaemum indicum	-	+
Ischaemum rugosum	-	+
Iseilema prostratum	+	+++
Mnesithea laevis	+	++
Narenga porphyrocoma	+ (g)	+
Panicum austroasiaticum	-	+
Phragmites karka	_ (g)	++
Pseudopogonatherum contortum	+	+
Saccharum spontaneum	+++	+
Schizachyrium brevifolium	+ (g)	?
Setaria glauca	++	+
Sorghum halepense	+ (g)	++
Themeda quadrivalvis	+ (g)	+++
Themeda triandra	++(g)	+++
Vetiveria zizanioides	++	+

Note : Legends indicate, intake: High +++, Medium ++, Low +, Very low or none; (g) fed upon only when green; underlined: Fed upon regularly.

(b) Captivity : The main captive facility which breeds the species is Zoological Garden, Lucknow (UP). The population in other zoos in the country hails from this zoo. The kinds of ration provided to the barasingha (*Cervus duvauceli duvauceli*) in different captive facilities are entered in table 12. While comparing the quantity of diet being fed in different captive facilities it is evident that 250 g concentrate is the minimum quantity being fed in Zoological Garden, Lucknow and maximum quantity of 2.250 kg is fed in Zoological Garden, Mysore.The minimum and maximum quantities of green fodders fed are,5kg and 15 kg in National Zoological Park, New Delhi and Zoological Garden, Lucknow, respectively. Unchaffed fresh green fodder such as oats, berseem, lucerne, young maize, lobia @ 10 to 12 kg and concentrate mash 1.5 kg per adult per day is sufficient maintenace diet. The quantity of the chaffed green fodder usually be 10% less than that of the unchaffed quantity.

(5) Manipur/Sangai deer *(Cervus eldi eldi).* (A) Conservation : The species is under serious threat. Its population in 1991 was reckoned to be 95 individuals in its only natural habitat-Keibul Lamjao National Park (Manipur). Among captive facilities in the country National Zoological Park, New Delhi and Zoological Garden, Calcutta are successfully breeding the species.Presently , the total number of the species in all the captive facilities is around 125.

(B) Food (a) Nature : The sangai deer do not have much competition with other herbivorous mammals of the Keibul Lamjao National Park as they can not enter the floating swamp of Phumdi. The luxuriant growth of vegetation on the Phumdi includes tall reeds and grasses. Table 7 furnishes the kinds of plants utilized by the species as food.

Table 7: Plants eaten by sangai deer(Tombi Singh,1992).

Sl.No.	Name of plants	Local name	Parts eaten
1.	*Lsing kambong*	Shoots, leaves	
2.	*Saccharum munja**	Khoimom	Shoots
3.	*S. bengalensis**	-	-
4.	*Erianthus pucerus**	Singnang	-
5.	*E. ravennae**	Singnut	Shoots , leaves
6.	*Phargmites karka**	Tou	-
7.	*Echinochloa stagnina*	Urisa	-
8.	*Ishachne himalaica**	Hup laba	-
9.	*Panicum paludosum**	-	Shoots, flower
10.	*Polytoca digitata*	-	Shoot
11.	*Saccolepis mysuroides*		
12.	*Polygonum barbatum*	Yellang	-
13.	*P.flaccidium*	-	Shoots, leaves
14.	*P. perfoliatum*	-	shoots , leaves
15.	*Eupatorium ayapan*	-	-
16.	*Lersia hexandra*	Hup	Leaves, flowers
17.	*Oryza parennis*	Wainu chara	New shoots
18.	*Carex sp.*	Hundung	Flowers, leaves
19.	*Capillipedium sp.*	Wana manbi	-
20.	*Ecliptaprostata*	Uchi sumban	Shoots, flowers
21.	*Dioscorea bulbifera*	Ha	Leaves
22.	*Euphorbia hirta*	Phakhangleiton	Leaves
23.	*Coiz aquatica*	Shoots	Leaves
24.	*Cyanodon dactylon*	Tingthou	Shoots
25.	*Ranunculus scleratus*	-	Shoots, leaves
26.	*Oneothera javanica*	Komprex	-
27.	*Alpinia allunghas*	Pullei	Shoots, leaves
28.	*Alpinia sp.*	Loklei	-
29.	*Panicum sp.*	-	Shoots, flowers
30.	*Alternanthera philoxirodes*	Kabo napi	-
31.	*Capillipedium sp.*	Wana manbi	Flowers, leaves
32.	*Coix lacrymajobi*	Yawa chaning	Shoots
33.	*Jussia repens*	Ishing kondo	Leaves
34.	*Eragrostis sp.*	Kang mapal	Flowers, leaves

(b) Captivity: Species has generalized feeding habits. Author has tried to feed leaves of neem tree, siris, ficus, gutel and pipal and green fodder such as berseem, oat, chari and vegetables such as pumpkin, cucumber, kakari were edible. Amaltas leaves were not eaten, however. The types of rations being fed to the species in certain captive facilities are mention hereunder.

(i) Zoological Garden, Manipur:

Rice bran	0.750 kg	Wheat bran	0.750 kg
Maize crusad	0.500 kg	Oil cake	0.100 kg
Gram whole	0.200 kg	Heirru/heibong	0.100 kg
Mustard leaf/cabbage	0.100 kg	Green fodder	3.000 kg

(ii) National Zoological Park, New Delhi: Mash - 1.0 kg , Chaffed green fodder(Kutti) - 2.0 kg, Tree leaves(Ficus/ mulberry leaves with fine twigs) 5kg and *Emblica officinalis* fruits - 50 g(depending upon the availability is mixed in mash) are fed per adult per day. The percentages of ingredients in the composition of mash for the concentrate diet are given below.

Wheat bran	-	22%
Horse gram	-	13%
Barley	-	16%
Oats	-	8%
Oil cake	-	26%
Turmeric powder	-	1%
Mineral mixture and salt	-	2%

Note. Mash composition in the diet for deer and antilope species being fed at the National Zoological Park is same.Therefore this composition is not mentioned again and again under the diet schedules of artiodactylid species belonging to National Zoological Park.

(iii) Zoological Garden, Calcutta(WB)

Carrot + Red potatoes	=0.200 kg
Wheat bran	=1.200 kg
Barley (Crushed)	=1.025 kg
Oat (crushed)	= 0.100 kg
Gram (soaked)	= 0.300 kg
Salt	= LS
All days except Friday	
Groundnut/ Oil cake	= 0.060 kg
Vegetables/ leaves	= L S
Pulses (dry)	= 0.060 kg
Cattle feed/Mash =	7.000 kg
Green fodder	= 3.0-4.000 kg
Paddy straw	=0.100 kg

(iv) Zoological Park, Hyderabad(AP)

Cattle feed/Mash =3.0-4.0kg
(supplementation with vitamins & minerals)
Green fodder =7.0 kg

(v) Zoological Park, Kanpur

Pellets = .0-1.5 kg
(Concentrate)

Green fodder = 15.0-20.0 kg
(M.P.Chari, Berseem)
Gur/ Molasses = 0.100 kg*
* Only during winter

Note: In summer when green fodder is scarce dry fodder is given. The ration is supplemented with vitamins and minerals.

(vi) Zoological Garden Ahmedabad(Gujarat)	
Conc. mixture	= 1.5 kg
Green fodder	= 3.0 kg
Hay	*ad libitum*

(vii) Zoological Garden Thriuvananthapuram (Kerala)	
Gram(Bengal)	= 0.100 kg
Cattle feed	= 0.500 kg
Wheat bran	= 0.750 kg
Carrots	= 0.100 kg
Green gram	=0.100kg
Cotten seed	= 0.100kg
Fodderleaves	= 5.000 kg
Grass	=5.000

Note .Table 12 also be referred.

(6) Hangul deer *(Cervus elaphus hanglu)*. (A) Conservation: The species is a cousin of the European red deer (*Cervus elaphus elaphus*) and its distribution is mainly limited to the Dachigam National Park of Jammu and Kashmir. Some scattered animals are also found in other parts of the State and also in Himachal Pradesh (Mishra,1990).

(B) Food (a) Nature: Mustafa shah *et al.* (1983) studied food habits of the hangul deer (*C. e. hanglu*) for which faecal pellets and rumen contents of the deer were analysed. Seventeen plant taxa were identified in the diet. Buds, dry leaves and soft shoots of *Parrotiopsis jlacquemonitiana, Jasminum humile* and *Arthraxon lanceolate* were found to be the most important items in the food of this deer. During winter the variations in diet are influenced by the snow cover.

(b) Captivity: As the species is mostly found in Dachigam National Park, J&K and there is no exchange programme executed to breed the species in any other captive facilities of the country, the nutritional requirements related to different environmental conditions have not been studied.

(7) Barking deer *(Muntiacus muntjak)*. (A) Conservation : It is widely distributed in Asia from China through India down to Malay and the East Indies. The race of barking deer found in India and Nepal and is known as *Muntiacus muntjak vaginalis*.

(B) Food (a) Nature : The barking deer inhabits sal forests, riverine forests and grasslands. It feeds on highly digestible food, which is rich in protein and energy but poor in fibre. Such food items are usually found below 1.5 metres in height. These include fallen leaves, fruits and flowers on the forest floor and tender leaves growing on saplings, etc. As a result of their dependence on such succulent and protein rich food items they are more or less restricted to forests. Majupuria (1990) described that muntjacs are very selective for the plant parts they eat: small growing and fallen leaves of *Shorea robusta*, all except the petiole of *Adina cardifolia*, the flowers and fruits of *Buhinia purpurea*, dry fallen leaves of *Bischofia javonica*, leaves and stalk of *Schlecera trijuga* sapling and young fruits, flower and leaves of *Caria alborea*.

(b) Captivity : Table 12 includes diets being fed to the species in various captive facilities.

2. Family : *Moschidae*

(I) Himalayan Musk deer *(Moschus chrysogaster, Hodgson)* : (A) Conservation: Its distribution is in Himalayas and the borders of Tibet i.e. from Kashmir to central and north eastern Asia and also Nepal mainly above the tree line of 2,400m to 4,800 m. At the higher altitudes the vegetation is thin and quite sparse in patches, which are extensively exploited by the people for their own as well as for their livestock. Presence of a dwarf species (*Moschus berezovaskii*) mainly below the tree line of 2,400 m is reported.

(B) Food (a) Nature : The species has higher energy requirement/unit body weight than larger deer species. This can only be obtained by browsing on higher quality forage, which tends to be more dispersed in the habitat than the lower quality forage selected by larger ruminants. The musk deer (*Moschus chrysogaster*) was earlier related to family *Cervidae*. According to Green (1987 a) the species is to be classed as concentrate feeder owing to its small body size and with little variation in gastric anatomy. Now it is being considered under separate family : *Moschidae.*

Musk deer are shy, territorial and solitary except during the period of breeding. During the day animals remain in dense vegetation and converge for food in the very late evening and remain in open habitat till early dawn. In the lower altitudes animals frequent forests and shrubs during day time too. The availability of the food makes its density in the habitat. Hence, the movements of the species within home range are related to food and cover shelter. The diet of the species mainly consists of forbs and woody plant leaves.

Green (1987b) described that dietary profile of musk deer was similar to that of serow in all seasons except summer.It feeds on lichens, mosses, ferns and leaves but selectively on woody plants at all times of the year. During winter when the earth is covered by snow, it feeds on the leaves of oaks (*Quercus semecarpifolia*), gaultheria (*Gaultheria nummularioides*), rododendron (*Rhododendron campanulatum*) and Himalayan bamboo.

(b) Captivity : The feed given to musk deer at Musk deer Research Centre Dharmaghar Kotmanya district Bageshwar (Source: K.C.Tewari and Nayal, LM.S, 2000 CCRAS*)

Sl.No.	Local name	Botanical name	Part eaten
1.	Burars	*Rhodondendron aborium*	Flower
2.	Brahmi	*Centrella asiatica*	Leaf
3.	Labhed	*Jasminum ophicinale*	Leaf
4.	Katpul	*Scutellaria angusa*	Leaf
5.	Silpodo	*Virginia legulota*	flower
6.	Vudhpeto	*Ficus*	Leaf
7.	Anyari	*Strobilanthes dalhosians*	Leaf
8.	Goful	-	Leaf
9.	Reens	*Cotonester affinis*	Leaf
10	Tipatia	*Ferarium wallichiana*	Leaf
11.	Subanga	*Valeriana*	Leaf
12.	Gindwali	*Aclium*	Leaf

13.	Vajaradanti	*Potestiha*	Leaf
14.	Tilum	*Vibernum*	Leaf
15.	Gulab	*Rosa microphyla*	Leaf
16.	Bhuerj	*Jatula utilis*	Leaf
17.	Chili	*R. trigana*	Leaf
18.	Pulam	*Prunus domestica*	Leaf
19	Ratgiali	*Persica naptensis*	Leaf
20	Marchula	*Galinsoga parbiflora*	Leaf
21	Pasan bhead	*Berginia species*	Leaf
22	Pluli	*Reinwartia trigyana*	Leaf
23	Cucurmutta	*Agaricus species*	Complete
24	Jhula	*Lichen*	Complete
25	Khuhia	*Rumex naptensis*	Leaf
26	Palak	*Spinacea olecaracea*	Leaf
27	Frans been	*Phasiolus vulgaris*	Leaf
28	Soyabeen	*Soja bispida*	Leaf
29	Hisia	*Rubas naptensis*	Leaf
30	Guldawari	*Chymosynthenum caranium*	Leaf and flower
31	Chamkadig	*Halboella latifolia*	Leaf

* CCRAS=Central Council of Research in Ayurved and Sidha Almora, Uttaranchal

It has generally been observed that musk deer do not like *Schemia briola* leaves. In captivity, however, they relish germinated gram, wheat and millet.

(ii) Musk Deer Farm, Kufri (Himachal pradesh)

(M.S. Jain, Personal Communication,1992)

Grams	= 1.500 kg
Wheat Bran	= 0.500 kg
Carrots	= 1.500 kg
Tree leaves	= 3.000 kg
Fodder	= 5.000 kg
Salt	= 0.100 kg

Note:a) The diet is altered through the year to Black gram, wheat bran, groundnut cake and crushed maize in ratio of 2:2 : 1:1 with 1.0% salt added.

b) Agromix , a pelleted diet was also tried but was not relished by the animals.

c) Food is given twice a day i.e. early morning and evening. In winter dried lichen feeding is also practised. Oak leaf fodder is preferred than green berseem or grasses

(iii) Captive Breeding Centre, Kanchula Kharak, Distt Chamoli (Uttaranchal).

November to April	May to October
Lichens (*Kamastyehdalis sp.*), Kharsu oak leaves (*Ouercus Semicar pifolia*), dry *Strobilanthes wallichi* leaves and local Kathmal leaves.	Jungli gulab (*Rosa brunonli*) flowers, Jungli *Palak (Wild spinach) leaves, Jimal (Green* Strobilanthes) leaves, Moru oak (*Ouercus dilatata*) leaves and Local Khichru leaves.

The above mentioned fodder is provided @15 kg per day. But animals selectively eat about 5 kg (Banerjee,1993). On the principle the musk deer needs a higher energy requirement per unit body weight in comparison to large sized deer. Therefore forage of high quality be supplied to the animals in captivity.

3. *Bovidae* : This is the largest family of the Order Artiodactyla. Among native wild artiodactylid species, there are large number of species classed as endangered.

(1) Nilgai (*Baselophus tragocamelus*). (A) Conservation : Found in non dense forests and scrub forests and plains from foot of the Himalayas to peninsular regions. It is the largest antelope in the country. Presently, its population is fast increasing in the wild as well as in captivity.

(B) Food (a) Nature : The species is coarse browser but is also grazer. It feeds on the leaves and the fruits of various trees.

Agriculture crops are raided in winter and autum seasons particularly in Rohailkhand region of Uttar Pradesh.

(b) Captivity : Diet regimen per adult animal prescribed by various captive facilities is mentioned in table 12

(2) Blackbuck (*Antilope cervicapra*). (A) Conservation : Presently, considerable populations of species exist in Andhra Pradesh, Rajashthan, Tamil Nadu, Gujarat, Madhya Pradesh, Haryana, Karnataka and Uttar Pradesh. In Bihar and West Bengal the species populations are insignificant. In captivity the species is prolific breeder and its total population in all the facilities is around 400-500 animals.

(B) Food (a) Nature : The species is open land dweller and purely graminaceous. Its staple food is dub grass (*Cynodon dactylon*) throughout the year. Also for pods of *Prosopis cineraria* and *Prosopis nudiflora* blackbuck exhibits considerable palatability. I have observed in my early life in Terai region that during the summer months, the herds of blackbucks in the morning between 7.00 a.m - 10 a.m and in the evening between 5.00 p.m to 6.30 p.m grazed on the cultivated crops and in the mid of the day rested in open plain grassy areas either adjacent to the tall vegetation under trees or between shrubs/herbs nearby natural fosse. They used to eat sprouting tender parts of growing wheat (*Triticum aestivum*), gram (*Cicer arietinum*),oat (*Avena sativa*) and mustard (*Brasica compertris*) plants and nibbled new blades of burnt natural grasses. The species dietary items in nature have been studied by various workers (Ramana Rao and Prasad, 1982; Goyal *et al.*, 1986; Goyal *et al.* 1988). Observations about feeding of black bucks inhabiting the cultivated fields in Orissa are mentioned by Panda *et al.* (1997), which are reproduced in the table 8.

Table 8 : Dietary items of blackbuck (Panda *et al.* 1997).

Name of Plant species	Seasons		
	Summer	Monsoon	Winter
Grasses :			
Cynodon dactylon	+	+++	++
Panicum frumentacea	-	+	-
Andropogon aciculatus	-	+	-
Andropogon squarossus	-	+	-
Eragrostis cynosuroides	-	+	-
Celosia argentia	-	++	+++
Cyperus rotundus	+	+++	+
Commelina bengalensis	-	+	+
Crops :			
Oryza sativa (L.F)	-	++	+
Eleusine coracana (L.F.F)	-	+++	++
Pulses :			
Cajanus indicus(LFF)	-	++	++
Phaseolus mungo(LFF)	-	++	+++
Lathyrus sativus(L)	-	-	+
Millettia auriculata(LF)	-	-	+++
Cicer arietinum(L)	-	-	+
Pisum sativum(L)	-	++	+
Oils :			
Arachis hypogiea(L)	-	++	+
Others:			
Acacia nilotica(L)	+	-	+
Phoenix sylvestris(L)	+	-	-
Tridax procumbens(LF)	++	-	-
Abutilon indicum(L)	+	-	-

Note: +++= High ++= Medium += Low F= Fruits, F= Flowers, L= Leaves: - = Regularly eaten

(b) Captivity : Table 12 includes types of ration being fed to the species in different captive facilities. Some of the feed trials conducted at Van Prani Udyan, IVRI, Izatnagar(UP) are described hereunder.

Study 1: Table 9 includes observations about feeding behaviour of blackbuck fawns made At Van Prani Udyan, IVRI, Izatnagar (U.P).

Table 9 : Blackbuck fawn feeding behaviour (Arora, 1995)

Age	Suckling	Feeding behaviour	Habits 9a.m-5p.m.
1st week	3 times a day		Most of the time remained hidden in the vegetation even during suckling.
2nd week	-do-	At times nibbling	As above. Sometimes also

		dub grass.	seen with chitals/blackbuck.
4th week	-do-	Nibbling dub grass and green fodder leaves.	Mainly remained with black-bucks.
6th week	-do-	Nibbling dub grass and green fodder leaves.	Most of the time wandering with species individuals independent of mother,except during sucking
8th week	1-2 times	Picking up & eating dub grass and green fodder leaves.	-do-
10th week		Grazing dub grass and eating concentrate feed.	

Study 2: The following observations have been made during October - December, 1988 at Van Prani Udyan,I.V.R.I, Izatnagar (U.P).

(i) During the early hours most of the animals remained sitting upto 7. 00 a.m. They graze as late as till 7.00 p.m. The peak grazing periods were between 900 a.m, to 11.30 a.m and 4.00 to 6.00 p.m. When sitting they also pick up dub grass within approach around them. The observations in respect of chewing were as follows:

* Average chews per bolus per animal = 58
* Average time of chewing a bolus = 45 seconds
* Average time per chew = 1.24 seconds

(ii) When sal tree (*Shorea robusta*) leaves, bhimal tree (*Gavia optiva*) leaves, maize (chaffed), cowpea (*Vigna catjang*), lata (*Brussica sp.*) or berseem (*Trifolium alexandrinum*) were fed ad libitum. The animals exhibited considerable liking for fresh green berseem followed by green maize, cowpea and oat. Chaffed maize fodder was not likened.

These observations were taken in three animals (1:2) for a period of 5 days in case of each fodder.

Study 3 : Blackbuck can consume 2.2 and 3.5 kg DM/100 kg body weight fed on oats and berseem, respectively and on maize fodder, the intake is 2.25 kg DM/100 kg body weight. This indicates that species liked berseem more than oat and maize green fodders. Chemical composition and digestibilities of berseem and oat fodders were determined (Table 10a). It is observed that the nutrient digestibilities and the DCP value were generally better for berseem than for oats, whereas TDN values were comparable. Oats at preflowering stage may require some concentrate supplementation and berseem may require some high energy feed or low protein fodder.The effect of these two fodders on ruminal ciliate protozoa (Table 10b) and enzyme activities in the rumen content (Table 10c) revealed significant influence of fodders (Agrawal *et al* .,1997). Dry matter intake in case of green maize (milk to dough stage) is generally comparable to values observed for oat fodder. The rumen pH varies between 6.33 to 7.50 and specific gravity 1.07 + 0.01 on various feeding regimes. Activities of some rumen enzymes, population of ciliate protozoa and biochemical constituents in the event of feeding of two levels of maize grain along with ad libitum green berseem (*Trifolium alexandrinum*) fodder were determined in case of an adult male blackbuck (*Antilope cervicapra*). In the animal, permanent

rumen cannula was prepared. It was offered 250 g crushed maize and ad libitum berseem fodder continuously for 25 days including 5 days collection period of rumen liquor during the last week (treatment-1). After this, the amount of crushed maize was increased to 500 g per day with *ad libitum* berseem fodder in treatment 2. Samples of strained rumen liquor (SRL) were collected at 0,2,4,6, and 8 hours post feeding for counting ciliate protozoa and biochemical analysis, and at 4 hours post feeding for the estimation of enzymes. For enzyme estimation SRL was subjected to sonication for 10 minutes in ice bath followed by centrifugation at 27,000 x g for 30 minutes at 4°C. The clear supernatant was used as a source of enzymes. The carboxymethyl cellulase, xylanase, oc-amylase, protease and urease were estimated. Estimations of glutamate oxaloacetate and glutamate pyruvate transaminase (GPT) were also done as per Reitman and Frankel (1957).

Table 10 (a) : Chemical composition, mean digestibility and nutrient contents of oats and berseem % dry matter basis (IVRI)

Nutrient	Oats		Berseem	
	Composition	Digestibility coefficient	Composition	Digestibility coefficient
DM	14.9	64.9	12.2	74.5
OM	89.1	70.0	86.1	79.2
CP	13.4	67.4	20.1	7.3
EE	2.8	55.9	2.8	69.7
TCHO	72.9	72.5	63.2	81.6
NDF	55.3	58.8	47.3	66.2
ADF	36.8	45.5	39.0	64.8
DCP	-	9.9	-	14.7
TDN	-	69.2	-	71.3

DM = Dry matter OM = Organic matter , CP = Crude protein,
EE = Ether extract, TCHO = Total carbohydrate, NDF = Neutral detergent fiber,
ADF = Acid detergent fiber, DCP = Digestible crude protein, TDN = Total digestible nutrient

Table 10(b) : Total and differential counts of ciliate protozoa in the rumen of blackbuck fed on green oat and berseem (IVRI)

Protozoa count hours after feeding

Diet	Protozoa count (10^4/ml) hours after feeding						
	0	2	4	6	8	24	Average
Total Protozoa:							
Oat	30.79	35.85	41.75	42.20	40.23	32.36	37.18
Berseem	37.99	47.17	48.55	60.50	59.70	37.92	48.64
Holotrich:							
Oat	3.27	6.32	6.53	6.33	6.14	3.42	5.34
Berseem	3.57	9.56	8.68	11.84	10.98	3.93	8.09
Isotricha:							
Oat	1.83	2.43	2.47	3.08	2.97	1.91	2.42
Berseem	1.34	2.47	1.82	2.38	2.86	1.43	2.05

There are about 90 - 100 individuals in 20 captive facilities. Breeding of species is to be encouraged in Jaipur zoo, Bikaner zoo, Gwalior zoo and National Zoological Park.

(B) Food (a) Nature : The species is mainly browser and concentrate feeder. Absence of certain cellulloytic bacteria in the reticulo-rumen facilitating digestion of fibrous food is attributed for food preferences for low fibre leaves and of high nutrient requirements (like other concentrate feeders). Soni (1983) reported that Gazella dorcas inhabiting Thar desert eats leaves, flowers and fruits of the following plants: *Tecomella undulata, Aervato mentosa,Prosopis cineraria, Acacia jecomonsi,Crotalaria burhia, Zizyphus nummularia, Calotropis prosera, Cynodon, Dacryloctenium* and *Cyperus sp.* The crop species liked by the gazelles include *Phaseolus aureus, P. aconitifolicus, Cyamopsis tetragonaloba, Brassica campestris* and *Cicer arietinum.* During feeding an alpha male occupies the central position in a herd and enjoy the best available. Goyal *et al.* (1988) studied food preference of the species inhabiting an area adjoining Bishnoiyan village situated on the outskirts of Jodhpur city (Tables11 a,b). Their observations revealed that gazelles in winter preferred *Crotalaria burhia* and *Zizyphus nummuralia* leaves having 7-12 % crude proteins. During summer when most of the preferred plant species dry up the gazelles feed on the green leaves of *Maytenus emarginatus* and to some extent on the growing ground flora - *Elensine compressa* and *Cyperus arenarius.* These are good source of moisture and nutrients. During the period gazelles also eat green and dried pods of *Prosopis cineraria* and the micro-nutrients rich flowers of *Tecomella undulata.* This poor roughage digester species have forestomachs of comparatively smaller size particularly the rumen of low volume, which may be facilitating the fast leaping and escaping abirites from any danger of the species.

Table 11 (a) : Per cent plant species foraged by blackbuck and chinkara (Goyal *et al.* 1988).

Habitat I (utilized by blackbuck)		**Habitat II (utilized by chinkara)**	
Plant species	Percent of total cover	Plant species	Per cent of total cover
Tephrosia purpurea	67.1	*Crotalaria burhia*	52.48
Prosopis juliflora	17.2	*Tephrosia purpurea*	43.76
Capparis decidua	6.9	*Zizyphus nummularia*	17.5
Prosopis cineraria	2.78	*Capparis decidua*	2.15
Acacia nilotica	1.72	*Prosopis cineraria*	1.76
Acacia jacquemonti	1.6	*Balanites aegyptiaca*	1.4
Crotalaria burhia	0.47	*Maytenus emarginata*	1.0
Zizyphus nummularia	0.47	*Fagonia cretica*	0.70
Echinops echinatus	0.74	*Cocculus pendulus*	0.52
Leptadenia pyrotechnica	0.35	*Leptadenia pyrotechnica*	0.26
Tamarix articulata	0.35	*Aerva pseudotomen-tosa*	0.48
Mollugo cerviana	0.07	*Tecomella undulata*	0.17
Sericostoma			

pauciflorum	0.03	*Calotropis procera*	0.08
		Heliotropium spp.	-
Grasses			
Cynodon dactylon		*Grasses*	
Desmostachya		*Cynodon dactylon*	
bipinnata		*Desmostachya bipinnata*	
Dactyloctenium		*Eleusine compressa*	
aegyptium		*Sporobolus marginatus*	
Eleusine compressa Sporobolus marginatus			

Table 11(b) : Plant species eaten by blackbuck and chinkara during summer and winter in Rajasthan (Goyal et al., 1988)

Species	(a) Summer	(b)Winter
Blackbuck *(A. cervicapra)*	*Cynodon dactylon Desmostachya bipin nata, Mollugo spp., Prosopis cineraria, P.juliflora pods.*	*Cynodon dactylon. Desmostachya bipinn-ata, Dectyloctenium aegyptium, Eleusine compressa, Mollugo sp., Sporobolus mur-ginatus.*
Chinkara *(G.gazella)*	*Maytenus emarginata, Zizyphus nummularia, Eleusine compressa, Heliotropium spp, Prosopis cineraria*	*Crotolaria burhia, Zizyphus nummularia, Tecomella undulata (flowers). pods.*

(b) Captivity :

Table 11(c) Ration for chinkara per adult per day

(i) Zoological Garden, Ahmedabad(Gujarat)			**(ii) Zoological Garden,Gwalior (M P)**		
Conc. feed	=	0. 200kg	Gram (Crushed)	=	0. 250kg
Green forage	=	1.00 kg	Vegetables (seasonal)	=	0. 500 kg
Dry forage	=	ad lib	Green fodder	=	5.000 kg
(iii) Zoological Garden, Calcutta(WB)			**(iv) Zoological Garden, Mysore (Karnataka)**		
Wheat bran	=	O. 350kg	Horse gram	=	0. 200 kg
Gram crushed	=	0. 350kg	Wheat bran	=	0. 500 kg
Barley	=	0. 100kg	Green grass	=	3.000 kg
Carrot + Red			Hay	=	1.000 kg
Potato	=	0. 350kg	Lucerne	=	0.250 kg
Salt	=	L.S.*			
Leaves	=	L.S.*			
*Lump sum					
(v)Zoological Park, Hyderabad(Andhra pradesh)			**(vi) Zoological Park , Kanpur(UP)**		
Cattle feed	=	0.5-1.0 kg	Dry cattle feed	=	0. 500 kg
Lucerne	=	1.0-2.0 kg	Gur (In winter)	=	0. 500 kg
Pipal leaves	=	1.0-2.0 kg	Green grass	=	3.000 kg

(vii) National Zoological, Park, New Delhi			viii) Van Prani Uddyan,IVRI, Izatnagar (UP)		
Mash	=	O.500kg	Dry goat feed	=	0. 400 Kg
Gram soaked	=	0.250kg	Green fodder	=	1.000 kg
Kutti*	=	1.000 kg	(Berseem/Lobiya)		
Tree fodder	=	1.000 kg	Dub grass	=	ad lib
			Tree leaves	=	0.500 kg

* Chaffed maize/ jowar green fodder

(4) Chowsingha (*Tetracerus quadricornis*). (A) Conservation : It is the smallest antelope in Asia. The species inhabits wooded undulating low hilly terrain in Andhra Pradesh, Bihar, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu and Uttar Pradesh but not in the Malabar coast.

In 1998 there were only 60-70 numbers in 14 captive facilities. Zoological Garden, Junagarh (Gujarat), Van Vihar, Bhopal (Madhya Pradesh) and Zoological Garden, Mumbai (Maharashtra) - each one has more animals than any other facility in the country.

(B) Food (a) Nature : It mainly feeds on tender leaves, grasses and shoots.

(b) Captivity: Table 12 includes diet schedule for the species prescribed in various zoos.

(5) Chiru/Tibetan antelope (*Pantholops hodgsoni*). (A) Conservation : The animals inhabit desert of northern Tibet and occasionally cross into Chang Chen Mo Valley and a few are found in isolated valleys of Ladakh.

(B) Food (a) Nature : Chiru lives in large herds in northern Tibet, but small groups of four or five are seen in Ladakh. In early summer the herds frequent the higher plains and more exposed slopes, but as the snow melts, they ascend to higher regions to graze on the sprouting grasses.

(b) Captivity : Presently existence of any specimen in any of the captive facility is not known.

(6) Himalayan tahr (*Hemitragus jemlahicus*). (A) Conservation : The species is present throughout the Himalayas from Pir Panjal to Sikkim at high elevations but within tree-line.

(B) Food (a) Nature : Tahrs browse grasses growing out of the crevices of rocks and on leaves of other luxurious vegetation.

(b) Captivity : None of the zoos in the plains has the species. Zoological Garden, Nainital (UP) and Himalayan Nature Park, Kufri (Shimla) have some specimens. The latter facility feeds the ration with same quantity which is recommended for goral.

(7) Nilgiri tahr (*Hemitragus hylocrius*). (A) Conservation : Animal has an isolated distribution from Nilgiris to Annamalai and along the western ghats at elevations from 1200 to 2700 m in treeless terrain and the grassy lands. The main range areas of species are from Nilgiri hills (TN), Nelliamputty and Parambikulum hills (Kerala state), Annamalai and Amaravarthi hills (Tamil Nadu) to Eranakulam National Park (Kerala).

(B) Food (a) Nature : Being goat-like in nature, tahr is a true browser. It forages in the early morning and evening and consumes grasses growing out of the crevices of rocks and nibbles on the leaves of other luxuriant vegetation. Davidar (1978) described that food of tahr consists chiefly of grasses; hence, it is more grazer than browser. Study of Schaller (1970) revealed that in October and November when the green forage is plentiful throughout the habitat, the tahr feeds mostly on or near the cliffs. Grazing herds move either in a fairly compact unit or loosely scattered over the slope. They move in right file with an adult female in the lead and the saddlebacks usually in the rear. In addition to green grasses tahrs also feed on leaves of shrubs (*Strobilanthes kunthianus*), *Umbelliferae* (*Heracleum sp.*) and wattle (*Acacia sp.*). Between January and March the tahrs browse along the edge of the thickets and the bases of the cliffs. Schaller (1970) also mentioned that animal chews cud at the rate of about 3 chews per two seconds. Lal Mohan *et al.* (1998) described food preference of the species in order of *Andropogan spp, Cynbopogan spp,,Digitaria spp,Isachne sp, Arundinella spp, Tripogon spp ,Themeda sp, Pedicularis spp Crotalaria spp,* etc.inhabiting Kanyakumari district.

(b) Captivity : Zoological Garden,Thiruvananthapurum (Trivandrum) has this species. The diet provided per day per adult individual is consist of : Cattle feed, wheat bran and plantained each 0.250 kg, Bengal gram(soaked), carrot and cabbage each 0.100 kg and fodder leaves 1.0 kg and grass 2.5kg. The concentrate and green fodder provided to deer species is palatable. National Zoological Park, New Delhi had the species in the past. The animals were fed mash and green fodder of the same composition which is offered to bovid species(Table 12 ii).

(8) Goral (*Nemorhaedus goral*). (A) Conservation : It is Himalayan goat antelope inhabiting the Himalayas from 2000 to 3000 metres altitudes.

(B) Food (a) Nature : It is predominantly a grazer. It uses cover similar to musk deer but is very different in its feeding habits. Although there is dietary overlap between two species in winter, when food resources are in short supply, potential competition between the species is avoided by reduction in their use of cover. In the season gorals also shift to lower altitudes to avoid predation rather than to avoid food competition (Green, 1987a).

(b) Captivity : National Zoological Park , Delhi is the principal captive facilitity for successful breeding of the species. Diet schedule is entered in table 12. At Himalayan Nature Park, Kufri (Shimla- H.P.) goral is fed 1.5 kg mash and green fodder 5 kg per adult per day.

The mash composition includes wheat bran, 40%; maize crushed,30%;black gram 20%,Ground nut cake 8%; Salt, 1% and mineral mixture, 1%. Green fodder is Van robina , Karyal and other fodder tree leaves.

(9) Serow (*Capricornis sumatraensis*). (A) Conservation : Serows dwell at elevations between 1800-3000 m from Kashmir to Mishmi hills of Arunachal Pradesh. The hill ranges of Yunan, Szechuan, Myanmar, Siam , Malay Peninsula and Sumatra are inhabited.

The animals have been seen in Corbett National Park (Uttaraanchal). They usually frequent singly. But in the mornings or evenings in open slopes grazing herds consisting of 2 to 5 animals are not uncommon. Their diets consist of leaves and shoots of aromatic plants. Guwahati Zoo(Assam) prescribes the diet for the species (Table 12 vii).

(B) Food (a) Nature : The food habits of the species in nature have not been studied thoroughly.

(b) Captivity : It is not known if any captive facility other than Zoological Garden, Guwahati and Manipur Zoo maintains the species. The concentrate diet being fed to goral (*Nemorhaedus goral*) is found equally good for the species.

(10) Takin (*Budorcas taxicolor*). (A) Conservation : The species is almost exclusively found living in herds at the high altitudes of 2135 m to 3050 m in the dense bamboo and rhododendron jungles of eastern Himalayas from Bhutan to Mishmi hills of Arunachal Pradesh and the mountains of the Salween - Irrawaddy in Myanmar. It is heavily built goat antelope and congregates in large numbers during summer near water sources. It comes down to lower elevations of 900 to 1200 m in tropical forests of Mishmi hills for pasturing in severe winter.

(B) Food (a) Nature : Not much is known or studied about the food habits of takins. The animals subsist mainly on leaves and shrubs.

(b) Captivity : Only mini Roing Zoo in Arunchal Pradesh possesses some specimens since it is a goat antelope, be well maintained on the diet presented for other similar species.

(11) Asiatic ibex (*Capra ibex sibirica*). (A) Conservation : Widely distributed within Indian limits above altitudes of 5000 metres from sea level in western Himalayas and trans -himalayan ranges east of Kumaon, the population of asiatic species is estimated from 9000 to 15000 animals, of which Pin valley (HP) has 700 to 1200 animals. Presently no captive facility is breeding the species. At the lower altitide. Indian Veterinary Research Institute (IVRI), Mukteswar in Kumaon Hills can be choosen for establishing a captive breeding facility for the species and then after for releasing of their F2 population in natural forest reserve of the Institute.

(B) Food (a) Nature: It lives in higher elevations above the tree line. In the spring, it comes to lower valleys below the snow line for new grass on the steep slopes. Manjrekar and Bhatnagar (1997) studied the animals, food ecology in Pin valley. They found that during winter, the species feed on parts of herbs such as *Artemisia, Arnebia, Linde logfia* and *Tragopogon*. The fruits of high fat and sugar content, particularly of Rosa and Cotton easter plants, are likened. On the onset of the summer ibex starts feeding at lower altitudes of about 3,800 metres where snow melting and sprouting of highly nutritious plants are earlier. Thereafter, animals keep moving upwards with progressively increasing melting of snow and coming up of vegetation in the higher altitudes of about up to 4,800 metres. The leaves and fruits form the predominant component of the diet of the species. During the period between May and August the diet predominantly consists of dicotyledonous

herbs, and there is enough food; leaves, flowers and fruits for the species. 29 out of the 37 plant species identified to be consumed over all seasons were observed in the faecal samples analysed. Manjrekar (1997) determined the crude protein levels and caloric values of ibex food plants. Her findings are presented below.

Nutritive values of the plant species eaten by ibex in Pin Valley National Park(HP).

Values	Autumn	Winter	Spring	Summer
Diet	Fruits	Fruits	Leaves	Leaves
Crude protein	7.6±	5.9±	23.2±	14.5±
(per cent)	0.45 SE	0.64 SE	0.54SE	0.45SE
Energy	4.53±	4.899 ±	4.40 ±	4.50 ±
(Kcal/g)	0.00SE	0.16 SE	0.00SE	0.05SE

The conclusion drawn were; i) diet choice not seem to influenced by crude content (P>0.1), but caloric value of the food plants seemed to influence diet chice to some extent (Pearson's correlation coefficients: spring r=0.4883, autumn r=0.5853;P<0.1) and 2).forage digestibility might influence food selection by ibex.

(b) Captivity: Zoological Garden,Darjeeling possessed a pair

(12) Bharal/Blue sheep (*Pseudois nayaur*). (A) Conservation : In structure and habits the bharals hold a place intermediate between sheep and goats. Species is mainly inhabitant of Tibet but its distribution, in altitudes between 3660 m to 4860 m from sea level, ranges from Ladakh-Kumaon hills to Sikkim, Bhutan and Nepal.

(B) Food : Prater (1971) described that bharal is main Himalayan ranges are found at levels between the tree line and snow line where there are rich and abundant grasses. On the slopes above the tree lines (Ladakh range) the availability of the food is scarce in patches of coarse grass, moss and draft shrubs. The species subsists mainly on grass and tend to browse far less than goats. Like sheep they graze in open and do not enter into forest or scrub of any kind. The herds graze and rest intermittently throughout the day.

(13) Urial/Shapu (*Ovis orientalis*) : Species is also called as Ladakh urial. It has wide ranging distribution in the northern areas with habitat that stretches across the desert steppes of the Indus Valley (between 1,000-1,8000 m elevation) and extends along the river Indus and its tributaries until it reaches an elevation of 4,200 m in the alpine/snow field zone.

(14) Gaur (*Bos gaurus*). (A) Conservation : It is the largest of all native wild bovines and lives in herds, each comprising of 8-20 individuals. Gaur is essentially dweller of tropical deciduous hilly forests in Arunachal Pradesh, Assam, Madhya Pradesh, Maharastra, Karnataka,Kerala and Peninsular region of Andhra Pradesh. They graze early in the mornings up to 10 a.m. and in the late evenings, then converge at dawn and graze near the water source at much lower elevations. Between 10.00 a.m. to 4.00 p.m. they retire to shelter and seclusion of the hilly forests. In captivity only 15 (8:7) animals were present during 1998 in the country. The maximum number 9 (4:5) were in the Mysore zoo.

(xiii) Zoological Garden, Imphal - Manipur

Food items	Chital	Sambar	Hog deer	Barking deer	Serolo	Nilgai
Rice bran	0.750	1.000	0.500/0.330	0.500	0.500	1.000
Wheat bran	0.750	1.000	0.500/0.330	0.500	0.500	1.000
Maize crushed	0.500	0.500	0.500/0.330	0.250	0.250	1.000
Oil cake	0.100	0.100	0.100/1.060	0.100	0.050	0.100
Gram whole	0.200	0.200	0.100/0.060	0.100	0.100	0.250
Heirru/Heibong	0.100	0.100	0.100/0.060	0.100	0.100	0.100
Mustard leaf/cabbage	0.500	0.200	0.100/0.060	0.100	0.200	0.200
Green fodder	5.000	8.000	4.000/2.666	4.000	2.000	8.000

3. Family - *Tragulidae*

(1) Mouse deer (*Tragulus meminna*). (A) Conservation : The animal is highly endangered and its populations in wild are not reckoned. This species occurs in Andhra Pradesh (Pakhal, Eturnagarom), Tamilnadu (Mudumalai), Maharahstra (Tadoba and Nagzira), Kerala (Wynad),Rajasthan (Ranthambore), Madhya Pradesh (Kanha), Arunachal Pradesh (Mahao), Orissa (Simplipal, Kuldhia and Satkosia gorge) and Bihar (Dalma). It is also found in Sri Lanka.

(B) Food (a) Nature : It is a solitary creature, seclusive and crepuscular in habits. It keeps itself among rocks up to an elevation of 1850 m and rarely ventures to open areas from its hideouts inside the forests. Species is frugivorous mainly.

(b) Captivity: Ration in different facilities for the species (per adult) is mentioned hereunder.

(i) Zoological Park Sepahijala (Tirpura)

Gram (soaked)	= 200 g
Banana	= 4 nos
Vegetables	= 750 g

(ii) Zoological Park, Hyderabad(AP)

Gram (soaked)	= 100-150 g
Carrots	= 30-50 g
Tomatoes	= 20-25 g
Lucerne	= 500 g

iv) Zoological GardenAhmedabad(Gujarat)

Gram (soaked)	= 20 g
Vegetables (mixed)	= 200 g

(iii) Biological Park,Bhubaneshwar(Orissa)

Boiled rice,boiled pulses,milk, brinjal, sweet potatoes,banana. Dub (*Cynodon dactylon*) and other edible grasses.

4. Family-*Giraffidae* : This includes giraffes which are exotic species. Only few zoos in the country are importing and exhibiting the species for public education. Zoological Garden, Calcutta (WB) and Zoological Garden, Mysore (Karnataka) have successfully bred the species. Where as National zoo failed in this mission.

Table 13: Diet schedules for Giraffe (*Giraffa camelopardalis*)

(i) Zoological Park, Hyderabad (AP)

Food Items	Forenoon	Afternoon
Wheat bran	1.200	1.200
Crushed maize	0.5-0.700	0.5-0.700
Peepal leaves	5-10000	5.0-10.000
Lucerne	1.0-2.000	1.0-2.000
Babool leaves	ad lib	ad lib

(ii) Zoological Park, Kanpur (UP)

Green grass	25.000
Cattle ration	2.500
Horse ration	2.500
Gur -in winter	0.250
Onion	1.000

Note: 1% mineral mixture mixed in ration daily.

(iii) Zoological Garden, Guwahati (Assam)

Food items	Adult	Subadult
Crushed gram	3.000	1.500
Crushed maize	2.000	1.00
Wheat bran	1.000	0.500 g
Mal bhoug (Banana)	10 nos	6 nos
Carrot	1.000	0.500
Apple	0.500	0.250
Orange	4 nos	3 nos
Mousambi	0.200	0.150
Common salt	0.050	0.025 g
Black salt	0.500 g *	0.250
Green fodder	75.000	50.000

*: Total in one month

(iv) Zoological Garden, Mysore(Karnataka)		(v) Zoological Garden, Culcutta(WB)	
Hay	5.000	Maize (crushed)	0.600
Lucerne	1.500	Wheat bran	2.50
Wheat bran	2.000	Barley (crushed)	1.00
Horse Gram	1.500	Gram (crushed)	0.750
Bengal gram	1.000	Oat (crushed)	0.400
D C oat	2.000	Carrot/Red	2.600
Carrot	1.000	Potato	-
Cabbage	2.000	Onion	2.400
Onion	1.000	Bean	1.100
Apple	0.750	Banana	3.15
		Apple	1.100
Note: Sub adult is given half			
Orange		Orange	0.750
		Guava	0.500
		Pulse (boiled)	0.400
		Molasses	0.125
		Ground nut/ oil cake	0.325
		Salt	0.025

5. Family : *Suidae* :The family includes only three native species.

(1) Wild boar (*Sus scrofa cristatus*). (A) Conservation: In the habitat large sounders of wild boars ranging from a few to 30-40 are seen in and around large water sources, during summer. The herd of 4 to 7 individuals is not uncommon, otherwise. Sometimes during the hotter period of the day sows with their piglets crossing the forest roads to visit the water sources are encountered. They have fixed home ranges. During night they often foray into the tourist camps in the National Parks and Sanctuaries in search of edible left over.

(B) Food (a) Nature: The species is omnivorous. Fleshy underground rhizomes, roots and tubers are probed with snout and eaten. It also scavenges on left overs of predators' kills. If they spill over to cultivated lands, they will eat sugarcane, potato, ground nut, maize and paddy. The tubers notably of *Panicum repens* in

marshy areas seem to be an important food item in Periyar Wildlife Sanctuary. Feeding on tadpoles of Rana cutiepes and certain fishes is also reported . A case of wild boar feeding on carcass of its own species was mentioned by Ramachandran *et al.* (1986). In Kanha National Park pigs feed on fallen mahua fruits (*Madhuca indica*).

(b) Captivity : Table 14(a) furnishes the diet for per adult wild boar in certain zoos.

Table 14(a) . Diet for per adult wild boar per day in some zoos

Food items	NZP, Delhi	ZP, Kanpur	ZP, Hyderabad	ZP, Chennai	ZG, Mysore	ZP, Bhub-
Deer Mash/ Cattle	1.00	0.750	1.0-2.0	-	-	1.000
Wheat bran	-	-	-	1.00	1.000	-
Rice	-	-	-	0.500		
Hoarse Gram	-	-	-	0.100*	0.500	0.100
Vegetable leaves (seasonal)	1.00	0.500	-	-	-	-
Tapyca	0.250					
Carrots	-	-	0.500	0.250	0.300	
Potato	1.00	0.500	-	0.250	-	0.250
Groundnut	-	-	0.100	-	0.500	
Cabbage	-	-	-	0.250	-	-
Green-grass/Hay	-	-	ad lib.	2.000		
Lucerne	-	-	1.000	-	-	
Salt	--	--	--	0.010	-	
Total	3.00	1.750	2.63	2.110	4.800	1.350

Note. *White Bengal gram

All Zoos in Rajasthan feed the same ration (composition= Gram-1.00 kg, green fodder-6.0kg, and vegetable and fruits-0.500kg) at the same rate per adult individual per day .The ration being fed by Zoological garden , Ahmedabad (Gujarat) is also given to the species in Hyderabad zoo. In addition to wallowing water facility provision for fresh supply of drinking water be ensured.

(2) Andaman wild pig *(Sus scrofa andamanesis)*. (A) Conservation: Its distribution is restricted to Andaman Islands.

(B) Food : Lives in forest but often comes out to feed on cultivated crop. About the natural feed not much has been studied.The species is omnivorous in diet, and lives on crops, roots, insects, offal and carrion.

(3) Pygmy hog (*Sus salvanius*). (A) Conservation: Species occurrence was known in Tarai and Duabs of the Himalayan and Sivalik foot hills in northern India. Occurrence east to Assam was well marked in the past. At present its existence is only restricted to Manas National Park, Assam and its status is precarious, demanding rigid ecological conditions for viability and survival.

(B) Food (a) Nature: Species inhabits open Savannah and rarely is observed in grasslands interspersed with trees. It is diurnal and very active in the morning and

evening. The animal is omnivorous. Five to six species of plants are identified as food source. It feeds on roots, bulbs of grass and herbs, grasses, leaves, earthworms and also on small birds and their eggs, lizards , insects(provide substantial quantity of protein), etc. While foraging it undoubtedly consumes large quantities of earth as well. It generally avoids water, but has been seen paddling in muddy water under confined conditions.

(b) Captivity: Observations of Oliver *et al.* (1997) in respect of food preferences of pigmy hog are entered in Table 14. On the visit during Decembar, 1999 to Basistha Pigmy Hog Centre, Guwahati (Assam) author had discussed with the Veterinary Officer and Wildlife Biologist of the project workers and recorded following information.

a) In the paddocks, the hogs browse on grass shoots, teak pods and the roots of grasses and herbs which were collected from Manas and transplanted therein.

b) Sixty different food items all purchased from the local markets, are offered to the hogs. It is said that pigmy hogs eat ravenously apples, bananas, papayas, melons dates and coconuts and seldom any amount is left as waste. The hogs were encouraged to consume less favoured or previously untried foods, such as yams, cauliflowers, etc. by sweetening the food with condensed milk. The foods were presented on trays in the stalls, while certain preferred or less perishable foods were chopped and scattered around the paddocks to encourage foraging.

Table 14(b). Food preferences of captive pigmy hogs(Oliver *et al.*, 1997).

(i) Preferred items (i.e. those selected preferentially, and seldom left uneaten).

Fruits: apple, banana, plantain, papaya (ripe), melon (bangi or bami), date (with stones removed), coconut (chopped kernel).

Others:boiled egg (shelled), sugarcane (peeled pieces), milk cereal (Cerelac, given for hoglets).

(ii) Favoured items(i. e.not selected preferentially, but usually consumed)

Fruits: guava, jack fruit (ripe), mango (ripe), Bengal quince (or bael, ripe), pear, pineapple, water melon, tomato, gumi or khesra (an oval, yellow or greenish yellow, striped fruit/vegetable, 3 to 6 cm long, like miniature bangi, eaten raw).

Tubers/ roots:red or white sweet potatoes (various varieties, rawor boiled), potatoes (boiled), arum roots (boiled, preferred varieties include: doodh kochu, panchamukhi and any small sized kochu).

Others: bantam eggs (raw), milk (whole milk powder given with cooked rice or soaked flat rice).

(iii) Less favoured items (i.e. often left uneaten).

Fruits: grapes, water-chestnut (or paniphal, peeled, raw or cooked).

Roots/ Tubers:beetroot (boiled), carrot (raw), manioc or simolualu (Manihot utilisima), large arum root (e.g., bah kochu, ol kochu).

Cereals: parboiled rice (cooked), maize (fresh or cooked, on cob), bread (especially moistened or sweetened), coarse-ground wheat (dalia, cooked), flat rice (chira, soaked), rusk (moistened), gram (soaked or germinating), coarse-ground corn.

Others: fish (carp, par-boiled and deboned), goat meat (cooked, chopped or minced), soya bean (processed chunks, boiled), commercial swine food (corn and soya based concentrate, eaten if moistened and sweetened with jaggery), peanuts.

(iv) Unfavoured items (ie. seldom or never eaten).

Fruits/ Vegetables: citrus fruits (all varieties), raw papaya (green), pumpkin ; gourd; cucumber ; pea (raw or boiled), string bean ; egg plant or brinjal ; okra (bhindi); cabbage (raw or lightly cooked), cauliflower (raw or lightly cooked) and all other leafy green vegetables.

Roots/ Tubers: yam (raw or boiled), turnip (raw or boiled), radish, kohlrabi (raw or boiled) and kathalu (raw or boiled).

Cereals: moong, lentil (soaked, germinating), non-parboiled rice (cooked), Bora rice (local breakfast cereal, soaked or cooked).

Others: crickets (frozen/defrosted), earthworms (live) and dried fish.

II. ORDER - PERISSODACTYLA

1. Family *Rhinocerotidae*:

(1) Great Indian one horned rhinoceros (*Rhinoceros unicornis*). (A) Conservation : There is only one native surviving species of the family known as great Indian one horned rhinoceros (*Rhinoceros unicornis*) in India and Nepal. Its population is estimated to be around 1700 in Kaziranga National Park and Jaldapara wildlife Sanctuary. Re-introduction of this species in 1984 into Dudwa National Park has been a successful attempt. Two rhinoceroses rescued from Kaziranga National Park and Nowgaon, respectively in 1987 and 1989 were maintained in the State Zoological Garden, Guwahati. In 1997 one was released in Gorumara National Park and the other in Jaldapara Wildlife Sanctuary of West Bengal. Among captive facilities, Guwahati zoo possesses maximum number of individuals. During 1998 in all there were 38 animals in thirteen zoos in the country.

(B) Food (a) Nature : The Indian rhinoceros (*R. unicornis*) is mainly grazer but also browser as well and has a prehensile tip in the upper lip which may not be distinctive in some cases. The rhinos prefer cool climate and swampy habitat. Hence also feeds on aquatic vegetation. They are found grazing in the open fields mostly between 9 a m. to 10 a.m. and thenafter retire to rest in the tall grass or wallow in the water/mud to cool the body. In the afternoon they again start browsing when the day is cool and they may spend 75% of their time for grazing. They are fond of *Sacchrum* spp. of grasses.

Rhinos generally prefer grasses like *Sacchrum* spp., *Cynodon dactylon* (L) Pers., *Arundo donax* (L)., *Polytoca digitata* (Lf) druce, *Hygroryza aristata* (Retz.) Nees, *Vetiveria zizanioides* (L) Nash, *Imperata cylindrica* (L.) P. Beauv., *Themeda*

spp., *Chrysopogon aciculatus* (Retz.) Trin., *Setaria pallidefusca* (Schumach.) Stapf et C.E. Hubb, *Paspalidum flavidum* (Retz.) *A. Camus, Narenga porphyrocoma* (Hance Bor and *Phragmites karka* (Retz.) Trin., sedges like *Cyperus* spp. as well as herbs, shrubs and saplings of species like, *Polygomum plebelium* R. Br., *Aageratum conyzoides* L., Erigeron sp., *Artemisia nilagirica* (Clarke) Pam., *Eupatorium odoratum* L., *Solanum spp.*, *Colebrookia oppositifolia* J.E. Smith, *Murraya koenigii* (L.) Spreng., *Trewia nudiflora* L. *Litsaea sp.*, *Premna sp.*, Ehretia sp. etc. They also prefer aquatic plants like *Hydrilla verticillata* (L.f.) Royle, *Vallisneria spiralis* L., *Hygroryza aristata* (Retz.) Nees ex Wt. and Arn., *Potamogeton* sp., etc. During the rainy season they move along the river beds and in cultivated fields and sometimes take *Oryza sativa* L. Rhinoceros population in Kaziranga takes about 77% grasses and 23% herbs and shrubs (Singh and Rao, 1984).

According to Mary *et al.* (1998) in Kaziranga National Park, Assam rhinoceros (*R. unicornis*) feeds on 47 species of plants. Grasses comprised 75% of the total plant species eaten. The highly preferred grass species were *Cynodon dactylon, Eragrostis sp., Chrysopogon sp., Imperata cylindrica, I. indica, Aciculatus sp, Phragmites karka, Andropogon sp, Saccharum elephanatum, Saccharum sp, Pennisetum sp., Typha elephantina, Pollinia ciliata, Arundo donax,* and *Tamarix sp*. Among the marshy vegetation, the rhinos preferred *Eichhornia crassipes (water hyacinth), Andropogon sp. Ipomoea reptans, Nelumbo speciosum and Nymphaea lotus* the most.

(b) Captivity: Wide range of materials eaten by the Indian rhinos (*R. uniconis*) suggests that the animal is not very specific in its choice. The animals are fed generally twice a day i.e. in the forenoon green fodder and in the afternoon concentrate diet. Composition of the rations fed to an adult or young rhinoceroses (*R. unicornis*) per day in different captive facilities are detailed in table 15(a) . Also rations for exotic rhino species presently being maintained by some of the zoos have also been indicated (Table 15 (a) viii)

Table 15 (a). Diet (food items in kg) for rhinoceros per adult per day in certain zoos.

(i) National Zoological Park, New Delhi

Tree fodder (wholesome) or Green fodder	= 50.0-75.0
Kuti(chaffed green maize/jowar fodder)	= 30.00
Deer Mash	= 8.00
Khichari	= 4.500

(Khichari composition: Rice, Mung and Gur 1.500 kg each,Mustard oil, 0.500kg , Amala 0.050kg , Banana 6-10 no.,Linseed 0.100 kg, Haldi(Tumeric) 0. 100kg , Common salt 0. 100 kg).

(ii) Zoological Park Hyderabad(AP)

Cattle feed	= 9.0
Green leaves (Peepal) or green grass Half in the forenoon and rest in the afternoon.	= 50.0

(iii) Zoological park, Kanpur (UP)

Sugarcane (November)	= 100.00
Green fodder	= 150.00
Hoarse ration *	= 6.00
Banana	= 12.500
Gur	= 1.00

(iv) Zoological Garden, Lucknow (UP).

Wheat bran	= 1.0
Wheat	= 1.0
Rice	= 1.0
Banana	= 3.0
Gur	= 1.0
Milk	= 1.0
Green Fodder +	= 75.0

* In winter replced by khichari prepared from : Wheat bran, 1.0kg, rice 1.0kg, groundnut cake, 1.0 kg, gur 1.25 kg and milk 1.25litre cooked in water. Note. 1% mineral mixture is provided mixed in ration daily. Sugarcane to be substitute of green fodder in season.

+= Berseem / chari. In dry season on non availability of green fodder 30 kg cucumber is given.

(v) Biological Park, Bhubaneshwar (Orissa)

Black Gram whole	=1.000
Bengal gram whole	=2.500
Carrot	=1.000
Mineral mixture	=0.100
Wheat bran	=3.500
Common salt	=0.100
Tree fodder (Pippal)	=30.000
Ripe Banana	=2.000
Para grass	=50.000

(vi) Zoological Park, Patna (Bihar)

Gram	= 3.000
Urd/urad	= 2.000
Banana	= 70 no
Wheat bran	= 3.000
Napier(chaffed)	= 10.000
Grass	= 100.00

Note: Occasionally, powdered sattu, gur and turmeric in season for each animal are fed once every fortnight.

(vii) Zoological Garden, Mumbai (Maharashtra)

Wheat bran	=	15.00
Gram soaked	=	10.00
Sweet potatoes	=	7 .00
Green grass	=	15.00
Sugarcane	=	20.00
Rock salt	=Always available.	

(viii) Zoological Garden, Mysore (Karnataka)

Food items	**Indian rhinoceros (*R.unicornis*)**	**African black rhinoceros (*D.bicornis*)**	**White African rhinoceros (*D.simus*)**
Green grass	40.000	30.000	40.000
Paddy straw	20.000	10.000	20.000
Hay	10.000	10.000	10.000
Lucerne	1.000	1.000	1.000
Cabbage	0.500	0.500	0.500
Carrot	1.000	1.000	1.000
Wheat bran	6.000	5.000	6.000
D.C. oats	5.000	4.000	5.000
Bengal gram	0.500	0.500	0.500

(ix) Zoological Garden, Calcutta(WB)

R.unicornis		
Wheat bran	=	10.00
Crushed oats	=	0.500
Crushed barley	=	0.500
Soaked gram	=	1.250
Sweet potatoes+	=	1.250

(x) Zoological Park, Chhatbir(Chandigarh)

	R. unicornis
Wheat bran	= 2.00
Moong (soaked)	= 1.00
Gram (soaked)	= 1.00
Brinjal	= 5.00
Banana or	= 2 no

Carrots			Papaya or	= 0.200
Black salt	=	0.150	Sweet Melon	= 0.200
Boiled pulse	=	0.500	in season	
Gur/Molasses	=	0.500	Gur	= 1.00
Turmeric				=0.050
Green leaves/	=	60.00	Salt (Weekly)	= 0.050
Grass/fodder			Green fodder	= 2.2 q.

(xi) Zoological Garden, Guwahati (Assam)

Food items	*D. bicornis* Adult	*R. unicornis* Adult	*R. unicornis* Subadult
Gram	2.000	2.000	1.000
Wheat bran	1.000	1.000	0.500
Mung-black	1.000	1.000	0.500
Assami. banana	10 no	10 no	5 No.
Common salt	0.040	0.040	0.020
Black salt*	0.500	0.500	0.250
Green grass (dal, para)	200.000	150.000	75.000
Milk	-	-	3 litres

*Once in a month

(c) Infants

Cooked rice	0.500
Dal (pulse)	0.250
Sugar	0.050
Lactogen powder milk	0.500
Fine green grass	20.00

2. Family : *Equidae* : The family includes only two native sub-species of Indian wild ass- *Equus hemionus*

(1) Wild ass (*Equus hemionus khur*). (A) Conservation : The sub-species is restricted to the Rann of Kutch in Gujarat (India). It exists in Pakistan (Baluchistan) too. In India in captivity the number of species is always poor. Presently only Junagarh zoo (Gujarat) possesses the maximum population of three breedable pairs.

(B) Food (a) Nature: Lives singly or in small or large parties. It feeds in the early morning and late afternoon. Rests during the hot parts of the day. At night visits cultivation . Its number is estimated to be about 800. Most preferred plant species reported on which animals are feeding are Aleuropus lagopoides, *Aristida sp., Chloris barbata, Cyperus sp., Suaeda sp.* and pods of *Prosopis juliflora*. Unlike the African wild ass, the Asiatic wild ass is very much dependant on water. It visits water source once or twice a day preferably at dawn and sunset.

(b) Captivity : The diet schedule being followed in Ahmedabad and Junagarh zoos seems to be appropriate.

Table 15(b). Diet for wild ass per adult/ day in various zoos.

(i) Zoological Garden, Junagarh

Green fodder	= 15.00
Dry fodder	= 5.00
Gram	= 1.00
Wheat bran	= 0.500

(ii) National Zoological, Park, New Delhi

Wheat bran	=1.00
Gram crushed	=2.00
Barley crushed	=2.00
Greengrass	=5.00

(iii) Zoological Park,Chennai (Tamil Nadu)

Wheat bran	= 1.00
Gram (white)	= 0.100
Green leaves/ Grass	= 30.00
Minerel mixture	= 0.050

(iv) Biological Park, Bhubaneshwar (Orissa)

Green grass	=15.0
Deer mash	=3.00
Stylo	= 5.00

(v) Zoological Garden , Ahmedabad (Gujarat)

Dry concentrate (Gram crushed, Groundnut, Gowar korma, Cattle feed Hindustan Liver Ltd.)	= 5.00
Green forage	= 10.00
Dry forage	=ad libitum

Note: Presently, the Zoological Garden, Calcutta (W.B) does not possess the species. Sanyal, (1892) had prescribed the diet (Crushed gram, oats, Indian corn, bran, hay, paddy straw) for the species.

(2) Tibetan wild ass (*Equus hemionus kiang*). (A) Conservation : The normal habitat of the kiang lies between 12000 to 18000 feet above sea level in Ladakh and Tibet where the climate is severe and the plant growth is sparse.

(B) Food: The animal is very wary. While feeding, one animal always remains on guard to keep surveillance for any danger. Its presence in any captive facility is not known.

(3) Zebra: The zebras are exotic species being imported only for wildlife education purposes. Species is breeding well in Zoological Park, Kanpur (U.P.). Table 15 (c) mentions type of ration provided per adult/day in certain captive facilities

Table 15 (c). Ration (in kg) for zebra per adult / day prescribed by certain zoos

Food items	I) Zoological Park, Chennai	ii) Zoological Park,Hyderabad	iii) Zoological Garden ,Mysore	iv) Zoological Garden, Mumbai
Wheat bran	1.500	1.200	2.000	1.000
Horse gram	-	-	1.500	1.000
Gram (white)	0.100	-	1.000	-
Grass & leaves	30.000	ad lib	10.000	2.000
Lucerne	5.000	3.00	1.000	1.000
Mineral mixture	0.050*	-	-	-
Cattle feed**	-	1.200	-	-
Hay	-	-	5.000	2.000
Carrots	-	-	0.500	0.250
Cabbage	-	-	0.500	-

*: Ten days in a month **Composition not mentioned

v) Zoological Garden, Calcutta (West Bengal)		vi) Zoological Park, Kanpur (Uttar Pradesh)	
Wheat bran	= 2.250	Horse ration*	= 3.0
Crushed corn	= 0.900	Green grass	= 20.0
Gram (crushed	= 0.900	Note 1% mineral mixture to be mixed in ration.	
Barley (crushed)	= 0.700		
Carrots	= 1.00	*Composition not given	
Salt	= 0.50		
Green leaves	= 5.00		
Green grass	= 2.00		

III. ORDER - PROBOSCIDEA

(1) Family - *Elephantidae*

Indian Elephant (*Elephas maximus*). (A) Conservation: According to recent information only 30 to 40 thousand wild elephants are surviving in Asia. Half of them are in India.

(B) Food (a) Nature : Asian elephant (*Elephas maximus*) is threatened in the wild. The plant fodder is the major food item of elephant. Elephants is mainly browser but on the ocasion of necessity is also grazer.Mentioned has also been made that the foraging efficiency of elephants on grass is high(80%) compared to feeding on browse(50%), moreover selection of the food species whether it is grass or browse depends on the nutritive value(Easa, 1997). Trunk of the animal is used for collecting the food. The grasses, pulled up with roots by trunk, are cleared off clinging soil by beating the same on the ground or against belly or pressing under the foot. They are broken or arranged with trunk and eatable portions of the grass/plants are then placed into its mouth. Barks of many plants are also eaten by elephants.

The length of alimentary tract per unit body weight is less in elephants as compared with that in the other herbivores and as such, elephants eat incessantly throughout the day to satisfy their insatiable appetite which in turn is controlled to a certain extent by the caloric requirement and the rate of passage of food through the intestinal tract. Benedict (1936) stated that residue of any given food begins to pass out of the body through the intestinal tract of the elephant in about 24 hours and completely disappears in about 50 hours. The faeces formed in the rectal canal are as boluses. The defecation occurs throughout the day but more frequently during night. On most of the occasions, the herds converge from the forests at a place at about 5.0 p.m in winter and between 6 and 7 p.m in the evening in summer for feeding, watering, bathing and dusting their bodies in the open areas where food and water are plentiful. They stay in the area till 9-10 a.m. in winter and till 7-8 a.m. in summer and thereafter, move in file into the forest. In summer if the day is cold they may spend little more time in the open. Like most animals, elephants feed on varied diets. While feeding they are scattered but never too far, except for one or two adult individuals. During the hot season animals frequently visit the

water source. Migration to seasonal feeding areas is always through traditional routes. The matriarch is the fountain head of wisdom who learned from her elders where to take the herd for food in each season.

Elephants (*E. maximus*) in forests eat a variety of plants(hence is called as polyphagus), a great deal of bamboos and reeds and also wild fruits, if available. An adult healthy elephant may consume 250 to 350 kg of green fodder and spend 15 to 18 hours a day for feeding. According to some studies a free living elephant requires food approximately 6% of its body weight per day. It is also reported that elephants consume between 1.5% (in dry season) and 1.9% (in wet season) of their body weight in 12 hours of feeding (Essa, 1997). Laws *et al.* (1975) mentioned that an elephant requires fodder about 1.5 % to 2.6% of its body weight.. They estimated that on the basis of stomach contents an African elephant (*Laxodonta africana*) consumes fodder 1.55% of its body weight every day. According to Sukumar(1985) an average sized elephant requires between 27 and 36 kg dry weight fodder daily or 9.9 to 13.1 tonnes annually. If it consumes about 150 kg green matter it will defaecate about 80 kg of faecal matter. Vinod (1995) described that elephants in Idukki Wildlife Sanctuary feed on 38 species of plants. About 38% of the food plants belong to the family *Poacae*. Bark of 24 species of tree were fed upon. Fruits of *Careya arborea* and *Dillevia pentagyna* were commonly eaten by the elephants.

In Rajaji National Park (UP) twenty four species of plants were observed to be consumed by elephants. Eighty five percent of the diet (# 662) over the season consisted of browse indicating the importance of tree in the diet. *Mallotus phillippensis* (45%), *Ehretia laevis* 6.3%). *Acacia catechu* (5.8%), *Dalbergia sisoo* (2.6%), *Ougeinia oojeinense* (2.5%) and *Shorea robusta* (1.7%) were the important elephant food trees. The above mentioned six important elephant food trees constituted 51.2% of the total trees (# 2287) enumerated in the ten metre radius plots. Elephants feeding was mainly associated with branch breaking (30%), main stem breaking (13.7%), debarking (10.3%) and pushing (6.7%), whereas loppings (27.7%) and cuttings (11.3%) were the main forms of damage caused by humans to the food trees (# 494). Elephants' food trees like *Acacia catechu, Kydia calycina, Ougeinia oojeinense* and *Zizyphus xylopyrus* experienced a high level of damage due to practices like lopping and cutting. To modulate future trends in densities. *Acacia catechu*, a tree species used as a food plant by elephants and as fodder species for buffaloes, and *Ehretia laevis*, an important elephant food tree, which experiences only indirect pressure like trampling of seedlings by the buffaloes and wild ungulates, were chosen as case studies for detailed analysis. Data (# 2720 trees) from the 250 m x 10 m transects were used for this purpose. Both tree species experienced mortality due to pushing and debarking by elephants (from Project Report WII, Dehradun, 1998).

Mishra (1985) made observations at Palamau and Dalma areas about the food preferences of elephants.The bamboo (*Dendrocalmus strictus*) is their favourite food, together with wild plantains (*Musa sp*) and grasses (*Imperata, Panicum , Cymbopogon, Andropogon*, etc). The leaf, fruit and bark of the following species are eaten: ber (*Zizyphas jujuba*), patdhaman /phalsa (*Grewia asiatica*), gular (*Ficus glomerata*), dumar (*Ficus histida*), pakar (*Ficus infectoria*), pipal (*Ficus*

religiosa) and Kanhi (*Bridelia retusa*). The roots and bark of the following tree are eaten: simul (*Bombax ceiba*), salai (*Boswellia serrata*), ginjan (*Lannea grandis*), kekor (*Garuga pinnata*), sal (*Shorea robusta*),. The fruits of bel (*Aegle marmelos*), ber (*Zizyphus sp*) and Kath bel (*Feronia limonia*) are relished. The flowers of mahua (*Madhuca latifolia*) and gular (*Ficus glomerata*) are their favourite.

They feed barks of various tree species to meet their demand for essential fatty acids such as lenolic acid, and minerals such as manganese, iron, copper, boron, calcium and sodium. An adult elephant may require 60 g of Ca daily and Na 75 to 100g(Easa, 1997).

(b) Captivity : In captivity elephants are maintained by the following agencies : (i) Forest Departments in their campuses (ii) Zoological gardens/parks (iii) Temples (iv) Private owners (v) Circuses. Now - a - days the Government wildlife facilities are the major agencies maintaining elephants in captivity. Providing proper dieting requirements in these facilities is a matter of primary concern. Only Kerala Veterinary College has undertaken the work on the nutritional aspects of the species properly.

Gokula (1993) mentioned that on an average every day a temple elephant receives 10.3 ± 5.87 kg of cooked food and 54.7± 39.87 kg of natural food, a zoo elephant 9.0± 5.1 kg of cooked food and 133.3± 86.17 kg of natural food, and a camp elephant 15.1± 7.61 kg of cooked food. In total feed given is 64.1± 31.6 kg per day for a temple elephant and 142.3± 31.6 kg per day for a zoo elephant indicated that the temple elephants are not adequately fed. Krishnamurthy (1992) reported that on a dry matter basis, the grain ration requirement was 0.5% of the body weight and the daily ration of elephants should be according to the different age groups. Such a ration was maintained in the forest camps and zoos only, while in the temple there was no proportionate feeding of elephants according to their age groups.

Sanderson (cited by Evens, 1910) carried out numerous experiments and found that about 363.2 kg (800 lb) of green fodder may be consumed by a full sized elephant in a day. A dry matter consumption of 4.5, 4.1 and 5.1 kg for 100 kg body weight was found respectively when chopped (30 cm size) palm leaves were fed ad libitum to elephants weighing 2020, 1880 and 1160 kg, respectively (Bhaskaran Nair and Ananthasubramaniam , 1989) . When the whole palm leaf was fed *ad libitum* the dry matter consumption was 1.57, 1.55, 2.13 and 1.94 kg per 100 kg body weight by elephants weighing 4178, 3032, 1194 and 1480 kg, respectively (Ananthasubramaniam,1989). The commissariat scale of ration for elephants in Bengal, Chennai (Madras) and Myanmar (Burma) as cited by Evans (1910) included 6.81 kg (15 lb) of grain, 90.8 kg (200 lb) dry fodder, 218.0kg (480lb) green fodder, 60g salt and 30ml of oil for large elephants on command(referred below). The importance of giving different rations for idle and work animals, pregnant and lactating animals and calves has been stressed in "Gajasastra" (Anon. 1958). The items of salt, grass, garlic, jaggery, gingilly oil, butter, curd, cooked and uncooked paddy, malt and alcohol have been mentioned as dietary ingredients in this ancient work. Elephants in the forest department of Tamil Nadu get bamboo leaves, grass and ficus twigs in an ascending order as per a scale based on height ranging from

106.26 cm (calves) to over 273 cm (adults), weightage to the extent of 50 per cent being given to wastage (Gopalan, 1962). A wastage figure of 30 per cent has been reported by Ananthasubramaniam (1989) when whole palm leaves were fed *ad libitum* for elephants. The concentrate, especially for work animals, is constituted by such grains as rice, pulses and millets. The concentrate is fed twice a day. Elephants are fed on classwise basis as calves, adults of varying height groups, working, pregnant and lactating animals (Krishnamurthy, 1978). In Kerala the concentrate part of the ration for elephants is constituted by rice, wheat, ragi and horse gram, singly or in combination in a cooked form. The staple roughage fed is palm leaves (*Caryota urens*).The elephants maintained in the Forest Department of the State are fed on the basis of size assessed by height, work load and on other productive performances as growth, pregnancy and lactation (Nair and Gadgil, 1978).

Nutrient allowances: Benedict (1936) obtained a positive nitrogen balance in an elephant, 'Jap'(name given) by feeding it with hay. The basal metabolism of this elephant 'Jap' weighing 3630 kg was estimated as 49000 Kcal for 24 hrs. Brody (1945) determined the basal metabolism of an elephant weighing 3833 kg and that of another weighing 1360 kg and found the same to be 30924 Kcal/day and 16020 Kcal/day, respectively, after deducting 30 per cent for standing and heat increment. In terms of metabolic body size, daily requirements of nutrients for adult idle and growing elephants have been determined. Feeding standards were formulated for adoption in the State (Ananthasubramaniam, 1979, 1980).

Table 16. Nutrients requirement of elephants in term of metabolic body size (0.73) per day.

Nutrient For	maintenance of adult elephant (2500 to 6000 kg)	For growing elephant (500 to 3500 kg)
DM	0.108kg	0.142kg
DCP	0.006kg	0.007kg
TDN	0.058kg	0.070kg
DE	278 Kcal	335 Kcal
ME	237 Kcal	279 Kcal
Ca	0.005kg	0.006kg

Working elephants : For purposes of scientific feeding and judicious treatment particularly in the absence of a weigh-bridge with owner, refinement in the different formulae involved were based on body measurments to predict body weight of elephants and these need further refinements. Various compositions of rations given to captive elephants are indited in the proceeding text. The tame elephants love gur/jaggery.

Most of the National Parks, Sanctuaries and Tiger Reserves maintain working elephants. They are used for daily routine wildlife monitoring and surveillance pursuits and also for visitors education/excursions. In some wildlife natural units working elephants are released into the jungles in the evening and are collected early next day morning between 5 a.m. - 6 a.m. In others the animals are released after excursion/patrolling at 11 a.m. to 4 p.m. for grassing in the natural vegetation and also for bathing in the rivers. Each elephant is fed about 75 to 150 kg per day of the fodder collected from the jungle.

Evans (1910) prescribed scale of ration for the forest camped elephants at command based on their heights.Before the ration schedules prescribed for captive elephants in various states of the country during the recent era ,the same is rementioned for the sake of knowledge of Wildlife Veterinary Officers

Size (in cm) of elephant	Grain(kg)	Fodder(kg)	Bhusa(kg)	Salt(g)	Oil(ml)
Large above 260	7.000	90.000	220.000	60	30
Medium, 230-260	7.000	80.000	180.000	60	30
Small below 230	7.000	70.000	145.000	60	30

(i) At Kanha National Park the following diet is supplied (Saxena, 1991).

Working diet (in kg) (Ist Nov.- 30th June)		Rest diet (in kg) (Ist July-31st Oct.)	
Wheat-baked Roti	= 5.0 - 9.0	Wheat/rice	= 5.000
Rice raw/boiled*	= 0.300	Gur	= 0.300
Gur	= 0.500	Salt	= 0.100
Salt	= 0.200		

* For feeding balls to be formed

- If work is taken during off season, these elephants are given full working diet.
- From 16th March to 31st October rice is given, and from Ist November to 15th March, wheat is given.
- No separate diet for calf is prescribed.
- After feeding, the elephants are released in the forest. They are left there for feeding and resting during night. They feed on all types of grasses, bamboo (leaves) *Ficus glomerata* (leaves), *Mallotus phillipinesis* (small branches), sal (bark) and teak (bark), etc.
- After one week of calving, mother is fed 5-6 coçonuts (probably to augument milk secretion) and elephants regain the strength very fast.
- It is also described that adding of tamarind 200 g and Gram (whole) 1 kg. keeps the elephants in good health. Paddy can be used in place of rice.
- Calf is considered up to 2 years of age.It is given training in the morning after a bath in fresh or running water. Gradually the calf is put to work behaviour after 5 years and till 15 years light work is taken.

(ii) Andamans. The following ration is fed to elephant calf per day during training.

Paddy	= 2.000 kg	Gur	=0.500kg
Tamarind	= 0.100kg	Salt	=0.100kg
Gram (soaked)	= 0.500kg		

(iii) Dudwa National Park (U.P.)

(Source: De Rupak.1999)

Chapati (Wheat flour)	= 5.000 kg
Salt	= 0. 200 kg
Gur (Oct. to Dec.)	= 0. 500 kg
Green fodder (Sugarcane in winter)	= 2 to3 quintals

October-March: Pipal (*Ficus religiosa*), khurhur (*Ficus cunia*), gajhar (*Ficus rumphii*), jack fruit (*Artocarpus integrifeelia*) gular (*Ficus glomerata*), bargadh (*Ficus bengalensis*), April-July: Rohini (*Mallotus philippinesis*), narkul (*Arundo donax*), shahtut (*Morus alba*),bamboo (*Dendrocalomus strictus*), jowar (*Sorghum halepense*), berseem (*Trifolium alexandrium*). August - September: Ulla grass (*Themeda arundinacea*), karbi, *Ficus rumphii, F. religiosa, F. bengalensis.*

During one month of summer for cool and comfort special preparation/ drink is also provided consisting of: Katinara 1.50 kg + Mishri 1.50 kg + Aniseed 3 kg + Tukhmallanga (*Lallemantia royleana*) 1.50 kg + gulabjal(rose water extracted from petals of *Rosa indica*) 5 bottle + Sugar 25 kg + Rice sattu 25 kg.During summer at times elephants are fed 1.0 kg boiled paddy every day for each animal to meet the carbohydrate requirements. It is fed as long as necessary.

(iv) Corbett National Park (Ramnagar,Uttaranchal)

Source : Mohamad (1999)

- From 15th November to 15 th June the following ration per adult working elephant besides the 4 quintals green fodder is given. To non working elephants only green fodder is given.

Rotti(wheat flour)	= 6.000 kg	Salt	=0.250 kg
Oil	= 0.050 kg	Gur/jaggery	=0.500 kg

- From October onwards 2 quintals sugarcane to each adult elephant is fed till the availability, instead of green fodder.
- Elephants are daily released for 4 hrs for natural feeding.
- Boluses of a aromatic spice preparations - consisting of a variety of vegetable substances such as, cardamoms, nutmeg, assafoetida, coriander, aniseed, jaifal, bansmishiry prepared in clarified butter (ghee) is given.
- In summer some special cold drinks are also given.

(v) Kaziranga National Park (Assam)

- In winter elephants for natural grazing in the park are released for 8 hours .Generally, timings are between 5a.m.and 9 a.m.and again after 2 p.m
- In summer elephants are released for midday grazing and also at night.
- Animals put to heavy duty are fed 10 kg soaked gram per adult/day and those at rest are fed 5 kg soaked gram.To each animal salt is also given.
- In winter animals subjected to duty are fed 8 kg paddy and non duty animals only half quantity of paddy.Salt is given to each one.

(vi) Kerala Forest Camped Elephants. In Kerala captive elephants are generally fed with palm leaves or coconut leaves and grains like rice, ragi, horse gram, green gram, wheat, etc. Elephants maintained by the forest department are given roughage in the form of bamboo leaves, grass, ficus twigs and grain rations. A medium sized elephant weighing about 3000 kg requires a minimum of 150 to 200 kg palm leaves per day.

Ration(in kg) for an adult elephant per day			Nutritive constituents in palm Leaves	
Food itmes	Working	Resting	Dry matter	38.8 %
Horse Gram	5.000	3.000	Crude protein	2.0 %
Ragi	10.000	7.000	Crude fibre	9.3%
Rice	3.000	3.000	Nitrogen free extract	22.9 %
Salt	0.100	0.100	Ether extract	1.1 %
Jaggery	0.050	0.050	Total ash	3.5 %
Calcium	0.35 %			
Total	18.150	13.150	Phosphorus	0.23 %

Table 17 : Elephant dietary requirements supplied based on its heights (Mohan Das, 1997)

Classs	Height (cms)	Rest diet	Working diet	Cut fodder (Palm leaves)
I	Above 244	Wheat - 4 kg, Ragi- 6 kg, Horse gram- 4 kg, Karipatti or/ raw sugar 100 g.	Ragi - 6 kg, Horse gram -2 kg, Salt - 200 g	20 branches (25 kg)
II	Above 213	- do -	- do -	18 branches (25 kg)
III	Above 183	- do -	- do -	16 branches (25 kg)
IV	Below 183 and Above 150	- do -	- do -	14 brnaches (25 kg)
V	Below 150	- do-	- do -	Few branches

Special diet : (a) Elephants above 60 years of age are retired from work and their diet consists of wheat - 3 kg, ragi - 3 kg, Horse gram - nil, Salt - 200 gms, Karipatti (a variety of jaggery.) - 100 gms.

(b) The forest Veterinary Officer is authorised to prescribe diet for ailing elephant, bulls in musth and pregnant cows, etc. Mohouts are not allowed to cut fodder from outside but they do so in cases of sickness or musth when the elephant may require more food.

(c) Care during and after pregnancy is vital . The quantity of ration is raised. A special diet consisting of vitamins, minerals soaked green grams and 6-8 cocconuts and after delivery 8-10 cocconuts per day are provided (Krishnamurthy, 1997)

The concentrate feed is prepared within the camp and the official feeding timings are 8 a.m. and 6 p.m. The cut fodder system is practised in areas, where the elephants cannot be let cut to graze in the forest. If forest areas are available aound the camp site, the elephants are allowed to graze in the forest. A long, trailing chain is tied to their hind leg and a bell is tied around their necks before being released into the forest for grazing. The next morning the mahouts go in to the forest to bring the elephants back.

Elephant defecates 14 to 18 times per day as 5 to 6 boluses each time. The passage time of food materials through the gastrointestinal tract ranges from 18 to 24 hours.This the reason the jumbo needs feeding at frequent intervals.

Table 18. Ration (in kg) per adult animal per day in certain captive facilities.

(i) National Zoological Park, New Delhi

Sugarcane/ Green fodder	= 200.000
Tree fodder	= 50.000
Dry fodder	= 50.000
Gur	= 2.000
Mung	=1.000
Rice	=1.000
Bajra	=1.000
Haldi	=0.100
Salt	=0.100
Mustrd Oil	=0.100
Banana	= 24 nos

(ii) Zoological Garden, Calcutta (WB)

Roti	= 1.250
Wheat bran	=4.500
Gram	=1.600
Paddy	= 3.300
Boiled rice	=0.750
Boiled dal	=0.750
Gur	=0.300
Salt	=0.200
Gram-sattu	=0.300
Green grass/tree leaves	=150.00
Sugarcane	=10.000
Paddystraw	=30.000

(iii) Biological Park, Bhubaneshwar (Orissa)

Food items	Diet A	Diety B
Bamboo leaves	10.00	10.000
Caster oil	0.100	0.100
Common grass	50.000	20.000
Molasses	0.400	0.400
Common salt	0.250	0.150
Elephant Fodder	100.000	100.000
Para grass	-	50.000
Deer Mash	4.000	4.000
Turmeric	0.100	0.100
Wheat	6.000	6.000
Gram shhatu	0.200	-
Mineral mixture	0.010	-
Gram whole	0.300	-
Egg	1 no	-
Garlic	0.010	-
Green sag	0.250	-
Onion	0.050	-
Ripe Banana	0.200	-

(iv) Zoological Park, Itanagar

Paddy	4.000
Salt	0.200
Molasses	0.050
Mussabar	0.500
Dry chilly	0.250

(v) Zoological Park, Hyderabad (AP)

Per adult:

Cattle feed	=8.0-10.0
Green tunga	= 80.0-100.0
Lucerne	= 5.0-10.0
Kadvi	= 80.0-150.0

Tobacco leaves 0.250kg	Per calf:
Note: Animals are released	Ragi = 8.0-10.0
for natural grazing daily.	Bud (ficus)
	Leaves = 60.0-100.0

(vi) Zoological Garden, Guwahati (Assam)

Feed Items	(b) Adult	(c)Sub adult
Whole gram	4.000	2.000
Molasses	0.250	0.250
Garlic	0.050	0.020
Sugarcane*	1.000	1.000
Banana	10 no	4 no
Common salt	0.040	0.040
Black salt	0.500 kg/m.	0.250 (kg/m.)
Banana tree (with leaves)	5 No	4 no
Green grasses (Dub, para, etc.)	250.000	100.000
Baby elephant		
Cooked rice	2.000	Note: In addition to
Dal	0.250	above the elephants are
Lactogen milk	1.000	taken to nearby woods
Banana	4 No	for grazing and excercise
Sugar	0.100	for 4 to 5 hours during
Banana tree (with leaves)	4 No	morning hours every day * During excercise

(vii) Biological Park, Patna (Bihar)

Napier grass	= 35.000
Sugarcane(90days)	=35.000
Paddy	=3.500
Maize corn(90days)	=25 No
Wheat	=3.500
Rice	=1.500
Moung dal	=0.750

(viii) Zoological Garden Ahmedabad (Gujarat)

Raagi flour + cattle ration	= 6.000
Coconut	= 1 no
Jaggery	= 0.250
Sugarcane	= 5.000
Forage (green)	= 50.000
Foliage leaves	= ad lib.
Gram sattu	=0.200

(ix) ZoologicalPark, Kanpur (UP)

Ghee	=0.150
Green fodder	= 150.00
Haldi	=0.025 kg
Gur (Sugarcane in winter)	=0.100 kg
Roti (wheat flour)	= 4.000
Gur	= 0.500

(x) ZoologicalPark, Chattbir (Chandigarh)		(xi) Zoological Garden, Lucknow (UP)	
Black gram	=1.500	Roti(wheat)	= 5.000
Maize crushed	=2.000	Green fodder	= 50.0-200.0
Banana or	=6 no	(MP chari/sugarcane/tree fodder)	
Papaya	=0.500		
Sweet melon(seasonal)	=0.500		
Gur (in winter)	=1.000		
Salt (weekly)	=0.200		
Green fodder	=250.00		

(xii) Zoological Garden, Thiruvananthapurum (Kerala)

Food items in kg :

Asafoetida	Banana	Green	Jaggery	Fodder	Palm	Plantains	Rice	Sugar
0.1 (m)	0.5	15	2(w)	50	11.5	1	3	5(w)

m=monthly, w= weekly

(xiii) Zoological Park, Vandalur, Chennai (Tamil Nadu)

Feeding preferences of elephants studied at the Park has revealed that :

a) Elephant prefers napier grass over the fodders such as paragrass, subabul, bamboo, tree fodder, etc.

b) The total consumption of fodder per day is increased when the elephant is supplied with mixed fodder than with single type of fodder.

c) Among tree fodder, the elephant likes more of ficus leaves.

d) A middle aged elephant requires about 140 kg of fodder per day (Anon, 1986).

(vix) Zoological Garden, Mysore(Karnataka)

Food items	*E. maximus* (kg)	*L. africana* (kg)
Reed grass	400.000	400.000
Green grass	25.000	25.000
Hay	25.000	25.000
Rice	6.000	6.000
Salt	0.050	0.050
Agi flour	3.000	3.000
Coconut	2.000	2.000
Jaggery	1.000	1.000
Carrot	3.000	3.000
Sugarcane	10.000	10.000

Note: (i) Branch fodder 300 kg on Sundays and on general holidays.(ii) Cut branches in place of reed grass 320 kg twice in a week. (iii) 0.500 kg carrots only to Indian young species (iv) Lower limits are to be given to young/female animals.

Elephants need large quantities of water to drink - about 200 litres every day, about 20 to 45 litres at a time The trunk can hold up to nine litres of water. Elephants keep cool by bathing and swimming at least once a day and are never far from a water hole. It gets a thick coat of mud on its body, which prevents insects and other matters from troubling it.

IV. ORDER - PRIMATES

Non-human primates are represented by 19 species in the Indian sub-continent. These are 7 species of macaques: rhesus (*Macaca mulatta*), bonnet (*Macaca radiata*), assamese(*Macaca assamensis*), stumptailed (*Macaca speciosa*), pigtailed (*Macaca nemestrina*), crab- eating (*Macaca facicularis*) and lion tailed (*Macaca silenus*), 5 species of langurs: common langur, golden langur, nilgiri langur, capped langur and spectacled monkey, one species of ape: Hoolock gibbon and two species of lorises: slow loris and slender loris. Macaques and baboons are omnivores, therefore, their diets include insects, grubs and spiders. The chief food of apes, and leaf monkeys are leaves, flowers and fruits. The langurs being arboreal are folivores, have a four compartment stomach but do not ruminate. To enrich the subject information on macaques feeding habits have been extracted from the published articles of Behura (1989) and other workers. The precise requirements of nutrients for non-human primates are not available. Based on the NRC data supplemented with further information some outline has been prepared (by some workers) and given under chapter VII Appendix.

1. Family: *Cercopithecidae*

(1) Rhesus monkey (*Macaca mulatta*). (A)Conservation : The species is very common and well distributed all over the country. Besides the forests and forest margins it frequents in large troops at railway stations, temples, historic monuments, etc. where public crowds are always tremendous, in orchards during fruiting season and also on the trees along the road sides. Now a days the species has become almost a great menace in metropolitan cities. The respect paid to monkeys in India through religious sentiments overshadows any action for their elimination in any way and even capturing and relocating them into the remote scrub jungles.Author had advised for the sterilization of male individuals for all the trapped males, keeping them and kept under observations for about two weeks and then after releasing only healthy individuals in safe areas.

(B) Food (a) Nature : Rhesus monkeys, in wild, frequent in troops. Being largely frugivorous they feed chiefly on leaves, young buds, flowers, fruits (mango, fig, banyan, tamarind, guava, berries, mulberry, blackberry, etc.), seeds and bark of certain plants. Mushrooms, algae of ponds, insects, crabs and fish (small sized), if available, are picked up and eaten.The seeds of Areus precrius are reported to cause death in humans and animals and fruits of *Caseria graveo* beans (Dalz) and C. temantosa (Roxb) poisonous to fish are eaten by monkeys (Lindburg, 1976). Mukherjee (1969) described species main food consist of mango, paker and neem trees, mango fruits, grass or food grains. Insects also formed a part of their diet. There is no evidence of feeding on animal matter other than insects. The diet varies considerably on seasonal basis due to changes in food availability. Regional differences in diet may be primarily a consequence of regional variation in available food plants. The information about food plants utilised by Forest Research Institute, Dehra Dun (FRI) population of monkeys for a 12 - month - period (Table 19 a) and monkey population of Siwalik forests over a period of 9 months (not imbibed in this report) was garnered by Lindburg (1976). He has also presented list of food plants utilized by rhesus monkeys in other parts of the country **(Table 19b).**

Table 19 (a): Partial list of food plants utilized by rhesus monkeys at the FRI Dehra Dun.

Species	Part consumed
Grass	
Saccharum spontaneum Linn.	Stem, shoot
Herbs	
Launaea aspleniifolia DC.	Leaf, flower
Polygonum serrulatum Lagasc.	Flower
Pueraria phaseoloides Benth.	Stem
Rubia cordifolia Linn.	Stem pith,leaf, fruit
Vicia sativa Linn.	Seed.
Climbers	
Paederia foetida Linn.	Leaf
Passiflora suberosa Linn.	Fruit
Shrubs	
Camellia theifera Griff.	Stamen
Caryota mitis Lour.	Pith of stem
Clerodendron infortunatum Gaertn.	Flower, fruit, new leaf
Desmodium gangeticum (L) DC.	Leaf
Diospyros cordifolia Roxb.	Fruit
Flemingia congesta Roxb.	Seed
Hamiltonia suaveolens Roxb.	Leaf
Hibiscus rosa-sinensis Linn.	Pith of stem, flower
Karogana chamlagu Lam.	Flower
Rauwolfia serpentina Benth.	Leaf, fruit
Wistaria sinensis Sweet	Flower
Trees	
Alseodaphne keenanii Nees	Fruit
Aleurites fordii Hemsl.	Leaf, flower, shoot
Anthocephalus cadamba Miqw.	Fruit
Bauhinia purpurea Ilnn.	Flower
Bischofia javanica Bl.	Fruit
Broussonetia papyrifera Vent.	Leaf, flower, fruit, Shoot, pith of stem
Cedrella toona Roxb.	Fruit
Chrysophylum oliviforme Linn.	Fruit
Cinnamomum comphora Linn.	Fruit
Eriobotrya japonica Lindl.	Fruit
Ficus benjamiana Linn.	Fruit
Ficus glomerata Roxb.	Fruit
Ficus palmata Foresk	Fruit
Ficus palmata Forsk.	Leaf, fruit
Hovenia duccis Thunb.	Fruit
Leucanea glauca Benth	Leaf, seed
Litchi chinensis Sonner	Fruit

Litsaea polyantha Juss	Pith of stem
Mangifera indica Linn.,	Fruit, flower, seed
Mimusops hexandra Roxb.	Fruit
Morus alba LInn.	Bud, new leaf, fruit
Premma latifolia Roxb.	Leaf
Prunus persica Benth	Fruit
Psidium guyava Linn.	Fruit
Quercus serrata Thunb.	Seed
Santalum album Linn.	Fruit

Table 19 (b) : List of plant foods consumed by rhesus monkeys in other forest areas in India (Lindburg, 1976).

Species	Where collected	Part consumed
Grasses :		
Arundinella nepalensis Trin.	Corbett Park	Stem
Dendrocalamus strictus Nees.	South Kheri	Leaf
Saccharum spontaneum Linn.	South Kheri	Shoot
Herbs :		
Galium aparine Linn.	Mussoorie	Whole plant
Shrubs :		
Berberis lycium Raf.	Mussoorie	Bud, new leaf
Carissa spinarum A. DC.	West Timli	Fruit
Ervatamia coronaria Stapf.	South Kheri	Leaf
Punica granatum Linn.	Tatura, Chandigarh	Leaf
Reinwardtia trigyna Planch.	Mussoorie	Flower
Strobilanthes glutinosus Nees	Mussoorie	Flower
Trees :		
Azadirachta indica A. Juss	Corbett Park	Leaf
Bauhinia malabarica Roxb.	South Kheri	Seed,seed pod
Butea monosperma Lamk.	Mohand	Flower
Careya arborea Roxb.	Corbett Park	Pith of stem
Dalbergia sissoo Roxb.	Corbett Park	Seed, bud new
Ehretia laevis Roxb.	Mohand	Fruit, flower
Ficus nemoralis Wall.	Mussoorie	Leaf stem
Ficus religiosa Linn.	Corbett Park	Leaf
Madhuka latifolia Gmel.	South Kheri	Bark
Pinus roxburghii sargent	Chandigarh	Seed
Quercus incana Roxb.	Mussoorie	New leaf
Rhododendron arboreum Sm.	Mussoorie	Leaf, flower
Shorea robusta Gaertn.	West Timli	Flower

(b) Captivity : At times difficulty is experienced when the enclosure is housing a large number of animals and the most of the food offered is being consumed by the dominant individuals. The nutritional deficiency is only apparent after a couple of

days in the subordinate ones. The diet offered in the zoos to the species consists of fruits, roasted grams and ground nuts. Some zoos also offer green vegetables. The kinds of food items and their quantities commuting a diet for an adult rhesus monkey per day are entered in the table 26.

(2) Bonnet monkeys (*Macacca radiata*). (A) Conservation : The bonnet macaque is the most common monkey of South India. Its domain is confined to the southern part of the Indian Peninsula and extends as far north as Mumbai on the west and river Godavari on the east. Bonnet macaques of Travancore are considered a distinct race (Macaca radiata diluta). In the area of its distribution the Bonnet macaque is common in the plains as well as in the foot hills. They are found up to an altitude of 2100 metres above the sea level. They are common in the villages as well as in the jungles, but do not enter deep forests. They are usually seen on banyan trees about 30 m high. It is the Bonnet macaque which is considered the showman of South India.

(B) Food (a) Nature : Species is an omnivorous voracious feeder. Its vegetable diet consists of leaves, flowers, young shoots, fruits, nuts and seeds of a large variety of plants. During season, it feeds on mango fruits, wild figs, berries of lantana, bamboo shoots, tender leaves and fruits of tamarind, mulberry and Acacia and fruits of Ficus. They also feed on eggs of birds, grass hoppers, flies and sometimes lizards caught by them.

Though arboreal, the monkeys spend considerable time on the ground. After foraging in the morning, the macaques sleep on the tree tops for an hour or two at mid-day and continue feeding activities till evening. Before retiring in the evening to the tree-tops for rest at night, they visit a nearby stream or pond to quench their thirst. They are good swimmers and readily take to water.

(b) Captivity : Certain zoos are maintaining the species. No special food, different from that prescribed for rhesus monkeys, is computed for the Bonnet monkeys.

Table 19(c). Diet per adult bonnet monkey per day in certain large zoos.

Food items	Zoological Garden, Mysore	Zoological Park, Chennai	Zoological Park, Kanpur
Milk	0.100		
-			
Bread	0.200	0.100	-
Rice	-	0.050	-
Fruits	-	0.050	-
Sathukudi(Orange)/			
Mango	-	1/4 no	-
Guava	-	3/4	-
Apple	0.100	-	-
Grapes	0.100	-	-
Banana	0.300	3 nos	0.200
Vegetable	0.050	-	0.400
Spanish		-	0.005

Onion	-	-	0.025
Carrots	0.050	-	-
Cabbage	0.050	-	-
Tomato	0.050	-	-
Beans	0.050	-	-
Groundnut	0.100	0.015	-
Gram(baked)	-	0.015	0.100

Nambi *et al.*(1998) have described certain normal serum chemistry values in case of a single male bonnet monkeyas follows. BUN=79/dl;Serum total protein=4.2g/dl;Serum creatine =0.6mg/dl. Glucose=52.2mg

(3) Assamese macaque (*Macaca assamensis*). (A) Conservation : The domain of the Assamese macaques extends over large area from the Himalayas in Uttar Pradesh eastwards through Nepal, Bhutan,India (Assam and Sikkim), Myanmar, Thailand, Laos, Campuchia, Vietnam and China. It is also found in the southern parts of Sunderbans in West Bengal (Prater, 1971; Behura, 1989).

Like the Japanese macaque, *Macaca fuscata*, the Assamese macaque is accustomed to cold, 15-20°C below freezing point. In the Himalayas and in Eastern India, they live in heavy evergreen forests at altitudes ranging from 610 to 1830 m (2000 to 6000 ft). In Sikkim and in Darjeeling (West Bengal), during severe winter they descend to 610 m - 1220 m (2000 ft - 4000ft.)altitudes. The estimated population of species in wild is 8,000 (Choudhury, 1996). In captivity many zoos are maintaining the species for display purposes. In 1997 the total number in all the zoos was around 80-100 animals.

(B) Food (a) Nature : The food items of Assamese monkey diet include tender leaves, buds, fruits and insects. The macaque also raids maize crops. It lives in small to large groups consisting of 10 to 100 individuals.

(b) Captivity : Table 26 includes the composition of the diet prescribed in various zoos .

(4) Stumptailed macaque (*Macaca speciosa/arctoides*). (A) Conservation : In India it inhabits dense forests of Assam south of river Brahmaputra, from where its domain extends to Myanmar, northern Malaya, Thailand, Laos, Campuchia, Vietnam and southern China. This macaque is rarely seen and very little is known about its habits. The stump-tailed macaque lives in groups consisting of 25-30 individuals of both sexes of varying ages.

(B) Food : a) Nature. Monkeys feed on leaves, shoots, seeds, tubers and insects. In Assam, monkeys also eat hard seeds of the palm .

b) Captivity : Diets per adult stump - tailed macaque in certain zoos are entered in table 20. Table 26 also includes diets for this macaque prescribed in general for the macaque species by certain zoos. Sanjay Gandhi National Park, Boravili, Mumbai (MS) also prescribes diet consists of; banana 12 no, chikoo-12 no and dhuphi 1.0kg per adult/ day.

Table 20: Diet per day per adult stump- tailed macaque in certain zoos

Food item	ZG, Guwahati	BP, Patna	ZP, Tirupati +	ZG, Mysore
Milk	-	0.100	0.100	-
Bread	0.100	0.100	0.100	0.200
Rice	-	0.025	-	-
Groundnut	0.025	0.100	-	0.100
Gram(boiled soaked)	0.050	0.100	0.100	-
Fruits	-	-	0.210	-
Grapes	0.025	-	-	0.100
Apple	-	-	0.100	
Naspati(Pear)	0.100	-	-	-
Orange+Sweetlime	0.150	-	-	-
Banana	5 nos	12 no	0.250	0.300
Guava	0.100	0.100, or	-	0.050
Carrots	0.100	0.100, or	-	0.050
Bel	-	0.100	-	-
Sweet potato	-	0.100	-	-
Bean	-	-	-	0.050
Cucumber	0.100	-	-	-
Tomato/Bhutta	-	-	-	0.050
Cabbage/	-	-	-	0.050
Veg. green	-	-	0.075	0.050
Veg.leaves	-	-	0.050	-
Sugarcane	0.050	-	-	-
Lassura**	0.050	-	-	-
Honey	*			
Almond	--	0.100		

Z = Zoological, B= Biological, P = Park, G= Garden, N= National

* Honey is given in winter.**Indian cherry += Kumar and Raghavaiah (1996).

(5) Lion - tailed macaque (*Macaca silenus*). (A) Conservation : Lion tailed monkey is highly endangered species confined to a few ever green forests of the ghats in Tamil Naidu and Kerala. Its population is reckoned nearly 2,000. A small population of about 100-150 lion-tailed macaques also inhabits in the western ghat crest zone between Sharavati and Aghanshini rivers in Karnataka (Bhat,1996).On 17th October 1996 in the various Zoological Parks species total population was reckoned to be 47 (25:21:1)

(B) Food (a) Nature : The species main diet is plant origin(fruits,seeds, nectars, resins) and also to compensate protein deficiency animal origin food(snails, birds eggs and nestlings, squirrel nestlings, arthopods- catterpillars, pupae, insect eggs, spiders,preying manits, cidars and beetles(Kumar,1987). Thus, clearing of fruiting trees from its natural habitats will cause peril to the conservation of species. Menon (1993) described four tree genera *Cullena, Artocarpus, Ficus* and *Litsea* forming 70% of the lion-tailed diet at *Puthuthotam cardamom* forests. The former two species (timber trees) are key food sources for lion-tailed macaque diet during certain months. Ficus is available all the year round and hence, contributes significant share in the diet of the species in the region.

b) Captivity : The composition of diet given to lion tailed macaque at Zoological Garden, Thiruvananthapurum (Trivendrum), Kerala is as fallows: Banana, Apple/ mango/guava, Bread, Bengal gram, Carrot, Coconut, Groundnut (with out husk), Cheera, Grapes, Orange, Cabbage, Plantains each 0.050 kg and Egg 0.06 kg, Chicken 0.250 kg and honey 0.01 kg per adult per day. The diets being fed to the species in six other important zoological parks of the country are entered in the table 21(a). It is found that the diet being provided to species in different zoos are not of uniform composition. Diet vary in respect of quantity as well as quality. After discussion in the LTM PHVA Workshop,1993 a standard diet was computed and mentioned below.

Table 21(a) : Diet of lion-tailed macaque(*M. silenus*) per adult per day in certain zoos

Food Items	BP, Bhubaneswar	NZP Delhi	ZG, Mumbai	ZP, Chennai	BP, Patna
Milk	50 ml	100 ml	-	-	50 ml
Egg (boiled)	-	1 no.	1 no.	2 nos	-
Banana (Ripe)	0.250	2 no	2 nos	3 no	6 no
Orange/ Mango	-	-	-	1 no	-
Guava/Pear	-	0.100	-	-	-
Cucumber	-	0.100	-	-	-
Papaya/melon	-	0.200	2 no.	-	-
Vegetable and mixed/Leavs	0.150	0.100	0.050	-	-
Potato (sweet)	0.100	0.100	-	-	0.100
Carrot/B.Root	0.050	0.100	0.050	-	0.050
Lady^s finger	0.050	-	-	-	0.050
Cabbage	0.100	-	-	0.050	0.100
Brinjal	0.100	-	-	-	0.100
Onion	-	0.025	-	-	-
Tomato	-	0.025	-	-	-
G. nut	0.050	0.050	0.100	0.025	-
Soyabean	-	-	-	0.020	-
Green peanuts	0.050	-	-	-	-
Gram	0.050*	0.050*	0.050	0.015	-
Bread	0.030	0.100	-	2 slices	7 *
Corn-(Green)	-	0.100	-	-	-
Rice (cooked)	0.050	-	-	0.025	-

Note.B=Biological, Z=Zoological,P=Park, G=Garden, N=National *Rosted

Diet chart for the species of Biological Park, Bhubaneshwar includes the following food items.Bengal gram whole Ladies finger,carrot,grountnut, bean and rice each 50g.Brinjal and sweet potato each 100g, Banana(ripe) 100g, Bread,30g, milk 10g.

Standard diet for lion tailed macaque(*M. silenus*) recommended in LTM, PHVA Workshop 1993 is given here.

Food items	Quantity
Fruits	= 250 g
Vagetables	=200 g
Milk	= 50 ml
Boiled egg (60 g)	= 1 no
Minced meat/ insects/	=150 g
Honey	=10 ml
Nuts without shell and grams	=50 g
Bread and or rice	= 50 g
Greens	=100 g

PHVA Workshop,1993 also recommended that; I) The diet should provide at least 37% animal protein and some amount of nectors. ii) Animals should have free access to insects which form large part of their diet. iii) The supply of monkey chow should be looked for.

iv) The diet should provide the optimum requirement of vitamins and minerals.

v) Animal should be fed twice daily in the forenoon and in the afternoon.

The available TDN values of various food ingredients of the diet being fed to lion -tailed macaque(*Macaca silenus*) in certain zoos have been hypothetically assessed for nutritive values in respect of the lion tailed and presented in the Table 21(b) (Pathak, N.N, Head Div. of Animal Nutrition IVRI, Izatnagar-UP). Though theseTDN values may not be true but may be taken as guidelines for conducting trials in the species.

Table 21(b) : Evaluation of diets being supply to lion tailed macaque in certain zoos.

Name of zoo	Diet(g)	DM (g)	CP(g)	TDN (g)	DE	ME
B.P. Bhubneshwar	980	245	42.65	218	959	786
NZP, Delhi	900	248	43.00	220	968	794
ZG, Mumbai	975	263	57.5	234	1030	844
ZP, Chennai	900	160	49.00	144	634	520
ZP, Patna	1225	150	24.00	135	594	488
Standared diet (PHVA Workshop, 1993)	920	220	56	197	867	711

If the body weight of an adult is considered to be 10 kg the minimum and maximum Digestible energy (DE) and Metabolic Energy (ME) available to the animals will be 59.4 Kcal to 87.0 Kcal and 48.7 Kcal to 79.3 Kcal per g body weight per day, respectively.

Hypothetical analysis presented in table 21(a) alludes to that nutritive values of the maintenance diet prescribed for an adult individual at Patna Zoo appeared to be adequate.

(6) Crab eating macaque (*Macaca fascicularis*). (A) Conservation: Within Indian limits, this long tailed macaque inhabits the tropical rain forests of Katchall, little Nicobar and Great Nicobar islands in the Bay of Bengal. Its range extends to Myanmar, Malay, Indonesia (Java, Borneo, Sumatra and the smaller islands including the Lesser Sunda Islands, but excluding Celebes) and the Philippines. Several specimens were introduced into Mauritius and Kijuma islands (off the Chita peninsula in Mikaway Bay, Japan). They are found up to an altitude of 2000 metres above sea level.The census status of species in captivity is not known to the author.

(B) Food : The animals live in troops and are active through out the day. The species is usually vegetarian. Their food consists of buds, flowers and fruits. Due to change in the areas and conditions, the animals also take crabs and molluscs and hence, the name to the species "Crab eating macaque" is given. They live in groups of 6 to 30 and are good swimmers and divers.

(7) Pig - tailed macaque (*Macaca nemestrina*) : The domain of the pig tailed macaque extends from Assam through Myanmar and Malaya to Indonesia (Sumatra, Borneo and some adjacent islands). It has also been reported from Yunnan (China). The species live in deep evergreen forests at elevations of 75 m to 1300 m. Its distribution is symmetric with the stump- tailed macaque.

(B) Food : The species is omnivorous, feeding on young leaves, fruits, seeds and insects. The pig - tailed macaque lives in groups of 3 to 47 individuals. Table 26 includes the composition of diet being fed to the species in various zoos.

2.Sub- Family : *Colobinae*

(1) Common langur (*Presbytis entellus*). (A) Conservation : It is cosmopolitan with its range from Kashmir to Cape Camorin and from Gujarat to Bengal.It is found all over in the tiger reserves except Sunderbans. Above altitudes of 3660 metres from sea level they are usually not found (Pocock, 1939). However, a report from Nepal described presence of *Presbytis entellus* at 4270 metres (Bishop, 1978). The previous recorded height for the species is 3960 metres in Kashmir. The population of the species in wild may be around 50-60 thousands in the country. It is the most common langur displayed in zoos. In India the species is respected as Hanuman langur.

(B) Food (a) Nature : Animals eat fruits and leaves in wild. In Gir forests, the langurs spend morning (commencing at dawn and reaching at peak around 10.0 a.m.) and evening(peak around 17.00 hours) in vigorous feeding on the leaves, fruits and flowers of a variety of trees and climbers (Table 22 a). The young ones eat barks and tendrils. They also eat pupae found on leaves. Usually, tender leaves are selected but in the case of large leaves like those of Wrightia the blades are stripped free of the mid rib and eaten while the latter is discarded. Likewise leaves such as of Tamarindus were stripped from the stalk. One or both hands are used in feeding. Long fruits like those of Wrightia are plucked and held in the hand and eaten candy - like, with short bites. Fruits of Terminalia are the most preferred (Rahaman, 1973).

Table 22 (a) : Trees and creepers on which common langurs fe ɔd (Rahaman, 1973).

Sl. No.	Local name	Scientific name	Part eaten
1.	Saajad*	*Terminalia crenulata*	Fruits,leaves
2.	Timbroo*	*Diospyros melanoxylon*	Fruits,leaves
3.	Doodhlo*	*Wrightia tinctoria*	Fruits,leaves
4.	Karapti	*Garuga pinnata*	Leaves
5.	Ambli*	*Tamarindus indica*	Fruits,leaves
6.	Ambra*	*Emblica officinalis*	Fruits,leaves
7.	Shisam	*Dalbergia latifolia*	Leaves
8.	Bawal	*Acacia arabica*	Flowers,leaves
9.	Jamboo*	*Syzygium rubicundum*	Fruits,leaves
10.	Kalukda	*Holarrhena antidysen-terica*	Leaves
11.	Karamdi*	*Carissa carandas*	Leaves
12.	Behda	*Terminalia bellerica*	Leaves
13.	Vadlo*	*Ficus bengalensis*	Fruits
14.	Limbda	*Azardirachta indica*	Leaves
15.	Sarasda	*Albizzia odoratissima*	Leaves
16.	Saral	*Holoptelea integrifolia*	Leaves
17.	Ujad	?	Leavea,flowers
18.	Ron Rohan	*Soymida febrifuga*	Leaves
19.	Rhangari	*Morinda tinctoria*	Leaves,flowers
20.	Phangada	?	Leaves
21.	Kanthar	*Zizyphus sp.*	Leaves,flowers
22.	Saag	*Tectona grandis*	Pupae on leaves
23.	Umbra*	*Ficus glomerata*	Fruits
24.	Ravano	*Syzygium cuminii*	Leaves
25.	Belpathr*	*Aegle marmelos*	Fruits
26.	Kalum	*Mitragyna parvifolia*	Leaves
27.	Karung*	*Derris pinnata*	Fruits,leaves
28.	Kheria*	*Acacia catechu*	Leaves
29.	Kalukdo	*Holorrhena sp.*	Leaves
30.	Kadaya	*Sterculia urens*	Bark rarely
31.	Malvelo	*Combretum decandrum*	Leaves,flowers
32.	Dhamanah	*Grewia tiliaefolia*	Leaves
33.	Phagdove	*Genus Leguminosae*	Leaves
34.	Gondovelo	*Vitis sp.*	Leaves
35.	Malkankan	*Celastrus paniculata*	Leaves
36.	Phankove	*Argyreia sp.*	Leaves
37.	Santovel*	*Abrus precatorius*	Leaves
38.	Fagvel	*Rivea hypocrateriformis*	Leaves
39.	Phalli	*Arachis hypogea*+	Leaves,flowers
40.	Bajra*	*Pennisetum typhodeum* +	Fruits
41.	Boona	*Gossypium sp.* +	Leaves

Note: * in fruit during the study period. + Cultivated.

The evidence of common langurs at the height of 4270 m and surviving at the temperature of - 2°C (Bihsop, 1978) needs studies about the food habits of the species at such altitude.

Table 22 b furnishes the type of food items utilized by the Phayrei' leaf monkey and Capped langur in Wildlife Sanctuary, Sepahijala (Tirpura).

Table 22 (b) : Forest species used as food by langur (Das, 1998)

Species	Part Eaten	Eaten by	Season
Forest species :			
Mangifera indica	Ripe fruit	F/C	April-June
Mongifera sylvatica	Ripe fruits	F/C	April/May
Embelica officinalis	Green twigs/Fruit	F/C	Lean season
Cajanus cajan	Green pod	F/C	August/Nov.
Terminalia belerica	Fruits	F/C	Jan./March
Hymonodictylonexcelsum	Green leaves	F	All seasons
Bambusa pallida	Crown	F	June-August
Meocannabombusoides	Crown	F/C	May-August
Dendrocalamus hamiltoni	Crown	F	May-July
Zizyphus jujubi	Fruits	F/C	Dec.-March
Calamus tenuis	Fruits	F	May-June
Artocarpus chaplasha	Ripe fruits	F	August-Sept.
Michelia champaka	Flower	C	Flowering season
Adina cordifolia	Green leaves	F	All seasons
Albizia stipulata	Green leaves	F	All seasons
Bursera serrata	Fruits	F	June-August
Grewia micrpcoss	Fruits	F/C	
Grewia microcoss	Fruits	F/C	June-August
Bombux ceiba	Flower parts	C	Dec.-Feb.
Eugenia jambulanum	Ripe fruits	C	Feb.-March
Bauhinia sp.	Green leaves	F	All seasons
Careya arborea	Green leaves	F	All seasons
Leucanaleucocephala	Leaves	F/C	All seasons
Delenix regia	Twigs	F/C	All seasons
Hebia braciliansis	Fruits	F	May-July
Artocarpusheterophyllus	Ripe fruits	F/C	March-May
Mikania macarnth	Leaves	F	March-Nov.
Agricultural crops :			
Lablab purpureus(Bean)	Pods&Leaves	F/C	Aug.-Feb.
Brassica spp(Cabbage)	Leaves	C	October-March
Raphanus spp.(Carrot)	Fleshy root &leaves	C	October-March
Cajanus cajan(Arhar)	Pods & green twigs	F/C	Augugust-November
Cucurbita maxima(Pumpkin)	Twigs & Fruit	F/C	All seasons
Cucurbita spp.(Cucumber)	Green fruits	C	Summer & Winter
Lablab spp.(Climber bean)	Pods & twigs	F/C	March-December
Luffa indica(Jhinga)	Green fruits	F/C	March-August
Psium sativum(Matar)	Seeds & pods	C	December-February
Oryza sativa(Paddy)	Paddy	F/C	All seasons
Splanum melongena(Brinjal)	Fruits & twigs	C	Winter
Horticultural Crops :			
Carica papaya(Papaya)	Twigs, tender leaves flowers	F/C	All seasons
Artocarpusheterophyllus (Jackfruit)	Ripe fruit	F	March-July
Mangifera indica(Am)	Ripe fruit	F/C	March-July
Citrus melongana(Citrus)	Flowers	F	July-August
Psidium guajava(Guava)	Fruit & flowers	F/C	August-October
Musa paradisiaca(Banana)	Ripe fruits	F/C	All seasons

Note : F = Phayre's leaf monkey ; C = Capped langur

(b) Captivity : Table 23 (a) includes the composition of diet given to the species in different zoos.

(2) Capped langur (*Presbytis pileatus*). (A) Conservation : Species lives in the dense ever green hilly forests of northern Assam eastwards in Arunachal Pradesh and adjoining Bangladesh. According to Choudhury (1996) the estimated population of the species is 39,000. In 1994-95 the population in captivity was reckoned to be 27 (11:16).

(B) Food (a) Nature : (a) Nature : Species is arboreal. Their food is fruits, tubers and leaves.

b) Captivity : Only few zoos possess capped langur for education and display purposes. The compositions of the diets being fed per adult capped langur in the zoos are mentioned hereunder in Table 23a.

Table 23 (a) : Diet per adult Capped langur per day in three zoos.

Food items	Zoological Park, Chennai (kg)	National Zoological Park, Delhi (kg)	Zoological Park, Sepahijala (kg)
Rice	0.300	-	-
Egg	1 no	-	-
Bread	2 no	0.100	-
Milk	-	100 ml	-
Fruits:	-	-	0.150
Sathukudi(Orange)/Mango		1/2 no	-
Banana	-	-	6no
Grapes/Chikoo	0.200	0.100	-
Vegetables	0.050	0.100	0.200+ Veg. leves
Sweet potato	-	0.100	-
Carrots	0.025	0.050	-
Cabbage	0.030	-	-
Tomato	-	0.025	-
Onion	-	0,025	-
Beet root	-	0.050	-
Bengal Gram	0.015	0.050	0.150
Soyabean	0.020	-	-
Groundnut	0.015	0.050	-

Table 23 (b) : Food values per adult Capped langur

Zoo	Food (g)	CP%	EE%	ME (Kcal)
Chennai	985	58.8	33.4	946
% of food		5.97	3.39	96.04
Per kg B.W.		5.88	3.38	9.46
Delhi	750	57.1	39.3	1190
% of food		7.61	5.24	158.67
Per kg B.W.		5.71	3.93	11.90
Sepahijala	1100	49.0	8.0	1250
% of food		4.45	0.73	113.64
Per kg B.W.		4.90	0.80	12.50

(3) Phayre's leaf/spectacled monkey (*Presbytis phayrei*) :(A) Conservation : Species is highly endangered, only distributed in Tripura State with reported existence of a few member in North Catchar hills of Assam adjacent to the northern boundary of Tripura.

(B) Food : (a) Nature : In Sepahijala Wildlife Sanctuary following species of leaves are preferred by the animal : *Artocaprpus chaplasha,Lannea grandis, Albizia stipulata, A. procera,Syzygium, Cuminii, Terminalia belirica, Vitex peduncularis, Duabanga sonerotis, Bombux celiba, Acquilaria agalocha, Trewia nudifora, Mangifera silvatic, Lagerstroemla perviflora,* and *Dillenia pentagyna* (Das, 1991).

(b) Captivity : In Sepahijala zoo the food items constituting the diet include, mixed fruits 0.150 kg, soaked gram (bangal) 0.150kg, banana 10 no.,and raw vegetables(pumpkin, radish, cabbage, etc.).

(4) Nilgiri langur (*Presbytis johni*). (A) Conservation: The species is highly endangered. It is found only in southern India (Western ghats south of Coorg; the Nilgiris, Annamalai, Brahmagiri, and Palni hills) usually not below 915 m altitude. The Nilgiri langur troops size vary from 3 (1:2) to 24 (10:14/11:14). Results of breeding of the species in captivity are not encouraging. Only Chennai and Mysore zoos have experienced births in the species at one or two occasions. During 1998 , in all the captive facilities there were only about 2 dozen adult individuals, the maximum number 9 (4:5) was in Zoological Park, Vandular, Chennai (Tamil Nadu).

(B) Food : (a) Nature : Nilgiri langurs inhabit the sholas (ever green forests surrounded by grasslands). The species is arboreal. Its main food consists of leaves, flowers, buds, seeds, barks and stems of various plants, shrubs and trees. Many occasionally eat insects. The preferred food leaves are from *Peterocarpus marsupium, Grewia tiliaefolia, Artocarpus herterophyllus*; *Dalbergia latiofolia*, etc. in Periyar Wildlife Sanctuary. Prater (1971) described that the available plant species form customary vegetarian food of langurs and show considerable adaptiveness but marked preferences exist for particular foods. In areas planted with wattle (*Acasia melanoxylon* and *A. mollissima*) the flowers and buds are the major source of food. Also they are known to eat cardamom plant pith and other cultivated plants. They forage for food in the morning, rest at noon time and come out to feed again in the coolness of the evening.

(b) Captivity : Zoological Garden Thiruvananpurum (Kerala) ascribes the diet consist of: Apple/mango/guava, Bengal gram, Carrot, Coconut, Groundnut (with out husk), Cheera, Orange and Cabbage each 0.05 kg per day per adult and Banana, Bread, Grapes and Plantains each per day per adult 0.01 Kg . Only very few zoos possess the Nilgiri langur (Presbytis johni). The diet compositions being fed to Nilgiri langurs in captivity are detailed in table 24(a). Extrapolating available TDN digestibility coefficient values of various food ingredients, the nutritive values of the diet being fed to Nilgiri langur (Presbytis johni) have been hypothetically derived(table 24(b)). TDN values may be taken as guidelines for conducting feed trials in determining the actual requirements of the species (Pathak. N.N. Head Div. of Animal Nutrition IVRI, Izatnagar-UP).

Table 24(a): Diet per day per adult Nilgiri langur (*P. johni*) in certain large Zoos.

Food items	Z P, Chennai	ZG, Mysore	NZP, Delhi	ZG, Guwahati	BP, Bhubneshwar
Milk	-	100 ml	100 ml	-	50ml
Bread	2*	0.200	0.100	0.100	0.030
Egg**	1 no	1 no	-	-	-
Rice (boiled)	0.030	-	-	-	50g
Grapes/Chiku	0.020	0.100	0.100	0.025	-
Sathukudi (Orange)	1/2 no	-	-	1 no	-
Apple/Naspati	-	0.150	-	0.100	-
Guava/Papaya	1 no	-	-	0.100	-
Banana	4 no	3 no	2 no	5 no	0.250
Lassora*	-	-	-	0.050	-
Groundnut	0.015	0.100	0.050	0.050	0.050
Gramsoaked/ baked)	0.015	0.050	0.100	-	0.050
Vegetables (seasonal)	0.050	0.050	0.050	-	-
Cabbage	0.030	0.050	-	-	-
Carrots	0.025	0.050	0.050	0.100	0.050
Sweet potato	0.100	0.100	-	0.100	-
Tomato	-	0.050	0.025	0.100	-
Cucumbar	-	-	-	0.100	-
Onion	-	0.025	-	-	-
ladyfinger	-	-	-	0.100	-
Brinjal	-	-	-	-	0.050
Beet root	-	-	0.025	-	-
Beans/Soya	0.200	0.050	0.050	-	0.0 50
Sugarcane	-	-	-	0.050	-

Note:(i) *=Slices, ** Bi-weekly boiled egg.Chiku=Sapodilla,* Lassra(Indian cherry) Sebesten. (ii) Z=Zoological,P= Park, G=Garden, N=National, B=Biological

Table 24 (b) : TDN values determined in case of diet of Nilgiri langur/ adult/ day (hypothetical model) .

Zoo	Food (g)	CP%	EE%	ME (Kcal)
Chennai	855	37.2	22.6	926
% of food		4.35	1.64	108.30
Per Kg B.W.		3.10	1.88	77.17
Delhi	950	87.1	54.4	1610
% of food		9.17	5.73	169.47
Per kg B.W.		7.26	4.53	134.17
Guwahati	1375	46.5	27.0	1295
% of food		3.38	1.96	94.18
Per kg B.W.		3.88	2.25	107.92
Mumbai	1325	107.5	83	1980
% of food		8.11	6.26	149.43
Per kg B.W.		8.96	7.0	165.00

One can percieve the difference about the in nutritive values of diets being fed to the species in various captive facilitiesand develop the model to determine the specific food requirement.

(5) Golden langur (*Presbytis geei*). (A) Conservation : Species is highly endangered. Merely about 1,000 Km 2 of favourable habitat is available for the species in Assam. It lives in dense tropical to moist deciduous forests of south - central Bhutan and north western Assam bounded by river Sankosh on west and Manas in the east. During winter, the langur population increases in Assam due to seasonal migration from Bhutan. The estimated population of the species is reported to be 500 about (Choudhury, 1996).There are only few captive facilities maintaining *Presbytis geei* and the number is meager.

(B) Food (a) Nature : The golden langur lives in small groups. The species is diurnal in habitat and feeds on leaves, buds, flowers and fruits of several trees and occasionally eats salty earth to meet the mineral requirements. The flowers of simul trees are very much liked by the langurs.

b) Captivity : The composition of diets being fed to Golden langur is given in table 25.

Table 25: Diet for golden langurs per adult per day

Food items	Zoological Park, Sepahijala	Biological Park, Patna
Milk+Rice	-	100 ml + 0.025
Bread	-	2 nos
Sai	4 nos	
Bengal Gram	0.250	0.100
Banana	6 nos	12 no.
Fruits (mixed)	0.250	0.150
Almond	-	0.100
Sweet potato	-	0.100
Vegetable	0.300 + Green leaves	0.200
Carrots	-	0.100
Bael	-	0.100
Jaggery	-	0.100

Table 26 : Flat diet scale per adult/day for some native and exotic primate species.

(i a) Biological Park, Bhubaneshwar (Orissa)

Food items	Assamese macaque (kg)	Bonnet macaque (kg)	macaque (kg)	(kg)
Greem whole	0.050	0.050	0.050	0.050
Brinjal	0.100	0.100	0.100	0.100
Ladies finger	0.050	0.050	0.050	0.050
Bread	0.030	0.030	0.030	0.030
Ground nut	0.050	0.050	0.050	0.050
Bean	0.050	0.050	0.050	0.050
Milk	0.010	0.010	0.010	0.010
Rice	0.050	0.050	0.050	0.050
Banana (Ripe)	0.250	0.250	0.250	0.250
Carrot	-	0.050	0.050	0.050
Sweet potato	0.100	0.100	0.100	0.100

(ib) Biological Park, Bhubaneshwar (Orissa)

Food item	Patas monkey	Chimpanzee	Papiobaboon
Green whole	-	0.100	-
Apple	0.100	0.300	0.100
Brinjal	0.100	-	0.100
Ladies finger	0.050	-	0.050
Bread	0.100	-	0.100
Ground nut	0.050	-	0.050
Bean	0.050	0.050	0.050
Milk	0.010	0.100	0.010
Rice	0.050	0.200	0.050
Banana (Ripe)	0.250	0.300	0.250
Carrot	0.150	0.100	0.150
Sweet potato	0.050	-	0.050
Cucubmer	-	0.100	-
Grape	-	0.200	-
Tomato	-	0.100	-
Green sag	-	0.200	-
Egg	1 no	1 no	1 no

(ii) Zoological Garden, Jaipur/Jodhpur (Rajasthan)

Species	Food items	Quantity
	a) Macaque species :	
Lion- tailed/	Fruits & vegetables	00.500 kg
Stump tailed /	Boiled rice	00.125 kg
Bonnet /	Milk	00.250 kg
Rhesus /	Bread slices	2 no
Pig - tailed.	Groundnut	00.100 kg
	Roasted gram	00.050 kg
	b)Langurs :	
Nilgiri langur/ Capped langur	Same as for a)	
	c) Ape and other exotic species :	
Gibbon	Fruits & vegetables	00.750 kg
	Boiled egg	2 nos
	Milk	00.250kg
	Bread slices	2 nos
Capuchin/Spider	Fruits & vegetables	00.500 kg
Red/Patas/Sooty	Bread slices	2 no
Mangabey, Douroucouli	Milk	00.050 kg
	Roasted gram	00.050kg
	Boiled egg	1 no
Mandrill/Baboon	Fruits	00.500 kg
Drill	Bread slices	4 no
	Vegetables	00.250 kg
	Milk	00.250 kg
	Roasted gram	00.100 kg
	Boiled egg	1 no

(iii) Zoological Garden, Guwahati (Assam)

Monkeys & langurs :	
Bread	=0.100
Gram baked	=0.050
Carrot	=0.100
Mousembi	=0.050
Groundnut	=0.025
Sugarcane	=0.050
Lassor (Indian cherry)	=0.050
Guava	=0.100
Cucumber	=0.100
Grapes	=0.025
Orange	= 1 no
A. banana	=1 no
Ch. banana	=4 no
Naspati	=0.100
Mandrill/baboon:	
Fruits	=0. 500
Bread	=4 nos
Vegetable	=0.250
Gram baked	=0.100
Boiled egg	=1 no

(iv) Zoological Park, Patna (Bihar)

Stump-tailed monkey & Golden langur	
Bread	= 0.100
Milk	= 100 ml
Gram baked	= 0.100
Carrots	= 0.100
Rice	= 0.025
Sweet potato	= 0.100
Guava	= 0.100
Almond	= 0.100
Banana	= 12 No

(v) Zoological Garden Kanpur, UP (Source:Ref.37/23-3 dated 13 July, 1999)

Food items	Baboons (kg)	Old world monkeys*(kg)	New world monkeys** (kg)
Bread	0.100	0.100	0.100
Banana	0.300	0.200	0.100
Mixed fruits	0.200	0.100	0.100
Gram (baked) or Ground nut cake	0.100	0.100	0.100
Mix.vegetables	0.600	0.400	0.250
Spinach	0.050	0.050	0.025
Gur/Honey (in winter)	0.050	0.050	0.025
Onion	0.025	0.025	0.025
Egg	1no+		1no
Bel (in summer)	1/4	1/4	1/4
Maize corn	1/2	1/2	1/2

Note : New world monkeys (Platyrrhini). Monkey from south and central America; two families: *Cebidae* (cebid monkeys) and *Callitrichidae* (marmosets).**Old world Monkeys:** Monkeys form all geographical areas except south and central America (family *Cercopithecidae* two subfamilies: *Cercopithecinae* and *Colobinae*).

(v) Zoological Park, Hyderabad (Andhra Pradesh)

Food items	Native Species	Exotic Species
	Forenoor.	
Bengal gram	0.050 - 0.100	0.050 -0. 100
Ground nut	0.025 - 0.050	0.025-0.050
Apple	1/2 - 1 no	1/2-1 no
Banana	0.100 -0.200	0.100-0.200
Carrots	0.025-0.050	0.025-0.050
Cabbage	0.020 -0.025	0 020-0.025
Sweet lime	1/2- 1 no	1/2-1 no
Palak	0.025 -0.050	0.025-0.050
Egg	-	1/2-1 no
Grapes	-	0.025 -0.050
	Afternoon	
Bread	0.100	0.100-0.200
Apple	1/2 - 1 no	1/2 -1 no
Banana	0.100 -0. 200	0.100-0.200
Sweet lime	1/2- 1 no	1/2-1 no
Milk	-	0.200-0.250
Grapes	-	0.025-0.050

(vii) Zoological Park, Itanagar, (Arunachal Pradesh)

Food items (For all species)	Quantity
Rice	0.02
Banana	1.00
Sweet potato	0.02
Milk powder	0.10
Pumpkin	0.02
Cucumber	0.03
Pine apple	0.01
Chana	0.01
Green pea	0.01
Naspati	0.01
Orange	0.01
Bogori	0.01
Cabbage	0.25

(viii) Zoological Park, Vandalur, Chennai (Tamil Nadu)

Food items	Capuchin species	Baboon species	Chimpanzee
Milk	-	-	1 litre
Bread slice	-	-	8 no
Egg(boiled	-	1 no	2 no
Bi-weekly)			
Rice	25 g	50 g	30 g
Groundnut	25 g	25 g	25 g
Gram	-	100 g	50 g
Banana	-	2 no	10 no
Sathukudi			
(Sweet orange)/			
Mango	1/2 no	2 no	4 no
Guava/Papaya	1 no	4 no	8 no
Apple	1/2 no	-	1 no
Grapes	50 g	-	-
Greens(mix)	-	-	50 g
Cabbage	25 g	50 g	100 g
Carrot	25 g	100 g	100 g
Cucumber	-	50 g	-

3. Family *Lorisidae*. Belonging to this family there are only two native species

(1) Slender loris (*Loris tardigradus*). (A) Conservation : Found in tropical rain forests, woodlands and swampy areas up to about 1,850 m altitude. It inhabits both forests and woodlands of southern India and Sri Lanka. It is nocturnal i.e. it sleeps during the day in hollows of trees or forked branches remains active in the night.

(B) Food : Prater (1971) described fondness of loris for the berries of lantana (Lantana sp.) bushes. It also eats insects, lizards, small birds, tree frogs and any thing that it can seize and overcome. Animal catches the prey stealthily by grabbing with both hands. Moisture taken from the leaves is sucked up from the finger. The young are nursed for a long time and continue to suckle when half grown and no longer solely dependent on maternal feeding.

(2) Slow loris (*Nycticebus coucang*). (A) Conservation : Found in the ever green and semi- ever green forests south of the Brahmputra river in India.Species is also found in Bangladesh, Myanmar, Thailand, Malay, Indonesia and the Philippines. A report on primate distribution and its abundance in Assam describes the estimated population to be 16,000-17,000 on south bank of Bramhaputra river (Choudhury, 1996). It is also active at night i.e. nocturnal..

(B) Food (a) Nature : Slow loris inhabits in the ever green and semi-green forests. Though young starts tasting food from one month of age, it remains suckling beyond six months and remains clinging till full grown in 10 months (Prater, 1971). It is found in small family groups unlike slender loris. It feeds on young roots, leaves, fruits, insects, birds eggs and small birds. Haque and Siddiqui (1988) observed its food preferences and noted that cockroaches, house lizards and bananas were the items most preferred by the animal. Though slow loris is omnivorous and reportedly feeds on leaves and shoots, it rejects young leaves of a few species when offered to it. The animal, on an average, consumes 190 grams food per day.

(b) Captivity:

Table 27: Diet per adult/ day for slow Loris (*Nycticebus coucang*).

(I) Zoological Garden, Guwahati (Assam)		**(ii) Biological Park, Patna (Bihar)**	
Boiled egg	= 1 no	= 2 nos Munia(bird)	=3 nos
Banana	= 125 g/3nos	Banana	=12 nos
Milk	=100 ml	Milk	=200 ml
Cooked rice	= 0.100		
Mutton	= 0.100		
Musomi & Orange	= 2 nos		
(iii) Zoological Garden, Mysore (Karnataka)		**(iv) Zoological Garden, Itanagar (Arunachal Pradesh)**	
Bread	=25 g	Apple	=200 g
Milk	=25 ml	Banana	= 500 g
Grapes	=25 g	Mango	= 100 g
Banana	=25 g	Sweet potato	= 100 g
		Egg (weekly)	= 1 no

(v).Zoological Garden,Lucknow (UP)

Slow loris (Ref.464/IVRI/27April, 2000)

Bread =4 no; Banana = 4no; Egg (only in winter) = 2 no

4. Family *Pongidae* :

Only one species of the ape exists in India that is hoolock gibbon (*Hylobates hoolock*). The exotic species which are most commonly imported and exhibited in zoos are chimpanzee (*Pan troglodytes*) and orang- utan (*Pongo pygmaeus*) and rarely gorilla (*Gorilla gorilla*). Information about their distribution and natural feeding has not been garnered. However, diets being provided to them in our zoos are given in the table and respectively.

(1) Hoolock gibbon (*Hylobates hoolock*). (A) Conservation : Hoolock gibbon is the only representative of apes in India, with a single species. This species is extremely rare. It is found in south west Asia. In India the animal lives in dense forests in north eastern States. Its group consists of a male, female partner and off springs.

(B) Food (a) Nature : Tilson(1979) published his studies carried out on feeding behaviour of Hoolock population inhabiting Hollongapar forest reserve of Jorhat in Sibsagar district of Assam. He had identified a total of 43 fruit species utilised by the gibbon. Of the 43 species, 53% produce fruits eaten by gibbons. He noted that, on an average, gibbons spend 67% of their feeding time on fruits, 32% on leaves and flowers and 1% on insects during winter. Average feeding time over a 10 - day period was 322 minutes per day (range 260-445 minutes). It was not significantly different in summer. The study of Alfred and Sati (1994) carried out in Garo hills of the state of Meghalaya (25°N and 90°E) on two groups of *Hylobates hoolock* revealed that they spend nearly 35% of their total awakening time on feeding. Hoolock is basically vegetarian. The adult female feeds more than the male. Fruits, particularly wild figs, comprised their major diet which formed nearly 60-65% of all the food eaten. However, the adult male ate more of these fruits. The female gibbon feeds more on the tender leaves and creeping vines which is the next major constituent of the gibbon diet. Flowers also form a portion of the food along with a minor fraction of insects, spiders and termites. Accidentally if hoolock catches a small bird it may eat the same. It is not averse to eating birds' eggs. Though fruits formed the largest portion of their diet, it was seen that maximum fruits were eaten in winter months. In spring and summer, the flowers and leaves respectively increased proportionally in the diet.

In Namdapha National Park, Arunachal Pradesh hoolocks are found to feed mostly on fruits, leaves, young shoots, spiders, insects, grubs, eggs and some birds. About 60% of the total time was spent on feeding. Fig fruit (*Ficus carica*) was the preferred food item. Feeding bouts in morning session were found to be longer than evening ones. The food items (fruits) in the forenoon were basically energy rich food items (*Vulgaris, Ficus religosa, Moringa pterygosterma* and *insects*) and those eaten in the afternoon were rich in fibre (Mary *et al*., 1996).

(b) Captivity: Status of the species in captivity is poor. Like other primate species the diet requirements for hoolock gibbon has also not been scientifically assessed.

Diets being fed :

(i) Zoological Garden Manipur

The zoo procured a male gibbon from a villager (Serhlimn Chura, Chandpur) who reared the animal for over four years. The gibbon used to be provided cooked rice and green leaves and every morning was fond of taking black tea. The gibbon used to dip his palm and lick it clean. When taken on the accounts of the zoo, the diet was not changed from black tea in the morning (S.K Bhomic Vet. Officer, Sepahijala Zoological Garden,Personal Communication 1997).

Table 28. Diet for hoolock gibbon per adult per day in certain zoos

Food item	(ii)ZP, Kanpur	(iii) NZP, Delhi	(iv)ZG, Guwahati	(v)ZP, Sepahijala
Milk	-	0.100	-	-
Bread	0.050	0.100	1 no	-
Cooked rice	-	-	0.100	
Egg (Boiled)	-	1 no	1 no	-
Gram barked	0.050	0.050	-	0.150
Groundnut	-	0.050	-	-
Banana	0.800	2 no	6 no*	10 no
Fruits mixed	0.200	-	-	0.150
Apple	-	0.100	0.100	-
Pears	-	0.100	0.100	-
Sweet lime	-	0.100	0.100	-
Orange	-	-	1 no	-
Beet root	-	0.100	-	-
Tomoto	-	0.025	-	-
Cucumber	-	0.100	-	-
Bhutha (corn)	-	0.100	-	-
Potato	-	0.100	-	-
Melon	-	0.100	-	-
Onion	-	0.025	-	-
G.V. leaves	-	0.100	-	0.200+
Sugar	0.050	-		
Sugar cane	0.100			

* Assamese banna 2 Malbhog banana 4. , +=Vegetables

(vi) Zoological Garden, Lucknow (UP): On 24th July, 1999 zoo received a young adult female aged about 4 years from a private person living in Vadodara (Gujarat). The various items of diet being fed by the owner included banana, chiku, mango (*Mangifera indica*), anar (*Punica granalum*), jamun(*Syzgium cumini/Myrtus cumini*), cherry, green leaves of dhania, soaked mixed cereals, sugarcane, cucumber, tomatoes, cabbages (*Brassica sp.*), tulsi leaves, masud, etc. The quantity fed to the animal was between one to one and half kg. On arrival at the zoo several fruits and vegetables were offered to the gibbon. She accepted only fresh raw brinjal (*Solanum melongena*), cucumbar (*Cucumis sativus*), chollai (may be cowpea), mosumi (*Citrullus sinensis*), jamun and apple. Bread and milk were not accepted. Further observations of food preference aresss being made (U. Shukla, Deputy Director, Zoological Garden, Lucknow. Personal communication, August, 1999).

Diet schedules for exotic primate species prescribed by the various zoos are furnished in Table 29(a, b).

Table 29 (a) : Diet for an adult chimpanzee (*Pan troglodytes*) per day in certain zoos.

Food items	NZP, Delhi	ZP, Hyderabad	ZP, Kanpur	ZG, Guwahati	ZP , Chennai	ZG, Mysore
Rice	-	-	-	-	0.030	-
Bread	0.200	300 -400	0.200	0.200	+8 slices	0.400
Biscuits						
Gram	-	-	-	-	0.050	-
Milk	800ml	1.0 lit*	1.000	500 ml	1 lit.	500 ml
Egg	1 no.	1 no.	2 no	1 no.	2 no.	1 no.
Sugar/Gur	0.050	-	0.125	0.050	-	0.100
Banana	10 no	16*-20 nos	12 nos	17 nos	10 nos	0.750
Carrot	0.250	0.450 *	-	0.200	0.100	0.500
Sweetlime	0.400	4 nos *	0.500	1.00	-	-
Apple	0.750	0.500	0.500	0.500	-	1.000
Fruits (mix)	0.650	0.200	2.000	1.200	0.800	1.500
Barley/						
Bean	-	-	-	0.050	0.050	0.100
Grount nut	-	-	0.100	-	0.025	-
Vegtables	0.850	0.400	0.250	-	0.150	0.350
Mou/Ora	-	-	-	-	-	0.500
SF	-	-	-	-	-	-
C/T	0.100	-	-	-	-	0.025

Note: Fruits (mix) also include Grapes C/T= Coffee/Tea

Table 29(b) : Diet for orang-utan (*Pango pygmaeus*) and gorilla (*G. gorilla*) per day in captivity.

Orang-utan		Gorilla	
Zoological Park, Kanpur		Zoological Garden, Mysore	
Milk	1 litre	Milk	150 ml
Bread	0.150	Bread	0.400g
Banana	1.000	Egg	2 nos
Fruits(mixed)	2.500	Sugar	0.100
Sugar/Honey	0.050	Apple	1.00
Gur	0.050	Banana	0.750
Egg	2 nos	Grapes	1.000
Tomato	0.150	Vegetables	0.100
Bael	1 no.	Carrot	0.250
Maize Corn	2 nos	Cabbage	0.250
		Beans	0.050
		Mou/ora	0.300
		SF	0.500
		C/T	0.025

SF=Additional seasonal fruits C/T =Coffe/ Tea

V. ORDER - CARNIVORA

I. Family - *Felidae*: Of the 36 cat species included in the family distributed worldwide 15 species are found in India. Of these,four are large ones (tiger-*Pnthera tigris, lion- Panthra leo* sub species *P.l. persica* , leopard-*Panthra pardus* and snow leopard- *Uncia uncia* and the rest 11 are medium to small cats. Because of their peculiar anatomical features of the skull, teeth, feet,and sighting and hearing senses and alimentary tract they are adapted to predatory life.Certain other carnivore species may be sympatric in resource exploitation but definitely vary in their nutrient requirements for perspective subsistence. In this regard the available information and data are presented in the following text.

(1) Tiger (*Panthera tigris*). (A) Conservation: Presently tiger (*Panthera tigris*) is mainly found in India, Myanmar, Nepal, Bhutan and Bangladesh. The total population in the country is 3,241 as per the census report of 1997 of Ministry of Environment and forests, New Delhi. The species is highly endangered struggling for its survival. In 25 tiger reserves the population of tigers is about 1450 and in captive facilities around 270.

(B) Food (a) Nature : At the onset a brief description about the comparative predation behaviour of tiger (*Panthera tigris*) and leopard (*Panthera pardus*) is presented . This will be beneficial for the Wildlife Veterinarians.

Tiger usually seizes its prey by the nape of the neck which is frequently broken. The tiger has been described as a versatile killer and follows no stereotyped methods.

Leopard generally seizes its prey by the throat. Leopard can readily climb trees and sometimes jumps on the back of its quarry and then kill may be taken up on to the tree or hidden with leaves to be eaten later on.

Tiger starts eating the rump area, hunches, thigh muscles and first except in case of huge large prey. An adult leopard may start feeding on its kill in the same place normally from the anus or pelvic region and invariably tears open the stomach. The tiger, on the contrary, avoids, probing of the stomach: rather it removes stomach to some distance. An adult healthy male tiger may eat up to 30 kg flesh mass on the day of the kill. Like in case of dogs and cats all wild cats cannot chew their food, and the meat or flesh is cut into pieces with their carnassial teeth and gulped quickly, leaving very little time for their sparse taste buds to taste the food. The taste buds in tigers are set mainly on the margin of tongue and are fewer and smaller in number. Leopard never dares to face tiger for sharing his kill.

Studies about predation and food habits of tigers conducted in various National Parks showed that chitals (*Axis axis*) and common langurs (*Presbytis entellus*) were in order the major prey species. However this is not the case in Panna National Park. Based on scat analysis (conducted by Wildlife Institute of India, Dehra Dun) sambar's contribution in the diet of tiger was found higher in summer, nilgai much lower and langurs only 27 %. The chitals contributed more in monsoon than in other seasons. In Bhutan the main prey of tiger consists of wild boar (*Sus scrofa*), sambar (*Cervus unicor*) and barking deer (*Muntiacus muntjak*) and at higher elevations serow (*Capricornis sumatraensis*) and takin (*Budorcas taxicolor*). Percentages of incidences of predation reported from Kanha National Park are: chital 51.4%, langur 14.14%, sambar 11.72%, wild pig 9.3%, barasingha 5.52%, gaur 2.7% nilgai 1.03%, barking deer 2.38% and others 2.8% (Panwar, 1990).

In Dudwa National Park predation of barasingha (*Cervus duvauceli duvauceli*) is estimated to be 50 per cent (Singh, 1982) and in Kanha National Park 17 percent (Schaller, 1967). The tiger predacity depends upon the preponderance population of deer species in its territory. The tiger often kills its prey in weight class, 100-700 kg and food consumption is found to be approximately 1.375 chitals (*Axis axis*) equivalent per week i.e. about 72 chitals equivalent per year (Johnsingh, 1979). According to another study tiger needs on an average about 3000 kg of prey per year. Large sized prey , despite its low predation rate, provides more biomass. For example, langur predation is higher but yields less biomass compared to gaur (Kotwal and Rajesh, 1993). Tilson *et al.* (1994) cited observations of Tamang's(1979)study on Bengal tigers and their prey populations,which are as follow. The free ranging tigers consume a daily requirement of 7 kg.To obtain this food a tiger would need to kill 18 sambars or 111 hog deer or 68 chitals per year(based on the assumption that only 70% of prey is considred edible). Predation of porcupine sometimes is fatal to tiger. While striking the porcupines, its spines may get lodged in the forepaw and tiger may suffer of severe wound, which may incapicitate the beast to hunt.

(b) Captivity : In all the captive facilities including safaris fresh beef with bones is supplied six days in the week. In most of the zoos feeding of beef quantity ranges

from 10 to 12 kg per adult per day. Maximum quantity of beef inclusive of bones up to 15 to 16 kg is fed only at few zoos .They have been advised to curtail the quantity. Some zoos also give half to one litre milk (mixed with one raw egg) to each tiger in the forenoon about 2 to 3 hours before the beef (Table 30). Biological Park, Bhubaneshwar feeds beef for six days in a week; Monday is the off day. On an average adult tiger is given 14 kg of fresh raw beef with bones per day. Vitamin supplements are added to beef intermittently. Zoological Park, Chhatbir (Chandigarh) zoo feeds one litre of milk for 3 months and 3 kg goat meat or 5 fowls to the mother tigress and lioness. Municipal Corporation Zoo, Aurangabad (MS) feeds 2 kg extra beef to the suckling tigress till her cubs are 6 months old. The cubs usually start eating flesh by 40th day along with the mother. Tender calf beef to the cubs in relation to their growth is provided as mentioned below:

3 months - 6 months = 1.00-2.00

7months - 12 months = 3.00-5.00

1 to 2 years = 5.00-8.00

(30% - 40% long bones of limbs).

Note : (i) It is not uncommon that mother, soon after delivery of its offspring, eats away the placenta. Care is to be taken to avoid this event.

(ii) Cub born is immature. Its both eyes are closed and it is unable to walk. It approaches the mothers' belly by process of fumbling and propelling. The warm area of the teats is said to provide thermoradian attraction and facilitates each cub to reach there and explore the teats for suckling. Mother assumes lateral recumbency with its upper hind limb stretched out and head resting on the floor or up in normal position. During suckling, if the tigress gets any disturbance, she may stand up and inquisitively look around and may also become aggressive.

iii) The cubs may die of starvation if mother ignores the cubs and artificial hand rearing is not instituted in time. Sometimes, the cubs get infection and die. When the size of litter is large i.e. 4-6 the quantity of milk available to the cubs is usually suboptimal. The weaker cub may die due to getting insufficient nourishment.

Studies are required to evaluate feed supply to zoo animals at adequate intervals, as consumption reflects on both quality as well as its salutary effect on the state of health of animal. Little study on the aspects undertaken during summer months in 1990 in case of tiger (*P. tigris*) belonging to National Zoological Park, New Delhi and the observations are indited in table 31.

Table 30 : Diet regimen per adult per day for Tiger, Lion, Leopard, Cheetal.

Zoo/ Safari	Beef (kg)	Milk (ml)	Fowl (kg)	Eggs (Nos)	Remarks
(1) Tiger(*Panthera tigris*)					
Ahmedabad	8-10	-	-	-	7-9 kg For(F)
New Delhi	12.0	0.500	once*	1*	*Off day

Kanpur	15.0	-	-	-	-
Lucknow	8-11	-	-	-	-
Guwahati	11.0	-	-	-	-
Hyderabad	8-10	0.500	-	1	250-500 g liver
Patna	12.0	0.500	1.0	2*	*In winter
Mysore	10.0	-	1.0	-	-
Chennai	8.0	0.250	I*	-	Liver 500g *Twicea week.
Mumbai (Zoo)	14-16	-	-	-	-
Chatt Bir	12-15*	0.500*	2.0*		*To white
Darjeeling	10-11	-	-	-	-
(2) Lion (*P.leo persica*)					
Ahmedabad	8-10	-	-	-	7-8 kg For (F)
Junagarh	8-10	-	-	-	-
Kanpur	8-14	-	-	-	-
New Delhi	12.0	-	-	-	-
Chennai	8-12	-	3/4-1.0	-	1/4-1/2Liver
Hyderabad	8-10	0.500	-	1	-do-
Patna	7.00	0.500	1	2*	*In winter
Mysore	10.0	-	1	-	-
Chatt Bir	-	-	-	-	-
Guwahati	11.0	-	-	-	-
Borivali	12.0	-		-	To new arrivals 15kg for some period
(3) Leopard (*Panthera pardus*)					
Sepahijala	1.5	-	-	-	-
Kanpur	4.0-5.0	-	-	-	-
Chennai	4.0	-	0.750	-	250 gLiver
Hyderabad	3.0-4.0	0.250	-	1	150-250 g Liver
Patna	4.0	0.250	1	2*	*In winter
Guwahati	4.0	-	-	-	-
Chatt Bir	4.0	-	-	-	-
New Delhi	4.0-6.0	-	-	-	-
Mysore	8.00				
(4) Cheetah (*Acinonyx. jubatus*)					
New Delhi	3.0	-	1-2*	-	*Off day
Kanpur	3.0-5.0	-	-	-	-
Hyderabad	3.0-4.0	0.250	-	1	Liver

150-250 g

Note : (i) Additional 1 to 2 kg of chicken (may be given twice/thrice in a week) , 250 ml of milk and Calcium supplement at regular intervals to tigress after she has given birth to cubs (Basavaraju *et al.*, 1994). (ii) Lower limit of quantity is mostly supplied to females.

Table 31 : Observations on beef consumption by adult tigers (Arora,1998)

Animal	Period (days)	Av. beef supplied (kg/day)	Av. beef Consumed % kg/day	Av. Leftover: % kg/day	
				Beef	Bone
Male (Sunder)	38 days June-Aug 1990	11.28	6.74/59.75	0.88 7.88	3.66 32.45
Male (Sohrab)	-do-	11.34	6.89/60.76	1.16 10.23	3.29 29.01
Female (Santi)	-do-	11.07	6.71/60.61	1.37 12.38	2.99 27.01
Female (Sohali)	21 days June-Aug 1990	11.24	5.24/51.17	2.29 20.37	2.71 24.11

The male tiger consumed little more than female. The average beef consumption was found to be 6.5 kg per tiger per day. 10kg feef with bones is sufficient as maintenance diet. The pregnant and suckling mothers should be fed extra diet. To primiparous mother beef / meat quantity should be 15 % more, and in the subsequent parturitions 20 to 30 % more than maintenance diets divided into two feedings till weaning of cubs.

(2) Asiatic Lion (*Panthera leo persica*). (A) Conservation : Presently, nearly 250 individuals are existing in the lone habitat, Gir forests, in Gujarat. It is planned to translocate a few numbers in the Kuno Wildlife Sanctuary (345 sq. km) being developed in Madhya Pradesh.Presently there are about 80 to 90 lions (*P.leo persica*) in captivity.

(B) Food (a) Nature : The lions are most active in the predawn hours and at dusk. These are periods when they do nearly all their hunting. Aside from these periods of activity, the lion spends most of its time resting or sleeping. During rest, the lion actually is conserving its strength for those important hunting times. It is observed that the resting periods are also used to reinforce the bonds of family ties when the proud lions groom cach other, vocalize and play in other ways to reinforce the important social bond. Tigers do not engage in such activity except during mating period. Lions hunt in pride i.e. in family group. An adult lion attacks the prey. In one sniff of its paw, the lion knocks down a herbivore weighing about 300 kg and by grasping and holding firmly on to its neck, drags the prey to his family. It starts feeding at the groin region and the family members may feed at other parts simultaneously. Except stomach compartments in ruminants large entrails are consumed. Based on examination of type of species preyed by lions (*Panthera leo persica*) and analysis of the scats Chellam (1993) determined the prevailing patterns of the lions diets within and around the protected area of Gir forest ,which are

presented in the table 32 and explained succinctly. (I) Between 1987-90 season wise wild ungulates killed in and around the Gir Protected areas were 68.3% in summer, 42.3% in monsoon,19.15% in postmonsoon and 52.0% in winter. During the period the livestock predation was-31.7%,57.0%,80.7% and 48.0% respectively (Table32). This evidences that between July - Decemeber there is a large influx of livestock in the Gir protected area and constitutes the major prey for lion. The chitals and the cattle are always the predominant species killed. (ii) Reverine forests and reservoir bed are crucial hunting habitats of chitals and sambars. In the other season Teak-Acasia-Zizyphus woodland is the habitat in which chitals are killed most often by lions.(iv) Results of analysis of lions scats collected from the Gir PA presented in the table 32 (iv) indicate that wild ungulate prey species in order were chital, sambar, nilgai, wild pig and langur. (v) In case of wild ungulates lion's predation propensity is for the adults both males and females.

Table 32 (i) : Prey species killed by lions within (a) and around (b) the Gir PA, 1987-90 (# 201).

Species	No. of Kills			Percent Kills	
	(a)	(b)	Total	(a)	Over all
Wild prey:					
Chital	62	1	63	36.7	31.3
Sambar	22	3	25	13.0	12.4
Nilgai	5	4	9	3.0	4.5
Wild pig	5	2	7	3.0	3.5
Leopard	1	0	1	0.6	0.5
Total	95	10	105	56.2	52.2
Livestock:					
Cattle	40	22	62	23.7	30.9
Buffalo	32	0	32	18.9	15.9
Camel	2	0	2	1.2	1.0
Total	**74**	**22**	**96**	**43.8**	**47.8**

Table 32 (ii) : Seasonal percentage prey species killed by lions in and around the Gir PA, (1987-90) (# 200).

	Summer (# 79)	Monsoon (# 45)	Post Monsoon (# 26)	Winter (# 50)
Wild prey:				
Chital	39.2	26.7	3.8	38.0
Sambar	20.3	6.7	3.8	10.0
Nilgai	6.3	2.2	11.5	0
Wild pig	2.5	6.7	0	4.0
Total	**68.3**	**42.3**	**19.1**	**52.0**
Livestock:				
Buffalo	11.4	20.0	34.6	10.0
Cattle	20.3	35.6	42.3	38.0
Camel	0	2.2	3.8	0
Total	31.7	57.8	80.7	48.0

Table 32 (iii) : Composition of lion diet in the Gir PA in 1989, based on analysis of scats.

Sl. No.	Prey Species (# 320)	Frequency of occur-encl (# 397)	% occurrence	Rank
1.	Chital	48.1 (154)	38.8	1

2.	Sambar	19.1 (61)	15.4	2
3.	Nilgai	10.3 (33)	8.3	5
4.	Cattle	15.3 (49)	12.3	4
5.	Buffalo	15.9 (51)	12.8	3
6.	Wild Pig	6.9 (22)	5.5	6
7.	Langur	4.7 (15)	3.8	7
8.	Peafowl	1.6 (5)	1.3	8
9.	Porcupine	0.9 (3)	0.8	9
10.	Chowsingha	0.3 (1)	0.3	11
11.	Camel	0.9 (3)	0.8	9

Table 32 (iv): Age and sex composition of wild ungulate prey killed by lions in and around the Gir PA 1987-90 (# 104).

Prey species	Young			Prime Adults			Old Adults		
	M	F	U	M	F	U	M	F	U
Chital (# 63)	4	1	5	21	14	2	9	5	2
Sambar (# 25)	0	0	0	8	7	0	7	3	0
Nilgai (# 9)	1	0	0	6	2	0	0	0	0
Wild pig(# 7)	0	0	0	1	4	2	0	0	0
Total	5	1	5	36	27	4	16	8	2

M=Male F= Female U= Unsexed

Results of analysis of 58 scats of lion collected from different areas of Gir forest from September to December, 1995 described by Singh *et al.*, (1999) are as follows. Of 58 lion scats analysed, one was full of grass and 3 contained only bones, thirty- nine (67.24%), contained single prey remains, 10 (17.24%) contained two prey species, and 5 samples remained unidentified . Livestock remains were found in 32.74%(which include buffalo-20% and cow- 12.06%) and wild prey remains were found in 51.69% (chital- 24.13% , sambar-10.34% , nilgai) of the scats This deciphers that lion sometimes may prey on more than one species to fulfil the food requirement of the family.

b) Captivity : An adult lion can eat as much as 20 to 30 kg of flesh at a single meal. Exceptionally an adult healthy male may consume maximum of 35 kg. Generally in zoos t the scale of beef supply to each adult lion ranges from 8 to 12 kg per day (Table 30), six days in a week. According to Soni *et al.*, (1992), at Zoological Garden Junagarh (Gujarat) the average amount of beef consumed per day is 7.4 kg and 5.9 kg by a male and a female respectively. Based on this data they estimated that a lion would need 2,701 kg and a lioness 2,154 kg of beef per year. The diet regimen for the species being adopted at Zoological Park, Chennai (Basavaraju *et al.*, 1994) is mentioned below;

Food items	Male	Female	Remarks
Beef	10.000 kg.	10.000 kg	-

Milk	00.500 kg	00.500 kg	-
Liver	00.500 kg	00.500 kg	Twice weekly.
Live fowl	1 no.	1 no	Alternate day.

Apart from vitamin 'A' 2.5 ml, calcium 5 g supplement is also given to each animal. Drinking water is provided inside the room and yard every day.

Note. A study conducted in the foreign zoo showed that lions can digest grain based diets. The advantages were said to be, lower feed waste, elimination of refrigeration and freezing and storage requirements andavailability of choice of feeding of alternate diet.

(3) Leopard (*Panthera pardus*). (A) Conservation : The leopard is the most widely distributed large carnivore in the Indian subcontinent ranging from the Himalayas in the north to Sri Lanka in the south.

(B) Food (a) Nature : Leopards rarely prey on large herbivore species such as nilgai , sambar and wild buffalo. Leopard generally seizes its prey by the throat and kills. Sometimes it jumps on the back of quarry and then the prey is killed and it may be taken up onto the tree. Leopard may start feeding on its prey at the place of the kill. Leopards normally start feeding from the anus or pelvic region and have been described as dirty feeders because they invariably probe the stomachs. The tigers, on the other hand, remove the paunches (stomachs).Leopard avoids to face the tiger over the prey.

The leopard, like tiger, heavily preys on chitals (A. axis). According to a report, predation of langur is 15%, barking deer 11%, rodent 11% and of nilgai, goral and wild pig rare (Johnsingh *et al.*, 1993), Annual prey requirement has been estimated to be around 1000 kg.

Table 33 (a) : Frequency of occurrence of prey items in leopard scats

Prey	(a) Mundanthurai Plateau		(b) Gir Forests
	No. of scats	Percentage	Percent
Sambar	43	50.0	5.87
Hare	14*	16.2	4.59
Chital	8	9.3	27.74
Mouse deer	6	6.9	
Nilgiri langur	6	6.9	
Pangolin	3	3.4	
Monkey	2**	2.3	14.25
Wild pig	2	2.3	
Porcupine	2	2.3	7.24
Civet			4.60
Feral dogs			4.59
Peafowl			6.37

Livestock	6	6.9	12.50
Others			12.06

(a)Study from December, 1987 to April, 1988 by Sathyakumar, (1992).(b) Study by Srivastav, (1999).
* Black naped. ** Bonnet macaque

Results of analysis of 102 scats of leopard collected from different areas of Gir forest from September to December, 1995 described by Singh et al.,(1999) are as follows. Analysis showed scats contained remains of 28 % chital , 14.70 % monkey, about 10% peacock and 8% civet and sambar(fawn). Scats contained remains of single prey species in 48%, two prey species in 26.4% and 3 species in 7.4%. Livestock consumption was found to be only 7%.

(b) Captivity : Table 30 includes the diet for leopards being fed in various captive facilities. Most of the zoos feed 4.0 kg per adult per day. In Biological Park, Bhubaneshwar (Orissa) on an average each animal is fed with three kg of fresh beef with bones six days in a week and no beef is provided on Monday. But the pregnant and nursing pantheresses are provided with goat meat or poultry meat on Mondays in place of beef. Vitamins and mineral supplements are provided added to beef frequently.On the contrary diet chart of Mysore zoo prescribed feeding of 9.0 kg beef per adult per day.

(4) Snow leopard (*Uncia uncia*). (A) Conservation : The species inhabits high mountain range between 1500 m - 3000 m in India, Nepal and Bhutan. Its presence during hard winter at lower altitudes up to 500 m is not unusual.The species total population in Indian limits is reported to be around 500. In captivity Zoological Garden, Darjeeling had 9 animals on 31.4.1997 and Zoological Garden, Kufri (Himachal Pradesh) had one subadult female on 14.5.1999.

(B) Food (a) Nature : Majority of preys are killed by bites in the neck or by breaking the spine. Being nocturnal in habit, it kills its prey either in the early morning or in the very late evening and at times during day hours also in undisturbed areas due to its camouflaging and concealing ability. Eye sight and hearing are well developed in the snow leopard. Its main prey species are bharal/ blue sheep (*Pseudois nayaur*), shapu/urial (*Ovis orientalis*), nayan (*Ovis ammon*), markhor (*Capra falconeri*), ibex (*Capra ibex*), takin (*Budorcas taxicolor*), serow, (*Capricornis sumatraensis*), tahr (*Hemitragus jemlahicus*), goral (*Nemorhaedus goral*), musk deer (*Moschus moschiferus/ chrysogaster*), woolly hare (*lepus spoiostolus*), marmot and also birds. Snow leopard can subdue prey nearly 3 times its weight. Unlike the common leopard, the snow leopard begins eating its kill from the posterior portion of the body. The available reports evidence that an adult snow leopard on an average consumes about 4 kg meat of prey per day, if the prey species are abundant; otherwise it maintains itself on an average of 1.5 to 2.5 kg meat per day. Some plant material is also consumed by animal perhaps to keep its digestive system fit.

b) Captivity : Darjeeling zoo feeds mutton (with bones) 3.5 to 4.5 kg per adult per day and 2.0 to 2.5 kg per subadult six days in a week. Also one egg and Complan (Heinz Pvt Ltd.) 35 to 40 g are fed per day. The major portion consists of the hind limbs excluding hooves and ribs . One goat head with skin is also given to each

animal once a week. At the zoo, the animal consumes less food in rainy season but more in winter season. Special emphasis is given to provide vitamin A, vitamin D-3 and vitamin E with calcium supplement. In captivity the north American zoos feed a commercial "feline diet" usually consisting of ground meat (Horse) five days per week. This is supplemented with 1.5 chicken backs + large beef bones for two days per week (Bahuguna, 1996). It is reported that beef can cause diarrhoea and feeding with fowls may cause severe injuries in the alimentary tract.

(5) Clouded leopard (*Neofelis nebulosa*). (A) Conservation : Animal is a forest dweller and frequents solitarily except at the breeding time. It inhabits various hill forests at elevations ranging between 1425 to 3050 m. Its distribution is in tropical wet evergreen forests of eastern Assam to Manipur, Sikkim,Nepal, Bhutan and also in Taiwan and Myanmar. Species is nocturnal, mainly arboreal, but it also frequents on the ground. According to CZA report 1998, there were nine males and four females on display in seven Zoos. The species has bred in Zoological Park, Patna, Bihar.

(B) Food (a) Nature : Presence of strong upper canine teeth and strong jaw enables the animal to prey on comparatively large animals. In wild it preys upon small sized herbivores such as deer, pigs, porcupines, etc. Pieters (1976) recorded many instances of clouded leopard devouring monkeys on the ground after having killed them by inflicting a bite on the head There appears to be no other such report.

(b) Captivity : Mutton is preferred over beef. Fowls, pigeons, rabbits, if given alive, are relished much.

Table 33(b) : Diet for an adult clouded leopard (*N. nebulosa*) per day in captivity

Zoo/Safari	Mutton/Beef (kg)	Milk (ml)	Remarks
Zoological Garden, Darjeeling (WB)	2.00	-	-
Biological Park, Patna (Bihar)	2.5-3.0	500	Summer and rainy seasons
	3.0 - 3.5	500	Winter season
Zoological Park, Itanagar (AP)	1.25-2.0	500	Fasting ones in a week
Biological Park, Bhubaneshwar(Orissa)	1.75 kg	-	Mutton
Zoological Garden, Ahmedabad(Gujarat)	2.0-2.5	-	Fowl 2 kg given in addition

(6) Cheetah (*Acinonyx jubatus*). (A) Conservation : The Asiatic cheetah (*A. jubatus venaticus*) in India became extinct in 1952 and the IUCN Red Data Book 1990 has indexed the species as highly endangered.India has imported African cheetahs (*Acinonyx jubatus*) on several occasions with the sole objective of contribution in perpetuation of the species in asiatic region. But all efforts to maintain and breed them have proven fruitless so far.Four(2:2) cheetahs were imported in

1990 and the last of these four cheetahs died in 1995 (Arora, *et al.* 1999)

(B) Food (a) Nature : Principal foods of cheetahs are small antelopes(black bucks, gazelles/ chinkara), deer and birds.

(b) Captivity : At National Zoological Park,New Delhi fresh raw, tender beef (beef from adult and old animals causes diarrhoea) @ 3-4 kg per cheetah per day and dressed/undressed fresh fowl on the off day formed the diet. Diet was also supplemented with chicken essence, bone meal, vitamins and minerals at frequent intervals. . The foreign workers ascribe that cheetahs under three years of age shall be fed on daily basis. During the last two weeks of gestation and until the weaning of cubs raised by mother 250 ml to 500 ml milk per day also be supplied, added with vitamins and minerals.

(1) Caracal (*Caracal caracal*) : This cat looks similar to small lynx, but has a longer tail and slimmer body with broad head and tufted pointed ears. The cat depends upon its extreme agility to prey on birds, rodents, antelopes, etc. It is believed to rear its young ones in porcupine burrows, in the crevices of rocks or in the hollows of trees. Although certain zoos possessed this species in the recent past but they did not succeed in multiplying the species from conservation point of view.

Table 34 : Diet for an adult small wild cats in captivity

Name of the Zoo	Fowl/Mutton (kg)	Liver(kg)/Egg (No.)	Milk
Jungal cat (Felis chaus)			
Zoological Park, Sepahijala	0.500	-	-
Biological Park, Patna (Bihar)	1.000	-	250 ml
Zoological Park, Hyderabad(AP)	-/0.100	-/1 no.	100 ml
Zoological Park, Chennai(TN)	-/0.250	0.100 kg	100 ml
Zoological Garden, Jaipur(Rajasthan)	-/0.750	-	-
Leopard cat (*Prionailurus. bengalensis*)			
Zoological Park, Sepahijala			
Biological Park,	-	-	-
Patna(Patna)	0. 500	-	-
Zoological Park, Hyderabad(AP)	-/0.100	-/1 no.	100 ml
Zoological Park, Chennai(TN)	-	-	-
Zoological Garden, Jaipur(Rajasthan)	-/0.750	-	-

(2) Rusty spotted Cat (*Prionailurus rubiginosa*). (A) Conservation : It inhabits in certain pockets of southern India (western ghats), Madhya Pradesh, Gujarat and Jammu.

(B) Food (a) Nature : Grass lands, scrubs and jungles are the species dwelling areas. To some extent species is arboreal in habit. Not much is known about its feeding habits.

(b) Captivity: At present there is no specimen in any zoo of the country. Zoological

garden, Ahmedabad (Gujarat) has bred the species in its past. Dressed guinea - pig , rabbit, poultry fowl, or goat meat can be fed.

(3) Leopard cat (*Prionailurus bengalensis*). (A) Conservation : The leopard cat is exclusively an Asian animal that today has a wide geographical distribution in south east Asia. In the wild it frequents in solitary state. The animal is mainly nocturnal in habit and is hardly seen in the day time. Presently there are about 60 to 70 animals in captivity.

(B) Food (a) Nature : Species is generally regarded as being a notorious chicken-thief. In areas where human settlements and forests are juxtaposed, it is known to destroy poultry. It is an excellent swimmer and can climb trees with ease in search of its prey. Published literature indicates that its diet includes spectrum of prey species of small mammals up to the size of squirrels and hares. It is known to feed on lizards, amphibians, birds, rodents and even small deer.

(b) Captivity : Table 34 furnishes the diet being fed to leopard cat in captive facilities.

(4) Fishing cat (*Prionailurus viverrina*). (A) Conservation : Species inhabits thick jungles, scrub, grassy swamps, small rivers and tidal creeks. It is equally at home in estuarine mangrove, coastal back waters and inland perennial water- bodies. In 1997 existence of 13 specimens have been reported in various zoos.

(B) Food (a) Nature : Diet of the species consists of fish and fresh water molluscs. Small mammals and birds are relished too. There is scanty ecological information about the food habits of the species. To catch its prey it does not enter the water but remains meditated in crouching or over hanging position with acute focus on the prey. Then suddenly it scoops up the fish with a blow of its paw.

Study 1 : In Howrah district the major food of fishing cat has been found to be fish, although goats, chickens and ducks of the nearby villages were also killed (Bhattacharya,1989).

Study 2 : Haque and Vijayan (1993) have made the following observations:

- Fish remains were found in the scats throughout the year and out of the 144 scats analysed, 76 % had fish remains in them. Monthly variation in the percentage of scats having fish remains ranged from 41 % to 100 %. It was the preferred food during winter.

- Birds are the next preferred food (27%) of the fishing cats. During different months the frequency ranged from 13 % to 53 % although bird remnants were not present in the scats during January, May and June. Valid reason for the absence of bird remains during these months remained unexplicit.

- Grasses formed 21% of the food of fishing cat. It was present in all the months except August. The frequency ranged from 8% to 96% Among the three seasons grasses were preferred equally during winter and summer but least during monsoon.

- Insects and rodents were seen in relatively small number of scats 13% and 9% ,respectively. The maximum number of insects in the scats were in summer followed

by winter and the least in monsoon, while the maximum number of rodents were during monsoon followed by summer and the least in winter.

- Others items which formed 7% of the diet included seeds, hairs of hare and cattle, molluscs, scales of snakes and monitor lizards (*Varanus bengalensis*).

(b) Captivity : Fishing cat relishes beef, fish, chicken, pigeon and rabbit. The milk is also likened. On non - availability of beef/goat meat, fowls (poultry), pigeons or meat of laboratory rabbits can be fed.

Milk 200 ml, Egg. 1 no., Beef 0.400 to 0.5kg., Fish 0.200 kg. Live

Fowl on off day

According to Sanyal (1892) the adult animal also relishes land and fresh water snails.

(5) Golden Cat (*Catopuma temmincki*). (A) Conservation : The species ranges from Nepal to Assam and Nagaland extending into Myanmar and south eastern Asia. It is the most rare wild cat and its population census is required to be taken up by the experts. Presently Zoological Park, Patna (Bihar) and Zoological Garden, Guwahati (Assam) are the only facilities having one or two specimens of golden cat.

(B) Food (a) Nature : Species inhabits dense forests of the foothills of the Himalayas and the tropical forests throughout its range of distribution. It uses the hollows of trees for bringing up youngs. It lives among rocks and preys upon small mammals and birds.

(b) Captivity : Diets prescribed either is the past or present in some of the zoos are given as below .

i) Zoological Garden, Calcutta : Fowls, pigeons, rabbits and mutton (Sanyal, 1892).

ii) Biological Park, Patna (Bihar) : Dressed fowl 1.0 kg per adult per day.

iii) Biological Park, Bhubaneshwar (Orissa) : The zoo prescribed 750 g goat meat + 250 g beef with bones six days in a week. Only 375 g of goat meat on off day.

(6) Marbled Cat (*Pardofelis marmorata*). (A) Conservation : Its distribution is in Nepal in the north and in the eastern in India further extending into Myanmar and Malaysia.

(B) Food (a) Nature : Living in forests, arboreal and nocturnal in habits, it preys upon small mammals and birds.

(b) Captivity: At present there is no specimen in any zoo of the country and its diet formulation therefore, is not known.

(7) Desert cat (*Felis silvestris ornata*). (A) Conservation : Scrub waste land is the typical habitat of the species. The thickets of *Maytences emarginatus, Acacia modesta, Salvadora spp.* and those particularly of *Capparis decidua* provide suitable

hunts for desert cat. Thickets of *Tamarix diocia* and *Prosopis julliflora* also provide suitable habitat for the species.

(B) Food (a) Nature : The available published report entails that the cat largely lives on the desert gerbille (*Meriones hurrianae*). It also hunts hares (*Lepus sp*), doves (*Streptopelia decaocto* and *S. Senegalensis*), grey partridges (*Francolinus pondicerianus*), sandgrouses (*Pterocles exustus*), peafowls (*Pavo cristatus*) and bulbuls (*Pycnonotus spp*) in the jungles and the house sparrows (*Passeer domesticus*), rats (*Rattus spp*) and the blue rock pigeons (*Columba livia*), etc. in the agricultural fields (Sharma, *1979*).

(b) Captivity : Species status in captivity is not known.

2. Family : *Canidae.* The nutritional requirements of wild canids parrel those of the domestic counder species. Taxonomically all canids are considered carnivores but they are also omnivores and certain species use high percentage of plant material such as fruits, seeds in their diets . Wallach and Holf(1982) described that during gestation the caloric requirements of canids are 84 to 101 cal/kg body weight as compared to 79 to 92 cal/ kg b.w for maintenance. The lactation will need 136 cal/ kg b.w.during the first week and 275 cal /kg day for subsequent 8 weeks of lactation.. The present situation of surviving of offsprings of our native canid species in zoos is not encouraging. Therefore similar nutritional studies in our native canid species are warrented.

(1) Dhole/ Wild dog (*Cuon alpinus*). (A) Conservation: In the continent the dhole is found in India, Tibet and Nepal. The species occurrence is not reported from Sri Lanka. Of the nine subspecies recognized, three subspecies occur in India. They are *Cuon laniger* in Kashmir and Ladakh, *Cuon alpinus primaevus* in Garhwal, Kumaon, Nepal, Sikkim and Bhutan and *Cunon alpinus duknunesis in* south of the Ganges. The dhole found in the Namdapha area in Arunachal Pradesh could be *Cunon alpinus adjustus* from Myanmar (Johnsingh, 1997). Thus, dhole inhabits varied habitats. Kanha, Sariska and Bandipur National Parks are the important habitats of the species.

Presently Zoological Park, Chennai (Tamil Nadu) is the only one captive facility breeding the species in the country.

(B) Food (a) Nature : Wild dogs dwell in the dense forests and thick scrub jungles where there are abundant prey species. They are diurnal. Similar to wolves, wild dogs move and hunt in packs. Their number in a pack may be 20 to 30 comprising of young and adult individuals. Wild dogs do not bark but utter yaps/excited whispers when they sight their prey. They communicate with each other by peculiar whistling cries which can be imitated by blowing into an empty cartridge case. Artiodactylid species such as cheetals, sambars and pigs are the chief prey species. They run at tireless trot and nothing is safe from them. Even tiger, leopard, gaur or buffalo coming in the way is attacked. It is said that the sambar wallowing into a lake will be charged and drowned by simple pulling of the animal under water. They hunt in day time predominantly. Once they attack an animal, they never relax the persuit till the prey is exhausted, perplexed, shocked and victimised. They bite at the flank, above

the region of hock and at the face particularly on muzzle.Thus dhole is rapacious predator. A stag too is rarely able to escape. They start eating, hanging on to body of the quarry, often when victim is alive. They all feed peacefully on it. Every dog is on bolting as much meat as quickly as possible. Entrails are never eaten. Owing to their weak jaws, they do not crush the bones of any artiodactylid prey, and the prey skeleton is left completely devoid of any muscular mass. In case the fawn is killed, its bones and skin may be eaten alongwith flesh. Food requirement of an adult dhole is estimated to be about 680 kg per year. Johnsingh (1997) reported that dhole consumed maximum about five kilograms of meat, which was little over one fourth of its body weight . On an average, each dhole eats 1.8 kg meat per day. Being coursing predator it presumably needs higher energy expenditure per unit body weight in comparison to the felids which are stalking predators. The dhole needs water at least 2 to 3 times in a day. In Sariska National Park there has been a pack of dholes visiting the water body at least three times between 8 a.m. to 6 p.m. It is said that the bitch mother who stays with her pups, regurgitates to provide meat to her pups. Pups do not leave den until they are about 2 months old.

(b) Captivity :

Zoological Park, Vandalur, Chennai(TN)

Beef (without bone)	=	2.500
Liver	=	0.100
Chicken (Bi-weekly)	=	0.500
Milk	=	0.250

(2) Jackal (*Canis aureus*) : (A)Conservation : There is only one species inhabiting areas from foothills of the Himalayas to Kanya Kumari. It lives in forested regions as well as in open grasslands and scrub jungles. Only in the delta regions, it is absent (Sankhala, 1993).

Mostly it depends upon the food killed either by tiger or leopard. Jackal is fearful, wary and cautious about the tiger. At the kill site , it will quietly bide its time and in the event of the absence of predator impetuously rushes to feed upon the remains. Apart from scavenging habit, jackal preys independently on birds, hares, rats and fawns of sambar, chital, barasingha and chinkara and on disabled and old weak chitals too. Predation on piglets has been reported by Sankhala (1993). The ceraceous diet comes from the fruits of amaltas (*Cassia fistula*), ber (*Zizyphus jujuba*), jharber (*Ziziphus nummularia*) and jamun (*Syzigium cuminii*). Ripe mangoes and the ripe drupes of *Lantana* and *Zizyphus mauritana* are also eaten. Around human habitations, it feeds on kitchen wastes. Sometimes, it also preys on birds and when it approaches villages, attacks poultry.

Schaller (1970), in his studies on Nilgiri tahr (*Hemitragus hylocrius*), reported predation of new born tahr fawn by jackals(*C. aureus*) and wild dogs (*Cuon alpinus*). He had analysed 119 scats of droppings of jackals to determine food menu of the species in the area and his findings are mentioned below

Food items	Occurrence
Small rodents	44.4%
Lizards & snakes	29.4%
Crabs	10.0%

Insects	6.7%
Seeds	5.8%
Sambar hairs	2.5%
Snails	0.1%

Jackals living along the coastline are also reported hunting crabs during night along the forest shores (Krishnan, 1971).

(b) Captivity : Many zoos possess the species. Diet chart of Zoological Garden,Mysore shows feeding of only 1.000 kg chicken per adult jackal per day and Z.P. Chennai provides beef without bones.Table 35 mentions diet being fed in certain other captive facilities in the country.

Table 35 : Beef (in kg) per adult canid per day in certain zoos.

Name of Zoo	Jackal	Wolf	Fox	Remarks
National Zoological Park, New Delhi	2.000	4.000	0.500	With bone
Zoological Garden, Lucknow	1.000	2.000	-	Boiled
Zoological Park, Kanpur	1.000	2.00	0.500*	With bone * No bone
Zoological Park, Chennai	0.500 0.100 (liver)	2.000 0.500 (fowl)	-	No bone
Zoological Park, Hyderabad	1.000	1.200	-	No bone
Zoological Garden, Mumbai	1.000	-	-	-
Zoological Garden, Mysore	1.000 (fowl)	-	-	-
Zoological Park, Sepahijala	1.500	-	-	-
ZoologicalGarden, Jaipur	1.000	2.000	0.750	-
Zoological Garden, Junagarh	1.000	-	-	-
Zoological Garden,Auragabad	1.000	-	-	-
Zoological Garden, Itanagar	-	-	0.300	-
Biological Park, Patna	-	-	1.000	Fown on weekely off day
Zoological Garden, Calcutta	-	-	1.000	Bone less

(3) Wolf (*Canis lupus*). (A) Conservation : Two subspecies in India are *Canis lupus papillipus* and *Canis lupus chenco*.The former is found in Uttar Pradesh, Bihar, Madhya Pradesh, Gujarat, Karnataka, Ladakh and part of Kashmir.

(B) Food (a) Nature : Presently in the wild the population of the species is not much. When it sneaks into livestock grazing areas, it preys primarily on sheep and goats rather than other domestic species. In the deserts gazelle and blackbuck fawns are eaten. In Velavader National Park(VNP) blackbuck is the major prey (88.12%) and out side of the VNP prey includes livestock (35.86%) of wolf (Bharat Jethva, 1994-97). Foxes, hares and birds are prayed upon. Wolves prefer feeding on the hams, brisket and entrails in order. The flanks and hamstrings are reported to be the points of attack.

(b) Captivity : For diet schedule in different zoos see Table 35. Zoological Garden,Aurangabad prescribes diet for wolf cubs as follows.

Cub 2 to 6 months = 0.200

Cub 6 to 12 months = 0.500- 1.000

Zoological Garden, Mysore also prescribes diet for an exotic wolf species-manned wolf (*Chyscosyon bradjyurus*) as below.

Grapes = 0.200 kg Chicken = 2.500 kg Banana = 0.200 kg

(4) Red fox (*Vulpes vulpes*): Occurs in the country in areas from west Sikkim to western Himalayas, as well as in the deserts of the north western part.

(a) Nature: In the Himalayas it lives in brushwood and cultivated lands, while in the deserts among the sand dunes or in broad sandy beds of dry rivers. It is nocturnal and preys chiefly on rodents and also picks up scraps of discarded food and offal near human dwellings.

(b) Capitivity : Kanpur zoo feed chicken @ 0.50 g/adult/day

(5) Indian Fox (*Vulpus bengalensis*) : Inhabits open country in wastelands, scrub cultivations, rocky hills, etc.

(a) Nature: During the day it lives in self dug burrow and comes out at dusk. It preys on very small animals, particularly rodents and reptiles and also feeds on fruits.

(b) Captivity : In Zoological Garden ,Calcutta Sanyal (1892) prescribed boiled meet beef/mutton, eggs and plantains. Further see Table 35.

3. Family - *Hyaenidae*: It includes only one native species.

(1) Striped Hyena (*Hyaena hyaena*). (A) Conservation: Found more commonly in the drier parts(plains, deserts, rocks, scrub-covered, holes and nulahs, grassy jungles) of many states of the country. It is not an endangered species.

(B) Food (a) Nature: It is nocturnal and feeds on the animals that have died of disease or killed by larger beasts of prey.It also kills feral dogs and goats and sheep kids. It shares the coarser remains of refused food of other predators, hence is scavenger. Animal has large head and powerful jaws and is able to crush and ingest bones due to which its stools are hard and calcareous.

(b) Captivity : Diet being fed in certain zoos is entered in table 36.

Table 36: Diets (in kg) per adult per day for hyaena (*H. hyaena*)

Facility	Beef	Remarks
(i) Zoological Park, Chennai (TN)	2.500	Liver 100 g and chicken 500 g
(ii) NationalZoological Park, New Delhi	4.000	is fed additionally -
(iii) Zoological Garden Mumbai (Maharashtra)	2.000	-
(iv) Zoological Garden, Calcutta (West Bengal)	3.000	In winter 1 kg extra. Boneless to bone meat ratio 1: 2/3
(v) Zoological Garden, Ahmedabad (Gujarat)	1.5-2.000	-
(vi) National Park, Borivali, Mumbai	3.000	-

(vii) Zoological Garden, Mysore (Karnataka)	5.000

4. Family-*Ursidae*. The animals are capable of inflicting serious wounds with long claws but they are rather poor of hearing and sight. Animal often attacks when surprised. The bear may eat entrails first and then open the carcass ventrally to eat heart, liver and firm flesh parts. The sloth boar (*Melursus ursinus*) and Himalayan black bear (*Selenarctos thibetanus*) are the two main native species (each belonging to two separate genera) each adopted to different ecological conditions. In food habits both species are omnivorous. Hence, their food constituents in nature are varied. To prepare themselves for the winter sleep, the bears eat huge amounts in early period to build up fat deposits.Bears of 2-4 years of age are classed as sub-adult and above that are classed as adults.

(1) Sloth bear (*Melurus ursinus*). (A) Conservation: Species is endemic to India and Sri Lanka. It ranges from base of Himalayas to southern parts of India. In wild its census is not available. In captivity the total number of sloth bears may be around 100 individuals.

(B) Food (a) Nature : The sloth bear is an expert climber. It is truly omnivorous. It has poor eye sight and low sense of hearing but its sense of smell is peracute/ extremely good. Jungle fruits such as Jamun, ber, bel, species of *Grewia*, species of *Diospyres*, *Cassia fistula*, the flowers of mahua, honey, grubs, insects (specially termites) and the tender shoots of grasses are eaten (Krishnan, 1971). It is described that bears occasionally in the mornings and late evenings visit the cultivated fields in Himalayan foot hill areas and cause damage to potato and maize crops. Bear needs water frequently; hence remains around the perennial water source. On one occasion I have observed the bear visiting the water source during the hottest hours of the day three times in Dudwa National Park.Rajesh Gopal(1992) listed species natural diet items season wise **(Table, 37).**

Table 37 (a) : Food of sloth bear in Bandhavgarh National Park, M.P. (Rajesh Gopal, 1992)

Botanical name	Local name	Part eaten	Availability
Aegle marmelos correa	Bel	Fruit	May-June
Asparagus racemosus	Satawar	Root	August-December
Buchanania lanzan spreng	Chirongi	Fruit	April-May
Cassia fistula Linn.	Amaltas	Fruit	Nov.-Jan.
Cordia muza. Auct	Amaltas	Fruit	April-June
Curcume angustifollia	Muzal Mundi	Rhizome	Jan-Feb- July-Dec.
Diospros melanoxylon	Tendu	Fruit	April-June
Emblica officinalis	Aonla	Fruit	Nov.-Feb.
Ficus glomerata Roxb.	Receptacle	Fruit	May-June
Madhuca indica Gmel.	Mahua	Flowers, Fruit	March-June
Mangitera indica linn.	Wild Mango	Fruit	May-June

Peucedanum dnana Ham.	Bhojraj	Root	Sept-Dec.
Pimpinella hevneana	Tejraj	Root	Aug-Dec.
Semacarpus anacardium	Bhilwan	Recepticle	Jan-March
Syzigium cumini Gaertn.	Jamun	Fruit	June-July
Zizyphus jujuba Linn.	Ber	Fruit	Dec-Feb.
Z. oenoplia Mill.	Makoi	Fruit	Oct-Dec.
Other items ;			
Decayead flesh	Mans	Entire	Nov-Feb.
Honey	shahad	Entire	Feb-April
Ants	Chiti	Entire	Jan-April - June-July Oct-Dec.
Termites	Dimak	Entire	Jan-April - Sept-Dec.

(b) Captivity : Table 37(b, c) furnishes the diet being fed to bears in the different zoological parks/ gardens. I have found private owners- madaris feeding the bears with musk melon and water melon in the season. The usual diets being fed by the madaris consist of Roti (wheat, maize and bajara flour, rice), skimmed milk, milk, bhutta(Indian corn in season), fruits and vegetables.

Table 37 (b) : Diets for sloth (*M. ursinus*) bear per adult per day.

Food items	Z G, Gwahati	Z P, Jamshedpur	BP, Patna	ZG, Ahmedabad	ZG Thiruv.
Rice (cooked)	0.500	0.750	-	0.500	0.300
Bread	-	-	-	0.400	1.000
Flour	-	0.750*	70 roti	0.250	
Milk	0.500	2 lit	200ml	0.250ml	
Egg	1 no	-	-	-	
Sweet-potato	0.200	0.250	1.250	-	
Groundnut	-	0.100	-	-	
Banana	2 no	4 no	45no	-	0.250
Fruits(seasonal)	-	-	-	0.500	0.375
Carrots	0.100	-	1.250	-	
Pumpkin/ Cucumber	-	0.500	-	-	
Vegetables	-	-	-	2 .000	
Honey/	-	-	0.075	-	0.250
sugar/Jaggery	0.050	0.050	-	0.125	0.200

* Mixed flour= Gram+ maize + wheat.Otherwise wheat flour. Thiruv.= Thiruvananthapurum

Table 37 (c) : Diets for sloth bear(*M. ursinus*) per adult per day.

Food items	NZP, Delhi	ZP, Kanpur	B.P. Bhub.	ZP, Chennai	ZP, Chattbir
Ragi	-	-	-	0.250	-

Rice+gram (Grvel)	-	-	1.000 (Rice)	0.200 (3:1)	-
Khichri(Mung +rice ,1:1)	- -	- -	- -	- -	- 1.0-2.0
Egg	-	2 no.	-	-	-
Milk	0.500 ml	500 ml	0.100	0.500ml	0.250ml
Bread	1.000	0.800	0.200	2slices	0.500
Maize (Bhutta)	1.000				
Banana	3 no.	1.500.	0.250	-	0.300
Chikoo/grapes	0.500	-	0.200	-	
Carrot/		-	-	0.200	0.200
Beet root/Pine apple	0.250	-	-	-	-
Sweetpotato-boiled	0.250	-	0.250	-	-
Sweetlime	-	-	-	-	2no
Ber/Bel	0.100	1 no	-	-	-
Fruits seasonal	-	3.000	0.700	1.000	0.300
Tapioca	-	-	-	-	0.100
Green pea	-	--	0.100	--	--
Papaya/ sweetmelon	0.500	-	-	-	0.300
Vegetables	0.250	3.000	0.350	0.850	0.600
Radish/turnip Groundnut	- -	- -	- -	0.100 0.100	0.100 -
Jaggery/Honey	0.100	0.080 (Nov.Feb. weekly)	0.025	0.200	-

* In powder. Note. Alternative food item is not prescribed by the facility. Honey in winter

At Mysore zoo diet prescribed for an adult individual per day is: rice 300g, bread 2270g, milk 2.750 lit. banana 500g, egg 1 no , apple 335g, graps 325g and mou/ ora 200g.

Vanvihar Bhopal (Maclhya Pradesh) feeds following diet per adult per day. Rice 1.00, Milk 1.000, Wheat flour; 1.000, fruits and vegetables (sweet potatoes, cucumber Carrot, ber, etc.) 3.000 kg. and Jeggary 0.200 kg. The Total diet in nearly 6.0 kg.

(2) Himalayan black bear (*Selenarctos thibetanus*). (A) Conservation: Species inhabits from Kashmir Himalayas to Assam. In summer it dwells between 3050 and 3660 metre altitudes and in winter comes down to the lower valley at a height of around 1225 m. Its exact population in wild is yet not censused. In captivity the number could be around 150 individuals in different zoos.

(B) Food (a) Nature: The food comprises mainly of fruits and insects which it seeks in dark. Being the most carnivorous of bears, it has been known to kill domestic animals (sheep, goats) for subsistence. Preter (1971) stated that black bears are primarily nocturnal. Schaller (1969) examined 82 droppings of the black bears and his observations were as follows.

Black bears obtained much of their fruit by climbing onto trees, sometimes into the upper branches 10 or more metres above the ground. They were also found active during the day time in Dachigam Sanctuary.

The most important foods were *Celtis australis* (40%), valnuts (32.9%) and acrons (12.1%).

In the early October, walnuts and acorns were prominent in the diet, but by late October, when these two species had been largely eaten up, the bears switched to Celitis, a pea sized fruit ripening at that time.

Scattered apricot and apple trees and grape vines grow in the fields bordering the sanctuary, Only one dropping contained the fruits of wild rose even though they were abundant.

(b) Captivity. See **Table 38 .**

Table 38: Diet for Himalayan black bear (*S. Thibetanns*) per adult per day in certain zoos

Food items	ZP, Hyderabad	ZP, Chennai	ZP, Chattbir	NZP, Delhi	BP, Bokaro
Ragi cooked	-	0.150	-	-	-
Rice+gram	0.200	0.200	-	-	0.800
Rice+Mung* (1:1)	-	-	1.000	-	-
Bread	2.800	2 salices	0.200	1.000	0.700
Milk	1.0 lit	500ml	500ml	500ml	500 ml
Maize	-	-	0.250 (Roti)	-	-
Banana	2 nos	-	-	3no	4 no
Sweet lime	1 nos	-	-	-	-
Fruits	1.000	0.550	0.700	0.500	0.250
Tapioca	-	0.100	-	-	-
Tomato	0.250	-	-	-	-
Carrots	0.250	0.100	0.100	0.250	0.500
Radish/Beet	-	0.100	-	-	-
Root/Potato	-	-	-	0.200	0.250
Sweet potato	-	-	-	0.250	0.500
Brinjals	-	-	0.500	-	-
Cucumber	-	0.250	-	-	-
Groundnut	0.050	-	-	-	-
Ber	-	-	-	0.100	0.020
Honey (twiceweekly)	-	0.100	-	-	-

Zoological park Itanagar (Arunachal Pradesh) prescribed following diet (food items in kg). Wheat flour: 0.700, banana 1.000 nos; sweet potato 0.400, milk powder 0.020, mango 0.200, pumpkin 0.400, pine apple 0.200, cucumber 0.600, naspati 0.300, oragne 0.200, green pea 0.100, tomato 0.250, carrot 0.250.

The total diet given per adult per day is nearly 5.0 to 5.500 kg. seasonal replacement substitute for vegetable items have not seen indicated.

(3) Himalayan brown bear (*Ursus arctos*). (A) Conservation : It inhabits grassy slopes above the tree line, close to the snow in western and central Himalayas. In winter it hibernates and remains torpid until the spring.

(B) Food (a) Nature: Generally it is regarded as omnivore. Its diet includes a wide variety of foods like young sprouts of grasses, herbs, tubers, wild fruits, nuts, honey, insects and various species of rodents. At times it kills larger animals such as sheep, goats and ponies and unusually animals even of its own species. All such incidences are occasional and accidental.

(b) Captivity. Table 39(a) includes diet compositions being formulated in various captive facilities.

Table 39 (a) : Diet for brown bear per (*Ursus arctos*) adult per day

Food items	ZP, Chattbir	ZG Mysore	ZP, Chemmai	ZP Hyderabad	ZP, Kanpur
Ragi	-	-	0.520	-	-
Bread	1.000	2.270	5(slices)	3.500	-
Egg	-	2 no	-	-	-
Milk	0.500	2.750	500 ml	2 lit	-
Rice	1.000	-	0.500	-	-
Maize	0.500	-	-	-	0.300
Vegetables:					
Tubers	1.000	-	0.500	0.100	-
Brinjal	-	-	-	-	-
tomato	-	-	-	-	-
Pototoes	-	-	-	-	-
Carrots	-	-	-	-	-
Vegetable	-	-	-	-	0.500
Leaves					
G. nut	-	-	0.500	-	0.250
Fruits(seasonal)	0.700	0.960	0.250	0.500	-
Huney/Gur	-	0.300	0.100	2 no	0.100

Mysore zoo also feeds 500 g beef. Banana included in fruits items.

(4) Malayan sun bear (*Helarctos malayanus*). (A) Conservation : This is the smallest of the eight species of bears known in the world. It inhabits the hilly forests of north - east states of the country - Manipur, Mizoram, Meghalaya, Nagaland and Assam (south of Brahamputra). It also occurs in the central Himalayas among the bare peaks above the tree line.

(B) Food (a) Nature : Malayan bear is an arboreal frugivore and folivore. Fruits, grasses and tubers are taken from the ground. Animal is equipped with powerful claws, which make it an agile climber and it searches for fruits, buds, insects, and other small prey. It is said that in the wild, the animal is active chiefly at night. During the lean period it resorts to killing small mammals such as sheep or goats for subsistence.

(b) Captivity : Population of this species is poor in ex-situ facilities.Table 39 (b) furnishes diet for the species.

Table 39 (b). Diet per adult Sun bear (*H. malayacinds*) per day

Food items	ZP, Hyderabad	ZG, Mysore	NZP, Delhi
Milk	1.0lit	2.750	0.500
Bread	20(slices)	2.270	1.000
Egg	-	2 no	-
Rice	-	1.6	-
Fruit (Seasonal)	0.400	0.960	*
Banana	1 no	0.500	3 nos
Carrots/Beet root	0.500	-	0.250
Tomato/Water melon	0.250	-	0.500
Potato	-	-	0.250
Cucumber	-	-	0.250
Mou/ora	-		0.300

* Seasonal fruits also given. Note. Mysore zoo also prescribes the same diet to its Himalayan black bear.

5. Family - *Procyonidae.*

(1) Red Panda/Cat bear/lesser panda (*Ailurus fulgens*). (A) Conservation : The species is highly endangered. Its home range is eastern Himalayas at elevations from 1500 to 3500 M. Besides Arunachal Pradesh (Namdhapa) the existence of the species is reported in Neora valley, Kalimpong, Sikkim (Kanchanjanga). Zoological Garden, Darjeeling is assigned a project for breeding of red panda. Presently, this zoo has about 10 individuals.

(B) Food (a) Nature : Nocturnal in habit, it sleeps during the day on trees. It has prominent sense of smell than sight and hearing. Usually frequents solitarily but frequentig in pairs is not uncommon. Mostly remains active from dusk to dawn. The young ones remain with parents till another brood is about to appear. Species is herbivorous through necessity and omnivorous by opportunity. In the wild, staple food of red panda is bamboo which accounts for 95% of its food. Chakraborty (1995) mentioned fruits and berries as the main food items of this animal in wild. It is also reported to eat small mammals, birds, eggs, blossoms and berries.

(b) Captivity : The Red panda's nutritional requirements are nearly like those of dog except that the red panda has greater requirement for high cellulose fibres, hence they need high bulk diets (heavy jaws supported with strong masseter muslces). The zoos feed bamboo leaves. Additional items vary, however. Usually a gruel is formed and given such as Sooji (of wheat) with milk or rice with milk. Most of the zoos give some fruits such as apple, banana, grape, chikoo, guava, etc. and specifically mention vitamin supplements. Extra protein source and boiled egg are also given

Diet : Recommendations on red panda diet by working group in the Training Workshop on Conservation and Management held at Darjeeling zoo in April, 1995 are reproduced hereunder.

(i) Red pandas should be provided with a nutritionally balanced diet.

(ii) Dietary ingredients should be fresh and of good quality. Every effort should be made to avoid spoilage of the food during warm weather.

(iii) Red pandas should be fed at least two times in a day. Old remaining food should be removed from the exhibit when the new fresh food is presented.

(iv) Under normal circumstances red pandas should not be provided with gruel/ porridge. The exceptions to this are points 9 and 10 below.

(v) In order to monitor food uptake and prevent disease it is recommended that food be presented in such a way that it is inaccessible to vermins.

(vi) Food consumption should be monitored closely and adjustments made in accordance with the number, size, weight and nutritional condition of the animals.

(vii) Red pandas be supplied more food in the winter months, during pregnancy, lactation and growth to the extent that at least 3% of the total is left uneaten.

(viii) Food should be offered in more than one bowl and at several locations.

(ix) Red pandas which are not taking their food can be tempted to eat by sweetened gruel/porridge. It is important that the sweetener/gruel is withdrawn from the diet as soon as possible to avoid dental problems.

(x) Young pandas around the time of weaning (5-7 months old) are susceptible to death through starvation. The animals which are not eating enough should be provided with sweetened gruel/porridge and extra bamboo at this time. They can then be weaned onto the normal diet gradually.

(xi) Bamboos should be provided daily.

(xii) Animals with restricted water intake will also have decreased food intake.Therefore, sufficient fresh water must be available to all animals at all times of the day. Sturdy ceramic bowls are suitable for providing water as they are not easily tipped over.

Table 40 (a). Diets prescribed for red panda in (*A. fulgens)* zoos

(i) Zoological Garden, Darjeeling

a) Conventional diet(without supplement of vitamins)		**Diet of red panda w.e.f.1996 (No349/tech/Diet/PNHZPARK 16-6-1999)**	
Semolina (Suji)	0.075 kg	Sugar	20 g
Sugar	0.050 kg	Milk	1 lit
Egg	1 no	Carrot	0.200 kg
Condensed milk	0.300 kg	Papaya	0.200 kg
(make it 1.5 lit. of milk)		Protemex	0.010 kg
Bamboo leaves	3.000 kg	Apple	0.400 kg
		Banana	3 pcs
b) Improved diet w.e.f. 1995		Egg	2 each
Semolina (Suji)	0.075 kg	Bread	0.015 kg
Sugar	0.0 50 kg	Bamboo leaves	2.000 kg
Egg	2 nos		
Milk (powder)	0.300 kg	For the new borns (two)	

Bread	0.015 kg		
Corn flakes	0.010 kg	Egg	1 pc
Vitamin and mineral supplement		Carrot	0.100 kg
Vit A	60000 IU	Papaya	0.100 kg
Vit D	1000 IU	Protemex	0010 kg
Vit B1	10 mg	Apple	0.100 kg
Vit B2	10 mg	Banana	1 pc
Vit B6	3 mg	Bamboo leaves	1.000 kg
Vit B12	15 µ		
Vit C	150 mg	Diet for the newly arrived panda	
Vit E	225 mg		
Calcium pantothnate	16.30 mg	Papaya	0.200 kg
Calcium phosphate	129 mg	Carrots	0.200 g
Magnesum oxide	60 mg	Apple	200 g
Ferous Sulphate	32 mg	Banana	3 pcs
Mangnesium Sulphate	2.03 mg	Eggs	2 pcs
Copper Sulphate	3.39 mg	Cornflakes	0.020kg
Zinc Sulphate	2.20 mg	Milk	150 ml
Protein supplement	10 g	Bread	0.015 kg
		Honey	0.010 kg
		Bamboo leaves	0.800 kg

Note : The diet is given twice a day. The quantity of sugar is reduced and eventually replaced by honey. Milk and protein supplements also to be discontinued in due course of time (Chakraborty, 1995).

Table 40 (b) : Target nutrient levels for red (*A. fulgens)* pandas

Nutrients	**Recomended minimum level**	**Estimated level of diet for: Rasident Panda**	**New Panda**
Crude protein	18.0%	14.32	2.42
Carbohydrate	-	34%	11.6
Fat (EE)	5.0%	13.5%	2.4
Fibre (ADF)	10.0%	Not estimated	No estimated
Calcium	0.75%	0.81%	0.46%
Phosphorous(P)	0.6%	0.63%	0.1642%
Sodium (Na)	0.15%	Not estimated	Not estimated
Potassium (K)	0.65%	Not estimated	
Magnesium (Mg)	0.1%	10.90	
Iron (Fe)	100.0 OPPM	5.81 %	
Copper (Cu0	8.0 ppm	61.63%	
Maganese (Mn)	40.0 ppm	0.36%	
Seledum (Se)	18 ppm	Not estimated	
Zinc(Zn)	50.0 ppm	0.04%	
Thiamin	2.5 ppm	1.81%	
Riboflarin	5.0 ppm	1.81%	
Vitamin B6	2.0 ppm	0.54%	
Vitamin B12	30.0 ppm	2.72%	
Niacin	30.0 ppm	Not estimated	

Folate	600.0 ppm	Not estimated	
Biolin	100.0 ppb	Not estimated	
Choline		1250.0 ppm	Not estimated
Pantothenate	15.0 ppm	Not estimated	
Vitamin A	8000 IU/Kg	9090 IU	
Vitamin E	220 IU/kg	45..5%	
Vitamin D	800IU/kg	181.8IU	

NB: all calculation done in terms of 100 gms of leed given to Pandas

Table 40 (c) : Nutritional composition of different feed stuff for red panda (*A. fulgens*).

Food items	Moisture	Carbo.	Protei	Fat	Mineral	Fibre	Energy	Ca	P
Apple	84.6	13.4	0.2	0.5	0.3	1.0	59	10	14
Papaya	90.8	7.2	0.6	0.1	0.5	0.8	32	17	13
Carrot	86.0	10.6	0.9	0.2	1.1	1.2	48	80	530
Banana	70.1	27.2	1.2	0.3	0.8	0.4	116	27	36
Egg	73.7	nil	13.3	13.3	1.0	nil	171	60	220
Skimmed Milk	4.1	58.9	16	18.5	6.8	nil	19.5	580	440
Honey	20.6	79.5	0.3	00	0.2	nil	319	5	16
Shoots	88.8	5.7	3.9	0.5	1.1	nil	4.3	20	60

(i) Zoological Park, Itanagar (Arunachal Pradesh): During 1993 zoo had received a red panda from wild. The animal in captivity adjusted well, on diet consisting of milk, bread, apple, banana, sweet potato, orange and bamboo shoots. During summer it was feeding less. After couple of months due to certain technical dificulty faced by the zoo the panda was released back into wild in the Eagle Nest Wildlife Sanctuary.

(ii) Zoological Garden, Calcutta (West Bengal): Presently the zoo does not have any specimen. According to Sanyal (1892), red panda eats plantains, dates, bread, milk, bamboo leaves and sprouts, grass, eggs and small birds (sparrows).

(iii) Biological Park, Bhubaneshwar (Orissa): Presently, there is no specimen in the zoo.

The zoo used to feed semi-liquid cooked food which consisted of champion oats, wheat flour (Sooji), sugar, eggs, cut pieces of apples and oranges, grapes and sufficient quantity of succulent bamboo leaves. The diet was supplemented with vitamins. Boiled water was given for drinking. (Acharjyo and Patnaik, 1990 b).

(iv) Zoological Garden, Jaipur (Rajasthan): Though the Zoo is not permitted to keep the species, it prescribes the diet for the species as follows.

Horlicks	0.025 kg
Oat powder	0.025 kg
Bamboo leaves	0.500 kg
Fruits & Veg.	0.100 kg
Wheat flour	0.250k g
Milk	500 ml

(v) Zoological Garden, Guwahati (Assam): Presently, the zoo does not possesses any specimen. However, its animal diet chart includes the following diet for the red panda.

Cooked rice	0.250 kg
Milk	0.250 kg
Egg	1 no
Banana	6 nos
Sugar	0.025 kg
Carrot	0.050 kg

(vi) Sundervan Nature Centre, Ahmedabad (Gujarat): The centre had a female red panda (*Ailurus fulgens*) which died at the age of approximately 14 years on 10 February, 1998. The red panda was kept in an air - conditioned enclosure, which had an average temperature of 27-32°C. The enclosure, measured 4.2 m x 2.8 m x 17 cm (14' x 9.5' x 7") in dimensions, with wooden walls and ceiling. Since after arrival in 1983 the animal was fed four times a day. Its morning diet consisted of 250-350 grams of chopped apples and about 100 grams of fresh bamboo leaves. The same quantity of apples and bamboo leaves were provided at noon. This was followed by about 1 litre of milk with 50 g of sugar in the evening and about 200-250 grams of cut pieces of apple in late evening at 7 p.m. The only other ingredient to this diet added was grapes during every summer. The above vegetarian diet regime was maintained for the last 5 years and perhaps even before, though no meat or egg was provided. The animal once caught and ate a captive ringed parakeet.

6. Family : *Viverridae.* Food habits of only 8 species are discussed.

(I) Binturong (*Arctictis binturong*). (A) Conservation : The species inhabits forests of Assam, Arunachal Pradesh (Namdhapa National Park), Sikkim (Khangchendzonga National Park), Nepal and Malayan regions.

(A) Food (a) Nature : It dwells in dense forests and is mainly arboreal and nocturnal. The earlier inquisitions showed that its diet in nature consisted of small mammals, birds, fishes, earthworms, insects and fruits. However, presently it is recognised that the species is vegetarian and thrives well on the various foods which mainly include fruits.

(b) Captivity : The animal is rare in captivity. The kinds of foods prescribed by different captive facilities are detailed in table 41.

Table 41 : Diets prescribed for binturong (*Arctictis binturong*) in some zoos.

Food items	NZP, Delhi	ZG, Guwahati	ZG, Mysore	ZP, Chennai	ZP, Itanagar
Beef	-	-	0.100	0.250*	0.200
Rice	-	0.250	-	-	0.500
Milk	100 ml	250ml	1.0 lit	-	0.020 **
Bread	0.100	-	0.100	-	-
Egg	1 no	1 no	1no	-	-
Banana	10 no	6 no	0.100	6 no	0.250
Papaya	0.100	-	-	-	-
Grapes	-	-	0.100	-	-
Apple	0.100	-	0.100	1 no	-
Naspati	-	-	-	-	0.200
Carrot	-	0.050	-	0.100	-
Sugar	-	0.025	-	-	-
Potato (sweet)	-	-	-	-	0.200

Orange/ Mango/ Guava	-	-	-	4 no	0.200
Tomato	-	-	-	0.100	-

Note: N = National, Z= Zoological P= Park, G = Garden. * Calf beef 250 g additional once in a week. ** Milk powder. Substitution with seasonal fruits is not uncommon.

The diet described by Sanyal (1892) for the binturong in Zoological Garden, Calcutta, (WB) included boiled beef/mutton, eggs, small birds, fruits, bread, boiled rice, biscuits and milk. The regimen is mentioned below.

Fore noon :	Evening:
Plantains/palm dates/ fruits 8-12 nos bread/little	1/2-1 lb boiled meat with bits of boiled rice.

Note: i) Eggs, small birds, or insects occasionally as a change of diet. ii)Some individuals prefer fruit diets.

Zoological Park Sepahijila (Tripura) prescribes diet consist of 6 number banana (600 g), mixed fruits 150g and vegetable 600 g.

(2). Common palm civet (*Paradoxurus hermaphroditus*). (A) Conservation : The toddy cat, so called from its tendency to drink the sweet juice from the pots of toddy tappers (the name palm civet has much the same derivation), is much more arboreal, though it also hunts prey on the ground. It is nocturnal.

(B) Food (a) Nature : Common palm civet preys on rats, birds (raid their nests) and squirrels. In day time it sleeps in a hole or between branches of tree.

(b) Captivity : Diets for the common palm civet per adult per day in certain zoos are mentioned in the table 40(a,b).

Table 42(a) : Diet per adult plam civet per day in certain zoos

Food items	NZP, Delhi	ZG, Mumbai	ZP, Chennai	ZG, Mysore	ZP, Chattbir
Milk	350 ml	250 ml	50 ml	100 ml	-
Bread	0.250 kg	-	-	0.100 kg	-
Beef/	-	0.200 kg	0.150kg	-	0.500kg
Chicken	-	-	-	0.100kg	1 no
Eggs	-	1 no	-	-	1 no
Banana	3 no	-	1 no	0.100kg	-
Papaya	0.050kg	-	-	0.100kg	-

Table 42(b) : Diet per adult palm civet per day in certain zoos

Food items	ZP, Itanagar	ZG, Nainital	ZG, Aurangabad	BP, Bhuba neswhar
Beef	0.100	0.250	0.500	0.050
Banana	0.800	0.200	0.100	0.200
Sweet Potato	0.200	-	-	-
Naspati	0.100	-	-	-
Milk	-	-	-	0.005
Snail(without shell)	-	-	-	0.050
Fish	-	-	-	0.100

(3) Small Indian civet (*Viverricula indica*). (A)Conservation : It is found in the plains as well as in the hilly forests, plantains, scrub jungles and is usually seen singly in the vicinity of villages. Although it climbs trees, it is always seen on the ground. In captivity many zoos exhibit the species.

(B) Food (a) Nature : In addition to feeding on small animals and berries it preys on insects like beetles and grass hoppers.

An adult civet while crossing the road near Delhi was runover by a vehicle. The carcass was collected and brought to I.V.R.I., Izatnagar (U.P.) and subjected to recropsy examination. Also collected ingesta from its alimentary tract and analysed. Results are mentoned as below.

Contents	DM	CP	EE	T-CHO	Ash
Stomach	18.95	37.81	9.96	45.66	6.57
Intestinal	8.06	39.08	3.16	50.32	7.45

(b) Captivity: Many captive facilities maintain small Indian civet successfully on the diet: Bread = 100 g; Milk = 100 ml. Banana = 150 g, Chicken/Goat meat = 100 g and also one boiled egg.

(4) Large Indian civet (*Viverra zibetha*). (A) Conservation : Prater (1971) described its occurrence in Sikkim ,Assam and upper Bengal and its distribution is in all the adjacent countries. There is need to conduct its distribution surveys in Himachal Pradesh, Uttar Pradesh, Bihar, Orissa and Rajasthan (adjoining the areas of Haryana and Delhi) .In Arunachal Pradesh it is found in the plains as well as in the hill forests, plantations and scrub jungles, and in the vicinity of villages, it is usually seen singly (Choudhury, 1998).

(B) Food (a) Nature : Animals are active in the very early morning and late evening but sleep in day time. In nature large Indian civet eats land and fresh water snails, frogs, lizards, eggs and small birds. Prater (1971) described that like most carnivores it feeds on any thing worth killing, as such its food may include snakes, frogs, crabs, and even insects. Fresh small live fish are also eaten. Equally addicted to a vegetable diet. Berries, fruits and roots provide seasonal supplement to its animal food.

(b) Captivity : In captivity its diet includes mainly bread, milk and beef(minced), boiled rice, boiled egg, banana. Table mentions diet being fed in some zoos.

Table 43. Diet per adult/day for civet

Food items	Z G, Calcutta	Z P, Chennai	ZG Mysore	Z P, Hyderabad	Z P, Ita nagar
Milk		500 ml.	100ml	100 ml	
Bread	+	Slices	0.100	2slices	-
Beef /Goat meat*	0.680	0.150	0.100	0.100	0.100
Fish**				0.100	
Sweet Potato					0.200
Fruits					0.300
Banana	8-12no	1 no	0.150	1no	0.800

Note : *Kima ** Karandi Sanyal, (1892) + Biscuit or bread to be given as substitute for plantains/

bananas. Note. Sepahijala Zoological Park (Tripura) feeds 500 g dressed poultry meat and Rajasthan zoos feed beef 750 g per adult animal per day.

(5) Malabar civet (*Viverra megaspila*). (A) Conservation : The Malabar civet is a medium sized carnivore somewhat similar to the more common small Indian civet (*Verricula indica*) and the toddy cat (*Paradoxurus hermaphroditus*) but differs from them mainly in being much bigger and in having a crest of hairs along the back and a bushy tail ringed by five incomplete white bands. The available records allude its distribution throughout the Malabar coast from the latitude of Honore (Honnavar, N.Kanara district,) in Karnataka to Cape Camorin and further to north Kerala. It usually dwells among bushes and thickets in richly wooded lands (rarely in trees).

(B) Food (a) Nature : It hides during the day time and seeks its food at night, which consists largely of rats, shrews and poultry (when available). It also eats fruits like berries. Thus, the diet is almost the natural same as that of large Indian civet cat.

(6) Himalayan/ Masked palm civet (*Paguma larvata*). (A)Conservation : Less abundant than the toddy cat. Its distribution ranges from western to eastern Himalayan states of the country. One of the three races is also found in Andaman Islands.

(B) Food : Species is omnivorous. It subsists on fruits, small animals and birds, therefore, it searches its foods on trees as well as on ground.

(7) Small- toothed palm civet (*Arctogalidia trivirgata*). (A)Conservation : Not much is known about the species conservation status and natural food habits. A report describes its existence in Arunachal Pradesh (Choudhury, 1998) and is also not uncommon in Mizoram.

(8) Spotted linsang (*Prionodon pardicolor*). (A) Conservation : Rarest of all the civets. It may occur in the forests of foot- hills and hills of north-east states of the country.

(B) Food : Not well studied.

7. Family : *Mustelidae*. Many genera are included in this family. Otter species are important and encompassed by two genera. About badgers, weasels, ratels and martens substantial information about their natural diets is not available. Probably, this is the reason that zoos are not able to maintain them regularly. In general diet should contain animal protein 35 to 40% , fat content 20 to 25%.The ash content of the diet be 7 to 8%(Wallach and Half, 1982).

A. Otters : There are three otter species in the country.

(1) Common otter (*Lutra lutra*). Found in Jammu and Kashmir, Himalayas, Assam and in the peninsula except in South India (Prater, 1971). And also in some parts of Europe and North Africa.

(2) Smooth coated otter (*Lutra perspicillata*). The species dwells in the hills (not in higher hills and mountains) and plains in rivers, lakes , marshes, pools and ponds throughout the country from the Himalayas to the extreme South. In 1999 about 14 to 16 adult individuals were present in captivity in the country. Outside India limits the species is found in Myanmar, Southern China and Malay.

(3) Short clawed/clawless otter (*Aonyx cinerus*). Found mainly in the plains and

Himalayan foot hills including those of the Namdapha National Park. In 1994-95 there were about 45 specimens in various zoos in the country.

(B) Food. (a) Nature : Smooth Indian otters (*Lutra perspicillata*) inhabiting in the dry lands of Central India, when pools and streams dry up adapt well to changed conditions. Fish is the staple diet of these animals. Besides fish they feed on frogs, crayfish, insects, fresh water turtles and birds. All these animals need protein as an energy source from food; hence they produce more waste nitrogen and sulphur compounds causing their urine to be concentrated.

(b) Captivity : There is no substitute to providing daily diet of live fish. However, when there is problem of regular supply of live fish, fresh, dead fish can be offered. In such circumstances live fish is given at least twice a week. Poultry chicks 2-3 days old per head will be advantageous. Feeding of freshly grated carrots in small quantity mixed with one raw egg is recommended to maintain the body coat.

Table 44. Diet per adult otter per day in certain zoos

Food item	Zoological Park Chennai (A.P.)	Gharial Rehabiltation Centre, Kukrail (U.P.)	National Zoological Park, New Delhi
Fish	1.500 kg	1.25-1.500kg	1.500kg
Crab	0.300kg (twice weekly)	-	-
Sardine/maeril	1.500 kg (once in a week)	-	-
Carrots	-	0.100-0.200kg	-

B. Badgers and ratels:

(1) Hog - badger (*Arctonyx collaris*). (A) Conservation : Of all the badgers and ferret badgers, hog badger is widespread in the forests as well as in well - wooded parts of the country side. According to Prater (1971) no true badger species exists in the country.

(B) Food (a) Nature : Not much is described about the natural food of hog-badger. It is omnivorous.

(b) Captivity : Presently, perhaps no zoo possesses this species.

Sanyal (1892) had prescribed it's diet as follows.

Morning : Plantains/other fruits and some quantity of bread.

Evening : 0.454-0.900 kg(1-2lb) of boiled meat.

(2) Ferret Badger (*Melogale spp.*). (A) Conservation : Wilson and Reeder (1993) stated that range of Myanmar(*Burmese*) ferret badger (*Melogale personata Geoffroy*) extends from Nepal and through India (Assam) to most of Indochina including Peninsular Thailand and Malaysia. It has been reported to occur in West Bengal by Agrawal *et al.*(1992) and Chakraborty and Bhattacharyya (1999). It is also to occurs in the foot hills in the grass lands of north - east states. During the visit to Mizorum on 25th September 2000 author has also confirmed species presence in the state.

(B) Food : Species has the habit of burrowing and feeding during night. A sow

ferret badger received from the wild was supplied ad libitum tubers, fruits, grams, sugarcane and honey but refused to eat. When the eggs were broken and offered, the ferret badger ate the contents with relish. Animal also regurgitated and ate again the regurgitated matter. The animal also ate frogs, toads (live), lizards and chopped meat but it liked earthworms more than others (Ramakantha, 1992).Food like cooked rice, gourd, and fish are also eaten by the species (Chakraborty and Bhattacharyya ,1999).

Note : The European badgers are carnivores.

(3) Ratel / Honey badger (*Mellivora capensis*). (A) Conservation : It ranges from Himalayas to Cape Camorin. It is omnivorous. To see this creature in the forests is difficult owing to its predominantly nocturnal habit of preying. Its food includes insects, small birds, mammals, honey and small fruits. Some reports also mention that it eats reptiles. There are very few zoos which maintain ratel. Diet being fed in captivity is detailed in table 45.

Table 45 : Diet per adult ratel (*Mellivora capensis*) per day

Food item	ZP, Itanagar	ZG, Mysore	ZG, Ahmedabad	B.P,Bhuban-eshwar
Honey	-	-	-	0.020
Bread	-	0.250	2 slices	-
Beef	0.100	0.500	-	0.400
Goat meat	-	-	-	0.200 +
Rice	0.250	-	-	-
Milk	0.020	0.200	50ml	-
Powder	-	-	-	-
Banana	0.200	0.200	-	0.200
Papaya	-	-	0.250	-
Bone(with marrow)	-	-	1 piece	-
Chiken	-	-	-	1.500 *
(last Monday)				

Note:(i) Instead of beef, every Monday half the quantities of beef and goat meat are given.(ii) Z=Zoological, B=Biological, P=Park, G=Garden. *=Last Monday, += On every Moday only 100g

Note : In New York Zoological Park chopped raw dog meat, bone meal, cod liver oil, fruits, vegetables and, at times, rat or chicken and honey are fed (Crandall, 1965).

C. Weasels and Martens : They have hardly been maintained in captive facilities. Himalayan yellow throated marten ranges from Himalayan west Kashmir to North eastern states and Nilgiri marten in the Nilgigri hills and south Coorg..

(1) Himalayan Yellow throated marten (*Martes flavigula*). It is larger than stone or beech marten (*Martes foina*).

(2) Yellow bellied weasel *(Mustela kathiah).* It occurs between altitvied of 1000

to 2000 m but in winter may descend to below 1000 m.

(3) Himalayan / Siberian weasel (*Mustela sibirica*). It occurs above 2400 metres.

(4) Striped backed weasel (*Mustela strigidorsa*). Found between hilly terrain altitudes1000 to 2000 m.

(B) Food (a) Nature : Marten (*M. flavigula*) has sharp partially retractive claws for seizing hiding preys. Animals are excellent predators, their main prey species include; rats, mice, squirrels, hares and birds. And is known for killing animals larger than itself. Fruits (apricot, berries, fig, etc.) and nuts are also likened. At times predation of juvenile musk deer by marten has also been noticed in Kedar Nath Sanctuary(UP).

(b) Captivity. Zoological Garden, Imphal (Manipur) is the only zoo having some experience of maintaining marten for some period. The ingredients of the diet (quantity not mentioned) provided are chopped meat, sugar cane, fruits.

VI. RODENTIA

This order includes a vast number of species. It is not possible to describe the food habits in respect of all the native species. The diets are surveyed only in case of species which are maintained in captivity for public education and scientific conservation point of views.

1 Family *Hystricidae*.

(1) Porcupine (*Hystrix spp.*). (A) Conservation : The Indian porcupine (*Hystrix indica*) is ubiquitous than the second known species- Hodgson's porcupine(*Hystrix hodgsoni*). The latter is found only in the central and eastern Himalayas, Assam and lower Bengal at altitudes up to about 1500 m. Another colour phase of *H. Indica* is red porcupine found in some of the southern hill ranges in Mysore, Coimbatore and Kerala. Zoological Garden, Ahmedabad (Gujarat) is breeding profusely *H. indica*. The species thrives well in all climates and conditions.

(B) Food (a) Nature : The porcupine is purely nocturnal, coming out of burrows or rock crevices well after dark to feed. In nature the main food of porcupine includes vegetables of all kinds, grain, fruits, barks, roots and tubers. It has no hesitation to feed on carrion. In Sariska National Park it has been observed that porcupines gnaw bark of young khai (*Acasia catecher*) trees to the extent of causing the tree girdles to dry. Also in Kanha National Park (MP) species eats bark of *Cassia fistula* and *Bombax ceiba*.

(b) Captivity : Table 46 includes composition of diet being fed per adult of the species in various captive facilities.

(2) Crestless Himalayan Hodgson's porcupine (*Hystrix hodgsonii*): Its distribution is stated above. Not much is known about the specific diet of this species.

Table 46: Diet (in kg) for Indian porcupine (*Hystrix indica*) in certain zoos

Food item	NZP, Delhi	ZP, Chennai	ZP, Hyderabad	ZG, Guwahati	ZG Mumbai	ZG, Junagarh
Bread	0.100	-	-	-	-	-
Rice	-	0.100	-	-	-	-

Gram (Soaked)	0.200	- 0.100	0.060 to	0.100	0.100	0.050
Maize (Boiledcorn)	1 no	-	-	-	-	-
G. nut	0.100	0.150	0.010 to 0.020	-	0.100	0.010- to 0.20
Banana	-	-	1 no	2 no	1 no	1no
Potato (Sweet)	0.200	0.100	-	0.100	0.150	-
Potato	-	-	-	0.100	0.050	-
Tomato	-	-	0.025 to 0.050	0.025- 0.050	-	-
Carrot	0.200	0.100	-	0.050	0.050	-
Soybean	-	0.020	-	-	-	-
Vegetable (leaves)	0.200	-	-	-	-	-
Tapioca	-	-	-	-	-	-
Guwava	-	-	0.100 to 0.200	0.100 to 0.200	-	-
Palm	-	-	-	0.050	-	-

N=National Z=Zoological, P=Park, G= Garden

Zoological Park, Sepahijala (Tripura)		**ZoologicalGarden, Ahmedabad, (Gujarat)**	
Egg(boiled)	1 No.	Pea Gram dal	0.100-150kg
Gram(soaked)	0.150 kg	Fruits&vegetables (Papaya,	
Mixed Fruits	0.150kg	pumpkin, brinjal, cabbage,	
Vegetable	0.150 kg	banana(peeled)	0. 500 kg
Zoological Garden , Jaipur (Rajasthan)		**Zoological Garden, Pune(MS)**	
Gram(soaked)	0. 125 kg	Beet root	0.240
Ground nut	0.050 kg	Carrot	0.200
Bhutta	0. 125 kg	Sugar cane	0.080
Vegetable/		Banana	0.200
Fruits	0. 250 kg	Guava	0.050
		Gram (soaked)	0.080
		Ground nut	0.020

Note: All species of old world porcupines at New York Zoological Park are fed with grain especially corn (maize), lettuce, cabbage, celery, carrots, raw white or sweet potatoes, bananas, peanuts and a dish of cooked or raw chopped meat mixed with dry dog meal, fine bone meal and cod-liver oil (Crandall, 1965).

2. Family : *Sciuridae*

(1) Large brown flying squirrel (*Petaurista petaurista philippenis*): This is the largest of all squirrels, being slightly larger and heavier than the red flying squirrel (*P. petusista albiventer*). It inhabits the southern western ghats, extending to Cape

Camorin. The common giant squirrel inhabits Nagaland, Assam, Kashmir and Uttranchal. Its rich distribution is in the forests of the South Peninsula, Orissa and Maharashtra. It seems to prefer deciduous forests to true evergreen forests.

(B) Food (a) Nature : It is arboreal and spends the day in round mouthed holes in tree. The hole (created nest) is elongated and comfortable about 3.4 m up in the tree. It perches high up a tree and glides from one tree to another for social and feeding pursuits. The glides of about 45.73 m are reported. Besides tree barks, fruits, leaf buds insects (including termites) and fresh newly sprouting grasses are eaten (Krishnan, 1971).

(b) Captivity : For diet of the species in captivity see table 47.

A flying squirrel was captured from wild and hand reared by Dehingia (1994). On arrival, the following diet regimen was tried. The third diet was found to be suitable.

Ist diet : Fruits like banana, pine apple (ripe) and a few rago fishes were not accepted.

2nd diet : A plateful of fresh unboiled cow's milk provided during night was all consumed.

3rd diet : Fruits, vegetables, boiled rice and milk (250- 300 ml) were all consumed.

(2) Indian giant squirrel (*Ratufa indica*). (A) Conservation : It inhabits the deciduous and semi-evergreen forests of the Peninsula. It is not found in open dry forests. The squirrel is diurnal and highly arboreal. It spends the night in big globular nests of twigs at the tops of trees . In the nests young ONES are also born and nursed. It establishes its territory and may have several sleeping nests in the territory.

(B) Food (a) Natural : They feed on a large variety of fruits, barks and seeds. Ratufa indica extensively eats teak seeds, jackfruit, *Xylia xylocarpa, Termi- nalia paniculata* (fruits), *Bombax malabarica* (seeds), *Machilus macaranga* (flowers), *Pterocarpus marsupicum* (bark), *Lagerstroemia microcarpa* (leaves, twigs, bark), *Cardia wallichii, Dillenia, pentagyna, Radermachera xylocapra*. etc. in Periyar and Parambikulam Wildlife Sanctuaries (Ramachandran, 1985; Ramachandran *et al.*, 1986) and leaves and twigs of *Anogeissus, Garuga pinnata, Lagertroemia lancelata* and *Grewia filiaefolia* in Madumalai Sanctuary (Krishnan ,1972).

b) Captivity : See table 47.

Table 47: Diet for giant squirrel per adult per day in certain zoos

Food items	ZP, Chennai	ZP, Hyderabad	NZP, Delhi	ZG, Lucknow	ZG Thiru
Milk	-	100 ml	100 ml	-	-
Bread	1 (slices)	1 no	0.100 kg	-	-
Gram (white soaked)	0.025 kg	-	0.050 kg	-	0.015
Apple	1/2 no	1/4 no	-	0.050	0.025
Grapes(green)	0.050 kg	6 no	-	-	0.025
Bread slices	1 no	-	-	-	-
Banana	1 no	1 no	6 nos	4 no	0.025

Ground nuts	0.025 kg	-	0.100 kg	0.100	0.025
Sweet lime/orange	-	1/2 no	-	-	0.020
Carrots	0.025 kg	6 no	-	-	-
Cabbage	0.025 kg	-	-	-	-
Sathukudi/ Orange/mango	1/2	-	-	-	-
Coconut/with Shellathi/ tamarind/ Neem leaves	0.100 kg	-	-	-	-
Papaya	0.050 kg	-	-	-	-
Mixed fruits	-		0.500 kg	-	-

VII. ORDER LAGOMORPHA

1. Family *Leporidae*

(1) Hispid hare (*Caprolagus hispidus*) : Its range is along the foot of the Himalayas in a few isolated places from Uttar Pradesh to Assam. The species is found in Kishanpur Wildlife Sanctuary and Dudwa National Park of Uttar Pradesh and Manas Wildlife Sanctuary in Assam. The species is nearly related to rabbit. It feeds a special kind of grass called as Thakaso/Thatch grass (*Saccharum spontaneum*). It is nocturnal.

In captivity attempt has been made to maintain successfully one wild caught specimen on the following diet. Dub grass (*Cynodon dactylon*) with roots, soaked dried pea, lettuce, cabbage and carrot. But cucumber remained unconsumed (Mallinson , 1971).

(2) Indian wild hare (*Lepus nigricollis*) : Seven sub- species are known to exist in India.They are nocturnal, dwelling in the terrestrial habitats. There is no much work on their food habits.Only Zoological Park, Sepahijala,Tripura maintains the species.The diet prescribed per adult per day is as follows.

Banana	= 4no	Water : *Ad libitum*
Vegetables	= 200g	
Dub grass	= 250g	

VIII. ORDER-INSECTIVORA

1. Family : *Erinaceidae*

It encompasses the following three genera :

Erinaceus : African and Eurasian hedgehogs

Hemiechinus : Long eared deserted hedgehogs

Paraechinus : Desert hedgehogs

(1) Long eared desert hedgehog (*Hemiechinus auritus*). (A) Conservation :

Long eared hedgehog (*H. auritus*) and pale hedgehog (*Paraechinus microplus*) are well known species found in very northern regions on plains of South India. In captivity their survival is always precarious.

(A) Food.a) Nature : Hedgehogs are nocturnal creatures and come out to feed at dusk and retire at dawn. They mostly inhabit dry places and desert. They live in holes beneath bushes or tufts of grasses. They are omnivorous and eat slugs, lizards, rats, mice, eggs, fruits and roots.

(b) Captivity : Hedgehogs have high metabolic rate; therefore, their diets should be fairly high in protein and low in fat. The standard diet of the animals is insects,but they should be provided much balanced calcium and phosphorus levels with ratio of 1.2 to 1.5 : 1.0 to prevent calcium deficiency. In view of its requirements exclusive insect diet is prohibited. They feed during night hours.The care for water requirement should be taken care of by providing clean water in a pot or bottle kept fixed with a system to suck.

(i) Zoological Garden, Calcutta(WB)

Boiled eggs, bread and milk are given. It also eats cockroaches, grass hoppers and millipedes (Sanyal, 1892).

(ii) National Zoological Park, New Delhi		**(iii)ZoologicalGarden, Jaipur(Rajsthan)**	
Egg boiled	=1 nos	Banana	=125 g
Bread	=50 g	Milk	=250 g
Milk	=50 ml		

Kathju (1995) caught a hedgehog (*Paraechinus micropus*) from the wild in Ahmedabad, Gujarat and hand reared the same by various diet regimens to find a suitable diet for the species.

Ist: Milk and minced meat and chappatis. Animal passed loose faeces.The milk was excluded from the diet. The faeces became firm and well formed.

2nd : Gave lesser quantity of milk and chopped meat instead of minced. Animal had difficulty in chewing the chopped meat.

3rd: Meat, chappatis, crushed ground nuts and milk constituted regular diet. In addition poultry eggs after a hole made on the top of the shell were given . The contents of the eggs were sucked by the animal with its long thin tongue.Besides (i) small dead birds such as fledglings of bulbul, streaked warbles and house sparrows at all times and (ii) Slugs/ crickets/earthworms were fed during monsoon.

IX. ORDER PHOLIDOTA

Out of the seven species of pangolins known in the world, two species of pangolins are known to exist in India.

(1) The Indian pangolin (*Manis crassicaudata*) : It is distributed in the plains and lower slopes of the north-eastern hilly regions and western and eastern ghats, and

adjacent plains including cultivated lands.It has 11 to 13 rows of scales around the body. Animals live in very deep burrows. They are nocturnal and come out during night for feeding. Animals are selective in food habits.

(2) Chinese pangolin (*Manis pentadactyla*) : It ranges through Assam and the eastern Himalayas to Nepal, Burma and south China and has 15 to 18 rows of scales around the body.

(B) Food (a) Nature: The food of pangolin consists of eggs, young ones and the adults of termites and ants. They dismantle the termite mounds with powerful claws of their forelimbs and collect the food using tongue which is very long and has sticky fluid. The pangolin lacks teeth and the food is directly swallowed into stomach which is divided into two parts, the proximal crop-like portion and a distal muscular portion.

(b) Captivity : Lal Mohan (1998) described that in captivity *M.crassicaudata* is fed with minced meat,egg yolk and milk. A standard diet was said to be beef, raw egg, milk powder,oat meal , larvae, vitamins and salt (Hoyet,1987)

(i) Biological Park.Bhubneshwar (Orissa)

Tree termites eggs	=0.600kg

(ii) Zoological Park, Vandalur, Chennai(TN)

Beef(chopped)	= 200 g
Egg (boiled)	= 1 no
Carrots	= 100 g
Termite mound	= 1 no
Cabbage	= 50 g

(iii) Zoological Park, Hyderabad(AP)

Egg	=1 no
Milk	=250 ml
Ants & insects	= 50 g

(iv) Zoological Garden, Imphal(Manipur): Recently ,the species was collected from the wild in hill districts of Manipur and was brought to State zoo. A diet of a mixture of mashed banana and raw eggs was offered. The animal could survive only for about three months (Ramakantha, 1992).

X. ORDER CHIROPTERA

In feeding habits, bats are fruit and Nector feeders, insectivorous bats (meal worm larvae), carnivourous bats (eating beef, mice, rats, birds, lizards fish) and blood-eating bats (Vampire bats). In zoos mainly fruit eating bats are maintained, in the nocturnal house. Vitamins and minerals (calcium and phosrous) deficinces are to be cared.

♦♦♦

IV. HAND REARING

Despite the fact that there is no substitute for mother care for her offsprings, there are circumstances when hand rearing becomes necessary.

The phenomenon needs circumspection about three important points: (1) The circumstances for hand rearing. (2) The procedures and diet regimens to be followed for raising neonates. (3) The expected outcomes of such adventurism. The excellent article "An international survey of hand rearing techniques and animal milk analysis" by Vivienne Lyallwastson, 1962 in International Zoo Year Book, vol. iv page 282-332 is recommended for consultation.

(1) Circumstances a) Wild born : During heavy rains and deluge in the rainy season herds of chitals (forest dweller) and blackbucks (open land grazers) converge and get safe refuge for shelter and food in high, open areas near the agricultural fields and villages. But under such circumstances, the predators too move out from their core areas in search of their prey. Having perceived the presence of predator, the herd flees helter-skelter and a few young ones may get separated. If the herd enters into water logged paddy fields some infants and old weak individuals are trapped in the muddy soil. Such stranded and stressed infants are apparently visible to villagers and they rescue them. Sometimes, such infants are injured severely/killed by the stray village dogs.

Finding of newly born and very young or infant tiger/leopard cubs all alone in the forest or species habitat is not sufficient reason in itself for parting them off home. In nature it is quite normal behaviour for the mother tigress to rear her infants in a secluded place till they are able to frequent along with her. During this period of phase, in search of prey the mother has to leave her cubs for some time, may be for 2 or more hours. If the cubs are between 40 to 60 days old they may venture to creep out from their dens and accidentally may come to the notice of the patrolling forest officials or any passersby who inquisitively may collect them considering them orphan, to save them from starvation, predators or poachers. On extermination of man eating or live stock predating mother, her offspring often is found wandring in the area and accidently is rescued by the forest officials or other persons. The cubs are handed over to a nearby zoo.

b) Captive born : The Wildlife Veterinarians take all steps to ensure optimal dietary requirements and health care and make adequate provisions for environmental and social conditions for the pregnant, parturitng and lactating females. The young ones should get sufficient suckling care from mothers. But circumstances forcing hand-rearing of newly born offsprings cannot be ruled out.

i) Whenever the dam during parturition process is disturbed owing to strange activities around her, presence of male, cracker noises, keepers unusual actions, etc., it may show aberrant behaviour and even infanticide attitude.

ii) When the infant, soon after its birth, is handled by caretaker, the mother (particularly primiparous) may not accept her offspring due to human smell/ imprinting.

iii) Agalactia due to non functioning /atrophied teats.

iv) When the young is born sick or during its suckling life becomes sick, mother may desert her offspring.

v) Neonate retrieved by manual management of dystocia or through caesarian in certain cases may not be accepted by mother.

vi) When mother expires in the course of obstetrical procedures or dies due to some disease or accident before the young one attains weaning age.

vii) When mother's milk dries (agalactia) before the young one attains weaning age due to some pathological condition such as mastitis, metritis, etc.

Since physiology of the stomach of wild mammals is extremely complex, artificial rearing of young ones in postnatal life, particularly in cases of those collected from the wild and put on artificial feeding, poses plethora of problems for the veterinary staff such as selection of diets, estimation of optimum dietary requirements and mixing of hand reared animals with their con-specific individuals, etc. Presently, no species specific standard diets for the purpose of artificially rearing orphan neonates are available in the Indian markets.Therefore, one has to attempt hand- rearing by making adjustments in the context of available previous successful experiences of hand rearing of neonates of wild mammalian species.

Milk analysis values in respect of certain exotic and native mammalian species compiled by Benshaul (1962) are entered in the table 48 (readers may consult original)

Table 48 : Milk analysis of certain exotic and native mammalian species

Species	Water	Fat	Protein	Carbohydrate	Ash
(a) Artiodactyla					
Domestic pig(*Sus scrofa*)	84.00	5.00	3.70	5.00	0.631
Wild pig(*Sus scrofa*)	82.8	5.1	7.1	3.7	1.1
Hippopotamus (*Hippopotamus amphibius*)	-	3.49	5.30	4.32 (Lectose)	0.80
	90.43	4.51	-	4.40	0.11
Bactrian camel(*Camelus bactrianus*)	-	5.39	3.8	5.10 (Lectose)	0.69
Arabian camel(*Camelus dromedarius*)	-	4.47	3.5	4.95	0.70
Llama(*Lama glama*)	86.55	3.15	3.90	5.60	0.80
Giraffe(*Giraffe camelopardalis*)	77.2	12.5	5.9	3.4	1.0
	86.1	4.7	2.9	5.4	0.7
	12.50	5.76	3.41	0.90	-
Sika deer(*Cervus nippon*)	63.9	19.0	12.4	3.4	1.4
Red deer(*Cervus elaphus*)	65.9	19.7	10.6	2.6	1.4
	9.2	10.4	2.8	-	-
Water buffalo					

(*Bubalus bubalis*)	82.76	7.38	3.60	5.48	0.78
	77.1	12.0	6.0	4.0	0.9
Bison(*Bison bison*)	86.9	1.7	4.8	5.7	0.9
Thomson's gazelle (*Gazella thomsoni*)	65.8	19.6	10.5	2.7	1.4
Palestine gazelle (*Gazella gazella*)	63.9	19.0	12.4	3.3	1.5
Domestic goat(*Capra hircus*)	87.14	4.09	3.71	4.20	0.78
Sheep(*Ovis aries*)	79.50	9.00	4.70	5.80	1.00
(b) Proboscidea					
Indian elephant (*Elephas maximus*)	83.82	3.89	-	11.82	0.47
	6.7	3.4	6.4	0.4	-
(c) Perissodactyla					
Black rhinoceros (*Diceros bicornis*)	-	Trace	1.54	6.06	0.34
Zebra(*Equus sp*)	86.2	4.8	3.0	5.3	0.7
(d) Cetacea					
Bottle-nosed dolphin (*Tursiops truncatus*)	-	16.7 (Total solids 28.63)	9.64	0.773	-
Porpoise(*Phocaena sp*)	41.11	45.80 (Total solids 58.89 = 1)	11.19	1.33	0.57
Great Blue Whale (*Balaenoptera musculus*)	47.17	38.13	12.79	-	1.43
Baleen whale(*Balaena sp*)	69.80	19.40 (Total solids 30.20)	9.43	-	0.99
(e) Lagomorpha					
Rabbit(*Orpyctolagus cuniculus*)	69.50	10.45	15.54	1.95	2.56
Mountain Hare (*Lepus timidus*)	-	19.3	19.5	0.9	-
(f) Rodentia					
Grey Squirrel (*Sciurus caro-linensis*)	72.4	12.6	9.2	3.4	1.4
Porcupine (sp. ?)	71.2	13.2	12.4	1.8	2.3
(g) Primates					
Rhesus macaque (*Macaca mulatta*)	-	3.9	2.1 Mean10.6	5.9	0.26

Orang-utan (*Pongo pygmaeus*) # 1	88.53	3.5	1.43	6.02	0.24
Chimpanzee (*Pan satyrus*)#	88.1	3.7	1.2	7.0	0.21
Man (*Homo sapiens*)	87.0	4.0	1.3	6.5	0.2
(h) Carnivora:					
Wolf (*Canis lupus*)	76.9	9.6	9.2	3.4	1.2
Jackal (*Canis aureus*)	78.0	10.5	10.0	3.0	1.2
Domestic dog (*Canis familiaris*)	75.50	11.80	8.65	3.25	0.80
	78.88	8.56	6.82 (6 days lactation)	4.09 (by	1.08
Fox (*Vulpes vulpes*)	-	6.30 (Total solids 18.13 on average of 5 animals)	6.25	4.56	0.96
Brown bear(*Ursus arctos*)	89.00	3.2	3.6	4.0	0.2
Grizzly bear(*Ursus arctos horribilis*)	88.09	3.0	3.8	4.0	0.3
Polar bear(*Thalarctos maritinus*)	76.0	9.5	9.6	3.0	1.2
Otter (sp.?)	62.0	24.0	11.0	0.1	0.75
Domestic cat(*Felis cattus*)	82.35	4.95	7.15	4.90	0.65
	81.63	3.33 (Data of colostrum 24 hrs. after birth, total solids 18.37)	9.08	4.91	0.58
European lynx (*Felis tynx*)	81.5	6.2	10.2	4.5	0.75
Leopard(*Panthera pardus*)	80.6	6.5	11.1	4.2	0.75
Lion(*Panthera leo*)	63.9	18.9	12.5	2.7	1.4
Cheetah(*Acinonyx jubatus*)	76.85	9.5	9.4	3.5	1.3

Table 49 : Milk Analysis on 4th day of parturition of Indian rhinoceros (*R. unicornis*).

Sl.	Constituents	Jha *et al.*,(1987)	Mishra & Jha, 1993
1.	Specific gravity	01.0362	1.045
2.	pH	05.79	11.35
3.	Per cent total solids	10.99	-
4.	Per cent solid not fat	9.99	-
5.	Water (%)	89.01	94.46. Protein (%)
		3.26	3.45
7.	Fat (%)	1.0	9.5
8.	Carbohydrate (%)	-	1.25

Table 50: Chemical composition of milk of an Indian rhinoceros (*Rhinoceros unicornis*) at midlactation(Nath *et al.*1993)

	Postaparturient days			
	30	37	44	Mean±SE
pH	6.47	6.15	6.48	6.49±0.01
Specific gravity	1.02	1.03	1.02	1.0296±0.0002
Total solids(g/dl)	9.64	9.88	9.92	9.81±0.09
Fat (g/dl)	1.50	1.40	1.30	1.40±0.06(14.27)a
Nonfat solids(g/dl)	8.14	8.48	8.62	8.41±0.14(85.73)

Lactose (g/dl)	7.21	7.80	7.80	7.60±0.02(77.47)
Total protein (g/dl)	1.44	1.37	1.37	1.39±0.02(14.17)
Casein (g/dl)	1.00	0.97	1.03	1.00±0.02(10.19)
Whey protein (g/dl)	0.44	0.40	0.34	0.39±0.03(3.98)
Beta-Lactoglobulin (mg/dl)	264.00	232.00	187	227.67±22.33(2.31)
Alpha-lactalbumin (mg/dl)	176.00	168.00	153	165.67±6.74(1.68)
Serum albumin	ND[b]	ND	ND	
Immunoglobulin	ND	ND	ND	
Urea (mg/dl)	40.50	48.00	43.80	44.10±2.17(0.45)
Calcium (mg/dl)	80.16	82.16	90.18	84.17±3.06(0.87)
Sodium (mg/dl)	23.00	25.60	25.60	24.70±0.87(0.24)
Potassium (mg/dl)	90.16	92.14	90.16	90.82±0.66(0.92)
Inorganic phosphorus (mg/dl)	24.44	24.44	26.69	25.19±0.75(0.25)
Chloride (mg/dl)	36.50	35.50	37.50	36.50±0.58(0.37)

a Values in parentheses = % on a dry matter basis.

b ND = not detectable.

Table 51 : Composition of elephant milk(Anon, 1981)

Constituents	Values	
	From	To
Specific gravity	1.033	1.038
pH	6	7
Total solid %	16.4	28.55
Total ash %	0.57	0.8
Fat %	5.802	19.0
Total protein %	4.4	2.5
Casein %	1.4	2.5
Lactose %	3.4	5.4
Calcium mg %	84.6	178.0
Phosphorus mg %	186.0	309.0
Vitamin C mg %	0.25	0.4
Chloride mg %	42.0	64.0

Note: Krishnamurthy (1989) mentioned that the composition of elephant milk often various at different stages of lactation particularly the fat content various from 0.63% to 9.0% , the protein content various from 1.9% to 3.0% and carbohydrates 4 to 8%.

Published case reports as well as author's own observations on hand rearing infants of some wild mammalian species are included hereunder.

I. Artiodactylids

In deer and antelopes, the young born are relatively mature than any other wild terrestrial mammalian species. At birth temporary incisors are present. Although, premolars and molars are not cut but their hard structural existence is well marked. In their first 10 days of life fasing fawn remains hidden under vegetation for most of the time. Mother visits the site for suckling the fawn. In the first 2 weeks of life, in day time between 10.0 a.m to 5.0 p.m, suckling is usually 3-4 times in captivity. Less number of suckling frequency is due to many reasons such as frequent visits by the patrolling staff, presence of predator, mother is injured, any strange activity in the vicinity, etc. The fat percentage in the milk (colostrum) of blackbuck and chital 8% soon after their parturition.

Fawns of deer and antelope species start nibbling grass / fodder from second week of their life. By eight week the fawns are marked for picking up and eating green grass/fodder and frequenting with mother (Arora, 1995).

The characteristics of hooves, dryness of navel cord and presence of milk teeth are the criteria to be considered for estimating the approximate age of the neonates.In hand- rearing milk should not be sweetened. Sucrose is contraindicated in ruminant neonates. From primiparous died of foetal dystocia 50 ml colostrum collected was analysed. The composition found was as follows.

DM= 25.7

Protein = 12.9%

Fat = 8.0%

Ash = 1.3

Certain case reports of hand rearing of artiodactylid species are cited below.

Case 1 : In Rajasthan and Uttar Pradesh, villagers have been rearing successfully blackbucks (*Antilope cervicapra*), chinkara (*Gazella gazella*) and chitals (*A. axis*) traditionally, theb former species more commonly.

Case 2: Zoological Garden, Mysore hand reared a deer fawn on the following diet regimen (Krishna Gowda, 1962).

Diet: Up to 1 month : 85.5ml milk, 85.5ml boiled water and 2 tea spoonful glucose four times per day. Also two drops Adexolin and 1 tea spoon gripe syrup, once per day.

1-2 months : 114 ml milk and 114 ml water, four times per day. No change in supplements.

2-4 months : 114 ml milk and 114 ml water, three times per day. No change in supplements. Small quantity of green grass and boiled horse gram with wheat bran offered.

4-5 months :114 ml milk and 114ml water, twice per day. No change in supplements. Green grass given freely. 0. 171 kg boiled horsegram and 0.057 kg wheat bran also given.

5-6 months : 114 ml milk and 114 ml water, once daily. No change in supplements. Green grass given freely. 0.228 kg boiled horse gram and 0.0 57 kg wheat bran also given. Lucerne added to fodder.

6 months: Milk discontinued.

Case 3 : Zoological Garden, Mysore hand reared a bison (*Bison bison*) (Krishna Gowda, 1962). Diet (i) : Up to one and half months : 0.852 litre buffalo milk, 0.852 litre distilled water and 3 teaspoonful glucose, four times per day.14.5 ml gripe water, 15 drops Adexolin and 2 yeast tablets once per day.

(ii) One and half to 2 months: As above with milk diluted with 25 per cent water.

(iii) 2-4 months : As above with buffalo milk undiluted.

(iv) 4-6 months : As above, with feedings reduced to three times per day. Green grass provided.

(v) 6-12 months : As above with addition of little boiled horse gram.

(vi) 1 year : Milk discontinued.

Medical report : To this feeding schedule calf was susceptible to diarrhoea.

Case 4 : A male chital (*Axis axis*) fawn soon after birth deserted by mother was successfully hand reared on the cow milk and at the age of 1 year was released with herd in VPU, IVRI, Izatnagar (U.P.).

Case 5 : From a villager Dr. Ajay Mathur of Jeollykot, Nainital procured a fawn of barking deer (*Muntiacus muntjak*) weighing 900 g on 16th June, 1991. The fawn was reared on the milk of a German Shepherd bitch up to 17 days and then the fawn was put on bottle feeding using cow milk mixed with vitamins and minerals. The vigour of the animal was fair. It started nibbling grass. After about 7 months the animal was released into the forest area. The animal never returned and thereafter it's fate was also not reported.

Case 6 : A female fawn of blackbuck (*Antilope cervicapra*) soon after birth was deserted by mother due to some disturbances in VPU of IVRI, Izatnagar. The fawn was then raised on cow milk mixed with vitamins ABDEC - fed thrice a day. After 3 months of age milk feeding was only twice in a day in the morning and the evening. The vigour of the animal was fair.

Case 7 : Five chowsingha (*Tetracerus quadricornis*) fawns received from wild (source of animals not clearly indicated) on different occasions were reared on goats milk but all died when they attained the age of about 6 months (Singh, 1991).

Case 8 : A chinkara (*G. gazella*) fawn of 2-3 weeks age strayed from the mother and came along with a herd of goats in the village and was handed over to Zoological Garden, Indore (MP). It was bottle fed with 200 ml of dairy milk three times a day alongwith B complex vitamins. The average milk consumption reached to 750 ml per day after 45 days of age when the fawn started eating gular leaves and wheat bran. Further information was not available (Mahodaya, 1990).

Case 9: Mallinson (1977) described a case of 4 piglets of pigmy hog (*Sus salvanius*) hand reared by A.Wranghm at Paneery (Assam).The piglets had to be hand reared as their mother died after 3 days of farrowing. The piglets were initially bottle fed

every two hours day and night on undiluted cow milk, and they took approximately 12 ml each per feed. The multivitamins - ABDEC were added to each feed. When one week old, they were fed the baby food preparation, Farex, mixed with cow milk in addition to the bottle feed. At three weeks the piglets were eating Farex on their own. By nine weeks they were fed 4 times a day on a variety of foods which included minced meat, sweet potatoes mashed in milk, unpolished rice, fresh boiled milk, fruits and vegetables, such as papaya, pine apple, mango, lichie, banana, strawberry, etc,. A calcium supplementation was also added to the diet.

II. Carnivores

1. Family: *Felidae*. In large cats like tiger (*Panthera tigris*), lion (*Panthera leo*) and leopard (*Panthera pardus*), the offsprings born are destitute owing to their closed eyes and underdeveloped bones and joints in their limbs. In nature the cubbing is always in the dens/lairs near to the prey abundance and water holes.

In captivity breeding cells are provided in the house. Hence, there is a protection from the extrinsic and ambient hazards.According to Sankhala (1993) during the first 24 hours suckling continues for about 70 per cent of the day hours. This is reduced to 60 per cent after 10 days, and to 30 per cent after 40 days; after 90 days, less than 10 per cent of the day is spent in suckling. Thereafter, some mock-suckling attempts, which the non-lactating mothers dislike, are made by the cubs. Mothers do not allow the cubs to even lick meat until they are about 40 days old. After that they are allowed a little meat to supplement the mother's milk, and are completely weaned by the time they are 90 to 100 days old. At this age cubs can eat up to a kilo of meat per day.

Ideally to receive sufficient colostrum and milk all neonatal and juvenile felids should be mother - reared because: (1) The natural mother does the best job. (2) The mother reared young ones till their weaning age become strong and adjust better behaviorally as adults. (3) A mother and her cubs make a terrific exhibit. (4) It saves considerable personal time and reduces management cost. In the event that the mother rearing is impossible because of maternal neglect or for health reasons, the cubs should be hand raised.

Following birth, new born cubs should be allowed to remain in bond with the mother for 24 hours before performing the first physical examination. Complete neonatal examination should be conducted on all cubs regardless of whether scheduled for hand or maternal rearing. Body weight, rectal temperature and sex should be determined and individual cubs identified using a transponder (this is yet not being practiced in Indian zoos). Soon after birth the navel of the cub should be cleaned and swabbed with an appropriate disinfectant such as Betadine (weak solution of iodine) or Acriflavin. The examination should include observations for congenital abnormalities like cleft palate, bow legs, status of the mucus membranes, skin turgor for level of hydration, etc. Foreign workers recommend that a blood sample should be collected during the first few days of hand rearing for a complete blood count and serum chemistry saved in the event that they may be required for subsequent medical treatment. The cub should receive injection of a long acting antibiotic as to provide prophylactic measures against bacterial infections.

If deficiency in passive immunity is suspected, each cub should be given subcutaneous and oral species-specific serum. This serum should be collected using sterile techniques from the dam, if she is healthy. If the mother is unavailable, serum from a healthy adult conspecific living in the same collection for at least 1 year can be used as an alternative. Serum should be filtered to remove bacteria and then given at the rate of 5 to 8 ml/kg subcutaneously for 2 days and orally @ 2 to 5 ml per feeding for 3 to 5 consecutive days (Bush *et al.* 1994).

Several protocols are available for the hand-rearing of felid cubs using various products. They recommend that initially the cubs should receive 10% dextrose for the first 3 feedings followed by milk replacer(sweetened condensed milk containing sucrose is never included in the diet of orphan). An enzyme to break-down lactose (Lactaid) should be added to the milk which appears to decrease the incidence of gastrointestinal upset (diarrhoea, blood in stool). For the first 2 days, cubs should be fed a diluted formula (half strength) in volumes of 8 to 10 ml every 2 to 3 hours to enhance appetite and to minimize gastrointestinal problems. During subsequent days, milk volumes are increased and frequency decreased, especially if the cub continues to gain weight and gastric impaction or distension does not occur. Concentration of the milk replacer may be increased stepwise over several days to full strength. Feeding frequency schedules have varied considerably among institutions. Several products are available (in the foreign markets) for feeding the neonates such as Esbilac (Borden Dairy Co,N.Y.), KMR-kitten milk replacer (Borden Inc, Hampshire), Nabraska frozen feline and feline diets (Lincon,Nabraska), Royal canin(Ruskin pet products), etc. These are reported to be complete and balanced foods for the carnivore species. They closely simulate cat's milk, containing approximately 20 % solids comprising 44% crude protein, 25% fat, 26% carbohydrate and 7% ash. As cow's milk is not suitable ,a mixture of 20 gram skim powder dissolved in 90 ml warm water to which 10 ml of corn oil or 30 gram egg yolk is added (Scott,1977). Studies have shown that cats possess low glucose tolerance. Similarly diets high in polyunsaturated fatty acids may lead to steatitis or yellow fat disease. Being strict carnivores they need high active nitrogen protein and are incapable of adopting to very low nitrogen diets. Total protein requirements of large cats vary between 15 to 30% of the diet (on dry matter basis) for adult and young animals.

Esbilac (Borden Dairy Co.) contains crude protein 33%, crude fat 40%, mineral salts 6%, various vitamins, etc. The manufacturer recommends that the product be given in increasing concentration.

Additional feeding including minced meat and liver between the second and eighth week, is of value. Additional feeding at an earlier or later time has not been found advantageous. The milk formula should be given at least until the third or fourth month. Klos and Lang (1982) described feeding schedule with Esbilac. The same has been reproduced hereunder:

- Food is first offered 12 hours after birth since the meconium is shed by this time.
- Esbilac dissolved in boiled water is provided every 2-3 hours from 8:00 hours until midnight. The amount given is approximately 10% of the cub's weight. A cub weighing about 500 grams would thus receive 50 ml of Esbilac daily.
- The milk must be at body temperature (38-40°C) and must be kept at this

temperature while being served (automatic bottle warmer). Two bottles may be used to simplify the procedure; while the one is in use, the other is being incubated.

- Initially, a nipple is used with a very small opening which is gradually enlarged. Fast drinking causes bloating by swallowing excessive air which in turn prevents the cub from playing with its front paws 'on the mammary system'. It is, therefore, important to hold the neonate in a physiological position as of natural suckling by an infant to its mother. The neonate should have the opportunity to either cling to or push itself off the gland.

- The daily quantity of Esbilac@ can be fully prepared and refrigerated. Each feeding requires a fresh sterilized (boiled) nipple and a fresh sterilized bottle (preferably plastic).

- Overfeeding be avoided. The cub will show contentedness.

- Daily weight measurement indicates milk quantity to be provided. Birth weight is usually doubled by the end of the second week.

- Massaging the belly after each meal enhances digestion.

- The anogenital region is to be lightly massaged three times daily with a finger which has been moistened in warm water. This usually triggers urination while defecation generally occurs once daily.

- Soft faeces or diarrhoea is first counteracted by feeding at shorter intervals (every 1-2 hours) with the daily quantity being unchanged.

- Should this method fail, an antibiotic is added to the milk for 2-3 days (Chloromycetin-Palmitat@ Park Davis; Kaopectate N@ Upjohn,kaolin-pectin-neomycin anti-diarrhoeal).

- The optimal ambient temperature for hand-rearing of large felines is 20°C during the first week. Then, it is gradually lowered to room temperature by the fourth week. This can easily be accomplished by varying the distance from an infrared light.

- The success of all these measures listed will depend entirely on the availability of skilled, patient and conscientious keepers.

(1) Tiger (*P.tigris*). Young growing cub requires about 380 kcal/kg body weight at birth, decreasing to 250 kcal/kg at weaning (Miller and Allison, 1958). These energy requirements translate to 494 kcal for a newborn 1300 g tiger cub, and 1495-1864 kcal for the same cub when solid foods are first introduced (6-8 weeks of age), ignoring potential metabolic body size differences (Binczik *et al.*, 1987). Amounts of energy requirements and a suggested feeding schedule to meet these requirements indited (Bush *et al.*1994) are entered in table 52.

Table 52 : Feeding routine for hand-reared tiger cubs.

Age	Feed	No. of meals/ 24 hours	Milk (ml) per meal	Body wt.(g)	Min. Kcal
Day 1	Milk	6	50-60	1300	494
1	Milk	6	100	2296	825
2	Milk	6	115	3033	1000
3	Milk	6	140	3770	1184
4	Milk	6	150	4507	1316
5	Milk+ solid	6	165	5245	1416

6	Milk	6	175	5981	1495
7	Milk+ solid	5	175	6718	1680
8	Milk+ solid	4	150	7456	1864
9	Milk +solid	3	125	7600	2000
10	Milk +solid	2	100	8930	2250
11	Milk + solid	1	100	9667	2425
12	Weaning completed	-	1000	2500	--

The substitute milk formula evolved for raising carnivore cubs at the National Zoological Park, New Delhi consisted of 3 parts of Amul Spray (Milk powder), and I part of Complan. A few drops of multi-vitamins -A B D E C (Park - Davis) are added to the mixture. Boiled water is added to the above mixture to prepare the milk of medium consistency which can easily flow through the nipple of the feeding bottle. Approximately the fluid/ milk quantity required is about 10% of the body weight of the cub per day. The feeding schedule should be about every three to four hours from early morning to late evening. The last feed should not be later than 10 p.m. It is not necessary to feed the cub round the clock. A cub should take 28.5 to 43.0 ml (1 to 1.1/2 oz) of milk at each feed during the first week. Some may take more or little less. The general guide is that as long as the stomach is comfortably stretched after each feed, the cub is getting enough. The liquid diet may continue up to four weeks which is the most critical period in the life of a hand reared cub. The weight of a carnivore cub will decrease by about 50 g during one or two days after birth; however, from third day onwards its weight should increase by 50-100 g daily.

Boiled minced meat (about 5 g per day) may be introduced at the fifth week age. The quantity may be increased gradually. Small quantity of boiled liver may be added to the meat diet from sixth week onwards. From eight week onwards the meat diet may be given twice a day and corresponding milk diet may be stopped. From tenth week onwards the cubs should be given three feeds of meat and three feeds of milk. By 12th week the cub should receive four feeds a day at four-hour-intervals. The four feeds should consist of 2 feeds of milk 171 ml (6 ozs each time) and 2 feeds of meat (about 200 g each time). At the end of four months, the cubs should receive only one feed of milk in the morning and two feeds of meat (500 g each feed). At this stage, the cub can be considered as weaned and ready for rehabilitation with its own kith and kin (Desai, 1996).

Note : The cub should be stimulated to urinate and defaecate at each feeding by massaging the ano-genital area with cotton moistened with warm water. If diarrhoea is evident, the formula should be diluted with oral electrolyte solution and the total volume decreased by 20 to 40% for 8 to 12 hrs. If diarrhoea is severe and persistent, all oral intake should be stopped for 12 to 18 hrs and the cub supported with subcutaneous fluids (40 ml/kg / day as maintenance). Beginning 12 to 24 hours later, oral electrolytes should be provided followed by diluted formula and eventually normal feeding.

Case 1 : A tigress (*P. tigris*) littered 2 cubs in Palamau Tiger Reserve. At their age of about 2 weeks, both the cubs were lifted by the forest staff and fed with milk. However both were placed back (date and time not mentioned). But then the mother (tigress) had not accepted her cubs and both were reported to have died of sun

stroke (Sinha, 1979).

Case 2: On 31.3.1989 forest officials found one male and one female tiger cubs in solitude in a sugarcane field, near Katarniaghat in Uttar Pradesh and were collected by them and handed over to Lucknow zoo. The cubs were reared by the Director at his residence. Both the cubs were bottle fed with goat milk (quantity not mentioned) at an interval of 2-3 hours. But the female cub died on 14-5-1989 due to internal haemorrhages (Shukla and Das, 1990).

Case 3: Alongwith Collector, forest officials stealthily removed cubs of a tigress from the forests of Pilibhit district of Uttar Pradesh. As a result mother tigress became violent and created panic in the area. The cubs were then released back into the same area, but the mother tigress did not accept them and both died (Joshi, 1977).

Case 4: On 9th January, 1973 a villager, Mr. Bhudhan Baiga, collected one male and two female tiger cubs aged about one week from a forest in Bihar. All the three cubs were kept by Divisional Forest Officer of Chapra in South Bihar. They were fed with lactose 285 ml(10 oz) per cub. Their umbilical cords dropped off within 5 to 10 days and cubs opened their eyes within 12 to 15 days. On 12th day cubs passed greenish mucoid stools and were treated for dysentery. But all of them died one after another within a period of three weeks (Chatterjee, 1975).

Case 5: At Zoological Garden, Mysore, tigress (*P. tigris*) Mumtaz gave birth to one male and two female cubs which were deserted soon by the mother. They were subjected to hand rearing with the help of goat milk, by allowing the cubs to suckle the milk from teats of the goat directly . Meanwhile, human immunogloblin were also administered parenterally and supplemented with vitamins and necessary antibiotics. But all the cubs died within 20 days due to pneumonia and constipation (Mysore Zoo Annual Report, 1988-89).

Case 6 : Hand rearing of seven (7) captive and wild born tiger cubs undertaken at National Zoological Park, New Delhi has been described in table 32 (Khurana, 1974).

Table 53: Tiger cubs hand reared at National Zoological Park (Khurana, 1974).

Reasons for hand rearing	Remarks
Case (a) : A litter of three cubs. From 6th day without any apparent cause the mother became suddenly angry with her cubs and would not permit them to suckle. So they were removed to the hospital to make time till the mother calmed down by tranquilizers and allowed the cubs to suckle again.	The cubs remained alright and gained weight (observed for five days).
Case (b) : A litter of 5 cubs. From 14th day all cubs became ill. 3 cubs had died. Remaining 2 had grown very weak, anaemic, with	Besides the treatment and mother suckling, the surviving cubs were also bottle fed for for ten days. Both the cubs survived.

discharge from nostrils and were hardly able to suckle the mother.	
Case (c) :'A litter of three cubs. On 31st day a minor injury at the base of the external ear of the Ist cub became spoiled due to licking by the mother. After a fortnight's treatment the cub was put back with mother.However,it was not accepted and the entire litter was rejected by mother. To avoid any mishap all the 3 cubs were removed to the hospital for further rearing.	All survived the period of 93 days of hand of hand rearing.
Case (d) : A litter of four cubs received from the wild, age not known	Subjected to hand rearing but all died on 13th day.
Case (e) : Ist litter of two white cubs (1 : 1) were borne to Homa, the tigress.But she had no milk to feed ,as cubs were not seen suckling any time during 24 hours. Then, the cubs were separated and hand reared for 120 days.	Both cubs survived.
Case (f) : A litter of two cubs was born in captivity.When cubs were 2 weeks old, their mother developed a severe gastroenteritis. Then cubs were hand reared.	Reared for 130 days. Both the cubs survived and sold to a dealer at the age of 15 months.
Case (g) : Single female cub. From very first day cub born to , tigress Rani who had absolutely no milk in her breast was put to hand rearing.	Reared for 150 days without any problem.

Case 7 : A tiger(*P.tigris*) cub was hand reared at Zoological Garden, Mysore (Krishna Gowda, 1962) on the diet regimen mentioned below.

Diet : Up to 1 month : 1 ounce cow milk diluted with equal amount of water five times per day. 1/2 teaspoon glucose, 5 drops gripe water and 5 drops Adexolin (details of product not mentioned) were added to first feed. 1-2 months : 42.5ml (1.1/2 oz) cow milk diluted with equal quantity of distilled water given five times per day. One Vitamin C tablet and 1/2 tablet calcium gluconate D were added to first feed. 2-3 months : 57 ml (2 oz) cow milk mixed with same quantity of distilled water five times per day. Supplements as above, plus minced mutton and 57g (402) 5 drops Adexolin per day. 3-5 months :57 ml (2 oz) cow milk and 57 ml(2 oz) distilled water four times per day. Supplements as above, plus 0. 228 kg (8 oz) minced mutton, 5 drops Adexolin and one multi-vitamin tablet per day. 5-6 months : As above. Minced mutton increased to 0.454 kg (1 lb) 6-7 months : As above. Minced

mutton increased to 0.900 kg (2 lb) 7-8 months : As above, plus one raw egg twice per day and 228 g (8 oz) beef without bone. per day. 8-9 months : Milk feeding reduced to twice per day. Other supplements, beef and mutton unchanged. Also one long bone with flesh added to diet. 9-15 months : The milk and supplements unchanged. Mutton reduced to 0.454 kg (I lb) and beef increased to 1.716 kg (4 lb). Adexolin replaced with 2 teaspoons shark - liver oil. 15-18 months : The milk and supplements unchanged. Beef increased to 2.724 kg (6 lb) (including bones) and 2 teaspoons shark-liver oil continued but mutton discontinued. 18 months : The milk supplements and raw egg discontinued. Beef with bones increased to 3.632 kg (8lb) with 2 teaspoons shark-liver oil.

Case 8 : Thiruvananthapurum Zoo, Kerala successfully reared a tiger cub on meat soup, goat milk and vitamins in syrup form until the age of 3 months, when it was weaned (Nair, 1962).

Case 9 : A litter of three tiger (*P. tigris*) cubs born at Zoological Garden, Mysore (Karnataka) was home reared, from day old because of inadequate facility in the zoo (!). But they died in a week as they had been deprived of their mother's first milk - colostrum (Walker, 1984).

Case 10 : Zoological Park, Chandigarh claimed to have successfully raised a tiger (*P.tigris*) cub by nursing it on a foster mother-Dobermann bitch. The mother tigress (*P.tigris*) had given birth to 2 cubs on April Ist, 1993. One of them had died soon after birth.To the lone surviving cub its mother showed an instinct to care but it did not allow the cub to suckle her. Then, the cub was made to suckle a recently whelped domestic bitch-Dobermann and this went well.

Note : Based on the above reports author suggests that solid food (meat diet) should be introduced at 4 weeks of age. Weaning from milk should occur at 10 to 11 weeks of age. Hand- raised cubs should be weighed regularly to monitor weight gain and to calculate necessary food intake. Growth curves can be compared to published information to indicate the normality of the hand-rearing process

(2) Asiatic lion (*Panthera leo persica*). In the pride, new borns are successfully raised by mothers. Sometimes, it is reported that foster-bitch-mothers facilitate raising the neonates. Licking by bitch mother increases the blood circulation. A rise of 1°C body temperature due to licking is reported. The schedule of feeding is normally adjusted best by the mother; feeding six times during the first four weeks is reported to be adequate(Rashid and Reubin David,1992).

In hand rearing after four weeks, some solids are required to be fed in addition to milk and milk powder. The solids may include egg, meat, etc. The eggs may be given half-boiled and along with shell so as to provide further calcium in addition to the main source through milk. The cubs need more protein (10 to 30 %) and the need is met by feeding meat, cheese and eggs. The cow milk contains 3.5% protein, goat milk 4% protein, bitch milk 6.54% protein and cat milk 9.08% protein. Besides vitamins and minerals, fortified milk is also provided for proper growth and development.

Case 1 : Rashid and David (1992) described balancing artificial feed adopted for hand rearing of lion cubs with one teaspoonful "COMPLAN" (Heinz India Pvt.Ltd. New Delhi), 1/2 tea spoonful distilled water and 1/2 tea spoonful Woodward's gripe

water with each feed . Calcium liquid is given as age advances. Multivitamins also need to be supplemented, especially Vitamins A, D3, etc. (Adexolin or ABDEC drops).

After artificial feeding, always clean the mouth of the cub with damp cloth and gently massage the abdominal region for easy movement of bowels. The cubs may also be fed with beef as per the following schedule;

Cubs feeding schedule :

1st to 2nd month	=	180 g to 240 g
3rd to 4th month	=	240 g to 450 g
5th to 6th month	=	450 g to 600 g

Continue feeding milk formula up to 6 or 8 months of age or even more. The basic amount of meat or beef fed to each cub is 500 g for every 10 kg of body weight.

Lion cubs, when 2 months old, may be given 500 g of raw finely cut meat. This may be increased to 1.5 kg at 3 months. By the time the cubs are 6 months old, they are given 3 kg of meat and 4 kg when 1 year old. To this raw meat diet, bone meal is also added. Grown-up lions may be given 8 to 10 kg of raw meat per day depending on individual size.

Case 2: In Zoological Garden, Ahmedabad after gestation period of 110 days a lioness gave birth to a dead cub and two live cubs (Reuben David, 1962). The lioness was separated from male 5 days before delivery and given Calcium phosphate and Adexolin added to ration. She ate less than normal for last 2 days. Watery discharge 4 days before birth occurred.Three cubs, including one still born, were born between 12.30 p.m.and 9.00 a.m., but were ignored by mother. The live 2 cubs (a male and female) were cleaned, weighed and their body temperatures recorded as mentioned below.

Body Weight		Temperature
At birth	:	
Dead male	: 1.310 kg	
Male	: 1.217 kg	
Female	: 1.104 kg	
4th day	:	
Male	:	36.3°C
Female	:	36.2°C
9th day	:	
Male	: 1.471 kg	
Female	: 1.415 kg	
IIth day	:	
Male	: 1.610 kg	
Female	: 1.482 kg	
20th day	:	
Male	: 3.363 kg	37.7°C
Female	: 3.591 kg	37.7°C
62nd day	:	
Male	: 5.187 kg	
Female	: 5.415 kg.	
93rd day		
Male	:7.410 kg	37.8°C
Female	:7.638 kg	37.8°C

Both the cubs were put to suckle a lactating bitch that was near to end of her lactation. At 2.00 p.m. cubs suckled from lactating bitch. At 4th day the cubs were put to suckle another bitch that was in 5th day of lactation.The cubs were weighed before and after feed to discover consumption.

(a) Female:	Before feeding	Temp.	36.2°c
		Body Weight	1.088 kg
	After feeding	Temp.	36.2°C
		Body Weight	1.177 kg
(b) Male :	Before feeding	Temp.	36.4°C
		Body Weight	1.244
	After feeding	Temp.	36.3°C)
		Body Weight	1.310 kg

The female consumed 89.4 g and male consumed 66.3 g in each feed. Extra feed at 12 noon of 85.5 ml goat milk and one teaspoonful Promolan (protein compound) was provided.

8th day : Remained with bitch throughout day, and fed at 12 noon as before. One egg per day added to milk . Extra goat milk feeding done at 6.00 p.m.

17th day : 228ml milk and three teaspoonfuls of Promolan prepared. 57 ml of such milk preparation was fed at 6.00 a.m., 9.00 a.m., 12.00 noon, 3.00 p.m., 6.00 p.m. and 9.00 p.m.

19th day : Female developed slight gripe. 5 grains calcium phosphate added to morning feed. Teaspoonful gripe water regularly added to diet.

30th day : At 7.00 a.m. cub was fed 85.58 ml goat milk, 1/2 egg, 5 grains calcium phosphate, 1 teaspoonful Promolan, 1 teaspoonful gripe water and 1/2 teaspoonful cod liver oil each. At 12.00 noon cub was fed 85.58 ml goat milk, 1 teaspoonful Promolan and 1 teaspoonful gripe water each. At 9.00 p.m. 3 oz. goat milk, 1 teaspoonful Promolan and 1/2 teaspoonful gripe water each were fed.

52nd day : The bitch udder had dried.

62nd day : At 9.00 a.m. cub was fed 171 ml buffalo milk,5.25g Promolan, 1.75 ml cod-liver oil, 20 g calcium phosphate, 3.5 ml gripe water and 1 egg. At 1.00 p.m. cub received 171 ml buffalo milk, 3.5 g cod-liver oil and and 1.75ml Promolan. At 4.00 p.m. 171 ml milk and 3.5ml gripe water. At 8.00 p.m. - 171 ml milk and 3.5 ml gripe water were given.

97th day : Began lapping and eating minced meat.

98th day : Given 0.227 kg meat added for each cub.

110th day : Given 0.454 kg meat per cub .

122nd day : Given 0.681 kg meat and 681 ml milk per cub.

131st day : Given 0.908 kg meat and 681 ml milk per cub.

136th day : Given 0.908 kg meat and 454 ml milk per cub.

140th day : Given 0.712 kg meat and 454 ml milk per cub.

164th day : Diet schedule included morning feed - 0.681 kg minced meat, noon feed - 0.454kg beef afternoon feed -0.454 kg beef and evening feed 0.681 kg beef plus 681 ml milk.

196th day : 2.27 kg meat per cub.

Proportion increased to adult quantity.

Remarks on development : At birth the ears were drooping, eyes were closed and no teeth were present.

4th day : ears began to stand erect.

8th day : ears became upright, male's right eye started opening at right corner.

9th day : slight enlargement of gums. Slight discharge in right eye of male - cleaned with boric lotion.

11th day : right eye of male opened .

12th day : left eye of female opened from centre.

13th day : left eye of male opened from centre and right eye of female opened from centre.

15th day : both eyes of male opened but no definite vision.

16th day : both eyes of female opened but no definite vision.

20th day : lower incisors of male cut.

22nd day : lower incisors of female cut.

24th day : upper incisors of male appeared.

26th day : lower canines of male cut, upper incisors of female cut.

28th day : upper canines of male cut, lower canines of female cut.

42th day : canines of both cubs cleared of sheath.Cutting of lower molars and perforations of upper molars marked in female. Perforations of molars of male also observed.

49th day : molars in female cut and upper molars of male cut completely.

60th day : teeth of both cubs completely erupted.

Illness : On 79th day male developed pneumonia in outside enclosure. Teaspoonful spirit villum gallacy every 4 hours.On 80th day injection of procaine penicillin and fomentation of chest. 81st day condition of the cub improved. 1/2 tablet Sulphadiazine every 6 hours for 4 days given.

Case 3 : About 50 days old lion (*P.leo persica*) cub was hand reared at National Zoological Park , New Delhi. It was bottle fed on standardised milk of Delhi Milk Scheme and was successfully, hand reared up to 100 days

Medical Aid : Treated for dysentery.

(3) Snow Leopard (*Uncia uncia*) :

Case 1 : A wild born 12 days old female cub, considered to be abandoned by mother, was collected by Divisional Forest Officer Kargil (Ladakh region) and was received on 22.7.1993 Wildlife Veterinary Officer of the State Wildlife Department of Srinagar. The cub was marked for its ill health due to acute gastro - enteritis (rectal temperature 30°C). It was provided medical aid, mentioned as below (Mansoor, 1995).

i) The cub was cleaned with cotton soaked in warm and weak solution of antiseptic.

ii) Dependal M syrup (furazolidone 25 mg metronidazole 75 mg, pectin 50 g, light kaolin per 5 ml syrup) = 3 ml t.i.d. for a week.

iii) Dextrose 10% 20 ml (bottle fed) 2 hourly.

iv) No other liquid feed was offered during the first 24 hours of its arrival.

v) Fresh cow milk (conc 50:50) with some quantity of lac tase enzyme was given for about a week.

vi) Every day just before first and last feed the cub was given 2-3 ml of multivitamin syrup and after every alternate feeding during the first month of age.

vii) From 18th day of hand rearing milk concentration raised to 75:25 and feeding quantity was 35 ml x 6 meals. During 4th week of hand rearing concertration raised to 80:20 and quantity consumed was about 100 ml x 6 meals per day.

viii) At 5 weeks of age, cub had developd taste for solid food. In first instance, minced sheep liver was introduced to the cub. This was continued up to 9th week of age. Thenafter, it was replenished with long bones.

ix) From 9th week 200 ml of milk and minced liver 150 g thrice a day were fed.

x) From 15th week of age, the cub was given 250 ml milk twice a day and mutton 170 grams thrice a day. Body temperature was 37°C ± 1°C.

xi) The physical and development features noted during hand rearing were:

Physical & behavioral features	Age (days)
Complete opening of eyes	14
Self grooming	18
Complete opening of ears	20
Standing & walking freely	21
Eruption of Ist tooth (top middle incisor)	26
Retraction of claws	29
Defecation without stimulation	30
Leaving nest box on its own	38
Eating of solid food voluntarily	40
Sitting and playing with objects	42
Holding of tail upwards	49
Washing of face with paws	55
Stalking & chasing	56

(4) Leopard (*Panthera pardus*) :

Case 1: One leopard (P.pardus) cub of unknown age received at Zoological Garden, Mysore was hand reared (Krishna Gowda,1962).

Feeding : Up to 30 days : Cub was fed with 21.37 ml cow milk, diluted with equal quantity of distilled water four times per day and 1/2 teaspoonful glucose once. Besides 5 drops of gripe syrup and 5 drops multivitamin syrup were given once per day.

Up to two and half *months* : 2 ounce cow milk diluted with equal quantity of distilled water, four times per day. 1 tablet Berin B1 and 1 tablet vitamin C once per day. 75-90 days: 57 ml cow milk mixed with 57 ml of distilled water three times per day. 1 tablet Berin B1, I tablet vitamin C, 5 drops Adexolin and 57 g minced mutton once per day. 120 days: milk discontinued.

Case 2 : Two leopard (*P. pardus*) cubs of unknown age with their opened eyes but unable to stand hailing from Gelakey Tea Estate, Nazira, Assam were hand reared on the following diet (Leetham , 1962).

Diet : First 2 weeks : Fed cow milk with calcium powder and 4-5 drops Adexolin added. 3rd week : Cooked beef added in small quantity to milk; By 2 months of age they were eating 0.908 kg beef per cub per day. Milk, vitamins and calcium were continued.

Case 3 : A 2 weeks old black leopard (*Panthera pardus*) cub with eyes just opened was collected from Thowra Tea Estate, Rajinai Post Office, Assam and hand reared by Eastmure (1962).

Diet : First 2 weeks : Every 3 hours was fed 4 once cow milk and water (2:1), glucose and few drops of Adexolin.

4th week : Night feeding stopped. Solids introduced were chopped raw meat with liver, feathers, calcium powder and shark-liver oil once daily.

8th week : The diet included bread and milk in morning and raw meat twice per day. As many sparrows and doves as could be eaten were also offered.

20th week : 0.908 kg raw meat at each meal plus sparrows and doves.

Remarks : The milk diet was not satisfactory, as the fur was in poor condition and constipation occurred.

Case 4 : In Zoological Garden, Indore on 20th May, 1990 13 years old female leopard (P.pardus) gave birth to two male cubs. Due to mother's insufficient milk, both cubs had to be separated on Ist June 1990. One cub died during night and surviving cub was subjected to hand rearing on the following diet regimen (Mahodaya,1990).

2nd to 7 th June, 1990 : The cub was fed with 20-30 ml goat milk by bottle at an interval of three hours (i.e. about 300 ml milk fed in 24 hrs.).

15th June, 1990 : Quantity of milk increased to 400 ml in 24 hrs.

21st June 1990 : Five to six drops Live - 52 syrup plus 25 ml each Osteocalcium

syrup Livo-feral syrup and B-Complex syrup mixed in milk in every feeding given.

27th to 30th June, 1990 : During the period cub weighed 2250 g and fed with 600 to 700 ml of milk daily. In addition 50 ml of soup of boiled 100 g of intestines and kidneys of chicken given. The quantity of milk increased to 800 ml and of soup to 100 ml.

Ist to 8th July, 1990 : Given boiled 100 g liver twice daily along with milk.

15th July, 1990 : Quantity of milk reduced. Liver fed and additional vitamins and minerals given as mentioned above (16 to 21 June).

22nd to 30th July, 1990 : Soup of 100 g liver along with milk and liver.

Ist to 7th August, 1990 : Instead of liver, boiled 100 g mutton was fed three times a day. The quantity increased to 200 g. On the later dates on non availability of mutton 2 to 3 raw eggs were fed.

20th August, 1990 : 250 g boiled mutton twice a day along with milk. The cub weighed 11. 5 kg.

Medical aid : The cub was dewormed at the age of 60 days with 400 mg of piperazine.

Case 5 : On 25th Jan. 1989 Zoological Garden, Mysore received from Forests of Karnataka, one male and one female panther (*P.pardus*) cubs which had not yet opened their eyes. Then both were fed with 50% of goat milk, 25% of boiled water and 25% of pure crystalline amino acids with the usual vitamin (ABDEC) supplements (wholesome goat milk caused diarrhea). On 12th day cubs opened their eyes.This alludes that cubs were lifted within a few hours of their birth. The cubs started growing well and were gradually taken on cow milk and minced chicken meat after one and a half months (Annual Report, Z.G. Mysore, 1988-89).

Case 6: A normal coloured leopard (*P. pardus*), assumed to be orphan was collected from forests of Maharashtra (Singh 1991). Its eyes were open and it was hand rared on the following regimen .

Diet: On first day of the cub's arrival, it was fed 25 ml of goat milk mixed with 75 ml water. Thereafter, gradually increased the milk quantity and reduced water.

Case 7 : On 18th July, 1982 Zoological Garden, Jaipur, Rajasthan received a 10 days old female panther cub as her mother was killed by poachers from forest of Taragarh in Ajmer, Rajasthan The cub was reared on cow milk. Besides, chicken soup was also fed. She attained breedable age (3 years 6 months and 26 days) and mated for the first time with a male on 13th Feb., 1986(Yadav,1986).

(5) Clouded leopard (*Neofelis nebulosa*)

Case 1 : On 18th June, 1996 two clouded leopard (*Neofelis nebulosa*) cubs were collected from the dense forest close to the confluence of the Sipue and Subansiri rivers in Subansiri district of Arunachal Pradesh. They were handed over to State Zoological Garden, Itanagar . Both cubs were males approximately 2 months old and measured as below:

Measurments	Male 1	Male 2	Dentition
Body weight(kg)	1.0	1.0	I 6/6,C2/2 M2/0
Length (cm)	58	60	
Height (cm)	18	18	

a) Housing : Cubs were housed together in a wooden box sized 1.5x1.5 metres with wire netting on all sides for a month. Paddy straw was used as bedding material and that was changed periodically. Objects like balls and hanging ropes were provided inside the box to keep them physically active. After a month they were let out in an open room sized 3.036 x1.82 m in the day time but were shut at night in their box. Area of day time frequenting was later on increased to 20x15 m. When they grew about 10 months old they were released into a newly built fenced enclosure.

b) Food : On arrival into the zoo the cubs were fed minced mutton and cow milk 5 times a day. The cubs were fed chicken on Sunday. The quantity of milk was increased from 250 ml to 500 ml and meat from 0.250 kg to 1.250 kg once per day. At r 12 months of age the cubs weighed 14 and 16 kg respectively.

c) Medical care : Both cubs were dewormed against round worms with Fenbendazole and against tapeworms with Niclosamide (Ringu and Gogoi, 1996).

2. Family-*Viverridae.*

Case 1 : Binturong (*Arctictis binturong*) : In Zoological Garden, Guwahati, on 9th May, 1973 at about 1.25 p.m one female binturong gave birth to a female cub. It weighed 425 g and measured 40 cm from its nose to end of tail. But the cub was immediately killed by the mother. Again at 3.15 p.m. she delivered another female cub. Fearing mother's infanticide behaviour the cub was removed and reared on diluted cow milk mixed with vitamins and gripe water fed through feeding bottle @ 25 ml. at a time x 7 times per day. The cub survived for only 12 days and died due to gastro-enteritis (Dalbaruh, 1973).

3. Family *Mustelidae* : Various diets for hand rearing otter cubs have been tried.

Case 1 : Zoological Garden, Mysore (Karnataka) hand reared otter (species not specified) cub on the diet schedule mentioned below (Krishna Gowda, 1962).

Diet : Up to 1 month:given 28.5 ml buffalo milk mixed with equal quantity of distilled water and one teaspoonful glucose, four times per day. Besides one teaspoonful shark-liver oil and I yeast tablet once per day were also given.1-2 months: one and half ounce buffalo milk and equal quantity of distilled water, four times per day. Also one teaspoonful shark-liver oil and one yeast tablet once per day. 2-3 months: Ten small live fish per day in addition to above diet. At 3 months: 42.7 ml buffalo milk mixed with equal quantity of distilled water given twice per day. Besides one teaspoonful shark-liver oil , one yeast tablet and 0.250 kg. small live fish were given per day.

Case 2 : Museum and Zoo, Thirvananthapuram (Kerala) had successfully reared two wild-caught otter cubs, 1-2 months old on the following diet (Nair, 1962).

Diet : 57 ml of liquid made from boiling mackerel in water, mixed with 28.5 ml boiled milk fed when hungry, not less than five times per day. Bottle-fed for 4 months. Began eating small raw fish when 6 months old.

Remarks : One lived for eleven years, the other for 6 years.

4. Family-*Hyaenidae* : Usually, hyena cubs start feeding solid from 12th to 14th week of age.

Case 1 : An orphan striped hyaena (*Hyaena hyaena*) cub received at Madhav National Park, Shivpuri (Madhya Pradesh) on Ist of the year 1986 was hand reared. At its early age, it used to be released in the night to prowl around and it used to return next morning on its volition. It was on 30th June, 1986, when it did not return and on search it was sighted that the animal was being engulfed by an adult python (*Python molurus*) and within 2 hours it was consumed fully (Mishra, 1986).

Case 2 : On 27th Sept, 1985 one about 7 - day - old female hyena (*Hyaena hyaena*) and on 14th Feb, 1986 a brace of one month old hyena (*Hyena hyaena*) cubs were handed over to Sanjay Gandhi National Park. Borivli, Mumbai by the forest officials. They were found abandoned in the forests and, for fear of their lives due to starvation or predation, were picked up. The cubs were fed with toned milk having 3% fat and 85% SNF diluted with equal volume of water and enriched with ABDEC drops @ one drop per ounce. Osto-calcium with vitamins B12 syrup @ 5 ml per day was also given mixed in milk. The problem of constipation initially faced was solved by gently rubbing the anus of the cub with cotton swab soaked in lukewarm water. Water contents in diluted milk were reduced to the ratio of 3:1 from 45th day and 5:1 from the 60th day. Frequency of milk feeding was also reduced from 8 times to 4 times in a day by the end of third month. After 6 months undiluted milk was fed @ half litre per cub. Farex @ 1 to 4 teaspoonfuls and whole egg mixed in milk were also fed. From 9th day meat diet was also started. All the cubs grew well to be strong except for once occurrence of diarrhoea once in one of the cubs (Batwe, 1988).

Case 3 : A hyena (*Hyaena hyaena*) cub was collected when found as orphan (abandoned by mother) from the forest (Maharashtra). It was hand reared on goat milk. Cub at the age of 8 months developed colourlessness in the skin. The condition was cured on administration of vitamin A parenterally (Singh, 1991).

Case 4 : After the mother hyena had eaten away its two cubs at their birth,a lone surviving cub was successfully raised on cow milk fed mixed with few drops of multivitamin.The cub took milk @ 8% of body weight in 4-5 feedings per day. From 28th day onwards boiled minced meat was given and from 56th day onwards milk was reduced and eventually stopped (Jagnathan Rao,*et al.* 1995).

5. Family-*Canidae.* (1).Dhole/wild dog (*Cuon alpinus*)

Case 1 : The Arignar Anna Zoological Park, Chennai acquired eight(8) five-week-old pups of wild dogs from the wild for captive rearing (Gopalakrishnan *et al.* 1989).

Diet : In the beginning each pup was fed 500 g of beef per day from the date of capture. In the first week of March, 1985, three of eight cubs developed acute enteritis. Then pups were offered 300 g of goat meat which had been washed in boiling water for five minutes and supplemented with Vidaylin (r) drops. From the second week of March, as the pups grew, the quantity of food was gradually increased by 50 g per week. Three male and two female pups between 2nd and 3rd week of their arrival had died (details given under medical aid). From the age of 13 weeks onwards, each of them was given 450 g of mutton per day. To make the animals acclimatise to the increased quantity of food, it was divided into two equal parts and fed morning and evening. Once it was established at the age of 16 weeks that the animals were able to utilize the full quantity of feed given to them without any side effects, they were fed 300 g of goat meat and 150 g of beef in two sessions. From the 17th week onwards and up to the 22nd week, the goat meat was gradually replaced by beef, by reducing 50 g of mutton and increasing 50 g of beef every week. The cubs were finally consuming 450 g of beef daily. From the 24 th week beef feeding increased to 500 g . From the 26th week onwards, the morning beef feeding increased by 50 g and reducing the same amount from the afternoon feed was continued up to 30th week of age, when the full quantity of 500 g was spplied in the morning. The total feed was increased to 550 g and 600 g from the 30th week onwards. Gradually, amount of beef supply increased at regular intervals of one week . At the age of 34 months each pup was fed with 750 g of beef every day and the animals were quite active and free from any disease.

Medical aid : Eight pups (5:3) about 5-6 weeks old were procured from the forest.Five of them were given prophylactic vaccination against distemper, hepatitis and leptospirosis with Candur-DHL vaccine(Behring Werke A. G. Merburg,Germany). All the vaccinated pups however, died between seven and eight weeks of age. In all the cases acute gastro-enteritis and gastrointestinal ulcers were predominant necropsy findings. The remaining animals exhibited symptoms of mild gastroenteritis. They were treated with furazone with Kaolin and Pectin to which they responded favourably. By the end of the 12th week, the remaining animals showed no sign of gastroenteritis.

Their feed supplementation included Vidaylin-M drops from 5th-12th weeks; Ostocalcium with vitamin-D and B_{12} syrup from the 13th - 21st weeks; Liv 52 tablets from the 22nd-30th week, and again ostocalcium with Vit-D and B_{12} from the 31st-35th weeks.

Case 2 : Wolf (*Canis lupus*): On 14.2.1999, Zoological Garden, Lucknow (UP) received 7 wolf pups aged about 45 days from Lalganj Rai Bareli (UP). On their arrival they were fed 500 g raw goat meat per pup. Every pup consumed its full diet and also took some water. From next day instead of goat meat they were fed with boiled beef. Although every one used to consume the beef but had started diarrhoea and 3 pups had died till the end of February, 1999. From 1.5.99 the remaining 4 pups were fed on 500-700 g boiled goat meat and then after no diarrhoea occurred. From 2.8.99 they were fed boiled beef with minerals and vitamin syrup (U. Shukla, Personal communication August, 1999) further the observations were not available to the author.

(2) Fox (*Vulpes sp.*).

Case 1: On 8th March,1989 three common fox (*Vulpes bengalensis*) pups of about 3 weeks old were received at the Centre for Wildlife, I.V.R.I.Izatnagar (U.P). All the cubs were given about 20-30 g minced poultry meat.Half slice of bread was also offered. As the pups grew the quantity of meat was increased. One of the pups died at the 7th month of age. The rest pups were reared successfully on tender beef which was supplied from 5th week of their arrival.

6 Family : *Ursidsae*

(1) Sloth bear (*Melursus ursinus*)

Case 1 : On 4th January, 1992 from the forests of Andhra Pradesh two sloth bear cubs (1:1) (specific age not given) were brought to the Zoological Park, Hyderabad. They were subjected to hand rearing. First, the cubs were fed by means of a bottle but from 29 January they could lick the milk from a bowl. Feeding timings were: 6 a.m., 8 a.m., 11 a.m., 3 p.m. and 9 p.m. The details of the diet and weight gains by the animals documented by Pillai (1992) are presented in table 54.

Table 54 (a) : Feeding schedule of sloth bear cubs (Pillai,1992).

Period	Quantity per cub
04.01.92 - 17.01.92	40 ml milk
18.01.92 - 29.01.92	50 ml milk
30.01.92 - 31.01.92	75 ml milk
01.02.92 - 02.02.92	75 ml milk + bread slice
03.02.92 - 20.02.92	100 ml milk + bread slice
02.02.92 - 01.03.92	100 ml milk +2 bread slices
02.03.92 - 08.03.92	100 ml milk +4 bread slices
09.03.92 - 09.06.92	100 ml milk +1/2 loaf bread with tomato

Table 54 (b) : Periodic weight gains by the animals.

Date	Body weight (kg)		Difference
	Male (a)	Female (b)	(a)&(b)
06.01.1992	2.00	1.80	0.20
17.01.92	2.20	1.95	0.25
24.01.92	2.35	2.20	0.15
31.01.92	2.38	2.25	0.13
01.03.92	4.75	3.75	1.00

Case 2 : During the year 1988 two sloth bear cubs which had not opened their eyes and were received from the forests of Maharashtra were hand reared on goat milk supplemented with jawari and sugar. After they attained the age of one and a half years, both were sent to Zoological Garden, Aurangabad (MS). On one another occasion a female sloth bear cub about 2 weeks old was also received from the forest and was hand reared with goat milk, jawari and sugar. After the cub attained the age of 15 months, it was released back into the jungle and was verified to have been adapted to the wild (Singh, 1991).

Case (3) : In 1996, two sloth(?) bear cubs found in Tripura jungles were brought to Zawlnuam, Mizoram. The male bear cub was kept in a cage and female bear cub was restrained with chain in open . Both the cubs were hand reared on cow milk and bread . The male bear cub developed hindlimb paralysis and attained smaller body size compared to female cub. After a couple of months one more pair of male and female bear cubs were found in the Tripura forests. They were received at Vety. Dispensary, Mizoram. They were fed with cow milk, sugar, cerelac and rice till they attained age of 2 years. The cubs showed better body conformation and vigour than the previous pair of bear cubs. Unfortunately the cubs were killed by an unidentified person (Pachau, 1999).

Case 4 : In 1997 National Zoological Park, Delhi received a pair of one male and one female sloth bear aged about 45 days. Both the cubs were raised to adulthood on milk and butter (Zoo Vet. Officer, personal communication).

III. Primates

Monkeys are devoted parents, and it is practically impossible to take a baby away from its mother. She will defend it to her last breath and drop of blood. It is very difficult to collect any orphan or sick baby for care from a free ranging troop or group.In captivity if mother dies and there is no other female in the enclosure, one can collect the sick baby for hand rearing.

There may be several cases of hand rearing in case of rhesus and common langurs but due to space constraint author has not included the same in the present text. A few important case reports on other species (exotic and native species, however, are cited.

Case 1 : Nehru Zoological Park, Hyderabad (Andhra Pradesh) maintained 1:2 Sumatran Oragn-utan (*Pongo pygmeus*). On 5th December, 1986 a female baby was born to a 13 year old primiparous female. Immediately after birth the baby was cleaned and was fondled on his chest by her father. The mother made no attempt to retrieve her baby from the male. During night, keeper clad with blanket, was put on the watch. At one occasion light of the enclosure went off. When it was restored, movements of the watchman perhaps frightened the male oran gutan and he ran into adjacent chamber leaving the baby on the floor. Then, at once keeper shut the door to keep the male away and lifted the baby. It was cleaned and weighed (1.5 kg). Then, drops of glucose D were administered. Feeding of toned milk diluted with boiled water in the ratio of 1:3 started after 30 hrs. The infant consumed an average of 50 ml milk per feed given at about 3 hourly intervals. On 3rd day it passed stool and also vomited without any untoward effects. ABDEC drops were added in milk after a week and infant started growing well. Consumption of milk also increased. From 6th month of age it started taking fruits. Cerelac-Frax in the form of semi-solid was also fed to her. After one year of age it was vaccinated with polio drops and triple antigen (Kumar and Rao,1988).

Case 2 : The female chimpanzee "Zooma" of Zoological Park, Kanpur(UP) gave birth to a male baby on 10th December 1986. But she could not produce milk and teach the baby to suckle her. Realizing the situation, baby was separated from her mother and was hand reared successfully by the zoo veterinary officer.

Case 3: At Zoological garden, Mysore a chimpanzee (*Pan satyrus*) mother and its 6 month old baby caught cold. Then baby developed pneumonia and was removed from mother for treatment and hand feeding was practiced as mentioned here under.

Feeding : 42.75 g cow milk diluted with equal volume of distilled water five times per day. One teaspoonful gripe syrup, 10 drops multivitamin, 1/2 teaspoon honey, 14.25 g orange juice was given once per day. Milk was gradually increased to 57 ml milk, and fed with 57 ml distilled water, five times per day. A 9 months 1 teaspoon Lysotone and sliced apple were also added (Krishna Gowda,1962).

Case 4 : Hoolock gibbon (*Hylobates hoolock*). History: Manipur Zoological Garden procured a male gibbon from a villager (Village Serhlimn of Churachandpur Distt.) who had hand reared the animal for over four years. The gibbon was provided with cooked rice and green leaves. and every morning black tea. The gibbon used to dip his palm and lick it clean (*Zoo print* VII (5) 24).

Note : Hoolock infants are breast fed for about 6-8 months, sometimes up to 12 months. After one year infants progress from milk to more solid foods(fruits and tender leaves) slowly and gradually.

Case 5 : A female baby of golden langur (*P.geei*) was hand reared at Sehpaijhala Zoo in 1992. However, details ware not known.

IV. Rodents

Case 1 : About 1 week old flying squirrel (*Petaurista philippensis*) (Phillips, 1953)

Feeding : (i) Milk, glucose, calcium, water every 2 hours from 6.00 a.m. - 10.00 p.m. for 1-7 days (ii) 2 teaspoonful milk, 2 teaspoonful glucose and pinch of calcium mixed in water at each feed for further 10 days. Mashed sieved banana also added after 10 days :(iii) Double diet and balance feeds for next 21 days.

Apparatus : Glass tube bottle with piece of felt wrapped around it to form a feeding funnel and mouth piece. Felt is more suitable than rubber as it gives a better grip.

Case (2) : About 15 to 18 cm long (age unknown) Indian porcupine (*Hystrix indica*) collected from Thowra Tea Estate, Rajmai Post Office, Assam, (Eastmure, 1962).

Diet : On first day 114 ml cow milk with water (2:1) and glucose and a few drops of Adexolin. On 2nd day it began eating bread in milk. Soon it was weaned on to vegetables.

V. Proboscida

According to Jackson (1997) the date when people began taming and using Asian elephants (*E.maximus*) is lost in the mist of time. Perhaps orphan baby elephants were found and cared for in ancient Mesopotamia, the source of most of our domestic animals. In Kerala, the elephant professionals are trained to rescue the calves from the forests successfully. Chances of survival of calves over one month of age are more. The elephant has single stomach and requires nutrition and medical care akin to equine species. The rescued calf which has opportunity to suckle mothers's first milk (colostrum) and those suckled for about 2 weeks have

enough immunoglobulins and sufficiently developed immune mechanism to provide vitality and adaptability to hand rearing. Sometimes the mother may reject her newly born calf or may have no milk in her udder (even administration of oxytocin injection fails to induce colostrum or milk) and calf dies due to inanition if not subjected soon to hand- rearig. From the forests orphan calves are often received by the zoos for hand-rearing. In the past collection of elephant calves from the forests have been practiced by local people for monetary gains, which is now, by Wildlife Protection Act, banned. If the calf has not received the first milk and is to be hand-reared, it should be administered colostrum or serum from another healthy cow-elephant. The cow or buffalo milk can not be perfectly substitute elephant milk. For rearing neonate elephant calf, cow milk diluted with fresh clean water in ratio of 2:1 to 1:1 is considered. Krishnamurthy (1989) has suggested certain requirements for hand-rearing of elephant calves mentioned as below.

(i) The first faecal matter is expected after the first feeding. Calf after birth is able to be up on its legs within 5-10 minutes and suckle at the breast of its mother within an hour.

(ii) During the first three months the calf is exclusively dependant on the mother's milk and feeds at frequent intervals ranging from 60-90 minutes. During this time period the calf always stays close to the mother and follows her to the grazing area.

(iii) It is able to nibble at grass between 3-6 months of age and also continues breast feeding frequently at the same rate.

(iv) Coprophagy (eating the freshly dropped dung of its mother) is often observed among calves.

(v) Calves getting adequate milk show a growth rate of 2-3 cm per month.

(vi) Six to twelve months old calves feed on various types of fodder and gradually suckling frequency becomes less and intervals vary from 120 to 180 minutes.

Case 1 : History : Zoological Garden, Mysore (Karnataka) received one month old elephant calf in poor condition deserted by mother in the wild and was hand reared (Krishna Gowda, 1962).

Diet : (i) Calf was given for 1 to 1.5 months,0.568 litre(1 pint) buffalo milk, mixed with 0.568 litre (1 pint) boiled water and 8 teaspoonful glucose, six times per day. Two teaspoonful gripe syrup, 2 teaspoonful multivitamin syrup and 2 yeast tablets per day were also given.

(ii) Up to 3 Months : 0.852 litre (1.5 pint buffalo milk, 8 teaspoons glucose, six times per day. 2 teaspoonful gripe syrup, 2 teaspoonful multivitamin syrup and 2 yeast tablets also once per day.

(iii) When 3-4 months old: 1.136 litre (2 pints) buffalo milk with 8 teaspoons glucose, four times per day were given regularly. In addition, supplements too were given. About half kg rice-gruel with little milk and 75 g ghee (clarified butter) were also fed once per day.

(iv) When 4-6 months old :1.136 litre (Two pints) buffalo milk with 8 tea spoons glucose, four times per day. Two tea spoons gripe syrup, 2 teaspoonful multivitamin syrup and 3 yeast tablets were also given per day. Also half kg rice- gruel with milk, 2 tablespoonful oats and 114 g ghee per day.

(v) When 6-12 months old : 3.408 litres (Six pints) buffalo milk with 8 teaspoons glucose, twice per day. 2 teaspoonful gripe syrup, 2 teaspoonful multivitamin syrup and 3 yeast tablets per day. About one kg cooked rice with unrefined sugar were gradually raised to 3 kg rice per day. The quantity of ghee was raised to 151 g per day. Green grass and green leaves were also freely fed.

Case 2 : A two months old elephant calf received from the forest was sent to Zoological Garden, Mysore for rearing. The calf was emaciated. It was fed with cow milk, rice gruel, bread and feed supplements and jaggery. Gradually, the calf was provided grass and sugarcane and it started growing well (Annual Report, Mysore Zoo, 1986-87).

Case 3 : On 15th April, 1990 one about 3 months old female calf having severe wounds and abrasions on both sides of the body and on the ears was rescued from a pit in Mudumalai (Tamil Nadu) and was handed over to Zoological Park, Chennai (Madras). It was hand reared and medical aid provided.

Diet : The calf was given cow milk after cooling with glucose. The wounds were treated. From 20th April, 1990 and onwards the calf was fed with milk containing Amul spray and Cerelec mixed in warm water. Using a clean rubber hose with one end dipped to a bottle containing milk, the other end of the hose was carefully placed well back into the pharynx. Vitamins - B complex and ABDEC drops were mixed in the milk. To satisfy the hunger with increase in age of the calf, milk quantity was increased but care was taken to avoid over feeding. The increase of body weight was about 454 g per day (Chakravarty *et al*. 1991)

Cases 4 and 5 : At 7:20 p.m. on 7th November, 1996 Pavan kali (*E.maximus*) of National Park, Dudwa (UP) calved a female calf (named Laxmi). Delivery was almost normal. However, retention of placenta and development of metritis were the postpartum complications. Metritis was diagnosed for *Actinomyces (Corynebacterium) pyogenes* infection. Animal was treated for both the conditions. But the cow's udder dried. The calf was hand reared successfully on the diet schedule mentioned below

Diet schedule:

	On 23rd day onwards	
01.12.96	=	10 lit. milk + 10 lit. water
12.12.96	=	15 lit. milk + 15 lit. water
	On 65th day onwards	
12.01.97	=	15 lit. milk + 15 lit. water + 500 g rice + 500 g gur(kheer)
19.01.97	=	15 lit. milk + 10 lit. water + 500 g rice + 500 g gur(kheer)
	On 86th day onwards	
01.02.97	=	10 lit. milk + 10 lit. water + 1 kg rice + 500 g gur(kheer)
02.02.97	=	10 lit. milk + 10 lit. water + 1 kg rice + 500 g gur(kheer)
04.02.97	=	10 lit. milk + 10 lit. water

		+ 2 kg rice + 500 g gur(kheer)
09.02.97	=	10 lit. milk + 10 lit. water
		+ 1 kg rice + 5OO g gur
01.04.97	=	7 lit milk + 7 lit. water
		+ 1 kg rice + 500 g gur
08.04.97	=	15 lit milk + 10 lit. water
		+ 1 kg rice + 500 g gur
22.04.97	=	13 lit milk + 10 lit. water
		+ 1 kg rice + 500 g gur
01.05.97	=	15 lit. milk + 10 lit. water
		+ 1 kg rice + 500 g gur
01.06.97	=	10 lit. milk + 10 lit. water
		+ 1 kg rice + 500 g gur
	On 235th day onwards	
01.07.97	=	10 lit milk + 10 lit. water
		+ 2 kg rice + 500 g gur
	On 257th day onwards	
01.11.97	=	5 lit milk + 5 lit. water
		+2 kg rice + 500 g gur.

(Kaityar, R., Rupak De, and Arora, B.M.,during 1998 attended the case).

In this park hand rearing was necessitated when the cow elephant Pushpakali had given birth to a healthy male calf on 16 th July 1999 at 22 hours. The calf was measured. It was 90 kg in body weight and 103 cm in length (head to base of tail along the spinal curve). Its height at shoulder was 90 cm and chest girth measured 112 cm. The mother assisted the calf for suckling. However, it was only at 4.10 a.m. onwards the calf had started attempting suckling at very frequent intervals but only for a few seconds. This phenomenon continued till next day (17.7.1999). The calf was examined and it was presumed that mother's udder was having insufficient milk or calf was feeling difficulty in approaching comfortably for suckling the udder.Then it was decided to i) raise the ground level under body area of its dam, ii) to administer 10 to 12 tablets of Leptaden (Alarsin Post Box, MIDC, Andheri (E), Mumbai-93) to mother in roti and iii) to feed the calf about 3 litres diluted cow milk (1:1 with sterilized water) @ 750 ml at 4 hrs interval per day till calf was able to suckle completely the mother's milk on its own. From 1st and 13th August the quantities of diluted cow milk per day were increased to 5 and 7 liters respectively. At 1 month of age calf weiged 135 kg and was reported hale and hearty suckling the mother without any assistance (Author attended the case)

Case 6 : In the month of November, 1987 a herd of elephants (*E. maximus*) numbering about 50 came to forests of Midnapore District of West Bengal from the Dolma Wildlife Sanctuary in Bihar. This herd gave birth to six elephant calves between December 1987 and January 1988 while moving into the Batsole forest area in the Naya Basant Forest Range. One of the calves (birth date or age not mentioned but estimated to be born on 29th/30th December, 1988), fell into a 4.55m (15 feet) deep well one evening. The herd trumpeted at the place the whole

night and left after failing to rescue the calf. Next morning the calf, was rescued by the nearby villagers. The villagers took the calf to their home and nursed it with milk. The abandoned calf thereafter, was brought to Midnapore town and put in a shed of the forest department and was also treated for the body injuries. It was given buffalo milk and other feeds as prescribed by the Veterinary doctors. Then on 5th January 1988 the calf was handed over to the Zoological Garden, Calcutta, WB (Das and Nandi, 1989).

Diet : On arrival the baby elephant in the zoo was fed daily up to 30th March, 1988 with 10 litres of cow milk, which was diluted by adding 5 litres of water. During the first 12 days, feedings were given at an interval of 2 hours starting from 6 a.m. and the last feed was given at 10 p.m.

Farex (75 g was added in the three feeds of the calf during the first 3 days of its arrival at the zoo. Thereafter the quantity of Farex was gradually increased up to 300 g per day and fed with two milk feeds.

Vitamins A,D,B_{12} and C were administered along with the two feeds during the first 18 days. Vitamins B - Complex and C were given in the feed from the 3rd day of its arrival up to 9th day. Chira 100 g (crushed paddy) soaked in water was added in 3 milk feeds and 200 g boiled rice also added on the 9th day of its arrival. Gradually the quantity of chira was increased to 800 g on 31st day and of rice to 1800 g at the end of 102 days. Thereafter, the quantity of chira was reduced to 600 g by 48th day. Gram powder 50 g was introduced on the 31st day of its arrival and gradually increased to 600 g. Boiled carrot 200 g was given in the feed on the 49th day and gradually its quantity increased to 700 g. Eight pieces of banana (4 in each feed) were introduced in the feed on the 55th day and gradually increased to 20 pieces. Tomato juice (250 g) which was increased to 400 g was given up to 8th day and thereafter orange juice of 4 pieces of oranges was introduced and the number of oranges gradually increased to 7 pieces. With the increase of solid food the quantity of milk was decreased from 10 litres to 8 litres diluted by adding 4 litres of water.

It was observed that the baby elephant did not take any solid food unless it was mixed with milk. Water was acceptable to it after 57 days of its arrival. The feeding was done through a polythene feeding bottle of 1 litre capacity (without nipple) by holding the trunk of the calf and placing the feeding bottle just over its tongue. It was also observed that the calf went to sleep at the end of each feed, up to 30 days of its arrival (age approx. 2 months).The body measurements of elephant calf were as follows.

When measured	Weight (kg)	Body length (cm)	Height (cm)	Girth (Chest) (cm)	Tail length (cm)
At Arrival	120	86	86	141.68	55.66
At 118th day	214	111.32	98.67	187.22	65.78

Crandall (1965) mentioned heights of new born young elephant calves ranging from 75.9cm (2 feet 6 inches) to 91.08 cm (3 feet) and weights from 79.38 kg to 96.84 kg. This calf attained the shoulder height of 98.67cm (3 feet 3 inches) at

the age of 145 days indicating its normal growth. Although Crandall (1965) has reported that both male and female elephant calves attained the height of 3 feet in the first year, the weight of the calf after its arrival increased progressively on an average 7 kg per week excepting in the last week of March 1988 when there was no increase in weight as the calf suffered from diarrhoea. Overall, the calf on an average gained 0.79 kg. of weight per day and gained the additional height of 12.67 cm (5 inches) in 118 days. The animal expired on 2nd August, 1988 due to pyemia caused by *Streptococcal* infection initiated by foreign particles in the intestine.

Case 7 : The climate of Assam is tropical, hot and humid and there are always heavy rainfalls between July and October. Brahmputra, Manus and other rivers of the State often flow above the flood marks thereby, causing inundation of State National Parks and Sanctuaries. Hence, the terrestrial mammalian fauna suffer heavy losses due to water logging in their habitats for long periods. Many infants of mammalian species are swept away in deluge and die. Some are trapped in water logged areas and are found crying for their mothers. Whenever they are noticed by the patrolling forest party, they are rescued and handed over to State Zoological Garden, Guwahati. Most of such cases are stressed and often also have some inflicted injuries on their bodies. Some of them may suffer from infectious diseases. When they are undertaken for hand rearing, they cry for some days and are reluctant to suckle milk from the feeding bottles. But gradually they become cooperative with their keepers. Thakuria *et al.* (1996) have given the modus operandi for the hand rearing of one to three months old orphaned elephant calves which were received from forests, and is briefly reproduced as below.

Diet schedule :

For 0 - 3 months infant : Lactogen powder (milk powder)- 500 g is mixed with luke-warm water and infants are fed at least 7 times at two- hour - intervals. Feeding bottle is prepared with the help of a 750 ml conical glass bottle fitted with a piece of rubber nipple.

For 3 - 6 months calf : Diet is made of Lactogen powder - 1 kg, boiled rice - 1/2 kg, sugar - 50 g prepared in luke warm water and drenched.

Note: Feeding of calves with boiled barley is not advised as it causes acute flatulence, discomfort and colicy pain. It was found that feeding with Lactogen milk was without the above effects; hence, recommended as food for hand- rearing elephant calves .With sugar, the boiled rice gave good results.

For 6 - 12 months calf : Diet includes Lactogen powder - 1 kg, sugar - 100 g, Athia banana (Assamese special type of banana) - 4 nos, rice - 1 kg and masur dal - 250 g. Diet is prepared by mixing properly with luke warm water with sugar and Athia banana (without seeds) and fed to the calves with the help of feeding bottle 5 times a day. "Khichri" is prepared by cooking rice and masur dal and offered to the calves 2 times a day.

For 12 - 15 months calf : Diet consists of Lactogen powder - 1.5 kg, sugar 100 g, Athia banana - 10 nos, rice - 1 kg, masur dal-1kg, and soaked whole gram - 1 kg. It is prepared as mentioned for calves 6 to 12 months old and given 4 - 5 times a day. Khichiri and soaked whole gram are given twice a day.

For 15 - 24 months calf : Diet as recommended for calves aged 12 to 15 months. The banana tree with leaves - 1 no and dol grass-50 kg are fed extra. Also grazing on natural vegetation.

For 2 - 6 years (sub-adult) : When the calves attain an average age of about two years, milk powder and sugar are withdrawn from the diet schedule and replaced by soaked whole gram 2 kg, sugar cane - 1 kg, Athia banana - 10 nos, molasses - 200 g, garlic - 25 g, turmeric (green) - 20 g, black salt - 250 g, common salt - 25 g dol grass - 1 quintal and banana tree with leaves - 2-3 nos. Also grazing is allowed on natural vegetation for 2-3 hours.

For over 6 years old (sub-adult) : Soaked whole gram - 4 kg, sugarcane - 1 kg, Athia banana - 10 nos,molasses - 200 g, garlic - 50 g, turmeric (green) - 20 g, black salt - 500 g (quantity seems to be higher !), common salt - 50 g, dol grass - 1 quintal and banana tree with leaves - 4 nos. Also grazing on natural vegetation for 2 - 3 hours.

Case 8 : Devaraj (1992) prescribed that once the elephant calves immune status is established the artificial diet formula mentioned as follows, can be introduced. Rice (cooked) 500 g, Boiled cow milk 500 ml, Sucrose 200 g, Water 8 litres, Soya protein 200 g, Bone meal 825 mg (Ca:P = 4:1) and multivitamins.

Amounts required and feeding schedules can vary among individual calves. Very young calves should be fed every two to three hours round the clock. As the calf attains age of 2 to 3 months, night feeding can gradually be dropped from the schedule but this will vary among individuals. By the time the calf is nine months old as few as 4 feedings per day may be adequate. Beyond this age the number of feedings per day will be determined by the calf's growth rate and the amount it may be able to happily consume per feeding, without being overfed. It is always better to leave the calf little hungry rather than to over-feed. Over-feeding is potentially far more harmful than slight under feeding. At the age of 12-15 months the calves adopt well to a diet of solid food. Generally, elephant calves should gain weight at the rate of 0.5 to 1.5 kg per day for extended period of time. Elephants have six complete sets of grinding teeth (molars) during life. The new born calf has one or two molars at birth. The first set of molars wear away and roots are resorbed as the second molars come forward. So from six months onwards small tender grass, chopped tender leaves or tender bamboo shoots may be introduced. This will vary with individuals to supplement their artifical diet. If the calf starts feeding gradually the quantity should be increased.

Case 9 : In Sept., 1994, one 4 months old elephant calf (female) was rescued from the flood waters near Sahebpara village of the Belakoba Range in Baikunthapur Forest Division of West Bengal. An attempt was made to introduce the calf with one of the three lactating cow elephants stationed at Wildlife Sanctuary, Jaldapara. Only Champakali accepted the calf readily, she already had a six months old suckling calf. The calf was treated for body wounds and injury and also dewormed with albendazole and fenbendazole, respectively for *Fasciola* and *Strongyles*. The daily ration schedule during the first two months of arrival is mentioned in the table 55. Boiled rice, dal, molasses and salt were mixed with Lactogen (in lukewarm water properly) and drenched in divided doses at about two hours intervals. For the

entire two months period the ingredients were mixed and drenched in the same schedule. Towards the end of this period the calf started using its trunk for feeding (Mukerjee *et al.*, 1997).

Table 55 : Diet (in kg) composition of the orphaned elephant calf (Mukharjee *et al.*, 1997)

Ingredients	First 15 days	Next 15 days	Next 15 days	Next 15 days
Lactogen-1	0.500	0.800	-	-
Lactogen-2	-	-	1.000	1.500
Boiled rice	1.000	11.000	1.000	1.000
Daal(Masur/Lentil)	0.200	0.250	0.250	0.300
Boiledsoyabean*	-	0.250	0.300	0.500
Germinatedgram**	-	0.100	0.150	0.250
Molasses	0.025	0.050	0.075	0.100
Salt	0.020	0.025	0.025	0.025
Ripebanana	-	-	10 nos	12 nos

* Boiled soyabeen given as a paste during the second 15 days.

Case 10 : On 12.9.1998 one female elephant calf aged approx 2 months was rescued from a trench of Chandaka Reserve Forest by the villagers of Chandaka. They kept it in their custody overnight and attempted to feed the calf with cow milk. But as reported the cow milk was not accepted by the baby elephant.

On intimation, the authority of Nandankanan Zoo, Bhubaneshwar advised the villagers to leave the calf near the trench from where it was rescued to which the villagers obliged the next day i.e. on 13.9.98. From nearby hideouts observations were carried out by the zoo authority. It was observed that in the afternoon the elephant herd came to that place i.e. nearer the trench. The mother elephant came closer to the calf, smelt different portions of its baby from different angles and finally left the calf abandoned. It followed the other members of the herd that was moving out from the area. The calf then moved a few yards but could not catch its mother. Then the calf was retrieved and brought back to the zoo and housed in an enclosure. The calf was named HIRA. The rectal temp. and the body weight were recorded as 36.7° C (98°F) and 91 kg, respectively. The animal was dull, depressed and having fearing tendency and marked lachrymation.

Health care and management: First of all the baby calf was given 500 g Amul milk powder dissolved in water, added with gripe water 20 ml, glucose 50 g, vimeral 2.5 ml as bottle feed 5 times at 4 hr. intervals in divided doses. Faecal sample was examined within the first week of its arrival which was found to be positive for *Ascaris* eggs. The calf was treated with Piperazine @ 200 mg/ kg body weight orally once. The animal showed signs of improved health after a couple of weeks. After 1 month of rescue, during October due to low temp. at night of 10°C, protective measures were taken by way of hanging gunny bags at the door and windows of the stable and providing 2 nos of 200 wt. bulb heat at night in addition to straw bedding on the floor. The calf adopted well to this artificially created warm condition. By the time it reached 4 months of age, the calf was trained for half a kilometer walk inside zoo as a routine morning schedule. At the age of four and half months, lake water bathing was practiced for the calf during mid- noon. At 6 months of age, a single dose of FMD vaccine (10 ml) was given s/c. At the age of 7 months, one

day the baby calf showed signs of dyspnoea, high temp. (100°F) and frequent coughing. On auscultation the fluid rales suggested that the animal may be suffering form aspiration pneumonia due to faulty drenching of the gruel. It was treated with Taxim 1 g. daily for 5 days including decadron 2 ml i/m and Ascoril - 5 ml orally twice a day for a week and the calf recovered. From 9 month onwards concentrate feed (crushed and cooked) was provided along with milk. By the time the baby elephant reached 1 yr. of age, 1 kg banana and 1 kg dry wheat were added to its diet with supplementation of 10 kg of tree fodder, grass and bamboo leaves each as per the acceptance. With provision of good feed and optimal management conditions the elephant calf adopted well to the zoo environment. Now at its present age of 1 yr. 2 months, the elephant calf at Nandankanan zoo is quite hale and hearty (Samantaray and Sahoo, 1999).

The accompanying table 56 furnishes the diet regimen adopted for rearing the rescued baby elephant.

Table 56 : Feed (in kg) regimen for an orphan male *Elephas maximus* calf (Samantaray and Sahoo, 1999).

Food items	0-3 mon.	3-6 mon.	6-9 mon.	9-12 mon.	Remarks
Amul milk	0.500	1.000	1.200	1.200	-
Cerelac	0.400	0.400	0.600	0.400	With Amul milk.
Glucose	0.050	0.100	0.050	0.050	-
Gripe water	20 ml	20 ml	20 ml	20 ml	-
Ostocal	-	-	20 ml	20 ml	-
Vimeral	2.5 ml	5 ml	5 ml	-	Once in week
Crushed ragi	-	-	-	0.100	Cooked in milk; drenched as gruel 5 times daily.
Crushed rice	-	-	-	0.050	
Crushed Wheat	-	-	-	0.050	
jaggery	-	-	-	0.050	
Turmeric	-	-	-	0.005	

Comments : (i) If an elephant calf from the wild is separated and is managed by human beings, and after some days the calf is released back in nature to mix with mother, it may not be accepted by the mother as well as the herd. (ii) Amul milk is more suitable for calf than cow's milk (iii) usually calf is weand between 16 to 20 months age.

VI. Perissodactylids

During the floods of 1998 in Kaziranga National Park several animals were washed away. One such animal on 26 October 1998 a female rhino (*Rhinoceros unicornis*) aged about 40 days old was swept away by flood water from her mother and was rescued from Kohora range of Kaziranga. The plight of the rhino calf was seen by the forest guards who timely managed to rescue the calf and brought it to the Range Office. The officials of the Range made efforts to keep the rhino well by hand feeding with diluted cow milk. The animal was named as Lahorani. Veterinary Officer, Zoological Garden, Guwahati visited Kaziranga National Park. and attended sick and injured female baby rhino stationed at the Range Office. It was found to be normal. Range Officer was adviced to make arrangements to shift the animal to the State Zoo, Guwahati, where husbandry and health care measurements could

be taken properly. After one month, the rhino calf was shifted to the Zoo. At the Zoo she was given a complete milk diet. The animal suffered from bouts of diarrhoea at frequent intervals but was treated successfully with;

Furazolidone tab = At (5 mg/kg) twice a day.
Liv. 52 syrup = 2 tsf daily two times before feeding.
Electral powder = 35 mg pkt daily twice with water.

She was dewormed with Mebendazole tab. Dose given was 8 mg/kg (single dose). To get rid of parasitic infestation the prophylactic deworming was scheduled at an interval of 3 months.

She gained weight and started nibbling the fresh grasses from the age of 6 months onwards. Quantity of milk was gradually reduced, since she started feeding on diet comprised of concentrates and green fodder. Water was provided ad lib. At the age of 9 months she was absolutely maintained on the green fodder and concentrates(Kakati, 1999).

Detailed diet regimen is entered in the accompanying table 57

Table 57: Feeding schedule of baby rhino (*R. unicornis*) per day (Kakati, 1999).

Age (days)	Diet	Feeding time table	per day	Others
30-60	(a) 12 litres lactogen (@50 g/lit water)	6 a.m 10 a.m 2 p.m 6 p.m 10 p.m 2 a.m	6 times 2 litres at a time	50 gm glucon D mixed with water (morning + evening) (not continuously)
60-90	-do-	-do-	-do-	
90-120	(a) 12 litres lactogen (@50 g/lit water)	6 a.m 2 p.m 10 p.m 2 a.m 10 a.m 6 p.m	(a) 4 times two and 3/4 litres at a time. (b) Cerelac feeding	Liv. 52 syrup 2 tsf. daily twice weekly Water given
120-150	-do-	-do-		-do-
150-180	(a) 10 lit. (lactogen @50 g/litre water) (c) Rice (crushed)150g+ (d)Vegetable leaves.	6 a.m 2 p.m 10 p.m 2 a.m 10 a.m. 6 p.m.	(a) 4 times two and half litres at a (c)2 lit. at	Electrol powder 35g twice daily with drinking water some time a times.
180-210	(a) 8 litres (lactogen @50 g/lit. water) (c)Rice crush 250g (e) Greengrass	6 a.m. 2 p.m. 10 pm 2 a.m. 10 a.m. 6 p.m	(a) 4 times two litre at a time (c) Rice (crushed) 2 times	Drinking water ad lib. 2.5 kg green grass (morning and evening)

Some more reports on handrearing of Rhino calves are avaliable but not discussed.

♦♦♦

V. DISEASES & DISORDERS

General : Evaluation of the nutritional status of the free living animals is very difficult unless sick or freshly dead specimens are not studied and habitat soil and its vegetation is not analysed. In captivity the animals are under direct observation and can be monitored in respect of their health condition (diminished appetite, weight loss, anorexic condition) by assessing feeding behaviour, size, vigour, weight, fertility, mortality, population growth, etc. Represssion of growth, delayed sexual maturity, low conception rates and increased intrauterine mortality indicate poor malnourished. Reduced physical condition in adult individuals is marked by increased prominence of bones (back bone, shoulder, pelvis, etc.) due to atrophy of fat and muscles. Severely malnourished animals will often have listless appearance and rough hair coat. Provision of unbalanced diet particularly during pregnancy as in case of domestic livestock and human beings affects the fertilization and development of foetuses in wild mammals.

Diagnosis of malnutrition after death is relatively easy. Post mortem examination of an emaciated animal should be thorough in order to rule out diseases which have malnutrition as a sign. The most obvious and important gross change is lack of fat in normal depots in the subcutaneous, cardiac, omental, renal and bone marrow regions. In a severely malnourished animal fatty tissue in these areas will take on a gelatinous appearance that is referred to as serious atrophy of fat. Bone marrow in the long bones of the legs (femur, humerus) should be examined. Estimates of bone marrow fat of growing animals must be made with care because of the normal reddish colour and small amount of fat stored in this location in young animals. Besides fat indices, development and beam diameters of antlers in deer species are also affected by many nutritional factors. Minerals such as calcium and phosphorus have marked effect on antlers' growth, as also in cases of deficiencies of both energy and protein. Rumen contents should be examined for quality and quantity of ingesta. A full rumen does not rule out malnutrition as a cause of death. Vitamin deficiencies in mammals in captivity at their growing stage are required to be evaluated.

1. Food related problems. Malnutrition is defined as a state of ineffective or deficient procurement, ingestion, digestion, absorption and utilizaiton of food. Starvation, by contrast, refers to a condition arising from prolonged deprivation of food. Young animals are most severely affected in situations of limited feed intake because they have higher nutritional demands associated with growth and greater heat loss due to smaller body size, lack of fat reserves and subordination in the social hierarchy resulting in decreased access to feed. Generally, carnivores and ectotherms tolerate starvation better than herbivores and endotherms but all endotherm use vital protein after 2-3 days of starvation.Acute loss of 10% body weight or chronic loss of body weight signals anorexia and animal needs nutritional support. Situations which can lead to malnutrition include poor or limited ranges (both winter and summer ranges), severe environmental conditions increasing energy demands, and diseases or injuries decreasing the ability of an animal to procure and utilize food. It is easy

to blame the deaths of many animals due to pathogens, but it is far less easy to determine that the animal died from deleterious food supply or nutritional deficiency. Even if the food supply remained constant the increasing population would make less food available per capita. The surplus individuals, usually juveniles or subordinates living at or near carrying capacity have two opt ions either to stay and perish or have to leave the area. If they move out, the odds will be greater and they will have to survive predators, diseases, accidents and even starvation.

(i) Quality of carbohydrates: A food having higher cellulose content cosists of more woodier plants and has comparatively less food value for most animals. Animals with pregastric fermentation may suffer from inadequate fiber content in their food. It would be practically very difficult and expensive to formulate animal diets without using ingredients containing carbohydrates. It has been reported that less than 7.0% dietary crude fibre would increase morbidity. Coarse hay/ fodder feeding to weaned fawns and calves may cause erosions and ulcers in their stomachs, since they adopt slowly to roughage digestion. Similarly weaned fawns and calves should not be offered diets containing milk because developing intestinal tissues lead to decrease in capacity for production of lactase for digestion of milk lactose. Ensley *et al.* (1982) and his colleaques have evidenced that when a diet including Acacia leaves is fed to captive langurs, digestive disturbances and subsequently deaths of some langurs were encountered. Food low energy levels in ruminants in last stage of pregnancy may affect development and parturition and directly following parturition, low energy levels may adversely affect rebreeding by anestrous in the begnning of the breeding season or female may not conceive at all.

(ii) Deficiency of essential fatty acids (EFA): Essential fatty acids are of lesser concern in feeding of animals since a good variety of foods provide the necessary amounts of essential fatty acids. As vitamins A, D and K combine with fats in food, a totally fat-free diet would lead to vitamin deficiencies leading to loss of hair, scaly skin, coarse dry hair coat, parakeratosis of the epidermis, sub- cutaneous haemorrhages, increased susceptibility to skin infection, impaired growth, reproductive failure, etc. 1-2 % of total caloric requirements supplied as linoleic acid can prevent EFA deficiency in primates.

(iii) Deficiency of protein: Ruminants do not need dietary requirement of essential amino acids once their gastric microfauna is established. In monogastric animals 10 amino acids are essential which cannot be synthesied by the animals, though the animals need all 20 amino acids. Protein deficiency may cause, lower reproduction, lighter birth weights and delay heat cycle, depression of growth, lactation, plasma albumin and resistance to diseases in carnivore species. The foods containing complete protein requirements are milk, meat, fish and animals.In extreme cases in short supply of carbohydrates to maintain the energy supply to glucose dependent cells, tissue protein is mobilized. In such cases size and function of vital organs is also affected.

(iv) Deficiencies of minerals and vitamins. The mineral levels in plants and animal foods vary considerably for species to species between young and old animals

and regions. Minerals needed in relatively large amounts are calcium (Ca), phosphorus (P), sodium (Na), potassium (K), magnesium (Mg), sulphur (S) and chloride (Cl).The trace elements: iodine (I), iron (Fe),copper (Cu), selenium (Se), zinc(Zn), mangnese (Mn) are required in very small quantities but nevertheless they are important elements. Growing, pregnant and lactating animals have higher demands for minerals. Vitamin D is necessary for absorption of calcium. Antlers growth in cervids need higher levels of calcium. Calcium and phosphorus ratio needs to be checked particularly in carnivorous species and quantities of sodium, phosphorus and calcium in elephants. Sukumar (1989) described that calcium content of dicotyledonous bark was much higher than that of grasses. Hence, supplementing the elephant diets with bark would certainly increase the calcium intakes to safe levels. The temple and zoo elephants do not have the chance to eat bark unless provided.

The common disorders noticed among the felines are metabolic bone diseases such as rickets and osteomalacia due to calcium and vitamin D deficiency. The disorders are easily discerned by the enlargement of bones and bending and painful condition of the long bones on palpation.Renal cortical atrophy and fibrosing renal disease have also been reported in large carnivores fed only muscle meat. Early recognition helps in correcting the maladies by providing adequate calcium and vitamin D. The calcium should be in the proportion 1.4:1 to 1:1 to phosphorus for ideal conditions (Merk Veterinary Manual). The tolerance range is 2:1 to 1:2 Ca:P. In certain fodders the ratio is extremely varied, therefore balanced and supplented ration is required. Otherwise biochemical imbalance may result to toxic reaction In mustelids. The ash content of the mustelid diet should range between 7 to 8% on dry matter basis.Their levels should be kept at aboult 0.4% of the diet on dry weight basis(Wallach and Hoff, 1982).The typical diet of fruits, vegetables, and bread offered to the primates is deficient in both P and Ca, but lower in Ca (Wallach and Hoff, 1982). In primates 'Dropped Wrist' and 'Sickle shin' syndromes, lordosis, scoliosis, and kyphosis are typical deformities described to vitamin D_3 deficiency. The chronic Ca deficiency in primate causesis fibrous osteodystrophy of the maxilla and mandible with separation and loss of teeth(Wallach and Hoff, 1982). Iodine deficiency also causes impaired in reproduction but no report is on record in our native wild mammalian species, so for.

Iron deficiency is not uncommon in cubs raised on milk or its substitute. It is well known that milk is very poor in iron content. The diagnosis is not difficult if the haematological examination is made for haemoglobin, red cell count and packed cell volume. Similarly, iodine deficiency can be detected by thyroid enlargement and bilateral posterior alopecia in animals fed only on muscle meat. Copper, manganese and zinc deficiencies are also described for poor growth, flat foot, etc.in domestic livestock.However, such reports are lacking in wild mammals.

Vitamin A, B and C deficiencies have been encountered in various species. Vitamin A deficiency may lead to loss of skin lustre and poor reproduction. Its severe deficiency in pregnant females may lead to birth of weak, malformed, or stillbirth offspring and xerophthalmia in growing individuals. Congenital defects

include opaque cornea, etc. Hyper-vitaminosis A is also seen where there is excessive feeding of liver showing symptoms of peri- articular exostoses limiting the movements.Vitamin C deficiency in primates causes scurvy and lack of resistance against infectious diseases in animals.Vitamin B_1(Thiamin) deficiency in non -ruminant mammalian species causes polyneuritis or Chastek paralysis/ syndrome (characterized by anorexia, salivation, ataxis, incoordination, pupillary dilatation, and suluggish reflexes. Convulsious are easily induced and are characterized by a strong ventroflexion of the head. Even at this stage of the syndrome, animals will respond rapidly to parenteral vitamin B_1, After two to three days of the severe neurological signs, animals pass into an irreversible phase of semicoma, opisthotonus, continual crying, and spasticity - Wallach and Hoff, 1982). The deficiency of B_1 is induced by a thiaminase present in certain fish as the enzymes destroys dietary B_1. In mustelids diagnosis of vitamin B_1 deficiency is made by utilizing the clinical signs, dietary history, and lesions. Postmortem lesions of the deficiency are characterized as emaciation, right ventricular Microscopically, lesions of the cnetral nervous system include edema, vascular dilatation, ventricular gray matter. Treatment of vitamin B_1 deficiency should include correction of the diet and parenteral administration of vitamin, B_1 at 5 mg/day until signs subside (Wallach and Hoff, 1982). In primates the deficiencey is designated cage paralysis syndrome, including enteritis, dilatation of the right ventricle, emaciation, a marked plantigrade gait, and paraplegic state, may be produced by chronic deficiencies of vitamin B_1. This syndrome is produced in primates fed a high proportion of fruit and vegetables and may be particularly pronounced in the smaller primate species that have a limited stomach capacity. Parenteral administration of 25 mg of vitamin B_1 with a subsequent increase in dietary vitamin B_1 and energy levels usually produces a rapid clinical recovery (Wallach and Hoff, 1982). Long term deficiency of biotin results in a progressive paralysis in mustelids. Raw eggs should not be fed regularly as the biotinase content of the albumin willl result in biotin deficiency. Treatment includes parenteral biotin 1 mg twice/week or 1 mg/kg of feed/day (Wallach and Hoff, 1982). Vitamin B_2 deficiency in primates produces retarded growth. dermatitis, alopecia, glossitis, cession of the estrous cycle, and testicular atrophy. Dietary levels of 100 mg/day will reverse and prevent clinical signs (Wallach and Hoff, 1982). Deficiency of vitamin E has been reported to cause myocardial degeneration, skeletal muscle weakness in elephants and rhinoceroses (Chakarborty,1995).

Note: Author had the experience to treat forelimb weakness without muscular dystrophy in case of one 8-month-old female blackbuck (Antilope cervicapra) maintained at National Zoological Park, Delhi. The animal showed difficulty in bearing weight of its body, walking and getting up on its fore limbs. She was administered 1 ml Macalvit (Calcium gluconolactobionate 137 mg, B_{12} 50 mg and D3 500 I.U) i/m for about a week and became absolutely alright then after. The exact cause of the condition could not be specified.

(v) Nutritional osteodystrophies: The manifestations of the nutritional dystrophies are osteoporosis, rickets, osteomalacia and osteodystrophia fibrosa. Most osteodystrophies result from more than one dietary imbalance and this makes the etiologic diagnosis of the condition more difficult.

(a) Rickets : It is the disease of growing bones,due to deficiency of vitamin D or lack of ultra violet rays of the sun. Still , work on the problem is required in respect of its etiology in wild carnivore , particularly in case of large cats. The defect in matrix mineralization in both rickets and osteomalacia has been attributed to local reduction in the ionic product of Ca and P.

Case 1 : Rickets is reported to be a major problem in siberian tiger and snow leopard in Zoological Garden, Darjeeling. Adequate supplementation of calcum, phosphorus and vitamin D3 is found to be of little help (Zoo Annual reports 1996-97 and 1997-98).

Case 2 : During night of 17-18th August,1996 in Gemini circus while stationed at Bareilly, an 8 - year - old tigrees had given birth to 3 cubs: one male and 2 females. All the 3 cubs used to suckle their mother and were developing normally. On the 10th day they had opened their eyes and from 13th day of the age they had started standing and walking a little. Surprisingly, on the last day of 4th week of their life all the 3 cubs developed quadriplegia, which progressed further. The cubs remained lying on their sternal recumbency with their fore and hind limbs completely spread away from the body, unable to position themselves and approach their mother for suckling on their own. Hence, with the help of a specially devised wooden plank they were pushed up to mother's abdomen to enable them to suckle. But this practice was found not much fruitful. Then the animal keeper of the circus devised to keep all the cubs on sling for regular exercise and fed diluted cow milk mixed with vitamins - A B D E C(Parke- Davis) drops and ostocalcium (Syndoze). At times suckling mother was also assisted. The cubs showed some improvement after 5th day of medical aid. The problem was tentatively diagnosed for rickets and analysis of blood for Ca and P besides the X-ray was advised to the owner. Unfortunately, the circus moved out of Bareilly and the cases could not be pursued. During 1990 in National Zoo one of the 2 tiger cubs born had bowed fore legs. X-ray examination showed extra ordinary widening of the epiphysis in its humerus. Therefore, occurrence of congenital rickets could not be ruled out.

(b) Osteomalacia : It is a disease of mature bones. Its cause is described under rickets.

Case 1 : An adult male jaguar (*P. onca*) died on 10th Jan., 1999 in Zoological Park, Kanpur (UP). The details of the history were not made available at the time of its death. On enquiry it was known that the animal had ambulatory problem and progressive anorexia. Necropsy showed skeletal abnormalities such as exostoses of spinous processes of T1-2, L-1 and L-2 vertebrae , olecranon process of ulnas, formation of hard growth (indistinguishable from bone in distal half of the tibia and fibula) and a healed fracture on ventral aspect of bodies of T11 to T13 vertebrae. Thoracic kyphosis was marked. Sample of normal scapula and abnormal growths on scapula and ulna were analysed for mineral contents. The total inorganic matter content (s) was found decreased by 10-15% in abnormal growth of bone compared to normal ones.In consonance with decreased mineral matter both Ca and P contents were lower in the growth part. However, phosphorus percentage in the mineral matter was little higher in ratio to Ca in the growth part. The chemical analysis is presented in the table 58.

Table 58 : Chemical analysis of bone specimens of Jaguar.

Bone specimen	Ca%	P%	Ash%	Silica (Acid insoluble Ash)
Seapula : a) Normal	20.61	10.31	51.53	0.55
: b) Growth	18.02	9.61	45.05	0.00
Ulna : a) Normal	23.56	11.78	58.88	0.33
: b) Growth	18.93	9.97	47.34	0.15
Tibia and fibula : b) Growth	21.67	10.23	54.16	0.11

Case 2 : Bone elements of one Hyena (*H. hyaena*) collected from Zoological Garden, Lucknow (UP) were examined for abnormalities. Skull and mandible showed erosive and osteoporotic changes. Cranial margin of each thoracic vertebral body developed pointed excrescences beneath the vertebral discs lipping over the body of preceding vertebra. Bodies of 11th and 12th thoracic vertebrae were fused together. There were curvatures in shafts of both right and left humeruses. The changes could possibly be due to osteodystrophy.

(c) Osteodystrophia fibrosa: This condition causes paresis of limbs, bending of long bones and staggering in lions. The disease appears to be caused by low calcium to phosphorus ratio (1:20) in the diet besides the chronic renal diseae or parathyroid tumor. The calcium and phosphorus ratio should be in the ratio of 1:2. The buffalo beef is poor in calcium, therefore, supplementation with calcium of diets of tigers and lions is recommended. Wackernagel (1966) recommended supplementation of bovine beef with the following preparation, skim milk powder 42%, dry yeast 42%, bone meal 8%, calcium carbonate 3%, salt 2%, and vitamin premix 3%.Seven per cent of this mixture is to be added to the meat.

(vi) Limb paresis

Case 1 : During September, 1993 an adult large Indian civet (*Viverra zibetha*) suffered from paresis of hind limbs. The condition neither could be diagnosed for specific cause nor symptomatic treatment was found to be beneficial. A thought was given to provide some natural feed. The immediate express idea went to feed live fish to the civet, besides administration of injection of Berin (vit. B_1). About 250 gram live fish was provided daily besides the vegetable diet being offered. The civet liked live fish and used to consume the full quantity. In the first week there was some improvement in bearing the weight of body on hind limbs. The civet was also able to follow the hopping fish. From the second week onwards further improvement in the condition occurred. By 3rd week the animal was on its feet and the state of paresis was cured. After that, consumption of fish was reduced to about 50-100 grams and gradually civet was on its regular diet.

This deciphered that the animal had developed paresis of its hindlimbs due to deficiency of vitamin B_1 or calcium, or other elements which the live fish might have supplied. In captivity such civets are not cared much for supplementation of their

diets and are routinely maintained on unvaried food. The large Indian civet, in nature, in its diet, has a variety of vermins such as snakes, frogs, crabs and fruits in its menu.In captivity, such items are usually included in its diet.

Case 2 : A seventeen-year-old female Himalayan black bear (Seleractos thibetanus) was found unable to bear weight on both her hindlimbs and was dragging her body with the help of its forelimbs. It was then shifted to hospital on 4.7.1992. There it remained under treatment up to 18.10.1992 but to no avail. On 19.10.1992 the animal was shifted to a bigger cage adjacent to another blind female of the species. Both the animals were looked after very well and kept in isolation away from all the public disturbances. As a result of palliative measures the paralysed bear started taking weight on her hind legs and was fully recovered in the month of May, 1993. For proper management of such crippled individuals separate facilities in isolation should be established and sufficient care be rendered in providing enriched diet and environment.

Case 3 : An adult striped hyena at Zoological Park ,Chennai was marked for weakness in condition. The animal was found to be moving in lethargic manner with tremors and mild bowing of limbs within the confined place. Its blood picture was normal (PCV 36%, Hb 12%, RBC 56 m/cmm, WBC 9600 /cmm and DLC-59% Neutrophils and 41% Lymphocytes).Animal was negative for any kind of parasitic infection. The biochemical examination revealed the blood urea nitrogen(BUN) value of 48.2 mg per cent, serum creatinine value of 1 per cent ,serum total protein level of 7.8 per cent, calcium level of 21.5 mg per 100 ml and phosphorus level of 9.2 mg per 100 ml. The finding of imbalance of Ca : P was considered to be the cause for the condition in the hyena (Jayathangaraj, *et al.*1998).

(vii) Infertility : Three tigresses at Zoological Park, Hyderabad (A.P) were being maintained in different enclosures with male partners. They were coming into oestrus and matings were recorded but all proved to be futile. Considering nutritional infertility be in either sex , males were given B_{12} and Tentex forte orally and females were given half kg. raw liver and osteocalcium with B_{12} (Glaxo) 60 ml in milk for a period of 4-8 months regularly . All the three tigresses then conceived and delivered their cubs (Ali Khan, 1983)

(viii) Blindness : Several cases of corneal opacity have been recorded in free ranging and captive wild mammalian species. Non opacity blindness has been recorded in chinkara (*G.gazella*), nilgai(*B.tragocamelus*) and elephants(*Elephas maximus*). However, cause of the condition related to nutritional deficiency has not been determined.

(ix) Alopecia : Most hand-reared felids begin losing hair at 6 to 8 weeks of age (Kloss and Lang, 1982). Adding liver homogenate to the diet which is reported to be helpful in preventing and correcting alopecia and solid foods to diet of the weaning cubs helps to facilitate regeneration of hair coat, growth and general appearance.

(x) Inanition : In the areas above the alpine regions there is always shortage of feed in severe winter seasons. Similarly, in hard summers in tropical arid zones

there is also scarcity of natural food.In free ranging animals sporadic deaths of infants due to flood, storm, freezing etc. cannot be ruled out. Impact of environmental temperature is extremely important in zoological conditions too. If during hard winter, adequate food provisions are not made, the ambient temperature may cause stress and starvation. The deaths due to hypothermia and hyperthermia are the management associated problems.

Intimidation of the subordinates by stronger mates may be the cause of starvation in the former. In captivity predominance of adult males in small herd of nilgais, in the mixed populations of deer and antelope species and in congregation of both sexes of rhesus monkeys chronic debility due to deprivation of food have been encountered mostly in the female individuals due to dominance of the males.In recent years it has been observed in certain Zoological Parks that rhesus macaques have become nuisance not allowing the small deer and antelope species to eat their ration, green leguminous fodder as well as concentrates. A large number of macaques visit the enclosure immediately after the keeper supplies the ration to his animal stock. They chase the enclosure inhabitants (hog deer/ sika deer/barking deer/ chinkara/ blackbuck) and occupy the feeding trough and consume a large quantity of the ration.When any small true carnivore species escapes from its exhibits and remains couple of days out hidden in the zoo environment, it may die of starvation. A pangolin(*Manis crassicaudata*) escaped from Zoological Garden,Manipur and died of starvation (Ramakanta,1994).

Besides the nutritional problems, scarcity of water, particularly in the arid zones, makes the animals to travel long distances and during such moves, stress is very high. The animal populations around the water sources in such lean period are found unusually high and pose food problems. The results are poor nutrition, diseases and deaths in unduly stressed animals.

No zoo can be perfect in providing nutritional requirements to the wild animals. Generally, one type of food continuance is the practice. Therefore, the animal may develop distaste and start losing weight and vitality. As food ecology of wild animals is extremely varied and the ecology of the stomach is extensively complex and adapted to certain nutritional requirements, sudden introduction to controlled feeding in captivity causes changes in ecology of resident microbial fauna leading to anorexic conditions. A history of anorexia signals consideration of nutritional support although the duration of harmless anorexia varies with the species. Generally carnivores tolerate starvation better than herbivores. But endotherms use vital tissue protein after 2 to 3 days.

2. Pulmonary calcification- ossification : Under our project studies on wildlife disease investigation, three cases of pulmonary ossification were encountered in blackbucks (*A. cervicapra*). The findings being unique in nature are succinctly communicated herewith.

Out of three, in two cases gross examination of lungs revealed discolouration to dull, whitish-grey with occasional visibility of small flat chips of bony tissue under the pleura and embedded in the lung substance especially towards the edges of

the lobes. The size of bony spicules varied up to about 2 cm in length and 1 cm in breadth. The size of calcified areas, however, was much larger and thicker. On palpation irregular texture of the lung substance was perceived, which contained hard elements of bony pieces and larger areas of calcification.

On histological examination there were large areas in the lungs in which there was calcification of alveolar tissue undergoing degeneration and calcification. Amongst the calcified areas minute foci of bony spicules were noticed. The spicules of bones were also found independently of the calcified areas in the normal lung tissue without inciting any reaction. No bacterial or parasitic infection of the lungs was marked in any case. The condition was not found in co-inhabiting chitals. The etiology of the condition could not be established. However, it may be related to problem in calcium metabolism.

3. Obesity : In captivity cases of obesity are rarely encountered. Author has seen abnormally heavy weight Himalayan black bear (*Selenarectos thibetanus*) in Jodhpur zoo in 1999 and stump-tailed monkey (*Macaca speciosa/arectoides*) in Lucknow zoo,and sambars (*Cervus unicolor*) in Deer Park, Haldwani in 1998. This problem is related to availability of the extra amount of ration and limited opportunities for excercise. Fatty animals are poor breeders. Demand and supply of food are to be meticuously estimated to avoid over-feeding.

4. Tympany/Bloat : In the routine zoo management ingestion of large quantities of fermentable green fodder or sudden change to palatable fodder may cause tympany in ruminants. Treatment should include attention to diet, withholding of changed diet and shift to accustomed diet. Tonics and nervine stimulants are administered to combat gastric atony, besides antizymotics to control gases. Prolonged treatment in refractory cases is required but such treatment is a serious constraint in case of intractable creatures. Two females and one male blackbuck which consumed large quantities of frosted fresh green berseem in winter developed typmany. Females were cured when 100 ml of Bloatosil (Wockhardt Veterinary Ltd. Bombay) to each was administered orally, but the male did not respond and succumbed.

Cases of tympany in deer and antelopes were encountered following chemical immobilization with a mixture of xylazine and ketamine, if animals were fed some hours earlier, and in sedation remained in lateral recumbency for a couple of minutes (may cause atony of the intestinal wall and excessive fermentation of the ingesta). Therefore, it is always necessary to ensure that animals are to be tranquilized early in the morning before the food is supplied. Tympany is got rid off by maintaining the normal recumbent posture.At the time of crisis animals were is assisted to attain sternal recumbency, tongue were taken out from mouth and sometimes back racking was done to evacuate the faeces. Use of yohimbine and effortil hastened the recovery and lessened the development of tympany too.

The cases of recurrence of tympany due to presence of foreign objects such as shoe leather pieces, ropes, clothes, plastic bags, etc. causing mechanical obstruction of the pyloric opening or duodenum in deer and black bucks have been encountered in captivity. Recurrnent tympany in a male adult black buck (A.

cervicapra) was related to stomach ulceration. Distension of the stomach in non-human primates is recorded in stum-ptailed and pig-tailed monkeys, and in Nilgiri and common langurs in captivity (Arora *et al.*,1985). It rarely leads to rupture of stomach due to excessive fermentation of ingesta.

5. Impaction : A carcass of tiger cub, belonging to a circus, subjected to postmortem examination revealed that a piece of heart of buffalo fed to the tiger cub was stuck in its larynx and almost blocked the respiratory passage. It was considered to be the cause of death of the animal (Balwant Singh, personnel communication, 3rd December, 1990). Elephants and rhinoceroses often eat earth and when there is teeth problem undigested fibrous large sized balls are formed which at times stuck in the lumen at the end of colon part of their intestines. If timely medication to dissolve the mass and enema to evacuate the same are not attempted animals life may be imperilled.

6. Perforation/Laceration of stomach and intestine : Owing to sharp ends of pieces of long bones ingested along with beef (flesh), rupture/laceration of stomach and intestine in one case each in lion and tiger in captivity were recorded. Ulcers in the stomach of a lioness died in captivity and in a male black buck died in wild were also encountered. Ensley *et al.* (1982) described intestinal obstruction and perforation caused by undigested Acacia sp leaves in langur monkeys.

7. Over - grown hoofs : This problem is often encountered in captivity. The cases have been recorded in barasingha, black buck, chinkara, Nilgiri tahr, zebra and elephant. On several occasions trimming of overgrown hooves in case of tahr and elephant was undertakenbut to no avail. The relation of the condition to feeding of excessive protein rich diets or to defective housing conditions has not specifically been attributed.

8. Food poisoning/Toxicity : Prolonged storages of feed and grains in humid conditions facilitate the growth of Aspergillus flavus and other fungus and thereby liberation of toxins including aflatoxin and others in feed. Ingestion of such mouldy feed by the animals may result in ill health and the condition is termed as aflatoxicosis/ mycotoxicosis. Large amount of aflatoxin ingestion may lead to severe liver damage. Low level uptakes, however, may induce carcinogenic lesions. Reported cases of aflatoxicosis and experimental studies on this aspect in captive wild animals are cited below.

Case (a) : At Zoological Park, Hyderabad 8 out of 13 bears died of aflatoxicosis due to consumption of high levels of toxin in the feed. At necropsy, lesions found were icterus, hepatomegaly, yellow fat, pale kidneys and blackish lungs. Massive parenchymatous necrosis, and in some cases degeneration and fibrosis were the histopathological lesions (Mohan Rao et al., 1989).

Case (b) : Nine hog deer (Axis porcinus) and two nilgais (Baselophus tragocamelus) died in the Nandan Kanan Zoological Park, Bhubaneshwar, Orissa. Necropsy revealed multiple greyish nodular tumorous growths in liver. Histopathological reaction alluded to lesions of aflatoxicosis (Rao, 1989).

It is common belief that wild animals in their natural habitats have the ability to cope with naturally present toxic plants rich in cyanides, oxalates, alkaloids, etc. by way of either avoidance, tolerance or detoxification in their digestive systems. In captivity, a species in its second or third generation may lack such ability to avoid strange fodders/foods supplied.Three documented instances of plant poisoning are cited below.

Case (a) : Indian gaurs (*Bos gaurus*) in the Bhadra Wildlife Sanctuary in Karnataka were reported to be affected after consuming bamboo shoot toxin Diarrhoea was report ed to be the main clinical symptom (Hindustan Times News Paper 24.8.1989).

Case (b) : Onion poisoning occurred in a sloth bear (*M.ursinus*) in captivity with clinical signs of haemoglobinuria. The change in the diet extenuated the condition (Dighe and Kazi, 1989).

Case(c) : During January, 1998 Biological Park, Bokaro, Bihar experienced sporadic deaths in its blackbuck herd. The Veterinary Officer of the Park communicated antemortem clinical symptoms as presence of copious frothy salivation and fluid from the mouth. The gross necropsy findings did not reveal any lesion. The food supply to the herd was then inquired. The animals were fed fresh leaves of subabul (*Leucaena leucocephla*) and mash (crushed maize, gram, wheat bran and rice bran) fortified with Agromin and vitamin A, D-3 was given to counteract the same. An advice was rendered to stop the feeding of subabul leaves and to feed other green fodder. The subabul may be causing toxicity due to its "mimosine" toxic factor. The advice was followed in letter and spirit and then after no case was reported. Study at IVRI, Izatnagar in domestic goats showed that subabul alone feeding over prolonged period caued hypothyroidism, abortion, and reproductive failure. Saline water treatment of dry subabul leaf meal was highly effective in reducing mimosine content.

9. Infectious and parasitic diseases : Summer months (April - June) of 1981 proved to be too hard to wild mammals in National Park, Ranthombore (Rajasthan). About 300 cervids and bovids died of paramphistomiasis and some suffering from pulmonary tuberculosis also succumbed. The scarcity of water and food (green grasses) in the Park led to convergence of all the population of deer (*A. axis, R. unicolor*) and antelopes (*B. tragocamelus*) around the drying natural water bodies of the Park. Shortage of natural feed and unfavourable environment augmented the susceptibility to diseases.

Possible contamination of animal blood.

Bacteria are normally cleared from the blood stream rapidly. Therefore, bacteraemia is uncommon in the healthy animals and the presence of Pathogenic bacteria in the blood indicates that sick animals has been slaughter the most common pathogens found in the blood include Pseudomonas aeruginosa, enteric bacteria *Escherichia coli, Pasteurella haemolytica, Staptylococuns aureus, Streptococcus pyogenes*, etc. similarly certain rickettsial infectious agnates such is *Anaplasma* may by present in the blood. The classic type of blood infection is septicaemia resulting from a virulent organism entering the blood from the focus of infection multiplying and travelling to various body tissues to initiate new infection.

Haemoprotozoan infection in carrier animals under stress particularly exposed malnutrition and transportation fatigue may cause overt clinical effect. *Babesi and, Theleria* in buffalo, horse, sheep, goats, deer may occur in clinical from. *Typanosama evansi, Haemobartenella* in large mammalian species, heart worm (*Dirofilara immitis*) in canids and *Strongylus vulgaris* in equines, are commonly encountered.

Table 59: Possible contamination through animal diet.

Possible contamination of Egg and egg products :

i).	Source	Fresh eggs (hen eggs)'
	Environment	Surface contaminants
	Pathogens	*Streptococcus, Micrococcus, staphylococcus, Bacillus, Pseudomo-nas, Escherichia, Proteus, Aerobacter and Salmonella*
ii).	Source	Duck eggs
	Pathogens	*Above and C. pefringens, Pseudomonas sp., Sarcina sp.*
iii).	Source	Liquid egg products (dried and frozen)
	Pathogens	*Alkaligenes, Pseudomonas sp., Flavobacterium sp, Escherichia sp.*

During 1971-72, FMD type 'C' virus caused deaths of 3 out of 8 bisons in Zoological Park, Hyderabad where American bisons (Bison bison) were affected more severely than Indian gaurs (Bos gaurus). Infected feed was attributed to be the source of infection .

Possible Contamination of Meat and Meat Products:

1.	Source:	Sheep and goat meats. organs. etc.
	Pathogens:	*Staphylococci. Enterococci, Coliform, Lactobacilli, E. Coli Aerobacter. E. freundii, S.aureus, S. epidermidis, E. Coli serotypes; 011, 015, 029, 030, 041 054, 055, and 085. Pseudomonas aeruginosa Br. melitensis, Salmonella Spp. S. anatum. S. dublin. S. Weltevreden and S. virginia and also S. infantis, S. london, s. newport, S. stanley, S. typhimurium.*
2.	Source:	Beef, Bone meal, Meat and Fish meal, Different organs/beef.
	Pathogens:	*S. paratyphi, B.s. anatum. S. bareilly, S. newport, S. kottbus, C. choleraesuis, S. butantan, S. typhimurium, S. london, S. dublin, s. virchow, S. kiambu, s. stanley.* *- S. tennesse, S. typhimurium, s. newport, S. weltevreden, S. inchanga, S. poona, S. bareilly, S. richow, S. eteritidis, S. give, S. anatum, S. infantis, S. paratyphi.* *- C. pefringens (A&C type) Cl. sporogenes, Cl, bifermentans, Cl. fallase, Cl. paraputri, Cl. caproccum, cl. multitermentans, Cl. tertium, Cl. innominatumn, Cl. telanomorphum.*
3.	Source:	Contaminated Species.
	Pathogens:	*E. coli, K. pneumoniae, K. zaenoe, Enterobacter hefinae, Entero liquafaciens. Pectobacterium.*

10. Perinatal morbidity and mortality : (1). Predators such as tiger, lion, leopard, etc. (when they follow the migratory herd of wild beasts) remain away from their cubs for pretty long periods in search of food. As a result some cubs die of starvation or abandonment. In captivity infant mortality in carnivores is due to neglect by mothers which leads to starvation and death of the offsprings, if management by hand rearing remains ineffective.

(2) In bottle raised cubs diarrhoea is a common and serious disorder. If not stopped immediately,complications may cause deaths of the individuals within a few days either due to inanition or severe dehydration or onset of bacterial gastro-enteritis. It is always advisable that cubs should be fed diluted milk (i.e. milk mixed with equal quantity of sterilized water supplemented with vitamins). Lactated Ringer's solution @40 to 50 ml/kg s/c daily can be administered. Oral fluid ,in severe cases, is recommended with 2 to 4 m Eq/ kg of bicarbonate added in Ringers solution to treat severe diarrhoea. Chloramphenicol 20 to 40 mg / per os is also given. When diarrhoea is due to overfeeding or feeding of an unsuitable or inadequately diluted milk substitute, the milk should be replaced with oral rehydration fluids for 24 hrs and the formula reintroduced or replaced gradually thereafter.

(3) In hand-reared primate babies, in their first month of life, vomiting is quite common and needs extra care to prevent the infant from asphyxiating as a consequence of regurgitated material entering the trachea. In case of constipation, glycerine suppositories and in extreme cases enema with a mild soap- water solution are practiced.

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VII. APPENDIX

(A) Daily requirements

(B) List of common trees and grasses

(C) Chemical analysis of herbages

(D) Glossary

(A) Daily requirements:

Table 60: Daily requirements of major nutrients (Source: Calgary Zoo keepers lecture notes, Zoo Zen volume 2, november 12, 1987).

Animal description	Protein (g)daily	Calories daily	Calcium (g)	Vitamin A(I.U.)	Vitamin C (mg)
Primates:					
0.454-4.54 kg Young growing.	1.5	50	.01	100	1
10-20 to 4.54 - 9.08 kg Young growing.	1.5	45	.01	100	1
0.454-4.54kg Adult for maitenance.	1.0	30	.01	100	1
4.54 13.62 kg Adult, for maintenance.	0.8	25	.01	50	1
Over 45.4 kg maintenance.	0.5	25	.01	50	1
Ruminants:					
Calves and fawns	1.0	25-30	0.10	50-75	NR
Adult 454-908 kg	0.3-0.5	15-20	0.05	30-40	NR
Adult over 908 kg	0.3-0.5	10-15	0.03	10-20	NR
Carnivores:					
4.54kg Young	3-4	50	0.1	100	-
4.54-13.62 kg	3	45	0.1	100	-
Adult:13.62 kg	2	20-25	0.05	100	-
Over 13.62 kg.	1.5-2	20	0.05	80	-
Rodents:					
0.227-4.54 kg *	1.0	50-60	0.1	100	-
0.227-4.54 kg**	1.5	50-60	0.1	100	-
4.54-13.62 kg	1.0	40	0.1	100	-

Note : The requirements for female during the last part of their pregnancy and during lactation is double the need for maintenance. Young growing animals also require approximately twice as many nutrients as adults per pound of body weight.
* Strictly herbivores ** Partly carnivores.

Table 61 : Energy and protein daily allowances for primates(cited byAgrawal,1996)

Species		Energy (DE, Kcal/kg,b.w.)	Proteina % ca lories	g/kg b.w.
Human				
	Infant	120-60	10(6.0)b	2.4(2.0)
	Adult	30-40	8(5.0)	0.8(0.5)
Baboon				
	Infant	<290	12	5.0
	Adult	53-72	12	2.0
Chimpanzee				
	Infant	120-100	12	5.0
	Adult	50-60	12	2.0
Rhesus & Cynomolgus				
	Infant	270-190	12(6.6)	8.0(4.0)
	Adult	75-120	12(6.6)	3.0
Cebus				
	Infant	400-250	13(7.0)	10.0(5.25)
	Adult	100-150	13(7.0)	5.0(2.3)

(B) List of common trees and grasses:

Table 62 : Scientific and common name of certain trees

Sl.No	Botanical Name	Local Name
1.	*Acacia arabica*	Babul
2.	*Acacia catechu*	Khair
3.	*Adina cordifolia*	Haldu
4.	*Aegle marmelos*	Bel
5.	*Ailanthus excelsa*	Aru
6	*Albizzia Lebbek*	Kala siris
7.	*Albizzia procera*	Safed siris
8.	*Barringtonia acutangula*	Neora
9.	*Bauhinia variegata*	Kachnar
10.	*Bauhinia racemosa*	Maholi
11.	*Bridelia retusa*	Khaja
12.	*Buchanania Lanzan*	Chironji
13.	*Butea monosperma*	Dhak
14.	*Casearia tomintosa*	Chilla
15.	*Cassia fistula*	Amaltas
16.	*Careya arborea*	Kumbhi
17.	*Cedrala toona*	Tun
18.	*Celtis tetrandra*	Kakai
19.	*Celistocalvx operculata*	Madanua
20.	*Cordia dichotoma*	Lasoora
21.	*Dalbergia sissoo*	Shisham

22.	*Dillenia pentagyna*	Aggai
23.	*Ehretia leavis*	Chamror
24.	*Emblica officinalis*	Aonla
25.	*Erioglossum edule*	anga banga
26.	*Erythrina suberosa*	Nasui
27.	*Eugenia operclata*	Piaman
28.	*Ficus cunia*	Khurhus
29.	*Ficus religiosa*	Pipal
30.	*Ficus bengalensis*	Bargad
31.	*Ficus rumphii*	Gajhar
32.	*Ficus glomerata*	Gular
33.	*Flacoustia indica*	Katia
34.	*Ficus palmata*	Anjir
35.	*Gardenia tugidia*	Churga
36.	*Garuga pinnata*	Kharpat
37.	*Grewia disperma*	Haria
38.	*Grewia subinaegulis*	Phalsa
39.	*Holarrhena antidysenterica*	Kura
40.	*Hymenodietyon excelsum*	Bhurkur
41.	*Kydia calycina*	Pula
42.	*Lagerstoemia parviflora*	Asidh
43.	*Lannea coromandelica*	Jigna
44.	*Litsaea glutinosa*	Maida
45.	*Mangifera indica*	Am
46.	*Madhuca indica*	Mahuwa
47.	*Miliusa tomentosa*	Choti Kari
48.	*Mitragyna parvifolia*	Kaim
49.	*Morus curstralis*	Sahtut
50.	*Moringa oleifera*	Sahjan
51.	*Mallotus philippensis*	Rhini
52.	*Piliostioma malabaricum*	Amlosa
53.	*Pterocarpus marsupium*	Bijasar
54.	*Putaranjiva Soxburghii*	Patju
55.	*Randia aliginosa*	Pinsar
56.	*Randia dumetorum*	Mainphal
57.	*Salix tetrasperma*	Bilsa
58.	*Salmalia malabarica*	Semal
59.	*Schleichera oleosa*	Kusum
60.	*Semecarpus anacardium*	Bhilawa
61.	*Shorea robusta*	Sakhu (Sal)
62.	*Spondias pinnata*	Ambara
63.	*Syzygium cumini*	Jamun

64.	*Sterculia villosa*	Udar
65.	*Streblus asper*	Sehor
66.	*Strereospermum Suaveolens*	Padal
67.	*Tectona grandis*	Sagon
68.	*Terminalia aarguna*	Arjun
69.	*Terminalia belerica*	Bahera
70.	*Terminalia chebula*	Bahera
71.	*Trawia nudiflora*	Gutel
72.	*Terminalia tomentosa*	Asna
73.	*Zizyphus jujuba*	Ber

List of Common grasses

Botanical Name	Common Name
Agropyron elongatum	Wheat grass tall
Arundo donax	Reed/Narhal grass
Andropogon/Heteropogon contortus	Spear grass
Andropogon sp.	Blue stem grass
Apluda mutica	Bhanjura (*Gramineae*)
Aristida mulabilis	Fine needle grass
Axonopus compressus	Carpet grass
Bothriochola intermedia	(*Gramineae*)
Brachiaria mutica	Fingo/Para grass
Bromus inermis	Bromegrass
Cenchrus ciliaris	Anjan/Blue/buffalo grass
Cenchrus setigerus	Dhaman grass
Chloris gayana	Rhodes/Gint rhodes grass
Cynodon dactylon	Doob/Star/Bharmuda/Bhamas
Cymbopogan shoenanthus	Rousaghas
Cymbopogan jwarancusa	"
Cyperus niveus	Mat grass(*Cyperaceae*)
Crotalaria medicegirea	San (*Papilionaceae*)
Echinochloa pyramidalis	Antelope grass
Eragrpstos cilianensis	Grey love grass
Dactylis glomerata	Cocksfoot grass
Dactyloctenium aegyptium	Crowfoot grass
Dendrocalamus strictus	Solid bans(*Grminaeae*)
Desmostachya bipinnata	Dab/Durva "
Desmodium gangelian	(*Papilionaceae*)
Dichanthium annulatum	Delhi/Marbal/Jarga
Digitaria spp.	Finger grass
Digitaria decumbens	Pangola grass
Eulaliopsis binata	Babni/Baggar (*Gramineae*)

Eragrostis chloromelas	Lovegrass boar
Eragrostis japonica	
Heteropogon contortus	Tangle head grass
Hymenachne amplexicaulis	Bamboo grass
Imperata cylindrica	Ulu
Indigofera linifolia	Suurmainil (*Papilionaceae*)
Kauhatia gracilis	
Lasiurus indicus	Seven/Sewan grass
Latipes senegalensis	Hook grass
Launnea nudicaulis	
Lolium spp.	Rye grass
Melinis minutifora	Molasses grass
Nepeta lindostana	(*Labiatae*)
Panicum antidotale	Blue panic grass
Panicum italicum	Indian buffalo grass
Panicum maximum Jacz	Guinea grass
Paspalum dilatatum	Dallis grass
Paspalum notatum	Kodri grass
Pennisetum clandestinum	Kikuyu grass
Pennisetum orientale	Bimalsia grass
Pennisetum purpureum	Elephant/Napier grass
Phalaris arundinacea	Red cenary grass
Phalaris canariensis	Cauarg grass
Phaseolus aureus	Golden grass
Phragmites karka	Narkul(*Gramineae*)
Rhynchelytrum repens	Natal grass
Rottboellia exaltata	Itch/Buffalo bean
Saccharum munja	Munj (*Gramineae*)
Saccharum spontaneum	Kans/Kasa (*Gramineae*)
Scleria stachyafusca	
Setaria palmifolia	Aruna grass
Sorghum halepense	Johson grass
Sorghum/Andropogon sudanense	Sudan grass
Stenotaphrum secundatum	Crab/Salt grass
Swertia pangustiafolia	Chiratta(*Gentianaceae*)
Themeda arudinacea	Paper grass(*Gramineae*)
Trichodesma sedwickianum	
Urochloa mosambicensis	Sabi grass
Vetiveria zizanioides	Panni/Khas(*Gramineae*)
Vico vestita.	

(C) Chemical analysis of herbages.

Table 63 (a) : Chemical composition of herbages on dry matter basis (a consolidated report of studies for the work of Tak and Lamba,1984 and for a project analyses conducted at IVRI Izatnagr).

Name	CP	EE	OM	T-CHO	Ash
Acacia catchu	12.31	3.33	87.88	72.24	12.12
A.leucocephale	15.40	3.12	85.99	67.47	14.01
Achyranthes	11.87	3.38	87.62	72.37	12.38
Capperis sepiarie	12.95	3.37	86.74	70.42	13.26
Cassia tora pods	10.31	1.89	89.65	77.45	10.35
Chlotis					
- stem	3.32	1.47	93.62	88.83	6.38
- leaves	3.66	1.42	94.88	89.80	5.12
- flowering	6.19	1.83	91.28	83.26	8.72
- whole grass	6.07	2.12	91.04	82.85	8.96
- whole grass	6.34	1.96	92.66	84.36	7.34
Desmostachya leaves	6.37	1.79	90.73	82.57	9.27
- do -	3.99	1.39	92.91	87.53	7.09
- do,post burn	8.69	2.37	90.32	79.26	9.68
- do-	7.81	2.61	91.73	81.31	8.27
- do -	8.94	2.02	90.67	78.80	9.33
- do -	3.27	1.59	92.59	87.73	7.41
- do -	7.21	2.48	90.65	83.44	9.35
- do -	6.51	1.78	90.86	82.57	9.14
- do -	4.96	1.33	92.29	86.00	7.71
- do stem	4.19	1.46	93.57	87.92	6.43
- do -	2.89	1.10	92.75	88.76	7.25
- do -	3.11	1.59	92.59	87.00	8.12
- do -	6.90	2.14	91.04	82.00	8.96
- do -	3.48	1.50	92.30	87.32	7.70
Euleliopsis leaves	9.54	2.47	90.19	78.18	9.81
- do -	7.42	2.11	91.64	82.11	8.36
- do -	6.34	1.98	90.67	82.35	9.33
- do -	5.82	2.14	90.13	82.17	9.87
Heteropogon stem	3.74	1.60	93.22	87.88	6.78

- do-leaves	3.94	1.68	93.13	87.51	6.87
- do-whole	2.91	1.41	93.00	88.68	7.00
Neyraudia					
leaves	6.76	1.85	91.30	82.69	8.70
whole	6.85	1.58	91.95	83.52	8.05
Phoenix	8.46	1.66	91.16	81.04	8.46
Themeda					
leaves	4.04	1.34	93.43	88.05	6.57
- do -	5.74	1.45	90.37	83.18	9.63
- do -sten	5.11	1.98	91.98	84.89	8.02
- do - Post					
burn lush	8.90	3.27	91.04	78.87	8.96
- do -	7.20	2.23	89.99	80.56	10.01
Apluda	6.68	2.44	91.52	82.40	8.48
Oogenia	6.95	2.27	91.07	81.85	8.93

Table 63 (b): Per cent chemical composition of certain plants (Studies conducted at IVRI, Izatnagar)

Plant species	Protein Crude	Ash	Calcium	Phosphorus
Solanum nigrium &	17.17	25.25	02.99	0.233
other spp. also	11.96	37.93	03.96	0.145
S. nigrium only	19.91	17.60	02.06	0.203
Murraya paniculata	12.11	07.33	08.32	0.204
Murraya koenigii	22.10	13.61	02.71	0.185
Helictoceros isora	16.31	10.39	01.65	0.228
Ficus rumphii	09.71	09.85	01.97	0.177
F. religiosa	13.39	14.67	03.31	0.336
F. bengalensis	03.39	08.99	00.79	0.150
Glyconis arbora	12.55	12.70	02.08	0.212

Table 64: Chemical analysis of antlers and horns (Itodied conducted at IVRI, Izatnagar)

	Barasingha	Chital	Hogdeer	Nilgai
DM (%)	90.48+0.17	91.80+0.12	91.05+0.52	91.54
CP (%)	31.99+0.10	35.16+1.36	36.54+4.73	31.54
EE (%)	5.08+063	2.41+1.09	3.92+1.79	3.14
Ash (%)	62.94+0.59	62.53+1.14	60.27+1.87	65.32
Ca (%)	23.44+0.16	23.43+0.63	22.05+0.87	23.18
	(37.24+0.13)	(37.49+0.99)	(36.57+0.70)	(35.49)
P (%)	12.62+0.83	10.83+0.63	12.23+0.55	13.08
	(1.17+0.05)	(1.27+0.03)	(1.23+0.03)	(20.02)
Mg	0.73+0.03	0.80+0.03	0.74+0.55	1.10

Table 65 : Analysis for major mineral in teeth of an adult individonal of certain mammalian species

Species	Ca	P	Mg	Total arh
				% DM
Wild Boar	26.07	14.02	0.93	71.37
Bear (AF)	27.26	14.03	0.90	74.94
Leopard (A)	27.52	14.13	0.91	76.2
Jaguar (AM)	27.58	16.64	0.94	76.71
Tiger	28.41	14.40	0.95	76.97
Lion (AF)	29.34	14.44	0.93	0.93

(D) Glossary :

Definitions and explanatory notes of various scientific terms referred hereunder have been drawn mainly from the 'Dictionary of Economic Plants' by Meheshwari Paul Singh,U.(1964) published by I.C.A.R., New Delhi and Dictionary of Animal Nutrition and Feed Technology published by Malhotra, Publication House, New Delhi.Webster's Dictionary, and Ecology and Field Biology , 3rd Edition by Robert Leo Smith by Harper and Row, Publishers, New York.

Ad libitum feeding : A system of feeding under which, animals are allowed to eat the feed materials freely without any restriction.

Abash Neem (*Millingtonia hortensis*) : Belongs to family *Bignoniaceae*. It is also called as Indian cork tree, grown as an avenue.

Amala (*Emblica officinalis*) : Belongs to family *Euphorbiaceae*. Its fruits- Amala are used in diarrhoea and dysentery.It is rich in Iron and vitamin C

Anar (*Punica granalum*): A shrub/ small tree belongs to family Puncaeae. The seeds are edible and also have medicinal values.

Angur/Wine grape(*Vitis vinifera*) : A woody shrubby vine belongs to family Vitceae, yielding fruits.

Apple/seb (*Malus sylvestris*) : Yields edible fruits. Cultivated mainly in Kashmir, Himachal Pradesh and Uttar Pradesh(Kumaon).

Arboreal: Animals inhabiting/abounding trees

Babul (*Acacia arabica*) : The bark of which is used for tanning, and leaves and pods as fodder for animals, especially for camels and goats. The pods contain 15 per cent CP, 10.5 per cent DCP and 75 per cent TDN. The crushed pods can replace either wheat bran or rice bran in concentrate mixture for ruminants.

Bael (*Aegle marmelos*) : Belongs to family Rutaceae. The un ripe fruits are used as astringent, stomachic and also in the treatment of diarrhoea.

Bajra (*Pennisetum typhoides*) : A quick growing, disease resistant, high tillering fodder crop, suitable for sowing in arid and semi arid regions. CP ranges from 10 to 12 per cent and TDN from 70 to 75 percent.

Balanced ration : A ration having all nutrients in desired proportions according to the requirement of animals.

Bamboo: There are many varieties. The Indian large bamboo is known as Dendrocalmus (*Gramineae*). Bamboo leaves are favourite diet of red panda.

Banana (*Mus sapietum/M.paradisiaca*) : Native of India and Malaya. The ripe fruits are edible and the green fruits are eaten as vegetable.

Barley (*Hordeum vulgare*) : An energy rich grain having CP 9-10 per cent, oil 2 per cent, CF 5-6 percent and TDN 70 to 80 per cent. It should be crushed or ground before feeding to animals. Average ME value is 2.80 Mcal/kg

Basal metabolism : Quantity of chemical energy expended for body maintenance measured under specific conditions, i.e. standard metabolism for tissue activity or physico-chemical changes of a resting animal.

Beef : The flesh of cattle; compositon varies with the amount of fat present and the particular cut, e.g., brisket, forerib, rump, silverside, etc.

Beet root/Chukandar (*Beta vulgaris var bengalensis*) : Belongs to family Chenopo-diaceae. Its leaves are eaten as vegetable. Rich in vitamin A and C.

Bengal gram (*Cicer arictinum*) : Grains and straw are used for livestock feeding. The grain contains of about 18 per cent CP, 9 per cent CF, 5 per cent EE and 64 per cent NFE while straw contains 6 per cent CP, 44 per cent CF. Also known as chickpea, gram or chana. Grains are used mainly for human consumption.

Beri (*Zizyphus jujuba*) : A commonly grown shrub in dry regions; leaves used as a conventional fodder for sheep and goats; contains 8 per cent CP, 30 percent CF, 1.7 per cent EE and 49 per cent NFE but its CP digestibility is only 36 per cent. Also known as Chinese date or jujube.

Berseem (*Treifolium alexandrinum*) : One of the most important very palatable fodder and gives several cuts in a season, used as green fodder or hay, contains 15 to 26 per cent CP, 14 to 28 per cent CF , 1-3 per cent EE and 38 to 43 per cent NFE depending upon the stage of maturity. The DCP is 13-14 per cent and TDN 59-61 per cent. To cattle this green fodder is fed after wilting or mixing with dry roughage like straw. In many captive wildlife facilities fresh berseem is fed to cervids, bovids, elephants and rhinoceroses. On forst loys care se tacken not to out the fodder very early or feed immeddhately after cutfungi from the fieed. It is better to keep the fodder exposed to sun light for 1 or 2 hours before the feeding.

Bhoosa : The chaffed straw of cereals, especially from wheat and some pulses, fed to ruminants to provide bulk; low in nutritive value due to high lignin content. It contains negligible DCP and 40-44 per cent TDN (see chemical and microbiological treatment for their improvement).

Biomass : Weight of living material, usually expressed as dry weight per unit area. In case of live organism it is the living weight of an organism at any time in an ecosystem. This gets progressively reduced from the first trophic level to the last resulting in a pyramid. Thus in an environment containing plants ,the biomass of the producers is usually the greatest, occupying the base of the pyramid, whereas the biomass of the trophic level occupying the apex of the pyramid is small(Rajesh Gopal, 1992).

Biome : Major regional ecological community of plants and animals; usually corresponds to plant ecologists and European ecologist's classification of plantation and classification of life zones, respectively.

Biosphere : Thin layer surrounding the earth in which all living organisms exist.

Black gram (*Phaseolus mungo*) : See for Urd.

Bottlegaurd/Loki (*Lagenarie siceraria*) : Belongs to family *Cucurbitaceae* originated from Africa. It is used as vegetable.

Brassica : The genus of plants which includes brussels, cabbage, kale, mustard, rapeseed.,etc.Its plant and their parts are known for pungent taste due to the presence of glucosinolates.

Brinjal/Baigun (*Solanum melongena*) : Belongs to family *Solanaceae*. It is native of India. Its fruits are eaten as vegetable.

Browse : Is another important forage group for many large mammals. Comprize of small stems, leaves, flowers, and fruits of shrubs and trees.

Browsing : The feeding on browse.

Cabbage/Phulgobhi (*Brassica oleracea var batrytis*) : Belongs to family *Crucifereae*, cultivated as edible inflorescence.Bandhgobhi is *B.oleraceae var capitata*.

Carnivore : A flesh eating animal of an order of mammals, chiefly flesh eating, including cats, dogs, bears and others.

Carrot (*Daucus carota*) : A vegetable orange root not grown for animal feeding belongs to family *Umbelliferae*. However, it may serve as a vegetable feed for all farm animals, especially horses (can be given to rhino cevos, would ass) and also included IN diets of a large number of captive wild mammalian species. It contains 11-13 per cent dry matter 12 per cent CP, 10 per cent CF, 1.5 per cent EE, 68 per cent NFE and starch equivalent is 70.

Carrying capacity : The maximum rate of animal stocking possible without undue damage to vegetation or related resources, may vary from year to year because of fluctuations in forage production.

Casia tora (*Saccharum spontaneum*) : It is a leguminous plant growing in the monsoon season. It contains 21 per cent CP, 7 per cent EE, 16 per cent DCP, 59 per cent TDN and 2619 kcal/kg ME. It may be incorporated upto 10 per cent level in the concentrate mixture of lactating cows. Boiling incrases its palatability.

Cassava (*Manihot esculenta*) : Tropical tuber crop, used for both human and animal feeding; contains cyanogenic glycoside linam- arin, therefore, grated and soaked in water to activate the conversion of glycosides to hydrocyanic acid which is then washed out. Also known as tapioca, manioc and yucca. It contans 2-3 % CP, 1-3 % CF and 80-90 % NFE. Its leaves are richer in CP 25-29 % and minerals, and relished by all classes of livestock. The byproduct, obtained after extraction of starch, i.e. starch extraction waste (DCP 2 %, TDN 64 %) can replace maize in concentrate mixture for livestock.

Cervidae : A family of Order Artiodactyla which includes deer species.

Chaff : Culms, husks or other seed coverings together with other parts; separated from seed in threshing or processing.

Chiku (*Achras sapota*) : Its ripe fruits are rich in sugar and are eaten.Unripe fruits may be ripened at a temperature of 11° to 17° C. Fruits can be preserved for 45 days at minus 2° C.

Chukandar (*Beta vulgaris*) : A biennial herb ,belongs to family *Chenopodiaceae*. Its roots and leaves are used as vegetables.

Cocoa (*Theobroma cacao L.*) : Oil cake, beans and shells contain the poisonous alkaloid theobromine and limits their use for feeding purpose. Expeller pressed oil cake containing 25 per cent CP, 9 per cent CF, 5 per cent EE and 54 per cent NFE; may be used for livestock feeding. Cocoa products, such as shells, beans and cake can be rendered harmless by cooking in water for 1-2 hours. The processed product can be included upto 25 per cent in ration for pigs without any adverse affect on weight gain or feed efficiency.

Coconut *(Cocos nucifera) meal* : Residue after extracting oil from copra, contains 20 to 25 percent CP, 1-12 percent EE and 8 to 20 percent CF which restricts its use for monogastric animals. Susceptible to rancidity during storage due to higher oil content. Lysine and histidine contents are low. Owing to capacity to absorb molasses, it is commonly used in compounded feeds. Also known as copra meal.

Cod liver oil : The oil of cod fish liver, a potent source of vitamin A and D. On an average, it may contain 120-200 mg vitamin A and 1-10 mg vitamin D per gram. According to British Pharmacopoeia Standard, vitamin A content should be minimum 180 mg and vitamin D 2 mg per g; should be protected from strong light and stored air tight as its vitamin contents are easily oxidized and destroyed.

Colostrum : Initial milky secretion from mammary glands soon after parturition, containing a high proportion of protein, vitamins and antibodies. The colostrum has nutritive value , easily digested and aids in disease resistance.

Corn : Generic term fora cereal in UK and it means maize.

Corn cobs : The fibrous inner portion of the ear of corn from which the kernels have been removed.

Crab meal : The undecomposed, dried and ground waste of the crabs, contains shell, viscera and part or all the flesh; crude protein not less than 25 per cent.

Crude fibre : In the proximate analysis of feed stuffs, the carbohydrates are determined by a chemical method as two groups, i.e., crude fibre and nitrogen free extract. Crude fibre consists primarily of cellulose and other polysaccharides which serve as the structural and protective part of plants, i.e, hemicellulose and lignin. This is determined by subjecting the feed sample after removing the ether extract to successive boiling treatments with 1.25 per cent sulphuric acid and 1.25 per cent sodium hydroxide. The organic residue thus obtained is crude fibre.

Cud : The solid mass of ingesta regurgitated and masticated during the rumination.

Dals : Split peas of various kinds, e.g., pigeon pea (*Cajanus indicus*), khesari (*Lathyrus sativus*), lentil (*Lens esculenta*), etc.

Deficiency : Lack or shortage; a condition characterised by presence of less than normal or necessary supply of nutrients.

Diet : Feed ingredient or mixture of ingredients including water consumed by animals.

Digestibility coefficient : A measure of proportion of food or feed or any nutrient not excreted in faeces (and assumed to be absorbed in the gastro - intestinal tract of animal) expressed in percentage (for example if an animal received 1.0 kg protein and excreted 0.5 kg protein the digestible protein is 50%). It is measured by conducting the digestibility trial for feed or mixture of feeds (for 7 days after a minimum adoption period of 21 dasy) which constitute the entire ration but digestibility of feeds that cannot be fed alone is measured by the method of difference in which feed under investigation is fed alongwith basal ration whose digestibility has been previously determined. Digestibility of feeds can also be measured by indicator method in which digestible reference substance, such as ferric oxide, chromic oxide (chrome green), lignin, silica, faecal nitrogen and chromogen (a naturally occurring plant pigment) is used. Recently, isotopes have been used to quantify animals diets.

The digestion coefficients for caloric content, dry matter, protein, fat, ash, total carbohydrate, and, where applicable, acid detergent fiber are calculated for each diet-group using the formulae (refer text book on Animal Nutrition).

Percent apparent nutrient digetibility is defood

as : $\frac{\text{Nutrient intake- Nutrient excretion}}{\text{Nutrient intake}} \times 100$

Digestible energy : The proportion of gross energy of feed not recovered in faeces; calculated by subtracting gross energy (GE) of faeces from the gross energy(GE) of feed consumed; referred to as apparently digestible energy as faecal energy from endogenous sources (mucous cells, microflora residue, etc.) is not accounted for.

Digestion : The process of breaking down the feed in the digestive system that can be absorbed and assimilated.

Diurnal : Pertaining to day time. Animals active during day time.

Domestic animal : The animals which have been domesticated and are useful to mankind for making life better in various ways.

Drying : Removing water or any other liquid from the material.

Dub grass (*Cynodon dactylon*) : It is an important pincer grass, having creeping stems which root at the node and quickly covers any surface under favourable condition. It may grow sufficient ranks to be cut as hay. It is staple food for black buck.

Dry matter : Moisture minus weight of the food stuff consumed . It is estimated in percentage

Eating : Includes prehandling feed, chewing, mixing with saliva and rolling as needed to form a bolus which is swallowed and taken into the anterior rumen or stomach.

Ecology : The science that deals with the study of interrelationships of organisms in nature and to their environment.

Egestion : The process of elimination or discharging food or waste product from the body.

Energy : Capacity for doing work, stored largely in plants as carbohydrates and in animals as fats. The terms that are used to express energy are ergs, joules, calories, kilocalories, mega calories, Thermos and BTU (British Thermal Units). Usually in animal nutrition terms used are, gross energy (GE), digestible energy(DE), metabolizable energy (ME) and net energy (NE) and productive energy values of diets.

Note : ME=DE-energy in urine and combustible gases. Energy in urine arises in most part from nitrogenous products which are completely oxidized urea/ uric acid.This varies greatly between species. Energy in the urine of swine=2-3% of GE, in urine cattle 4-5% of GE.

Fat : Mixture of glycerol esters of fatty acids i.e. triglycerides, solid at room temperature.

Fat soluble vitamins : Vitamins A, D, E and K in food associated with fat fraction; stored in the body to a greater extent than the water soluble vitamins.

Feeding standard : Table giving nutrient requirements for a particular category of animals for specific function.

Foodstuff : Any component of animal ration serving useful purpose.

Ficus : See for gular and Pilkhan

Fish : Contains 65% or more moisture or performed water. Additional water is generated from oxidation of nutrients. theoretical yield is 1.07 g H_2O per gram of fat and 0.4 g H_2O / g of protein. Fish is a good source of digestible protein, having a high utilization co-efficient as well as a high biological value. The amino acid pattern is similar to that found in other consumable meats. Some differences include higher levels of histidine and lysine, and lower levels of the sulpher containing amino acids, methionine and cystine.

Fodder : Any green plant or crop meant for animal feeding for the supply of nutrients and bulk.

Foliage : All the leaves of a plant.

Food : It is the material which, after ingestion by animal, is capable of being digested absorbed and utilized as in the body and its waste is egested.

Food chain: A group of organisms in which there is a transfer of food energy through a series of repeated consumption/ movement of energy and nutrients from one feeding group of organisms to another in a series that begins with plants and ends with carnivores.

Forage: Vegetable matter, fresh or preserved, gathered and used as a feed for animals.

Forb: Any herbaceous/fleshy broad leafed plant, other than those in the *Gramineae*, *Cyperaceae*, and *Juncaceae* families, that is eaten by animals.

Fruit: The ripened ovary of the flower which encloses the seed.

Ginger/Adrak (*Zingiber officinale*): Native of south-east Asia. Cultivated in many states of the country.It is used as spice and condiment, and also as carminative and a digestive stimulant.

Gram/Chana (*Cicer arietinum*): Belongs to family *Papilionaceae*. It is herb, commonly grown in U.P., Punjab, Rajasthan, Bihar and Madhya Pradesh. The seeds are edible and the vegetative parts are used as salad and fodder.

Guava (*Psidium guava*): Belongs to the family *Myrtaeceae*, yields edible fruits, resistant to heat upto 68 C but susceptible to frost.

Gular(*Ficus glomerata*): Its leaves and twigs are used as fodder particularly for elephants and rhinoceroses. The fruits of tree are seasonal and are eaten by animals and birds.

Graminivorous: Eating or subsisting on grasses

Green gram (*Phaseolus aureus*): Belongs to family *Papilionaceae*. It is cultivated as pulse crop.

Gross energy: The total heat generated by oxidation of a feed sample in a bomb calorimeter.

Ground nut (*Arachis hypogaea*) cake: The cake obtained after the extraction of oil from decorticated groundnut kernels.

Habitat: Place where a plant or animal lives.

Hay: The aerial portion of grass or herbage especially cut and dried or cured so as to conserve its nutritive value for animal feeding.

Herbage: Plants having slender stems and or whose leaves are used as feed or medicine.

Herb: Any plant with a soft or succulent stem which dies to the root every year.

Herbivore: A plant eating animal, viz. deer, antelope, rhinoceros, elephant, hare,etc.

Herbivorous: Animals subsisting on plants.

Hibernation: Winter dormancy in animals.

Himalayan foot hills: Region extending from eastern frontiers, Kashmir to Assam.

Home range: Area over which an animal ranges throughout the year.

Horse gram (*Dolichos biflorus*): A drought resistant crop suited to sandy and shallow soils and cultivated for forages throughout India. . The seeds contain 24 per cent CP, 5.7 per cent CF, 1.0 per cent EE, 5.5 per cent ash and used as concentrate feed for cattle.

Indian clover (*Melilotus parviflora / M. indica*): Belongs to family *Papilionaceae*. A drought resistant fodder crop of Agra- Mathura region grown in alkaline soil, contains 14-15 per cent CP. Also known as Marara.

Indian millet: See ragi.

In-situ: In its (original) place.

Interspecific: Between individuals of different species.

Intraspecific: Between individuals of the same species.

Intrinsic: Situated entirely within or pertaining exclusively to a part.

Intrinsic factor: A transferase enzyme secreted by the mucosal cell of the stomach. It is required for the absorption of vitamin B12 throughout the intestinal wall. Deficiency of this factor produces pernicious anaemia.

Jamun (*Syzgium cumini/Myrtus cumini*): The fruits are edible by non-human primates, bear.

Jangli jamun (*Eugenia fruiticosa*): Belongs to family *Mystaceae*.

Jawar/Jowar/joar (*Andropogan sorghum*): Belongs to family *Gramineae*. Cultivated as fodder in many states.

Jangli jalebi (*Pithecellobium dulce/Mimosa dulcis*):It is naturally found as well as is cultivated in many parts of the country.Its pods are eaten by certain wild mammals.

Kadbi: Dried stalks of maize/jowar/bajra plant after their cobs are removed for seed purposes; used for animal feeding after chaffing and mixing with other feed ingredients.

Kakri (*Cucumis melo utilissimus*): Belongs to *Cucurbitaceae*, yields green edible fruits.

Kans (*Saccharum spontaneum*): A weed, can be used as poor quality roughage for animals at preflowering stage.

Karela/Bitter gourd (*Momordica charontia*): Belongs to family *Cucurbetaceae*. A climbing trailing herb cultivated all over India for its fruits which are eaten as vegetable. Mitta karela is known as *Cyelonthera pedata*.

Kasni (*Cichroium intybusl*): A weed occurring in berseem fields, used for animal feeding; contains 15 % DCP and 54 % TDN. Its seeds may also be used for feeding.

Kharbuja/Musk melon (*Cucumis melo*): Belongs to family *Cucurbitaceae*. Cultivated in monsoon season in North West India for its edible fruits.

Kharif: Summer crops like maize, jowar, bajra and cowpea.

Khejri (*Prosops cineraria*): It is the dominaant tree species, particularly in alluvial and sandy, undulating plains. Despite its slow growth rate,this extremely drought-resistant tree has been rightly called the " king of desert trees"for its contribution to the sustenance of both human and animal life under desert conditions. In Rajasthan during the lean periods of summer, maximum consumption of pods of *Prosopis cineraria* is by black buck than chinkara.

Kheshari (*Lathyrus sativus L.*): An annual herb with many variation, differing in flower and seed colour; foliage and seeds are used for forage; dal made from seeds is toxic to human, fresh mid bloom foliage contains 18 % CP, 30 % CF, 2.4 % EE and 37% NFE.

Khira (*Cucumis sativus*): Belongs to family *Cucurbitaceae*. Cultivated for its edible fruits.

Legume: A plant such as the pea, characterised by a dry fruit pod that splits open by two longitudinal sutures and has a row of seeds on the inner side of the ventral suture.

Lentil: Seed of leguminous plant (*Lens esculanta*) grown for human consumption; also known as red dal or massur dal.

Lessuda/Indian cherry (*Cordia dichotoma*): A small tree (*Ehretiaceae*) found in the Punjab, Rajasthan, M.P. and A.P. Its fruits are edible.

Lobia/Cow pea (*Vigna spp.*): Belongs to family *Paliolinaceae*, cultivated throughout India. Young pods (fruits) and leaves are edible. A lobia variety is *V. sinensis* cultivated throughout India. The young pods (fruits) and seeds are used as vegetable and pulse. *Phaseolus lunatus* is also called lobia. Its young pads are used as vegetable and the seeds are eaten as pulse.

Lucerne (*Medicago sativa*): A leguminous winter fodder crop having high crude protein, has a beneficial effect on fattening and lactating animals; contains oestrogenic substances; DCP 18 % and TDN 66 %. Also known as alfalfa.It provides nutritious fodder during both the lean periods i.e. May -June and December-January.

Mahua (*Madhuca indica/M.latifolia*): Its cake is a residue left after extraction of oil from madhu seeds,which contain high level of saponins and cause toxicity in livestock.

Maize (*Zea mays*): One of the best energy rich feed ingredients for all classes of animals. CP varies from 8 to 12 %, deficient in lysine and methionine,DCP and TDN are 7.4% and 84 %, respectively and ME 3.07 Mcal/kg. Maize fodder is also used for animals.

Mango (*Mangifera indica*) seed kernel: A byproduct from mango juice extraction or mango pickle industry; contains about 8 per cent crude protein and about 75-80 % NFE; may be used in the ruminant ration without affecting growth, milk production and fat content. However, its tannin content (about 5-7%) restricts its use in poultry ration.

Mash: A mixture of feed ingredients in meal form.

Meat: The muscle tissue of any animal, such as beef, lamb, veal, mutton, pork or poultry. Most muscle meats contain about 29 % protein and 10-30 % fat.

Meconium: Intestinal contents formed before birth, hatching or exclusion.

Metabolic rate (*MR*): It is expressed as a function of the total body surface area or of the metabolic weight,an exponential function of body weight. Knowledge on the M R of an animal is essential to decide on the quantum of dietary energy to be supplied daily to the animal.

Metabolism: Sequence of chemical processes that take place in the living organism, includes catabolism and anabolism.

Millet: A term applied to several species of cereals which produce small grains cultivated in tropics and warm temperate regions of the world, e.g., rag, Japanese millet, broom corn millet, scrobic, koda, pearl millet or tail millet, horse millet, finger millet, etc. Sorghum is not considered as a millet although it is sometimes erroneously referred to as such. These should be crushed or ground before feeding to artiodactylids. However, whole seeds can be given to galliformes. Scrobic seeds and small seeded varieties as well as unripe seeds cause toxicity. The CP and CF ranges between 8 and 12 % and 2 and 7 % respectively. Millet is inferior in feed value than maize.

Mineral: Any non-organic(inorganic) homogenous solid substance from earth crust. The mineral content in food is related to mineral presence in the soil where plants have grown. Atleast 26 minerals have been shown to be required by some animal species. Required minerals can be divided into two groups depending on their dietary requirements. They are classed as macro and micro or trace minerals. Some minerals have toxic effects too.Minerals are constituents of the ash in food analysis.

Mineral mixture: A mixture of certain salts of minerals required to be supplemented in the diets of certain categories of animals. This may be a mixture of only major and or trace elements with or without common salt.

Mineral salts: Inorganic salts including sodium, potassium, calcium, chloride, phosphate, sulphate, etc. used as mineral supplements.

Mung bean (*Phaseolus aureus Roxb*): Grown as pulse crope. A tall drought resistant herb with yellow flowers and thin cylindrical pods containing green seeds; fresh aerial part contains 13 % CP, 21 % CF and 60 % NFE; seeds contain 23 % CP, 6 % CF, AND 63 % NFE. pod husk containing 8 % CP and 35 % CF IS used for animal feeding. Also known as green gram or golden gram.

Munj (*Saccharum munja*): A coarse weed having low nutritional value; can be fed to animals after chaffing and mixing the molasses; more nutritional at flowering stage.

Musambai/Sweet orange (*Citrullus sinensis*): Belong to family *Rutaceae*.

Muscle: An structure of body made of contractile fibres or cells.

Mustard (*Brassica campestris*) seed cake: A protein supplement obtained as a residue of oil extraction from the seeds. Expeller pressed cake contains CP 37 percent, oil 7 % and CF 8 %. The oil cake, having pungent odour, good supplement for ruminants but not used for poultry ration; contains glucosinolates.

Napier grass (*Pennisetum purpureum*): Called also elephant grass. Belongs to family *gramineae*. It is high oxalate content and is associated with the occurrence of osteodystrophia fibrosa in horse.

Kikuya grass (*Pennisetium clandestinum*): It is perennial, creeping grass with hairy leaves and inconspicuous seedheads. Has a rapid summer growth suitable for green crop, silage or grazing. May have a law fibre content and cause depression of fat content of milk. A very valuable grass producing en enormus bulk of feed in suitable climate. It can be poisonious causing abdominal pain, paralysis of tonque and pharynx, and tremors probably caused by injection of fungs growing on plant debris after period of lush growth or infestation with cater pillors. Can also cause oxalate and nitrite poisoning (Bailliere's Comprehensive Veterinary Dictionary, D.C. blood and Studdert, V.P. Bailliere Tindall, 1988)

Naspati/ Nakh/Pear (*Pyrus communis*): A small tree (*Rosaceae*) yields edible fruits. Found in Kashmir, H.P and Kumaon.

Niche: Functional role of a species in the community including activities and relationships.

Nitrate: Natural constituent of plants like oat hay, corn, beets and sorghum. Certain fodder plants can accumulate it at toxic levels. Plants containing more than 1.5 % nitrate (as KNO3 by weight) may prove fatal to livestock; some of nitrate is converted into nitrite within one or two days after harvesting which is more toxic than nitrate.

Nitrites: Salts which are poisonous in case of their excess intake by converting haemoglobin into methaemoglobin and the transportation of oxygen to tissues become difficult and death may occur.

Nitrogen free extract (*NFE*): A measure of easily digestible carbohydrates of feeds. It is obtained by different method.The sum of percent ash, crude protein, crude fibre, and ether extract is subtracted from 100. The constituents of NFE may be sugars, fractions, starch, pectins, organic acids, resins, tannins, water vitamins, hemicellulose and lignin.

Nocturnal: Pertaining to the night time; of animals feeding at night time.

NPN (*Non-protein nitrogen*): Nitrogen of non- proteinous constituent. In plants, it may be in the form of amino acids, amines, amides, nitrogenous lipids, purines, pyrimidines, nitrates and alkaloids, NPN compounds are useful as protein sources for ruminants e.g., urea, biuret, ammonium salts, NPN is valuable to rumen microbes as it can be degraded to ammonia.

National Research Council (*NRC*): The committee on Animal Nutrition of the National Academy of Sciences National Research Council of the United Sates of America makes available a summary of a massive data on nutritional requirements of various categories of animals. Using these requirements, a ration of an animal may be scientifically balanced for the desired purpose.

Nutrition: The sum of the processes involved in taking in nutrients, their assimilation and utilization.

Oak (*Quercus spp.*): A tree whose buds and early leaves are poisonous to cattle; danger of poisoning lessens as the leaves mature but intoxication can still occur; contains about 10 % CP, 30 % CF and high levels of tannins.

Oats (*Avena sativa*): Cereal grain, protein content is higher and amino acid composition is relatively favourable than for maize.At the milk- ripe stage,it contains about 25 to 30 per cent dry matter. TDN 70 to 72% comparable to maize. Oats grain contains about 11 % CP and 11-12 % CF. It is usually advantageous to mix the oats with other grains.

Oat hay: Contains about 7-10 % CP, poisoning may be caused due to large amount of nitrate present in green oat.

Omnivorous: Eating both plant and animal foods.

Osteodystrophy: A condition known to occur in horses fed with diets containing excessive phosphorus or a low calcium, phosphorus ratio; demineralization of the bones accompanied by a fibrous dysplasia during the course of disease. Also known as osteodystrophia fibrosa.

Onion/Piyaz (*Allium cepa*): Belongs to family Liliaceae, growing all over the country. The bulbs are used as fruits.

Orange/ Santra (*Citrullus reticulata*): Belong to family *Rutaceae*, cultivated in Himachal Pradesh, Uttar Pradesh, West Bengal, Maharashtra, Tripura, and Sikkim.

Osteomalacia: A disease related to weak bones in old animals wherein excessive calcium is mobilised from the bones either due to low dietary calcium, vitamin D, phorphorus or imbalance of two elements.

Osteoporosis: Abnormal rarefaction of bone; it may occur secondary to other diseases.

Osteosis: The formation of bony tissue.

Paddy (*Oryza sativa*): The rice grains in their hulls are very hard and abrasive and must, therefore, be ground before feeding. Rarely used for animals due to high cost, consist about 20 % hulls, 10% bran, 3 % polishings and 67 % rice grain depending upon variety and processing.

Palatability: Dietary characteristic or condition which stimulate a selective response by animals. It is essentially a summation derived from sight, smell, touch and taste as affected by physical and chemical factors.

Papaya/Papita (*Carica papaya*): A small tree belongs to family *Caricaeae* cultivated in many states, yields edible fruit - Papita,which is a good source of enzyme-papain. The ripe fruits are edible and unripe raw fruits may be poisonous.

Para grass: (*Bracharia mulica*): It is perennial with stout stolons,as much as 4.57 m long and culms, 0.914- 1.82 m high from a creeping base and panicles 10.12-15.18 cm long which is cultivated for forage.

Pasture: A piece of land with herbage meant for grazing of animals.

Peanut: Seed kernels of the plant *Arachis hypogaea* cultivated as commercial crop. Made into peanut meal after the oil is extracted. The meal is subject to fungal growth and may cause aflatoxicosis (Bailliere's Comprehensive Veterinary Dictionary, D.C. blood and Studdert, V.P. Bailliere Tindall, 1988)

Peepal/Pipal (*Ficus religiosa*): Tree belongs to family Moraceae. Its leaves are fodder for elephants and also for many other animals.

Pilkhan (*Ficus lacor*): Belongs to family *Moraceae*. It is commonly found in North India, Madhya Pradesh and western Peninsula. Grown as avenue.Its leaves and small branches and twigs are used as fodder for the elephants and rhinoceroses in captivity.

Potato (*Solanum tuberosum*): A tuber crop. Together with maize, rice and wheat, it is one of the four most valuable of world crops.

Predator: An animal that kills and consumes other animals.

Primates: The highest order of mammals including man, ape, monkey, etc.

Protein: An organic compound made up of amino-acids and containing carbon, hydrogen, oxygen and nitrogen.

Protein supplement: Livestock feed which contains 20 per cent or more protein.

Rabi crops: The crops cultivated during winter season in the plains of India.

Radish/Muli (*Raphanus sativus*): A herb (*Cruciferae*) cultivated in many states. The roots, young leaves and the fruits are used as vegetable.

Ragi (*Eleusine coracana L.*): A millet, also known as finger millet, Indian millet or rupuko. Seeds are hard, therefore, should be ground or crushed before feeding to ruminants while whole seed can be fed to galliformes, contains about 10% CP, 3.7 % CF and 2.10 % EE, 3.6 % DCP and 79 % TDN.

Ration: The amount of total feed provided to an animal over a period of 24 hours.

Reed grass (*Arundo donox*): A tall grass growing in marshy area.

Rice (*Oryza sativa*): The cereal grain, contains about 20 % husks and 3 % polishing

Rickets: A deficiency disease of growing bones due to insufficient vitamin D or imbalance of calcium and phosphorus in diet.

Roughage : A feed containing more than 18 per cent crude fiber when dry, examples hay and silage.

Tomato/Tamatar (*Lycopersieon crulantum*): A shrub (*Tiliaceae*) found in large number of states. The fruits are edible.

Total body water: The water content distributed all over the body.

Total volatile fatty acids: The sum of all the volatile fatty acids including acetic, propionic, butyric, isobutyric, valeric and, isovaleric acids estimated by steam distillation.

Toxicity: The quality of being poisonous, especially the degree of virulence of a toxic microbe or of a poison.

Toxicosis: Any diseased condition due to poisoning.

Tuber: The underground storage organ of some plants. Serves as an organ of vegetative propagation. Contrary to root crops, these contain either starch or fructose as the main components. Examples, sweet potato (*Ipomoea batatas*), tapioca and potato (*Solanum tuberosum*).

Tukhmalanga (*Lallemantia rayleana*): A perennial herb mainly found in Punjab. The seeds are used in flatulence and constipation.

Turnip (*Brassica rapa rapa*): The biennial plant with a white juicy root, contains a goiter producing factor (Glucosinolate). Roots contain CP 10% , CF 11-12 %, EE 1.2-1.6 %, ash 8-10 %, DCP 8.9 % and TDN 84 % Turnip is rich in calcium, iron, and vitamins A, B and C.

Urad (*Phaseolus mungo*): Belong to family *Papilionaceae*, cultivated as pulse crop in U.P., M.P., Punjab, Delhi and West Bengal.

Veal: The meat of a young calf (not less than three weeks old) when killed for table use.

Vegetable: Pertaining to or derived from plants; any plant or species of plant, specially the one utilized as a source of food.

Vilayati babul (*Prosopis juliflora*): It is a leguminous tree. It yields pods in winter and summer, which can be used as feed by wild animals.Pods contain 8.5-16.5 per cent CP,1.2-4.3 per cent EE,15.8 -33.6 per cent CF,and 47.4-60.9 per cent NFE.The DCP and TDN of pods are in the range of 5.9-7.0 per cent and 57.8-75 per cent, respectively. Tannin content, 0.74-1.5 per cent does not harm animals and can be incorporated at 20 to 30 per cent in the concentrate ration of ruminants.

Vitamins: They are organic substances essential for body functions, not considered as food. Vitamins are found in different foods. Animals with part bacterial digestion receives vitamins from bacteria which produce vitamins. Vitamins are commonly added to zoo animal diets in controlled doses. The body cannot store vitamins sufficiently, with the exception of vitamin A. They must be continuously supplied. Vitamins control or influence many important processes. Provitamins are fomrs which must be changed to absorbable form by the animals; example carotens to vitamin A. The change is made in the liver by the enzyme carotinase and the hormone thyroxin. Ergosterol is an animal fat and contains provitamin D. This provitamin is changaed by the action of ultraviolet (UV) light exposure to the skin of the animals.

Wallowing: Rolling into swamp or into water. Buffalo, sambar deer, barasingha, rhinoceros,etc. wallow to keep them cool, especially n summer months.

Water soluble vitamins: These vitamins include thiamine, riboflavin, niacin, pantothenic acid, pyridoxine, biotin, folic acid, vitamin B12 ascorbic acid, choline and para aminobenzoic acid.

Weaning: The gradual deprivation of young growing animals from the dams milk. In case of dairy cattle, newly born calves are often taken away from their mothers as soon as they are born and have some of the first secreted milk called colostrum. Then they are reared separately.

Wheat (*Triticum vulgare, T.aestivum*): The world's most important cereal crop. Whole wheat yields about 70 % flour and 30 % offal, consisting of bran and germ. Can be included in concentrate ration upto 25 %,. Contains about 13 % CP, 3 % CF, and 79 % NFE. Wheat straw is used for animal feeding as a source of roughage.

Wheat bran: Consists of the seed coat of wheat which is removed during the grinding to wheat flour. It is mild laxative and is a good source of phosphorus (0.9%). DCP and TDN are 10.6% and 67.5%, respectively.

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ABOUT THE AUTHOR

Dr. B.M. Arora, M.V.Sc. Ph.D., Principal Scientist (Wildlife) Indian Veterin Research Institute (ICAR), Izatnagar(U.P.) and former, Director, National Zoolog Park, New Delhi has long experience of about 25 years of working in the fiel wildlife management and health care in India. He has established Centre for Wild Conservation, Management and Disease surveillance and Van Prani Udyar the Institute. He had organized training programmes for Post Graduate Diplo Course for trainees of Wildlife Institute of India, Dehradun from 1977 onwards IVRI. Besides Dr. Arora has guided post graduate students including one fr USA. From 1995 National Diploma Course on Zoo and Wild Animal Health C and Management was initiated at his instance at IVRI, deemed to be University. holds the position of President of Association of Indian Zoo and Wild Veterinarians, founded in 1991. He has been Secretary of All India Zoo Direct Association from 1990 -1993. Dr. Arora worked as Advisor to National Zoologi Park, New Delhi from 1981-1990 and from 1995 onwards as a Member of the Z Advisory Committee. Presently he is Member in the Technical Committee and Z Evaluation Committee of CZA, Ministry of Environment and Forests. He has be opted as a member of SSC (IUCN), Switzerland.

Dr. Arora has authored about 100 research articles in various national a international journals/periodicals. He has published his first book on 'Wildl Diseases in India' in 1994 which included information on the occurrence diseases in native wild mammalian, reptilian and amphibian species recorded duri the past more than 100 years. He has also authored manual on Restraint a Translocation of Wild Mammals and a compendium entitled Progress in Wildl Conservation and Management. Based on his practical zoo mangement experien he has drafted guidelines for Zoo Service Management (for the large zoos). A b annual Wildlife Information Bulletin is being regularly brought out by him, sin 1995. He has organized several workshops and seminars and short courses wildlife husbandry management and health care, besides carrying out resear projects on the various facets of wildlife conservation and management.