ECOLOGIC AND ECONOMIC ASPECTS OF RHESUS MONKEYS (*Macaca mulatta* Zimmermann) ON MANGO CULTIVATION IN MALDA DISTRICT, WEST BENGAL, INDIA

By

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Dedicated

to the memory

of

Late Mrs. Bimala Mandal

&

Late Mr. Biswajit Das

UNIVERSITY OF NORTH BENGAL
DEPARTMENT OF ZOOLOGY

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1. INTRODUCTION

Our country is blessed with a wealth of wildlife, varieties of forests and diverse habitats. Presently wildlife of India comprises of about 372 species of mammals, 1228 species of birds in nearly 2100 forms and more than 20,000 species of insects and a large number of other animals (Saharia, 1998). It is a 'Megadiversity' country with atleast to 'Hot-Spots' containing a large number of endemic forms. However, we must also realize that along with this grace we also inherit a huge responsibility to conserve, utilize and pass on this treasure to generations to come. The task is far from simple with a democratic-secular form of Government against the growing demands of about 1.1 billion people and 600 million farm animals. Besides, a large number of people belonging to 'Below Poverty Line' and varies ethnic communities often depend to a large extent on the living natural resources of the country for their subsistence. To meet the demands of growing population; wildlife and forest areas of the country are decreasing every year. Per capita forest area in our country is less than 0.12 hectare while the world average ins 1.0 hectare.

We have an antique tradition to maintain a peaceful, respectable association with the environment. Our 'Vedas', 'Brahmans', 'Aranyakas' and 'Puranas' tought us to live peacefully with nature. Emperor Ashoka (B.C. 269-227) scripted the first laws of the world to protect fish, game and forest in his 'Fifth Pillar Edict'. Lord Buddha, Emperor Ashoka and Mahatma Gandhi of our country preached 'Non-violence'. We have a lot of religious doctrines and taboos to be kind and conserve all living beings including plants. But the present human population pressure in most developing countries particularly in our own has reached such an acute level that any leniency to the cause of wildlife and forests may tantamount to defeat in the struggle for survival in the Darwinean sense, - and there can never be any compromise on the issue of survival. Despite having such divine preachings and ancient tradition of peaceful, attruistic co-existence with nature people in various corners of our country at present do not hesitate to fight

adversaries, - a monkey or a tiger or any other. Thus, ensues the phenomenon of 'Man-Animal Conflict', - a phrase of common usage in many parts of the world.

Linnaeus (1758) named the group of animals to which we ourselves belong as primates. The primates in general inhabit a variety of habitat types from tropical wet evergreen forest to moist dry temperature forest. As such reduction of forest areas due to developmental activities affect their population. Today, there are fewer types of primates than there were in the past. The extant primates are a large and diversified group of mammals encompassing more than 50 genera in which atleast 200 species are well defined. Many modern primate genera are at present restricted in distribution as well as number in comparison to the past. In general, the more arboreal the species the greater is the tendency for it to be restricted in geographical distribution.

Field study in a natural environment provides the full range of behavioural patterns in most species. Field studies are essential to sort out problems of : relationships of behavioural patterns to population pressures, to the ecological or climatic changes, to the presence of predators or to the formation of a social group. It also helps to determine the social structure and group dynamics. C. R. Carpenter actually pioneered primate field studies in middle and South America and in East India during the 1930's and published a series of excellent monographs. After independence the leaders of our country framed policies for all round development within a schedule period particularly in agriculture and industry. Consequently massive dams, numerous irrigation canals, National Highways and giant industrial complexes started coming up one after another. At the same time due to improved medical facilities, health and sanitary conditions human population experienced on unprecedented explosive growth rate. Naturally more and more forest areas were taken up under cultivation to materialize the 'Grow more food' campaign. The results were disastrous in general on the forests, the biological support system and on the wildlife in particular.

The reasons for studying primate ecology and behaviour are varied. Apart from the obvious values of primates in biomedical research, primates studies have yielded new perspectives in problems of group dynamics, beavioural ecology and evolutionary history of man (Altmann, 1962; Bernstein, 1968; Carpenter, 1934; Lindburgh, 1969; Southwick, 1967 and many others). Recently, economic or rather socio-economic impact of primate populations are more and more coming under scientific investigations mainly from two separate and diagonally opposite considerations i.e. economic gain through wildlife tourism involving monkeys and great apes and economic loss due to crop destruction and other forms of damage caused by monkeys and apes. The later forms of loss is on the increase in most developing countries with high human population necessitating conversion of wildlife habitats to agricultural fields, industrial areas, urbanization and various other developmental requirements. This situation engenders the problem of man-animal conflict which assumes critical dimension in many parts of our country.

The proposed research programme belongs to an investigation of the later category in that it attempts to determine :

1. Different habitats of rhesus including mango orchard, crop field, grassland, roadside and human households.

2. Population studies of rhesus macaques at the study area. This involved population estimate, population dynamics, home range, birth season, sex ratio, population composition, natality, mortality, population increase and population density.

3. Feeding behaviour includes identification of food species, plant parts estimation, food selection ratio, feeding mode of rhesus, food species analysis, diet and seasonal variation, total food intake and drinks.

4. General activity pattern of rhesus includes several diurnal activities, resting sites and utilization of different areas of tree.

5. Social organization consists group types, group size, group composition, sub-grouping activities and interaction with other species.

6. Mango production and employment of people in this trade includes climate and soil factors in mango cultivation of Malda district, cultivated land and nature of production, variety of mangoes, nature and number of mango orchard, involvement of people in mango trade, events promoting mango cultivation and production, mango as medicine, problems and remedies associated with mango cultivation and trade.

7. Interactions between rhesus and humans in Malda district involved incidence of monkey population in different blocks, crop raiding by monkeys, damage induced by monkeys in mango production, subsistence of monkeys in the non-mango season, direct competition and overt attacks on humans by monkeys, assult on humans by the rhesus under various situations, diseases transmitted to human by rhesus, commensal and altruistic association between rhesus and man.

1.1. Importance of rhesus in scientific research

Rhesus monkeys occupy an unique position among non-human primates because of various reasons. They naturally occur in the forests, rural regions and even in urban areas. Macaques are the only group of old world monkeys (Family : Cercopithecidae) that occur in Asia as well as in Africa. Seven species of macaques occur in India of which *Macaca mulatta* or rhesus macaque is the most important species not only because of its wider range of distribution and dominance in number but also because of its importance in biomedical research. This animal is used extensively in the production of vaccines and in other laboratory research. It may be mentioned here that previously large number of juveniles of this species were exported to western countries mainly for use as test animals in Medical Research (Southwick, Beg and Siddiqi, 1970). Its importance in biomedical research is due to the fact that its disease spectrum is very similar to that of human beings. Thus detailed study of this species both in wild state and in

captivity is of more than ordinary interest and it is not surprising that *Macaca mulatta* received more attention than any other non-human primates from scientific community.

It is also one of the most attractive species among the macaques. It lives in wide variety of habitats, including cities, villages, farms, forests and even mountains upto 2600 meters (Southwick, Ghosh and Lauch, 1964; Neville, 1968b). Rhesus macaques can easily be tamed & taught various tricks, especially when young, but is never fully domesticated. In India, a small human community make their living by showing various tricks performed by their pet trained monkeys. This species is also popular as pets in many parts of our country.

1.2. Systematic Position

According to J. Z. Young (1962) the systematic position of rhesus macaques is as follows :

Phylum – Chordata
Sub-phylum – Vertebrata
Super-Class – Gnathostomata
Class – Mammalia
Sub-Class – Theria
Infra-Class – Eutheria (Placentalia)
Order – Primate
Sub-Order – Anthropoidea
Super-Family – Cercopithecoidea
Family – Cercopithecidae
Genus – *Macaca*
Species – *mulatta*

1.3. Close relatives

The genus *Macaca* include several species other than *mulatta* which are shown in Table.1.1. with their present distribution.

The animal has four sub-species recognized by Ellerman and Morisson – Scot (1951), Napier and Napier (1967), all found in South Asia (Table.1.2.). Fodden (1964) stated that *Macaca fascicularis* is a sub-species of *Macaca mulatta.* Hill (1972), however, has shown that *Macaca fascicularis* is an independent species.

1.4. Phylogenetic Consideration

It is difficult to pinpoint the time of origin of primates, however, most authorities believe that the group originated in the early Cenozoic although most of their evolutionary development was confined to Oligocene and subsequent ages (Simpson, 1945). It seems highly probable that tree-shrews of early Cenozoic time were at once the descendants of true insectivores and the ancestors of higher primates. The Eocene prosimian forms resembled monkeys in dentition and skull structure. At any rate it is clear that Cenozoic prosimians were the ancestors of higher primates. The earliest members of the family cercopithecidae arose and evolved from Eocene prosimians during Oligocene epoch (60 million years). The earliest members of old world monkeys and apes may have originated from the ancestral stock, 'Parapithecus', found in Egypt during Oligocene period (Gregory, 1916 and Colbert, 1969). The evolutionary history of macaque was recorded in the middle Pleistocene epoch (about 1 million to 2,50,000 years ago), but outside the Asian mainland. The distribution pattern of macaque confirms with a pattern of evolution away from the Asian mainland (Centered on Burma & Thailand), rather than one having several foci on the 'Sundashelf' (Medway, 1970). *Macaca fascicularis,* a kin of the species *mulatta*, however, has represented the earliest stage of macaque evolution from the middle Pleistocene.

1.5. Present distribution

The family cercopithecidae comprises of the old world monkeys in Africa and Asia and is divided into thirteen genera, of which *Macaca* alone is common to both regions. Of the remaining twelve six are African (*Cercocebus, Cercopithecus, Colobus, Erythrocebus, Papio* [including *Mandrillus*] and *Theropithecus*) and six are Asian (*Cynopithecus, Nasalis, Presbytis, Pygathrix, Rhinopithecus* and *Simias*). Only three genera are in South Asia : *Macaca, Presbytis* and *Rhinopithecus*. Of some 200 known species of recent primates 25 are in South Africa.

The genus *Macaca* is found in North Africa and South and South-east Asia from eastern Afghanistan through Tibet to China, Japan and Formosa; South to India and Ceylon, Philippines and several neighbouring islands. It is found at altitudes upto 3,140 metre in the Himalayas. The distribution pattern of *Macaca mulatta* is extensive : from south-east Afghanistan to the South Godavari river in India to Burma (Fry, 1928) and in small pockets of Laos, Cambodia, Vietnam, Tibet and China.

Present distribution of rhesus monkey in India and neighbouring countries is shown in Figure.1.1. In several areas of Northern India its distribution is curiously discontinuous (Krishnan, 1972). Annekov, Mirvis and Kotrikadze (1972) suggested that there are two groups of populations, a Chinese-Vietnamese and an Indian. Figure.1.2 also shows sites of recent investigations on rhesus in India. At present several wild groups (Pal, Bhattacharjee and Guin, 1982; Kali, 2002) are known to exist in protected forest reserves of North Bengal (Table.1.3.).

1.6. Objectives of the present study

The general objectives of this research work was to study the ecology and behaviour of rhesus monkeys in different blocks of Malda district in the mango and non-mango season. Special emphasis was given to how the ecologic and behavioural aspects of rhesus monkeys affect mango production and subsequently

influence economic well being of local populace. The specific objectives of the study were to determine :

A. MONKEY : Populations and group size, behaviour profile, food habits and interaction with man in the mango and non-mango season.

B. MANGO : Area under mango cultivation, amount of production in weight and price, production per year in monkey infested and non-monkey infested areas, nature and quantum of damage at different phases of mango season.

C. MAN : Number of people involved in the transaction of mango-producing land, gardens, mango cultivation, security of mango orchards, transportation of mango, basket making, mango processing, research on horticultural aspects and various other involvements in mango production. Damage caused by monkeys to properties, crops, fruits and vegetables other than mango and direct physical attacks on man inflicting serious injuries were also studied.

Table.1.1. Present distribution of species under the genus *Macaca.*

	Name of the Species	Local Names	*F/D	Distribution	Authority
1.	*M. arctoides* I. Geoffroy, 1831.	Stumptail Macaque	F/D	China, India, Burma, Laos, Thailand, Cambodia, Vietnam, Malay; Sea-level upto 2400 m* altitude.	Medway (1969, 1970), Southwick and Siddiqi (1970).
2.	*M. assamensis* McClelland, 1840.	Assamese Macaque	F	India, Nepal, Bhutan, Burma, Thailand, Laos, Cambodia, Vietnam, Yunnam, 610-1330m. altitude.	Roonwal (1950); Napier & Napier (1967); Hill & Bernstein (1969); Khajuria & Ghose (1970); Fodden (1971).
3.	*M. fascicularis* Raffles, 1821.	Long-tail Macaque	F/D	India, Burma, Malay, Thailand, Vietnam, Indonesia and Phillipines, upto 2000m altitude.	Furuya (1962, 1965); Medway (1969, 1970); Fodden (1971); Southwick and Cadigan (1972).
4.	*M. nemestrina* Linnaeus, 1766.	Pig-tail Macaque	F/D	India, Malay, Indonesia, upto 900m. altitude.	Fodden (1969); Medway (1970).
5.	*M. radiata* E. Geoffroy, 1812.	Bonnet Macaque	F/D	India, upto 2100m. altitude.	McCann (1933); Simonds (1965); Krishnan (1972).
6.	*M. Silenus* Linnaeus, 1758.	Lion-tail Macaque	F	Peninsular, India, upto 610 to 1300m. altitude.	Sugiyama (1968); Southwick and Siddiqi (1970); Krishnan (1972).
7.	*M. sinica* Linnaeus, 1717.	Toque Macaque	F	Ceylon.	Phillips (1935); Pocock (1939); Napier & Napier (1967).

* F = Forest, D = Domestic, m = Metre.

Table.1.2. Present distribution of four sub-species of *M. mulatta.*

Serial No.	Name of the Species	Distribution	Authority
1.	*M. m. memohani*	North-Eastern Afghanistan and Pakistan, about 1,100m.* of altitude.	Pocock, 1932.
2.	*M. m. mulatta*	Nepal, Bhutan, India, Thailand, Laos, Cambodia, Vietnam and Southern China.	Zimmermann, 1780.
3.	*M. m. vestita*	Tibet.	Milne-Edwards, 1876.
4.	*M. m. villosa*	Northern India (Southern Kashmir, Upper Punjab and Kumayun Hills).	True, 1894.

* m = Metre.

Table.1.3. Forest reserves in North Bengal with sizable rhesus monkey populations at present.

Province		Forest Reserve	Altitude (m*)	Authority
West Bengal	1.	Senchal Wildlife Sanctuary, 1915.	1500-2600	Southwick, Ghosh and Louch (1964), Louch (1964), Kali (2001).
	2.	Jorepokhri Wildlife Sanctuary, 1985.	-	Southwick, Ghosh and Louch (1964), Kali (2001).
	3.	Mahananda Wildlife Sanctuary, 1949.	150-1200	Southwick, Ghosh and Louch (1964), Neville (1968), Kali (2001).
	4.	Gorumara national Park, 1995.	Above 120	Neville (1968), Pal and Guin (1981), Kali (2001).
	5.	Chapramari Wildlife Sanctuary, 1940.	Above 100	Neville (1968), Pal and Guin (1981), Kali (2001).
	6.	Jaldapara Wildlife Sancturary, 1941.	Above 150	Neville (1968), Pal and Bhattacharjee (1980), Kali (2001).
	7.	Buxa Reserve (Tiger), 1982-1983.	150-1500	Neville (1968), Kali (2001).

* m = Metre.

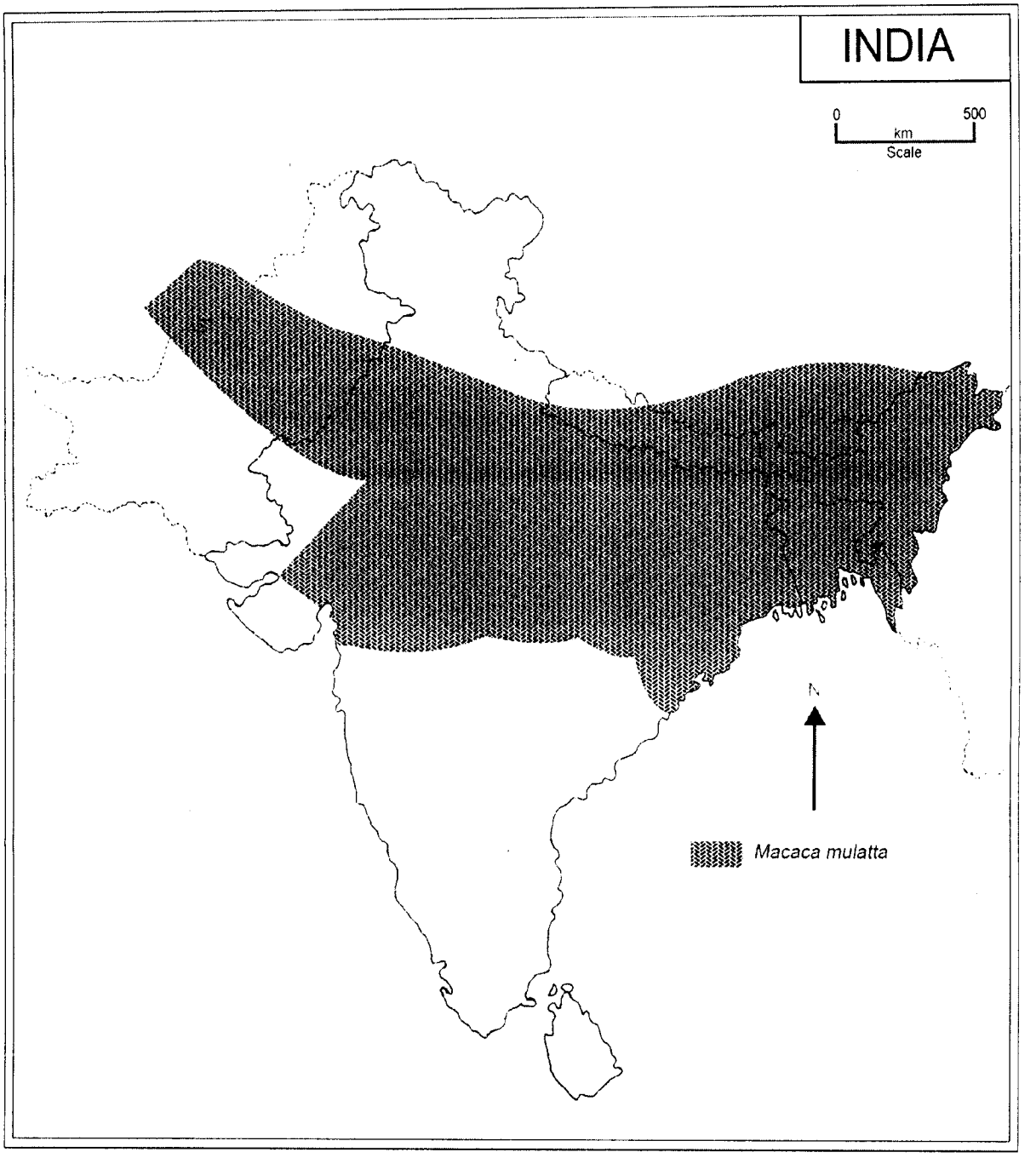

Figure. 1.1. Approximate geographical distribution of *Macaca mulatta.*

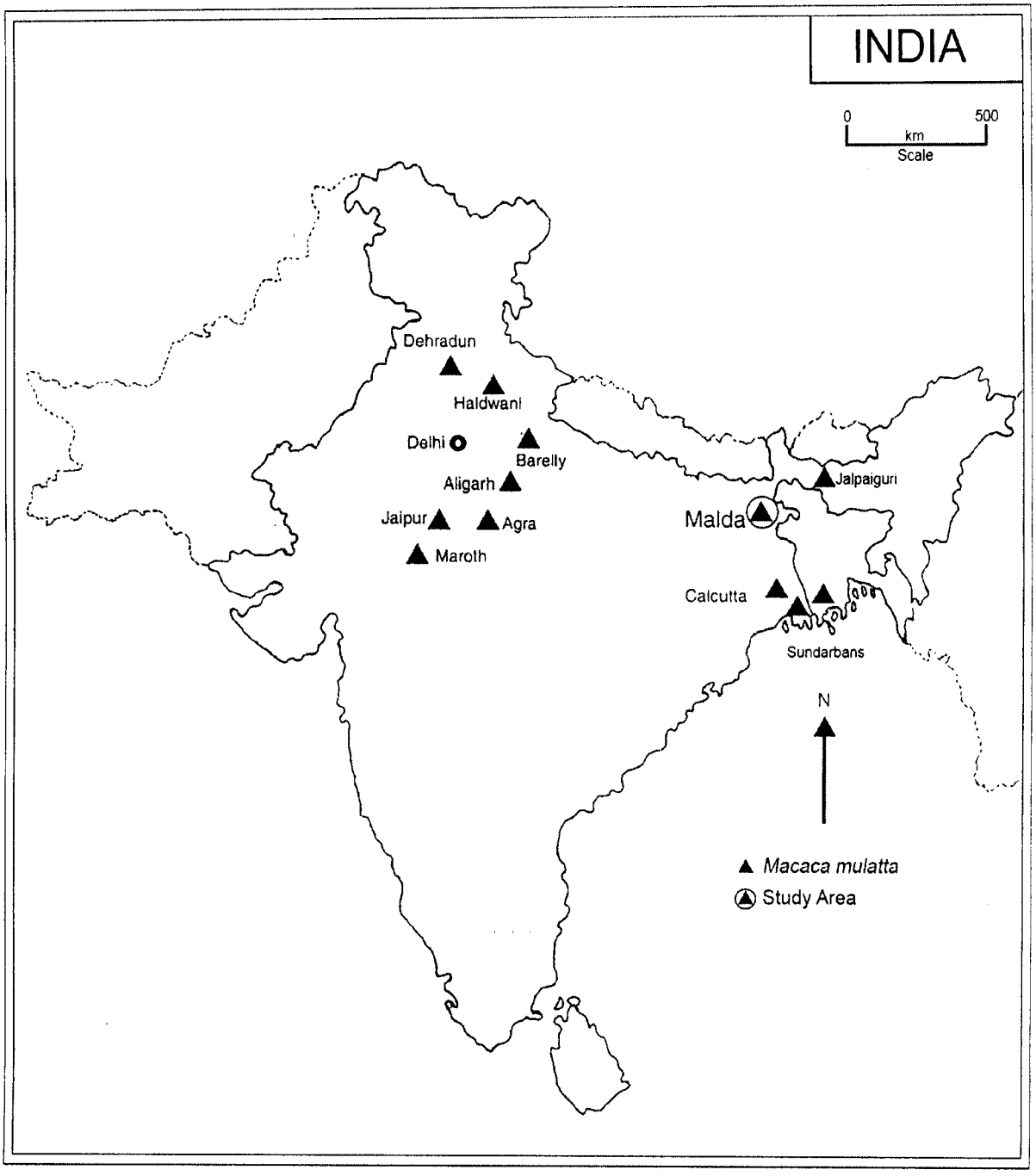

Figure.1.2. Sites of recent feild observations on rhesus monkey in India.

2. LITERATURE REVIEW

Primates in general and rhesus macaques in particular have received lot of attention from various authorities since the time of Darwin and even earlier. Thus, unlike many other subjects there is an abundance of information both in the field and in laboratory on primates. This probably due to their closeness to humans in genetic make up, physiologic and behavioural responses and ecologic requirements. It is, however, often a daunting taste to review the literature on a subject with abundance of information. In recent times raiding crop fields and orchards by monkey is almost a global problem. Their population is much higher in extensive crop production area than moderate cultivation areas. It may, however be pointed out that source of food such as mango may not be the only criteria for promoting large population. Eminent primate biologist C. H. Southwick pointed out in the late 70's that permanent source of water, availability of food and shelter in the form of tall trees and favourable human attitude may together support existence of rhesus monkey population (Personal communication).

The world "rhesus" comes from the Greek word "Rhesos", the king of Thrace who assisted Priam at Troy (Jaeger, 1972). The common name rhesus monkey is responsible for the naming of the hereditary blood antigen Rh-factor that was discovered on their red blood cells in 1940. Rh-factor is also found in humans. The mixing of Rh blood with non-Rh blood during blood transfusions can result in potentially dangerous defense reactions (Nowak, 1991).

Studies on phylogeny and evolution of both old world monkeys and apes has been studied by Gregory (1916), Simpson (1945), Young (1962), Colbert (1969). The evolution of *Macaca arctoides, Macaca nemestrina* and *Macaca fascicularis* besides *Macaca mulatta* were done by Medway (1970).

Rhesus monkeys enjoy an extensive distribution from south-east Afghanistan through India to northern Thailand and is said to have been abundant in sourthern China and Tibet prior to massive environmental degradation due to human pressure that forced most wildlife populations to the present dwindling state.

Today most countries maintain captive populations of rhesus monkeys in natural or semi natural condition to meet the demands of bio-medical research (Nowak, 1991; Parker, 1990; Wilson and Reeder, 1993).

Distribution of Rhesus in India was studied by Zimmermann (1780), Jerdon (1874), Pocock (1932), Prakash (1958, 1960, 1962), Southwick et al. (1961a, 1961b, 1964, 1965, 1966, 1967, 1968, 1970, 1972, 1977, 1980 and 1982), Louch (1964), Mandal (1964), Mukherjee and Gupta (1965), Prater (1965), Neville (1968), Lindburgh (1969, 1971), Mukherjee (1969), Krishnan (1972), Kali (2001).

Occurrence of rhesus and their relatives outside India was reported by Zimmermann (1780) in Nepal, Bhutan, Thailand, Laos, Cambodia, Vietnam and China; Milne-Edwards (1876) in Tibet; Pocock (1932); Ellerman and Morrison-Scott (1951); Fodden (1964); Napier and Napier (1967) in South Asian countries; Southwick and Siddiqi (1970), Hills (1972), Southwick and Cadigan (1972) in Malayasia; Ghimire (2000-2001), Chalise and Johnson (2001) in Nepal; Hill and Agestsuma (1998), Saito and Tokida (1998), Knight (1999) in Japan; Hill (1997), Saj, Sicotte and Paterson (2001) in Uganda.

The habitat of rhesus monkeys in India has been exclusively studied by Prakash (1958), Southwick et al. (1961a, 1961b, 1964 1970, 1971), Mandal (1964), Mukherjee and Gupta (1965), Neville (1968a), Lindburgh (1971) and Kali (2001).

Data on physical structure of the species i.e. body size, weight, colour, specific structure in different age-sex classes have been reported by shortridge (1914), Schultz (1933, 1969), Southwick, Beg and Siddiqi (1961a), Napier and Napier (1967) and Fodden (1971).

Studies on population of rhesus macaques in various habitats was done by Jerdon (1874), Dodsworth (1914), Carpenter (1942, 1958, 1964, 1972), Prakash (1958, 1962), Southwick et al. (1961, 1964, 1965, 1967, 1968, 1970, 1971, 1980), Altmann (1962, 1965, 1967), Koford (1963, 1965, 1966), Mandal (1964), Neville

(1968), Mukherjee and Gupta (1968), Mukherjee (1969), Lindburgh (1971), Bernstein and Carolyn (1986), Kali (2001).

Social organization of rhesus was studied by Prakash (1958, 1962), Koford (1963), Mandal (1964), Altmann (1965), Mukherjee and Gupta (1965), Sade (1965), Southwick et al. (1965), Mukherjee (1969), Lindburgh (1971), Ojha (1974), Tartabini and Dienske (1979), Belzung and Anderson (1986), Dewaal (1986), Dewaal and Luttrell (1986), Wilsons (1986), Reinhardt and Hurwitz (1993), Reinhardt (1994). Social organization among other non-human premates was studied by carpenter (1942), Jay (1965), Nishada (1966), Neville (1968), Dittus (1974), Oppenheimer (1977), Green and Minkowski (1977), Whitemore (1984), Toru Ot (1989), Bernstein (1968), Mendoza (1991) and Petto (1994).

Feeding behaviour as well as different aspects of food habits of rhesus monkeys was studied by Corner (1941), Stoddart and Smith (1955), Roonwall (1956), Mukherjee and Gupta (1965), Lindburgh (1971), Puget (1971), Krishnan (1972), Petrides (1975), Altmann (1974), Clutton and Brook (1977), Mohnot (1977), Oppenheimer (1977), Maruhasi (1980), Jen (1987), Brennan (1988), Mori (1988), Nakagawa (1989), Parker (1990), Nowak (1991), John and Lindberg (1996), Maliukova, Uvarova and Silakov (1992), Johnson (2000), Pelaes, Gil-Burmann and Sanches (2000), Mathy and Isbell (2001), Santos, hauser and Spelke (2001), Kali (2001). Feeding behaviour and food habits of monkeys other than rhesus have been reported by Sugiyama (1971), Harrison (1983), Dittus (1984), Jonson (1985), Barton (1987), Boccia, Laudenslager and Reite (1988), Imakawa (1988), Ihobe (1989), Nakagawa (1989), Isbell, Cheney and Seyfarth (1990).

Crop raiding by primates is a global problem at present. Unprecedented increase in human population in the developing world where most wildlife species occur naturally necessitated massive deforestation and wildlife habitat destruction. This situation force most wildlife species to come into direct conflict with man incurring loss of crops property and sometimes life. A large number of scientists are engaged in this area. Notable contributions to this end include : Boulton,

Horrocks and Baula (1996), Hill (1997), Oda et al. (1997), Funakishi (1998), Hill (1998), Hill and Agestuma (1998), Hill and Hill (1998), Naughton, Treves, Chapman and Wrangham (1998), Saj, Sicotte and Paterson (1999), Siex and Struhsaker (1999), Hill (2000), Chalise (2001) and Saj, Sicotte and Paterson (2001).

Conflicts between rhesus monkeys and man occasionally escalate to direct physical attack by monkeys on man. Although most wild animals tend to avoid contact with man the monkeys due to their prolonged association with man are well aware of the limitations and vulnerability of man and do not hesitate to attack them if situation so demands. Attacks often include scratching, biting and stamping causing serious injury with gushing wounds. Thus possibility of transmission of a large number of diseases from rhesus to man is very high. Clinical studies on this aspect was done by Lindsay (1966), Sedgwick, Parchen and Durham (1970), Latt (1975), Machotka et al. (1975), Sesline et al. (1975), Fleischman et al. (1982), Holmberg et al. (1982), Honser et al. (1982), Tryphonas and Wong (1982), Bellinger and Bullock (1988). Keusch et al. (1986), Clerc et al. (1987) and Libdberg et. Al. (1988) noted transmission of shigellosis from rhesus macaques to humans.

Studies on status of mango in Asia was done was Chadha (1993). Some workers such as Passam (1982), Hasabnis and D'Souza (1987), Fornaris and Guadalupe (1989), Balasubramanium (1991), reported on storage on mango fruits. Prasad and Fortune (1989), Cunningham (1991), Pena, Mohyuddin and Wysoki (1996, 1998) reported on management of mango pests while physico-chemical characteristics of mango was studied by Ghosh, Dhua and Mitra (1985), Kundu and Ghosh (1992).

Mukherjee (1984), Maiti, Sen and Bose (1979) reported on varieties of this fruit in West Bengal. A number of scientists such as Bhan, Samaddar and Jadav (1969), Majumdar and Rathore (1970), Tiwari and Rajput (1972), Hoque and Hussain (1974), Maiti and Biswas (1980), Singh and Srivastava (1981),

Chakrabarti and Sadhu (1983), Chakrabarti and Sadhu (1984) worked on grafting of mango.

Medicinal use of mango plant was studied by Patel et al. (1988), Carlier et al. (1992), Khan et al. (1993), Zhu et al. (1993) and Wauters et al. (1995). Reports on other medicinal plants and traditional folk medicine of tribal communities in India and abroad was presented by Bhargava (1983), Mitra and Jain (1991), Schultes (1992), Pal and Seal (2002).

3. STUDY AREA

Malda, a district of West Bengal is unique in that it contains Gour, the ancient Hindu capital of Bengal. The district maintains its traditional agrarian culture. Some of the historical monuments of the district include : the mosque Jami Masjid (1566) and the land mark Nimasarai Tower across the river Mahananda. The present district town English Bajar served as a river port of the Hindu capital "Pandua". During the 18th century it was the seat of prosperous cotton and silk industries. Presently the district produces rice, jute, legumes and oil seeds besides silk and mango. Mango trade and silk manufacture are the main economic activities of this district.

3.1. Geographical Location

Malda is the gate way of North-east India. The district is surrounded by Uttar Dinajpur, Murshidabad and Dakshin Dinajpur district of West Bengal in the north, south and east respectively. The eastern part of the district is also bordered the Bangladesh. The western part on the other hand is demarcated by Bihar (Figure.3.1.). Malda (26.043m MSL) is situated between $25^0$33'8" and $24^0$40'20" latitude in the northern hemisphere and very close to the Tropic of cancer. The eastern and western most extremities of the district is marked by $88^0$28'10" and $87^0$45'50" longitude respectively.

3.2. Area and Population

The district spans over a total geographical area of 3733.00 sq. km. (as per census, 2001), with 2 administrative subdivisions, 15 blocks and 147 gram panchayets with a total population of about 3.29 million and population density of 881/sq. km.. The mighty Ganga engulfed nearly 23.00 sq. km. of land area along with some mango orchards at Panchanandapur of English Bajar block during the last 5 years.

3.3. Meteorology

The district receives on average 1400 mm rainfall per year, the mean maximum and minimum temperature is 36^0C and 16^0C respectively. The relative humidity of the district varies from a maximum of 85% to a minimum of 57%.

The average monthly precipitation recorded during the study period i.e. January 1998 to December 2001 is shown in Figure.3.2. The district receives highest rainfall 292 mm i.e. 20.87% of yearly 1400 mm in July and more than 80% rainfall during the monsoon i.e. from May to September.

Figure.3.3. presents average daily maximum and minimum temperature of the district during 1998-2001. Temperature reached a maximum of 38^0C in May and declined in a regular fashion to a minimum of 11^0C in January.

Mean relative humidity stays on the higher side throughout the year. A minimum humidity of 57% was recorded in March and increased to a maximum of 85% in July and September. Percent humidity varied little (70% to 75%) during the winter months, November to February (Figure.3.4.).

The district is flood-prone and during the year 1971, 1978, 1989, 1996, 1999 and 2001 serious devastations occurred. Many blocks are regularly inundated by flood during the monsoon period.

Cyclonic storms often accompanied by gusty rains called "Kal Baishakhi" are frequent in the pre-monsoon period. Sometimes it causes severe damage to mango inflorescence. Hail-storms causing severe damage to mango inflorescences, buds and young fruits are also not infrequent during pre-monsoon period.

3.4. Rivers

Rivers that flow through the district are Ganges, Mahananda, Bhagirathi, Fulhar, Pagla, Kalindri and Tangan all of which in general flow from north to south. The Ganges makes an island i.e. BHUTNI DIARA at Manikchak block. Another important river i.e. Mahananda comes from the north and after traversing through Malda enters into Bangladesh. Figure.3.5. shows the rivers of the district.

Most of the rivers are flood-prone and inundate vast areas in the monsoon almost every year. Despite all the calamities the district produces lot of crop materials, probably due to deposition of fertile alluvium during inundation. It may, however, be pointed out that sizable land areas are engulfed by the Ganges every year particularly at Panchanandapur of English Bajar block. The State and Central Government has already taken some urgent step in this context.

3.5. Soil

The district can be subdivided into three district regions according to physiography and hydrological characteristics of soil i.e. – BORIND, TAL and DIARA. BORIND areas include Gajole, Bamongola, Habibpur and Old-Malda. TAL situation prevails at Ratua-I, Ratua-II, Changhal-I, Chanchal-II, Harishchandrapur-I, Harischandrapur-II and DIARA situations at English Bajar, Manikchak, Kaliachak-I, Kaliachak-II and Kaliachak-III. Figure.3.6. shows the three regions of the district. Table.3.1. presents the characteristics of the regions in tabular form.

Organic matter status belongs to medium category ranging from 0.5% to 0.75% throughout the district. In certain areas of Ratua-I, Manikchak and Old Malda organic matter was found lower i.e. below 0.5%.

3.6. Vegetation

Agro-climatically the district falls under lower Gangetic plain region (Zone-III) and is fortunate have a fertile soil and abundant water through rainfall and rivers for irrigation of agricultural fields. Thus a number of major crops are produced in the district besides silk and mango. The major crops are rice, wheat, rape seed, jute, gram, sugar cane, maize and potatos. Table.3.2. presents quantity in tones (per annum) and value as % of district total of those crops.

3.7. Mango Cultivation

Mango is the primary cash crop of the district and is cultivated in all the 15 blocks (Table-3.3). Total area on mango orchards in the district is 24560 hectares with an estimated production of 253876 MT. The country as a whole has an area of 1522600 hectares under mango producing about 10237000 MT. The comparable figures for West Bengal is 65,400 hectares with a production of 585000 MT.

Seven blocks i.e. Kaliachak-I, Kaliachak-II, Old Malda, Ratua-I and Ratua-II, Manikchak and English Bajar accounted for 88.4% of the land on mango cultivation of which English Bajar alone contributed more than 35%. Two blocks i.e. Bamongola and Habibpur together accounted for less than 1% and the rest of the blocks i.e. Kaliachak-III, Harishchandrapur-I, Harishchandrapur-II, Chanchal-I, Chanchal-II and Gajole accounted for about 11% (Figure.3.7.). It may be pointed out that State Government is trying to promote mango cultivation in the district particularly in Bamongola and Habibpur for about two decades – as a result present area under mango cultivation is about 14% higher than in 1986-87 i.e. 21140 hectares (1986-87) to 24560 hectares (2002-03).

3.8. Monkey Infested Blocks

Rhesus macaques are one of the few animals that are exploiting human ecosystems and are becoming more and more dependant on cultivated land,

orchards and gardens as a primary source of food. This situation may be considered as a direct fall out of human extension into forest and wildlife habitats – escalating man-animal conflict. It is observed that monkey density is quite high in blocks with high mango production. Thus concentration of monkeys is high in blocks with extensive mango cultivation such as English Bajar, Ratua-II and Old Malda. It is further observed that in some blocks even with extensive mango cultivation areas such as Manikchak, Kaliachak-I, Ratua-I concentration of monkeys is low because production of mango is rather low due to the fact that most plantations in these blocks are young and production is low. As already pointed out State Government is promoting mango plantation and Fruit Processing Industry in the district in a big way and substantial portion of plantations in some blocks are young with low production.

More than 90% monkey populations are found in extensive mango cultivation blocks and the rest are found in blocks with moderate mango cultivation. No monkeys are found in blocks with poor mango cultivation. Figure.3.8. shows monkey affected blocks of the district.

3.9. Specific Study Spots

Although mango plantations occur in all the 15 blocks of the district the extent of plantation and production of mango vary considerably in different blocks. Monkey population in the blocks varies as a function of mango plantation and production. Specific aspects of the work was actually conducted at a number of spots dispersed over the extensive and moderate mango cultivation areas. The study spots are Gopalpur, Jaharatala, Sadullapur, Jadupur, Manikpur, Mehedipur, Baluchar in English Bajar block; Kotwali, Bachamari, Old Malda of Old Malda block; Araidanga, Paranpur, Ekbarna of Ratua-I and Ratua-II block. Besides these, some areas namely Baluchar, Golapatty adjacent to Malda town under English Bajar block where human population density is high with no mango cultivation also served as study site as some human communities of the area regularly fed monkeys with nuts, bananas and other food items on religious considerations.

The factories for mango products, Govt. mango processing centres may also be considered as a study spot because these factories were regularly visited in order to collect various data regarding mango preservation, processing and training of personnel etc. Different wood workshops of the district and various villages were also visited in this study because a large number of people are directly engaged in making baskets for transportation of mangoes in various parts of the West Bengal as well as India.

Table.3.1.Some of the characteristics of three regions, mainly based on the soil properties of the district.

CRITERIA	BORIND	DIARA	TAL
Area :	1,32,761 hect.	1,09,493 hect.	1,14,100 hect.
Land situation :	High (59.7 mt).	Flat	Lowering area, slope towards south-west.
Soil :	Old alluvial	New alluvial	New alluvial
pH :	4.5 to 7.5 (Strongly acedic to nutral)	Near about 7 (Mildly acedic to nutral)	Near about 7 (Mildly acedic to nutral)
Major Crop :	Rice, Jute	Rice, Jute, Sugar cane, Legume, Wheat, Oil seeds	Rice, Jute, Wheat, Oil seeds
Soil Composition :	Sandy : 7-9% Sandy loam : 15-16% Loam : 45-47% Clay loam : 13-15% Silt loam : 11-12% Clay : 5-6%	Sandy : 2-3% Sandy loam : 8-9% Loam : 35-36% Clay loam : 42-43% Silt loam : 4-5% Clay : 5-6%	Sandy : 2-3% Sandy loam : 8-9% Loam : 35-36% Clay loam : 42-43% Silt loam : 4-5% Clay : 5-6%
Blocks :	Gajole, Bamongola, Habibpur and Old Malda	English Bajar, Manikchak, Kaliachak-I, Kaliachak-II and Kaliachak-III	Ratua-I, Ratua-II, Chanchal-I, Chanchal-II, Harishchandrapur-I and Harishchandrapur-II

Table.3.2. Major crops of Malda district and their quantity per annum and value as % of district total.

Crop	Quantity (tones)	Value as % of district total
Rice	387,960	72.03
Wheat	71,090	9.29
Rape Seed	15,856	6.01
Jute	131,410	4.37
Gram	7,166	2.04
Sugar Cane	71,973	1.33
Maize	9,413	1.66
Potatos	15,080	1.13

Table.3.3. Block-wise mango cultivation land of Malda district for the year 2002-2003.

Name of the Block	Area (in hectares)	Category of plantation
Bamongola	20	Poor
Habibpur	60	"
Chanchal-II	200	Moderate
Kaliachak-III	220	"
Harishchandrapur-I	400	"
Gajole	430	"
Harishchandrapur-II	620	"
Chanchal-I	900	"
Kaliachak-II	1780	Extensive
Old Malda	2000	"
Kaliachak-I	2000	"
Ratua-I	2150	"
Ratua-II	2160	"
Manikchak	3000	"
English Bajar	8620	"
Total	24560	

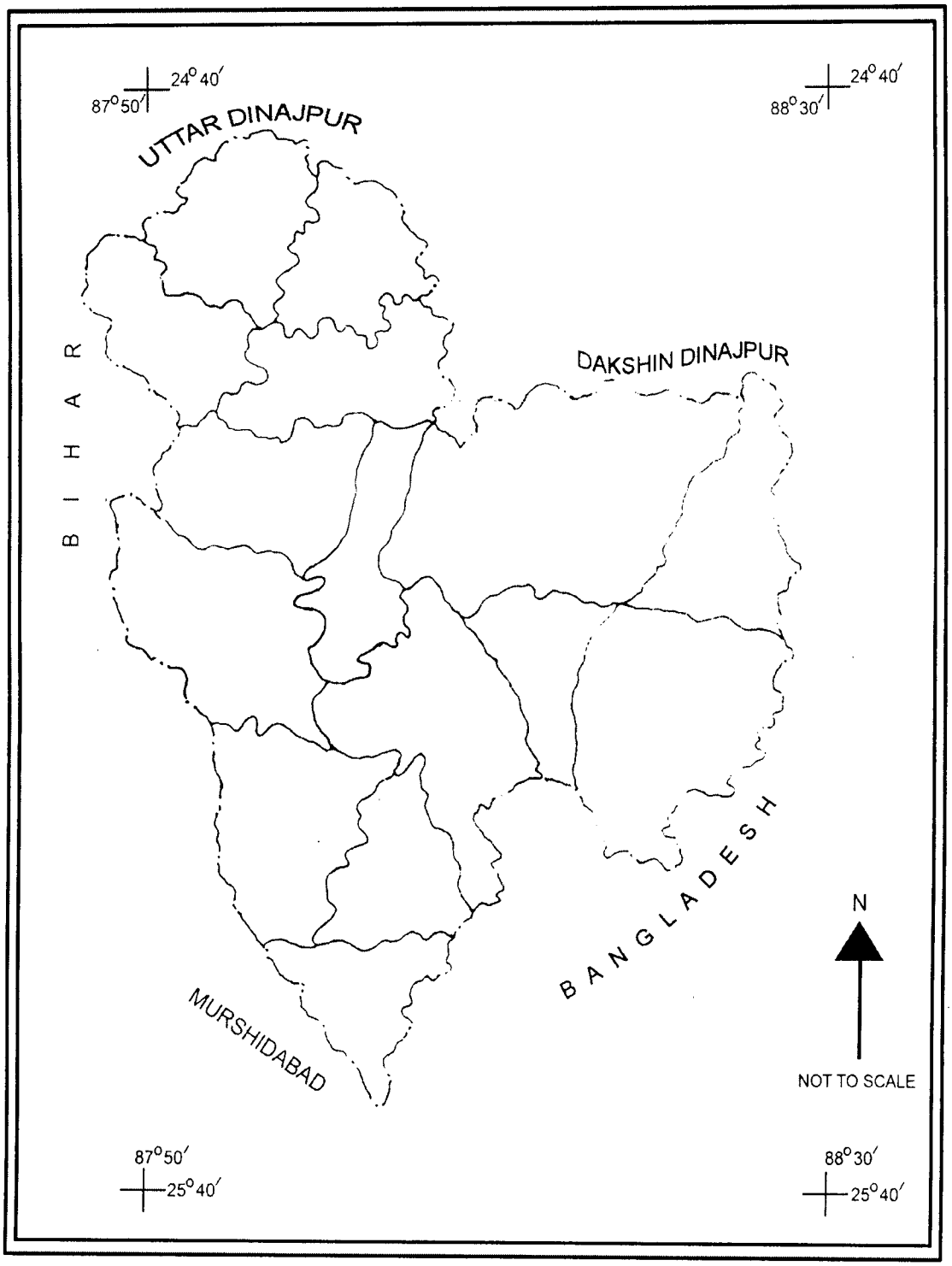

Figure.3.1. Malda District

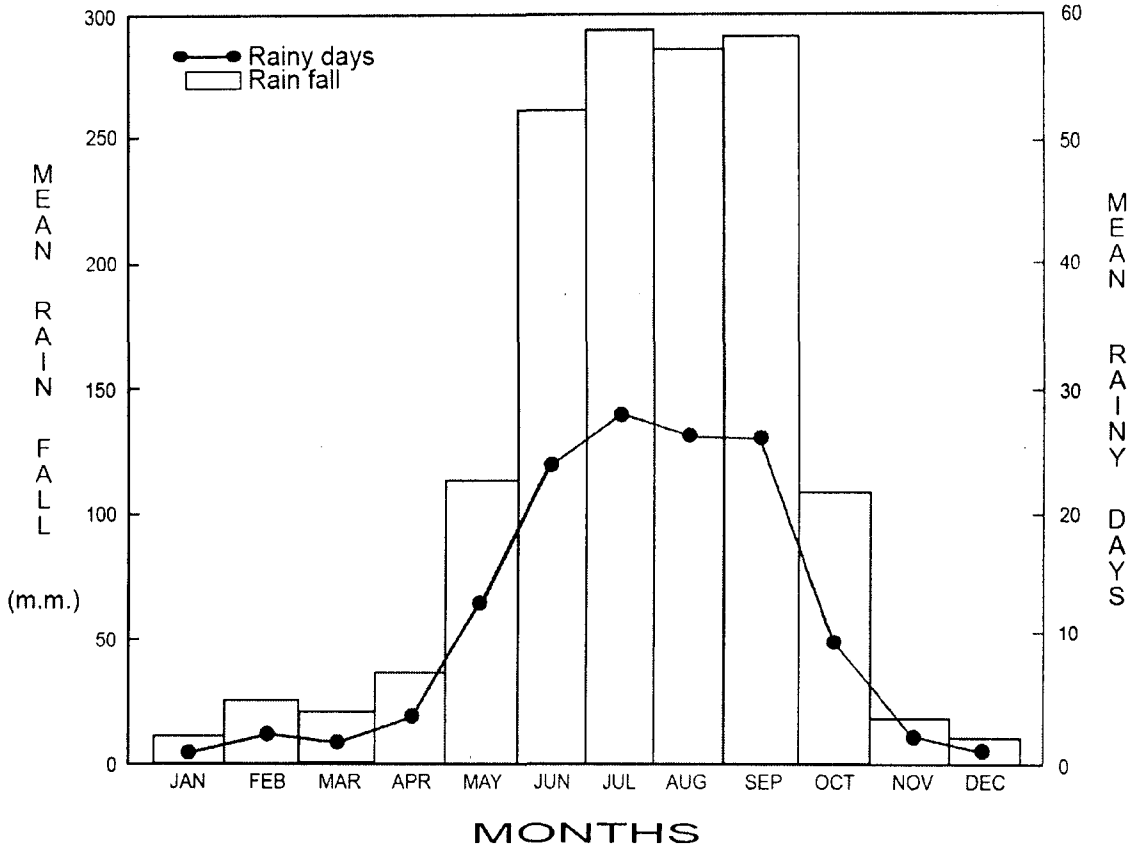

Figure. 3.2. Mean monthly rain fall at Malda district during the period January, 1998 to December,2001.

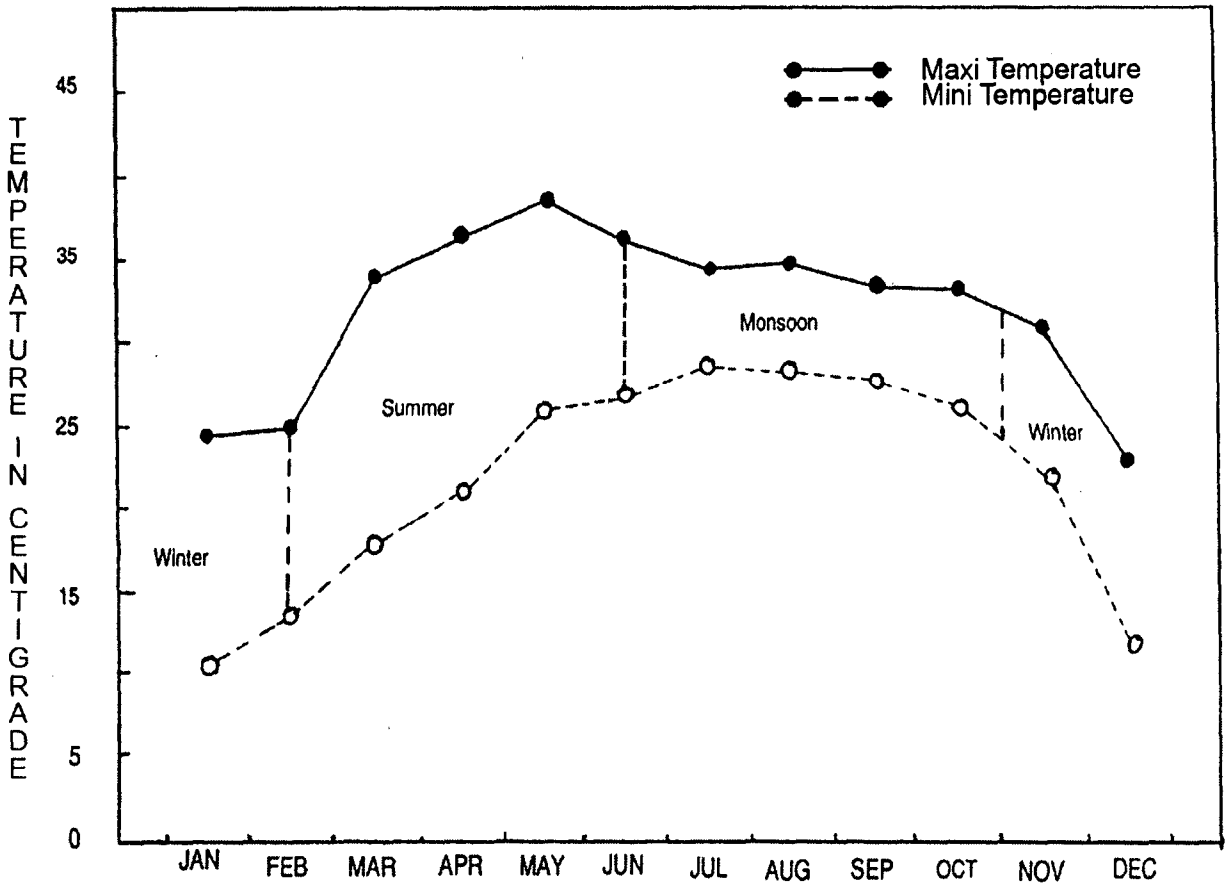

Figure. 3.3. Average monthly maximum and minimum temperature at Malda district during the period January,1998 to December,2001.

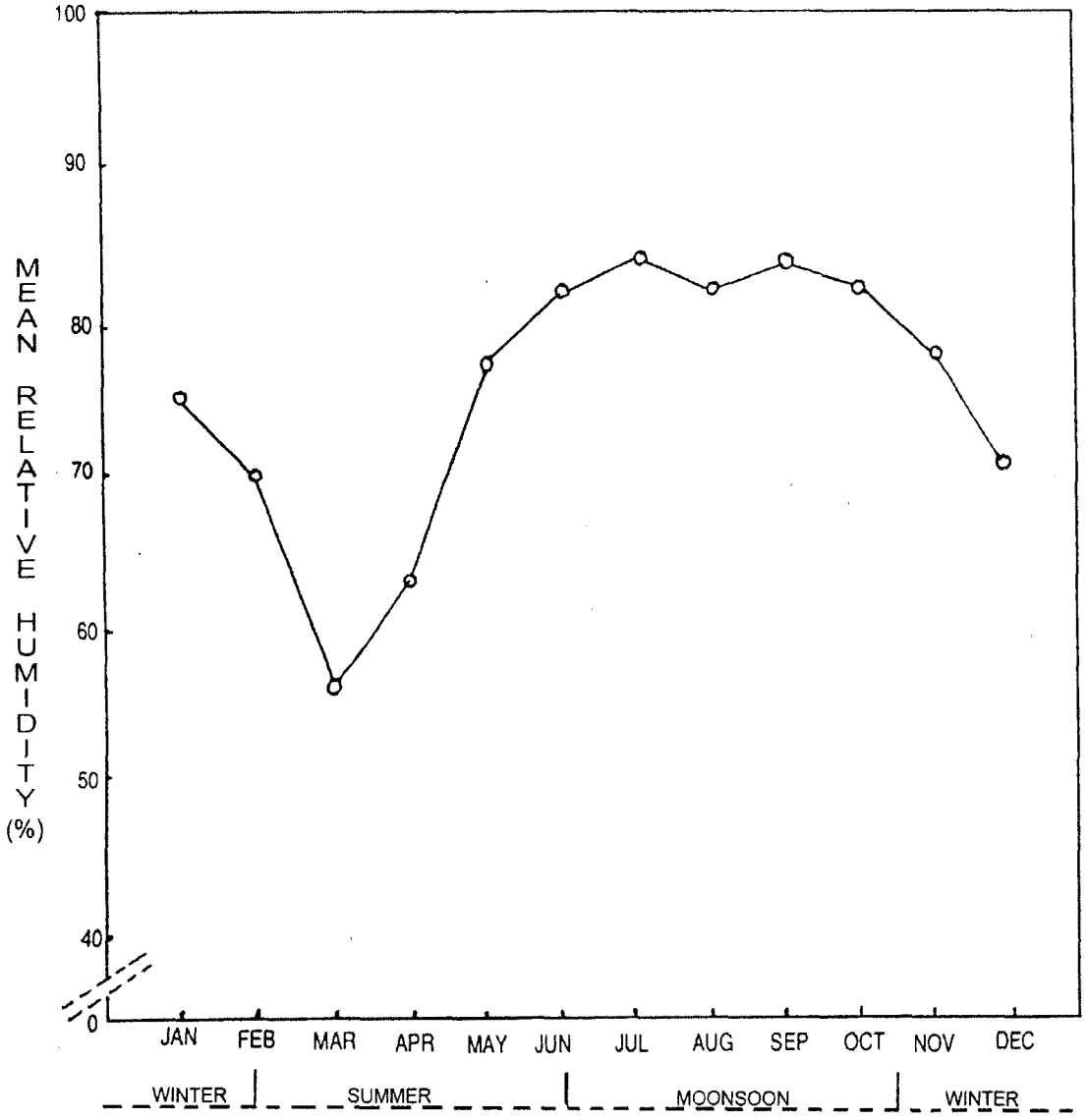

Figure. 3.4. Mean monthly relative humidity at 07.00 hour at Malda district during the period January,1998 to December, 2001.

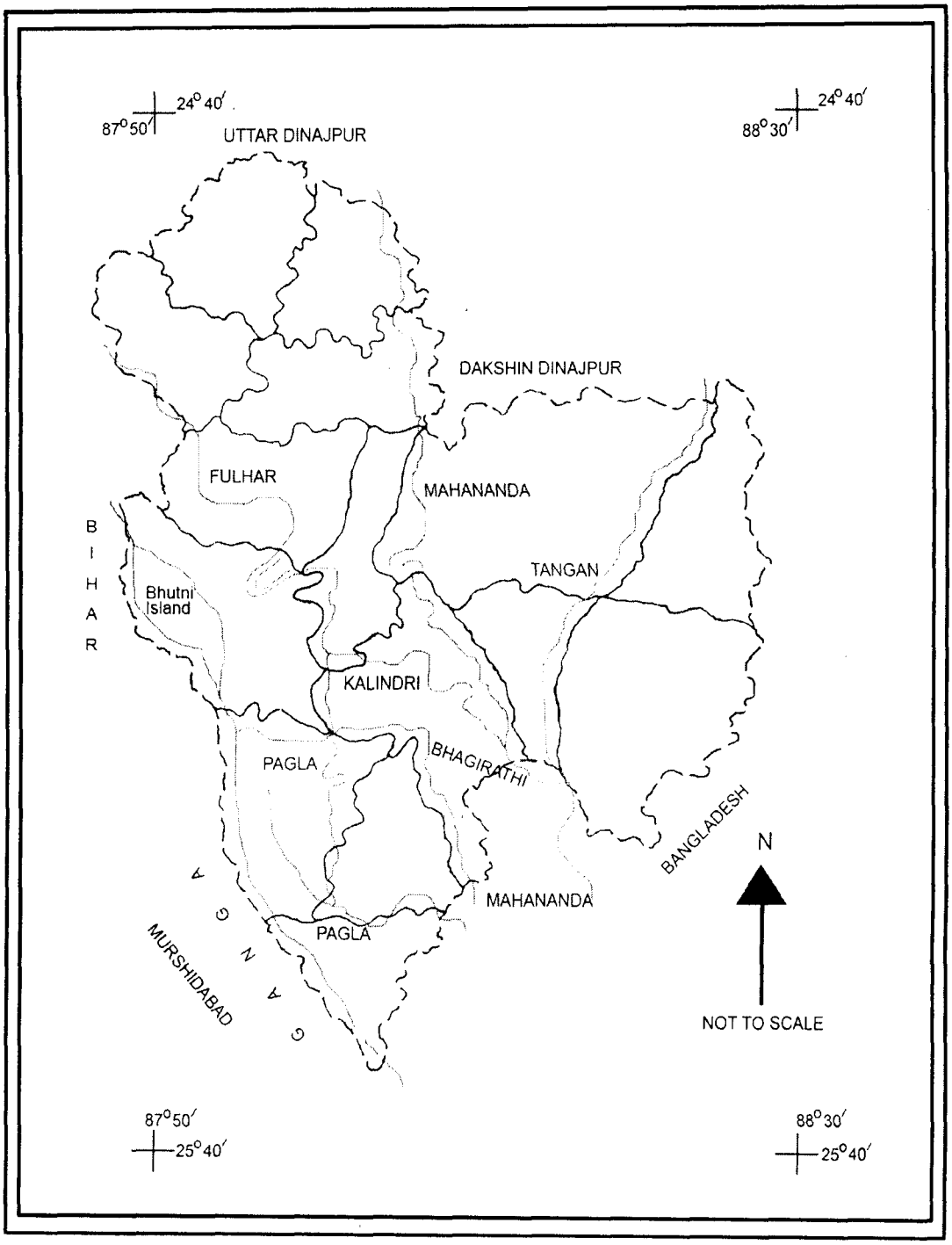

Figure.3.5. Rivers of Malda district.

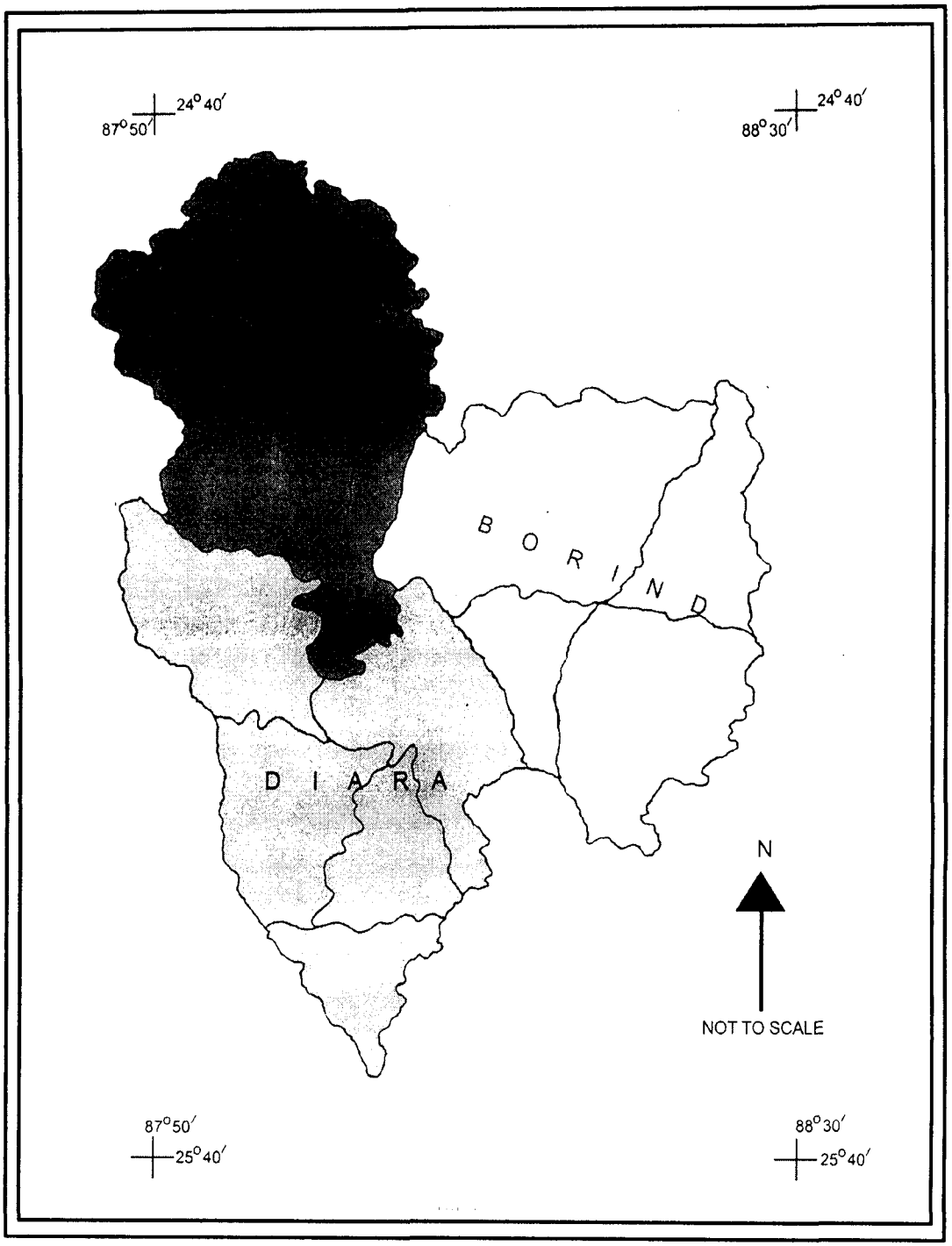

Figure.3.6. Three distinct region of district as per nature of soil.

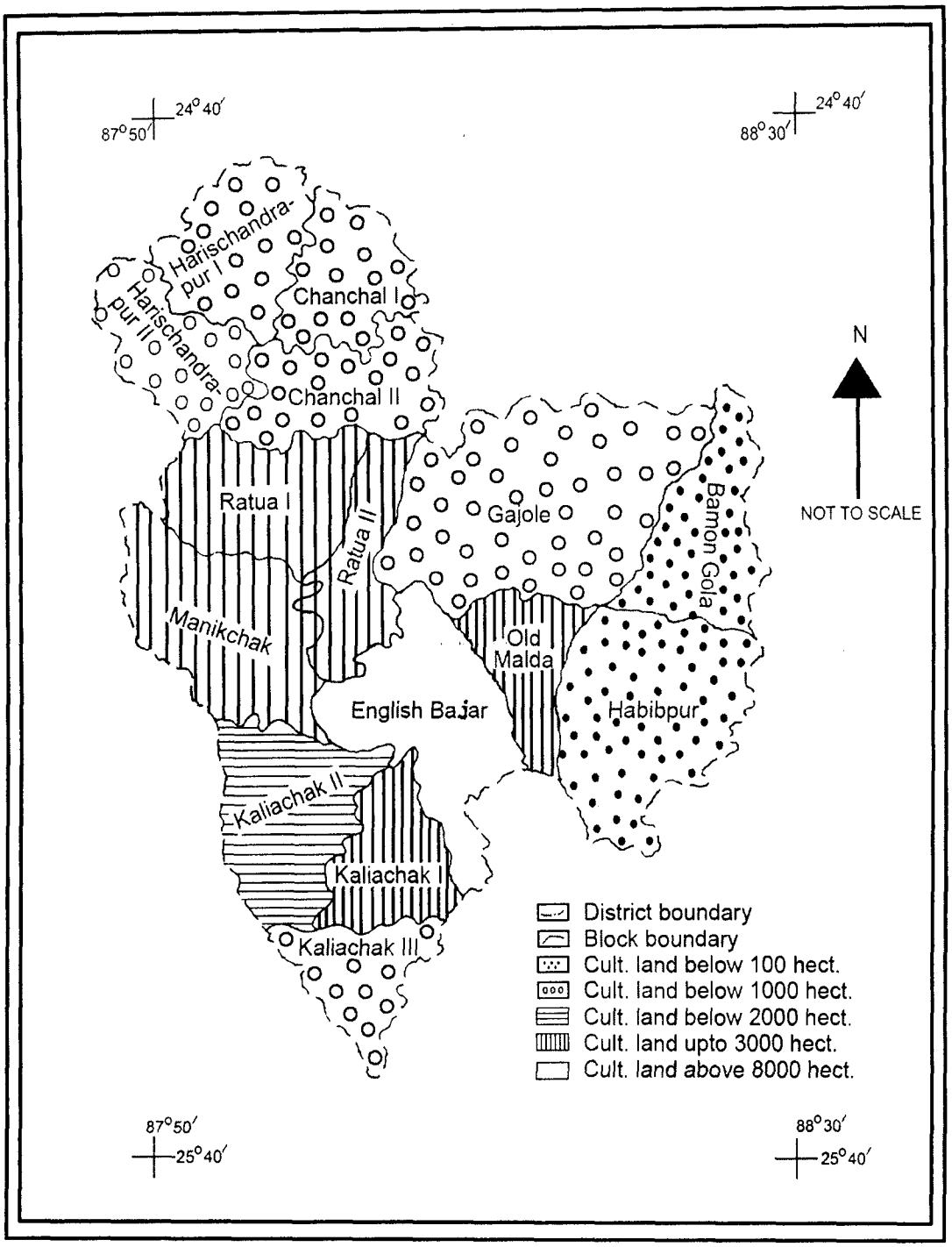

Figure.3.7. Area of mango cultivation land of different blocks of Malda district.

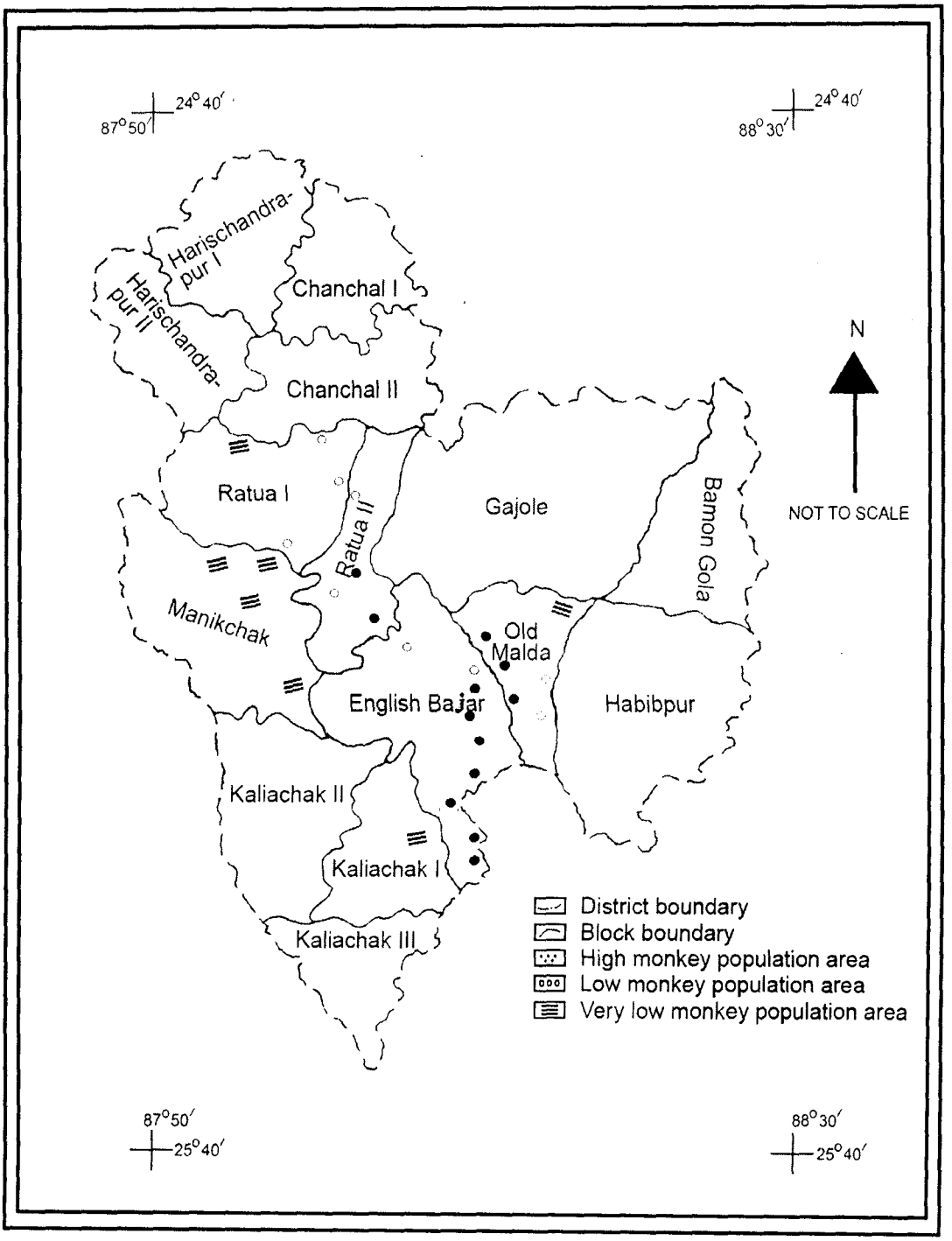

Figure.3.8. Monkey affected blocks of the district.

4. GENERAL METHODS FOR OBSERVATION

4.1. Introduction

Study on the behaviour of free-ranging primates has been the subject of many recent field studies and as a result the comparative study of primate behaviour is beginning to take a concrete shape. Some generalizations are possible and the trends apparent in recent studies can be evaluated (Phyllis Jay, 1972).

In the nineteenth century, many notions about primate behaviour were formed from anecdotes, incidental observations and travelers tales. Yerkes and Yerkes (1929) summarized this early era in their book, "The Great Apes". Zuckerman's "The social life of Monkeys and Apes" (1932) also has had a profound and continuing effect. The pioneering efforts of those men systematized the study of primate behaviour to a great extent. Presently unseemly empirical observations gave way to valid systematic observations with quantitative data on monkeys and apes but also for all free-ranging animals. C.R. Carpenters (1934) study on the howling monkeys has been a model for primate studies for quite a while.

Experiments and observations are the two main methods for studying behaviour of animals in the field. Niko Tinberger, Karl Von Frisch and Konlard Lorenz further established the importance of systematic accurate observations and experiments in the field. Von Frisch and Tinberger showed how observations and experiments can reciprocate each other. The commonest method for studying animal behaviour in the wild conditlon involves waiting patiently at a suitable spot where animals are likely to be observed most without disturbing them in any way and to record the data in a systematic manner on a well prepare data sheet. Quantitative data on behaviour is usually collected following two basic techniques i.e. "instantaneous sampling" (Altmann, 1974, 1980) and "continuous sampling" over some unit time. The observer gathers data on basic activities which can be

tested by experiments and therefore their combined effects often result in more accurate facts and theories (Scott, 1958).

Accuracy of recording data in the field can be enhanced by using tape recorder, binocular, still and movie camera, stop watch, measuring tape and other suitable instruments. Besides some biotic factors such as presence of predators, dominant member of opposite sex, proximity of parents or other altruistic events, it is also required to analyse the observed behavioural data with respect to time of the day, season, temperature, rainfall, humidity and other environmental factors. So, records of these parameters are also very important in the study of animal behaviour. The various equipment which were used in this study are described in this section.

4.2. Study Area

Malda district of West Bengal is renowned for its mango production. The amount of mango cultivation land is 245.6 sq. km. which is 6.58% of the total land area (3733 sq. km.) of the district. The mango cultivation land in the district is 37.55% in the context of West Bengal and 1.61% of India. The district produces 43.39% mango of West Bengal and 2.48% mango of the total country as a whole. The population of rhesus is high in extensive mango producing blocks, low in moderate mango producing blocks and nil in low mango producing blocks.

It is observed that monkey groups splitted into smaller groups in the non-mango season but coalesced again in the mango season in the mango producing blocks.

Mango is the chief cash crop of the district. Over 33% people are directly associated financially to this crop. As a result man-monkey conflicts takes place regularly in this district. Thus the mango orchards served as important study site for studying crop-raiding and man-animal conflict.

Collection of data on mango cultivation, plantation, preservation, marketing etc. involved all the 15 blocks of the district while for raiding of mango, man-monkey conflicts in the blocks with high monkey populations such as English Bajar, Ratua-II, Old Malda block and low population blocks i.e. Manikchak, Kaliachak-I and Ratua-I were utilized.

4.3. Study Period

The study spanned over a period of 7 years (April, 1995 to July, 2002) at different parts of the district. Observations, however, often discontinued for the 6-10 days in a month for discussion at the University Department and other relevant activities. The records collected by the field assistant were used for periods of absence of the author.

4.4. Daily Observation Schedule

Daily routine observations were divided into three phases i.e. morning (06.30 hour to 09.30 hour), noon (11.00 hour to 13.00 hour) and afternoon (14.00 hour to 18.00 hour). Deviation from the routine schedule of observations never lasted for more than 30-60 minutes. Often observations were started ahead of the schedule and some-times extended beyond it. In general, observations were made throughout the day, covering all the three sessions. It is to be pointed out that no attempts were made for nocturnal observations during the course of the study.

4.5. Mode of Observation

The distance of behavioural observation of rhesus varied from 2 metres to above 75 metres. Binoculars were used for proper observations when the distance was 50 metres or above (Plate.4.1.). Detailed observations were mostly done at specific activity sites during the activity or after the departure of the animals. The monkey groups were followed keeping a safe reaction distance from them whenever they moved from one spot to another either inside or outside of the mango orchards. In non-mango season sometimes the rhesus even venture to steal

food materials both raw as well as cooked from human households. So in this season observations on conflict between rhesus and human were conducted inside the dwelling house of the people of the area. Householders co-operated graciously on all occasions. During non-mango season vegetable fields such as brinjals, bananas, guavas, cucumbers, potatos etc. were raided by the monkeys when vegetable plots served as observation sites. Incidence of direct competition and overt attacks on humans by rhesus were observed in human households, crop fields and even on roads.

By-cycling and walking through the roads both inside and outside the mango-orchards was found to be a suitable means during pursuing monkeys from one spot to another. A motor cycle (YAMAHA) was used (Plate.4.2.) for transport from one orchard to another but to avoid disturbing the animals by the sound of the motor cycle, the bicycle was used inside the orchards.

4.6. Equipment Used

In general, the monkeys were observed by naked eyes or field binoculars (Nikon Travelite-III, 7 X 20, 7.1). Photographs were taken by still camera (OLYMPUS, 700 X B, Lense : 38-70mm, f 5.6 / 9.6). A small portable tape recorder (PHILIPS, INDIA) was used for recording observations and monkeys vocalizations. A stop watch (GEM, Licence, hanhart, West Germany) was used to record time. A 50 metres cloth tape was used for measuring distance. Meteorological records were taken with the help of maximum and minimum thermometer, Rain-gauge and dry bulb-wet bulb thermometer. Data on specific parameters recorded by different Government and private organizations associated with meteorology, soil testing, food-processing and horticulture etc. such as Malda Mango Merchant Association; Department of Health Services, Govt. of West Bengal; Soil Testing Laboratory, Govt. of West Bengal; Meteorological Department, Govt. of India; Mango-planters guild of each block; Mango-product factories of Malda and some others were considered. Reasonable observations and accounts obtained from villagers were also recognized.

4.7. Methods of Recording Behaviour

Most of the observations were recorded in the well prepared data-sheets for various aspects of the study. Magnetic tape-recorder were used in recordings in conditions where previously made data-sheets were not applicable for some specific situations which were further analysed in details and the data-sheets were changed accordingly. Some descriptive observations were recorded at once in the tape recorder or in the field note book immediately after the event. All of these three devices were used in collecting data as demanded by specific situations. Data on areas infested by monkeys were collected by systematic survey, from the mango-planters guild and responsible reports from the local people. Specific data on human causalties due to monkey attacks were collected through house to house survey, from Government health centers and hospitals and also from responsible reports.

Plate : 4.1. The author in a study field observing monkeys with the help of binoculars.

Plate : 4.2. The field assistant on the motor-cycle.

5. HABITAT

5.1. Introduction

Macaca mulatta live in a wide range of habitats. They show a significant degree of adaptability. They seem to be equally comfortable in arid deserts, dense forests, flat plains, mountaneous regions with temperatures below freezing point, hot-humid mangroves and in human ecosystems – rural, semi-rural and densely populated concrete forests with asphalt paths. Eminent primate biologist C.H. Southwick believed that any habitat with abundant trees for shelter, permanent water and food sources potentially can serve as a suitable habitat for monkeys.

Since recent past monkeys in general and rhesus macaques in particular are sharing human ecosystems and becoming more and more dependant on cultivated land, orchards and gardens as a primary source of food. This study finds support from incidence of higher rhesus population in the blocks with higher mango cultivation and production areas in the district.

Roadside survey of rhesus monkeys in Bengal studied by Southwick, Ghosh and Louch (1964). Southwick, Beg and Siddiqi (1961b) also reports on habitat of rhesus monkey at transportation routes and forest areas in North India. Report on desert habitat also forwarded from Prakash (1958) in Rajasthan. Mukherjee and Gupta (1965) brought forward the forest habitat of rhesus in the Sundarbans. Kali (2001) studied on grassland and forest habitat of rhesus macaques in Baikunthapur Forest Division, Jalpaiguri, West Bengal.

5.2. Methods

Habitat survey of rhesus monkeys was conducted mainly in the blocks with extensive and moderate mango cultivation areas of the district. Overwhelming abundance of monkeys observed in blocks with extensive mango cultivation areas such as English Bajar, Ratua-II and Old Malda. In fact about 98% (Table.5.1) of the total rhesus population of the district was found in these areas.

Systematic field study for cropland, orchard and village was conducted from 06.30 hour to 11.00 hour and 13.00 hour to 18.00 hour with the aid of a field assistant following Southwick et al. (1961a). The work was conducted by walking, cycling in the study area. On occasions local people helped in the work. On sighting a group, their number, age-sex composition and their locations were carefully recorded.

5.3. Results and Discussions

5.3.1. Habitat types in the present study area

In the present study five distinct categories of habitats were demarcated depending mainly on food source. The categories are mango orchard (Plate.5.1.), crop field, grassland (Plate.5.2.), human household (Plate.5.3.) and roadside (Plate.5.4.). Some of the features of the habitats are given below.

I. **Mango orchard :** There are over 1,18,710 mango orchards covering an area of 24,560 hectares in the district. In the present study the orchards in the extensive and moderate mango cultivation areas in three blocks each were studied. More than 70% of the orchards belong to extensive and moderate cultivation areas. The orchard areas are dotted with ponds & ditches which are mostly perennial and serve as water source to the monkeys although the water level descends down in the mango season. The monkeys start visiting the orchards (Plate.5.1.) even before they come to bloom during February-March and assumes an important part until the end of the mango season i.e. July-August.

II. **Crop fields :** The total crop field area of the monkey infested blocks is 21,770 hectares. A variety of crops are grown both in the summer and winter seasons. These include paddy, wheat, maize, *Cicer*, pisum, lens, potato, brinjal and many others. About 40% of the cropland area produce multiple crops in a year. The crop fields are situated at a distance of less than half a Km to a maximum of 5 Km from household and orchards. Rivers, irrigation

canals and ponds supply necessary water for irrigations in the crop fields. These water sources are also utilized by the monkeys.

III. **Grassland :** Grassland (Plate.5.2.) cover more than 30,000 hectares in the monkey infested areas. The important grass, herb and shrub genera in this sector are *Cynodon, Digitaria, Imperata, Spinacia, Lycopersicon, Saccharum* etc. The ponds, marshy areas and rivers are the main source of water (Plate.5.6.) for the grazing cattle and monkeys. Most grassland (Plate.5.5.) are located at 5 to 7 Km from households and orchards.

IV. **Household :** The human habitations in the village areas were mostly patchy intervened by crop field, mango orchard and grassland. The pattern of households in the township areas are, however, concentrated and clustered. Most (more than 70%) households in the village are mud-walled and thatched, while the rest are brick-walled with tin or concrete-roofs. Some of this houses are protected by high brick-walls. Usually the houses are rather close to the orchards and cultivated fields. Some of the house-holders maintain a kitchen garden along with plantations of fruit trees. Thus at the time of food scarcity in the non-mango season the monkeys do not hesitate to trespass in to the household (Plate.5.3.) for food.

V. **Roadside :** Most village roads (Plate.5.4.) are of mud, brick and asphalt roads are found in townships. The roads are generally 6ft - 20ft in width. Irrigation canals and ditches are commonly seen to run along one or both side of the road. At the crossing of roads shops, temples and markets are often found. Bullock-carts, tractors, cycle-vans etc. ply along the village roads while motorcars, buses, tractors are common in township roads. The monkeys usually reside on the roadside trees at junction of roads where shops, temples and market places are situated specially in the non-mango season.

5.3.2. Habitat : Food Resource

It has been observed that monkey population increased in both the extensive and moderate mango cultivation areas in the mango season and declined in the non-mango season throughout the study period i.e. 1995-2002 (Table.5.1.). The table also shows that the percent sightings of monkey population is always higher in extensive mango cultivation areas than in moderate cultivation areas in both mango and non-mango seasons.

Due to gradual but consistent encroachment of forest area by the human beings wildlife habitat is shrinking every year. This situation is not peculiar to Malda or India but is a global phenomenon that compels the animals to invade crop fields, orchards and gardens in search of food causing man-animal conflict. The degree of the conflict depends on the magnitude of human encroachment of wildlife habitat which is a function of human growth rate.

5.3.3. Habitat : Season

Season exerts a profound effect on the habitat both in the biotic and abiotic component. Abundance of food and quality of shelter, the habitats provide are a function of season.

Table.5.2. shows the effect of mango and non-mango season on percent sightings as per habitat types. It is observed that mango orchards are preferred over any other habitats irrespective of season. More than 45% monkeys were sighted in the mango orchards. The point to be noted that about 18% monkeys were sighted in the mango orchards even in the non-mango season higher than those for all other habitats except grasslands. Again a clear shift in preference infavour of the habitat types other than mango orchards in the non-mango season is also observed. Table.5.3. once again shows that the monkeys prefer mango orchards over any other habitat as also the shift of preference to other habitats in the non-mango season. Percent sightings in the crop fields in the non-mango season dropped from 16.24 in the mango season to 13.57 in the non-mango season

when a variety of vegetables are grown may be due to enhanced vigilance and protection of crop fields during that period. The over all percent sightings in grassland was always comparatively higher than other habitat types except mango orchards is rather unexpected and may be due to the fact that grasslands provide some essential food materials which must be procured. Percent sightings in grassland was highest in the non-mango season.

Table.5.1. Number of monkeys sighted in extensive and moderate mango cultivation areas in mango and non-mango season over 7 year study (1995-2002) in Malda district, West Bengal, India.

Study Year	Mango Season			Non Mango Season		
	BEMC Area	BMMC Area	Total	BEMC Area	BMMC Area	Total
1995-96	477	19	496	380	07	387
1996-97	554	00	554	437	06	443
1997-98	600	21	621	328	00	328
1998-99	632	11	643	466	12	478
1999-00	722	00	722	427	07	434
2000-01	809	17	826	563	00	563
2001-02	840	00	840	631	08	639
Total	4634	68	4702	3232	40	3272

* Mango season : February to July; Non-mango season : August to January.

* BEMC : Blocks with extensive mango cultivation (English Bajar, Ratua-II and Old Malda).

* BMMC : Blocks with moderate mango cultivation (Manikchak, Kaliachak-I and Ratua-I).

Table.5.2. Habitat-wise number and percent sightings of monkeys at different habitats in mango and non-mango seasons in extensive and moderate mango cultivation areas from 1995 to 2002.

Habitat	Mango Season		Non-mango Season		Overall	
	No. of monkeys	% of sightings	No. of monkeys	% of sightings	No. of monkeys	% of sightings
Mango orchard	2972	82.17	645	17.83	3617	45.35
Crop field	796	65.62	417	34.38	1213	15.21
Grassland	647	39.74	981	60.27	1628	20.41
Human Household	214	29.07	522	70.93	736	09.22
Roadside	273	35.00	507	65.00	780	09.78

Table.5.3. Season-wise number and sightings of monkeys at different habitats in mango and non-mango seasons in study area from 1995 to 2002.

Habitat	Mango Season		Non-mango Season	
	No. of monkeys	% of sightings	No. of monkeys	% of sightings
Mango orchard	2972	60.62	645	21.00
Crop field	796	16.24	417	13.57
Grassland	647	13.20	981	31.93
Human household	214	04.37	522	16.99
Roadside	273	05.57	507	16.51

Plate.5.1. Monkey at Mango orchard.

Plate.5.2. Monkeys at Grassland habitat.

Plate.5.3. Monkeys at human household.

Plate.5.4. Rhesus group at roadside habitat.

Plate.5.5. A rhesus group by the side of a pond beneath a bamboo groove in a grassland.

Plate.5.6. A thristy male on a bamboo stump inundated by rain water.

6. PHYSICAL FEATURES

6.1. Introduction

The age and sex characteristics are of great importance in behavioural studies. It would be very difficult to study behaviour of a species in which all animals looked morphologically identical. Fortunately, most animals exhibit some structural differences among the different age-sex classes. The distinctions of physical features among different age-sex classes in rhesus monkeys are discussed in this chapter.

6.2. Methods

Determination of age and sex are often difficult in the field. There is no universal method by which one can determine the age and sex of wild animals in their natural habitat. Southwick et al., 1961a determined age and sex of rhesus in the wild from direct observation depending on some of the morphological characteristics such as, body size, weight, colour, condition of the tail, fur and skin of the rump, external genitalia, mammary glands etc.

6.3. Results and Discussions

6.3.1. Age

Like all other moderate body-size primates the accurate determination of age in case of rhesus macaques is not easy. Tooth eruption and replacement although serves well in determining age in the laboratory condition, the process is not suitable in the free-ranging rhesus macaques. It is, however, possible to have a reasonably accurate workable age-scale of rhesus based on some easily visible morphological features such as body-size, weight, sexual skin, crown and some specific behavioural patterns as used by Southwick (1961). Individuals were categorised into four groups : adult male, adult female, juvenile and infant (Table.6.1.).

6.3.2. Morphological Features

6.3.2.1. Adult

In macaques sexual dimorphism is generally well marked. Rhesus monkeys usually become sexually mature when they began to show the dimorphic characters following their third years of age. Adults are with a moderate tail, usually about half of the body length. Tail is uniformly covered with hair from the base to the tip. Hairs of the crown are directed backwards from the brows without a whorl and not forming a definite crest on the cheek but usually a whorl low down on the cheek. The face which is bare, is light pink, flesh or reddish in colour. The head, shoulders, arms and fore back are generally olive coloured, but speckled with duller or brighter buff while the loins, rump and the base of the tail are reddish in varying intensities. The skin of the face, hands and feet is pale although the face is sometimes suffused with red. The males are with large penis with elongated gland. There is no catamenial swelling in the female but the skin of the rump is often bright red. The vagina is situated just beneath the anus and is normally covered by the tail. The mammary glands are with two nipples that hang down from the breast region between the forearms. The glands can be seen in an anterior view. The body length including tail of the adults is given in Table.6.1. The glands and the nipples are prominent in the lactating condition. Among macaques males in general are quite a bit larger and heavier than females.

6.3.2.2. Juveniles

The juveniles of this species having a smaller body size than adult categories and they are usually one to three years of age. Body colour ranges from blackish to grey with prominent flesh to light tan colour in the hind quarters. Juveniles were identified as young which were largely independent of the mother. Body length, weight, tail length etc. are given in Table.6.1.

The juveniles are often seen to be associated with their mother and they were also found to play with infants.

6.3.2.3. Infant

The infants were generally less than one year old. Their body length, body weight etc. are shown in Table.6.1. The infants have a light grey to whitish body colour in the hind-quarters. Most of the time they remained closely associated with their mothers but frequently moved some distance from mother particularly during play and feeding.

Data on body size and weight of different categories of individuals of rhesus were recorded by Shortridge (1914), Schultz (1933, 1969), Napier and Napier (1967) and Fodden (1971).

6.3.3. Sex

In arboreal primates dimorphism of sex is weak or absent (Mohnot, 1975). In general, males are larger than females in less arboreal or semi-terrestrial primates, such as baboons and macaques (Schultz, 1969). They are capable of defending the group from predators. Adult rhesus macaques are rather easy to sex in the wild because the external reproductive organs of both sexes could be seen from a distance. But it was difficult to determine the sex of young ones because of their less prominent sex organs. As such no attempt was made to determine their sex in order to avoid bias.

Table.6.1. Age and sex classes of rhesus macaques depending on some morphological characters (measurements are approximate).

Age Class	Age (in Years)	Body Colour	Colour of hind quarters	Head and body length (in cm.)	Total length (in cm.)	Body weight (in Kg.)
Adult Male	Above 3	Light blackish grey	Bright red	46.5 – 62	19.7 – 29.2	5.2 – 10.3
Adult Female	Above 3	Light blackish grey	Bright red	45 – 54	18.3 – 27.1	3.4 – 10.1
Juvenile	Above 1 less than 3	Blackish grey	Flesh coloured red to light tan	26.1 – 31.8	10.9 – 15.7	2.2 – 5.1
Infant male	Less than 1	Light grey to whitish	Pale grey with slight blackish	15.9 – 21.8	6.0 – 9.8	0.27 – 0.69
Infant female	Less than 1	Light grey to whitish	Pale grey with slight blackish	14.7 – 21.2	5.2 – 9.1	0.23 – 0.61

Table.6.2. Body size and body weight in different Macaque species (measurements are approximate).

Name of Species	Average head and body length (in cm.)		Average tail length (in cm.)		Average body weight (in Kg.)	
	Adult Male	Adult Female	Adult Male	Adult Female	Adult Male	Adult Female
Macaca arctoides	64.5	50.35	7.0	3.5	12.0	10.0
Macaca assamensis	52.8	48.35	28.2	22.5	8.5	5.7
Macaca fasicularis	53.0	47.7	51.5	47.5	5.0	4.1
Macaca nemestrina	74.5	48.85	20.25	16.5	10.35	7.65
Macaca radiata	55.75	43.5	60.0	55.75	8.65	5.0
Macaca silenus	56.0	46.0	32.0	38.7	6.8	4.2
Macaca sinica	48.7	43.7	58.5	51.7	6.4	3.85

7. POPULATION STUDIES

7.1. Introduction

Population of animals are fundamental units in ecology; as important to the ecologists as tissues and organs are to anatomists and physiologists (Southwick, 1972). A population by definition is a group of individuals of the same species operating in a specific time and space (Pearl, 1937; Sladen and Beng, 1969; Odum, 1971). Knowledge on population help us to determine their present status, reproductive potential, distribution and abundance in the area under observation. Data on population and ecology of rhesus monkey is rather scarce in North Bengal region. The present study attempts to record data on population ecology in the field in Malda district.

Population studies of rhesus monkeys in India has been extensively done by Southwick and his associates (1961a, 1961b, 1965, 1966, 1967, 1968, 1970, 1977); Neville (1968); Lindburgh (1971) and Kali (2001). This chapter presents data on distribution, group size, population density, composition, natality and mortality of rhesus population in Malda district.

7.2. Methods

The survey work on rhesus populations was conducted in English Bajar, Ratua-II and Old Malda i.e. extensive mango cultivation areas and Manikchak, Kaliachak-I and Ratua-I i.e. moderate mango cultivation blocks of Malda district. It is to be mentioned that population of rhesus is almost nil in the blocks where mango cultivation is low.

The technique adopted by Southwick et al. (1961) for systematic field study was followed in this study. Census schedule was maintained from 06.30 Hour to 11.00 Hour and 13.00 Hour to 18.00 Hour of the day. Survey work was conducted by walking, cycling in the study area with a field assistant for keeping constant watch on animals. A motor-cycle was used to cover longer distances between mango cultivation areas. On occasions local people helped in this survey work

with in and outside of the mango orchards. On sighting a group the number and age-sex classes were carefully recorded.

The census work was done from February, 1995 to January, 2002 on the basis of counting of groups and the counting of number in each group month-wise. Maximum counts were obtained in the months of May-June and minimum in the month of December-January of each year. However, it is to be pointed out that the young are born in all the months (from February to July) and disappearances or deaths take place in the last phase of monsoon and in winter.

Census of rhesus population were conducted through visual inspection in the home-range areas. Total counts were made of all individuals under all the four age-sex classes i.e. adult males, adult females, juveniles and infants. To begin with study areas were visited on three consecutive days to achieve accurate count while in the later stage it was done once in a week. The characteristics of age-sex classes were described by Southwick et al. (1965); Southwick and Siddiqi (1968) and Yamagiwa (1979).

The technique for the census followed in this study was direct count by spatial census method which by definition, "a spatial census" is one in which account is made of all the specified 'point in time' (Overton and Davis, 1969). The animals when they congregate together were counted from permissible distance during their feeding and resting period. It is to be mentioned that counting of the members of many group were made through raiding of house of local people for food in several occasion especially in non-mango season (i.e. August to January).

Incident of occasional trappings of animals in and around the study area during this observation periods were well marked. The counting of animals was possible to easy as they were generally in smaller groups but when they belongs in large groups it needed longtime observation even several days in many occasion.

Methods like aerial-count, time-transact count and analysis of foot-prints of animals commonly used in wildlife censusing were not followed in this study because of some obvious reasons.

7.3. Results and Discussions

7.3.1. Population Estimate

Mukherjee and Mukherjee (1972) gave specific figures for Northern India (Western Uttar Pradesh, Delhi and Hariana). Southwick, Ghosh and Louch (1964) indicated that the major rhesus populations have been distributed to the forest areas in northern Tarai (the Himalayan foot-hills). A hypothetical estimate by Southwick and Siddiqi (1965) gave the rhesus population in Uttar Pradesh (2,94, 634 sq.km.) as between 8,00,000 and 10,00,000 in 1960, distributed in various ecological situations : road side (48,000), canal banks (25,000), rail-road (4,000), villages (3,72,000), small and medium towns (1,33,000), large towns and cities (1,00,000), temples (20,000) and forests (1,00,000). Kali (2001) reported about 3,200 rhesus population at Baikunthapur forest division, Jalpaiguri, India. Inspite of this no estimate of population of this animal in North Bengal as a whole is available.

In the present study it is found clearly that rhesus macaques population are common in the mango producing areas of Malda district. The group number, group composition and average group size shown in Table.7.1. over 7 year (1995-2002) study in the district. Month-wise census data February to January is shown in Tables.7.2., 7.3. and 7.4. for the year 1999-2000, 2000-2001 and 2001-2002 respectively. The age and sex classes of animals were carefully counted. It is true that counts were not clearly inclusive of all the animals present in the study area on the specific dates. In general infants were accompanied their mothers but all other age-sex classes sometimes indulged in wondering about away from their groups particularly the juveniles and adult males. Possibly, for this reason often accurate population counts in a group could not be done in single glance counts. An accurate count could always be made by continuing observation on the group for an hour or so. Occasionally for larger scattered groups it was necessary to visit an area on several consecutive days to complete the count. Movement of adult males and juveniles sometimes caused great problems in counting number of a group. To overcome this problem the total of largest single glance counts on an age-sex class in individual sectors of the study area, irrespective of weather made on scheduled or non-scheduled dates, were considered to form the total population

of that age-sex class for the month. The sum of the largest counts of all the age-sex classes constituted the total population of rhesus for that period.

Census data of the district as a whole is shown in Table.7.1.Rhesus were less common in BMMC (Blocks with moderate mango cultivation) area. During feeding period they often concentrated in the shadey area of in side or outside the mango orchard. In the breeding season they were mostly found in deepest part of the orchard. They concentrated at the edge of the orchard or villages during the cultivation period. In non-mango season they were very much preferred human household especially for their source of feeding and even roadside also for collecting food materials from the street-passers. During December and January, population was low possibly because of heavy cold which kept them under some rest of cover there by hindering observation.

It is clear from the Table.7.2., 7.3. and 7.4. that monkey population is higher in BEMC (Blocks with extensive mango cultivation) area than BMMC area as because of feeding source is much more in the first one. The Tables are also shown the population is low in both BMMC and BEMC area in non-mango season in comparison with mango season which is also indicates higher incidence of animals is possibly due to greater abundance of food materials. However, it is to be noted that in Table.7.4. month-wise data for the period February, 2001 to January, 2002 the population of adult males reduced to 15 (July, 2001) from 29 (June, 2001) in BEMC area due to some local disturbance including attempts to trap and poisoned baiting. The population, however, increased to 24 in August, 2001. This could be due to return of some of the members who left the group due to disturbance or some juveniles attaining adult status.

Figure.7.1. shows that population of the study area peaked in May-June and were 304, 346 and 353 in the years 1999-2000, 2000-2001 and 2001-2002 respectively. Besides, some animals particularly isolated adult males possibly strayed outside the study area and escaped count. Births peaked in May-June-July in all the years, as new shoots, fruits and leaves errupted at that period following moderate rainfall along with peak-mango-growing season are obviously the great cause for longest count. Scarcity of food and heavy cold are the main cause in count significally lower in all the years in December-January. They possibly took

shelter at suitable sites under the cover and thus shielding themselves from outside.

Southwick et al. (1961, 1965, 1968 and 1977) made census of rhesus in different habitats. Kali (2001) reported rhesus habitats in riverine forest (38.7%), sal forest (14.7%), grassland (9.9%) at Baikunthapur Forest Division, Jalpaiguri, West Bengal. Table.7.10. shows population of rhesus in five different habitat categories of extensive and moderate mango cultivation areas of Malda district. The percentage of sightings in mango-orchard (45.35) habitat is higher among all the five habitat sector followed by grassland (20.41), crop field (15.21), roadside (9.78) and human household (9.22). It is to be noted that the population is much higher in mango orchard due to abundance of food materials. However, the grassland population is also significant and probably for security men of mango orchard and cultivators of crop field compelled them to take shelter in grassland habitat for their feeding substances in higher range. The weaker group (consisting of one or in few cases two adult male) in strength and as well as in number were exhibits this incident. In non-mango season roadside and crop field habitat were preferred by the monkeys for searching their food materials and even render the human households.

7.3.2. Population dynamics

The fact has been generalized that a rhesus monkey group comprises of various individuals i.e. male, female, juvenile and infant. The groups were specially dominated by adult male but few female dominated groups were also found during the study period. One group consisting a adult male and a adult female was found in few cases. The tendency of leaving original group by the grown-up males was noted. This chapter forwarded population dynamics in the following sections such as home range, birth season, group composition, sex ratio, natality, mortality and density of population.

7.3.2.1. Home Ranges

The home range defined as a composite measure of multiple daily ranges, taking seasonal changes into account, covered by an individual or a group in the

course of normal feeding and other all possible activities. Like many other animals rhesus monkeys restrict their activities to a rather measurable, circumscribed, geographical area known as home range. Size of home ranges varies in rhesus widely and it depends on nature of habitat, availability of food species and other basic requirements of the animals. Like other primates rhesus macaques are group living and home range refers to a group than individuals.

In this study area each group of rhesus has a definite home range which varied from 1.03 to 3.12 sq. km. in five different habitats. In each home range there is a smaller area, where the individual spends most of its time, this area is known as core area. Core areas usually include important resting sites and food trees (Jay, 1965). In this study area food trees are abundance in the mango orchard habitat and for this reason home range was prominent towards mango orchard. Table.7.9. shows home range size of rhesus groups in mango orchard, crop field, grassland, human household and roadside habitat. The home ranges is larger in grassland habitat (3.12 sq. km. ± 0.16) because in the non-mango season due to scarcity of food they have compelled to move in the grassland habitat for feeding various grasses and herbs. Due to abundance of food in the mango orchard home ranges should be taken in smaller form but in the mango season security men of the orchard compels the animals to take their home ranges in larger form (2.18 sq. km. ± 0.16). The position of home range in the roadside is 1.37 sq. km. ± 0.14 and in human household is 1.03 Sq. Km.± 0.09. The crop field habitat is also enriched with various food but farmers attitude in this sector also promotes the larger figure (2.26 sq. km. ± 0.17). Generally the size of home range depends on the distribution and density of food, resting-nesting trees and non interference of human population. However, by far the greatest number of sightings were made in mango orchard (43.35%) followed by grassland (20.41%), cropfield (15.21%), road side (9.78%) and human household (9.22%).

In temple population in western Uttar Pradesh, Southwick et al. (1965) noted that the groups were aggressive towards each other. In the mangrove swamps of Sundarbans the home range of a group (20-30 individuals) occupied an entire small island while more groups were found on larger islands (Mukherjee and Gupta, 1965). The extent of a home range may be governed partly by the activities of the dominant males (Southwick and Siddiqi, 1967). In the sub-mountain forests

of northern Uttar Pradesh the home range varied from 1 sq. km. to 3 sq. km. (Neville, 1968). It was estimated as about 0.05 sq. km. in the town of Haldwani (Neville, 1968). In Dheradun forests the home range was reported to be about 16 sq. km. (Lindburgh, 1971). In an introduced free-ranging colony in La Cueva Island (Puerto Rico), Vessey (1971) noted that the removal of alpha male did not affect group's home range. Kali (2001) reported the home range varied from 1.56 to 5.89 sq. km. in Baikunthapur forest division of North Bengal.

7.3.2.2. Birth Season

Many species have a definite birth season in a year but in primates it differ. Populations of a species may have birth season at different times of the year depending upon geographical distribution and associated climatic conditions. A comparison of timings of birth of rhesus monkeys reported by different authors seem to support the above statement. Dodsworth (1914) cited births in March and April in the Himalayas. Mandal (1964) found most new born young in April-May but some in September-October in Sundarbans. In Rajasthan Prakash (1958, 1960, 1962) found births in late March, April and May. He also observed births in September-October. Southwick et al. (1965), Lancester and Lee (1965) found births from March to June with a few in September in northern India. Lindburgh (1971) noted births to occur in April and May with a few in March in Dehradun forests. In north-eastern Afghanistan, Puget (1971) found births from April to early November. Southwick (1980), Johnson and Southwick (1984) noted peak births in May-June in Nepal and North India.

In Cayo Santiago, Carpenter (1942) observed births in June-August. Koford (1963, 1965) noted births from mid January to early July, with most births in February-April. Altmann (1962) also found births in late winter and spring to be the birth season. In La Cueva and La Par Guera, the introduced rhesus macaques showed births during March to August, the majority (about 80%) concentrated in May, June and July (Vanderbergh and Vessey, 1968). Kali (2001) reported 63.2% births occurred in May to June although births start in January but a considerable percentage of infants were sighted in March and April.

In this study a total of 763 new born were sighted over the study period i.e. February, 1999 to January, 2002 (Table.7.7.). The most births occurred in May (14.94%) and June (17.69%) followed by July (12.97%) and April (10.74%). It is to be noted that births occurred in almost all months in a year. In 1st sector that includes November-December-January the newborn percentage is least (8.91%), in 2nd sector consisting of August-September-October showed 18.61%, much better in 3rd sector (February-March-April) i.e. 26.87% and highest in 4th sector (45.61%) i.e. May-June-July sector.

From this above discussion it may be concluded that the reproduction of rhesus macaques are mostly seasonal. Births in South Asia generally occurs during February to June with a second birth period in September and October in some places. The present study however, shows births occurred in almost every month in this area but the new born percentage clearly indicate that May-June—July is the peak birth season of rhesus monkeys in Malda.

In many non-seasonal species females are renewal their sexual activities immediately after the death of infants (Altmann et al. 1978) but rhesus macaques undergo a phase of sterility which continues until the beginning of the next mating season. In the birth season, the timing of birth is dependent on the age and reproductive history of the mother (Drickamer, 1974). Paul and Thommen (1984) noted that in Barbary macaques 4-year old female gave birth significantly later than all others. So it may be conclude that May and June as well as March and April are important for behvavioural studies of rhesus.

7.3.2.3. Sex Ratio

For the study of any animal population age and sex are very vital aspects. A growing population must have a healthy ratio of adult males, females, juveniles and infants. Table.7.6. shows ratio of adult males and adult females varied from 39.9 to 51.3 : 100 during the study period. The table also shows that juvenile to adult ratio ranged from 52.2 to 57.1 : 100 and the ratio of infant to adult female varied from 72.3 to 80.5 : 100. Southwick (1965) noted that adult male and females ratio of rhesus population was 1 : 2 in forest areas. Lindburgh (1971) found sex ratio in forest area was 1 : 2.4 to 4. Average adult sex ratio, i.e. adult

females per adult male of protected and unprotected rhesus populations were 2.7 and 1.5 respectively in Uttar Pradesh. In the sub-Himalayas region (Kurseong and Darjeeling in North Bengal) the sex ratio of *Macaca assamensis* was 1 : 1.7 (Southwick, Ghosh and Louch, 1964). The sex ratio of *Macaca fascicularis* was 1 : 25 in Malay (Furuya, 1965). The Malayan pig tails exhibited sex ratio 1 : 8 (Caldecott, 1986).

7.3.2.4. Population Composition

Average percentage of age-sex composition of rhesus populations in extensive and moderate mango cultivation area of Malda district is shown in Table.7.5. The adult males comprised 15.12%, adult females 32.63%, juveniles 26.39% and infants 25.86%. The table also shows population composition in 1999-2000, 2000-2001 and 2001-2002.

Population composition of rhesus reported by Southwick, Beg and Siddiqi (1965) in Uttar Pradesh was 21.4% males, 43.6% females, 9.5% juveniles and 25.5% infants. Southwick (1961) noted that lower percentages of juveniles was due to high rate of trapping. In 1969, the rhesus population in India as a whole declined to about 5,00,000 but 43.6% were adult females and natality was 80% (Southwick et al., 1970). Prior to Indian Wildlife Conservation Act, 1972, field survey throughout the Gangetic basin and Himalayan foot hills, indicated that rhesus population was declining gradually, group sizes were getting smaller and population composition indicated serious shortage of juveniles (Southwick et al., 1961, 1965, 1969). In rhesus population juveniles are the most vital part and this age group was most intensively trapped for commercial export.

Mukherjee & Mukherjee (1972) found population composition in northern India as adult male 21.3%, adult female 41.5%, juvenile 11.1% and infant 26.1% which is very much similar to Southwick et al. (1965). In 1959 the population of Cayo Santiago island comprised 20% infants, 40% juveniles and 40% adults (Koford, 1963, 1965).

The population of rhesus in this study area having high percentage (26.39%) of juvenile in comparison to north India probably due to the following reasons :

1. Absence of trapping and hunting.
2. Absence of effective predators in this area.
3. Absence of exploitation including ceremonial hunting of tribals.

The percentages of infants (25.86%) and females (32.63%) are similar to that recorded for north India. The percentage of adult male (15.12%) is slightly low than 21.3% recorded in the population of northern India by Mukherjee and Mukherjee in 1972 and 21.4% by Southwick et al. in 1965.

7.3.2.5. Natality

Natality can be defined as the average number of offsprings produced per unit time. It is a measure of reproductive efficiency and growth potential of a species. The natality or birth rate of an animal is generally expressed as :

$$\text{Natality} = \frac{\text{Number of birth per unit time}}{\text{Average population}} \quad \text{----------} (1)$$

In case of primate population, it is like in the following form :

$$\text{Natality} = \frac{\text{Number of birth per unit time}}{\text{Average adult female population}} \quad \text{----------} (2)$$

[Odum, 1971]

The equation no. (2) was followed in the present study. Table.7.11. shows birth rate of rhesus macaques varied from 77.5 to 83.2 with an average of 79.4 which is very much similar to Sothwick's (1975) observation of 76.4% at Aligarh city (western Uttar Pradesh) of unprotected rhesus macaques population. The semi-protected population of the same area reached an average natality 90.7%. Koford (1965) reported rhesus population of Cayo Santiago average of 78% natality and Drickamer (1974) observed 73% natality of rhesus of La Par Guera. The Srilankan toque monkey showed 59.8% birth rate (Dittus, 1975). The above

discussion shows distinctly that on an average 21%-23% females do not able to give birth their infants probably for the following reason :

1. An effect of disturbed habitat condition.
2. Some physiological problems of female individuals.
3. Some juvenile members newly included in the adult section had not given birth to new ones.

The birth rate in this study area is lower than in the semi-protected rhesus population of Aligarh. It can be concluded that the rhesus population in this area is disturbed by human activities. The normal and ideal birth rate is 90.7% in rhesus monkeys. It is expected that population of this species in this study area will give better natality rate if they are provided with some partial protection. Observation of Koford (1965), Drickamer (1974), Southwick (1975) and present study are obviously close to the expected 90.7% natality.

7.3.2.6. Mortality

Mortality of rhesus population in this present study is based mainly on indirect data i.e. from analysis of population composition on the assumption that the same population stayed in the study area over the study period. The direct observations on mortality such as actual death or detection of any carcass or ramnants were not possible of some obvious reasons. From Table.7.11. we have 183 infants in 1999-2000 and 209 in 2000-2001. Thus infant loss during the two years (i.e. 1999-2000 to 2000-2001) is 183 + 209 – 211 = 181 which is of 46.17%. This shows that mortality is much higher to that of unprotected and semi-unprotected rhesus population of Aligarh city i.e. 18.5% and 15.4% respectively. Koford (1965) reported the mortality of the rhesus colony in Cayo Santiago is 8-9% and Drickamer (1974) observed annual mortality as 17-19%, in rhesus population of La Par Guera. However, the percenage of mortality is more or less similar to that of Baikunthapur Forest Division, Jalpaiguri, North Bengal which amounts 54.5% (Kali, 2001).

It is to be noted that during the course of the study period occasional trappings of infants to keep them as pets, to train them to do a variety of works such as plucking of fruits from lofty trees (coconut), perform some dance sequences for street shows and earn for them was observed. So, loss of infants due to occasional trapping could be a factor. According to Southwick (1977) immune system does not function properly among rhesus infants probably until the age of one year. Thus, chances of loss due to disease and starvation can not be eliminated. Southwick (1977) also mentioned that illegal trapping, lack of sufficient food materials and weather are the main factors of infant mortality. Accidental deaths of infants was also found during group movement in this study. Infant mortality of rhesus macaques varied according to the age and social rank of the mother and month of births (Drickamer, 1974).

7.3.2.7. Population increase

Table.7.1. shows the manner of moderate increase of rhesus population from 496 to 848 over the 7 years study i.e. from 1995-96 to 2001-02 with an average increase of 9.26%. Southwick and Siddiqi (1977) showed an average annual increase of 5.6% from 1959-1975 in rhesus population at Aligarh. Cayo Santiago population increased at 16% during 1960 to 1964 (Koford, 1966), Drickamer (1974) reported an average annual increase of 10.2% in La Par Guera and Kali (2001) observed 6.53% annual increase of rhesus population at Bakunthapur Forest, Jalpaiguri of North Bengal. Carpenter (1962) observed an average annual increase of howler monkey population at Barro Colorado island is 16%.

Occasional trappings and interference of human population as well as deforestation in this study area were well marked. The present population may be considered to be disturbed by human activities. Table.7.1 shows the percentage of increase population is very much lower in 2001-02 and 1998-99. This study indicate that monkey population are capable of increasing steadily when provided with suitable habitat, food and protection. The rate of increase of the present population is longer than that of other populations under comparable situations. Southwick and Siddiqi (1977) expected an average annual rate of increase of 10-16% in north India. But the data of present study were comparatively lower than that of expected.

7.3.2.8. Population density

Crook (1970) reported that primate population are well densed in those habitats where availability of food in greater range than that of in other habitats. However, the information regarding rhesus population density is inadequate. Most workers did not work out population density in details. Neville (1968) noted that 5-15 individuals per sq. km. in elevated chir forest, 57 individuals in the moist deciduous areas at lower elevation and about 753 in the towns of Uttar Pradesh. Population density of Hanuman langur in forest of North India was 57.9 to 134.6 per sq. km. (Oppenheimer, 1973).

In the present study in mango season the population density of rhesus is higher than that of in non-mango season. So the study shows nice parity with the statement of Crook (1970). It is to be noted that in non-mango season monkeys prefers most the crop field habitat in comparison to mango season. However, both in mango and non-mango season security men of mango-orchard and cultivators of crop field prevent them against the damage of crop, as a result monkeys are travel a long distance and make their home range bigger and bigger. So the figures of population density does not attain a healthy size. Table.7.8. shows the population density 4.22 per sq. km. in mango and 3.21 per sq. km. in non-mango season.

Table.7.1. Group number, group composition and average group size in extensive and moderate mango cultivation areas in mango and non-mango season in Malda over 7 years from 1995-2002.

Study year	Blocks with extensive mango cultivation [English Bajar, Ratua-II, Old Malda]												Blocks with moderate mango cultivation [Manikchak, Kaliachak-I, Ratua-I]											
	Mango Season						Non-Mango Season						Mango Season						Non-Mango Season					
	NOG	M	F	J	I	Total	NOG	M	F	J	I	Total	NOG	M	F	J	I	Total	NOG	M	F	J	I	Total
1995-96	52	72	156	128	121	477	42	57	124	102	97	380	02	03	05	07	04	19	01	01	02	03	01	07
1996-97	57	84	181	139	150	554	38	66	143	110	118	437	00	00	00	00	00	00	01	01	02	02	01	06
1997-98	62	91	196	161	152	600	44	50	107	88	83	328	03	03	06	08	04	21	00	00	00	00	00	00
1998-99	71	96	206	159	171	632	54	71	152	125	118	466	02	02	03	04	02	11	02	02	02	06	02	12
1999-00	72	109	236	194	183	722	52	65	139	107	116	427	00	00	00	00	00	00	01	01	02	03	01	07
2000-01	74	123	264	217	205	809	59	85	184	151	143	563	02	02	05	06	04	17	00	00	00	00	00	00
2001-02	83	127	274	211	228	840	63	96	206	170	159	631	00	00	00	00	00	00	01	01	02	03	02	08
Total	471	702	1513	1209	1210	4634	352	490	1055	960	834	3232	09	10	19	25	14	68	06	06	10	17	07	40
Average		1.49	3.21	2.56	2.57	9.83		1.34	2.99	2.72	2.37	9.18		1.11	2.11	2.77	1.55	7.55		1.00	1.66	2.83	1.16	6.66

* Mango season : February to July
* Non-mango season : August to January
* M = Adult Male, F = Adult Female, J = Juvenile, I = Infant
* NOG = Number of group.

Table.7.2. Month-wise census data from February, 1999 to January 2000.

Months	BEMC Area					BMMC Area					
	M	F	J	I	T1	M	F	J	I	T2	T1+T2
Feb,99	11	22	18	17	68	--	--	--	--	00	68
Mar,99	16	33	27	26	102	--	--	--	--	00	102
Apr,99	19	41	35	22	127	--	--	--	--	00	127
May,99	21	47	38	36	142	--	--	--	--	00	142
June,99	24	53	44	41	162	--	--	--	--	00	162
July,99	18	40	32	31	121	--	--	--	--	00	121
Aug,99	16	35	27	29	107	01	02	03	01	07	114
Sep,99	14	29	23	24	90	--	--	--	--	00	90
Oct,99	11	23	18	20	72	--	--	--	--	00	72
Nov,99	09	20	15	17	61	--	--	--	--	00	61
Dec,99	06	14	11	11	42	--	--	--	--	00	42
Jan,00	09	18	13	15	55	--	--	--	--	00	55

* BEMC – Blocks with extensive mango cultivation; BMMC – Blocks with moderate mango cultivation; M – Male; F – Female; J – Juvenile; I – Infant; T1 – Total population of BEMC area; T2 – Total population of BMMC area.

Table.7.3. Month-wise census data from February, 2000 to January 2001.

Months	BEMC Area					BMMC Area					
	M	F	J	I	T1	M	F	J	I	T2	T1+T2
Feb,00	12	25	20	19	76	--	--	--	--	00	76
Mar,00	17	37	31	29	114	--	--	--	--	00	114
Apr,00	22	46	38	36	142	--	--	--	--	00	142
May,00	24	52	43	40	159	--	--	--	--	00	159
June,00	27	59	49	46	181	01	02	02	01	06	187
July,00	21	45	36	35	137	01	03	04	03	11	148
Aug,00	21	46	38	36	141	--	--	--	--	00	141
Sep,00	18	39	32	30	118	--	--	--	--	00	118
Oct,00	14	31	25	24	94	--	--	--	--	00	94
Nov,00	14	27	22	21	84	--	--	--	--	00	84
Dec,00	08	18	15	14	56	--	--	--	--	00	56
Jan,01	10	23	19	18	70	--	--	--	--	00	70

* BEMC – Blocks with extensive mango cultivation; BMMC – Blocks with moderate mango cultivation; M – Male; F – Female; J – Juvenile; I – Infant; T1 – Total population of BEMC area; T2 – Total population of BMMC area.

Table.7.4. Month-wise census data from February, 2001 to January 2002.

Months	BEMC Area					BMMC Area					
	M	F	J	I	T1	M	F	J	I	T2	T1+T2
Feb,01	14	25	19	21	79	--	--	--	--	00	79
Mar,01	19	38	29	32	118	--	--	--	--	00	118
Apr,01	24	47	37	39	147	--	--	--	--	00	147
May,01	26	53	41	45	165	--	--	--	--	00	165
June,01	29	61	47	51	188	--	--	--	--	00	188
July,01	15	50	38	40	143	--	--	--	--	00	143
Aug,01	24	52	43	39	158	01	02	03	02	08	166
Sep,01	21	43	36	33	133	--	--	--	--	00	133
Oct,01	17	35	29	27	108	--	--	--	--	00	108
Nov,01	14	30	25	23	92	--	--	--	--	00	92
Dec,01	10	21	18	17	66	--	--	--	--	00	66
Jan,02	10	25	19	20	74	--	--	--	--	00	74

* BEMC – Blocks with extensive mango cultivation; BMMC – Blocks with moderate mango cultivation; M – Male; F – Female; J – Juvenile; I – Infant; T1 – Total population of BEMC area; T2 – Total population of BMMC area.

Table.7.5. Population composition of rhesus monkeys during February, 1999 to January, 2002 at extensive and moderate mango cultivation blocks in Malda district.

Year of Study	Male		Female		Juvenile		Infant		Total no. of animals
	No.	%	No.	%	No.	%	No.	%	
1999-2000	175	15.13	377	32.61	304	26.29	300	25.95	1156
2000-2001	210	15.11	453	32.61	374	26.92	352	25.34	1389
2001-2002	224	15.14	482	32.58	384	25.96	389	26.30	1479
Average		15.12		32.60		26.39		25.86	

Table.7.6. Different ratios on population structure of rhesus monkey during February, 1999 to January, 2002 at extensive and moderate mango cultivation blocks of Malda district.

Months	Adult Male : Adult Female	Juvenile : Adult	Infant : Adult Female
FEB	51.3 : 100	52.2 : 100	79.1 : 100
MAR	48.1 : 100	54.3 : 100	80.5 : 100
APR.	48.5 : 100	55.2 : 100	72.3 : 100
MAY	46.7 : 100	54.7 : 100	79.6 : 100
JUN	46.3 : 100	55.5 : 100	79.4 : 100
JUL	39.9 : 100	56.9 : 100	78.9 : 100
AUG	45.9 : 100	57.0 : 100	78.1 : 100
SEP	47.7 : 100	55.4 : 100	78.3 : 100
OCT	47.1 : 100	54.9 : 100	79.7 : 100
NOV	48.0 : 100	54.3 : 100	79.2 : 100
DEC	45.2 : 100	57.1 : 100	79.2 : 100
JAN	43.9 : 100	53.6 : 100	80.3 : 100

Table.7.7. Sightings of new born in different months in different years at extensive and moderate mango cultivation blocks of Malda district.

Months	1999-2000	2000-2001	2001-2002	Total	Percentage
FEB	16	18	19	53	6.94
MAR	20	22	28	70	9.17
APR	19	28	35	82	10.74
MAY	35	37	42	114	14.94
JUN	41	45	49	135	17.69
JUL	30	32	37	99	12.97
AUG	17	21	19	57	7.47
SEP	14	17	20	51	6.68
OCT	12	11	11	34	4.45
NOV	06	09	07	22	2.28
DEC	02	04	03	09	1.17
JAN	11	12	14	37	4.84

Table.7.8. Density of rhesus macaques population per square kilometre in mango and non-mango season at BEMC and BMMC area during January, 1999 to February, 2002.

Year of Study	Mango Season	Non-mango Season
1999-2000	3.62	2.17
2000-2001	4.15	2.83
2001-2002	4.22	3.21

Table.7.9. Home ranges of rhesus monkeys in different habitat of extensive and moderate mango cultivation blocks of Malda district over 7 years study (1995-96 to 2001-02).

Group No.	Mango Orchard	Crop field	Grassland	Human Household	Roadside
1	2	3	4	1.5	2
2	3.5	1	2	0.5	2.5
3	3	2	3	0.5	2
4	3.5	2	3	1.5	1.5
5	1.5	3	2	1	2
6	2.5	2	3.5	1	1
7	3.5	2.5	4	1	2
8	2	2	4	0.5	0.5
9	2.5	2	2.5	1	1.5
10	3	2	3.5	1	1
11	2.5	1.5	2.5	0.5	1
12	3.5	2	2.5	1.5	0.5
13	3.5	2	3	1	1.5
14	2	4	4	1.5	1.5
15	3.5	3	3.5	1	0.5
16	3	2	3	1.5	1
Total	45	36	50	16.5	22
Average	2.81 ± 0.16	2.26 ± 0.17	3.12 ± 0.16	1.03 ± 0.09	1.37 ± 0.14

* ± = Standard error.

Table.7.10. Percent sightings of rhesus monkeys in different habitat of extensive and moderate mango cultivation blocks of Malda district over 7 year study (1995-96 to 2001-02)..

Habitat	No. of monkeys counted	Percentage of shiftings
Mango Orchards	3617	45.35
Crop field	1213	15.21
Grassland	1628	20.41
Human Household	736	9.22
Roadside	780	9.78

Table.7.11. Population structure of rhesus monkey on maximum count on different age-sex classes.

Study Year	Male		Female		Juvenile		Infant		Total
	No.	%	No.	%	No.	%	No.	%	
1990-00	109	46.2	236	100	194	82.2	183	77.5	722
2000-01	125	46.5	269	100	223	82.8	209	77.6	826
2001-02	127	46.4	274	100	211	77.1	228	83.2	840
Average	120.3	46.4	259.6	100	209.3	80.7	206.6	79.4	796

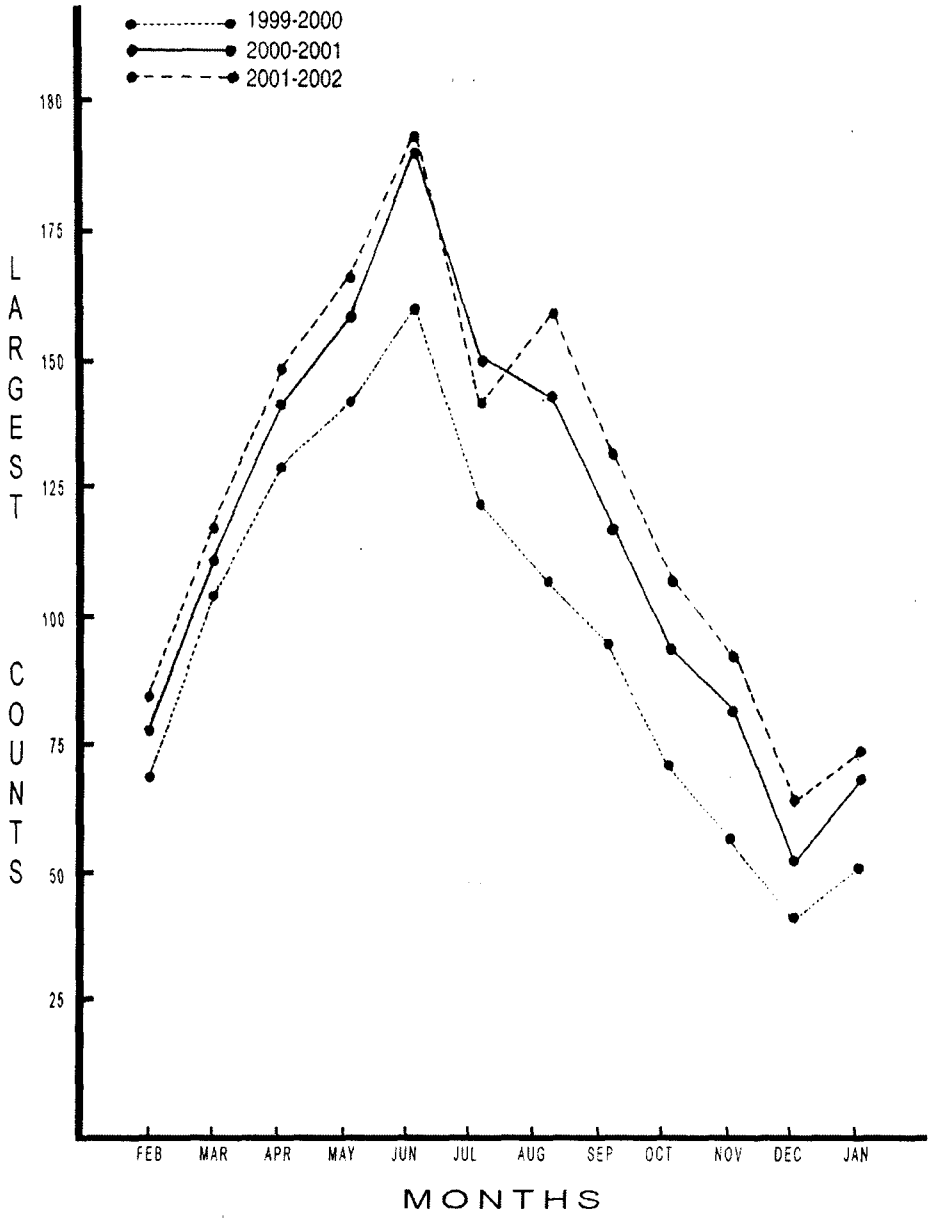

Figure. 7.1. Estimated population of rhesus monkey in different months of the year 1999-2000, 2000-2001 and 2001-2002.

8. FEEDING BEHAVIOUR

8.1. Introduction

The dietary habits of *Macaca mulatta* varied greatly depending upon where they live. They are omnivorous and often eat roots, herbs, fruits, insects, crops and small animals. They seem to choose their environment carefully in respect to food resources. Even when they are forced switch to lower quality food in the winter months, they do not exhibit higher mortality rates, although they may lose body weight (Nowak, 1991 and Parker, 1990). In general ripe fruits (74%), invertebrates along with plants (12%) and vertebrates (14%) constitute their normal dietary habits (Fa, John and Donald Lindberg, 1996).

It is essential to study feeding behaviour to understand ecological adaptations of animals to their habitat. Feeding behaviour is also important in analyzing ecological and behavioural problems of a species. Aggregation and segregation of the members of a social group is often influenced by the quality and quantity of vegetation and by the pattern of distribution of the foods resource. This chapter discusses food habits, food species, food selection technique, estimation of plant parts eaten along with drinking behaviour of rhesus macaques in the study area.

8.2. Methods

Feeding behaviour was conducted by observing the animals at specific feeding situations during the course of study and by direct observation of food species consumed by them. No data was recorded when the animals were not in clear view. The manner and part of the plant species consumed by the monkeys were observed carefully.

8.2.1. Identification of food species

Identification of the plant species eaten by the animals is one of the essential tasks of the investigator studying feeding behaviour. It was possible to identify a number of plant species and their parts eaten by the monkeys through direct observations with the help of binoculars at the study spot. All unknown food plants eaten by the animals were collected in a scientific manner for proper identification. At the time of sorting the local names were used for those food species whose local name were known and assigned the code numbers to other species which had no local name. Herbarium sheets were then prepared for the plants species collected following appropriate methods. The herbarium sheets were then sent to the Department of Botany, North Bengal University, for identification. Professor A. P. Das graciously helped the author in identifying the plants.

8.2.2. Plant parts estimation

Observations of food species and plant parts eaten by the subjects were estimated following time sampling method (Altmann, 1974). Data were systematically collected on feeding bouts, plant parts eaten etc. by the animals during January-December, 2001. The method involved recording the food species and plant parts eaten by the animals feeding in one glance at every 5 minutes interval. Data were recorded only on the animals which were in clear view. Thus, each 5 minutes scan included the animals that were feeding immediately and were clearly with in the range of vision (Clutton, Brook and Harvey, 1976). Parts of food species adopted in this study are :

a. Fruit : juicy fruits, nuts, seeds.
b. Leaf : new and mature leaves.
c. Stem : stems and twigs.
d. Flowers : flowers and inflorescence.
e. Bark : thick dead or partially dead surface of the trunk.
f. Other plant parts such as roots, buds and petioles (Maruhasi, 1980).

The records of feeding behaviour were analysed by summing the total number of records of each food species and finally expressing the same in percent of the total number of feeding records collected. A total of 400 hours of observations were made on feeding behaviour which included 8072 bout of feeding.

8.2.3. Food selection ratio

Selection of food usually depends on taste as well as the nutritive value of the food items and most of the animals are more or less selective regarding their food items in natural habitat. Petrides (1975) reported that selected species are those which are proportionately more frequent in the diet of an animal than their availability in the environment. Stoddart and Smith (1955) used the term 'choice that animals make' for this purpose. Techniques used by different workers for determination of food preference are : A. faecal sample analysis (Clutton, Brook and Harvey, 1977), B. tracer sample analysis, C. scanning method (Altmann, 1974). The first one is more suitable for wild population while the second is of much promise but requires more adequate facilities. In this study scanning method as used by Altmann (1974) in red and black-white colobus in East Africa was followed as it appeared to be most suitable. The method provides an estimate of the proportion of time which animals spent on feeding of each food species or parts of plant. The process involves selecting an experimental plot in the study area where the major food plants are present. In this study one spot at Bachamari of Old Malda block was selected to determine food selection ratio of rhesus macaques. Plants over 2 metres in height were recorded in a sample strip of 50m X 100m = 5000 sq. mtrs. for this work.

Total number of feeding bouts on each species and total number of trees of each species were counted in the experimental plot and converted into percentage time spent on feeding of each species (PTFS) and abundance of each species (PAS) respectively. Then selection ratio was determined dividing PTFS by PAS i.e. r = PTFS / PAS. The selection ratio for different species emphasized the strength of selectivity. Some of the plant species found at a high density were

irregularly selected whereas some tree species with low density were selected regularly.

8.2.4. Total food intake

Wet weight of green shoots taken by a single pluck was determined by comparison with an adjacent unplucked region. Number of plucks per unit time by members of different age-sex classes were recorded. The amount consumed was determined by multiplying the amount taken in a single pluck by number of plucks per unit time. Finally, this was again multiplied by average number of hours of feeding by different age-sex classes of animals.

8.3. Results and Analysis

8.3.1. Feeding mode of Rhesus

Rhesus monkeys are largely vegetarian. Fruits, green leaves, flowers, seeds, barks of different plant species, grass and grains and algae constitute their normal diet. Besides, plant material, rhesus monkeys were seen to feed on unidentified small insects from the soil (Lindburgh, 1971; Krishnan, 1972). Usually the members of a group engage themselves in feeding on different parts on finding a major food species with sparse distribution. On arriving at such a tree all the members of a group exhibited some degree of excitement and soon engaged themselves in feeding which often lasted for 20-45 minutes. Young individuals were often found to feed at the terminal branches (Plate.8.1.) where as older and heavier ones mostly fed at the central or middle parts (Plate.8.2.). Lindburgh (1971) and Kali (2001) observed this type of feeding behaviour in Northern India and North Bengal respectively. Fruits and berries are picked up with the hand and brought to the mouth (Plate.8.3.) with one hand and the berries or fruits are plucked by the other. Often in presence of other members of the group they filled their cheek pouches with food and then chewed the food materials on reaching a safe spot (Plate.8.4). They fed on grass, herbs (Plate.8.5., Plate.8.6.), dropped nuts (Plate.8.7.) and fruits (Plate.8.8., Plate.8.9.) on the ground. Feeding on ground

comprised 18% of their total feeding time although it varied seasonally because in winter feeding at the ground is higher than that of summer, when green leaves and fruits are easily available. Sometimes stolen food materials were fed by them in a safe place even on the top of the boundary wall of a protected garden (Plate.8.10.). Raiding of human households for food materials are not infrequent in the non-mango season (Plate.8.11.).

8.3.2 Food species analysis

Altogether 61 plant species belonging 55 genera under 30 families constituted plant food spectrum of rhesus monkeys at the present study site (Table.8.1). As the study area is primarily mango orchards, 26.2% of the trees, comprising food species are mango, *Mangifera indica* belonging to Anacardiaceae. The families Gramineae (11.1%), Leguminosae (10.8%) and Solanaceae (6.2%) together accounted for 28.1% of the food plants in the area. Thus although the food species of rhesus macaques in this area comprised of 30 families and 55 genera; only 4 families and 21 genera accounted for more than 54% of the food plant species in the area. All the food plants listed in Table.8.1. were, however, not eaten equally; only several species *Mangifera indica* (Plate8.13.). *Carica papya, Phyllanthus emblica, Syzygium cumini, Musa paradisiaca* (Plate.8.10.), *Bombax ceiba, Artocarpus heterophyllus* (Plate.8.2), *Citrus medica* (Plate.8.12), *Psidium guajava, Polyalthia longifolia, Solanum melongena, Cicer arietinum, Oryza sativa, Triticum aestivum, Spinacia oleracea, Solanum tuberosum, Ficus carica, Bambusa tulda* (Plate.8.1.), *Colocasia esculenta* (Plate.8.6.), *Cucumis sativus* were observed to be consumed in large amounts. As such these food species may be regarded as 'principal food', of rhesus as used by Petrides (1975). The other food species which were found to be eaten in smaller quantities were termed as 'auxiliary food'. The 'auxiliary food' were consumed during movement from resting sites to feeding sites and vice versa. The list of large scale of food items indicates that rhesus monkeys are wide spectrum feeder.

8.3.3. Food selection

One of the important aspects of feeding behaviour is food selection. The animal decides to consume a certain species 'X' in preference to species 'Y' and 'Z' under certain situation. The animals also decides on the amount to be consumed of the selected species. Frequent feeding on certain species may be due in part to its availability, but availability is not the whole story since many commonly available food items may be consumed little. Table. 8.2. shows percent abundance of tree species, percent time spent on them by monkeys and selection ratio. A selection ratio of more than unity indicates preference. Food selection ratios were done in the experimental area where 17 plant species were selected during the period from May to June, 2001. The experimental plot (Bachamari) was situated in Old Malda block and although dominated by *Polyalthia* (PAS = 6.8%), *Dalbergia* (PAS = 6.8%), Areca (PAS = 6.2%) and *Bombax* (PAS = 6.1%), showed lower rate of feeding, i.e. 0.32%, 0.31%, 0.26% and 0.19% respectively (Table. 8.2.). At the same time some species with parallel abundance were regularly selected, i.e. *Syzygium, Psidium, Artocarpus*. Some of the species found at moderately high density were irregularly selected while some genera with the same density were regularly selected, i.e. *Ficus, Phyllanthus* etc. It is to be noted that trees with intermediate density had a intermediate selection ratio, i.e. *Acacea, Delomix, Litchi.*

Besides selection ratio on trees, 11 most common grass, shrub and herbaceous genera were collected for identification as important source of food sources. Table.8.3. shows 3 grass genera, 5 herb genera and 3 shrub genera. *Cynodon* was found to be the most important food source among the grasses. *Oryza* and *Zea* were found as important food source among the five herb genera. Similarly among the shrubs *Citrus* and *Bambusa* were important.

8.3.4. Diet and Seasonal variation

Rhesus groups were observed to feed on 61 plant species under 30 families from March, 2001 to December, 2001, excluding two rainy months i.e. July and

August. The study was divided into two halves : I. Spring and early summer (March to June), II. Autumn and early winter (September to December). The records of different parts eaten were systematically collected to analyse diet quantitatively (Table.8.5. and Table.8.6.). The diet of rhesus monkeys include : fruits, leaves, flowers, stems, barks, buds, roots, petioles, some unidentified plant parts and small soil insects. The animals also consume a number of grass species also reported by Mukherjee and Gupta (1965), Lindburgh (1971) and Kali (2001).

Table.8.5. shows that in the spring – summer months i.e. March to June the monkeys spent about 82% of their feeding time on fruits and leaves. On the other hand they spent more or less similar proportion of time (75%) on leaves and stems in autumn – winter months (September to December, Table.8.6.). Over all the monkeys fed predominantly on fruits in the spring – summer months and leaves in the autumn – winter months. Percent time spent on other plant parts in the two seasons varied from item to item. Similar difference in plant part consumption has also been reported by Roonwal (1956), Lindburgh (1971) and Kali (2001).

The diet of rhesus is similar to that of *Macaca radiata* (Bertrand, 1969), *Macaca assamensis* (Fodden, 1971) and *Macaca silenus* (Sugiyama, 1971). Unlike these species *Macaca nemestrina* (Corner, 1941; Bertrand, 1969) and *Macaca fascicularis* (Fodden, 1971) are reported to be omnivorous rather than predominantly vegetarian. The diet of *Macaca fuscata yakui* (Maruhasi, 1980) is essentially fruits and is close to that observed in the present study.

8.3.5. Total Food Intake

Both intensity of feeding and time spent in feeding are maximum in mothers with infants and as such they consumed maximum amount of food i.e. 122.9 gms per hour during the feeding period (Table.8.4.) Higher rate of consumption by mothers was possibly required for regaining health after giving birth of the young and for milk production. The food consumption of adult males were lower than that of the adult females with or without infants. It may be mentioned that the infants suckled their mother's milk besides their diet of fruits, leaves, shoots and

grass in relation to their body weight. It is well known that animals with smaller body size requires more energy per unit of body weight as compared to the large bodied animals because of higher metabolic rate.

8.3.6. Drinks

Rhesus monkeys were observed to drink from all kinds of water sources such as rivers, ponds, ditches and even from irrigation channel. No particular period of the day can be pointed out as their "drinking time", however, they were found to drink at the early morning, mid-day and late after noon hours. Often they were observed to drink during intervals between feeding bouts when water sources were available in the vicinity.

Drinking pattern (Plate.8.16.) depended on the kind of water sources they were drinking from. When they drank from rivers, streams and pools their fore limbs were in the water bodies but the hind limbs were on the bank (Plate.8.14.). While crossing the rivers or sloppy bank of water source (Plate.8.15) they drank standing at knee-deep water. Again when they drank from small water bodies they just lowered their shoulders leading the mouth into the water source while maintaining their position on the hind limbs at the bank. They immersed their lips (Plate.8.17.) into water and sucked up water. Most often they drank for only few seconds at a time. On occasions they drank continuously for about 28 seconds. Drinking generally lasted 13 to 28 seconds in adults, 8 to 15 seconds in juveniles and 6 to 10 seconds in infants (Table.8.7.).

They were observed to drink clear and mud-free water. Authorities differed regarding drinking capacity of rhesus. Mukherjee (1969) is of opinion that rhesus drink at least two to three times a day. Kali (2001) noted that during the hot months they drink more often. It was also observed that, almost all the members of the group drank water (Plate.8.18.) whenever they came in contact with a large water source such as river or ponds.

Table.8.1. Food species of rhesus monkey at Malda district.

Sl. No.	Food species	Family	% of food species
1.	*Mangifera indica*	Anacardiaceae	26.2
2.	*Areca catechu*	Arecaceae	02.1
3.	*Acacea catechu*	Arecaceae	
4.	*Andrographis paniculata*	Acanthaceae	01.1
5.	*Colocasia esculenta*	Aeraceae	01.2
6.	*Polyalthia longifolia*	Annonaceae	01.2
7.	*Brassica campestris*	Brassicaceae	03.8
8.	*Brassica naigra*	Brassicaceae	
9.	*Brassica oleracea Var. Botrytis*	Brassicaceae	
10.	*Brassica oleracea Var. Capitala*	Brassicaceae	
11.	*Bombax ceiba*	Bombacaceae	01.4
12.	*Carica papya*	Caricaceae	01.3
13.	*Enhydra fluctuans*	Compositae	01.2
14.	*Terminalia chebula*	Combretaceae	01.2
15.	*Terminalia bahera*	Combretaceae	
16.	*Trichosanthus dioica*	Cucurbitaceae	03.0
17.	*Cucumis sativus*	Cucurbitaceae	
18.	*Lagenaria siceraria*	Cucurbitaceae	
19.	*Cucurbita peopo*	Cucurbitaceae	
20.	*Raphanus sativus*	Cruciferae	01.2
21.	*Spinacia oleracea*	Chinopodiaceae	01.1
22.	*Phyllanthus emblica*	Euphorbiaceae	02.1

Sl. No.	Food Species	Family	% of food species
23.	*Cynodon dactylon*	Gramineae	11.1
24.	*Saccharum officinarum*	Gramineae	
25.	*Triticum aestivum*	Gramineae	
26.	*Oryza sativa*	Gramineae	
27.	*Impereta cylindrica*	Gramineae	
28.	*Cicer arietinum*	Gramineae	
29.	*Digitaria sanguinalis*	Gramineae	
30.	*Zea maize*	Gramineae	
31.	*Bambusa tulda*	Gramineae	
32.	*Acacea auriculiformes*	Leguminosae	10.8
33.	*Pisum sativum*	Leguminosae	
34.	*Dalbergia sisso*	Leguminosae	
35.	*Lens culinaris*	Leguminosae	
36.	*Caesalpinia pulcherrima*	Leguminosae	
37.	*Delomix rigia*	Leguminosae	
38.	*Dolichos lablab*	Leguminosae	
39.	*Vigna sinesis*	Leguminosae	
40.	*Musa paradisiacal*	Musaceae	02.1
41.	*Melia azadirachta*	Meliaceae	01.4
42.	*Syzygium cumini*	Myrtaceae	03.6
43.	*Psidium guajava*	Myrtaceae	
44.	*Artocarpus heterophyllus*	Moraceae	02.7
45.	*Ficus carica*	Moraceae	
46.	*Abelmoschus esculentus*	Malvaceae	01.4
47.	*Pinus roxburghii*	Pinaceae	01.1

Sl. No.	Food Species	Family	% of food species
48.	*Cocos nucifera*	Palmae	02.3
49.	*Phoenix sylvestris*	Palmae	
50.	*Calamur rotang*	Palmae	
51.	*Punica granatum*	Punicaceae	01.1
52.	*Citrus medica*	Rutaceae	02.2
53.	*Litchi chinensis*	Sapindaceae	01.2
54.	*Solanum tuberosum*	Solanaceae	06.2
55.	*Lycopersicon esculentum*	Solanaceae	
56.	*Solanum melongena*	Solanaceae	
57.	*Corchorus olitorius*	Tiliaceae	02.2
58.	*Corchorus capsularis*	Tiliaceae	
59.	*Centella asiatica*	Umbelliferae	01.1
60.	*Zingiber officinale*	Zingiberaceae	01.7
61.	*Curcuma longa*	Zingiberaceae	

Table.8.2. Abundance of some food species and their Selection (Area = 100m X 50m) Ratio at Bachamari of Old Malda block of the district.

Name of the species	PTFS	PAS	Selection ratio : PTFS/PAS
Mangifera indica	21.7	10.8	02.10
Areca catechu	01.4	06.2	00.26
Polyalthia longifolia	02.2	06.8	00.32
Bombax ceiba	01.2	06.1	00.19
Carica papya	15.2	08.2	01.85
Phyllanthus emblica	06.7	04.4	01.52
Acacea auriculiformes	02.2	04.3	00.51
Dalbergia sisso	02.1	06.8	00.31
Caesalpinia pulcherrima	01.1	04.3	00.25
Delomix rigia	01.8	04.4	00.41
Melia azadirachta	01.7	04.2	00.40
Syzygium cumini	11.9	06.6	01.80
Psidium guajava	13.2	06.7	01.97
Artocarpus heterophyllus	09.1	05.8	01.57
Ficus carica	05.2	04.4	01.18
Cocos nucifera	01.1	04.8	00.23
Litchi chinensis	02.2	05.2	00.42

* PTFS = Percent time spent feeding on each species.

* PAS = Percent abundance of each species.

Table.8.3.Percent time spent on feeding of some of the most common genera of grasses, herbs and shrubs in the study area.

Genus	Type	Percent time spent in feeding
Cynodon	Grass	38.5
Digitaria	"	31.2
Imperata	"	30.3
Oryza	Herb	32.2
Zea	"	22.1
Brassica	"	09.1
Cicer	"	17.1
Solanum	"	19.5
Saccharum	Shrub	25.8
Bambusa	"	33.5
Citrus	"	40.7

Table.8.4. Total food intake (green-leaves) in gms. per hour by different age-sex classes of rhesus monkey.

Classes	No. of Plucks per hour (N)	Average wet weight of single pluck (W) [in gms.]	Amount of green leaves eaten per hour (A=N X W) [in gms.]
Adult Male	1020	0.089	90.8
Adult Female	1130	0.088	99.4
Adult Female (with infant)	1280	0.096	122.9
Juvenile	840	0.072	60.5
Infant	440	0.044	19.4

Table.8.5. Percent time spent on feeding of plant-parts irrespective of species in spring-summer months in 2001.

Month	Plant-parts						
	Fruit	Leaf	Stem	Flower	Bark	Seed	Others
March	51.2	20.6	11.3	12.3	00.4	03.9	00.3
April	70.1	11.9	09.6	04.4	00.1	03.2	00.7
May	76.9	09.8	08.4	02.1	00.2	01.7	01.0
June	78.3	07.8	09.4	00.8	00.4	02.8	00.5
Average	69.1	12.5	09.7	04.9	00.3	02.9	00.6

Table.8.6. Percent time spent on feeding of plant-parts irrespective of species in atumn-winter months in 2001.

Month	Plant-parts						
	Fruit	Leaf	Stem	Flower	Bark	Seed	Others
September	12.7	58.7	23.4	02.3	01.1	01.2	00.6
October	10.1	60.2	22.4	04.7	01.0	01.1	00.5
November	19.2	50.8	22.2	05.1	01.3	00.6	00.8
December	32.1	41.3	19.3	04.9	01.1	00.7	00.6
Average	18.5	52.7	21.8	04.2	01.1	00.9	00.6

Table.8.7. Duration of drinking (in seconds) in different age-class of rhesus monkey.

Age Class	No. of ~~Shiting~~ Sighting	Minimum	Maximum	Average
Adult	165	13	28	20.5
Juvenile	90	08	15	11.5
Infant	75	06	10	08.0

Plate.8.1. Young individual at the top of a *Bambusa tulda* during feeding.

Plate.8.2. Adult male in the middle portion of Jackfruit tree during feeding.

Plate.8.3. Banana picked up with the hands and brought to the mouth by the adult male.

Plate.8.4. An adult female of a small group in resting phase chewing food materials in her cheek-pouches.

Plate.8.5. One adult male and female along with one juvenile feeding on herbs.

Plate.8.6. Adult male at *Colocasia plantation* during feeding in the morning session.

Plate.8.7. Monkeys feed on nuts dropped on the ground.

Plate.8.8. An adult female with her infant feeding on bananas while the juvenile chewing food materials stored in cheek-pouch.

Plate.8.9. An adult female with her infant feeding on mango.

Plate.8.10. An adult male feeding on a banana stolen from a garden sitting on the boundary wall that is studded with glass spikes for protection.

Plate.8.11. A hungry adult male fed on brinjal in the kitchen of a household in non-mango season.

Plate.8.12. An adult female feeding on *Citrus* leaves beneath the tree in the morning hours.

Plate.8.13. A mango tree *(Mangifera indica)* an important food species with mature fruits. Bamboo poles are used to support the terminal branches to avoid breakage due to the weight of the fruits.

Plate.8.14. During drinking an adult female step up forelimbs in the water but the hindlimbs on the bank.

Plate.8.15. An adult male is drinking from a pond at knee deep water in the morning session.

Plate.8.16. A juvenile drinking in an upsight down position while hanging from a bamboo stump.

Plate.8.17. An adult male immersed his lips into water of a pond and sucked up.

Plate.8.18. Group drinking with a larger water source.

9. GENERAL ACTIVITY PATTERN

9.1. Introduction

To study behaviour of animals in the field, it is important to observe their daily activity pattern as because it enables the observer to make probable guess about where and when to find the animals within its habitat. However, the animal activities are not randomly organized but with reference to time and space it follow some definite schedule. The behavioural patterns varies according to species and environmental circumstances. Some biological clock mechanism seem to regulate their daily behavioural pattern. The total activity pattern of an animal is often referred as the behavioural repertoire, i.e. what the animals do and the frequency of occurrence of different activities with reference to time and space is called behavioural profile or daily activity budget or in otherwords where, when and how much of what they do (Pal, 1983). Many workers classified major activities of animals according to convenience. Generally two tendencies are observed so far : a group of scientists like McHugh (1958), Jerman and Jerman (1973), Jingfors (1980) classified animal activities broadly into 2 to 5 categories, whereas Saratchandra and Gadgil (1980), Pal (1982), Pal (1983) considered the finer activities totalling to more than 8 categories. In this study the behavioural repertoire of rhesus monkey has been classified into eight basic patterns and these are as follows :

1. Feeding : Eating and drinking mechanism of animals, also examining food items in different season.

2. Resting : Animals standing or lying, sitting on the ground or on tree branches without involvement in any other specific activity have been included in this category.

3. Locomotion : Walking, hopping, jumping, running all have been included in this section.

4. Social Grooming : Its involved cleaning of the body fur from insects, large dust particles etc. usually by a sub-ordinate member of a group from the body of a dominant member. In case of mother-infant and sexual partners the dominants were observed to groom the sub-ordinate.

5. Playing : Play mostly involved in grown-up infants juveniles and young adults. All types of interactions that although contained elements of other discrete acts such as aggression, sex etc. were incomplete, non-sequential or out of conext and as such could not be included in any other category.

6. Aggression : This involved fighting including threat, hop, chase, attack, biting etc.

7. Sexual inspection : It referred to presentation of sexual swelling by females to the males and physical, visual and olfactory verification of sexual parts by the latter.

8. Copulation : This included mounting of adult females by adult males followed by intromission of male organ into the vagina.

9.2. Methods

For studying animal behaviour many methods have been suggested by various field scientist from time to time. Attempts were made to refine widely used technique for more effective application under specific circumstances such as field and laboratory (Olson and Cunningham, 1934; Dumber, 1977; Simpson and Simpson, 1977 and Tylor, 1979). However, 'time-Sampling' method used in this study is one of the basic methods for studying animal behaviour. Olson (1929) is credited to be the first person to use this technique for studying children bahaviour.

The technique consists of taking a single count of numbers engaged in different behavioural activities glance on every unit time interval. In this study the

time interval was 5 minutes. Observations were distributed throughout the day time period from 06.30 to 09.30, 11.00 to 13.00 and 14.00 to 18.00 Hours. So that the total period of observation at any particular session of the day was comparable to any other period. The actual hourly break-up of the number of time-samples and number of rhesus observed is shown in Table.9.2.1.

9.3. Results and Discussions

9.3.1. Diurnal Activities

A total of 100 hours of observations was carried out on the activity of rhesus monkeys stretching over 06.30 to 09.30, 11.00 to 13.00 and 14.00 to 18.00 hours. Observations were made from January, 2001 to June, 2001. A total of 862 activity patterns were recorded in 694 time-sample units (Table.9.1.).

Table.9.2. shows percent of various behavioural patterns of rhesus monkeys at different hours of observation. Feeding behaviour had a bimodal distribution with peaks in the morning and afternoon session. The feeding behaviour continued throughout the day and was the most prominent activity. The process of feeding built up gradually and attain peaked during 11.00 to 12.00 hour, the peak dusk feeding was observed about 16.00 to 18.00 hour. Patterns of feeding behaviour of rhesus were reported by various workers such as Lindburgh (1971), Puget (1971) and Kali (2001). More than 60% of the animals were involved in feeding during the peak hours (Plate.9.1. and Plate.9.3.) In the noon session between 12.00 to 15.00 hour when temperature increases to about 30^0C or above feeding started to declined. Only about 20% of the total animals exhibited this behaviour during this (Plate.9.2.) period. It is to be noted that higher temperature in this session compelled the animals to rest instead of feeding. The rate of feeding in the mid-day was observed to be higher in cloudy days than hot sunny days.

They used shady spaces under the tree in most cases during resting. They rested in different postures either on the tree or on the ground. In the mid-day session i.e. between 11.00 to 15.00 hour when temperature ranged from 27^0C to

32^0C resting peaked (Plate.9.4., Plate.9.5., Plate.9.6. and Plate.9.9.). Southwick et al. (1962, 1965), Puget (1971) and Lindburgh (1971) reported resting to be restricted to mid-day session.

Locomotion behaviour occurred at almost all hours of the day. The groups mostly moved quadrupedally (Plate.9.10.) along the established routes. The arboreal pathways through orchard canopy appeared also to be well established. Horizontal jumps (Plate.9.12.) of incredible lengths were occasionally made by all age-sex classes except infants. Landing was always observed to be on their rear feet. However, occasional bipedal movement were also seen and such movements were less organized in mango orchard. Swimming behaviour (Plate.9.11.) was often seen in the study area during hot summer days.

Grooming was considerably higher in the late morning and in the afternoon session although it was observed at every hour of the day (Plate.9.13., Plate.9.14. and Plate.9.15.). Grooming occurred almost in all posture and on ground as well as on the branches of trees. Usually the groomed animal is dominant over the groomer (Plate.9.14.). However, mutual grooming between mating pairs were also observed. Infants and in some occasion juveniles received grooming from their mothers from time to time.

Playing activities was confined in the morning and in the afternoon session. It was slightly higher in the early morning session and absent in mid-day i.e. in between 11.00 hour to 14.00 hour.

Aggressive behaviour was recorded throughout the day but was maximum in the late morning session (i.e. 07.30 hour to 09.30 hour) as the temperature started to increase (Table.9.2.). It involved encounters between adults and adult-subadults (Plate9.16., Plate.9.17., Plate.9.18.). Adult females and infants (Plate.9.19, Plate.9.20, Plate.9.21.) were not involved in this behaviour. Infants always remained in safe custody of adult females (Plate.9.22., Plate.9.23., Plate.9.24.).

Sexual inspection of ano-genital parts was recorded mainly in the afternoon session (Plate.9.25., Plate.9.26.). It was completely absent in morning and noon sessions (Table.9.2.).

Occurrence of copulation (Plate.9.28., Plate.9.29., Plate.9.30.) was higher in the early morning and afternoon session and was rare in the mid-day period. Play copulation (Plate.9.27.) between the infants and juveniles were also found on several occasions.

9.3.2. Resting Sites

Rhesus maintained their diurnal activities both on the ground and on trees. Percent time spent by the animals on the ground (OG) and on the tree (OT) at different parts of the day is shown in Table.9.3. Records of sightings on the ground peaked in the morning i.e. between 06.30 to 08.30 hour and declined gradually throughout the day with the increase of temperature. Percent time spent by rhesus on the tree gradually build up and peaked at dusk (16.00 to 18.00 hour). Southwick and co-workers reported the similar pattern in 1965. Month-wise sightings on the ground declined from January and continued at a low level till May, when the temperature soared from 11^0C to 38^0C. The trend was just the reverse in case of sightings on the tree. Percent animals resting on ground and tree were 46 and 54 in the morning session (06.30 – 08.30 hour), 15 and 85 (11.00 – 13.00 hour) and 16 and 84 in the afternoon session (16.00 – 14.00 hour) respectively. In the morning session when the intensity of light and temperature was low most animals remained on ground but finally they moved to their sleeping sites by the evening in small clusters. Similar observations noted by Puget (1971), Vessey (1972) and Kali (2001). It may be concluded sightings of animals on the ground and on the tree in different parts of the day varied widely and was influenced by light and temperature rather than by the later alone. It may be pointed out that in May percent sightings on ground declined to 30.2 (lowest) but increased again in June to 40.3 despite the general trend of decreasing percent sightings on ground with rise of temperature probably because of increased availability of food i.e. dropped mangoes on the ground.

9.3.3. Utilization of different areas of tree

It was observed that the monkeys used different part of the canopy in specific manner. They, however, were observed to move to terminal parts of the canopy to pluck fruits and feed them. Besides resting and feeding various other activities such as grooming, aggression, play, maternal, mate inspection etc. were also observed at various parts of the canopy. The canopy may extend to a maximum of about 12-15 metres in height. The common nesting trees in this study area are : *Mangifera indica, Phyllanthus emblica, Melia azadirachta, Syzygium cumini, Terminalia bahera, Bambusa tulda, Acacea auriculiformis, Artocarpus heterophyllus* etc. A number of other trees in this study area also provide nesting spots to the animals. Use of different parts of the tree by rhesus were noted seasonally and during the course of the day. The animals were observed to use the entire canopy of tree although different parts were used for different activities. The canopy of tree was differentiated into 3 areas such as central area (C), middle area (M) and peripheral area (P).

Central area of canopy included a spherical area within a radius of 1 metre taking the mid-point of the canopy as the centre. The middle area referred to an area within a radius of 2 metres from the mid point excluding the central area (Plate.9.7.). The remaining part of the canopy was considered to be the peripheral area (Plate.9.8.).

During morning session, the sightings of animals in C and M gradually increased from January to June. On the other hand sightings in the P region was maximum during January and declined to a minimum in June. In mid-day hours the animals tended to spend more time in M and C areas in all the months. Percent time spent by rhesus macaques at different areas of tree during the different day-hours (Table.9.4.) seem to be a function of food, security, avoidance of heat etc.

The intensity of sun light and increase in temperature following compels the animals to spent more and more time in the C area during the noon and afternoon session and in the M area during the morning session. It may be pointed out that

mid-day sightings at M and P region gradually declined from the months of January probably due to increasing of temperature and sunlight. As a whole C area seemed to be the slight preferred region by the rhesus averaging a sighting percent of 43% in comparison to M (38%) and P (19%) region. The rhesus population spend a considerable part of their time in C region of the canopy as because this region apparently provide the animals better security, denser cover and more favourable resting spots (Plate.9.5.). It is to be noted that P region were preferred by the rhesus over C region in the morning session probably as a means to warm-up by absorbing heat from sunlight. Lindburgh (1971) noted that during heavy rainfall monkeys huddled together in the central areas of trees. Vessey (1972) and Sussman (1981) reported that the monkeys changed their nesting sites from one tree canopy to another with seasonal variations in canopy pattern in different tree species.

Table.9.1. Hourly distribution of number of time samples recorded and number of rhesus observed.

Hours	No. of time samples recorded	Total number of rhesus observed	Average number of rhesus per time sample
06.30 – 07.30	98	902	9.2
07.30 – 08.30	80	811	10.1
08.30 – 09.30	58	702	12.1
11.00 – 12.00	80	714	8.9
12.00 – 13.00	72	628	8.7
14.00 – 15.00	68	642	9.4
15.00 – 16.00	66	677	10.3
16.00 – 17.00	82	892	10.9
17.00 – 18.00	90	1056	11.7

Table.9.2. Percent activities of rhesus during study period at different hours of the day.

Average Temperature	:	19^{0}C	21^{0}C	22^{0}C	27^{0}C	30^{0}C	32^{0}C	26^{0}C	24^{0}C	22^{0}C
Hours Activities	:	06.30 07.30	07.30 08.30	08.30 09.30	11.00 12.00	12.00 13.00	14.00 15.00	15.00 16.00	16.00 17.00	17.00 18.00
Feeding	:	26.0	24.0	26.0	36.0	28.0	23.0	25.0	29.0	36.0
Resting	:	19.0	20.0	15.0	26.0	26.0	36.0	22.0	13.0	07.0
Locomotion	:	20.0	23.0	32.0	18.0	18.0	17.0	20.0	24.0	04.0
Grooming	:	08.0	14.0	10.0	08.0	16.0	10.0	09.0	18.0	38.0
Playing	:	09.0	07.0	02.0	-	-	01.0	05.0	02.0	02.0
Aggression	:	04.0	10.0	16.0	08.0	08.0	06.0	06.0	02.0	04.0
Sexual Inspection	:	-	-	-	-	01.0	02.0	02.0	05.0	02.0
Reproduction	:	14.0	02.0	-	04.0	03.0	05.0	11.0	08.0	07.0

* Index : '-' = Nil.

Table.9.3. Percent time spent by rhesus macaques on the ground and on tree in different time of the day during January, 2001 to June, 2001.

Months	Morning Session (06.30 – 08.30 Hours)		Noon Session (11.00 – 13.00 Hours)		Afternoon Session (16.00 – 18.00 Hours)	
	OG	OT	OG	OT	OG	OT
January	68.2	31.8	23.4	76.6	18.1	81.9
February	54.2	45.8	20.3	79.7	17.7	82.3
March	46.7	53.3	17.0	83.0	18.0	82.0
April	40.5	59.5	10.8	89.2	15.5	84.5
May	30.2	69.8	06.2	93.8	12.3	87.7
June	40.3	59.7	13.7	86.3	15.4	84.6
Average	46.6	53.4	15.2	84.8	16.1	83.9

* OG – On Ground; OT – On Tree.

Table.9.4. Month-wise data of percent time spent by rhesus macaques at different areas of tree during the different day-hours in the study period (January, 2001 to June, 2001).

Average Temperature	$19^0C – 21^0C$			$27^0C – 30^0C$			$24^0C – 22^0C$		
	Morning (06.30-08.30 Hrs.)			Noon (11.00-13.00 Hrs.)			Afternoon (16.00-18.00 Hrs.)		
Months	Different areas of tree			Different areas of tree			Different areas of tree		
	C	M	P	C	M	P	C	M	P
January	08.2	30.7	61.1	26.1	48.2	25.7	61.3	08.9	29.8
February	08.0	32.1	59.9	30.4	49.1	20.5	52.2	14.2	33.6
March	14.1	37.2	48.7	38.7	42.3	19.0	49.6	17.3	33.1
April	13.4	46.5	41.1	46.2	37.3	16.5	41.0	24.2	34.8
May	17.8	49.2	33.0	51.3	30.4	18.3	38.2	27.6	34.2
June	20.3	58.3	21.4	62.4	23.7	13.9	32.5	27.9	39.6
Average	13.6	42.3	44.1	42.5	38.5	19.0	45.8	20.0	34.2

* C – Central area of tree; M – Middle area of tree and P – Peripheral area of tree.

Plate.9.1. A group feeding on ground in the morning hours.

Plate.9.2. A juvenile feeding a mango beneath a mango tree.

Plate.9.3. An adult female feeding in a shady area in the morning hours by the side of a *Citrus* tree near a household.

Plate.9.4. A consort pair in resting posture in the mid-day.

Plate.9.5. A consort pair on the branch of a mango tree. The male is resting while the female is grooming.

Plate.9.6. A group is resting in the shade during a hot-humid noon. An infant is seen in contact with its mother.

Plate.9.7. An adult male on the middle portion of a mango tree at noon.

Plate.9.8. The juvenile at the periphery of a mango tree in the morning session.

Plate.9.9. A small group is resting while an adult is seen drinking in the shady pondside area at noon.

Plate.9.10. Quadrupedal group movement on the ground in the morning.

Plate.9.11. A monkey is swimming in a pond in a hot-humid summer noon.

Plate.9.12. A juvenile jumping horizontally while other members of the group are on quadrupedal motion.

Plate.9.13. A consort pair resting in the shade during noon time . The male is grooming the female.

Plate.9.14. A consort pair on the boundary wall of a house in the morning. The female is grooming her mate.

Plate.9.15. A female grooming her mate on the tree in the

Plate.9.16. Two adults and a grown-up juvenile engaged in a fighting interaction in the noon time.

Plate.9.17. Fight between one adult male and the juvenile.

Plate.9.18. Biting attack to the subordinate male by the victorious male, the looser fell down on the ground.

Plate.9.19.Threating posture of an adult male during ground feeding in the noon session.

Plate.9.20. The adult male chasing over the another male.

Plate.9.21. Aggressive encounter between two adults in the late morning session.

Plate.9.22. The infant is in the safe custody of his mother while the dominant adult male move away in search of food in morning hours.

Plate.9.23. An injured infants being nursed by his mother while an adult male looks on.

Plate.9.24. An infant with his mother during feeding in late morning.

Plate.9.25. Sexual inspection in the afternoon session.

Plate.9.26. The female partner inspects the mate in the afternoon session.

Plate.9.27. Play copulation between a juvenile and an infant in the morning hours.

Plate.9.28. An adult male clasping his female partner before copulation in the morning session (I).

Plate.9.29. The partners taking position for copulation (II).

Plate.9.30. Finally the process of intromission is achieved (III).

10. SOCIAL ORGANIZATION

10.1. Introduction

Animals are not only the producers but also the products of social structure. The structure of social relationships constrains individual behaviour in many occasions (De Waal, 1991). Group living is important for the survival of certain species, according to Clutton, Brook and Harvey (1977) for at least three reasons : (i) defense and avoidance of predators, (ii) finding and handling food and (iii) reproduction. Animals in groups are much less subject to predation than are animals in isolation. The individuals warn one another of approaching danger so that it is very difficult for a predator to get close to a group. When a good food source is located by one member, all are attracted to it by the signals and behaviour of the finder. Group life also facilitates reproduction in many ways by bringing the sexes together at the appropriate time. However, sub-grouping or fissioning of groups often occur for more harmonious functioning of groups particularly when group size increases to some unmanageable figure.

John and Lindberg (1996) reported that group size in rhesus macaques ranges from small to as large as 236 members but the average is 9-58 individuals. Group contains several adult males, 2-3 times as many adult females and an equal number of offspring in most cases. Adolescent males leave the group to form new groups while females stay with the original group throughout their lives. Male dominance is directly related to reproductive success. Males are aggressive towards other male and females. The females benefit from having relations with a high ranking male. Females also receive protection along matrilineal lines.

This present chapter deals with the group size, composition of group and nature of its stability.

10.2. Methods

Emphasis was given on individual identification of at least some group members to evaluate the cohesiveness of the group as well as to helped in group identification. Only those groups were taken into account whose age-sex composition could be established clearly and information about social

organization of animals was gathered by recording age-sex and number of individuals in each category constituting of the groups.

10.3. Results and Discussions

10.3.1. Group Types

There were four types of associative patterns found in rhesus colony in the study area and these are :

I. **Male dominated group :** It is established by the presence of a dominant male with adult females, juveniles and infants (Plate.10.1., Plate.10.2.).

II. **Female dominated group :** A dominant female with subordinate males, juveniles and infants were found in this category (Plate.10.3., Plate.10.7.).

III. **Pair Group :** It is characterized by the presence of one adult male and one adult female (Plate.10.6.).

IV. **Solitary :** Mostly aged male, alone individual who usually follows or associates to a particular group either of the first (i.e. male dominated group) or second (i.e. female dominated group) category. It is to be noted that the loner was a regular member of the group which he follows or associates (Plate.10.4., Plate.10.5.).

During the study period i.e. February, 1999 to January, 2002 a total 407 groups were recorded of which 278 (68.1%) were male dominated, 81 (19.8%) were female dominated, 41 (10.0%) pair groups and solitary group were only 8 (2.1%). The total number of animals in different group categories were 3091, 883, 82 and 8 respectively, totalling to 4024 individuals. Out of 4024 animals sighted 466 (11.6%) were seen in May and 537 (13.3%) in June suggesting that May-June to be the peak activity period of rhesus at Malda district. Percent sightings were moderate in March, April and July i.e. 334 (8.3%), 416 (10.3%) and 412 (10.2%) respectively. Male dominated groups were observed in all the months throughout the study period whereas female dominated groups were found in all the months except peak monsoon months i.e. July and August. Thus it indicates that rhesus

groups are mainly male dominated groups. Mandal (1964), Mukherjee and Gupta (1965), Ojha (1974), Kali (2001) stated that in rhesus populations all the groups are multimale.

As social units the males were observed to take initiative in forming groups. The initiatives often involve 1 or 2 rival adult males leaving the groups along with 1 to 2 adult females (Plate.10.13.) with their infants and juveniles. This type of de desertion to begin with is often temporary so that they often come back to the original group. But may ultimately lead to a permanent dissociation from the original group. Southwick et al. (1965) reported that grouping was mainly based on adult male activities. Lindburgh (1971) stated that rhesus groups are not closed social units. On the other hand Boelkins and Wilson (1972) reported that young males took much more initiative in forming groups, particularly at the age of 3 to 4 years old. The dyads were found during the months from January to June and solitary males were mostly seen during March to June. Mukherjee and Gupta (1965) and Ojha (1974) observed solitary males occasionally.

Nishida (1965) and Sugiyama (1976) reported that the Japanese macaques leave their natal groups at 3 to 5 years of age and join other groups or become solitaries. Male pig-tailed macaques leave their natal group at around 5 years of age and live as temporary grouped individuals, not yet as complete solitaries (Toru Ot, 1990). The males usually became complete solitaries at an older age. The occurrence of female dominated groups is rather common. The females are stable members of rhesus (Wall and Luttrell, 1986) and pig-tailed monkey groups (Toru Ot, 1990). Neville (1968) observed that in absence of adult males two adult females dominate the group.

Jay, 1965 observed a rhesus dyad to coexist peacefully with a group of langurs. This type of incipient association led to eventual formation of a stable and cohesive bond between the two opposite sexes.

10.3.2. Group Size

Group size of rhesus macaques in this study ranged from 6 to 43 with an average of 9.89 ± 0.92 (n = 407). A census of 125 groups in 1999-2000 revealed that the average group size in different category with the following composition :

6.1 ± 0.42, small group (Plate.10.9., Plae.10.10., Plate.10.11.); 11.0 ± 0.62, medium group (Plate.10.8., Plate.10.12.) and 20.6 ± 0.83, large group (Table.10.1). Report on group size of rhesus by different workers varied to some extent such as : Southwick (1960, 62); Southwick, Beg and Siddiqi (1961); Southwick, Ghosh and Lovch (1964); Southwick and Siddiqi (1966, 1968 and 1970) reported that average group size varies from 11.3 ± 1.4 to 49.8 ± 5.8 and number of adult males, from 2.6 ± 0.4 to 7.9 ± 0.9. Group size is small in road sides (11.3 ± 1.3) and larger in forests (49.8 ± 5.8). The present study site is not under the any forest areas. Crop field, Grassland, Mango orchard, Roadside, Human household habitat enriched the study site in a world where human interference is frequent. So the data of present study (group size, 9.89 ± 0.92) is very much alike to the data of roadsides (group size, 11.3 ± 1.3) by the eminent behaviourologists.

Large groups were seen in the study area during the month of May and June every year. This groups were seen in full form only during peak feeding hours (i.e. 11.00 hour to 12.00 hour). The largest such group observed was of 43 individuals containing 8 males, 16 females, 10 juveniles and 9 infants. The smallest group observed was of 6 individuals with one male, two females, two juveniles and one infant. Groups of various sizes i.e. 17 to 100 individuals were observed by Prakash (1958, 1962), Neville (1968) and Mukherjee (1969). Puget (1971) observed very large sized groups in Rajasthan comprising of 90-180 individuals which is larger than Baboon groups in Africa. In *Macaca assamensis* group size ranged from 10 to 50, as reported by Carpenter (1942), Southwick and co-workers (1964) and Fodden (1971). In *Macaca sinica*, the group size ranged from 8 to 43 individuals (Dittus, 1974), whereas in *Macaca silenus* it ranged from 6 to 34 individuals (Green and Minkowski, 1977). In case of *Macaca nemestrina*, group size varied from 8-81 individuals (Toru Ot, 1990), whereas in case of langurs it ranged from 5 to 120 (Jay, 1965) with an average of 12.8 to 37 for small and large size groups respectively (Oppenheimer, 1977).

Groups of various sizes indicate that there is little stability in group size and structure in other words social organization of rhesus group is characterised by sub-grouping based mainly on adult males. A sub group is a social association with in a group that is more stable than temporary aggregation. Temporary association occurs primarily but not exclusively between members of a group.

Large groups were possibly temporary associations of smaller groups induced by scarcity of food, water, shelter and predator pressure.

10.3.3. Group composition

Table.10.2. shows that the group size and composition are rather stable in different years over the study period. The average percent composition of different age-sex classes during 1999-2000 to 2001-2002, are adult male 15.2%, adult female 33.0%, juvenile 26% and infant 25.8%. As in some other macaques e.g. *Macaca fascicularis* (Southwick and Cadigan, 1972), *Macaca radiata* (Sugiyama, 1971) and *Macaca nemestrina* (Toru Ot, 1990) the size and composition of rhesus group is to some extent fluid in nature with members joining and parting freely at different times. Often, young adult males take part actively in social relationships, i.e. forming of sub-group. During the study period few cases of segregation and fission of groups were observed.

10.3.4. Sub Grouping Activity

Rhesus monkeys tended to spend most of the time in a multimale bisexual group (Southwick et al., 1965). Three observations recorded on reorganization of groups leading to new group formation including segregation and fission in this study are presented below :

Event – I : On November 13, 1999 one group in the Bachamari area of Old Malda block consisting of 5 males, 9 females, 7 juveniles and 6 infants segregated into two separate sub-groups (Table.10.3.). The original group was observed to maintain its integrity as a single unit from October 10, 1999 to November 7, 1999. The smaller unit maintained themselves as cohesive separate units throughout December, 1999 to January 12, 2000.

Event – II : On November 11, 2000 at Manikpur of English Bajar block, a large group consisting of 8 males, 16 females, 10 juveniles and 9 infants dissociated into two groups (Table.10.5.). The second group segregated further into two groups on December 16, 2000; so that three groups were formed out of the original group.

Event – III : Sixteen groups were observed at Manikpur of English Bajar block at the beginning of breeding season. Most of the groups maintained their integrity starting from non-breeding season upto the initial period of breeding season. As the breeding season advanced and mating activities including copulations started, on November 18, 2001 two of 16 Manikpur groups were found in a state of disorder as evidence by increased level of overt aggressions including lot of chasing, jumping, vocalization and chaos. Soon a new group namely NG, came to existence, appeared consisting of members originally belonging to two groups i.e. G1 and G2 (Table.10.4.). The newly formed group moved separately in the same general area in Manikpur but had separate resting spots. The groups thus formed travelled separately maintaining considerable distance from one another and had new group composition. At the time of group fission one adult female of G1 was seen to copulate with two adult males of G2 and the trio often moved separately (Plate.10.15.) from both the groups. Then several members of G2 joined the consort trio and moved with them. Thus a new group NG was formed which became stable as a group by the end of January, 2002. Table.10.4. indicates that the G1 lost only one adult female and a juvenile which joined the NG later on. The juvenile may or may not be related to the G1 adult female. At the same time G2 lost four adult females with three infants and two juveniles. The sub-group NG was thus formed by dissociation of adult and sub-adult members from both G1 and G2. It is likely that the two juveniles were the offsprings of the two G2 adult females.

Dissociations and ultimate formation of new groups are mostly done by male members among most macaques species. The females usually follow the dissociated males, their juveniles and infants subsequently join the consort pair. Seyfarth (1980) reported that females are the most stable members of the groups in rhesus macaques. Again Wall and Luttrell (1986) stated that females formed relatively strong social bond within a group. Formation of new group by fission from existing ones was also observed in Japanese macaque (Toru Ot, 1988), in pig-tailed macaque (Caldecott, 1986) in *Macaca silenus* (Sugiyama, 1967). Southwick. Beg and Siddiqi (1965) stated that sub-grouping in rhesus monkey was a prominent feature of their social organization. In the present study, the pattern of formation of sub groups varied among the groups. So it can be concluded that sub grouping among rhesus monkeys occurred due to certain socio-

demographic factors and these sub groups in course of time may be reorganized as distinct groups.

10.3.5. Interaction with other species

The rhesus monkey have altruistic interactions with several other mammalian and non-mammalian species, such as hanuman langurs, spotted deer (*Axis axis*) and several avian species. They are, however, susceptible to predation by pythons, tigers and leopards in the wild and may be harassed and occasionally killed by dogs. However, because of destruction of natural forest, by human beings they are forced to come and live in close contact with human habitation. This situation is tolerated by certain religious communities like the Hindus, Buddhists, however, traditional beliefs are under strain and may break down under continued pressure due to increasing human density and economic loss caused by rhesus monkeys. Some tribals are known to kill and consume monkey meat. In the present study area monkeys are often harassed by dogs but they live peacefully with cows and goats (Plate.10.14.) in the same habitat. However, it may be pointed out that conflicts between man and rhesus takes place regularly due to severe damage of various crops by the monkeys.

Table.10.1. Age-sex composition in groups of different sizes over the study period (February, 1999 to January, 2000).

	Small Group	Medium Group	Large Group
No. of Groups	69	43	13
Adult Male	1.1 (± 0.11)	1.9 (± 0.13)	3.9 (± 0.23)
Adult Female	2.0 (± 0.17)	3.6 (± 0.19)	6.7 (± 0.39)
Juvenile	1.5 (± 0.12)	2.7 (± 0.17)	4.8 (± 0.34)
Infant	1.5 (± 0.14)	2.8 (± 0.16)	5.2 (± 0.41)
Total	6.1 (± 0.42)	11.0 (± 0.62)	20.6 (± 0.83)

* Small Group = Upto 10 individuals.

* Medium Group = 11 to 20 individuals.

* Large Group = Over 20 individuals

* Standard errors are in the parenthesis.

Table.10.2. Average group structure of rhesus monkeys for the period, February, 1999 to January, 2002.

Year	Number of Groups observed	Male	Female	Juvenile	Infant	Total
1999-00	125	1.4 (15.1)	3.0 (33.3)	2.4 (25.8)	2.4 (25.8)	9.3 (100)
2000-01	135	1.6 (15.4)	3.4 (32.7)	2.8 (26.9)	2.6 (25.0)	10.4 (100)
2001-02	147	1.5 (15.0)	3.3 (33.0)	2.6 (26.0)	2.6 (26.0)	10.0 (100)

* Figures in the parenthesis indicate percentage.

Table.10.3. Segregation of a group consisting of 5 males, 9 females, 7 juveniles and 6 infants into 2 separate groups.

Sub Group No.	Male	Female	Juvenile	Infant	Total
SBG1	02	04	04	02	12
SBG2	03	05	03	04	15

*** SBG1 = Sub group 1; SBG2 = Sub group 2**

Table.10.4. Sizes and age-sex composition of two groups (G1, G2) during fission period.

	Before Fission Name of Group		After Fission Name of Group		
	G1	G2	G1	G2	NG
Male	03	06	03	04	02
Female	06	13	05	09	05
Juvenile	04	06	03	04	03
Infant	04	07	04	04	03
Total	17	32	15	21	13

* G1 = Group1
* G2 = Group2
* NG = Newly formed group

Table.10.5. Segregation of a large group consisting of 8 males, 16 females, 10 juveniles and 9 infants.

Date of Observation	Group No.	Male	Female	Juvenile	Infant	Total
10.11.00	MG	08	16	10	09	43
11.11.00	SBG1	03	06	04	03	16
	SBG2	05	10	06	06	27
16.12.00	SBG1	03	06	04	03	16
	SBG2 (I)	02	05	02	03	12
	SBG2 (II)	03	05	04	03	15

* MG = Main group
* SBG1 = Sub group 1
* SBG2 = Sub group 2

Plate.10.1. A male dominated small group resting beneath the mango tree at noon.

Plate.10.2. A male dominated medium-size group of 11 individuals feeding on the ground at late morning hours.

Plate.10.3. A female dominated group of 8 members feeding on ground in early morning.

Plate.10.4.A solitary male beneath the mango tree in the noon session.

Plate.10.5. A solitary male in resting posture on the branch of a mango tree at noon.

Plate.10.6. A pair group in the early morning hours in a grassland habitat.

Plate.10.7. A female dominated medium size group on ground feeding in the late morning session.

Plate.10.8. A medium size group of 12, 11 members are on the ground and one on tree at noon.

Plate.10.9. A small group searching food materials by the side of a pond in the morning session.

Plate.10.10. A nine member group near a pond at noon.

Plate.10.11. A female dominated 8 member small group resting beneath the mango tree.

Plate.10.12. A 13 members medium-size group during movement on a roadside habitat.

Plate.10.13. A 7 membered small group resting beneath the tree in the noon time.

Plate.10.14. Association among cows, goats and monkeys at roadside habitat.

Plate.10.15. Three individuals formed a new group (NG), the female came from G1 while the copulating adult male and the other male were from G2.

11. MANGO PRODUCTION AND EMPLOYMENT OF PEOPLE IN THIS TRADE

11.1. Introduction

Mango is one of the most popular crops in the tropics, adapted to a wide range of soil and relatively easy to cultivate. It is universally considered as one of finest fruit in the world, and is called the "King of Fruits" in the orient and the "national fruit of India". If there was a competition to decide the best fruit in the world for taste and aroma, the Indian mango would certainly be one of the front-runners. In a year, India harvests more than 12 million tones of mangoes. Mango is not only delicious but also full of nutritional value. It is high in beta-carotene, a precursor of vitamin A and is a rich source of vitamin B complex. Physico-chemical characteristics of mango was studied by Ghosh, Dhua and Mitra (1985); Kundu and Ghosh (1992). Mangoes are mainly consumed fresh. One hundred grams of raw mango (edible portion) contains 81.7 gm water, 0.7 gm protein, 0.4 gm fat, 16 gm carbohydrates, and food energy of 66 calories. Mangoes are also relatively rich in other elements such as calcium, phosphorous, iron, potassium and magnesium. Mango is not just India's most important fruit, India is also the World's largest producer of this famous fruit accounting for approximately 52% of the total World production. The World production of mango is estimated to be around 23,851,997 MT and India produces 12,000,000 MT. Mango, *Mangifera indica* is endemic to South-East Asia. It is not exactly known when mango cultivation started in West Bengal but evidences indicates that the Landlords and Nawabs established mango orchards, introducing quality varieties from different places. Thus at present more than 200 varieties are found in the state. In Malda mango orchards occupy about 245.6 sq. km. which is 6.58% of the total land area (3733 sq. km.) of the district. Production varies from about 0.7 million MT in the off season to around 3.0 million MT in the on season. Mango is the chief cash crop of the district. Over 33% people are directly associated economically to this crop. The present chapter deals with the study of nature of mango production, variety of the fruits, involvement of people in this trade, medicinal use of this

fruit-plant, nature of mango orchard, problems and remedial measures for its production including management of insect and monkey pests.

11.2. Methods

Data on specific parameters recorded by various organizations in Food Processing Industries and Horticulture, Malda Mango Merchant Association, Meteorological Department, Govt. of India, Soil Department, Govt. of West Bengal have been considered. Records on block wise area under mango cultivation, yearly production etc. were collected from mango-planters guild, data on areas infested by monkeys were collected by systematic survey, from the mango-planters guild and responsible reports from the local people. Orchards, mango-processing industries, research centre, multi-purpose cold storages were visited regularly for gathering up to date information various aspects. Wooden packing box, bamboo basket manufacturing centers of district were visited in the mango season, rural medicine men and patients were interviewed from time to time, national and state level mango festival in the district were visited for acquiring various types of data.

11.3. Results and Analysis

11.3.1. Climate and Soil factors in Mango Cultivation

Mango is well adapted to tropical and subtropical climates. It thrives well in almost all the regions of the country from sea level to an altitude of 1500 metres. However, it cannot be grown commercially in areas above 600 metres. Temperature, rainfall, wind velocity and altitude are the main climatic factors which influence its growth and fruiting. It cannot stand severe frost, especially when the tree is young. High temperature by itself is not so injurious to mango, but in combination with low humidity and high wind velocity the trees affected adversely.

In India most of the mango varieties thrive in places with good rain fall (75 to 375 cm per annum) and dry season. Distribution of rainfall is more important than its amount. Dry weather before blossoming is conducive to profuse flowering. Rain during flowering is detrimental to the crop as it interferes with pollination. However, rain during fruit development is good but heavy rains cause damage to ripening fruits. Strong winds and cyclones during the fruiting season can play havoc as they cause execessive fruit drop.

Mango grows well on wide variety of soils, such as lateritic, alluvial, sandy loam and sandy. Although it grows very well in high to medium fertility soils, its cultivation can be made successful even on low fertility soils by appropriate management especially during early stages of growth. Very poor and stony soils on hill slopes should, however, be avoided. The loamy, alluvial, well drained, aerated and deep soils rich in organic matter with a pH range of 5.5 to 7.5 are most favourable for mango cultivation. Extremely sandy, shallow, rocky, waterlogged, heavy textured and alkaline or calcareous soils are not suitable for mango cultivation.

Most of the favourable parameters are available in the district for the cultivation of mango. Average rainfall is about 140.0 cm, the mean maximum and minimum temperature is 36^0C and 16^0C and relative humidity varies from maximum 85% to minimum 57%. Sometimes strong winds along with heavy rainfall locally known as "Kalbaisakhi" occur in the mango season.

Agro-climatically Malda district falls under lower gangetic plain region (Zone-III) and sub-zone old alluvium and new alluvium. Organic matter is medium (ranging from 0.5 to 0.75),soil is acedic in nature with pH varying from 5 to 7. Thus climate as well as nature of soil promote mango cultivation in this district significally.

11.3.2. Cultivated land and nature of production

The mango cultivation land in Malda district is 37.55% and amount of production is 43.39% in the context of West Bengal and 1.61% cultivation land and amount of production is 2.48% of India. Almost every year the area of cultivation land increases (Plate.11.1). Table.11.1. shows areas under mango production and percent increase in area over the previous year in the district for a period of 10 years from 1993 to 2003, with an overall increase of about 2700 hectares. Percent year to year increase in area of cultivation varied from 0.04% to 4.69% but the rate was higher than 1% only in 3 years i.e. 1998-99, 1999-2000 and 2002-2003. Table.11.2 and Figure.3.7. shows block-wise total and percent area under mango cultivation in the year 2002-2003. Of the 15 blocks in the district mango cultivation is highest in English Bajar followed by Manikchak, Ratua-I and Ratua-II. Mangoes, however, are cultivated in all the blocks. Recently growers are interested to grow mango in the crop field as well. It is to be noted that paddy cultivation field is first choice of the farmers (Plate.11.2.).

11.3.3. Variety of Mangoes

As many as 41 species of mango are known to exist all over the world. Of these *Mangifera indica* which is endemic to India have about 1110 varieties and over 1000 to those varieties occur in India. Of the numerous varieties (Plate.11.3.) cultivated in India, twenty varieties are now accepted as commercially well established (Source : NHB Statistics, 1998). West Bengal is unique in having more than 200 varieties (Mukherjee, 1984; Maiti, Sen and Bose, 1979). In Malda district the varieties like Fazli, Langra, Himsagar, Laxmanbhog, Gopalbhog, Bambai, Kisenbhog, Zardalu, Ashwina etc. are commercially cultivated in Malda. Recently, Amrapali and Mallika varieties are cultivated in the district in massive way for their sweet flavour, aroma and taste. The Fazli variety is popular in the district and more than 38% mango cultivation land is occupied by the variety (Table.11.3.) followed by Ashwina (13.2%), Laxmanbhog (12.1%), Langra (11.8%).

11.3.4. Nature and number of mango orchard

Basing on size there are four types of mango orchard in the study site such as small (Plae.11.4.), moderate (Plate.11.5.), large and very large. The small orchard are within 2.0 hectares, moderate from 2.0 to 4.0 hectares, large from 4.0 to 6.0 hectares and very large covered above 6.0 hectares of land (Table.11.4).

It is to be noted that 14280.6 hectares of mango cultivation land is under the small orchard category followed by moderate (6560.6 hectares), very large (2175.3 hectares) and large (1543.6 hectares). Number of orchard in the small category is 1,12,350 which is 94.6% of the total orchard of the district followed by 5070 i.e. 4.3% in the moderate type. Only 840 orchards (0.7%) are in the very large and 450 (0.4%) in the large orchard category.

11.3.5. Involvement of people in mango trade

11.3.5.1. Selling and buying process of orchards

The process of selling and buying of mango orchards starts at the early mango season i.e. in the month of January-February when the new leaves appear on every branch of trees and the process continues up to the ripening of the fruits. About 1,82,000 people are involved in this process in the mango season in all the years which is 16.64% of the total people engaged in this trade (Table.11.6.).

11.3.5.2. Security men in the orchards

As mango is the most important cash crop of the district protection of the precious fruit is essential and many people are employed in the mango season to take care of the intruders i.e. thieves, monkeys and other pests. About 291000 people are engaged in this job in the mango season. As the number of small orchards is highest requirement for security men (Plate.11.7.) is also largest (254580) i.e. more than 87% (Table.11.5.). It is to be noted that the population of monkey is higher in blocks with massive mango cultivation. So, it is common to find security men at work at armed with fire crackers, bamboo-stumps, bows and

arrows etc. in chasing away invading monkeys in the orchards during the mango season. Table.11.6. shows that over 26% people are engaged in this job during the mango season. Generally a number of temporary tents (Plate.11.7.) are erected within the orchards for the security men. In case of large or very large orchard the number of such tents may be even five in each (Plate.11.8.). In general four security men share a tent, two of them work in the day i.e. from 06.00 to 18.00 hours and the remaining two work from 18.00 to 06.00 hours. Usually female villagers (Plate.11.9.) serve as security men during the day session.

11.3.5.3. Plucking of Fruits

More than 17% people associated in this trade are engaged in this job (Table.11.6.). The process of plucking starts after the ripening of fruits (Plate.11.10.). During plucking the pluckers use a long bamboo pole fitted with a basket made of nylon nets on its tip and collects the fruits from the tall branches of tree within the net basket (Plate.11.11.). Finally plucked fruits are gathered beneath a tree (Plate.11.12.) in the orchard.

11.3.5.4. Packing and Transport

In this sector over 9% people are involved. Plucked fruits are packed in bamboo baskets (Plate.11.13.) or wooden packing boxes (Plate.11.14.). Packed fruits are then sent to the mango storage centre in bullock-carts or cycle vans (Plate.11.15.).

11.3.5.5. Mango storage centres

The number of mango storage centers (Plate.11.6.) in the district is nearly 1255. More than 8000 peoples are involved in these centres. All these are temporary centres. Collected packed fruits were sent to their final destination by diesel trucks (Plate.11.16.) in all parts of the state as well as other states in the country from these storage centres. Fruits were also sent by bullock-carts or cycle vans to nearly local towns and markets. Passam (1982), Hasabins and D'souza

(1987), Fornaris and Guadalupe (1989), Balasubramanium (1991), Chadha (1993) reported the utility of cold-storage and air conditioned packing houses.

In absence of such facilities in the district the farmers are compelled to incur the losses as the fruit is perishable in nature and cannot kept in good condition for a long time in ambient condition. The loss is substantial during excessive production periods specially in the on-years. Recently Food Processing Industries, Govt. of West Bengal took some steps towards proper storage of fruits in cold preservation system so that the financial loss of the farmers and businessmen can be abated.

11.3.5.6. Basket making

Manufacture of bamboo baskets and wooden packing boxes is a regular phenomenon in the district. Thirteen leading shaw-mills at English Bajar, Ratua-I, Old Malda, Kaliachak-I and Kaliachak-II blocks supply a major portion of wooden packing boxes. Besides this baskets of bamboo also play a major role for packing of fruits in this district. Making of bamboo baskets is an important cottage industry in many villages in the district in the mango season. Villagers from children to adult (Plate.11.17.) all are involved in this work. Sometimes villagers engage themselves in this job even in the mango orchards (Plate.11.18.). Basket makers constitute 1.55% while the wooden packing box makers make 0.1% of the total people in the trade.

11.3.5.7. Mango product industries

There are 13 registered small food processing industries in the district which process mainly mango. Among them Gita Fruit Products (Plate.11.20.) Malcos (Plate.11.19.), Shiva Mango Processing are important for varieties and qualities their products such as jam, jelly, pickles (Plate.11.22.) soft drinks etc. Both males and females (Plate.11.23) work in these factories. Besides there are about 80-90 unregistered cottage industries in the English Bajar, Old Malda and Ratua-I blocks which employ workers during mango season. Large mango product industries

employ more than 1000 people for mango processing jobs while the small cottage industries involved nearly 400 people. Government of West Bengal have taken active initiative for promoting the cottage industries through fruit processing and in this context Department of Agricultural Marketing trained (Plate.11.21.) over 8000 people who benefited much through this training over the last 10 years.

11.3.5.8. Research Activities and grafting

Horticulture research development farm Government of West Bengal has several research projects (Plate.11.27.) for promoting cultivation of mango in the district. Propagation of mango cultivation (Chakrabarti and Sadhu, 1983, 1984) is gaining momentum through grafting instead of normal seed germination. Grafting also ensures quality of fruits (Bhan, Samaddar and Jadav, 1969; Majumdar and Rathore, 1970; Tiwari and Rajput, 1972; Hoque and Hussain, 1974; Maiti and Biswas, 1980; Singh and Srivastava, 1981) generation after generations. There are 6 moderate size horticultural nurseries and nearly 70 small nurseries in the district (Plate.11.25.). Over 15,000 mango grafts (Plate.11.26.) are raised annually from this nurseries. Research and Development farms also produce mango grafts. More than 200 people are involved in research and grafting activities.

11.3.6. Events promoting mango cultivation and production

The gross annual turn over in mango trade is more than 70 crores per annum. Thus, the socio-economic condition of the district is largely dependent on this crop. For this reason a number of promotional activities are organized in the district with the help of Government (Plate.11.28.) such as national level show in 1995 and 2003 (Plate.11.30.) while the state level festivals in the year 2000, 2002 (Plate.11.29.) and 2005. A large number of mango varieties and different kind of mango products are exhibited and awarded in this shows and festivals. The Postal Department, Government of India started a special programme to facilitate parcel of mangoes to any destination in the state (Plate.11.24.). Recently Government of West Bengal undertook programmes for export of mangoes to foreign countries.

11.3.7. Mango as medicine

In India mangoes are in use for several kinds of ailments for a long time. It strengthens and invigorates nerve tissues, muscles, heart and other parts of the body. It cleans the body of the filth within and is an ideal antidote for all toxic effects inside the body (Hashmi, Herbs and Spices – Curative properties of mangoes; E-mail hashmi.com). Almost all the parts of mango tree : root, stem, bark, the blossoms, raw and ripe mango, seeds have curative and medicinal properties.

Recently various active components have been isolated such as retinyl palmitate, saponins, mango agglutinin, mangiferin etc. (Patel et al. 1988, Carlier et al. 1992, Khan et al. 1993, Zhu et al. 1993 and Wauters et al. 1995) from mango plant (*Mangifera indica*).

Many tribes as well as poor villagers of different parts of the world uses different plant parts (Bhargava, 1983; Mitra and Jain, 1991; Pal and Seal, 2002 and Schultes, 1992) for various health problems. In Malda district the socio-economic condition is weak due to lack of major industry and low educational level. Health services available to the people is far from adequate but even the meager health services available in the rural areas is not utilized properly by the people because of their uncertain financial and mental attitude. Most of them, however, readily visit the village medicine-man for their health problems. The rural medicine-men use locally available medicinal and other plants depending on the traditional knowledge on their application. The treatment of number of diseases such as dysentery, blood dysentery, diabetes insipidus, diabetes mellitus, gastric ulcer, burn injury, cold and fever, carbuncle, hair fall, dandruff etc. are treated by the medicine men. It is to be noted that in all medicine preparations contain certain mango tree parts i.e. raw mango, leaves, stems, inflorescence, barks, seeds etc. Sometimes in combination with other herbals.

11.3.8. Problems and remedies associated with mango cultivation and trade

11.3.8.1. Major problems faced by mango growers

The problems faced by the mango growers are :

1. Irregular bearing habits of mango.
2. Most of the big orchards of mango in the district are above 60 years or older.
3. The production of those orchards are very low.
4. Most of the owners sell their gardens on lease/contract basis before or during appearance of fruits.
5. Non-availability of good quality, high-yielding grafts/materials.
6. Absence of proper developmental management of orchards due to practice of lease system.
7. Indiscriminate use of pesticides.
8. Mango cultivation in low-lying areas.
9. Location of brick-fields near the orchards.
10. Lack of infra-structural facilities.
11. Lack of varieties suitable for processing and export purposes.

11.3.8.2. Remedial Measures

1. Plantation of high-yielding, improved varieties on a regular basis.
2. Grafts should be raised from selected high-yielding mother plants through clone selection.
3. Poor yielder (below 40 years of age) should be changed by top working.
4. Regular application of nutrients as per recommended dose.
5. Regular surveillance for control of pests and diseases.

6. Plantation of high-yielding improved varieties in suitable areas.
7. Large-scale distribution of planting materials of improved varieties.
8. Replacement of old and unproductive trees by high yielding improved varieties.
9. Development of infrastructure facilities including construction of cold storage, pack-house, processing centre etc.
10. Modernization of markets and marketing system.
11. Improvement of drainage system.
12. Setting up of research stations for development of mango varieties and cultural techniques.
13. Regular awareness programmes to motivate mango growers.
14. Establishment of surveillance units to encourage the growers for using pesticides in need-base manner.

11.3.8.3. Problems of insects and monkeys

Management of insects and other pests (Prasad and Fortune, 1989; Cunningham, 1991; Pena, Mohyuddin and Wysoki, 1996, 1998) is very important for mango cultivation. Mango hopper (*Idiocerus atminsoni*), Mealy bug (*Drosicha mangiferae*), Fruit fly (*Daccus dorsalis*), Shoot borer (*Chlumetia transversa*) and Bacteria (*Xanthomonas campestris*) are the most common pests that are responsible for remarkable damage to this crop. Proper management and use of pesticides in a scientific manner may help in preventing damages to this cash crop. Besides these mango-raiding by the monkeys, a common phenomenon in blocks with massive production of this crop is to be tackled seriously. Monkey (*Macaca mulatta*) prefer mango leaves, twigs and fruits and invade mango orchards in the mango season. Security men armed with crackers, bow-arrows, bamboo stumps need to be employed for protection of the orchards in the mango season. The present study indicates that the quantum of damage is not insignificant as they start damaging the crop from the inflorescence stage and continue up to the

ripening of the fruits. It is to be noted that population of monkeys is increasing gradually every year in the blocks with extensive mango cultivation areas. This is also a great problem for the mango growers of the district.

Table.11.1. Year-wise (1993-94 to 2002-03) area under mango cultivation in Malda.

Year	Area (in hectares)	% increase from previous year
1993-94	21910	0.04
1994-95	22000	0.41
1995-96	22200	0.90
1996-97	22400	0.90
1997-98	22420	0.09
1998-99	23000	2.59
1999-2000	24080	4.69
2000-01	24120	0.16
2001-02	24259	0.57
2002-03	24560	1.24

Table.11.2. Block-wise area under mango cultivation in Malda district for the year 2002-03

Name of the Block	Area (in hectare)	Percent area under cultivation
Bamongola	20	0.08
Habibpur	60	0.24
Chanchal-II	200	0.81
Kaliachak-III	220	0.89
Harishchandrapur-I	400	1.63
Gajole	430	1.75
Harishchandrapur-II	620	2.52
Chanchal-I	900	3.66
Kaliachak-II	1780	7.25
Old Malda	2000	8.14
Kaliachak-I	2000	8.14
Ratua-I	2150	8.75
Ratua-II	2160	8.79
Manikchak	3000	12.21
English Bajar	8620	35.09

Table.11.3. Variety-wise mango cultivation area in Malda district.

Name of the variety	Cultivation area (in hectares)	Percent area of the total cultivation land
Laxmanbhog	2982	12.1
Himsagar	1615	6.6
Langra	2907	11.8
Amrapali	1243	5.1
Fazli	9443	38.4
Ashwina	3230	13.2
Others (including Gopalbhog)	3140	12.8

Table.11.4. Classification of mango orchard according to size in Malda district.

Type of orchard	Size (in hectares)	Total area (in hectares)	% of total garden	Number of total orchards
Small	upto 2.0	14280.6	94.6	112350
Moderate	2.0 to 4.0	6560.5	4.3	5070
Large	4.0 to 6.0	1543.6	0.4	450
Very large	Above 6.0	2175.3	0.7	840

Table.11.5. Orchard-wise involvement of people in different sectors of mango trade in the district.

Category of Orchard	No. of Orchard	Grower	Security Men	Pluckers	Packing and Transport	No. of Storage Centre	Peoples in Storage Centre
Small	112350	71670	254580	182970	98760	840	5040
Moderate	5070	5480	14890	10130	3140	260	1610
Large	450	490	1270	1140	470	70	480
Very large	840	760	10260	1550	860	85	970
Total	118710	78400	291000	195790	103230	1255	8100

Table.11.6. Number of people and percent engaged in different sectors of mango trade in Malda district.

Category of involvement	No. of people engaged	% total in respect of total people in this trade
Grower	78400	07.15
Garden Sellers and buyers	182290	16.64
Security men in the orchard	291000	26.55
Pluckers	195790	17.86
Packing and transport	103230	09.44
Peoples in mango storage centre	8100	00.75
Mango product industries	1080	00.09
No. of trainee in food processing (last 10 years)	8400	00.76
Basket makers	16970	01.55
Wooden packing box makers	1140	00.10
Mango sellers in market	208570	19.03
Dried mango extract makers	380	00.03
Research activities & grafting	240	00.02
Different organization and folk medicine	230	00.02
Total	1095820	100.00

Plate.11.1. New plantations at Manikchak block.

Plate.11.2. Cultivation of mango in a paddy crop field at English Bajar block. This practice is becoming popular recently.

Plate.11.3. Varieties of mangoes in a Mango Show, at English Bajar blcok, 2002.

Plate.11.4. Small orchard at Old Malda block.

Plate.11.5. Moderate sized orchard at English Bajar block.

Plate.11.6. Men with packed mango baskets at mango storage centre.

Plate.11.7. Security men with bamboo pole in a small garden at English Bajar block.

Plate.11.8. Security men infront of their temporary tents in a large garden at Ratua-I block.

Plate.11.9. Security women at their tent in a small garden at Old Malda block.

Plate.11.10. Men plucking fruits in a large garden.

Plate.11.11. Mangoes in the net-basket at the tip of the bamboo poles used for plucking.

Plate.11.12. Plucked fruits are huddled beneath a tree in the garden.

Plate.11.13. Packaging of fresh fruits in the bamboo baskets beneath a tree.

Plate.11.14. Mangoes are packed in wooden packing boxes in a garden.

Plate.11.15. Packed boxes are carried by cycle van to the storage centre.

Plate.11.16. Diesel truck are used for transport of mango boxes to long destination.

Plate.11.17. Villagers (children and adults) are involved in basket making at Amriti, English Bajar block.

Plate.11.18. Villagers busy in basket making in a large garden at Ratua-I block.

Plate.11.19. Malcos, a food processing industry at Old Malda block.

Plate.11.20. A leading food products company at Bachamari, Old Malda block.

Plate.11.21. Government Food Processing Training Centre at Malda Town.

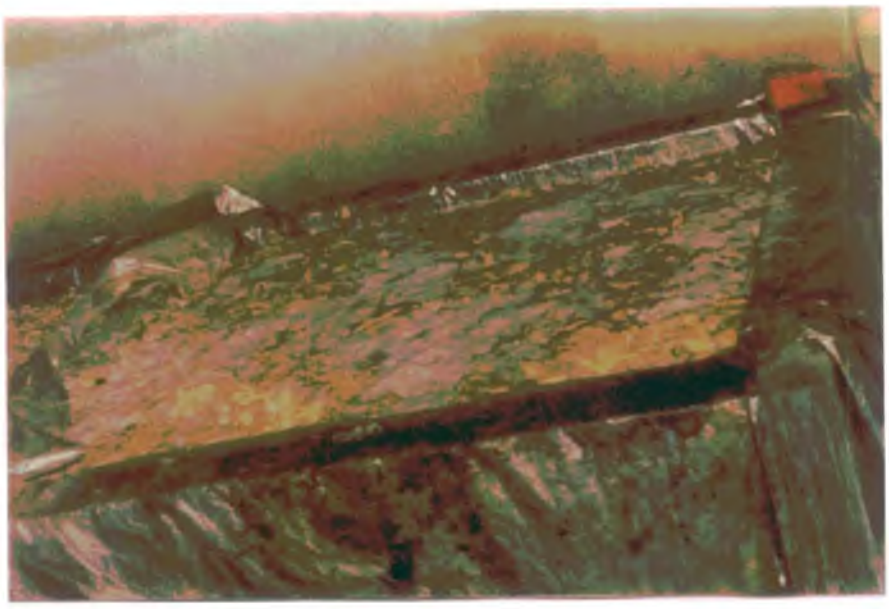

Plate.11.22. Storage chamber of sliced mangoes for preparing pickles in the GITA food products factory.

Plate.11.23. Women slicing the mangoes in the GITA food products factory.

Plate.11.24. Postal Department of Malda district arranged for parcel of mangoes under Mango-Post Scheme.

Plate.11.25. Grafting of mangoes in a small nursery at old Malda block.

Plate.11.26. A large tree supporting numerous grafts in a nursery at English Bajar block.

Plate.11.27. Government Food Processing Industries & Horticulture office where horticultural research activities are undertaken, at Madhabnagar, Malda town.

Plate.11.28. All India Show for mango and mango products, 1995 at English Bajar Town.

Plate.11.29. State level mango festival at Malda district town in 2002.

Plate.11.30. National level mango show at English Bajar block in 2003.

12. INTERACTIONS BETWEEN RHESUS AND HUMANS IN MALDA DISTRICT

12.1. Introduction

Rhesus monkeys in various parts of India live in close proximity with man specially in crop and fruit producing areas. It is not clear why and from when they started commensal life with man. It is however, suspected that due to expansion of human habitations into forest areas, destruction of forests and woodlands for various developmental activities resulted in shrinkage of primate habitat which compelled them to adopt a commensal strategy in human ecosystems since recent past. The rhesus macaques are disreputed to be one of the most aggressive monkeys in India. This probably is due to the fact that they suffered most from expansion of human ecosystem into their original habitat. It may be mentioned that this species enjoyed extensive distribution throughout North India, where rate of increase of human population as also developmental activities have been one of the highest after independence. Again the traditional protection on religious grounds is rapidly dwindling with time due to ever increasing human population density.

Raiding of crops by the primates is at present a global problem (Boulton, Horrocks and Baula, 1996; Naughton-Treves, Treves, Chapman and Wrangham, 1998; Saj, Sicotte and Paterson, 1999). Different authorities have reported this incident from different parts of the world. Oda, Matsumoto, Tashiro, Hinami et al. (1997); Funakishi (1998); Hill and Agetsuma (1998); Saito and Tokida (1998) have reported the incident of crop raiding by the Japanese macaques in various parts of Japan. Hill (1997) and Naughton-Treves (1998) studied this incident in western part and around Kibale National Park of Uganda respectively. Chaiise (2001) and Ghimire (2001) followed this raiding in Nepal. Thus humans are becoming less and less tolerant to the exploits of the monkeys which inturn makes the monkeys hostile to humans. Owing to leading a commensal life with humans they are well aware of human nature including their vulnerabilities under most circumstances. Thus they do not hesitate to harass, attack and even bite men when needed. This situation provides excellent opportunities for mutual transmission of diseases between man and monkey through air-borne and particulate infections agents because of close association and inoculation of disease agents through

biting. Various authorities such as Southwick (1970); Lindsey and Melby (1966); Sedgwick, Parchen and Durham (1970); Latt (1975); Machotka (1975); Sesline et al. (1975); Fleischman et al. (1982); Holmberg et al. (1982); Houser (1982); Tryphonas and Wong (1982); Bellinger and Bullock (1988); Trenton (1990) reported incidents of transmission of diseases from monkeys to man and vice versa including rabies, harpes-B, hepatitis, shigella, salmonella and many others. As such study of biting attacks on human by monkeys is of significant medical and public health importance.

12.2. Methods

Direct observations were made at different habitats infested by monkeys and the amount of damage to crops and mango orchards were estimated with the help of data recorded in the district year book. Data on assult of human beings were collected by direct observations, responsible reports from villagers and hospital records. Attempts were made to authenticate observations by photographs on various interactions with man both damaging and altruistics.

12.3. Results and Discussions

Malda is one of the prime mango producing district of West Bengal as well as India. More than 33% of human population of the district depends directly or indirectly for their livelihood on this cash crop, particularly in the mango season. As human population gears up for mango production in the mango season, so does the monkey population for its consumption. The density of monkey population increased appreciably in the blocks with extensive mango cultivation. Monkeys cause damage to the mango right from the appearance of new foliages and continues with the job up to the ripening of the fruits. Thus the stage is set for conflict of interests among man and monkeys. The owners of most mango orchards employ guards round the clock, armed with bows-arrows and fire crackers to drive away the invading monkeys. This probably makes the animals more and more aggressive to human beings resulting in even direct attacks on man including bites. Interactions of this kind continues in the mango orchards through out the mango season and after the mango season in vegetable cultivation areas. Close association of monkeys and man over generations emboldenes the monkeys

even to enter human households and get away with cooked and uncooked food materials particularly when the male members are away.

12.3.1. Incidence of Monkey population in different blocks

Rhesus macaques in the study areas heavily depends on mango orchards and cultivated lands for food. In the present study it was found that number of monkeys was much higher in the blocks with extensive mango cultivation areas (Figure.3.8.) than in areas with moderate and poor mango cultivation.

Table.12.1. shows that the average number of groups and average population per year varied from 67.28, 662 in the mango season to 50.28, 461.71 in the non-mango season in block with extensive mango cultivation. Similar figures for blocks with moderate cultivation are 1.28, 9.71 in the mango season and 0.86, 5.71 in the non-mango season. Average group size in blocks in high and moderate mango cultivation areas does not vary much in the mango (9.83 ± 0.23 and 7.55 ± 1.92) and non-mango (9.18 ± 0.46 and 6.66 ± 1.36) season. Further it may be pointed out that a much higher percentage of monkey population (69.75%) tend to stay on in the mango orchards even in the non-mango season in blocks with extensive mango cultivation than in the moderate cultivation areas (58.82%). This could be due to shelter and absence of threats mango orchard guards who are employed only in the mango season. Again the premise that monkey are higher in blocks with extensive mango cultivation areas does not apparently hold in case of some blocks such as Manikchak, Kaliachak-I and Ratua-I because recently Fruit Processing Industries and Horticulture, Govt. of West Bengal is taking active steps to increase mango-cultivation areas in these blocks. So, most of the areas under mango cultivation (Plate.11.1.) shown for these blocks are young and the production of fruits is considerably low.

12.3.2. Crop raiding by monkeys

The district Malda is placed with fertile soil and several perennial river systems which provide water for irrigation in the cropland areas. Many crops are grown in the district of which rice, wheat, rape seed, gram, sugar cane and potatos are important. The whole district, however, is not equally productive. It has been observed that production per unit area is higher in the blocks infested with monkeys such as English Bajar, Ratua-I, Old Malda, Manikchak, Kaliachak-I and

Ratua-II. These are also the blocks having extensive and moderate mango cultivation land.

It has been shown in chapter-5 that monkeys spent a considerable part of their time in the crop fields even during the mango season. Naturally, they consume significant amount of crop which they require in addition to the nutrients they derive from the mango orchards. Thus the loss in total production of crop is far from insignificant. Table.12.11. shows type of crops, cultivation area, amount produced and the value of the produce at the present rate. From the study of their activity in the crop fields and from reasonable reports from cultivators it is estimated that loss induced by monkeys in the crop fields is around 12% of the total produce. One second clearly they make our poor formers even poorer.

12.3.3. Damage induced by the monkeys in mango production

Rhesus macaques cause a lot of damage to the production of mango fruits. They actually consume less than they damage by their other activities such as jumping (Plate12.1.) from branch to branch, branch shaking (Plate12.2.) and breaking branches (Plate12.3.). A lot of mangoes drop on the ground in premature stage due to those activities (Plate12.4., Plate12.5., Plate12.6.). It may, however, be pointed out that when they break the apical bud of a branch a number of axial buds come up from the closest nodes. Thus several new foliages come up and the tree becomes more productive.

The mango growers recruit security men inside the orchards (Plate.12.7., Plate.12.8.) during the mango season to protect their crops. The security men use long sticks, bows and arrows, fire crackers etc. to drive the monkeys away from the orchards. Incidents of injury of rhesus by the orchard guards (Plate.12.9.) is not frequent. Deaths of monkeys due to attack by security men is, however, not common. Several such incidents occurred in the orchard area during the course of the study. As stated earlier monkeys damage mango production by feeding on new leaves, inflorescence, green mango, mature fruits and by some of their behavioural patterns From our experience over the study period in the mango orchard and considering responsible reports from senior mango planters it may be stated that the total damage induced by monkeys on mango production in the study area is not less than 20% of the total production (40,450MT). The damage is

proportionately much higher in the off-season when the total production is only a little more than one-third of an average of on-season production. As such the damage induced by monkeys can hardly be neglected even if there may be sound religious considerations.

12.3.4. Subsistence of monkeys in the non-mango season

In the non-mangoes season when the animals found their primary food source i.e. mangoes are not available they are compelled to move to other habitats in search of food materials. Table.12.2. shows that percent of sightings are much higher (60.62%) in the mango orchards in the mango season than non-mango season (21.00%). During this period they invade human households (Plate.12.10., Plate.12.11) much more (16.99%) than the mango season (4.37%). Similarly, sighting record in the roadside habitat is poor (05.57%) in the mango season than in the non-mango season (16.51%). The picture is similar also in the grassland habitat. Percent sightings is, however, slightly higher (16.24%) in the mango season than in the non-mango season in the cropland habitat (13.57%). It may be pointed out that in the mango season crop fields provide more varieties of food items than in the non-mango season.

12.3.5. Direct competition and overt attacks on humans by monkeys

In absence of their primary food, the mangoes in the non-mango season the monkeys raid other habitats including cropland and human households. Overt conflicts between the animals and man thus arises in the non-mango season. Man-monkey conflict is not peculiar to Malda district or to India but is found in various parts of the world as reported earlier.

The monkeys not only raid human households but also get away with uncooked and cooked food materials (Plate.12.12., Plate.8.11.). Householders of this area have taken some measures to protect their houses from the monkeys such as : plantations of several species of xerophytes (Plate.12.13.) in the open area of their houses, fix sharp iron and glass spikes on the top of the surrounding walls, fixing iron grills (Plate.12.14.) in the windows and balconies and the like.

The monkeys are intelligent animals, they are aware of the limitations and vulnerabilities of man and do not hesitate to attack them if necessary. Such attacks

often include scratching, stamping and biting. The over all area covered in this study is 1246.17 sq. km. and the human population in this area is 14,84,962 (census, 2001) with a density of 1191.6 / sq. km. It may be mentioned that only the blocks with atleast 2000 hectares infested with monkey were considered. The monkey population in this area is 848 with density of 0.68 / sq. km. In this area the rate of bites by monkeys is 6.21/year/100000 people.

Table.12.3. shows number of injured people during 1997-2002 in the district. It is observed that attacks (Plate.12.15.) on humans by monkeys are not random and wide variations exist in percent attacks on different age-sex groups. Thus, of a total of 466 attacks 50.43% were directed towards children (below 10 year age), 16.31% to teens (11-20) and 33.26% to adults (above 20 years). Again considering all the males and females above 11 year, the females were significally targeted more often i.e. 71% in comparison to 29% to the males. Thus the monkeys seem to be cognizant of the relative weakness of human age-sex categories.

12.3.6. Assult on humans by the rhesus under various situations

A total of 466 attacks were inflicted on humans over the five years (1997-98 to 2001-02) in the study site. Data show some interesting aspects on selections of victims by the monkeys. Table.12.4. shows that monkey bite incidences were higher (55.58%) in the non-mango season than in the mango season (44.42%). The time of the day (Table.12.5.) is one of the important factor. It was found that biting act were high in the morning session (53.01%), moderate in noon session (34.76%) and low in the afternoon session (12.23%). It may be pointed out that most animals are more excitable and aggressive when they are hungry as also during feeding period. Thus, higher incidence of attacks during morning period by monkey in general, follows normal physiological process of excitability.

Attacks were more frequent in roadside habitat (70.82%) than inside the human houses (29.18%). Table.12.6. shows that attacks inside houses were much higher in the non-mango season (69.12%) than in the mango season (30.88%). Sudden loss of their prime food mango in the non mango season probably forced the monkeys to a irritable state. Percent attack outside households is higher in the mango-season (67.57%) in comparison to non-mango season (32.43%) because

people of this area are very alert for protection of their valuable crops in the mango season against the monkeys.

Table.12.7. shows that people in dirty cloths (63.52%) were attacked more often than people in moderate (26.18%) and well dressed (10.30%) ones.

Again Table.12.8. shows that the male monkeys initiated the attacks more often than the females in both adult and juvenile categories. Of the 466 attacks 62.2% were executed by adult males, 3.2% by adult females, 30.9% by juveniles males and 3.6% by juvenile females. Table.12.9. shows the another interesting criteria is that attacks by rhesus monkeys is higher when they are alone 74.9% in comparison to when they in groups 25.1%. Group attacks were observed mostly when a group raids human households in search of food. This kind of attacks, however, are restricted only in the non-mango season.

Table.12.10. shows that most victims were alone when attacked by monkeys (75.32%) than when they were in groups (24.68%). Again, it is seen that overall 28.31% attacks occurred inside houses and 71.67% outside. It is to be mentioned that percent attacks inside houses were very high considering the frequency of encounters between man and monkey. One of the reasons for this situation may be due to the fact that monkeys raid the households when male members are away and that they are in extremely desperate attitude when they raid human households or else that a large number of attacks outside houses go unrecorded and without notice.

12.3.7. Diseases transmitted by rhesus on humans

Incidence of biting by rhesus on humans provides opportunities for mutual transmission of several diseases. Sometimes transmission of air-borne diseases occur because of close association for a long time.

Rhesus monkeys transmit a number of diseases to man such as : tuberculosis, shigellosis, rabies, salmonellosis etc. Trenton (1990) reported that about 12 different mycobacteria have been isolated from non-human primates. Classical tuberculosis is rare in wild monkeys from areas away from human localities but more common in areas close to human habitats. In general, TB is more common in old world monkeys and apes than new world primates. Macaques are generally

considered to be one of the most susceptible species in this context. Keusch et al. (1986), Clerc et al. (1987) and Lindberg et al. (1988) noted transmission of shigellosis from rhesus macaques to humans.

12.3.8. Commensal and Altruistic Association between rhesus and man

Since recent past due to population explotion of humans as well as rhesus population along with the huge loss of wildland areas the two species are forced to live in close association. Despite conflict between the two species occasional altruistic association between them are still found in various parts of our country. This type of association is also found in the present study area. Many people specially of Hindu communities feed them regularly as they consider rhesus as God. Several hanuman temples (Plate.12.19.) are located in the study area where worship of the "Hanuman God" (Plate.12.21.) takes place regularly. Many people begs with musks of hanuman in different festivals (Plate.12.20.). Some people make their livelihood by showing their pet-monkey perform various tricks and dance sequences in both rural (Plate.12.17.) and township areas (Plate.12.16.) as in circus. Some people simply keep (Plate.12.18.) monkeys as pets in different corners of the study site.

Table.12.1. Season-wise population of monkey in the extensive and moderate mango cultivation area during the study period (1995-2002).

Study Year	Mango Season				Non-Mango Season			
	BEMC Area		BMMC Area		BEMC Area		BMMC Area	
	TP	NOG	TP	NOG	TP	NOG	TP	NOG
1995-96	477	52	19	02	380	42	07	01
1996-97	554	57	00	00	437	38	06	01
1997-98	600	62	21	03	328	44	00	00
1998-99	632	71	11	02	466	54	12	02
1999-00	722	72	00	00	427	52	07	01
2000-01	809	74	17	02	563	59	00	00
2001-02	840	83	00	00	631	63	08	01
Total	4634	471	68	09	3232	352	40	06
Monkey/Group	9.83 ± 0.23		7.55 ± 1.92		9.18 ± 0.46		6.66 ± 1.36	

* TP = Total population, NOG = Number of group, BEMC = Blocks with extensive mango cultivation, BMMC = Blocks with moderate mango cultivation, Mango Season = February to July, Non-mango season = August to January, ± standard error.

Table.12.2. Habitat-wise number and percent sightings of monkeys in Mango and Non-mango season in Malda district for the year 1995-2002.

Habitat	Number of monkeys		% of sightings	
	Mango Season	Non-mango Season	Mango Season	Non-mango Season
Mango orchard	2972	645	60.62	21.00
Crop field	796	417	16.24	13.57
Grassland	647	981	13.20	31.93
Human household	214	522	04.37	16.99
Roadside	273	507	05.57	16.51

Table.12.3. Age and sex-wise distribution of injured human beings through monkey attacks in Malda district during the year 1997 to 2002.

Year	Upto 10 Yrs.	11-20 Yrs.			21-30 Yrs.			31-40 Yrs.			41-50 Yrs.			Above 50 yrs.			Total
	27	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	
1997-98	27	02	04	06	02	04	06	02	03	05	02	03	05	00	02	02	51
1998-99	53	05	13	18	04	12	16	03	11	18	03	10	13	02	01	03	117
1999-00	69	07	17	24	03	11	14	05	05	10	03	07	10	01	01	02	129
2000-01	41	05	08	13	03	08	11	02	07	09	01	05	06	00	01	01	81
2001-02	45	06	09	15	04	06	10	00	11	11	02	05	07	00	00	00	88
Total	235	25	51	76	16	41	57	12	37	49	11	30	41	03	05	08	466
Percent	50.43	32.89	67.11	16.31	28.08	71.92	12.23	24.48	75.52	10.51	26.83	73.17	08.79	37.50	62.50	01.75	

* M = Male, F = Female and T = Total

Table.12.4. Season-wise (Mango and Non-mango) monkey bite incidences in Malda district during the year 1997 to 2002.

Years of Study	Mango Season	Non-Mango Season	Total
1997-98	25	26	51
1998-99	49	68	117
1999-00	55	74	129
2000-01	38	43	81
2001-02	40	48	88
Total	207	259	466
Percent	44.42	55.58	

Table.12.5. Influence of time of the day on bite by rhesus monkey to human beings in Malda district.

Year	Session			Total
	Morning (6 AM to 10AM)	Noon (10 AM to 2 PM)	Afternoon (2 PM to 6 PM)	
1997-98	27	16	08	51
1998-99	61	45	11	117
1999-00	64	49	16	129
2000-01	44	25	12	81
2001-02	51	27	10	88
Total	247	162	57	466
Percent	53.01	34.76	12.23	

Table.12.6. Place of attack of rhesus monkey towards humans in Malda district.

Year	Attacks inside households			Attacks outside households			Total
	MS	NMS	Total	MS	NMS	Total	
1997-98	03	13	16	24	11	35	51
1998-99	11	20	31	57	29	86	117
1999-00	11	26	37	64	28	92	129
2000-01	08	18	26	36	19	55	81
2001-02	09	17	26	42	20	62	88
Total	42	94	136	223	107	330	466
Percent	30.88	69.12	29.18	67.57	32.43	70.82	

* MS = Mango season, NMS = Non-mango season.

Table.12.7. Influence of cloth type and attack by rhesus monkey.

Year	Cloth Type			Total
	Tiptop	Moderate	Dirty	
1997-98	04	12	35	51
1998-99	14	27	76	117
1999-00	13	29	87	129
2000-01	11	23	47	81
2001-02	06	31	51	88
Total	48	122	296	466
Percent	10.30	26.18	63.52	

Table.12.8. Age and sex of the attacker (Rhesus monkey).

Year	Adult			Juvenile			Total
	Male	Female	Total	Male	Female	Total	
1997-98	39	02	41	08	02	10	51
1998-99	67	06	73	43	01	44	117
1999-00	76	06	82	40	07	47	129
2000-01	50	01	51	23	07	30	81
2001-02	58	00	58	30	00	30	88
Total	290	15	305	144	17	161	466
Percent	62.23	3.22	65.45	30.90	3.65	34.55	

Table.12.9. Attacks by rhesus monkeys when in groups and when alone.

Year	In Group	Solitary	Total
1997-98	13	38	51
1998-99	29	88	117
1999-00	36	93	129
2000-01	18	63	81
2001-02	21	67	88
Total	117	349	466
Percent	25.11	74.89	

Table.12.10. Effect of being in single and in group of the victim on biting incidence.

Year	Victims in Group			Victim Alone			Total
	Inside house	Outside house	Total	Inside house	Outside house	Total	
1997-98	13	01	14	05	32	37	51
1998-99	21	06	27	07	83	90	117
1999-00	23	08	31	11	87	98	129
2000-01	21	02	23	05	53	58	81
2001-02	19	01	20	07	61	68	88
Total	97	18	115	35	316	351	466
Percent	20.82	3.86	24.68	7.51	67.81	75.32	

Table.12.11. Major crops, cultivation area, amount of production and their values in rupees of Malda district as well as monkey infected six blocks.

Type of Crop	Cultivation area (in 1000 hectares)		Amount produced (in 1000 ton)		Value of the produce (in crores)	
	District	MIB	District	MIB	District	MIB
Rice	242.00	80.80	388.00	130.50	465.50	156.60
Wheat	49.20	17.40	71.10	23.70	71.10	23.70
Rape Seed	19.60	6.80	15.90	9.30	12.70	7.40
Gram	4.80	1.70	7.20	4.20	5.00	2.90
Sugar cane	2.80	0.90	72.00	34.90	57.60	28.00
Maize	6.40	2.20	9.40	5.20	7.50	4.10
Potato	2.00	0.70	15.10	7.20	6.00	2.90

* MIB = Monkey infested blocks.

Plate.12.1. A monkey searching for food on a mango tree in noon hours (I).

Plate.12.2. On locating mangoes the monkey took position for plucking the fruit (II).

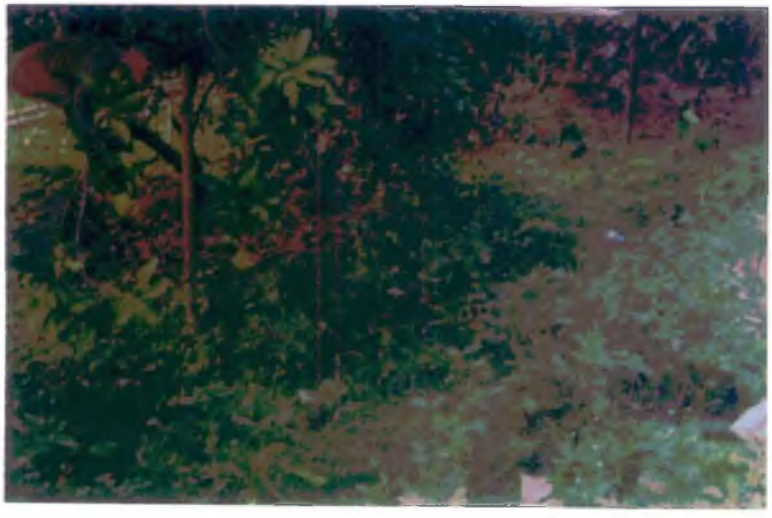

Plate.12.3. The monkey holds the branches of the tree where the fruits are located (III).

Plate.12.4. The monkey plucking the mangoes from the tree branches (IV).

Plate.12.5. The monkey cleaving the fruits from the branches using teeth (V).

Plate.12.6. Finally it sat down on the ground and started feeding the mango (VI).

Plate.12.7. Security men posing for the picture with bows and arrows in an orchard of English Bajar block.

Plate.12.8. The teens are also engaged in security at Ratua-I block.

Plate.12.9. An adult male injured by security men in a mango orchard at Manikpur of English Bajar block.

Plate.12.10. A rhesus group on a raiding mission in a human household at Baluchar, English Bajar block.

Plate.12.11. Raiding households by an adult male at Manikpur, English Bajar block.

Plate.12.12. Another raiding of monkey group in a human household at Bachamari, Old Malda block.

Plate.12.13. Householders use xerophytes for protection of their dwelling houses against the monkey at Bachamari, Old Malda block.

Plate.12.14. Householders protect their houses from invation of monkeys fitting iron-grills.

Plate.12.15. Children victim of Rhesus attacks on roadside at Manikpur, English Bajar block.

Plate.12.16. Monkeys show in township area at English Bajar block.

Plate.12.17. Monkey show in a rural area of Moulpur, Old Malda block.

Plate.12.18. A pet rhesus interacting with the lady of the house at Gopalpur, English Bajar block.

Plate.12.19. A Hanuman temple at roadside area at Mangalbari, Old Malda block.

Plate.12.20. An adult male wearing the musk of Hanuman on the last day of Bengali Year Festival (Charaka).

Plate.12.21. An idol of Hanuman being worshiped in a temple at Baluchar of English Bajar block.

13. SUMMARY

Damage of crops by primates is a common phenomenon in various part of the world for several decades. Among primates rhesus monkeys are involved in this kind of damage in major way because of their ability to survive in human ecosystems. Malda district of West Bengal is very famous for mango production. This study attempts to discuss extent of mango cultivation in different blocks of the district, monkey population in extensive and moderate mango cultivation areas, injuries incurred by various human age-sex classes through monkeys and to assess the impact of mango cultivation on the ecologic and socio-economic aspects of the people in the district.

The district receives on average 1400mm rainfall per year, the mean maximum and minimum temperature is 36^0C and 16^0C respectively. The land area of the district is 3733 sq. km. with a total population of 3.29 million. The district comprises of 15 blocks and the total area under mango cultivation of the district is 24,560 hectares. Most of the rivers of the district are flood-prone and inundate vast areas in monsoon almost every year. The rhesus macaque population in the study area is estimated to be around 850. Mango and silk are the main produces of the district.

The monkeys inhabit in several types of habitats such as mango orchards (19,570 hectares), crop field (21,770 hectares), grassland (30,000 hectares), households comprising of more than 20,000 thousand units distributed in scattered pattern in the villages and patchy in towns and roadside habitats in the blocks containing extensive and moderate mango cultivation orchards.

Altogether about 4,702 monkeys were sighted belonging to 480 groups of small, medium and large sizes over the 7 years study period. The average group size was 9.83 in the mango season and 6.66 in the non-mango season. The group composition was similar to the usual pattern i.e. adult male (15.21%), adult female (32.63%), juvenile (26.39%) and infants (25.86%). The density of rhesus macaques varied over the years from 3.62 to 4.22 per sq. km. in the mango season and 2.17 to 3.21 per sq. km. in the non-mango season. Most (45.60%) births

occurred in the hot-humid months of May, June and July. Most females gave birth to infant every year. Gross mortality rate was more than 45%.

Eight behaviour patterns i.e. feeding, resting, locomotion, grooming, playing, aggressive, sexual inspection and copulation were studied. Percent feedings was highest in the morning and afternoon session while resting peaked in the noon session. Most activities occurred throughout the day but in different frequency at different parts of the day.

The rhesus macaques are extremely versatile in their food habits. Mostly they consume fruits and leaves (82%) in the spring-summer and leaves and stems (75%) in the autumn-winter. In the study area they depended heavily on a single species i.e. *Mangifera indica* (26.2%), various grass species (Gramineae) including paddy, *Cicer*, maize and bamboo (11.1%), 10.8% legumes and 6.2% plants belonging to Solanaceae including potato, brinjal and tomatos besides their feed items belong to 24 different plant families. Some authorities reported rhesus to be omnivorous that includes small animals. In this study, however, no such activity was found. The food selection ratio for mango 2.1, papya 1.85, guava 1.97, black berry 1.80, jackfruit 1.57 and emblic myrobalan 1.52. Altogether food selection ratio was analysed for 17 different plant species. Adult females with infants were found to consume about 125 gms per hour during the feeding bouts followed by adult females without infants, adult males, juveniles and infants. They showed definite preference for *Cynodon* (38.5%) among grasses, *Oryza* (32.2%) among hurbs and for Citrus (40.7%) among shrubs.

Social organization among rhesus macaques is complicated due to associations and dissociations of individuals and sub-groups into larger groups and smaller sub-groups. Group sizes varied from 6 to 43 with an average of 9.89 (± 0.92), n = 407 (during the period February, 1999 to January, 2002). There were male dominated groups 68.1%, female dominated groups 19.8%, pair groups 10% and solitary individuals comprised 2.1%.

Mango orchards occupy about 6.6% land area of the district. Production of mangoes varied from 0.7 million MT to 3.0 million MT in the off and on-season

respectively. The total turn over in mango trade is over 80 crores on average and not less than 33% people of the district are directly or indirectly involved in mango trade in the mango season. Mango cultivation areas are on the increase in recent years because of Government efforts. English Bajar block alone contributed more than 35% land under mango cultivation in the district. Several varities of mangoes are produced in the district of which Laxmanbhog (12.1%), Langra (11.8%), Himsagar (6.6%) and Amrapali (5.1%) are famous for their taste and aroma throughout India. The mango orchards are of different sizes such as small (upto 2 hectares) 94.6%, moderate (2 hectares to 4 hectares) 4.3%, large (4 hectares to 6 hectares) 0.4% and very large (above 6 hectares) 0.7%. The total damage caused by monkeys is estimated to be around 20% of the total produce.

It is established that monkeys render a lot of damage to the crops including mangoes. Besides they transmit a host of pathogens to humans through their attacks and bites on them. Some of the diseases are deadly. It has also been observed that they select their victims using their knowledge on human limitations and vulnerabilities. Thus children, women, solitary people, people in dirty cloths are their common victims. However, we human beings are not without faults. Actually in recent past we have destroyed their natural habitats as a result the monkeys started invading human ecosystems beginning the episode of man-monkey conflict.

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