Chapter 2: Review of Literature

Taxonomy and External morphology: Mickleburgh et al. (1992; 2002) reported that there are about 1001 recognized species of bats worldwide, making up almost a quarter of all known mammalian species. They belong to the order Chiroptera and two suborders, the Megachiroptera and Microchiroptera. Corbet and Hill (1992) mentioned that they have not recognized any subspecies of *Pteropus giganteus* (Brunnich). However Sinha (1999) identified the specimens of Indian flying foxes as *Pteropus giganteus giganteus* (Brunnich). Smith (1977) stated from his observation that Megachiroptera is represented by only one family, the Pteropodidae. The genus *Pteropus* was assigned by Brisson in the year 1762. Bates and Harrison (1997) reported about five different species of the genus *Pteropus* from the Indian subcontinent such as *P. giganteus, P. vampyrus, P. famnulus, P. hypomelanus* and *P. melanotus*. Investigation on megachiropterans species were carried out by Koopman (1993) and noted that *Pteropus* is the largest genus of megachiroptera with 58 species which comprised of medium to large sized fruit bats.

*P. vampyrus* has been recognized as the largest of all the flying foxes available in the Old World with a fore arm length 195–209 mm as compared to 152–183 mm in *P. giganteus* (Bates and Harrison, 1997). Sinha (1986) reported about external morphology and skull bones of *P. giganteus* in his book “The bats of Bihar: Taxonomy and Ecology”. He has mentioned that
the forearm length of male and female *P. giganteus* were 150 – 170 mm (164 mm) and 155 – 180 mm (166 mm) respectively. Skull length of male and female were 69.5 – 73 mm (71.5 mm) and 69 – 69.5 mm respectively.

Prater (1971) and Anderson (1983) reported about the coat colour of *P. giganteus*. According to Prater (1971), head is usually reddish brown in colour with blackish snout. Colour of hind neck and shoulders varies from pale brownish yellow to straw; and the portions behind shoulders are dark brown or black. Ventrally the body is yellowish brown. Chin, neck, vent and flanks are darker. Wings are black. On the other hand, Anderson (1983) reported that Indian flying fox has coarse pelage; head is reddish brown with dark muzzle, neck and shoulder region are yellow, back brown and yellowish brown beneath.

**Distribution, Habitat selection and Roosting Behaviour:** Smith (1977) reported that the Megachiroptera is restricted to the Old World tropics of Africa and Asia. According to Andersen (1912), *P. vampyrus* is thought to be a seasonal migrant to the Nicobar and Andaman Islands. Koopman (1993) reported that the genus *Pteropus* is distributed from Mafia and Pemba Islands (Tanzania), Madagascar, the Islands of the Indian Ocean, Indian subcontinent, Southeast Asia, Philippines and Australia. Marimuthu (1988) reported that Indian flying foxes are found throughout India and like other species of the genus they are gregarious and tend to form large social groups. With a wingspan of four to five feet, Indian flying foxes are very conspicuous in their open roosts in large trees such as banyan and tamarind
where they spend their hours of rest. Sinha (1995) reported that he observed 1000 individuals of both sexes of P. giganteus on tree species such as Tamarindus indica, Saraca sp, Ficus religiosa, Azadirachta sp., Eucalyptus trees and on Bamboo brackets (Bambusa sp.).

Prater (1971) reported that majority of bats display a tendency to live or remain under particular conditions of environment. He cited that flying foxes are abundantly found on islands about 40 miles away from the African mainland, but no single species has established itself on the African Continent. Bates and Harrison (1997) have given the most convincing data in the distribution of Indian flying foxes. Distribution of Indian flying foxes has been recorded by them from Pakistan, Nepal, India and Maldives, Myanmar and China. In the Grzimek's Animal life Encyclopedia, Eisentraut (1968) wrote that the P. giganteus is found in the vast lowland areas of India and Ceylon, and slopes of Himalaya. Sinha (1999) reported about the distribution of P. giganteus colonies in the northeastern states of India.

Mickleburgh et al. (1992) reported that the habitats used by fruit bats vary. Many taxa are dependent to a greater or lesser extent on primary or well regenerated secondary forest. In the Philippines, they found Pteropus hypomelanus cagayanus in disturbed habitats. Marshall (Pers.com) mentioned that members of the genus Pteropus often form large aggregations on exposed tree branches. Rosevear (1965), Lim (1966), Wickler and Seibt (1976) and Marshall (1983) reported that roost site fidelity is generally high in the species of the genera Pteropus.
Food and Feeding habits: Fruit bats feed almost exclusively on plants, taking floral resources (largely nectar and pollen but also petals and bracts), and fruits and often seeds themselves and leaves (Marshall, 1985). However, Roberts and Seabrook (1989) reported that they observed *Pteropus seychellensis aldabrensis* on Aldabra Atoll feeding honeydew exuded by coccoids (*Icerya seychellarum*) present on a fig tree (Moraceae: *Ficus lutea*).

Marimuthu (1988) stated that just after sunset the bats start leaving their tree roost for feeding. They return at about two hours before sunrise after feeding on a wide variety of fruits, including figs, mango, guava and neem (*Azadirachta indica*), a tree native to India, whose seeds are dispersed by bats.

Racey and Nicoll (1984) recorded *Pteropus seychellensis seychellensis* feeding on 27 plant species from 14 families which includes Anacardiaceae, Apocynaceae, Bombacaceae, Caricaceae, Combretaceae, Flacourtiaceae, Guttiferae, Meliaceae, Moraceae, Musaceae, Myrtaceae, Palmae, Sapotaceae and Sonneratiaceae. McCann (1934) was of the opinion that Indian flying fox probably attacks the fruit or flower of *Polyalthia longifolia*, *Bombax malabaricum*, *Grevillea robusta* and *Terminalia catappa*; and fruits of *F. bengalensis*, *F. glomerata*, *F. infectoria*, *F. religiosa* and *F. retusa*. *P. giganteus* from India and Sri Lanka. He further stated that Indian flying foxes are found to feed on flowers and flower buds of *Gossampinus malabaricus*, *Spathodea compliculata*, *Eucalyptus robusta*, *Albizia falcata*, *Erythrina lithosperma*, *Heavea braziliensis* and *Cocos nucifera*. Prakash
(1961) also experienced that food of *P. giganteus* include the fruits of *Magnifera indica*, *Artocarpus integra*, *Annona muricata*, *Psidium guajava*, *Musa paradisiaca*, *Carica papaya*, *Syzygium cumini*, *Ficus* sp. Studies on food habits of Indian flying foxes were carried out by Phillips (1980) and Sinha (1986) and they reported that fruits of *Tectona grandis*, *Anona* sp, *Borassus flabelifer*, *Phoenix silvestris*, *Bassia latifolia* and wood apple (*Feronia* sp) were favourably eaten by the bat species. They are also found to eat many fruits and flowers of jungle trees in certain cases. They further informed that *P. giganteus* avoids all citrus fruits. In the non-fruiting season, *P. giganteus* are found to chew the soft leaves and twigs of *Bombax ceiba* and *Tamarindus indica* and flower of Mahua (*Bassia latifolia*). Goyal and Sale (1992) reported that at Dehradun, Indian flying foxes are found to feed on the fruits of *Ficus glomerata*, *F. religiosa* and an exotic *F. Benzamina*. Sinha (1999) also reported about couple of casual incidents observed on the feeding activities of *P. giganteus* from the north eastern parts of India; first report was from the Rongjuly area of Goalpara district of Assam where he saw a flying fox individual feeding on the floral resources of banana (*Musa* sp) and the second report was from the Dharam Nagar area of Tripura where he saw a *P. giganteus* individual running on a bunch of Dumra tree (Local name in Tripura) and taking of a fruit in its mouth and immediately flew away from the tree.
Brosset (1962) reported that individuals of *P. giganteus* leave their roosts some 20 minutes after sunset and fly one by one in long lines, all following one another in the same direction. Phillips (1980) however, suggested that they take little notice of each other, noting that “one will plane down into a tree while another, flying close alongside it, will carry steadily on”. Bhati and Srivastava (1989) reported that in Rajasthan, roosts are vacated about 30 minutes after sunset and revisited about 45 minutes prior to sunrise. Hill (1958) mentioned that individuals from colonies on North Male Atoll in the Maldives are rather more diurnal and are reported to be feeding long before sunset.

Bates and Harrison (1997) mentioned that Flying foxes cover immense distances in search of food. Burton (1974) reported that the distance may be of as much as 40 miles away from the roosting site. However, Bastawde and Mahabal (1976) reported that distances ranging from 2 to 20 km in the Poona city of Maharashtra. According to Wroughton (1912a) in Gujarat it is known to range over 16 km in search of suitable feeding sites.

Prater (1971), Anderson (1983) and Bates & Harrison (1997) reported that the flying foxes ingest only the juice and soft pulp and the solids are discarded. McWilliam (1985-86) found that the feeding behavior of three highly colonial species of *Pteropus* in Australia was dominated by the establishment and subsequent defense of long term feeding territories. Investigation using radio tagging showed that such visits to feeding sites
spanned at least 29.37 and 23 consecutive days for *P. poliocephalus*, *P. alecto* and *P. scapulatus* respectively.

Marshall (1983) reported that megabats detected their food primarily by smell and sometimes also by sight. Prater (1971) mentioned that *P. giganteus* have an uncanny memory for the location and fruiting time of trees. Burton and Burton (1974) reported that the direction of flight taken by flying foxes depends on what flowers are blooming or fruits are ripening in an area and they have efficient nostrils and can detect these at great distances.

Kock (1972), Kingdon (1974), Bergmans (1978) and Phillips (1986) reported from their observation that *P. giganteus* found to visit a river or lake and glide over the surface of water and thereby lapping up water to quench their thirst.

**Breeding and Parental care:** Marshall (1947), Moghe (1951) and Goyal & Sale (1992) reported *P. giganteus* as a seasonally monoestrous fruit bat. In case of this fruit bat species male exhibit only a single breeding period after which their reproductive organs involute and spermatozoa are lost. Prater (1971) describes that Indian flying fox breeds once a year and a single is born during early February after gestation of 140 to 150 days. Burton and Burton (1974) reported that babies of flying foxes born at about 6 months of gestation and the fecundity is usually one, sometimes two and the baby bat is carried about by mother for a month. They further reported that the youngster can fly at about two months, takes its foraging flights at three months and
becomes fully independent at 4-6 months. They attain sexual maturity at 18 months. Mickleburgh et al. (1992) reported that female fruit bats give birth to one young at a time after a 4-6 months gestation.

Sinha (1995) reported that he observed courtship of *P. giganteus* on 14 April 1995 at 0430 hours started with the vocal communication as “kri-kri-kril” converted into flapping of wings upon each other, rubbing neck-to-neck and touching mouth to mouth and nose to nose till they clasped- together in hanging position, touching belly to belly, after which separation started. Koilraj et al. (2001) reported that during mating season both male and female bats in the *P. giganteus* colony move in tree branches and are often restless. The male frequently approached its selected mate, stretched and fanned the wing towards the female and sniffed her. The female always attempted to repel from the male by screaming and leaving the branch of the tree. They further reported that during copulation male grips in the scruff of the female’s neck in his teeth while holding her with his thumbs. According to them copulation lasted for about 30-40 seconds. Grant (1994) reported the mating screams during mating season of *P. tonganus* in Samoa.

Goyal and Sale (1992) reported that during April, females at the day roost of Dehradun area of Uttar Pradesh were seen with their Youngs. The young ones get attached with to the breasts of their mothers immediately after the birth and are carried by their mothers for a period of two months during which they attain body weight of about 200gms. They also reported that the young one attained sexual maturity only in the next year at the age of about
18 months. Silbernagel (2005) also supported the same observation viz the average sexual maturity age of *P. giganteus* is 1.5 years.

**Diurnal behaviour:** Study of Marimuthu (1988) stated that during the daytime they fan themselves with the membranous wings, crawl over the branches, seek mates, and defend favoured roost location against other bats and if any stranger approaches, they squawk and chatter loudly.

Sinha (1995) commented on some behavioral activities of Indian Flying fox (*Pteropus giganteus giganteus*) (Brunnich, 1782) in Bihar, India. According to him, Indian flying fox is a colonial species which roost during day on the big trees having profused branches in large numbers without any fear of other animals. He further reported that bats remain hanging from the branches of roosting trees with the claws of their hind feet, keeping head downward in different directions. Burton and Burton (1974) reported that during early morning, there is much fidgeting and moving in the camps of flying foxes. Although sociable, they like to keep their distances from human being. When one flies in and lands closer to another a fight begins. Later in the day most of them settle down. He further mentioned that flying foxes use the same roost year after year. At sunset they began to take off.

**Population:** Goyal and Sale (1992) reported that knowledge of the population biology and demography of flying foxes is at a rudimentary stage. Mickleburgh et al. (1992) suggested that densities of fruit bats were once high throughout the Old World tropics. Heaney and Heideman (1987)
observed in the Philippines that roosts of up to 150,000 bats of *P. vampyrus* was common as late as the 1920s, but the largest colonies now number no more than a few hundred individuals by now. In India, Neuweiler (1969) reported about a colony of some 800 to 1000 individuals in Madras city of Tamil Nadu; Bastawde and Mahabal (1976) reported about a colony of population sizes between 274 (in April) and 1087 (in January) individuals in Poona area of Maharashtra; Marimuthu (1988) reported about a colony of around 500 Indian flying foxes roosts in a huge banayan tree in the small village of Puliangulam, about 40 miles east of Madurai in southern India. Goyal and Sale (1992) reported about a colony size 7000-9500 bats around Dehradun while Sinha (1995) reported about three colonies in Bihar with population sizes 150, 1000 and 1500 respectively; In Assam, Ali and Saikia (1999) reported about four roosting sites from the Greater Guwahati area. The areas were Kacharighat roost with 700 bats, Koitasiddhi with 350, Singimari with 210 and the Tatimara roost with 120 bat individuals of *P. giganteus*. Koilraj et al. (2001) reported about a colony of size 150 in the Chenniyanallur village in Nagai district of Tamil Nadu and recently Senacha (2005) reported about a colony of 200 bats on a *Ficus* tree near the Anand Railway Station of Gujarat state of India.

Happold (1987) reported about the seasonal migrations of *P. poliocephalus* colonies in Australia because of local fluctuations in food availability. Bastawde and Mahabal (1976) reported that colony size of *P. giganteus*
varies seasonally in the Poona city of Maharastra, India, without mentioning any cause of such seasonal variation.

Mickleburgh et al. (1992) reported that populations of the genera *Pteropus* undertake seasonal migrations in those parts of their ranges where there are distinctive wet and dry seasons.

**Threats and Conservation:** Sinha (1995) stated that in India causes of its death are only due to illegal hunting and electrocution. Wodzicki and Felten (1975), Racey (1979), Cheke and Dahl (1981), Carroll (1984), Pernetta and Hill (1984), Fujita and Tuttle (1991) and Pierson and Rainey (1992) reported that Habitat loss is the major factor contributing to declines in fruit bat populations. Mickleburgh et al. (1992) reported that many fruit bats are hunted both at a local or commercial level. In some areas there has been conflict between bats and commercial fruit growers. They further mentioned that fruit bats are also threatened by natural factors such as storms, cyclones and typhoons. Pierson and Rainey (1992) reported that catastrophic events such as cyclones and typhoons, and unnatural predation such as over hunting makes fruit bats ‘Vulnerable’. Sinha (1999) reported that causes of death for the *P. giganteus* of North East India are only due to illegal hunting and electrocution, and other than man this bat has no natural predators. No fatally diseased bats have been found or reported so far from this area.
Fujita and Tuttle (1991) emphasized a grave concern for the conservation of flying foxes, as these species are agents for seed dispersal and flower pollination. At least 443 products useful to man derive from 163 plant species that rely to some degree on bats for pollination and seed dispersal. These products include timber, fruits, fibers and tannins that contribute significantly to world markets as well as well known products such as medicines and food items important in local economies.

According to IUCN Red data book (2004), globally P. giganteus is not considered as a threatened species although it is treated as a pest by the farmers. Koopman (1993) listed it in the Appendix II of CITES. Conflict with fruit farmers provoked the Indian government to list this fruit bat species as 'Vermin' in the Wildlife (Protection) Act of India, 1972, which persists even today (Molur et al., 2002). In the IUCN Red Data Book (2004) it is mentioned as a Least Concern (LC) species.