Chapter 1: Introduction

1.1 Background

Indonesia is one of the most biodiversity-rich and ecologically complex nations in the world. Although covering only 1.3% of the globe, the Indonesian archipelago accounts for nearly 10% of the world's remaining tropical forest (BAPPENAS 1993), ranked second after Brazil for its forest area and the amount of biodiversity.

Despite increasing concern over the loss of tropical forest, significant local and international efforts to find solutions to the problem, and despite the country's extensive system of protected areas and production forests (forests available for logging), and the abundance of detailed land-use plans, the rate of deforestation in Indonesia continues to increase (Jepson *et al.* 2001 & Whitten *et al.* 2001 cited in Kinnaird *et al.* 2003). Kinnaird *et al.* (2003) also mentioned that Indonesia provides one mostly relevant example of the devastating effects of enormous deforestation. According to World Bank (2001, cited in USAID/Indonesia 2004), 20 million ha of Indonesia's forests have been lost at an average annual deforestation rate of 1.5 million ha between 1985 and 1997. Since 1997, the rate of forest lost is 2.4 million ha per year or more. Of about five million ha of forests were degraded by fires in 1997-1998 alone.

Sumatra, the westernmost of the main islands and the second-largest island in Indonesia, has less than 40% of its natural forest remaining and is losing forest rapidly at the rate of almost 2.5% a year (Supriatna *et al.* 2002). According to Kinnaird *et al.* (2003), the dramatic loss of Sumatra's forest cover is attributed to a variety of factors, including logging (legal and illegal), development of estate crops (primarily oil palm and pulpwood plantations), conversion to agriculture (by opportunistic settlers and those arriving through Indonesia's official transmigration program) and forest fires. They also stated that the conversion of Sumatra's lowland forests will finally result in putting the fauna, especially large mammals, in serious jeopardy. The consequences also occur in Sumatra's nearby islands, such as Bangka and Belitung Island.

Belitung is an island southeast of Sumatra and Bangka Island. The total land of the Belitung Island is approximately 480,060 ha (*ca.* 4,800 km²) and human population was 215,859 in the year 2002 (BPS 2002). The main resources are tin mining, kaolin, quartz sands and granite rock.

During the Dutch occupation, the tin mining industry was established and is still continuing until now. The plantations are mainly oil palm and pepper, also coconut, coffee and natural rubber but relatively less expansive than both first two mentioned. The highest land is Gunung Tajam, only 500m above sea level (Whitten *et al*. 2000). The land surface was originally tropical forest, but since the development of the palm oil industry in 1992 more than 40% of the land surface has been converted to oil palm plantations. There are some small lakes but most of them were constructed because of tin mining (http://www.indahnesia.com/indonesia.php?page=SSEBEL).

Tin mining and large scaled oil palm plantations directly or indirectly affect the natural habitats on Belitung Island. There is a permanent threat to the flora and fauna on the island, while actually there is no terrestrial conservation area on Belitung Island (Supriatna *et al.* 2002). The continuing deterioration of forest on Belitung Island means that there is a higher probability of the species becoming threatened.

The tarsier family (Tarsiidae, Order Primates) is a distinctive taxon confined to the Sunda Islands, the Philippines, and Sulawesi. Currently, eight species (Merker & Groves 2006) of the genus *Tarsius* are recognized; with the possibility of another new species from Sulawesi and its surrounding islands. One of the eight species is *Tarsius bancanus* Horsfield 1821 (Western tarsier[*]), which is distributed in Borneo, southern Sumatra, Bangka, **Belitung**, Karimata and the South Natuna Islands.

Among the four subspecies of Western tarsiers that have been described, *Tarsius bancanus saltator* Elliot 1910 is restricted to the island of Belitung. Brandon-Jones *et al.* (2004) stated that Hill (1955) recognized *Tarsius bancanus saltator* as a poorly defined subspecies, perhaps synonymous with *T. b. bancanus*, but Groves (2001) recognized that *T. b. saltator* has fur that tends to be less woolly and its dorsal tone more iron grey than other subspecies.

Tarsiers receive little conservation attention within their geographic range. This lack of attention is probably due to the fact that tarsiers are uncommon, elusive, rarely seen (because of their nocturnal habit) and compete for conservation attention with well-known flagship species, especially in Sumatra, e.g. orang utans (*Pongo pygmaeus*), Sumatran rhinoceros (*Dicerorhinus sumatrensis*) and tigers (*Panthera tigris*).

---

[*] Throughout this dissertation the common name "Western tarsier" was used for any tarsier from Borneo, Sumatra, Bangka, Belitung and Natuna; the name "Eastern tarsier" for any tarsier from Sulawesi and its surrounding islands and "Philippine tarsier" for any tarsiers from the southern Philippine Islands.

1.2 Objectives of the study

The subspecies *Tarsius bancanus saltator* is endemic to the island of Belitung. Geologically, Belitung Island is separated from Sumatra since thousands of years ago (Whitten *et al.* 2000, Voris 2000). Belitung, like Bangka as the nearest neighbouring island but not mainland Sumatra, are known as the islands of tin. The rare "Kerangas" ecosystem (heath forest), which does not occur on Sumatra mainland island, can be found on Belitung. This island is mentioned as one of the endemism centres of the Sumatran region (Natus 2005), however, there is no conservation area on the island (Supriatna *et al.* 2002). Moreover, tarsiers in Belitung (*Tarsius bancanus saltator*) were recognized as a distinct sub-species from *Tarsius bancanus bancanus* which occupies Bangka and some places of southern Sumatra (Groves 2001, Brandon-Jones *et al.* 2004).

This study is about the ecology of the *Tarsius bancanus saltator* on Belitung Island, Indonesia. The home range sizes, population densities, insect abundance, substrates for movements and habitat selection of the tarsiers were studied by telemetry. The study was aimed to identify the critical resources for the tarsiers' survival and adaptation on Belitung Island. Thus, the research should contribute to the conservation action of the species.

The specific aims of this study are: (1) to provide home range estimates, (2) to provide an estimate of the population size and densities of *Tarsius bancanus saltator* on Belitung Island; (3) to discuss the implications of this information in terms of the conservation status of the Belitung Island tarsier and (4) to create and increase awareness of the local people for the conservation of this unique creature.

Crompton & Andau (1986, 1987) reported a very large home range and low population density of the Western tarsier compared to the Sulawesi tarsiers (e.g.: Gursky 1998b, Merker 2003). It was also reported that tarsiers utilized primary and secondary forest. Merker & Muehlenberg (2000), and Merker *et al.* (2004, 2005) reported that tarsiers responded to human interference by adapting their ranging patterns to different levels of disturbance. Since there are different types of habitat on Belitung Island, it was hypothesized that the Belitung tarsiers would also adapt their patterns of range use to different types of habitats. Tarsiers will use any suitable habitat as long as that habitat provides enough food resources and appropriate substrates for locomotion.

Because patches of forests are surrounded by oil palm plantations, the question arise whether tarsiers use only the forest patch or need the adjacent habitat as well to meet all requirements for the life history? Do they leave the forest patch into the plantation? Or do they modify their behavioural ecology? To answer these questions, it is necessary to study their home range size, the pattern of range use, the nightly travel distances and the population densities of tarsier.

Therefore, one of the main questions of this dissertation was: do tarsiers need more than one habitat type to satisfy their home range? Or is one habitat type big enough to support the required home range? Is the density of tarsiers really low and do they have wide home range or are tarsiers just hard to see according to their nocturnal habits?

A second objective of the dissertation was the setting of the following question: what are the differences between *Tarsius bancanus saltator* and *T. b. borneanus* (studied by Niemitz 1979, Crompton & Andau 1986, 1987), *T. dianae* (Merker 2003) and the Spectral tarsier (Gursky e.g. 1998b, 2000a, 2002a, c, 2003b, 2005a, and 2006) concerning their home ranges, population density and social system? Different location, different populations and sample sizes would be expected as factors to explain the differences among those studies. In addition, it was also expected that there are different behavioural ecology among the species.

A third issue of the dissertation focused on the conservation: how is the conservation status of tarsier on Belitung Island? Since the high rates of deforestation and habitat changed still occur, even in protected areas in Indonesia, it was predicted that it would threaten the population density of Belitung tarsiers. Based on the home range size and population densities, the population size should be able to predict. Combined with the estimation of remaining suitable habitat for tarsier, their conservation status could be assessed and should not remain data deficient.

Chapter 2: General Review on Tarsier

2.1 Biology of Tarsier

2.1.1 Systematics and Distribution of the Genus *Tarsius*

At present there is only one extant genus of Tarsiiformes, *Tarsius*. The relationship of tarsiers to other primates, both living and fossil, has been the focus of numerous controversies. Yoder (2003), Wright *et al.* (2003a) and Gursky (2006) have been resumed those controversies over the tarsier classification within the order of Primates. Morphological evidence, including soft-tissue characteristics, suggests that tarsiers are closely related to small nocturnal prosimian primates (lemurs, lorises and bush babies), called *strepsirhine primates*. Another suite of anatomical and reproductive characters yet suggests that tarsiers may be more closely related to monkeys, apes and humans, called *haplorrhine primates*. Yoder (2003) stated that the situations of extreme phylogenetic uncertainty, such as seems to be the case with tarsier affinities, often relate to problems of short internal branches confounded by long external branches. She mentioned that it can happen that speciation and cladogenesis occur very rapidly and are then followed by a long period of independent evolution for the resulting lineages.

The taxonomy of the tarsier is also momentarily still in debate. How many extant species are there? The answers range from three to eight (Hill 1955, Niemitz 1984d, Musser & Dagosto 1987, Groves 2001, Wright *et al.* 2003a, Brandon-Jones *et al.* 2004, Merker & Groves 2006). Morphological evidence splits extant tarsiers into two distinct phenetic groups: a Philippine-Western group from the Philippines and the Greater Sunda Islands respectively, and an Eastern group from Sulawesi (Brandon-Jones *et al.* 2004). Moreover, there are also differences in chromosom numbers between some tarsier species. The Bornean and the Philippine tarsier are having a karyotype of 80 chromosomes (Dutrillaux & Rumpler 1988), Dian's tarsier have 46 chromosomes (Niemitz *et al.* 1991), while the karyotypes of the other species are still unknown.

Figure 2.1. Geographic distribution of eight currently recognized tarsier species. Source: Niemitz (1984d), Supriatna & Wahyono (2000), Groves (2001), Brandon-Jones *et al.* (2004), Merker & Groves (2006).

Discoveries of new populations as well as morphological, genetic and vocal-acoustic investigations, and the processing of historical data lead to the fact that in the next years, with a large probability, new tarsiers will be described. Today, tarsiers have a unique distribution only on a few islands within 4 countries in Southeast Asia (Figure 2.1).

The eight species of tarsiers currently described are (Merker & Groves 2006, distributions according to Brandon-Jones *et al*. 2004):

1. Dian's tarsier *Tarsius dianae* Niemitz, Nietsch, Warter and Rumpler 1991; distribution in Indonesia (northern areas of Central Sulawesi, from the Lore Lindu National Park to Luwuk). Merker & Groves (2006) stated that the correct name for this species may be *Tarsius dentatus* Miller & Hollister, 1921 as described by Brandon-Jones *et al.* (2004) based on morphological characters and acoustic form found by Shekelle *et al.* (1997).

2.   Peleng tarsier *Tarsius pelengensis* Sody 1949; distribution in Indonesia (Peleng Island and possibly other islands of the Banggai Island chain, Central Sulawesi)

3.   Pygmy tarsier or Mountain tarsier *Tarsius pumilus* Miller and Hollister 1921, distibution in Indonesia (Latimodjong Mountains, 2,200 m, South Sulawesi; Mt. Rorekatimbu, 2,200 m; Rano Rano, 1,800 m, Central Sulawesi)

4.   Sangihe tarsier *Tarsius sangirensis* Meyer 1897, distribution in Indonesia (Greater Sangihe Island, North Sulawesi)

5.   Makassar tarsier *Tarsius tarsier* Erxleben 1777; distribution in Indonesia (the South West peninsula, north to the Tempe depression, South Sulawesi; Gorontalo to Tanjung Panjang, North Sulawesi; Gorontalo to Manado, North Sulawesi; Palu Valley, West Central Sulawesi; Near Sejoli, border of North and Central Sulawesi; Selayar, South Sulawesi; Buton Islands and SE. peninsula, South Sulawesi; Tinombo, south to Ampibabo, Central Sulawesi; Togian Islands, Central Sulawesi. The name *Tarsius spectrum* might be a junior synonym of *T. tarsier*.

6.   Lariang tarsier *Tarsius lariang* Merker & Groves 2006; distribution on western Central Sulawesi (Gimpu, Lampelero, Tomua and Marena).

7.   Philippine tarsier *Tarsius syrichta* Linnaeus, 1758, distribution in the South Philippines islands (Samar, Mindanao, Bohol, Leyte, Basilan, Dinagat, Siargao).

8.1.   Western tarsier *Tarsius bancanus bancanus* Horsfield, 1821; distribution in Indonesia (Bangka, lowland southeast Sumatra from the Sunda Strait approximately to the Musi River; implausibly reported in Java)

8.2.   Bornean tarsier *Tarsius bancanus borneanus* Elliot, 1910; distribution in Brunei, Indonesia (Kalimantan), Malaysia (Sabah, Sarawak)

8.3.   Natuna tarsier *Tarsius bancanus natunensis* Chasen, 1940; distribution in Indonesia (Serasan, Subi, South Natuna Islands)

8.4. Belitung tarsier *Tarsius bancanus saltator* Elliot, 1910; distribution restricted to Belitung Island, Indonesia.
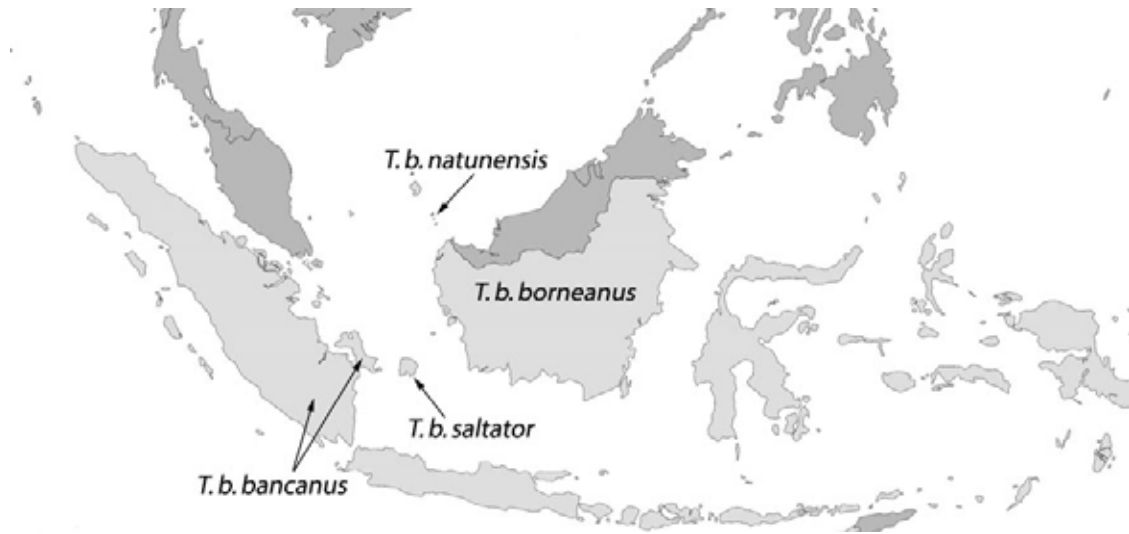
Figure 2.2. Geographic distribution of four subspecies of *Tarsius bancanus*

2.1.2 General Morphology of the Genus *Tarsius*

All tarsiers are small, nocturnal, vertical clinging and leaping, faunivorous animals and as such, they are anatomically and ecologically distinctive with regard to other primates. Schwartz (2003) resumed that the most clear-cut similarities between *Tarsius* and anthropoids include primary supply of the middle meningeal artery via the maxillary artery, lack of a tapetum, lack of a moist and hairless rhinarium and the inability to synthesize vitamin C.

Among tarsiers, however, there exists previously underemphasized variability. The differences may include body weight, intramembral indices, finger pads, absolute orbit size, absolute tooth size, limb proportions, the proportion of tail that is covered by hair, locomotor's behaviour, habitat selection, nesting/sleeping sites, communication, and social and ranging behaviour (Niemitz 1984, Jablonsky & Crompton 1994, Gursky 1999, Sussman 1999, Anemone & Nachman 2003).

The body of a tarsier is only around 12-13 cm long, but its tail is twice that length. Adult tarsiers weigh generally 100-140 gram, with differences among various species. Males may be slightly heavier than females (Fogden 1974, Niemitz 1984d, Crompton & Andau 1987, Neri-Arboleda *et al.* 2002, Merker 2003, 2006, Gursky 2006).

Tarsiers have huge eyes with the retina containing a fovea, but the eyes lack a light-reflecting *tapetum lucidum* and unlike most nocturnal animals whose eyes reflect light vividly, tarsiers' eyes only glow a dull orange/red when light is shone on them. The eyes' position is mobile in the orbital, as compensation of the head for over nearly 180° swivelling (Hill 1955, Niemitz 1984, Sussman 1999).

The colour of the dense fur of the Tarsier varies between gold-brown, dark-brown and grey, depending upon species and age of the animals (Hill 1955, Niemitz 1984). The hind-limb of the tarsier is characterized by an extremely extended tarsal (*tarsus*). The fingers and toes of the tarsier are extremely long and provided with terminal pads for better substrate adhesion. As vertical clingers and leapers, tarsiers are thus excellently adapted to the arboreal and jumping way of life. At the second and third toe there are grooming claws – a primitive characteristic within Primates – the other toes and fingers are protected by flattened and distally pointed nails.

2.1.3 General Behaviour of the Genus *Tarsius*

Insects represent the main food of the tarsier. Grasshoppers, crickets, cicadas, butterflies and moths are its favourite prey. In addition, ants, termites, beetles, cockroaches and even small birds and also lizards are eaten. Tarsier is the only primate, which has a diet exclusively consisting of animals. (Hill 1955, Fogden 1974, Niemitz 1979, 1984c, Crompton & Andau 1986, 1987, Jablonski & Crompton 1994, Crompton *et al.* 1998, Gursky 2002a, Merker 2003, Merker *et al.* 2004, 2005).

Little is known about the natural enemies of the tarsiers. Gursky (2002b) observed one successful predation of a tarsier by a snake (*Python reticulatus*). Shekelle (cited in Sussman 1999) observed similarly catch attempts by snakes and a successful predation by a Monitor lizard (goanna). In the presence of snakes, goannas, civets and raptors (and/or of mock-ups of these animals) tarsiers give warning calls (Gursky