Chapter 2

Literature Review

2.1 Description and Taxonomy of *Indotestudo elongata*

Tortoises are in the Kingdom Animalia
Phylum Chordata
Subphylum Vertebrata
Class Reptilia
Order Chelonia
Suborder Cryptodira
Family Testudinidae

The family Testudinidae includes 12 extant genera of tortoises (Ernst and Barbour, 1989) with some 40 living species currently recognized (Jenkins, 1995). *Indotestudo elongata* is one of the two tortoise species in the genus *Indotestudo*. Two common names are widely known: the elongated tortoise (Ernst and Barbour, 1989), due to the shape of its shell, and the yellow tortoise, due to the apparent color of its carapace. It has several local names such as Tao Laung, Tao Tien, and Tao Khanaeng (Nutaphand, 1979). The conspicuous characteristic of the yellow tortoise is the elongated domed carapace, dorsally-flattened with almost vertically descending sides. Usually 11 marginals scutes lie on each side, and the undivided supracaudal scute is downturned between the last two of the somewhat expanded maginals. The plastral formula is : abd > fem > pect > hum > gul > an. (Ernst and Barbour, 1989). The carapace is brownish yellow, greenish yellow or bright yellow, and the plastron has the same color range with each scute of both carapace and plastron frequently blotched with black. The head is pale yellow, except during the breeding season when both sexes have bright pink coloration around the nostrils and eyes (Das, 1991). It is possible that the pink color results from an increased vascularization of the sensory system associated with sex and

species recognition - i.e., the olfactory and visual systems (Pritchard, 1979). Males attain a maximum of 33.0 cm carapace length and females 28.9 cm. A 23.8 cm male weighs 1.77 kg. Males also have large tail nails (Das, 1991), thicker tails and deeper anal notches, to help breeding performance, than do females (Ernst and Barbour, 1989).

2.2 Distribution range

Indotestudo elongata ranges from Nepal, Bangladesh and northeastern India (Jalpaiguri, East Bengal, and Singhbhum in Bihar) southward through Myanmar, Laos, Thailand, Cambodia and Vietnam to Penang, Malaysia (Ernst and Barbour, 1989). The species is also found in China (Guangxi) (Zhao and Adler, 1993). Thirakhupt and van Dijk (1994) reported that the yellow tortoise is by far the most widespread turtle species in western Thailand.

2.3 Natural Habitat

Yellow tortoises are usually found on hills, mountains (Taylor, 1970) or on high plateaus (Nutaphand, 1979), where the vegetation types are tropical evergreen and tropical deciduous (Auffenberg and Iverson, 1979). Gairdner (in Smith, 1931) noticed that capability to this tortoise has for withstand extreme heat. Swindells and Brown (in Ernst and Barbour, 1989) reported that *Indotestudo elongata* can withstand an air temperature up to 48° C .

2.4 Diet

Nutaphand (1979) reported that this tortoise feeds mainly on plants, fungi and slugs. However, little is recorded about the diet of this species in the wild, though flowers and fallen fruits are known to be consumed (Das, 1991).

2.5 Status

The yellow tortoise is categorized as vulnerable in the IUCN RED LIST 1996 and is listed under Appendix II of CITES, which implies that it may be subject to monitored international trade, and consignments must be accompanied by proper papers from the countries of origin (Das, 1991). In Thai Wildlife Protected Law 1992, this species is listed in Wildlife Protected list 2.

Van Dijk (in Jenkins, 1995) reported that all three Thai tortoises have been hunted intensively, mainly for local consumption, to such an extent that populations of the elongated Tortoise collapsed in the 1970s and have not recovered. Puginier (in Jenkins, 1995) reported that the price of elongated tortoises in a market in northern Thailand ranges from 90 baht to 300 baht per tortoise depending on size.

2.6 Home range

The home range of an animal was first defined by Burt (1943) as the area traversed by the individual in its normal activities of food gathering, mating, and caring for young. Many biologists have defined the term "home range" in other ways, as follows:

Dice (1952) suggested that the area over which an individual animal habitually travels while engaged in his usual daily activity may be called its home range. Its nest, bed, or roosting place must be situated at some place inside this home range. The home range also includes all the feeding sites, breeding sites, and places of refuge habitually used by the individual, and all the other areas regularly traversed by them. Many reptiles, amphibians, and fishes are also known to restrict their activities to more or less fixed home range.

Clarke (1954) stated that many kinds of animals are known to establish a center of operation for themselves and to confine their roamings within certain boundaries. The area within which an animal tends to stay is known as its " home range".

Colinvaux (1973) suggested that all animals, except perhaps the drifting creatures of open water must have their own special places in which to live. Commonly an animal may have a resting place, where it spends much time sleeping, digesting or rearing young and a larger area of familiar ground in which it finds its food. It is natural to call this tract of familiar ground its home range.

Ricklefs (1973) stated that home range is an area from which intruders may or may not be excluded to which an individual restricts most of its normal activities.

Kendeigh (1974) defined that a home range is that area regularly traversed by an individual in search of food and mates and caring for young but is not defended.

Smith (1974) discussed that home range is the area in which an animal normally lives and it is not necessarily associated with any particular type of aggressive behavior.

Odum (1983) stated that individuals, pairs, or family groups of vertebrates and the higher invertebrates commonly restrict their activities to a definite area, called the home range.

Pianka (1983) discussed that the area or volume over which an individual animal roams during the course of its usual daily wanderings and in which it spend most its time is the animal 's home range.

Forman and Godran (1986) stated that the home range of an animal is the area around its home (e.g., nest, den, or burrow) that is used for feeding and other daily activities.

Ehrlich and Roughgarden (1987) defined home range as an area through which mobile animals regularly move in the course of their normal activity.

Variations in the size of home range are associated with the species, sex, and age of the animal, with the season, and with such ecological conditions as available food and intraspecific strife (Smith, 1974). In poor habitats the home range would be larger than in more adequate habitats (Dice, 1952). The overall size of the home range is influenced by food resources, mode of food gathering, body size, and metabolic needs. In general, carnivorous animals require a larger home range than herbivorous and omnivorous animals of the same size. Males and adults have larger home ranges than females and subadults (Smith, 1992).

The home range size of males are generally larger than of females in some species of tortoises such as *Gopherus polyphemus* (McRae, Landers and Garner, 1981), *G. agassizii* (O'Connor et al., 1994) and *Testudo hermanni* (Calzolai and Chelazzi, 1991). In the terrestrial turtle *Terrapene ornata*, there is no significant differences in home range size between sexes (Nieuwolt, 1996).

2.7 Activity Pattern

In terrestrial turtles, the yearly activity pattern is often affected by the necessity of a period of hibernation or estivation. In temperate areas most terrestrial turtles have the highest activity peak in spring, but in xeric habitats the highest peak occurs during rainy periods. The seasonal activity reflects the sum total of daily activities throughout the season. The daily

activity cycle is in large part a response to temperature and moisture conditions rather than to light. The mean daily movement of individual tortoises, regardless of species, seems to be greatest in populations where the shelter is apart from the feeding ground, or where food plants are scarce or widely scattered (Auffenberg and Iverson , 1979).

Activities of some species of tortoises were studied, such as *Testudo hermanni* by Calzolai and Chelazzi (1991), *Gopherus polyphemus* by McRae et al. (1981) and *Gopherus agassizii* by O'Connor et al. (1994), it was found that the males are more mobile than the females, but in *Terrapene carolina bauri* the activity patterns between males and females are similar (Dodd, Franz and Smith, 1994).

2.8 Radio – telemetry

The first radio-tracking technique was used for wildlife study nearly three decades ago (White and Garrot, 1990). The researchers, out of sight and hearing, follow the movement of the animal using portable radio receivers attuned to the transmitter signal of a target animal. The researcher may be on the ground, in a vehicle, or in aircraft, depending on how far and over what terrain the animal moves (Forman and Godran, 1986).

Biologists utilized animal radio tags for two main purposes : to locate study animals in the field, and to transmit information on the physiology or behavior of wild or captive animals. These uses can be described, respectively, as "radio tracking" and " radio telemetry", the latter term being derived from Greek words for distance and measurement (Kenward, 1987).

In Thailand, the radio-tracking technique was used in studying wildlife for the first time by Tsuji, Poonswad and Jirawatkavi in 1987, in a study of hornbills at Khao Yai National Park. In 1988, Ponsena used this

technique to study Green peafowl in Huai Kha Khaeng Wildlife Sanctuary. In 1990, Rabinowitz used this technique to study large carnivores in Hua Kha Khaeng Wildlife Sanctuary, while Prayursiddhi radio-tracked wild cattle in the same area during 1992-1996.

The radio-telemetry technique has been used in studying some species of turtles, such as *Gopherus polyphemus* by McRae et al. (1981), *G. agassizii* by O'Connor et al (1994), *Testudo hermanni* by Calzolai and Chelazzi (1991), *Terrapene ornata luteola* by Nieuwolt (1996), *Deirochelys reticularia* by Buhlmann (1995) and *Trionyx muticus* by Plummer and Shirer (1975).

2.9 Minimum Convex Polygon

Mohr (1947) (in White and Garrot, 1990) stated that minimum convex polygon is the oldest and most common method of estimating home range. The minimum area polygon is constructed by connecting the outer locations to form a convex polygon, and then calculating the area of this polygon. The adventage of the convex polygon are (1) simplicity, (2) flexibility of shape, and (3) ease of calculation (White and Garrot, 1991). Although it is more robust than other techniques when the number of locations is low, it does have a number of disadvantages. The range boundary encompasses all the locations, including occasional locations well beyond the main area of activity (Harris et al., 1990).

This method was used in studying home range of some species of turtle such as *Terrapene ornata luteola* by Nieuwolt (1996), *G. agassizii* by O'Connor et al (1994) and *G. polyphemus* by McRae et al. (1981).