POPULATION ECOLOGY OF THE ELONGATED TORTOISE *Indotestudo elongata* (Blyth, 1853) AT BAN KOK, KHON KAEN PROVINCE

Mrs. Kanlaya Sriprateep

A Dissertation Submitted in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy Program in Biological Sciences
Faculty of Science
Chulalongkorn University
Academic Year 2010

นิเวศวิทยาประชากรของ *Indotestudo elongata* (Blyth, 1853) ที่บ้านกอก จังหวัดขอนแก่น

นางกัลยา ศรีประทีป

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรดุษฎีบัณฑิต
สาขาวิชาวิทยาศาสตร์ชีวภาพ
คณะวิทยาศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2553

Thesis Title	POPULATION ECOLOGY OF THE ELONGATED TORTOISE *Indotestudo elongata (*Blyth, 1853) AT BAN KOK, KHON KAEN PROVINCE
By	Mrs. Kanlaya Sriprateep
Field of Study	Biological Sciences
Thesis Advisor	Associate Professor Kumthorn Thirakhupt, Ph.D.
Thesis Co-advisor	Varanya Aranyavalai, Ph.D.

Accepted by the Faculty of Science, Chulalongkorn University in Partial Fulfillment of the Requirements for the Doctoral Degree

…………………………………………...Dean of the Faculty of Science
(Professor Supot Hannogbua, Dr.rer.nat.)

THESIS COMMITTEE

……………………………………………….. Chairman
(Assistant Professor Duangkhae Sitthicharoenchai, Ph.D)

……………………………………….……. Thesis Advisor
(Associate Professor Kumthorn Thirakhupt, Ph.D.)

……………………………………………….. Thesis Co-advisor
(Varanya Aranyavalai, Ph.D.)

……………………………………………….. Examiner
(Assistant Professor Art-ong Pradatsundarasar, Ph.D)

……………………………………………….. Examiner
(Professor Thaweesakdi Boonkerd, Ph.D.)

……………………………………………….. External Examiner
(Kampanat Tharapoom, Ph.D.)

……………………………………………….. External Examiner
(Anchalee Aowphol, Ph.D.)

กัลยา ศรีประทีป : นิเวศวิทยาประชากรของ *Indotestudo elongata* (Blyth, 1853) ที่ บ้านกอก จังหวัดขอนแก่น. (POPULATION ECOLOGY OF THE ELONGATED TORTOISE *Indotestudo elongata* (Blyth, 1853) AT BAN KOK, KHON KAEN PROVINCE) อ. ที่ปรึกษาวิทยานิพนธ์หลัก : รศ. ดร. กำธร ธีรคุปต์, อ. ที่ปรึกษาวิทยานิพนธ์ร่วม: อ. ดร. วรัญญา อรัญวาลัย 167 หน้า.

การศึกษานิเวศวิทยาประชากรของเต่าเหลืองที่บ้านกอก จังหวัดขอนแก่น ได้ดำเนินการเมื่อปี พ.ศ. 2550-2553 จากการนับจำนวนในประชากรทั้งหมดพบว่ามีเต่าเหลือง 1,195 ตัว ประกอบด้วยตัวผู้ 396 ตัว ตัวเมีย 369 ตัว และที่ไม่สามารถจำแนกเพศได้ 430 ตัว พบว่ามีความหนาแน่นประชากรเท่ากับ 2.43 ตัวต่อเฮกเตอร์ อัตราส่วนเพศผู้ต่อเพศเมียเท่ากับ 1.07: 1 การศึกษาโครงสร้างอายุของประชากรพบว่า เต่าอายุในช่วงต้นๆมีเป็นจำนวนมากแต่มีเพียงเล็กน้อยเท่านั้นที่สามารถพัฒนาเป็นตัวเต็มวัยได้ ส่วนเต่าวัยเจริญพันธุ์มีจำนวนมากและมีความเสี่ยงต่ออุบัติเหตุต่างๆเช่น ถูกรถทับ และถูกไฟไหม้จากการเผาขยะ เป็นต้น การศึกษาอัตราการเติบโตพบว่า juvenile และ sub-adult มีการเติบโตอย่างรวดเร็ว และลดลงเมื่อเข้าสู่วัยเจริญพันธุ์ ตัวผู้เข้าสู่วัยเจริญพันธุ์เมื่อมีอายุน้อยและมีขนาดเล็กกว่าตัวเมีย การเปลี่ยนแปลงรูปร่างของเต่าจะเกิดขึ้นมากขณะเข้าสู่วัยเจริญพันธุ์และนำไปสู่ความแตกต่างระหว่างเพศซึ่งพบทั้งหมด 29 ลักษณะ ตัวเมียมีขนาดใหญ่และมีความกว้างของกระดองบนและกระดองล่างมากกว่าตัวผู้ พฤติกรรมการสืบพันธุ์เริ่มตั้งแต่เดือนพฤษภาคมถึงเดือนสิงหาคม ฤดูการวางไข่เกิดขึ้นในช่วงปลายฤดูฝนประมาณเดือนตุลาคมถึงเดือนมีนาคม จำนวนไข่เฉลี่ย 4.53 ± 2.26 ใบต่อรัง (1-9 ใบ, N = 23 รัง) ตัวเมียออกไข่ได้มากกว่า 1 ครั้งใน 1 ปี ลูกเต่าออกจากไข่ในช่วงฤดูฝนประมาณปลายเดือนเมษายนถึงเดือนมิถุนายน การประสบความสำเร็จในการฟักเป็นตัวในสภาพธรรมชาติสูงแต่อัตราการอยู่รอดค่อนข้างต่ำ สาเหตุการตายของลูกเต่าในพื้นที่ศึกษาได้แก่ ถูกรถทับ ถูกเหยียบย่ำโดยวัวและควาย และตายโดยไม่รู้สาเหตุ อาหารที่เต่าเหลืองบริโภคพบว่ามีหลากหลายชนิดได้แก่ ใบอ่อนของพืชล้มลุกชนิดต่าง ๆ ผลไม้ เห็ด หญ้า ไส้เดือนดิน ซากสัตว์ เศษอาหารและมูลสัตว์ ทั้ง juvenile และ adult กินอาหารประเภทเดียวกัน จากการสังเกตไม่พบศัตรูธรรมชาติของเต่าเหลืองในพื้นที่ศึกษา และไม่พบปรสิตตามภายนอกร่างกายของเต่า แต่พบพยาธิตัวกลมและพยาธิเส้นด้ายจำนวนมากจากมูลเต่า จากข้อมูลทั้งหมดแสดงให้เห็นว่าประชากรของเต่าเหลืองที่บ้านกอกไม่ได้อยู่ในสภาวะที่ถูกคุกคามอย่างรุนแรงอย่างไรก็ตามจำนวนประชากรของเต่ามีความหนาแน่นสูงมากกว่าในธรรมชาติหลายเท่า และมีการตายของเต่าวัยอ่อนโดยไม่ทราบสาเหตุสูงมาก ดังนั้นการติดตามข้อมูลในด้านต่างๆ และการจัดการในระยะสั้นและระยะยาวจึงควรมีการกระทำอย่างต่อเนื่อง

สาขาวิชา……วิทยาศาสตร์ชีวภาพ……ลายมือชื่อนิสิต……………………………..………….....
ปีการศึกษา…………2553……………ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์หลัก…...................
ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์ร่วม….. ....

4973803623 : MAJOR BIOLOGICAL SCIENCES
KEYWORDS : *Indotestudo elongata*/ POPULATION/ GROWTH/ REPRODUCTIVE/ DIET

KANLAYA SRIPRATEEP : POPULATION ECOLOGY OF THE ELONGATED TORTOISE *Indotestudo elongata* (Blyth, 1853) AT BAN KOK, KHON KAEN PROVINCE. ADVISOR: ASSOC.PROF. KUMTHORN THIRAKHUPT, Ph.D., CO-ADVISOR: VARANYA ARANYAVALAI, Ph.D., 167 pp.

Population ecology of the elongated tortoise *Indotestudo elongata* was studied at Ban Kok Village, Khon Kaen Province, northeastern Thailand, from 2007-2010. A total of 1,195 tortoises; 396 males, 369 females, and 430 unsexed juveniles were captured by total count method. Population density in a study area of 492 ha was 2.25 individuals per ha. The age and size structure exhibited normal pattern and the average sex ratio (males: females) was 1.07: 1. The early stage and adult stage were high. Only a small number of young tortoises in each class could develop to replace the higher class of population. Tortoises at any stage had a risk from various causes such as from car accident, fire from burning and landscape modification by local people. The growth rates were more rapid during juvenile and sub-adult stages and decreased markedly at adult stage. Males reached sexual maturity at a smaller size and less age than females. Ontogenic changes, distinguished by a marked decrease or increase of allometric growth after tortoises reach sexual maturity, led into sexual dimorphism in 29 characters. Females displayed larger size and had relatively wider carapace and plastron than males. Mating behavior started from May to August. Laying egg occurred at the end of the rainy season (October) until March. Hatchlings emerged at the beginning of the following rainy season (April to June). Female could produce more than one clutch in a season. Mean clutch size was 4.53 ± 2.26 per clutch. Percentage of hatching success was high but survival rate was low. The causes of mortality of hatchlings in the study area were from car traffic, trampling by large cattle, and unknown cause. This species could consume a variety of foods such as herbaceous leaves, fruits, mushroom, grass, earthworm, carcass, food particles and animal excrement. Both juveniles and adults could feed on the same food types. Predator was not found in the study area. There were no ectoparasites on tortoise body, whereas nematodes (round worm and thread worm) were observed from fecal samples. Results of this study indicated that elongated tortoise population at Ban Kok Village has not been threatened severely. However, short term and long term monitorings should be continuously conducted.

Field of Study : Biological Sciences　　Student's Signature ....

Academic Year : 2010　　Advisor's Signature ....

Co-advisor's Signature ....

ACKNOWLEDGMENTS

I would like to express the deepest appreciation to my thesis advisor, Associate Professor Dr. Kumthorn Thirakhupt for his encouragement, invaluable advice and help throughout my Ph.D. study. My grateful thanks to Dr. Varanya Aranyavalai, co-advisor, Assistant Professor Dr. Art-ong Pradatsundarasar, Professor Dr. Thaweesakdi Boonkerd, Dr. Kampanat Tharapoom and Dr. Anchalee Aowphol, member of thesis committee for their guidance, encouragement, valuable supervision and critical reading of the thesis.

This study cannot be completed without a wonderful help from field assistants and the villager at Ban Kok Village, I would like to thank all of them. Special thanks to members of the Thai Turtle Laboratory for their help and encouragement. This work was supported by the Collaborative Research Network (CRN), Ministry of Education, Thailand; Khon Kaen University and the Center of Excellence in Biodiversity, Faculty of Science, Chulalongkorn University CEB_D_15_2008. Finally, I would like to thank my family, especially my parents, Assistant Professor Dr. Keartisak Sriprateep (my husband), sister and aunt for their understanding and support.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Elongated tortoise, *Indotestudo elongata* (Blyth, 1853), belongs to the Class Reptilia, Order Testudines and Family Testudinidae. This species ranges from Nepal, Bangladesh, India, China, Myanmar, Thailand, Laos, Cambodia and Vietnam to Malaysia (Ernst and Barbour, 1989). It has been found in most part of Thailand, except Bangkok and surrounding provinces (Nutaphand, 1979). The elongated tortoise is categorized as an endangered species on the IUCN Red List of Threatened Species (2007), and is listed under the Appendix II of CITES. In addition, it is a protected species under the Thai Preservation and Protection of Wild Animals Act (No.2), B.E. 2546.

At Ban Kok Village, Mancha Khiri District, Khon Kaen Province, there is a population of *I. elongata* living with the local people. In the past, most area of this village was deciduous forest mixed with bamboo where the bamboo shoot was the main diet of the tortoise. About 20 years ago, human population has been expanding, therefore, the population of elongated tortoises has been threatened due to habitat destruction. However, the belief in spirit and the way of life of the villagers that do not eat and do not harm tortoises can protect them from hunting.

At present, the coexistence between the people and the tortoises here is interesting to tourism because a large number of wild tortoises living with the villagers. Some of these tortoises are local specimens that have been living in the village, while the others (about 2,000 tortoises) were introduced from surrounding areas (Chalad Kenanan, **interview**, April 20 2009). Because of no natural predator capable to kill the adults, the population of tortoise in the village is much higher than in the wild. However, the growth of the society such as road networks, agricultural area expansion and urban developments, in conjunction with fluctuating environmental conditions could affect the structure and finally the existence of this tortoise population. Accurate information about the biology and life history of *I. elongata* could provide instruction for establishing plans for the conservation and sustainable management of the indigenous population. Information on the life history of this species has been the subject of few studies (Nutaphand, 1979; Auffenberg and Iverson, 1979; Thirakhupt and van Dijk, 1994; Tharapoom, 1996; van Dijk, 1998). However, the information on growth, ontogeny and sexual dimorphism of this tortoise species is scarce. Besides, basic information and ecological data on reproduction of this species are not available. Thus, more study is need to understand the biological process and to protect this species. A complete field study will provide good base-line data for conservation management in the future. Although previous studies in western Thailand involved with the reproduction of this species (van Dijk, 1998), those data were not completed because the sample size was not enough. For the diet of tortoise, fews were observed and reported by van Dijk (1998), Nutphand, and Das (1991). The study on diet and reproductive biology of the elongated tortoise population at Ban Kok Village, Khon Kaen Province are suitable for the study due to the large population size of elongated tortoises naturally living under the protection by local people.

The study on population ecology and reproductive biology of this tortoise species is urgently needed for the purpose of conservation and tourism management. Therefore, the aim of this study is to study population size, population structure, growth, sexual dimorphism, ontogenic change, reproductive biology, and diet of the elongated tortoise at Ban Kok Village, Khon Kaen Province in order to provide ecological data on *I. elongata* which will be a basis for the proper conservation and tourism management plan for this species. The results will provide basic knowledge on population ecology and reproductive biology of *I. elongata* at Ban Kok Village, Khon Kaen Province and will be used for conservation and sustainable tourism management in the future.

CHAPTER II

LITERATURE REVIEW

Turtles are reptiles that descended from ancient animals which evolved a shell from over 200 million years ago. The earliest-known turtles are in Late Triassic (210 MYA) (Pough *et a*l., 2004). The conspicuous of turtles are shell morphology which reflects the ecology of each turtle species (Zug, Vitt, and Caldwell, 2001; Srinarumol, 1995). Many terrestrial turtles have high domed shell while aquatic and marine turtles have relatively flat streamlined shell (Pough *et al*., 2004). Tortoises are the members of the Family Testudinidae. They have well-developed, high domed shells and elephantine hindlimbs (Zug, Vitt, and Caldwell, 2001).

Indotestudo elongata is one of the tortoise species. It was first described as *Testudo elongata* by Blyth (1853) from “Arakan” in western Myanmar, apparently based on four syntypes (ZSI796, 798, 799 and 800) in the collection of the Zoological Survey of India in Calcutta (Das, Dattagupta and Gayen, 1998). Lindholm (1929) first recognized the distinctiveness of *Testudo elongata* and designated it as the type species of his new Subgenus *Indotestudo.* In 1957, Loveridge and Williams supported the recognition of the Subgenus *Indotestudo* (under Genus *Geochelone*), and included *elongata, forstenii* and *travancorica* therein. Bour (1980) subsequently elevated *Indotestudo* to full generic rank (including the same three species), a position supported by the cladistic analyses of Crumly (1982, 1984).

Two common names of *I. elongata* 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 Thai local names such as Tao Laung, Tao Tien, Tao Khanaeng and Tao Pek (Nutaphand, 1979).

Elongated tortoise is a medium size tortoise. Typically, they are about 32 cm long and 3.5 kg as an adult though there are larger specimens (Moll, 1989). The carapace is highly domed and dorsally-flattened with almost vertically descending sides. The 1st vertebral scute is about as broad as long, but the 2nd – 5th vertebral scute are broader than long. Well-defined growth annuli are present at the flat vertebral and pleural scutes. Usually 11 marginals lie on each side, and the undivided supracaudal scute is downturned between the last two of the somewhat expanded marginals. The carapace is yellowish brown or olive, with black blotches on the vertebrals and pleurals. The well-developed plastron has a deep anal notch. Its forelobe tapers anteriorly and is shorter and narrower than the hindlobe. The plastral formula is: abdominal > femoral > pectoral > humeral > gular > anal. The gular is somewhat thickened, and the bridge is wide with a small axillary and a larger inguinal scute (Ernst and Barbour, 1989).

The head is moderate with no protruding snout and a weakly hooked, tricuspid upper jaw. Its large prefrontal scale is longitudinally divided, and followed by a large frontal scale which is often subdivided while other head scales are small. The head is pale cream to yellowish green without dark spots or blotches. During the breeding season, the skin around the eyes and nostrils becomes bright pinkish red. Limbs are brown to olive. The anterior surface of the forelimb is covered with small to moderate overlapping scales (Ernst and Barbour, 1989).

A male has a longer and thicker tail and a concave plastron with shallow V-shaped anal notch while a female has a shorter tail and a flat plastron with a deep U-shaped anal notch (Ernst and Barbour, 1989). The species ranges from Nepal, Bangladesh, northeastern India (Jalpaiguri, East Bengal and Singhbhum in Bihar), China, Myanmar, Thailand, Laos, Cambodia, Vietnam, to in west of Malaysia (Ernst and Barbour, 1989). In Thailand, *I. elongata* has been found in every part of Thailand, except Bangkok and surrounding provinces (Nutaphand, 1979). The most widespread of this species is in western Thailand; however, its populations appear to have crashed in the last 10 to 15 years and nowadays it is nowhere common (Thirakhupt and van Dijk, 1994).

Elongated tortoise lives mainly in forests on high plateaus or in mountainous regions (Nutaphand, 1979), where the vegetation types are tropical evergreen and tropical deciduous (Auffenberg and Iverson, 1979). It is the most common terrestrial turtle found in Thailand, and even though it does not enter the water, it likes cool and humid areas (Nutaphand, 1979). Smith (1931) reported that *I. elongata* can withstand extreme heat. Tharapoom (1996) studied the radio-telemetry of home range size and activities of elongated tortoise at Huai Kha Khaeng Wildlife Sanctuary, reported that the median year-round home range sizes were about 0.2 km^2 and 0.15 km^2 in males and females, respectively. The home range sizes of males and females were not significantly different both in the dry and the wet seasons. Both male and female tortoises spent most of the daytime hiding and were more active in the wet season than in the dry season. They utilized different types of forests but were mostly found in the mixed-deciduous forest. Resting places are typically located under undergrowth and near fallen tree trunks and branches. In 1998, van Dijk studied this species in a hill forest mosaic in western Thailand. He found that elongated tortoise were scarce. Their population size was about 615 tortoises with 5 square kilometer. The population density was 123 tortoises per square kilometer or 1.23 tortoises per hectare. Mature adults and hatchlings were mainly population while juveniles were uncommon.

The diets of elongated tortoises in the wild are fruits and flowers (Das, 1991), but Nutaphand (1979) reported that this species feeds mainly on plants, fungi and slugs. From the direct observation of feeding elongated tortoises and fecal samples, van Dijk (1998) found that this species feed on a variety of plant leaves, fruits, seeds mushrooms snails or snail shells, leaf stalks, tubers and sand.

The elongated tortoise is commonly found in the Asian food markets and as a result of this, it is under dire pressures in its entire range. It is the most common tortoise shipped to the Chinese food markets from Vietnam (Hendrie, 1998). Jenkins (1995, cited in van Dijk, 1998) reported that all three Thai tortoises had been hunted intensively, mainly for local consumption, to such an extent that populations of the elongated tortoise collapsed in the 1970; and since then they have not yet recovered. It is categorized as endangered species on the IUCN Red List of Threatened Species (IUCN, 2007), and listed on Appendix II of CITES. In addition, it is a protected species under the Thai Preservation and Protection of Wild Animals Act (No.2), B.E. 2546.

Das (1991, 1995) reported that the nesting time of this species was from June to October with 1-7 elongated eggs comprise a clutch while van Dijk (1998) assumed that females oviposited in the late rainy season from September to October with 1-5 eggs per clutch and hatchlings emerged at the start of the following rainy season. Monitor lizards, *Varanus* spp., prey on eggs and juveniles (van Dijk, 1998). At Ban Kok Village this species was reported by Sutthitham and others (1996) that females laid eggs in the dry season from November to December with 4-5 eggs per clutch and hatchlings emerged in March to April. The eggs took 60-180 days to hatch. Besides, they surveyed the population of *I. elongata* in 1996 and reported that the population consisted of 364 mature adults, 116 juveniles and 24 hatchlings. Other detailed study concerning the population ecology and reproductive biology of this species at Ban Kok Village has not been conducted.

CHAPTER III

POPULATION SIZE AND POPULATION STRUCTURE OF THE ELONGATED TORTOISE *Indotestudo elongata* (Blyth, 1853) AT BAN KOK VILLAGE, NORTHEASTERN THAILAND

ABSTRACT

Density and population structure of the elongated tortoise *Indotestudo elongata* were investigated at Ban Kok Village, Khon Kaen Province, Thailand during an active season from May to August 2009. A total of 1,195 tortoises; 396 males, 369 females, and 430 unsexed juveniles was captured. The population density assessed by total count method in a study area of 492 ha was 2.43 ind. per ha. Size and age structures differed significantly among individuals of the elongated tortoise population. Approximately, 54.48% of the populations are adults which are more than 20 years old, suggesting that juveniles of the elongated tortoise are very sensitive to threats. For the better understanding, this population should be observed in longer period of time.

Key words: *Indotestudo elongata*, Population structure, Tortoise.

INTRODUCTION

The Elongated tortoise, *Indotestudo elongata*, belongs to Order Testudines and Family Testudinidae. This species ranges from Nepal, Bangladesh, India, China, Myanmar, Thailand, Laos, Cambodia, and Vietnam to Malaysia (Ernst and Barbour, 1989). It is categorized as an endangered species on the IUCN Red List of Threatened Species (IUCN, 2007), and listed on Appendix II of CITES. This species has been commonly found in the Asian food markets and it is the most common tortoise shipped to the Chinese food markets from Vietnam (Hendrie, 1998). Jenkins (1995, cited in van Dijk, 1998) reported that this species is one of the three Thai tortoises that has been hunted intensively, mainly for local consumption to such an extent that populations of the elongated tortoise collapsed in 1970, and since then they have not yet recovered. In 1994, Thirakhupt and van Dijk found that the population of the elongated tortoise is still widely distributed in the hills of western Thailand; however, its population appeared to have crashed in the last 10 to 15 years and nowadays, it is nowhere common.

There is one village in Thailand that has many elongated tortoises living with the local people. In the past, most area of this village was deciduous forest mixed with bamboo where the bamboo shoot was the main diet of the tortoise. Sutthitham *et al*. (1996) reviewed about the tortoise village since the settlement of humans in 1767. This area composed of a variety of plants such as *Azadirachta indica*, *Cananga odorata*, *Shorea obtusa*, *Shorea siamensis*, *Plerocarpus indicus*, *Dalbergia cochinchinensis*, *Sindora siamensis, Erythrophleum succirubrum*, and many big olives (*Olea europaea*) or Ma-Kok tree that grew inside the village and later its name has become the village name " Ban Kok ". This area has had many elongated tortoises (or Tao Phek which is the local name) living in the area of the village called "Don Phu Tha" for a long period of time. Phi Phek (*Vietnamosasa pusilla*), a species of bamboo was the main plant species of this area in the past and its name has become the local name of this tortoise species. The importance role of tortoises in the ecosystem of this area is to spread the seeds of several plants in its droppings, and consume vegetable, bamboo shoot, mushroom and snail.

This area, tortoises have been protected from exploitation by local people because of the belief in ghosts, the way of life of the villagers, and no natural predator capable to kill the adults. Thus, the population of tortoise has increased to the number that is much higher than in the wild.

Because of a large number of wild tortoises living with the villagers, Ban Kok village is well known for travelers that pass the Highway 2069 (Khonkean- Mancha Khiri route). Therefore, many tourists visit continuously and this leads to the problem of mortality of tortoise due to the car traffic. Thus, since 1993 "tortoise garden" has been constructed and surrounded with concrete structure in the area of "Don Phu Ta" to prevent tortoises from cars. Many tortoises have been collected and put into this garden for the purpose of tourism (Sutthitham *et al*., 1996). When the forest area in the village had been degenerated and modified by villagers, some animals, and plants which are foods of tortoises such as mushrooms, snails, phi phek were decreased. These are the cause that villagers have to buy the food to feed the tortoises in the village. At the same time, the growth of the society such as road networks, habitat loss and urban developments, in conjunction with fluctuating environmental conditions at the present time could affect the structure and finally the existence of this tortoise population. Accurate information about the biology and life history of *I. elongata* will help provide instruction in establishing plans for the conservation and sustainable management of the indigenous population. Although previous studies have dealt with the ecology of *I. elongata* population in western Thailand (Thirakhupt and van Dijk, 1994; Tharapoom, 1996; van Dijk, 1998), but there is only a few data about the studies of its population in Northeastern Thailand, particularly in the area of Ban Kok Village, Khon Kaen Province, Thailand.

The aim of this study is to investigate estimate the population density and the population structure of *I. elongata* at Ban Kok Village, Khon Kaen Province for providing ecological data on *I. elongata* which will be a basis for the proper conservation and tourism management in the future.

METHODOLOGY

Study area: The study area called the “tortoise village” is located at Ban Kok Village, Suan Mon Subdistrict, Mancha Khiri District, Khon Kaen Province, Thailand. The geographic position is approximately at zone 48 238269.36mE 1787990.7 mN with an average of 150 meters above mean sea level (Figure 3.1). The climate of the region is mostly hot and dry influenced by the southwestern monsoon. There are three seasons: summer, rainy and winter. In summer, the weather is hot to very hot and dry which is from the end of February to May. The period of June and October is the rainy season and the duration from October to January is called winter (Suan Mon Sub-district Administration Organization, 2010). The average annual rainfall (1990-2009) is 145.31 mm/year, most occurring from May to October. Air temperature in the hottest month (April) can reach 41.9°C and the minimal temperature is about 6.4°C in December (Thai Meteorology Department, 2010). The human population in the village is about 1,355 with 295 households (Suan Mon Sub-district Administration Organization, 2010). Most people in the village are farmers. They have frequently encountered and suffered with the problem about drought and sandy and salted soil. The general characteristic of Ban Kok Village is the same as other villages in northeastern Thailand. The villagers grow perennial plants, fruits and vegetables in their home gardens of which many kinds are food of the tortoises (Fig 3.2a). Some kind of plants such as *Artocarpus heterophylus, Mangifera indica, Annona squamosa, Morinda citrifolia, Tamarindus indica, Averrhoa carambola, Carica papaya, Psidium guajava, Solanum aculeatissimum, Coccinia grandis, Luffa cylindrical*, etc. are grown (Sutthitham *et al*., 1996). Some areas in the village are covered with the number of relatively small dense vegetations and very scattered plant cover (Fig 3.2b). These plants grow rapidly during rainy season and disappear during dry season. Figure 3.2 shows the view inside the village which is the habitat of the elongated tortoise. In the study area, tortoises are protected from hunting by local people and there is no natural predator capable to kill the adults.

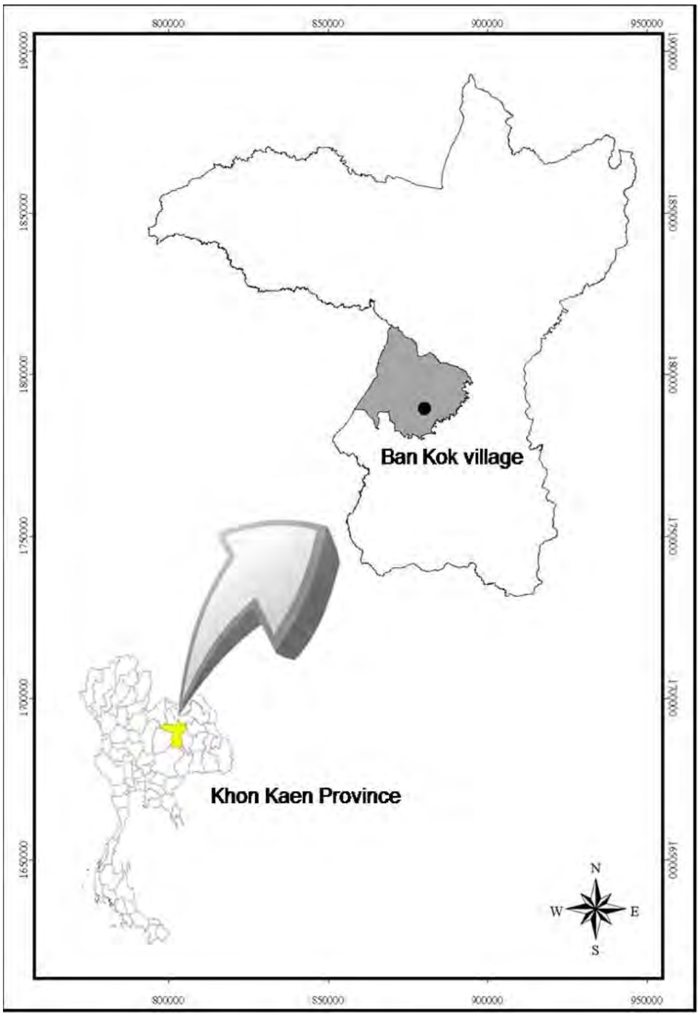


Figure 3.1 Location of Ban Kok Village, Khon Kaen Province, covering 4.92 km^2.

Figure 3.2 The habitats of elongated tortoises in Ban Kok Village. (a) The backyard of a house in the village where villagers grow perennial plants, fruits, and vegetables that are partly food of the tortoises. (b) An area in the village covered with relatively small dense vegetations and very scattered tree coverings, providing habitat and food for tortoises.

Animals: The tortoises were searched for by the total count method of which this procedure assumes a closed population. The study period was carried out during May to August 2009, when there is no new individual added to the population. All elongated tortoises in the village were collected by road cruising, intensive searches, and fortuitous encounters, and individually marked with a magic permanent marker on the marginal scutes which was visible for up to three months. Carapace length (CL) was measured by a digital caliper (accuracy ± 0.1 mm). Aduts, subadults, and juveniles were classified based on secondary sexual characteristics. Males have concave plastron and tail length much longer than females (Fig. 3.3) (Tharapoom, 1996; van Dijk, 1998), and these are generally reliable only after 4 years. Any tortoise without male characteristics was assumed to be a female, and tortoises that could not separate the sex were considered juvenile. Age and size at maturity was estimated by counting the annual rings at the scute and observation in the field based on sexual behavior in both sexes and also based on reproductive status in female (i.e., egg-bearing) (Lagarde *et al*., 2001). The criterion of sexual maturity in male was considered if they displayed copulation with females (Lagarde *et al*., 2001), and in female was considered from its laid egg. The smallest size at maturity for male was 175 mm, ~5-6 years. This size did not completely show all of the external male characteristics. The smallest size at maturity for female was 240 mm, ~ 8 years. In this study, the minimum size at maturity is larger than the minimum size at which sex can be determined the sex. Tortoises with carapace length $\leq$ 190 mm were considered juvenile because their sex could not be separated. Individuals larger than 190 mm in carapace length were considered adults or subadults.

Tortoise age was determined by counting number of scute annuli on the shell (Germano 1988; Germano and Bury 1998; Hellgren *et al*., 2000; van Dijk, 1998; Judd and Rose, 1983). The scute annuli on second right pleural scute were counted (Kaddour *et al*, 2006) and counts were crosschecked with other scutes (Znari, Germanob,and Mace, 2005). A newly hatched animal possessed a central areola with one annulus. All counts were therefore started from the next annulus (Stubbs *et al*., 1984). All individuals born after the first year of each period were not counted. Old tortoises (> 20 years) with indistinct annuli were difficult to assess the age and were grouped into 20 years old.

Statistical analysis

Population size was obtained by total count method. Population density was total number of tortoises with total area. Age and size distributions were compared using Chi-square test.

Figure 3.3 Male and female of the elongated tortoises. Male (left) has longer and thicker tail with concave plastron while female (right) has shorter tail and flat plastron.

RESULTS

Population size and Density

The population size in the village area was estimated to be 1,195 individuals. Thus, the population density was 2.43 individuals / ha (= 243 individuals/km^2). These tortoises included 396 (33.14%) males, 369 (30.88%) females, and 430 (35.98%) juveniles. The sex ratio (male: female) was 1.07: 1. For juvenile, it was not possible to determine sex in the field.

Age structure

The age frequency distribution of tortoise population was shown in Figure 3.4. Most tortoises in the village (44.18%) were more than 20 years old. Small 0-1 year tortoises were encountered up to 30.79%. The age distribution was significantly different between males and females ($P \leq 0.05$). Ages ranged from less than one year to more than 20 years for this site.

Size structure

The study on the size structure of the tortoise population is presented in Figure 3.5. In the graph, juveniles were divided equally between males and females accounted for 35.98% of the total sample. In adult, body size class distribution was significantly different ($P < 0.001$). Adult and subadult males represented 33.14% of the population, whereas adult and subadult females represented 30.88%.

Of the 765 animals, 383 (50.07%) were mature males, 268 (35.03%) were mature females, 13 (1.7%) and 101 (13.2%) were subadult males and females, respectively. The largest male attained 324 mm, and the largest female attained 340 mm. The largest female observed in dead animal attained up to 370 mm in carapace length.

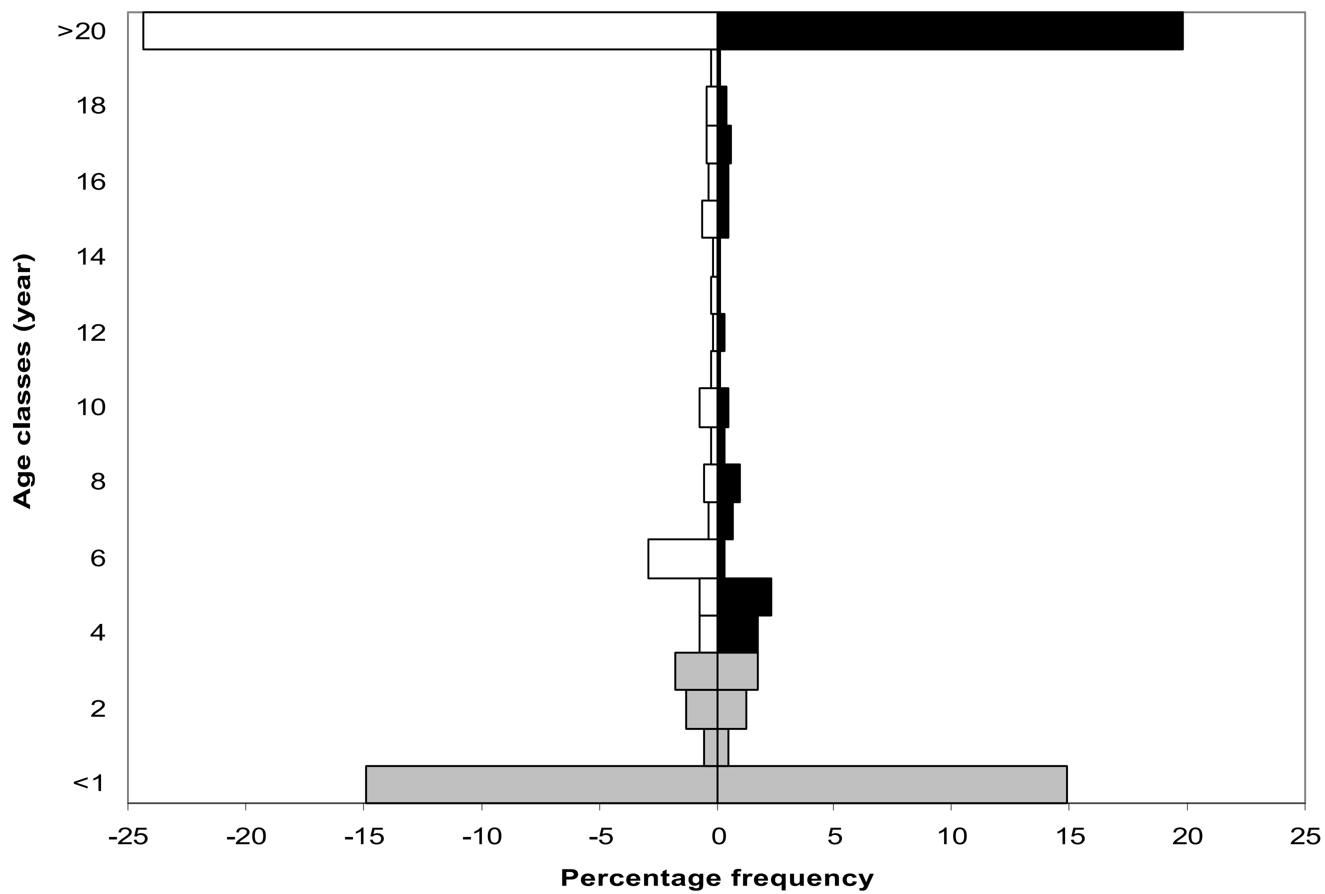


Figure 3.4 Age structure of *Indotestudo elongata* population from Ban Kok Village, Khon Kaen Province, Thailand. The population pyramid shows the percentage frequency of age classes for adult and subadult males (white bars), adult and subadult females (black bars) and juveniles (grey bars). Juvenile at the age up to 4 years cannot be sexed and were equally divided on the graph. Tortoises over 20 years old were grouped togeher.

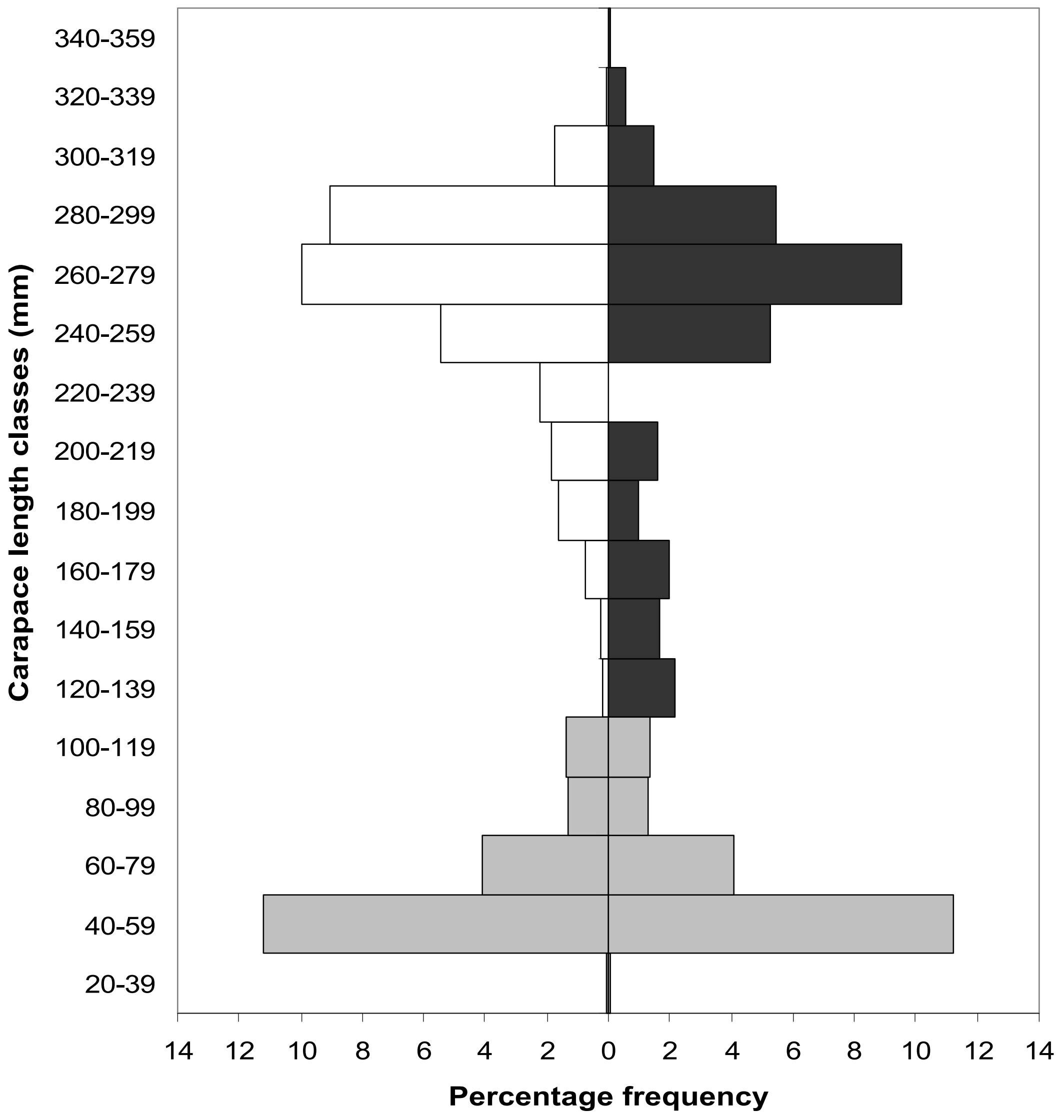


Figure 3.5 Size structure of *Indotestudo elongata* population from Ban Kok Village, Khon Kaen Province, Thailand. The population pyramid shows the percentage frequency of each size class for adult and subadult males (white bars), adult and subadult females (black bars) and juveniles (grey bars). Juveniles have carapace length less than 120 mm cannot be sexed.

DISCUSSION

In addition to the problem of habitat loss due to land development in Ban Kok Village, there is a common question of how many tortoises are living there. In this study, it was found that the population size of the elongated tortoise is about 1,195 individuals and the population density is 2.43 individuals / ha. With this number in an area of 4.92 km^2 it leads to the question whether the population is still increasing in size or not and how they are going to be in the future.

The observed ratio of adult males to adult females in this study is 1.07: 1 which was similar to the 1:1 ratio predicted by Fisher (1930, cited in Lovich and Gibbons, 1990) who originally envisioned a 1:1 sex ratio as evolutionarily stable predicting that parental investment should be equally divided between male and female offspring (Lovich and Gibbons, 1990). If the ratio is considered from the age at maturity (male = 6 yrs old, female = 8 yrs old), the ratio is 1.43: 1 (383 males to 268 females). This sex ratio showed a definite male-bias, older age classes are males more than females. Therefore, the sex ratio of adults will be affected by the age at maturity, with a bias towards the sex which reaches maturity earlier (Lovich, Ernst and McBreen, 1990; Lovichand Gibbons, 1990; Hailey and Willemsen, 2000). The observed maturation in this species was that males larger than 175 mm in carapace length are mature, whereas females greater than 240 mm are mature. Therefore, adult males were more than females due to their shorter time to reach maturity.

In many species of turtles, males and females reach sexual maturity at different sizes and ages (Hulse, 1982; Jones and Hartfield, 1995; Diaz-Paniagua, Keller, and Andreu, 2001; Rouag, Benyacoub, Luca, 2007). This shift from a 1: 1 ratio in mature tortoises is similar to the study of Hulse (1982, 1976) who studied population structure, growth and morphometrics in the turtle, *Kinosternon sonoriense*. He found that males in both populations matured at smaller size and at a younger age than females. At Tule stream, Yavapai County, the observed ratio of mature males to females was 1.9: 1; however, if all sexable turtles were considered the ratio would be 1: 1.1. He explained about this shift from a 1: 1 ratio in mature turtles by the fact that all males larger than 80 mm are mature and their growth rate has slowed down to approximately 1.5 mm/year, whereas the females are still in a period of rapid growth. When females mature at approximately 93 mm, their growth slows down and the sex ratio becomes approximately 1:1. The factors influencing adult population sex ratio are primary sex ratio, differential age at maturity for males and females, differential mortality between sexes, differential migration between sexes and sampling bias (Gibbons, 1990). The biased sex ratio suggests different survival rates of both sexes (Ayaz *et al*., 2007), and in this study it is expected that mortality of females is higher than that of males. Cause of death was not determined, but mortality of females may be caused by mating attempts from many males which lesion were found around the anal of females and the eggs that found in dead body of females in the field. Therefore, injury and infection may lead to the death of females. In *Testudo hermanni*, it was found that increasing of female mortality due to male-bias occurred from wounds following courtship (Hailey, 1990). Moreover, high female mortality may result from increased susceptibility to pathogens, impaired movement, or directly from calcium deficiency (Hellgren *et al*., 2000).

The age and size structure (Figure 3.4 and 3.5) of the elongated tortoise population in this village exhibited similar pattern. This pattern is different from other Chelonian populations (Bourn and Coe, 1978; Znari *et al*., 2005; Kaddour *et al*., 2006; Ayaz *et al*., 2007). The age estimation was one of problems for the tortoises. The non correlation between age and data on scute growth ring was found in the age more than 7 years old, which correspond to the studies of Bertolero, Carretero and Llorente (2005). They assessed the reliability of ring count for age determination in *Testudo hermanni* by direct observations in the field and photograph. They concluded that both of two methods were comparable. For photograph method, tortoises between 0 and 7 years old were reliable, whereas this tended to underestimate age for those between 8 and 11 years olds. Therefore, ring counts are only reliable for juveniles and subadults. In addition, van dijk (1998) found the problem on age estimates for *I. elongata* in a hill forest mosaic in western Thailand. The data on scute growth ring counts showed less than perfect correlation to known age. Tracy and Tracy (1995) studied about the estimating age of *Gopherus agassizii* from scute rings and found that the number of scute growth rings is related more closely to growth than to known age.

The shape of the pyramid (age and size distribution) tends to predict the normal of population in which the pre-reproductive size classes form a relatively small proportion. However, the tortoise is long live animal, thus this result may not be the case, and on the other hand, 54.48% of the adult may not be all old tortoises. Only a few of young tortoises in each class may develop to replace the higher class of population. In contrast, adult tortoises have a risk for various accidents such as from car accident, burning a rubbish and land development by human. Thus, this species should be monitored continuously in order to maintain its survivorship. The result also indicated that the survival rate of juvenile was low. Thus, survivorship curve of this population should be a concave type or type III. This type, there is very high mortality among the young age classes while adult survivorship is relatively high and nearly constant (Rockwood, 2006).

The majority of tortoises found in the village were adults. Small tortoises (< 1 year) were also easily encountered, because it was the period of hatching during the early and middle rainy season. Such a distribution that is highly biased toward old individuals may be because they suffer high mortality at the early stages of their life history (Chen Tien-His, and Lue Kuang-Yang, 1999), especially after hatching (0-1 year). Car accident, trampling by large ungulates (such as cow and buffalo), food availability and the environmental condition in the village which is unsuitable for small tortoises, are the causes of mortality of juveniles and small tortoises in the study area. The mortality due to unknown causes was also high in juveniles and could be the most important death cause. The causes of mortality in neonates studied by Adest *et al* (1989, cited in Butler and Sowell, 1996) in Bolson tortoise *Gopherus flavomarginatus*. They found that mortality was apparently very high in the nest and hatchling stages, and analyzed that the causes of death of hatchling were sun light, cold decalcification, desiccation, drowning and undetermined. Constantly high or fluctuating mortality appears to be characteristic of immature chelonians in general. Furthermore, the mortality of tortoises due to unknown causes was a case in the study. The mortality of tortoises occurred due to natural causes may vary among years, probably as a function of the climatic fluctuations (Keller, Diaz-Paniagua, and Andreu. 1998). Long-Term monitoring of this population is required for better understanding of its demographic trend and for future conservation management.

CHAPTER IV

GROWTH, ONTOGENIC CHANGE, AND SEXUAL DIMORPHISM OF THE ELONGATED TORTOISE *Indotestudo elongata (*Blyth, 1853) AT BAN KOK VILLAGE, NORTHEASTERN THAILAND

ABSTRACT

Growth, ontogeny and sexual dimorphism in a population of *Indotestudo elongata* at Ban Kok village were examined. Their growth rates were rapid during juvenile and subadult stages (up to 4-5 yr) and then decreased markedly. The variation in size and shell shape in *I. elongata* during ontogenic development and sexual dimorphism in adult were examined. Univariate method of analysis was used to test for differences in pattern of ontogeny in each age class and each sex. Results indicated that during the development of *I. elongata* from hatchling to adult, ontogenic changes in size and shell shapes of this species exist. These changes, distinguished by a marked decrease or increase of allometric growth after tortoises reached sexual maturity, lead to sexual dimorphism. Morphometric data was analyzed for the presence of sexual dimorphism using student *t*-test and ANCOVA. Our results indicated that females displayed larger size and had relatively wider carapace and plastron than males. Twenty-nine of 120 shell characters were sexually dimorphic. These characters indicated that they could be a result of sexual selection for fecundity and reproduction.

Key words: Elongated tortoise, growth, ontogenic change, sexual dimorphism

INTRODUCTION

Elongated Tortoise *Indotestudo elongata* is a species of tortoise found in Southeast Asia and parts of South Asia. At present, populations of this species are declining in the majority of their habitats. Elongated tortoise is considered as an endangered species on the IUCN Red List 2007 (IUCN, 2007), and listed on Appendix II of CITES (CITES, 2005). Although, this species has been considered as a protected species, large number of this species are widely sold in the Asian food markets (Hendrie, 1998). It is also the most common tortoise to be shipped to the Chinese food markets from Vietnam (Hendrie, 1998). The problems of selling as pet trade, catching for food by local people, and habitat destruction as a result of agricultural intensification, deforestation, and residential expansion have affected to the population of this species. In the past, there had been many tortoises in Thailand because the country is located in the tropical and subtropical zones and is a biologically rich area. Only a few of elongated tortoise populations can be currently considered abundant and free from human disturbance such as the elongated tortoise population at Ban Kok village, Khon Kean, Province, Northeastern of Thailand where tortoises live with the local people. However, the growth of the society such as road networks, habitat loss and urban developments, in conjunction with fluctuating environmental conditions could affect the structure and finally the existence of this tortoise population. Information on the life history of this species has been the subject of few studies (Nutaphand, 1979; Auffenberg and Iverson, 1979; Thirakhupt and van Dijk, 1994; Tharapoom, 1996; van Dijk, 1998). Thus, the study on growth, ontogeny and sexual dimorphism of this tortoise species is important to understand the biological process and to protect this species.

Growth

Growth is the relationship between age and body size. It is an important biological process for most species (Brown, Nacy and Morafka, 2005). In Chelonian, growth is commonly expressed as a function of changes in body size (Andrews, 1982; Chen and Lue, 2002) which body size is an important determinant factor for fecundity and competitive success (Chen and Lue, 2002; Spencer, 2002). Growth rates in most Chelonians indicated that there were highly variable (Kabigumila, 2000; Mushinsky, Wilson, and McCoy, 1994; Znari, Germano, and Mace, 2005; Chen and Lue, 2002; Litzgus and Brooks, 1998a). Thus, they are associated with changes in energy allocation at various life stages (Andrews 1982; Chen and Lue, 2002). During young stage, growth rates are rapid, and decrease after maturation. Several authors have pointed out that after maturation, energy is allocated to reproduction because most reptiles begin reproducing before they reach maximum body size (Chen and Lue, 2002; Znari, Germano and Mace, 2005). The differential energy allotment affects everything from survivorship to lifetime reproductive fitness, such as clutch size, egg size, hatchling size and age at maturity in each sex (Stearns, 1994; Znari, Germano and Mace, 2005; Brown, Nacy and Morafka, 2005). The study about growth of chelonians has been studied widely, because of their long life spans, hard shells, and their have annular rings appearing on the carapace and plastron scutes and these annular rings can be used to estimate the age and growth of the tortoise (Germano, 1988; Zug, 1991; Chen and Lue, 2002; Brook *et al.,* 1997). Generally, the parameters that affect growth rate of tortoises are likely to be the other turtles and reptiles (Auffenberg and Iverson, 1979; Andrews, 1982; Mushinsky, Wilson, and McCoy, 1994). These factors were various intrinsic and extrinsic factors such as maternal condition (Roosenburg, 1996), temperature (Gibbons, 1970; Parmenter, 1981; Sinervo and Adolph, 1989; Reiber, Malekpour and McDaniel, 1999) climate (Henen *et al*., 1998; Loehr, Hofmeyr, and Henen, 2007), incubation environment (Roosenburg and Kelley, 1996; Spotila, *et al*., 1994.), and food resource (Mushinsky, Wilson, and McCoy, 1994; Cagle, 1946; Hluse, 1976; MacCulloch and Secoy, 1983; Avery *et al*., 1993; Brown *et al*., 1994; Chen and Lue, 2002; Hazard, Shemanski, and Nagy, 2009). In chelonians, the carapace length or body weight is a function of changes in body size parameters of growth (Andrew, 1982; Chen and Lue, 2002) which body size is a imperative determinant factor for reproductive features such as reproductive effort and clutch size, as well as for vying success for extent and food resources (Chen and Lue, 2002; Andrew, 1982; Congdon and van Loben Sels, 1991, Brown *et al*., 1994; Litzgus and Brooks, 1998a). The studies on growth of tortoises have been established in many species (Jackson et al., 1978; Mushinsky, Wilson, and

McCoy, 1994; Hailey, and Coulson, 1999; Kabigumila, 2000; Znari, Germano and Mace, 2005) but little is known of *Indotestudo elongata* growth. van Dijk (1998), who studied the natural history of wild *Indotestudo elongata* in western Thailand found that the plastron length corresponded closely to the carapace length in immature and this character was reduced when the animal grew, whereas the weight increased when the length increased. The size of juveniles was rather rounded, and began to develop the characteristic elongated adult shell shape.

Ontogeny

The development of the individual organism from embryo to adult is called ontogeny. It acts as a mechanism of evolutionary change in morphological characteristics (Klingenberg, Neuenschwander, and Flury, 1996; Gould, 1977). The study of ontogeny can tell us about the evolution of a particular morphology (Burke, 1991) and know the direction of sexual dimorphism which may shift during ontogeny (Badyaev, 2002; Beaupre *et al*., 1998). In Diamondback rattlesnake (*Crotalus atrox*) growth trajectories were studied growth trajectories during ontogeny by Beaupre *et al*. (1998). They found that the different between the sexes began to diverge in size beyond sexual maturity. The development in size at different stages of this species might be affected by a variety of behavioral, bioenergetic, and selective forces. The knowledge of the ontogenetic process which underlies adult size dimorphism in elongated tortoises has never been reported. Thus, in this study, ontogenic changes in relation to age were examined in the elongated tortoise.

Sexual dimorphism

In most vertebrates, during early development, male and female are alike in morphology and undergo highly divergent growth to acquire different adult sizes, because of their different roles in reproduction (Badyaev, 2002). Sexual dimorphism is morphological differentiation of adult males and females (Fairbairn, 1997). It is an important pattern because it may indicate fundamental differences in the evolution, behavior, or ecology of males and females in the same population (Trivers, 1976; Anderson and Vitt, 1990; Beaupre *et al*., 1998). The difference between sexes may occur in body size, morphology, coloration, and behavior. For reptiles, these differences are common (Beaupre *et al*., 1998). There are two hypotheses of explanations for the evolution of sexual dimorphism has been proposed. They are sexual selection hypothesis or intraspecific niche divergence and dimorphic niche hypothesis or intersexual niche divergence. Sexual selection hypothesis was considered by Darwin (1871). This hypothesis, differences between sexes evolve when characters that confer an advantage in either competition for mates or mate choice and for reproductive success (Hedrick and Temeles, 1989; Shine, 1989; Fairbairn, 1997). An alternative hypothesis, dimorphic niche or ecological sexual dimorphism was proposed by Darwin in 1874. This alternative was suggested that sexual dimorphism in body size and morphology might evolve to reduce the competition between the sexes for food or intrinsic differences between the reproductive roles of the sexes (Hedrick and Temeles, 1989; Fairbairn, 1997). Beside, they could arise from natural selection for fecundity or parental care (Willemsen, and Hailey, 2003; Shine, 1989). In Chelonia, sexual dimorphism in size and shape often display which have been reported in many species of tortoises (Mcrae, Landers, and Cleveland, 1981; Willemsen and Hailey, 1999; Bonnet, *et al*., 2001; Lagarde, *et al*., 2001; Willemsen and Hailey, 2003; Mann, O'Riain and Hofmeyr, 2006; Zuffi, and Plaitano, 2007; Kaddour *et al*., 2008). Berry and Shine (1980) found that in terrestrial species, males are usually larger than females but in some species, females are larger than males. They analyzed sexual size dimorphism influence by sexual selection for reproductive strategy. For the differences in shape were purposed that they were more likely to be the result of sexual selection than of natural selection for fecundity (Willemsen and Hailey, 2003). Kaddour *et al*. (2001) suggested that at the species level that do not display parental care, the sexual differences in shape shell may be easier to interpret than sexual size dimorphism. For sexual dimorphism of *I. elongata* had been studied in western Thailand (van Dijk, 1998). van Dijk (1998) found mature males have plastron concavity, long tail, whereas, females have flat plastron and shorter tail than males. The proportion of distal cloacal was found that females have cloaca opening close to the tail base more than males. Besides, the anal notch of the plastron is generally V-shaped in juveniles and males but tends to be rounded in mature females. For the supracaudal scute in males tends to extend further downwards.

METHODOLOGY

Study area

The elongated tortoise *I. elongata* is a common tortoise in Northeastern Thailand. The studies on growth, ontogeny and sexual dimorphism were conducted at Ban Kok village, Khon Kaen Province from May 2007 through May 2009. In the past, this site was deciduous forest mixed with bamboo. After the settlement of humans in 1767 (Sutthitham *et al*., 1996), the fertility of forest has been decreased and changed to land field at present (Sutthitham *et al*., 1996). Ban Kok Village is located at Suan Mon Subdistrict, Mancha Khiri District, Khon Kaen Province, Thailand. The geographic position is at zone 48 238269.36 mE 1787990.7 mN with an average of 150 meters above mean sea level. The human population in the village is about 1,355 with 295 households (Suan Mon Sub-district Administration Organization, 2010). The area is covered with the number of relatively small dense vegetations and very scattered plant cover, including perennial plants, fruits and vegetables grew by human of which many kinds are food of the tortoises.

Animals: The *I. elongata* was captured and marked with a magic permanent marker on the marginal scutes which was visible for up to three months. Its carapace, plastron or claw could not be marked by permanent marker because tortoise here is a taboo. Juveniles, sub-adults, and adults were classified based on secondary sexual characteristics. Males have concave plastron and tail length much longer than females (Tharapoom, 1996; van Dijk, 1998), and these were generally reliable only after 4 years. Tortoises that could not be separated the sex were considered juvenile. Sub-adults were considered based on the incomplete development of secondary sexual characteristics. Age and size at maturity were estimated in the field based on sexual behavior in both sexes and also based on reproductive status in female (i.e., egg-bearing) (Lagarde *et al*., 2001). The criterion of sexual maturity in male was considered if they displayed copulation with females (Lagarde *et al*., 2001), and in female was considered from its laid egg.

Tortoise age was determined by counting number of scute annuli on the shell (Germano 1988; Germano and Bury 1998; Hellgren *et al* 2000; van Dijk, 1998; Judd and Rose, 1983). The scute annuli on second right pleural scute were counted (Kaddour *et al*, 2006) and counts were crosschecked with other scutes (Znari *et al*., 2005). A newly hatched animal possessed a central areola with one annulus. All counts were therefore started from the next annulus (Stubbs *et al*., 1984).

Growth

The study on growth of elongated tortoises was conducted between May and August 2009. Carapace length (CL) of 124 tortoises was measured by vernier calipers (accuracy ± 0.1 mm). Age was estimated using counts of scute rings. Each ring was assumed to represent 1 yr of growth (van Dijk, 1998) which this assumption was clearly found to match age in *I. elongata* here up to 7 yr, after this age, the scute ring formation is less reliable because carapace length usually displayed overlap of growth rings, and showed fine growth rings at the depressed scute edges. Thus, in the analyses of growth, tortoises with less than 8 yr were only used. Growth rate (GR) was calculated following the equation:

$$GR = (CL_2 - CL_1) / T$$

where GR was the growth rate at each age class, CL_1 was the mean of carapace lengths at the beginning of each age class (mm), CL_2 was the mean of carapace lengths at the next age class (mm), and T was one year period. Growth rates for males and females using the juvenile carapace length were separately done for each sex but the data from small juveniles from the base of the growth curve were for both sexes.

Growth curves were also constructed from the relationship between carapace length and age classes. Tortoises that there were growth rings and matched with age up through 8-19 yr, although growth ring formation is less reliable, were used to compensate for the absence of reliable growth ring data for age classed. The von Bertalanffy and logistic equation as defined in Frazer and Ehrhart (1985) were used to estimate and fit of data using nonlinear least-square regression (Mushinsky, Wilson, and McCoy, 1994; Chen and Lue, 2002). The growth equations used are:

Von Bertalanffy : $CL = a(1-be^{-kt})$

Logistic : $CL = a/(1+be^{-kt})$

where CL is carapace length, a is asymptotic length, b is a parameter related to length at hatchling size, e is the base of the natural logarithm, k is the intrinsic growth rate, and t is age in years.

Ontogeny

For the ontogenic change study in size and shell shape of *I. elongata*, the sample consisted of 157 tortoises captured (125 juveniles, 33 females, and 32 males) which were collected during 2007 to 2009. The data were obtained from individuals measured only once and released at the point of captured. Tortoises captured were grouped into seven age classes based on counting of annual rings. Group I was the hatchlings that have the age during 0-1 yr. The other tortoises were divided into six groups which were the tortoise age at 1- 7 years. Sex of animals was separated based on secondary sex characteristics. The shell morphology of each tortoise was measured in each age class up to 114 characters (Table 4.4). These characters were investigated what factor between age and sex that affected to their morphological change. Two–way analyses of variance (ANOVA, $P < 0.05$) were used to detect these relative in each age class and between sex difference, with CL as covariate, sex and age as factors. Significantly different slopes ($P \leq 0.05$) indicated ontogenetic change in the characters against CL.

Sexual dimorphism

Specimens for the study on sexual dimorphism of elongated tortoise were collected in the field in 2007. Thirty male and thirty female adult tortoises were collected randomly and measured their shell morphology up to 120 characters (Figure 4.1 and 4.2) including tail length and tail width. Sex was estimated based on secondary characteristics which were pronounced in adults, with males having much longer and thicker tails, and convex plastron (van Dijk, 1998). Shell morphology of collected tortoise samples were measured for 120 characters using straight-line measurements including tail length and tail width with vernier caliper (accurate to 0.1 mm). Tail length was measured from the cloaca to the top of the tail whereas tail width was measured from the distance from left to right side the tail base just posterior to vent.

Morphological analysis used each individual only once. Statistical analyses were performed with SPSS 15.0 statistical package for Windows. To investigate sexual dimorphism, shell characters, and tail of adult males and adult females were determined and tested for normality using the Kolmogorow-Smirnow test. Student's *t*-test (Srinarumol, 1995 and Aranyavalai, 1996) was used to compare means of shell morphology, tail width and tail length over the carapace length from both sexes. Another method was ANCOVA, it was widely used for comparisons of body shape (Bonnet *et al*., 2001; Willemsen and Hailey, 2003; Brophy, 2006; Munoz and Nicolau, 2006; Mann, Riain and Hofmeyr, 2006; Zuffi and Plaitano, 2007). It is useful in comparing the body shape of both sexes while controlling for body size and it can be used to compare body proportions relative to size (Mann, O'Riain and Hofmeyr, 2006). This method, shell characters were log transformed prior to analyses, with log transformed carapace length as covariate and sex as factor. Linear regression analysis of nonlog-transformed data was used to determine the relationship between CL and other morphological variable for each sex. Significantly different slopes ($P \leq 0.05$) performed sexual dimorphism in the shell characters.

Abbreviations of shell morphology

		Carapace	
CL	Carapace Length	M4LL	4th Marginal Scute Length (left)
CW	Carapace Width	M4WL	4th Marginal Scute Width (left)
NL	Nuchal Scute Length	M5LL	5th Marginal Scute Length (left)
NW	Nuchal Scute Width	M5WL	5th Marginal Scute Width (left)
V1L	1st Vertebral Scute Length	M6LL	6th Marginal Scute Length (left)
V1W	1st Vertebral Scute Width	M6WL	6th Marginal Scute Width (left)
V2L	2nd Vertebral Scute Length	M7LL	7th Marginal Scute Length (left)
V2W	2nd Vertebral Scute Width	M7WL	7th Marginal Scute Width (left)
V3L	3rd Vertebral Scute Length	M8LL	8th Marginal Scute Length (left)
V3W	3rd Vertebral Scute Width	M8WL	8th Marginal Scute Width (left)
V4L	4th Vertebral Scute Length	M9LL	9th Marginal Scute Length (left)
V4W	4th Vertebral Scute Width	M9WL	9th Marginal Scute Width (left)
V5L	5th Vertebral Scute Length	M10LL	10th Marginal Scute Length (left)
V5W	5th Vertebral Scute Width	M10WL	10th Marginal Scute Width (left)
SL	Supracaudal Scute Length	M11LL	11th Marginal Scute Length (left)
SW	Supracaudal Scute Width	M11WL	11th Marginal Scute Width (left)
C1LL	1st Costal Scute Length (left)	M1LL	1st Marginal Scute Length(right)
C1WL	1st Costal Scute Width (left)	M1WL	1st Marginal Scute Width (right)
C2LL	2nd Costal Scute Length (left)	M2LL	2nd Marginal Scute Length(right)
C2W	2nd Costal Scute Width (left)	M2WL	2nd Marginal Scute Width (right)
C3LL	3rd Costal Scute Length (left)	M3LL	3rd Marginal Scute Length (right)
C3W	3rd Costal Scute Width (left)	M3WL	3rd Marginal Scute Width (right)
C4LL	Costal Scute Length (left)	M4LL	4th Marginal Scute Length(right)
C4WL	4th Costal Scute Width (left)	M4WL	4th Marginal Scute Width (right)
C1LR	1st Costal Scute Length (right)	M5LL	5th Marginal Scute Length (right)
C1WR	1st Costal Scute Width (right)	M5WL	5th Marginal Scute Width (right)
C2LR	2nd Costal Scute Length (right)	M6LL	6th Marginal Scute Length (right)
C2WR	2nd Costal Scute Widt (right)	M6WL	6th Marginal Scute Width (right)
C3LR	3rd Costal Scute Length (right)	M7LL	7th Marginal Scute Length (right)

Abbreviations of shell morphology (cont.)

Carapace			
C3WR	3rd Costal Scute Widt (right)	M7WL	7th Marginal Scute Width (right)
C4LR	4th Costal Scute Length (right)	M8LL	8th Marginal Scute Length (right)
C4WR	4th Costal Scute Width (right)	M8WL	8th Marginal Scute Width (right)
M1LL	1st Marginal Scute Length (left)	M9LL	9th Marginal Scute Length (right)
M1WL	1st Marginal Scute Width (left)	M9WL	9th Marginal Scute Width (right)
M2LL	2nd Marginal Scute Length (left)	M10LL	10th Marginal Scute Length(right)
M2WL	2nd Marginal Scute Width (left)	M10WL	10th Marginal Scute Width (right)
M3LL	3rd Marginal Scute Length (left)	M11LL	11th Marginal Scute Length (right)
M3WL	3rd Marginal Scute Width (left)	M11WL	11th Marginal Scute Width (right)

Plastron			
PL	Plastron Length	PEWL	Pectoral Width (left)
PW	Plastron Width	ABLL	Abdominal Length (left)
ANTL	Anterior Lope Length	ABWL	Abdominal Width (left)
ANTW	Anterior Lope Width	FELL	Femoral Length (left)
POSL	Posterior Lope Length	FEWL	Femoral Width (left)
POSW	Posterior Lope Width	ANLL	Anal Length (left)
MPL	Midline Plastron Length	ANWL	Anal Width (left)
ANW	Anal Width	GLR	Gular Length (right)
MA	Maximum Apurture	GWR	Gular Width (right)
MAL	Minimum Apurtue (left)	HLR	Humeral Length (right)
MAR	Minimum Apurtue (right)	HWR	Humeral Width (right)
BLL	Length of Bridge (left)	PELR	Pectoral Length (right)
BLR	Length of Bridge (right)	PEWR	Pectoral Width (right)
GLL	Gular Length (left)	ABLR	Abdominal Length (right)
GWL	Gular Width (left)	ABWR	Abdominal Width (right)
HLL	Humeral Length (left)	FELR	Femoral Length (right)
HWL	Humeral Width (left)	FWR	Femoral Width (right)
PELL	Pectoral Length (left)	ANLR	Anal Length (right)

Abbreviations of shell morphology (cont.)

Plastron	
ANWR	Anal Width (right)
Tail	
TL	Tail Length
TW	Tail Width

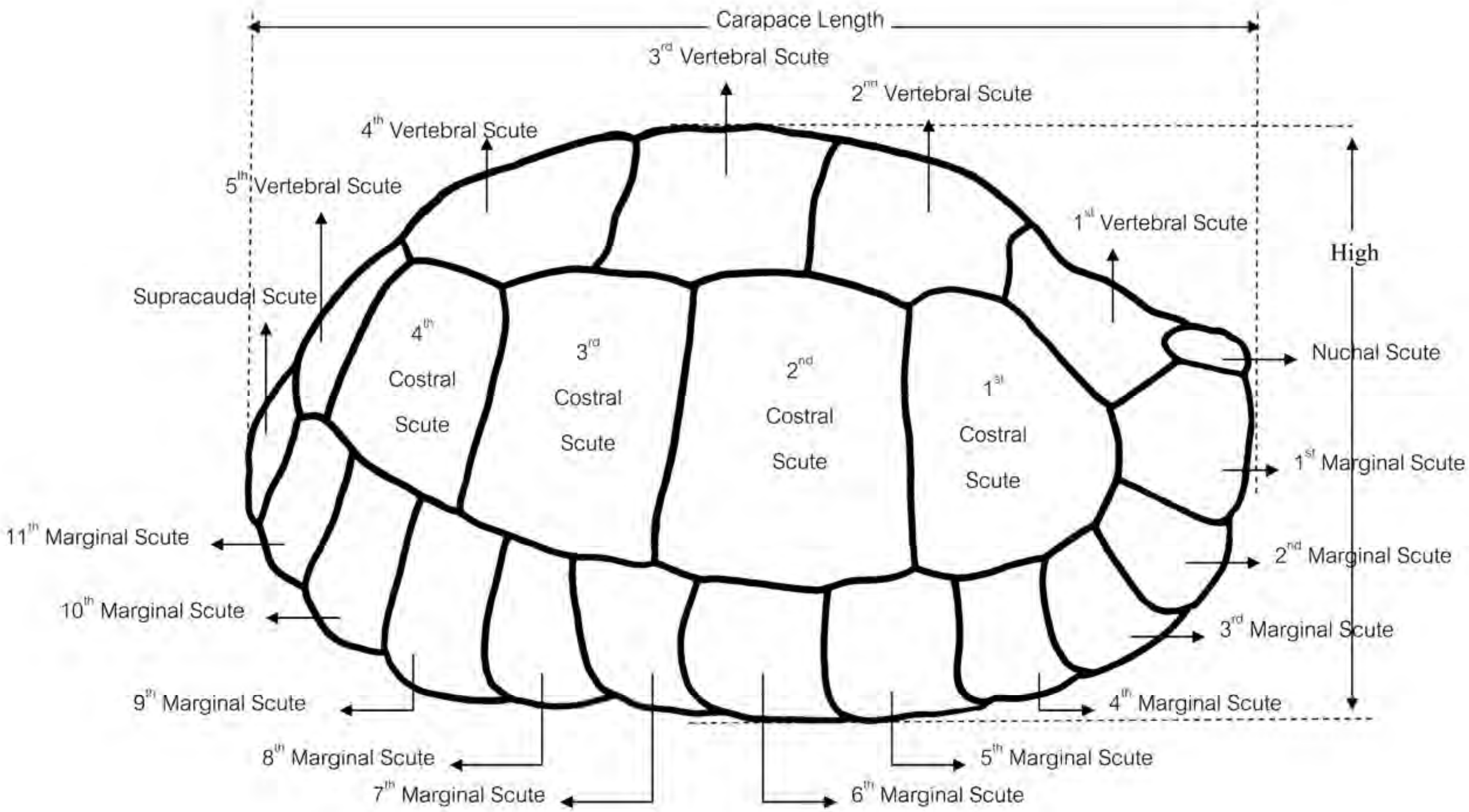


Figure 4.1 Morphology of carapace

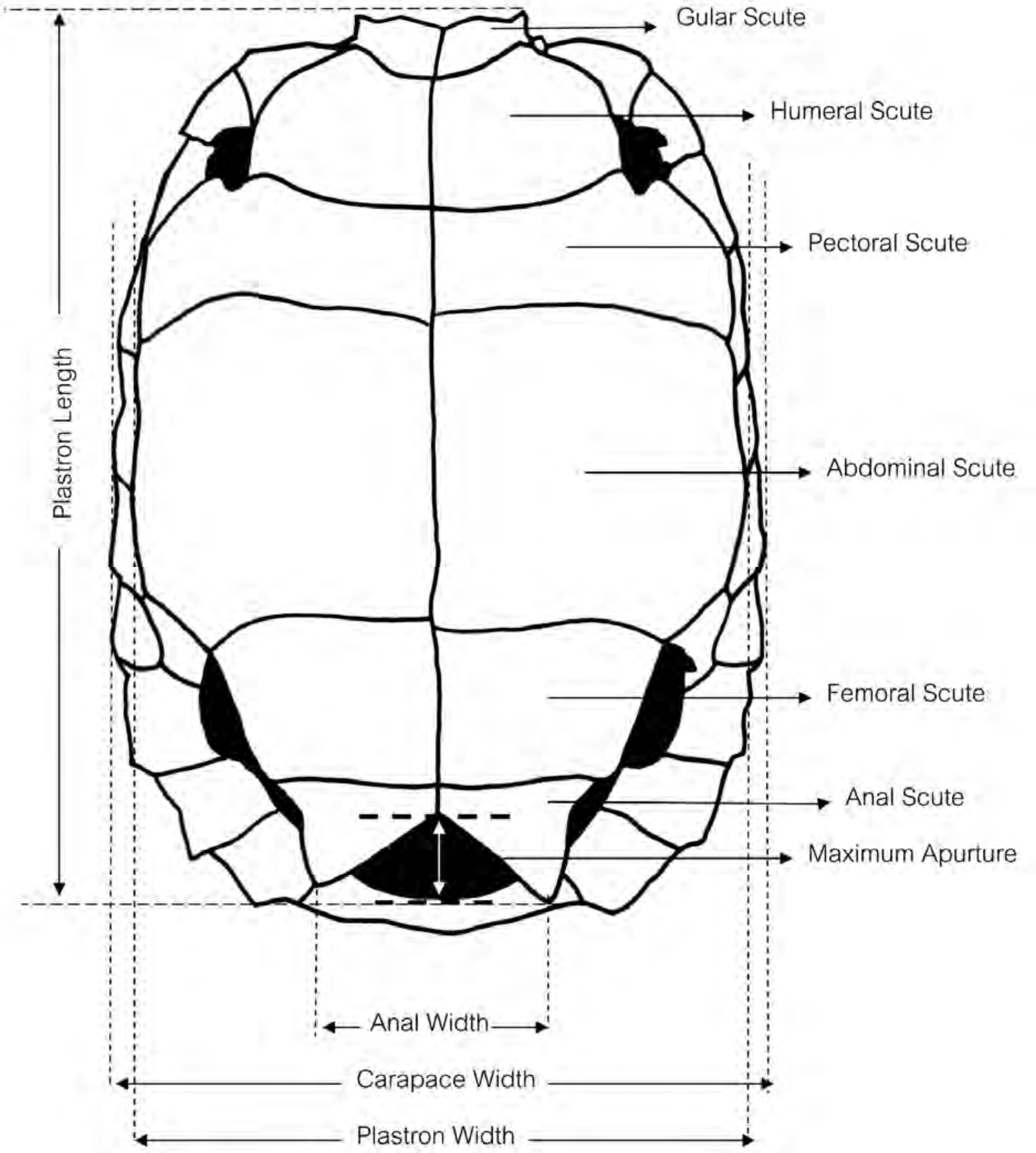


Figure 4.2 Morphology of plastron

RESULTS

Growth

A total of 124 tortoises (42 unsexed juveniles, 40 males, 43 females) were captured and recorded their growth rates. The relationships between age classes and carapace length in those specimens are shown in Table 4.1 and Figure 4.3-4.4. The variation in carapace length of each age class, it was found that juveniles (1-3 yr) grow at 11.4 - 33.33 mm/yr in carapace length. Growth rates were generally much less for adult males and females.

Growth curve was shown in Figure 4.3 and 4.4. In the graph, growth was relatively fast for the first 1-10 years old for both sexes based on carapace length and decreased rapidly after 10 years. The plot of growth of both sexes included first captures of all tortoises known age. Estimates of parameters of the von Bertalanffy and logistic growth curves from the non-linear regression are presented in Table 4.2. The residual mean square values from both of growth equation were found that the von Bertalanffy model was rather large than the logistic model. The values of asymptotic carapace lengths from the von Bertalanffy model were 267.8 mm for males and 268.18 mm for females. These values were greater than the mean size of largest of actual values in the tortoise population (males, n = 3, mean = 258.04; females, n =2, mean = 256.88). Although, the asymptotic carapace lengths from the logistic model were 249.12 mm for males and 249.15 mm for females which were less than the mean size of the largest of actual values in the tortoise population but these values were falling within the range of adult carapace lengths for both sexes.

Table 4.1 Mean±SD, range, and percent change of carapace length (mm) between successive age classes of *Indotestudo elongata* captured between May and August 2009

Age (yr)	Carapace length				
	N	Mean ± SD	Range	Annual increment (mm)	Percentage increase
		Juveniles			
Hatchlings	10	49.6 ± 8.36	37.8-61.2	-	-
1	10	82.93 ± 5.20	72-89	33.33	67.20
2	9	94.33 ± 4.64	85-100	11.4	13.75
3	11	119 ± 6.48	107-128	24.67	26.15
4	-	-	-	-	
		Females			
4	11	147.27 ± 11.71	107-128	28.27	23.76
5	14	173.36 ± 9.52	156-186	26.09	17.72
6	8	192.13 ± 8.58	183-208	18.37	10.60
7	10	203 ± 8.86	190-215	10.87	5.66
		Males			
4	7	143.43 ± 9.57	133-159	24.43	20.53
5	12	175.5 ± 8.76	158-188	32.07	22.36
6	9	180.33 ± 7.78	169-190	4.83	2.75
7	13	207.77 ± 5.07	201-218	27.44	15.22

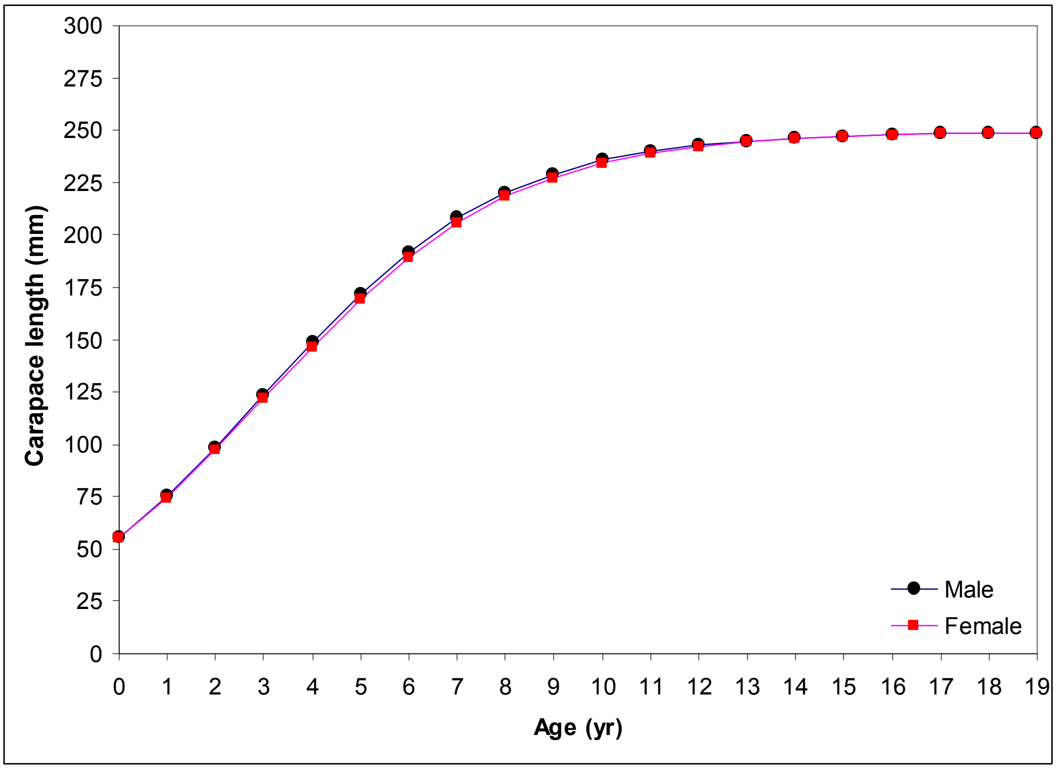


Figure 4.3. Growth curve of *Indotestudo elongata* from Ban Kok Village. The curves were constructed from non-linear regression of logistic growth equations.

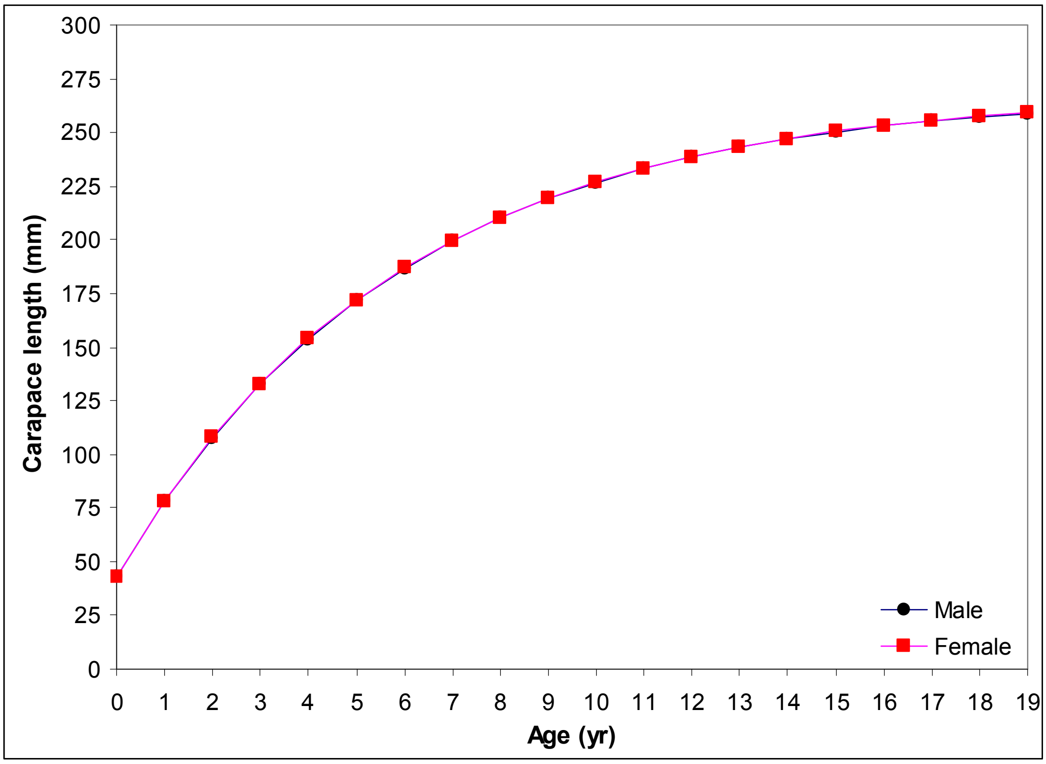


Figure 4.4. Growth curve of *Indotestudo elongata* from Ban Kok Village. The curves were constructed from non-linear regression of von Bertalanffy growth equations.

Table 4.2. Estimated values of parameters for the von Bertalanffy and logistic growth equations for a *Indotestudo elongata* population from Ban Kok village. The asymptotic length is a, b is related to length at hatchling, k is the intrinsic growth rate (95% confidence interval in parentheses), MS is the residual mean square, R^2 is the coefficient of determination.

	a	b	k	MS	R^2
von Bertalanffy					
Males	267.8	0.84	0.17	145.91	0.968
	(260.34 - 275.26)				
Females	268.18	0.84	0.17	167.03	0.960
	(260.52 - 275.85)				
Logistic					
Males	249.12	3.49	0.4	109.8	0.976
	(245.33 - 252.91)				
Females	249.15	3.483	0.4	138.34	0.969
	(245.06 - 253.25)				

Ontogeny

Two-way ANOVA showed significant differences between proportion of various shell morphology and carapace length among sexes and ages in 20 characters of the 118 characters (Table 4.3). These characters were NL/CL, V_4L/CL, V_5L/CL V_5W/CL, C_1LL/CL, C_2WR/CL, M_6LL/CL, SL/CL, SW/CL, ANTL/CL, ABLL/CL, ANW/CL, BLL/CL, and BLR/CL. Means of variable shell morphology were shown in Table 4.4. Ontogenic change of these characters influenced to the sex. The Mass/CL, PL/CL, PW/CL, ANTW/CL, POSW/CL and MA/CL influenced to the age. In the Table 4.5, mean ratio of morphological variable indicated the difference in length and width of various shell morphology in each stage of live history trait. It was found that mean ratios of NL/CL, V_4L/CL, V_5L/CL, SL/CL, and ANTL/CL of males were longer than females. Moreover, males also attained SW/CL and ANW/CL wider than females. In contrast, females attained BLL/CL and BLR/CL longer than males. For the V5W/CL, it was found that this character had wider in hatchlings than males and females. The relationship between mean ratios of various shell morphology differed in *I. elongata* among sexes and age classes was plotted and shown in Figure 4.5 - 4.8.

Morphological changes in size and shell shape of those characters for *I. elongata* from hatchlings to adult of both sexes were as follows:

During the shift from hatchling to adult male, the carapace increased in length especially in the V4L, V5L, and SL, SW, and ANTL of plastron also increased length markedly (Table 4.4).

V4L: The change of V4L was more evident from hatchling to second age class. Then it became less change from fourth to sixth age class in males. However, this change is different from females. The length of V4L in females decreased gradually more than that of males (Figure 4.5).

V5L: The change of the length of V5L in males was more evident from fourth to sixth age class. Then it became more gradual visible from sixth to seventh age class. In contrast, this change differed from female. The length of V5L in females decreased gradually more than males from fourth to sixth age class (Figure 4.5).

V5W: During the growth from hatchling to juvenile, the width of fifth vertebral scute was more evident from first to fourth age class. The difference between males and females were clearly separated in the fifth age class and it was found that the V5W in males was wider than that of females (Figure 4.6).

SL: During the growth from hatchling to juvenile, the supracaudal scute lengthening was more evident from first to fourth age class and still increased to the seventh age class. The difference between males and females were clearly separated in the fifth age class and it was found that the lengthening of the supracaudal scute in males was longer than females. The lengthening of the supracaudal scute was more evident in males whereas in females was more gradual (Figure 4.6).

SW: The change of supracaudal scute width occurred during the shift from juvenile to adult male. This change was more evident from fourth to seventh age class. The widening of SW in males was greater than females (Figure 4.7).

BLL, BLR: The change of bridge length (BLL and BLR) was more evident from fourth to seventh age class. Males are different from females in that, the lengthening of bridge in males was lesser than females (Figure 4.7 and 4.8).

Table 4.3. Results of two-way ANOVA analyses on age classes and between the sexes on morphology in *Indotestudo elongata*, with CL as the covariate. Significant results are shown in bold. R^2 is the coefficient of determination.

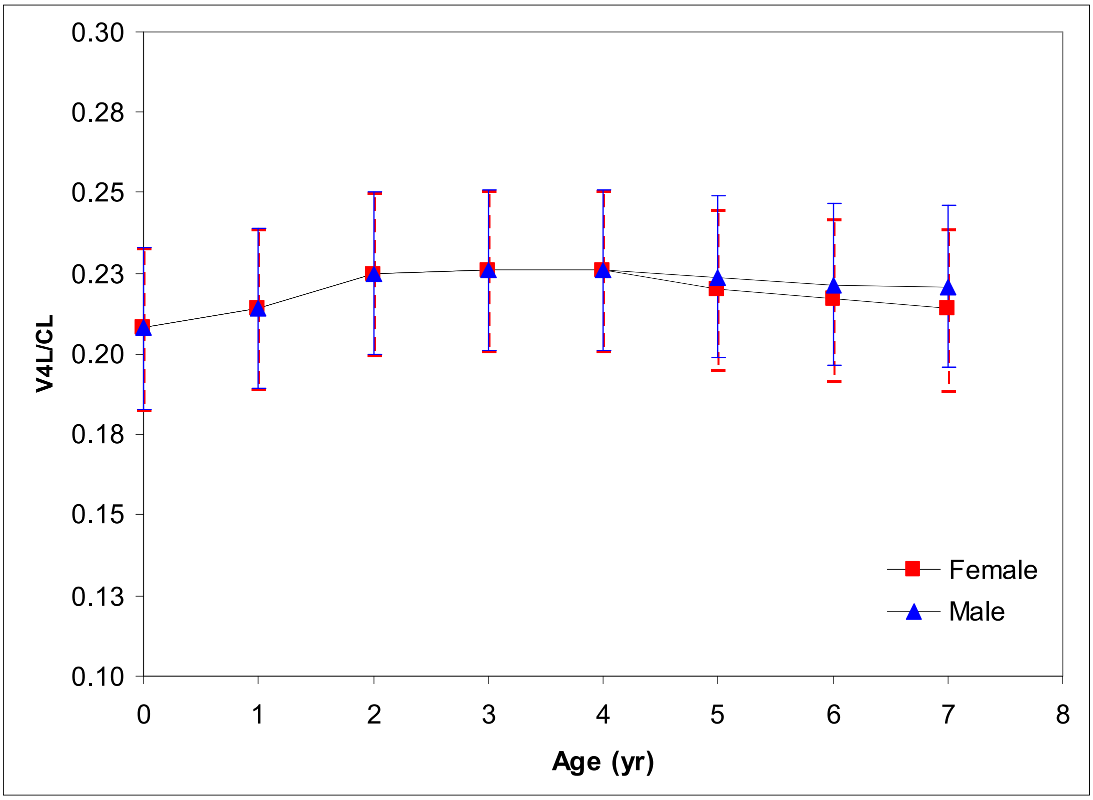
Characters	Source	*F*	*P*	r^2
NL/CL	Sex	6.796	**0.010**	0.321
	Age	3.452	> 0.000	
V4L/CL	Sex	5.612	**0.019**	0.217
	Age	1.85	0.050	
V5W/CL	Sex	10.363	**0.002**	0.286
	Age	1.179	0.305	
V5L/CL	Sex	19.56	**> 0.000**	0.268
	Age	0.755	0.684	
C1LL/CL	Sex	5.452	**0.021**	0.369
	Age	2.910	0.002	
C2WR/CL	Sex	6.136	**0.014**	0.711
	Age	9.601	> 0.000	
M6LL/CL	Sex	4.803	**0.030**	0.267
	Age	2.104	0.023	
SL/CL	Sex	12.565	**0.001**	0.710
	Age	11.264	0.000	
SW/CL	Sex	4.953	**0.027**	0.178
	Age	1.631	0.094	
ANTL/CL	Sex	4.148	**0.043**	0.150
	Age	1.188	0.299	
ABLL/CL	Sex	4.289	**0.040**	0.389
	Age	2.317	0.011	
ANW/CL	Sex	14.074	**> 0.000**	0.283
	Age	1.645	0.091	

Table 4.3. Results of two-way ANOVA analyses on age classes and between the sexes on morphology in *Indotestudo elongata*, with CL as the covariate. Significant results are shown in bold. R^2 is the coefficient of determination (cont.).

Characters	Source	*F*	*P*	R^2
BLL/CL	Sex	7.076	**0.009**	0.183
	Age	0.762	0.677	
BLR/CL	Sex	5.827	**0.017**	0.19
	Age	0.841	0.6	
Mass/CL	Sex	0.244	0.622	0.869
	Age	18.752	0.000	
PL/CL	Sex	0.006	0.939	0.215
	Age	2.735	0.003	
PW/CL	Sex	0	0.989	0.762
	Age	18.802	0.000	
ANTW/CL	Sex	0.59	0.444	0.299
	Age	2.687	0.003	
POSW/CL	Sex	0.161	0.688	0.493
	Age	3.55	0.000	
MA/CL	Sex	0.979	0.324	0.309
	Age	3.551	0.000	

Table 4.4 Means ± SD and sample sizes (N) of variable shell morphology in *Indotestudo elongata*.

Variable (mm)	Hatchling N = 16	Juvenile N = 109	Adult male N = 32	Adult female N = 28
CL	56.88 ± 5.66	114.17 ± 33.42	195.97 ± 21.31	198.29 ± 20.05
V4L	11.83 ± 1.49	25.30 ± 7.76	42.52 ± 5.13	41.83 ± 4.86
V5L	12.64 ± 1.7	25.54 ± 8.01	47.80 ± 7.12	43.34 ± 5.15
V5W	18.89 ± 1.85	35.1 ± 10.23	59.50 ± 6.29	56.91 ± 6.19
SL	6.91 ± 0.9	17.22 ± 6.35	34.50 ±5.68	32.75 ± 4.23
SW	16.44 ± 1.61	32.33 ± 9.51	58.78 ± 9.40	54.62 ± 6.59
C1LL	14.17 ± 2.0	27.93 ± 7.76	43.14 ± 6.58	45.37 ± 4.78
C2WR	19.67 ± 2.06	35.04 ± 8.84	51.85 ± 4.42	56.01 ± 5.22
M6LL	8.16 ± 0.94	16.12 ± 4.73	25.36 ± 2.57	27.39 ± 2.99
ANTL	12.92 ± 1.40	27.21 ± 8.41	50.52 ± 20.2	45.21 ± 5.75
ANW	12.20 ± 1.57	24.88 ± 8.00	48.94 ± 8.23	42.79 ± 6.92
BLL	25.90 ± 3.18	52.38 ± 14.80	80.23 ± 5.98	92.82 ± 28.38
BLR	25.88 ± 3.18	52.29 ± 14.75	79.86 ± 5.71	92.05 ± 28.59
ABLL	18.77 ± 2.13	37.45 ± 10.92	58.20 ± 5.10	61.65 ± 5.92



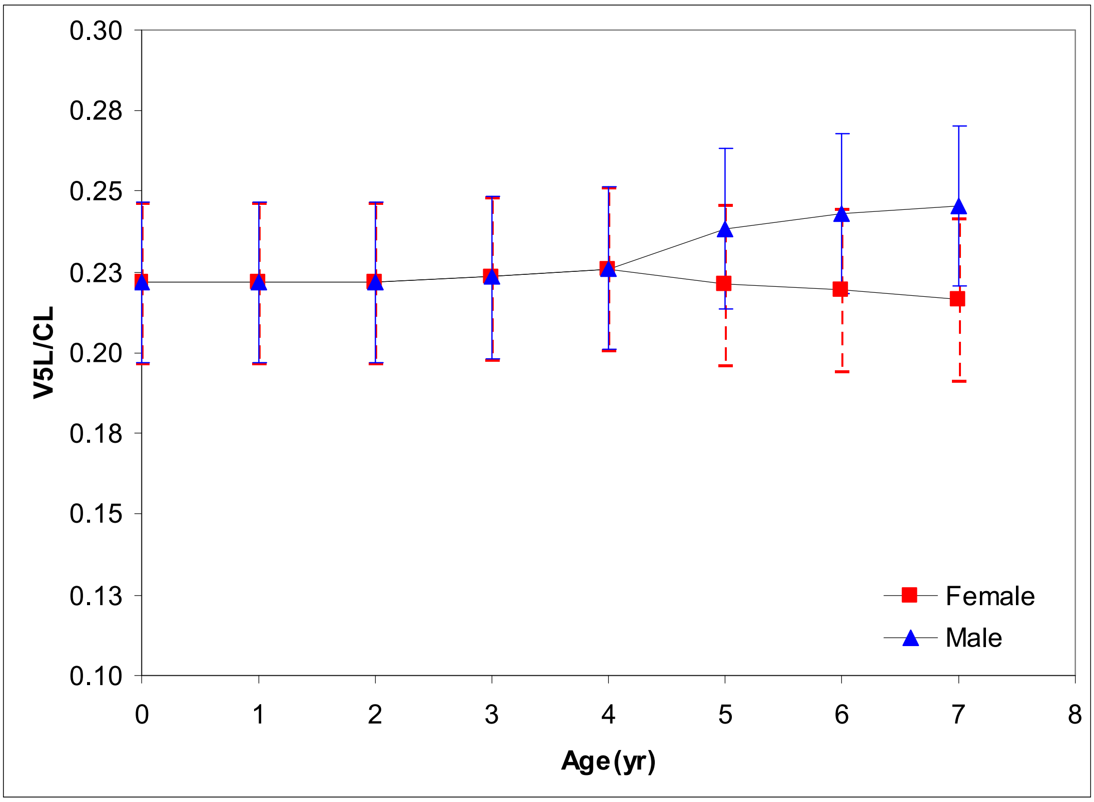
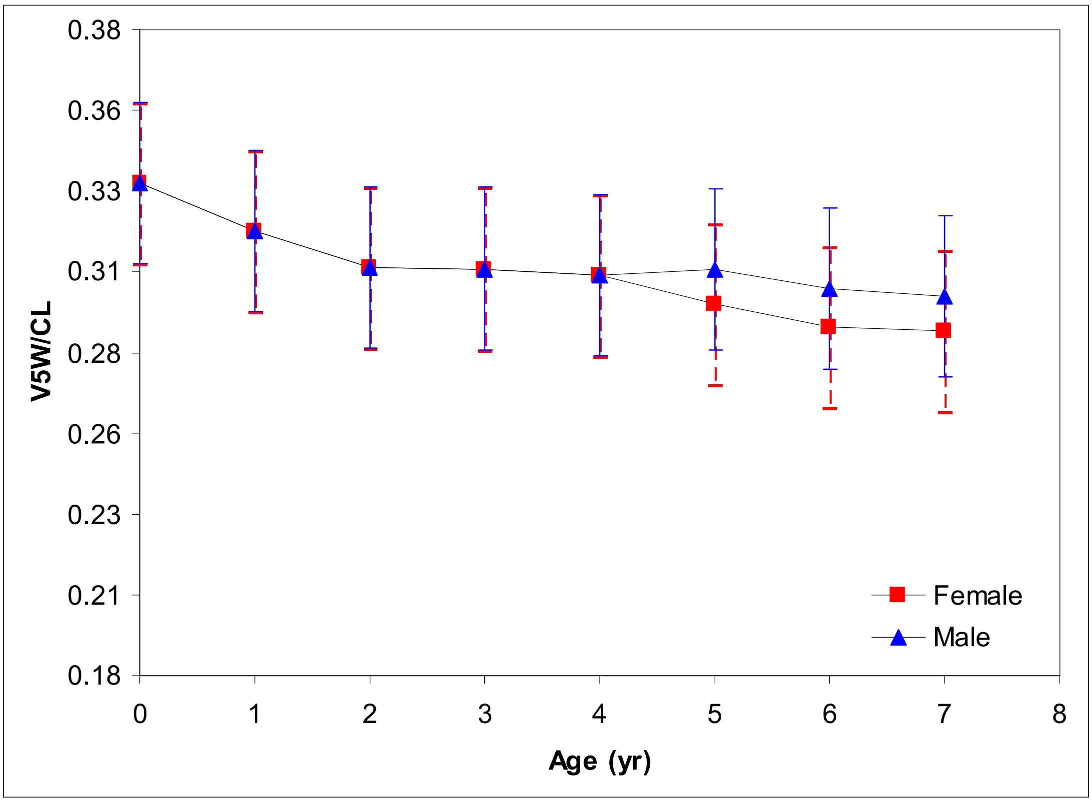


Figure 4.5 The relationship between proportions of shell morphology (upper) V4L/CL (below) V5L/CL among sexes and age class of *Indotestudo elongata*. Juvenile at the age up to 4 years cannot be sexed and were separately done for each sex.



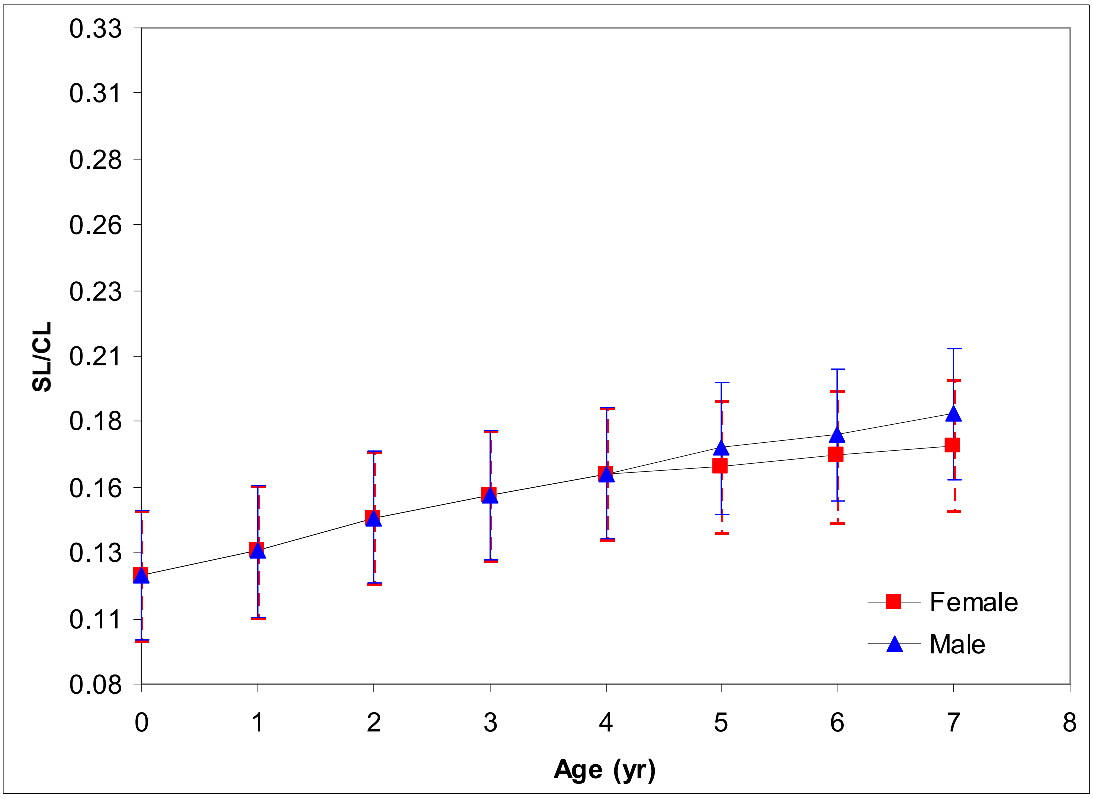


Figure 4.6 The relationship between proportions of shell morphology (upper) V5W/CL (below) SL/CL among sexes and age class of *Indotestudo elongata.* Juvenile at the age up to 4 years cannot be sexed and were separately done for each sex.

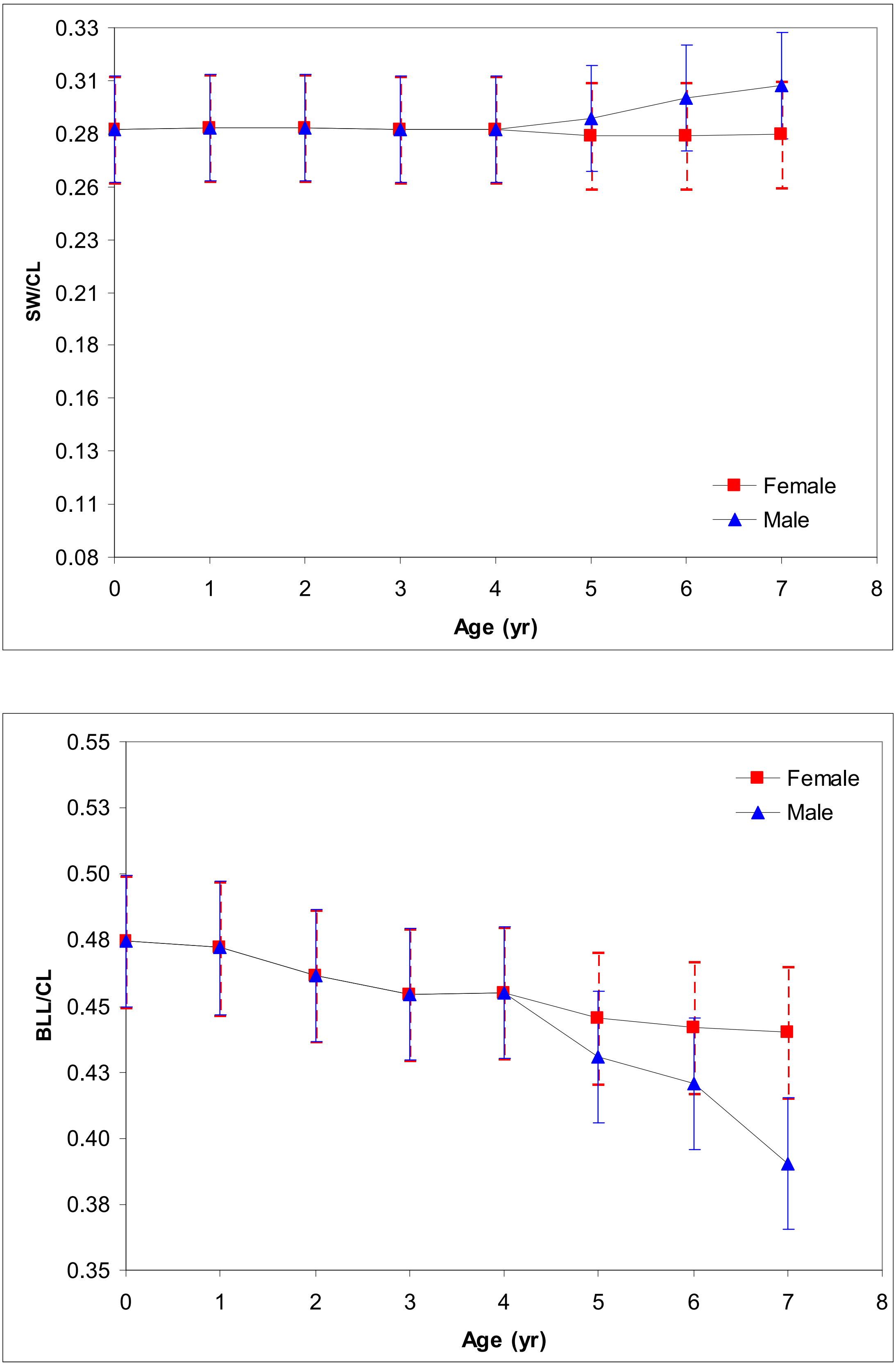


Figure 4.7 The relationship between proportions of shell morphology (upper) SW/CL (below) BLL/CL among sexes and age class of *Indotestudo elongata*. Juvenile at the age up to 4 years cannot be sexed and were separately done for each sex.

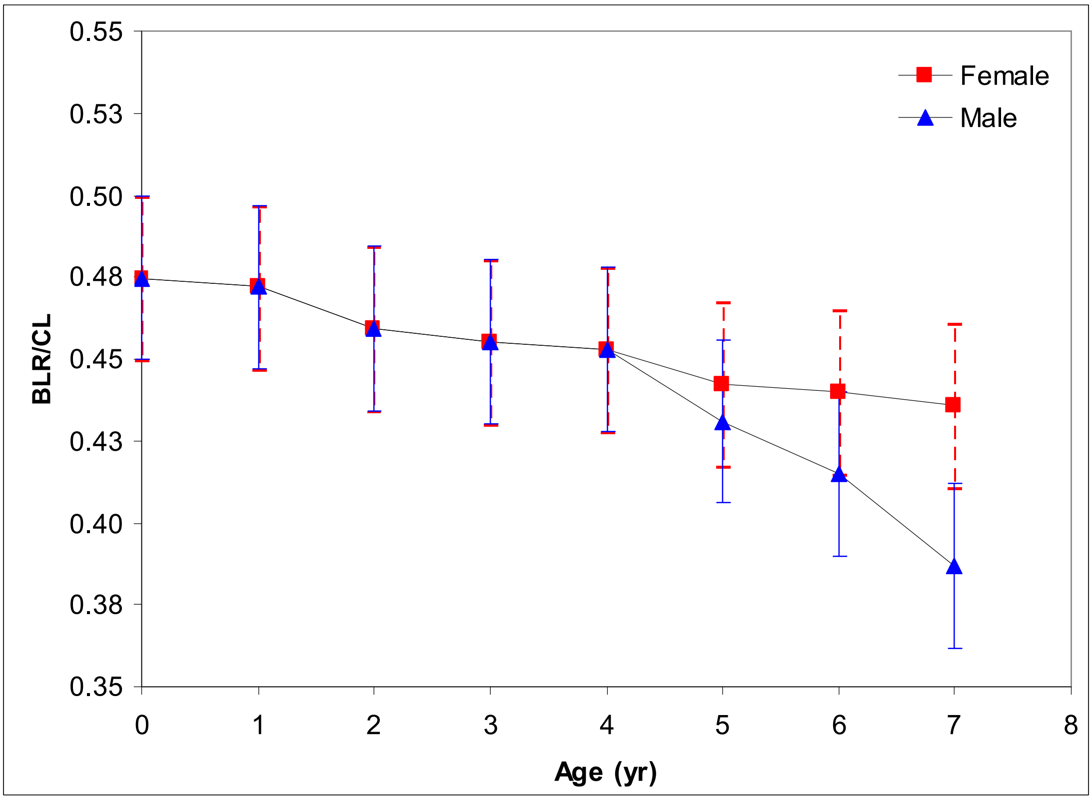


Figure 4.8 The relationship between proportions of BLR/CL among sexes and age class of *Indotestudo elongata*. Juvenile at the age up to 4 years cannot be sexed and were separately done for each sex.

Sexual size dimorphism

There were significant differences in carapace length (CL) between sexes (Table 4.5). It was found that females had longer carapace length than males (males = 265.32 ± 19.43 mm, females = 274.13 ± 21.12 mm, n = 60; *t*-test, $p = 0.05$).

Sexual dimorphism in shape

Sexual difference in shell shape was also evident. Student *t*-test indicated that males and females differed significantly ($P \leq 0.05$) in 1 of 5 characters examined (Table 4.5) whereas, ANCOVA indicated that the regression slopes of both sexes differed significantly ($p = 0.05$) in 28 of the 70 characters examined (Table 4.6). Among these, differences in relative shell width, nucal scute length, the third vertebral scute width and length, supracaudal scute width, the eleventh marginl scute length, and shell opening (maximum aperture) were most significant ($P < 0.05$). Females had relatively wider carapaces (ACW, ABW, V3L, and V3W) and wider in shell opening (MA) whereas, males had relatively longer NL, M11LL, M11LR, and wider SW than females. Two characters of particular interest were tail length (TL) and tail width (TW). The present data showed that males had relatively longer tail than females whereas females had relatively wider tail than males (Table 4.6; Figure 4.6).

Table 4.5 Results of Student's *t*-test, comparing male and female body measurements.

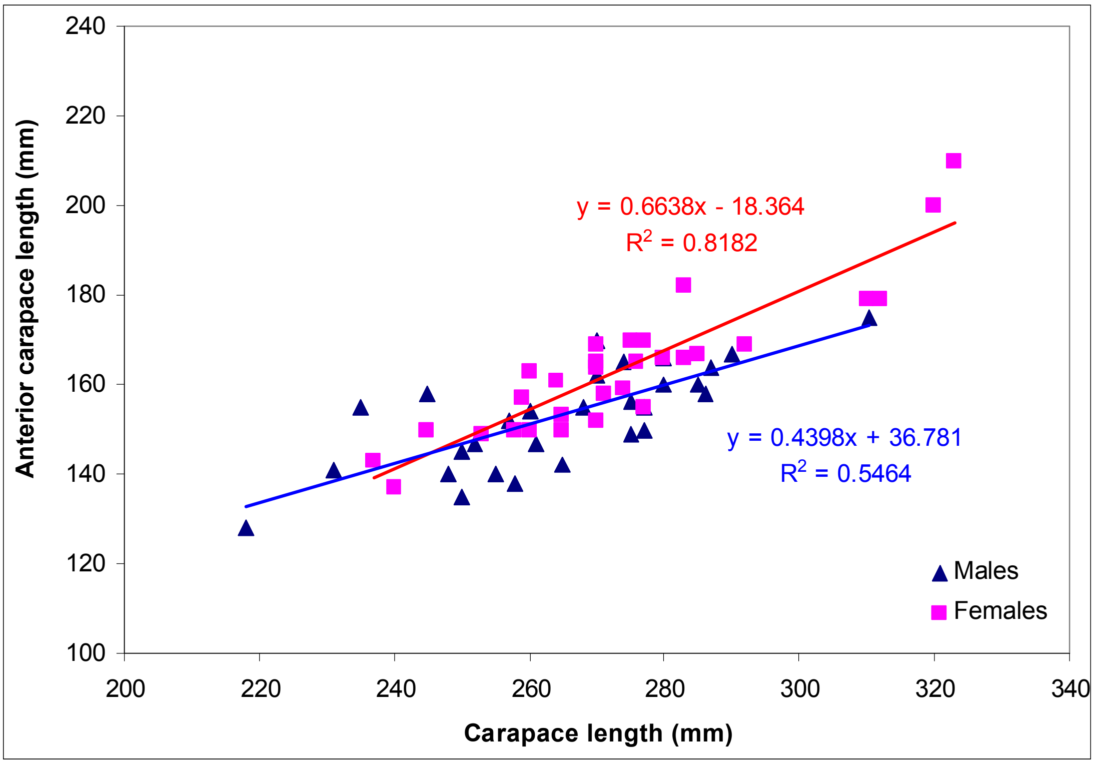
Measurement	Mean of Male	Mean of female	*P*-value
CL	265.32 ± 19.43	274.13 ± 21.12	0.049
Mass/CL	10.28 ± 0.340	10.88 ± 0.43	Ns
V4W/CL	0.24 ± 0.003	0.24 ± 0.003	Ns
PL/CL	0.85 ± 0.005	0.85 ± 0.005	Ns
GLL/CL	0.12 ± 0.003	0.12 ± 0.004	Ns
TL/CL	0.24 ± 0.007	0.20 ± 0.006	0.000

Table 4.6 Comparison of regression slopes (ANCOVA) of shell characters and carapace length among male and female *Indotestudo elongata* from Ban Kok Village (df = 1).

Measurement	Mean of Male	Mean of female	*F*	*P*
NL1	1.37 ± 0.02	1.34 ± 0.01	5.807	0.019
V1W1	1.72 ± 0.01	1.71 ± 0.01	4.967	0.030
V2L1	1.68 ± 0.01	1.71 ± 0.01	6.501	0.013
V2W1	1.78 ± 0.01	1.81 ± 0.01	4.967	0.030
V3L1	1.66 ± 0.01	1.70 ± 0.01	14.113	0.000
V3W1	0.26	0.27	17.215	0.000
SW1	1.90 ± 0.01	1.89 ± 0.01	8.246	0.006
C2WL1	1.83 ± 0.01	1.86 ± 0.01	5.339	0.024
C4LL1	1.73 ± 0.01	1.71 ± 0.01	20.814	0.000
C2LR1	1.71 ± 0.01	1.76 ± 0.01	17.648	0.000
C3LR1	1.70 ± 0.01	1.73 ± 0.01	12.405	0.001
C4LR1	1.73 ± 0.01	1.71 ± 0.01	16.373	0.000
C4WR1	1.75 ± 0.01	1.76 ± 0.01	12.405	0.001
M3LL1	1.47 ± 0.01	1.46 ± 0.01	6.281	0.015
M3WL1	1.58 ± 0.01	1.56 ± 0.01	4.999	0.029
M11LL1	1.63 ± 0.01	1.59 ± 0.01	17.581	0.000
M2WR1	1.60 ± 0.01	1.58 ± 0.01	10.076	0.002

Table 4.6 Comparison of regression slopes (ANCOVA) of shell characters and carapace length among male and female *Indotestudo elongata* from Ban Kok Village (df = 1) (cont.).

Variable	Mean of Male	Mean of female	*F*	*P*
M3WR1	1.57 ± 0.01	1.55 ± 0.01	21.022	0.000
M5LR1	1.47 ± 0.01	1.53 ± 0.01	27.021	0.000
M6LR1	1.51 ± 0.01	1.58 ± 0.01	31.106	0.000
M7LR1	1.52 ± 0.01	1.57 ± 0.01	26.995	0.000
M9LR1	1.53 ± 0.01	1.53 ± 0.01	6.688	0.012
M11LR1	1.63 ± 0.01	1.59 ± 0.01	32.040	0.000
M11WR1	1.63 ± 0.01	1.62 ± 0.01	5.874	0.019
MA1	1.64 ± 0.02	1.72 ± 0.01	14.552	0.000
ANLR1	-0.68 ± 0.01	-0.69 ± 0.01	14.273	0.000
ACW1	-0.83 ± 0.01	-0.83 ± 0.01	6.639	0.013
MCW1	-0.24	-0.22	5.625	0.021
TL1	-0.20	-0.20	19.387	0.000
TW1	-0.62 ± 0.01	-0.70 ± 0.01	4.824	0.032



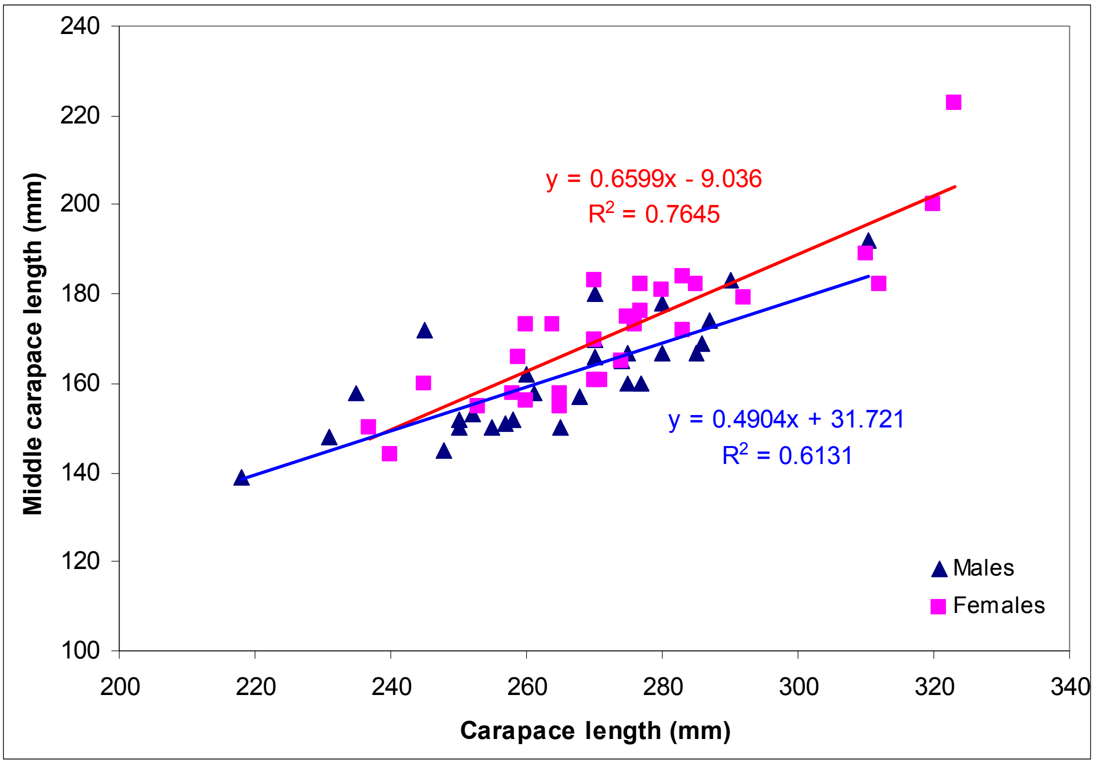
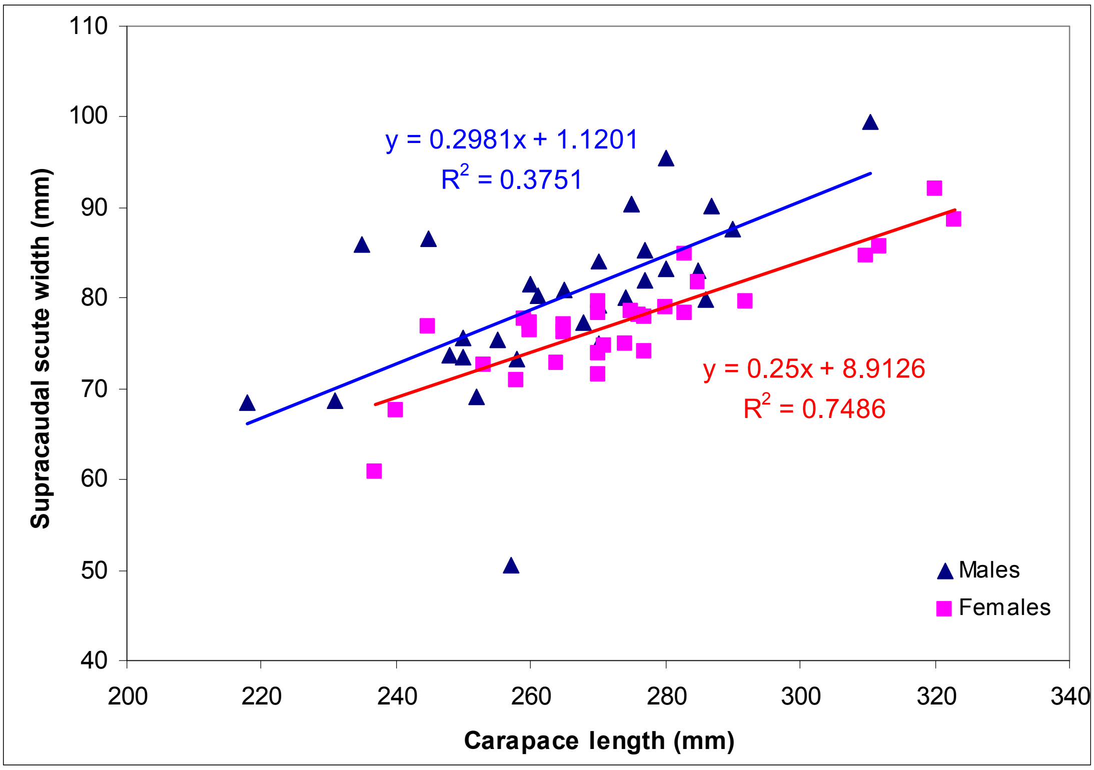


Figure 4.9 Linear regression equations of the relationship between (above) anterior carapace length and carapace length (below) middle carapace length and carapace length in both sexes of *Indotestudo elongata*



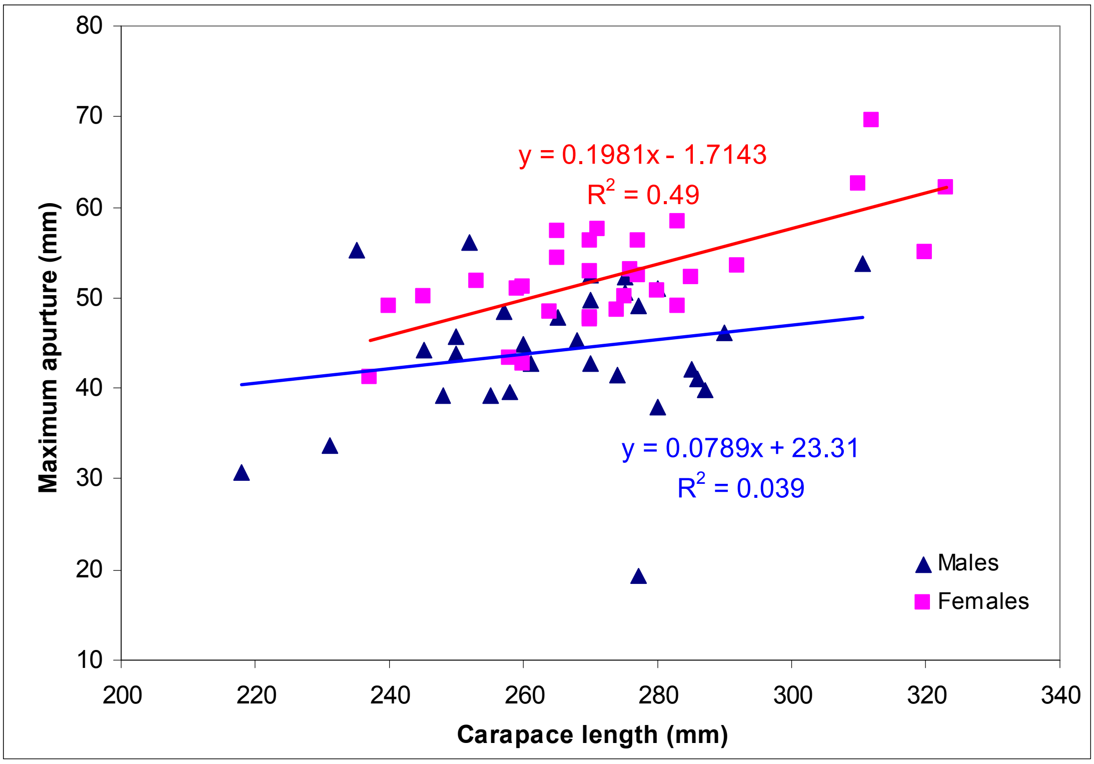
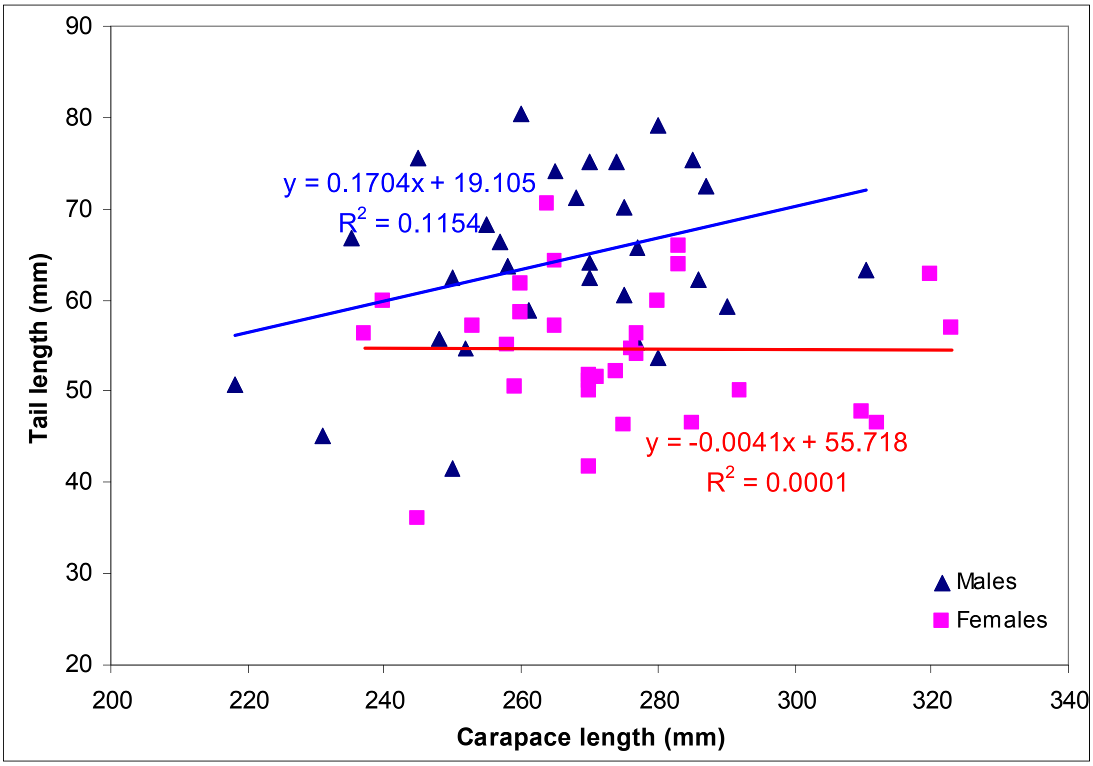


Figure 4.10 Linear regression equations of the relationship between (above) supracaudal scute width and carapace length (below) maximum aperture and carapace length in both sexes of *Indotestudo elongata*



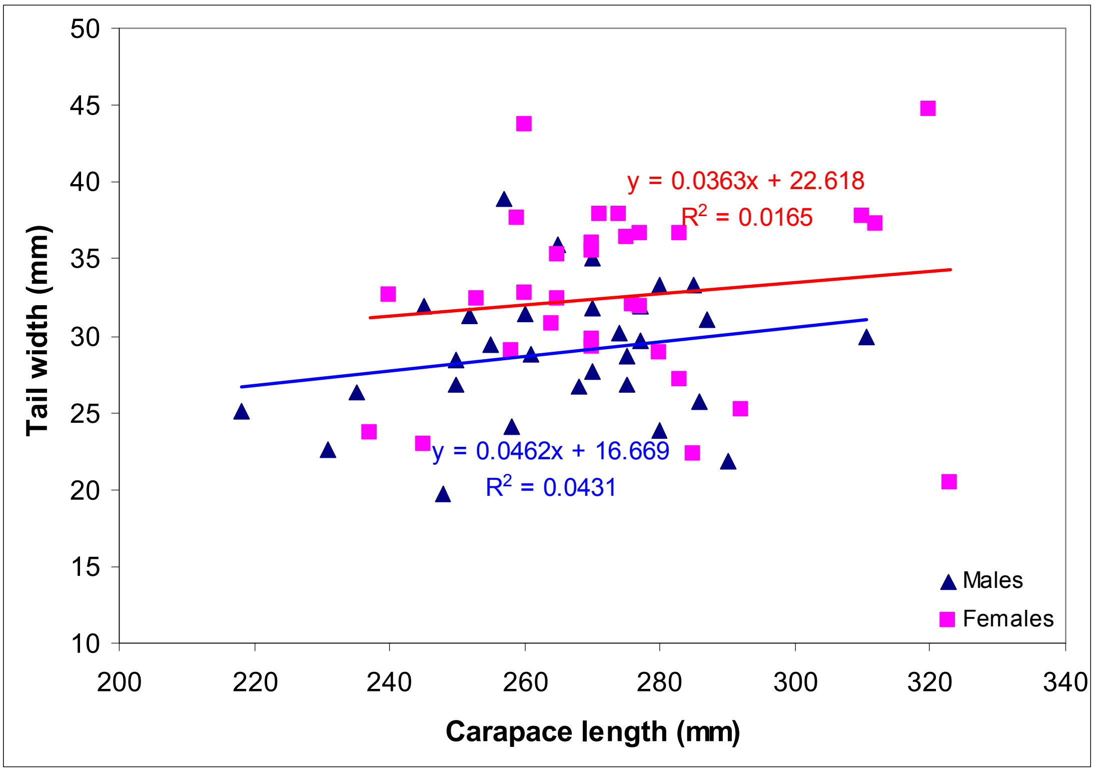
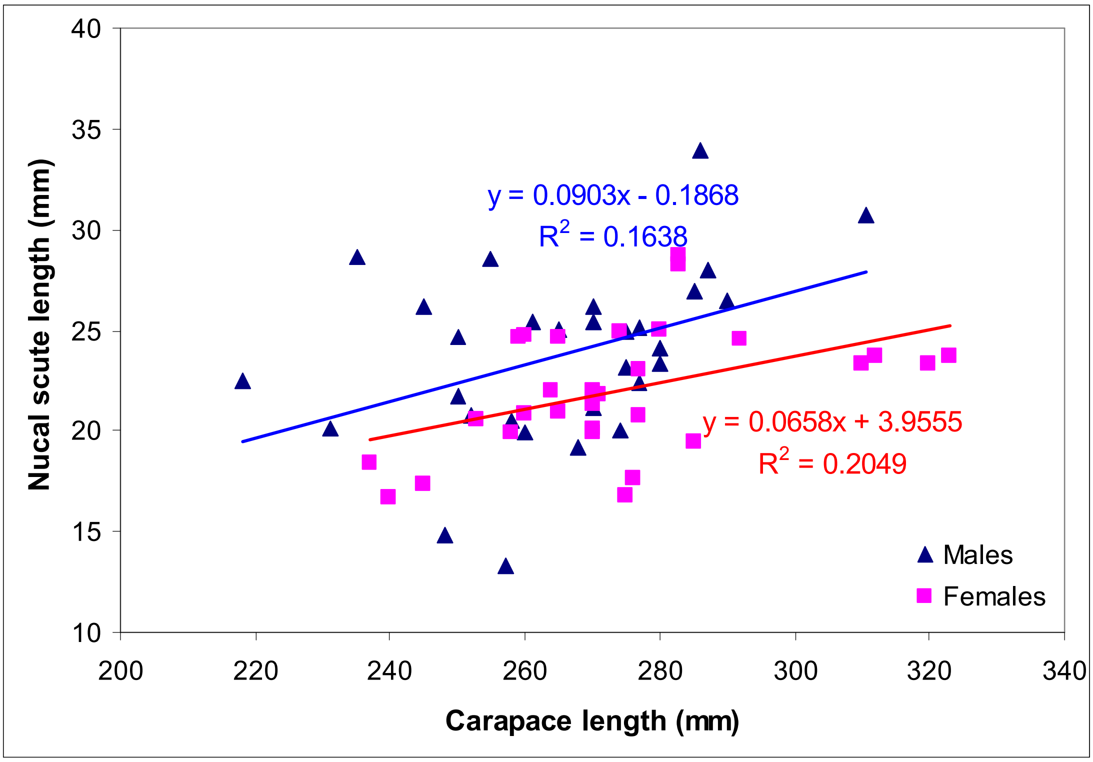


Figure 4.11 Linear regression equations of the relationship between (above) tail length and carapace length (below) tail width and carapace length in both sexes of *Indotestudo elongata*



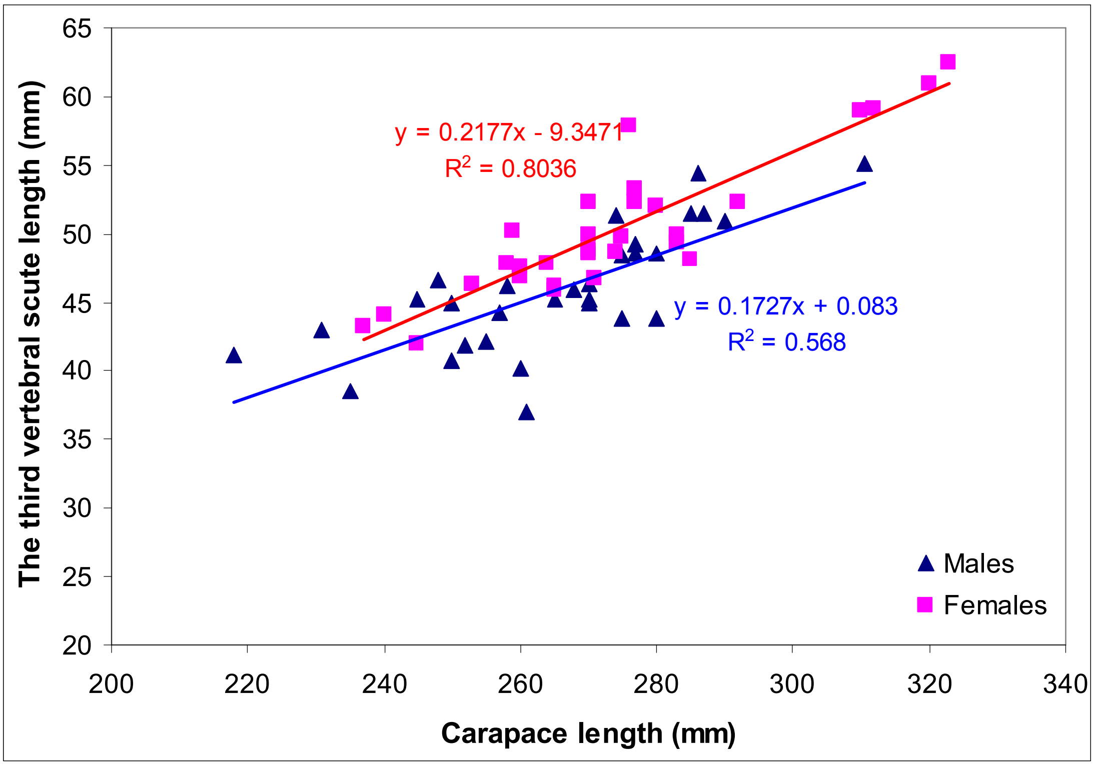
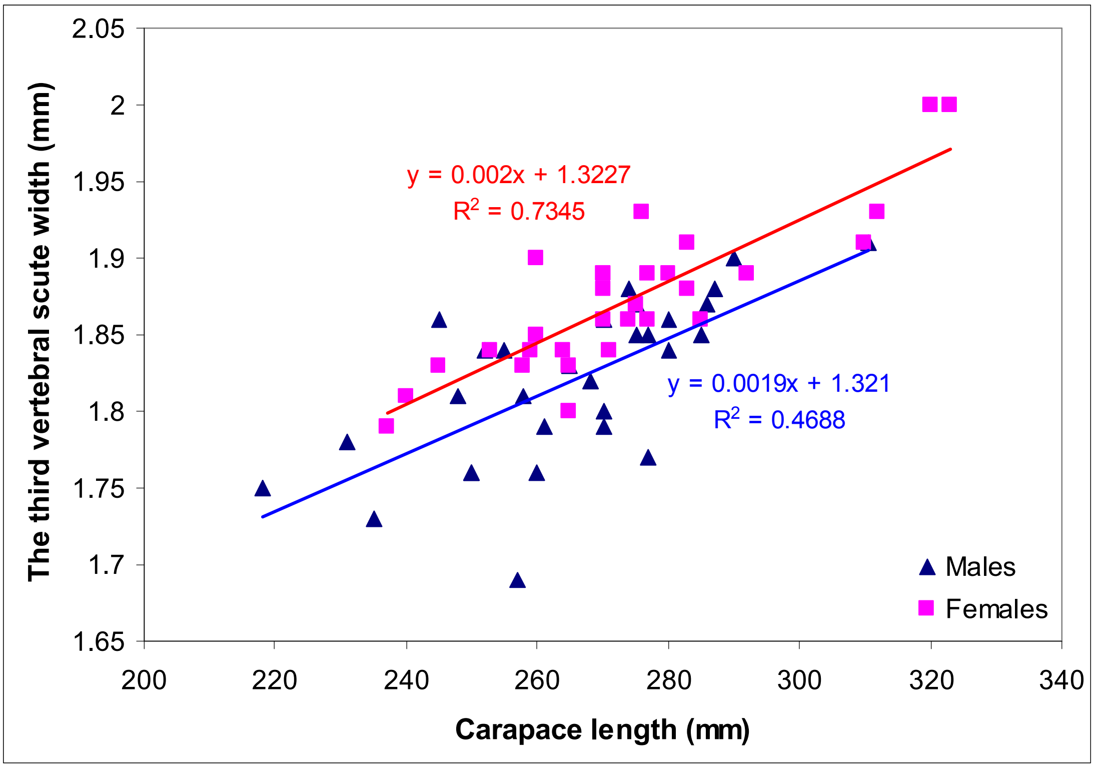


Figure 4.12 Linear regression equations of the relationship between (above) nucal scute length and carapace length (below) the third vertebral scute length and carapace length in both sexes of *Indotestudo elongata*



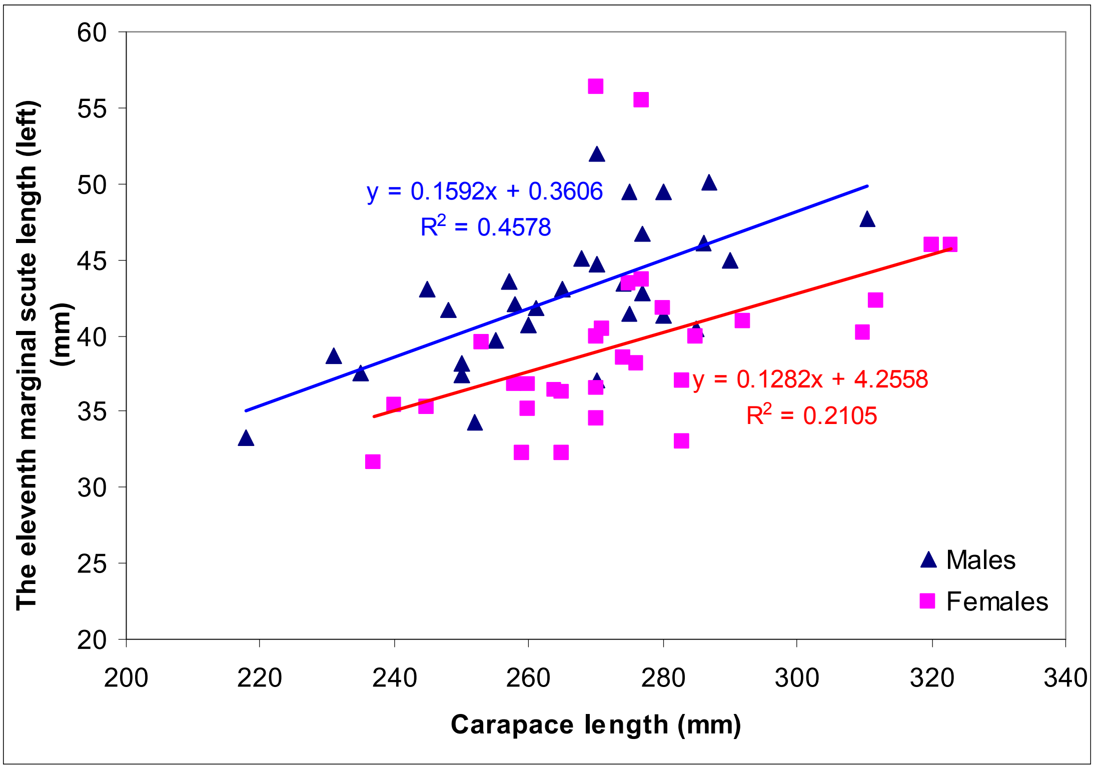


Figure 4.13 Linear regression equations of the relationship between (above) the third vertebral scute width and carapace length (below) the eleventh marginal scute length (left) and carapace length in both sexes of *Indotestudo elongata*

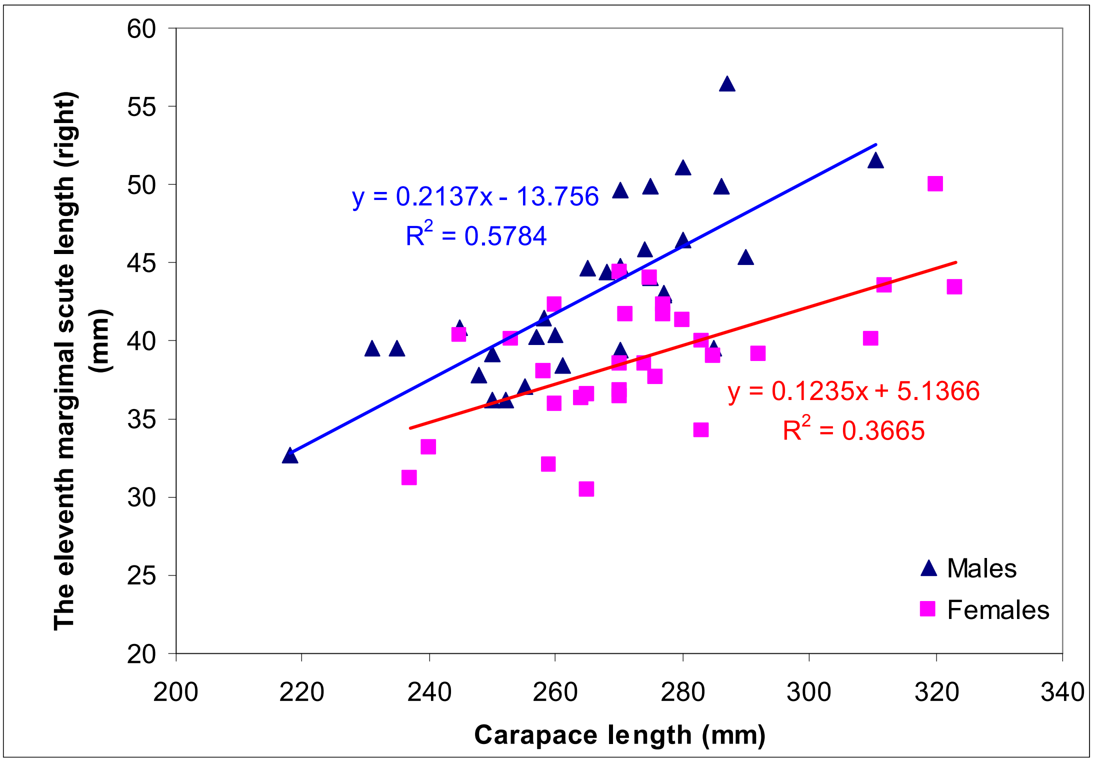


Figure 4.14 Linear regression equations of the relationship between the eleventh marginal scute length (right) and carapace length in both sexes of *Indotestudo elongata*

DISCUSSION

Growth

The result on growth of *I. elongata* showed that hatchlings grew rapidly whereas the adult group grew slowly. Rapid growth of hatchlings observed may be due to the change of energy from maintenance, storage, or reproduction for survival (Kozlowski, 1992; St. Clair, 1998) or reaching sizes that minimize predation risk (Znari *et al*., 2005). Rate of growth of *I. elongata* was high when they are subadults (4-5 years old) after that, growth rate declines with age. These changes reflect trade-offs between their growth and current reproduction after sexual maturation (Shine, 1990; St. Clair, 1998).

For the growth rate of *I. elongata* adult, it was found that rate of growth in adult males was less than that in adult females. That may be because the males spend energy for reproductive activities, such as male-male competition and courtship behavior, whereas females conserve energy for highest reproductive success, such as increase of internal body volume, clutch size and egg size. The size differences between the sexes during the growth of *I. elongata* may be the cause of the sexual size dimorphism after maturation. It can be concluded that the growth of *I. elongata* is similar to the growth in other chelonians which are more rapid during the juvenile and subadult stage and decrease markedly in adults (Davenport and Scott, 1993; Germano, 1994; Germano *et al*.,2000; Lagarde *et al*., 2001; Znari *et al*., 2005) or decrease dramatically after attainment of sexual maturity (Chen and Lue, 2002; Mushinsky *et al*., 1994; Kabigumila, 2000).

The estimated size at first reproduction in turtles can predict from size at which average growth rates are lowest (Aresco and Guyer, 1999). The estimated size at sexual maturity in elongated tortoises was that they grow slowly and attain maturity, approximately 7-8 years old for females and 6 years old for males. These results were similar to the results from the behavioral observations to estimate the age at maturity of tortoises in the field.

The smallest size of male exhibiting reproductive activity was 175 mm CL, approximately 5-6 years old. This size did not completely show all of the external male characteristics. The smallest size at maturity for female was 240 mm CL, ~ 8 years old. For the observation of van Dijk (1998) who studied the elongated tortoise in the wild of western Thailand. He found that the smallest mature male observed was 206 mm CL and it did not show any of the external male characteristics. The smallest mature female observed was 198 and 227 mm CL. It shows that size at maturity based on captive individuals will differ greatly from wild populations.

In the elongated tortoise population, the relatively early of age and size at first reproduction may be promoting greater reproduction potential of males than in wild population. Age at sexual maturity was considered to be one of the most important influences on population growth in turtles (Auffenberg and Iverson, 1979; Mushinsky *et al*, 1994). For the size and age at sexual maturity in females is unclear because it was hard to find them in large area when they were nesting. However, larger body size at maturity in females might be a benefit. It might be adaptive for increasing fecundity. The changes in fecundity and /or length of reproductive life are more important components of fitness than is age at first reproduction in populations with low intrinsic rates of increase (r) and high pre-reproductive rates of mortality (Meats, 1971; Galbraith, Brooks, and Obbard, 1989).

The data showed that *I. elongata* females were significantly larger than males of the same age class. The biggest size of female elongated tortoise and did not know its age was 340 mm CL and the biggest size of male tortoise was 324 mm CL. Using the logistic model has been found to be more appropriate than the von Bertalanffy model. Although, growth patterns in long lived chelonians generally followed the von Bertalanffy model has been wildly used. The selection of an appropriate growth model can be evaluated by a comparison of residual mean squares, or the comparison of asymptotic size and mean adult size. Thus, the von Bertalanffy growth function may poor statistical properties and might result in misleading and biased growth parameter estimates. Because of the asymptotic carapace lengths estimated by the von Bertalanffy model were greater than those estimated by the logistic model, and the values derived from the former were much larger than the largest individuals in the population under study.

Ontogeny

During the development of *I. elongata* from hatchling to adult, ontogenic changes in size and shell shape of this species exist. These changes are influenced by age and sexes. Changes in proportion of NL/CL, V_4L/CL, V5L/CL, SL/CL, ANTL/CL, SW/CL, ANW/CL, BLL/CL, BLR/CL, V5W/CL, Mass/CL, PL/CL, PW/CL, ANTW/CL, POSW/CL and MA/CL in each stage of life show that these characters may relate to the function and life history (Kardong, 2006). Particularly during after maturity, the size-related shape changes may be advantage for survivorship and reproduction and lead into sexual dimorphism of tortoise. The development of supracaudal scutes in adult males was lengthening and more curves. The lengthening and widening of this character in adult male may be help the tortoise for standing during mating.

The lengths of bridge in females that are longer than males may be adaptation of animal for more effective in protecting herself from predation because obviously, females compensate mobility for protection, therefore they possess proportionately long bridge. In contrast, this character is short in males, which correlated with space for the legs in activity and mobility during mating season (Zuffi and Plaitano, 2007). The larger of ANW/CL in males than female may be adaptation for success during mating. Many researchers suggested in the same way that the widening of ANW in males may be advantage to reproductive success (Bonnet *et al*. 2001; Kabigumila, 2001) and may reflect behavior of the male during copulation (McRae, Landers, and Cleveland, 1981). Ontogenic change in size and shell shape of tortoise may be defined in terms of optimality theory that affects an organism's ability to maximize their fitness.

Sexual dimorphism

Analysis of several morphological characters between the sexes in *I. elongata* showed that males and females are dimorphic. Males attained smaller size than females. This finding is similar to the result of Berry and Shine (1980), Willemsen and Hailey, (1999), Zuffi, and Plaitano (2007), Lagarde *et al*. (2001), and Willemsen and Hailey(2003) who reported that in some species of tortoises such as *Testudo kleinmanni, Testudo hermanni, Testudo horsfieldi*, *Testudo graeca, Psammobates tentoria, and Homopus areolatus*, males are smaller size than females. However, most tortoises, males are usually larger than females.

Sexual size dimorphism of tortoise was described in terms of sexual selection theory by Berry and Shine (1980). They proposed that sexual size dimorphism in tortoise correlate with sexual behavior and male mating strategies. By this strategy, sexual dimorphism may favor small males who invest their available energy into locomotion rather than growth, while females continue growing to increase fecundity. Small body size of males in some species of tortoise would facilitate the motility and reduce their transportation costs (Bonnet *et al*., 2001; Munoz and Nicolau, 2006) and increases ability to locate females. Beside, small size of males may relate to age at maturity (Gibbons and Lovich, 1990) and bring to the cause of the difference between sexes in this species. In contrast, large body size in females would allow them to produce more offspring. For the males that they are larger size than females in some terrestrial chelonian species, larger males are selected for mates, because they have to engage in combat.

The wider and longer in carapace and plastron (table 5 and table 6) of females *I. elongata* than males were found in this study. These results might be an adaptation to provide more room for accommodating eggs (Willemsen and Hailey, 2003; Kabigumila, 2001). The sexual dimorphism in some characters of shell of adult tortoises is similar to the present study such as the study of Willemsen and Hailey (2003). They found that the width of V2W and V3W in females of European tortoises are wider than males that might be the result of an increase in females to give greater stomach volume or of a decrease in males to give greater fighting ability.

The width of supracaudal scute in adult males was wider than females. The width of supracaudal in males may help them to be convenient during mating. Besides, the length of NL, C4LR, and ANLR in males were found that were longer than females. The data of anal scute length (ANL) measurement showed that males have relatively longer ANL than females. This result might relate to the shape of anal notches of males and females. Generally, the male's anal notch in *I. elongata* is V-shaped whereas females tend to be rounded (van Dijk, 1998). The V- shape anal notches and relatively longer ANL might be an adaptation for protecting precloacal region in males. The precloacal region of the tail in male is very important because it carries the male's penis (Mosimann and Bider, 1960; Brophy, 2006).

For the results of shell opening measurement, it was found the maximum aperture measurement (MA) or the midline distance from the posterior edge of the anal scutes to the ventral edge of the supracaudal scute differed between sexes. This character is important for females. It is the most restrictive measurement for eggs passage during lying and tail movements (Bonnet *et al*., 2001). Thus, space (MA) is needed to carry body reserves and egg follicles in the ventral part of their shell (Bonnet *et al*., 2001).

When comparing tail length and tail width of elongated tortoise, it was found that males had a significantly longer and narrower tail than females. Longer tail in male is similar to the previous study of *I. elongta* (van Dijk, 1998), and other species in terrestrial tortoise (Bonnet *et al*., 2001). Lawler (2011) stated that longer tail in males enables the penis to penetrate the cloaca of females.

CHAPTER V

REPRODUCTIVE BIOLOGY AND DIET OF THE ELONGATED TORTOISE *Indotestudo elongata* (Blyth, 1853) At BAN KOK VILLAGE, NORTHEASTERN THAILAND

ABSTRACT

The reproductive biology of elongated tortoises *Indotestudo elongata* was studied 2007 - 2009 at Ban Kok Village. Mating was observed from May to July when males exhibited reproductive behaviors. Twenty-three nests were found in nesting season between October and March. Mean clutch size was 4.53 ± 2.26 per clutch (1-9, N = 23). Mean egg length was 47.18 ± 2.91 mm (48.8 - 53.09, N = 74). Mean egg diameter was 39.0 ± 2.45 mm (39.37- 45.42, N = 74) and mean egg mass was 43.20 ± 7.5 g (26.2 - 60.18, N = 74). Clutch size was not correlated with egg length egg width, and egg weight. Of the 20 nests observed, hatchlings emerged during April through July. Mean incubation period was 157.88 ± 18 days (117-180, N = 49) for nests left in situ. The incubation periods of eggs varied greatly. Hatching success for clutch sizes 1, 2, 3, 4, and 6 were 100%, 100%, 75%, 81.25%, and 100%, respectively. One hundred hatchlings were assessed for survival rates and cause of mortality for 3 months during August - October. Results showed that most hatchlings died from unknown causes. The direct observations on diets showed that tortoises consumed a wide diversity of foods, predominantly herbaceous leaves, fruits, mushroom, grass, earthworm, carcass, food particles and excrement. Predators were not found in this study, but nematode helminthes such as round worm and thread worm were observed from feces.

Key words: *Indotestudo elongata*, reproductive biology, diet,

INTRODUCTION

The elongated tortoise, *Indotestudo elongata*, is common and widely distributed throughout Thailand except in Bangkok and surrounding provinces (Nutaphand, 1979). However, its population number has been sharply declined within its natural range because of hunting by local people (Thirakhupt and van Dijk, 1994; van Dijk, 1998). Basic information and ecological data on reproduction of this species are not available. A complete field study will provide good base-line data for conservation management in the future.

Although previous studies in western Thailand involved with the reproduction of this species (van Dijk, 1998), those data were not completed because the sample size was not enough. For the diet of tortoise, it was observed by van Dijk (1998) using the contents of fecal samples and direct observations of feeding. He found that the diet of this species included a wide range of fruits and leaves as well as some animal matters. Nutphand (1979) reported that they feed on plants, fungi, and slugs, whereas flowers and fruits were reported by Das (1991).

This study focused on diet and reproductive biology of the elongated tortoise population which include the following aspects: mating time, nesting time, clutch size, incubation time, hatching success, and hatchling survival rate of elongated tortoises population at Ban Kok Village in northeastern Thailand, which is suitable for the study due to the large population size of elongated tortoises naturally living under the protection by local people. This field study will provide good base-line data for conservation management in the future. Besides, it will provide essential knowledge for establishing plans for the conservation and sustainable management of the indigenous population.

METHODOLOGY

Data on the reproductive biology of elongated tortoises were collected from May 2007 through May 2009. Mating behavior was observed and recorded from the beginning to the end of mating activities. Time of egg deposition was also recorded. Eggs were removed carefully from the nest when the nest was found. Clutch sizes were determined by counting the number of eggs and measured for length and width using a vernier caliper, and egg mass using an electronic balance. After that the eggs were returned to the same position. Nests location were marked and photographed. Nests were checked every two weeks for emerging hatchlings. In this study, incubation period was defined as the time between egg deposition and hatchling emergence. One hundred hatchlings were collected randomly and marked with permanent marker on the vertebral scutes for studying survival rate. Each hatchling was measured for carapace length (CL), and carapace width (CW) to nearest 0.1 mm and weight to nearest 0.5 g. They were released in the field after data were recorded. Each tortoise was observed every two weeks up to three months.

Diets of elongated tortoise were investigated by direct observation. Parasites were collected from the shell, skin, head, neck and feces. Specimens were preserved in 70% alcohol and were identified under stereomicroscope.

Statistical analysis

Clutch size, egg size and percentage of hatching were recorded and determined from 23 tortoise nests. The differences between means of egg length, egg width, and egg weight from each clutches were analyzed using Kruskal-Wallis H. Incubation period and hatching success of each clutch were studied and the relationship between incubation periods and hatching success in each clutch was analyzed using Pearson correlation test.

RESULTS

Mating activity

In this study, 33 adult tortoises, 18 females and 15 males (1.2: 1 sex ratio) displayed reproductive behavior during May to August. Mating behavior can be found everywhere in the village. The conspicuous characteristic of adult male during this time was its brightly pink nose (Fig 5.1).

Figure 5.1 Mating behavior of *Indotestudo elongata*

The courtship and mating behavior in this species was observed in Ban Kok area. Courtship behavior started by the mature male approached toward mature female. His nose was around her cloaca, and used his anterior carapace to encounter the posterior end of the female. Male caught up the female by using its claws to hold the female's back around the costral scutes (Figure 5.1). On the female's back, the male fully extended and shaked his neck from side by side and tried to push his penis around the base of the female's tail, and at the same time then vocalized loudly.

The period of time of copulation was about 5 – 20 minutes. Besides, it was found that most elongated tortoises exhibited polygyny mating system because male tortoises could have multiple mating in a breeding season. However, promiscuity was also observed a few times during this study.

Figure 5.2 Clutch sizes of *Indotestudo elongata* at Ban Kok Village (a-e), ranging from 1-9 eggs per clutch

Nesting

A total of 23 nests was found and recorded. Nest deposition dates were from 29 October 2008 to15 March 2009. The evidence of a female tortoise laying egg more than one time per year was only found from one tortoise. Generally, female tortoises laid eggs in the hollow nest after digging the soil with back legs. They flattened the nest with plastron and left them. Usually, the sites were chosen near the tree base with high moisture. It was found that twenty one nests (91.30% of the total) were located in the soil near the tree base and bamboo clump (Fig. 5.3 (a-e). Two nests (8.7%) were found on the ground (Fig. 5.4 a, b). The shape of nests is flask shaped. Mean nest depth is 11 ± 1.66 cm (8.0-13.0, N = 9). The evidence of a tortoise laying egg more than one time per year was only found from one tortoise. Five eggs were laid on 11 February, 2010 and two eggs were laid on 15 March, 2010.

Figure 5.3 Egg nests of *Indotestudo elongata* at Ban Kok Village, showing: (a) eggs were laid on the ground under the cover, (b), (c) and (d) were egg nests found at the tree base.

Clutch size and egg size

The characteristic of elongated tortoise egg was spherical or oval shape and white colour. In this study, clutch sizes found varied from 1 to 9 eggs. Mean clutch size was 4.53 ± 2.26 per clutch (1-9, N = 23). Mean egg length was 47.18 ± 2.91 mm (48.8 - 53.09, N = 74). Mean egg width was 39.0 ± 2.45 mm (39.37- 45.42, N = 74) and mean egg mass was 43.20 ± 7.5 g (26.2 - 60.18, N = 74). Egg sizes from each clutch are shown in Table 5.1 and Figure 5.3. The result showed that there was no significantly different in mean egg length, mean egg width, and mean egg weight between clutch sizes (Kruskal-Wallis Test, $P > 0.05$). The number of eggs was also observed from the dead tortoises. Two individual produced 6 eggs and one produced 1 egg. All of them were medium to large female that had carapace length about 25.4, 27.7, and 27.2 cm, respectively.

Incubation and hatching success

Twenty clutches with known deposition dates were examined for incubation period nature. Most hatchlings emerged over a 5-week period between 25 April and 12 June in rainy season. The mean incubation period was 157.88 ± 18 days (117-180, N = 49). Hatchlings of the same clutch emerged at different time (Table 5.2). However, the relationship between mean of incubation period and clutch sizes was determined by Pearson correlation test. The results showed that there were not significantly correlated.

Of the 20 nests observed, 14 nests hatching rate was 70% (N = 52 eggs). Percentage of hatching success in each clutch was presented in Table 5.2. Mean percentage of success in clutch size 1, 2, 3, 4 and 6 were 100%, 66.67%, 33.33%, 81.25%, and 100%, respectively. Another 6 nests (30%) could not observe because the nest sites were disturbed by human and by chicken. Nest predation was not evident and predators were not found.

Table 5.1 Means ± SD and ranges of egg length, egg width and egg weight in different clutch sizes. “n” is total number of eggs measured.

Clutch size	Frequency	n	Egg length (Means ± SD) (mm)	Range	Egg width (Means ± SD) (mm)	Range	Egg weight (Means ± SD) (g)	Range
1	5	5	46.95 ± 3.62	46.95-52.63	37.75 ± 3.30	34.73-42.63	40.83 ± 7.90	32.97-52.66
2	2	3*	48.41 ± 2.43	45.82-50.65	39.96 ± 4.10	35.28-42.92	47.94 ± 11.01	35.23-54.37
3	4	12	47.61 ± 2.54	42.91-51.62	38.97 ± 2.16	36.26-43.11	44.44 ± 6.26	33.7-52.74
4	9	36	47.42 ± 3.15	41.67-53.09	39.27 ± 1.97	35.71-44.13	42.96 ± 7.43	26.2-59.3
5	1	3*	49.2 ± 1.37	48.8-50.72	40.36 ± 1.05	39.37-41.46	47.64 ± 3.15	44.9-51.08
8	1	6*	45.81 ± 2.91	41.48-49.36	39.48 ± 4.82	34.42-45.42	44.77 ± 13.08	31.15-60.18
9	1	9	45.55 ± 2.09	41.04-48.27	37.53 ± 1.47	35.5-39.54	39.7 ± 3.11	34.97-44.08

Note: * some eggs were broken and not measured

Table 5.2 Means of incubation periods and hatching success for eggs from clutches containing 1-6 eggs.

Clutch size	Clutch number	Incubation periods (days) egg (n =3)						Mean ± SD	Hatching success (%)
		1	2	3	4	5	6		
1	1	166	-	-	-	-	-		100
	2	174	-	-	-	-	-		100
	3	180	-	-	-	-	-		100
2	1	168	178	-	-	-	-	173 ± 7.07	100
	2	0	0	-	-	-	-	0	0
	3	157	163	-	-	-	-	160 ± 3	100
3	1	nd	nd	nd	-	-	-	nd	nd*
	2	nd	nd	nd	-	-	-	nd	nd*
	3	167	169	181	-	-	-	172.33± 7.57	100
	4	nd	nd	nd	-	-	-	nd	nd
	5	nd	nd	nd	-	-	-	nd	nd*
	6	136	139	142	-	-	-	139 ± 3	100
	7	117	0	0	-	-	-	117	33.33
	8	0	174	178	-	-	-	176 ± 2.8	66.67

Table 5.2 Means of incubation periods and hatching success for eggs from clutches containing 1-6 eggs (cont.).

Clutch size	Clutch number	Incubation periods (days) egg (n =3) 1	2	3	4	5	6	Mean ± SD	Hatching success (%)
3	9	nd	nd	nd	-	-	-	nd	nd
4	1	138	139	143	151	-	-	142.75 ± 5.91	100
	2	138	140	140	151	-	-	142.25 ± 5.91	100
	3	151	160	165	169	-	-	161.25 ± 7.76	100
	4	0	147	0	0	-	-	147	25
6	1	153	157	160	162	164	164	160 ± 4.34	100

Hatchling survival rate

Survival rates of the 100 hatchlings were observed between August to October 2009 in the study area. Thirty three dead hatchlings were found during the study period: 29 by unknown causes (dead tortoises did not wound and carcasses were complete), 3 by off-road vehicles and another by cattle. Predators were not found in the study area. Survival rates for the first, second, and third months were 89%, 88.8% and 84.8%, respectively. At the end of 3 month observation, 67% of hatchlings were alive.

Diets

From the direct observation of diets of the elongated tortoise at Ban Kok Village, it was found that tortoise got the food from 2 ways. First, they got the food by the villagers and another they got the food by themselves from natural habitat around the village. Information of food was summarized in Table 5.3 and Figures 5.6.

Parasite

The result of study was found that there were not found ectoparasites on tortoise body, whereas endoparasites were found from fecal samples. The endoparasites were round worms and thread worms.

Table 5.3 Diets of elongated tortoises *Indotestudo elongata* at Ban Kok Village, Khon Kaen Province.

Food from human	Food from natural habitat
Fruit	Invertebrate
Carica papaya L. (Malako)	*Lumbricus teppestris* (Earth worm)
Mangifera indica L. *(Mamuang)*	Vertebrates
Averrhoa carambola L. (Ma fueang)	*Rana rugulosa* (carcass)
Syzygium jambos L. Alston (Rose apple)	*Rattus* sp. (carcass)
Morinda citriforia L. (Yo ban)	Fruit
Psidium guajava L. (Farang)	*Coccinia grandis* L. Voigt (Tamlueng)
Cucumis sativus L. (Cucumber)	Herbaceous
Cucumis melo L. (Taeng thai)	*Amaranthus lividus* L. (Phak khom)
Artocarpus heterophyllus Lam. (Khanun)	*Basella rubra* L. (Phak plang)
Ananas comosus L. Merr. (Sapparot)	*Talinum paniculata* (Jacq.) Gaertn. (Wan phak pang)
Citrullus vulgaris Eckl. Zeyh. (Water melon)	*Ipomoea aquatica* Forssk. (Phak bung)
Pithecolobium dulce (Roxb.) Benth. (Ma kham thet))	Grass
Vegetable	*Ruellia tuberosa* L. (Toi ting)
Brassica oleracea L. var. *capitata* L. (Cabbage)	*Comphrena celosioides* Mart. (Baan mai ruu roi paa)
Others	*Sida acuta* Burm. f. (Ya khat bai yao)
Oryza sativa	*Sida subcordata* Span. (Ya khat luang)
	Cyperus sp. (Kok)
	Mushroom
	other animal excrement

Figure 5.4 Diets *of Indotestudo elongata*; a = *Pithecolobium dulce* (Roxb.) Benth. (Ma kham thet)); b = *Psidium guajava* L. (Farang); c = *Carica papaya* L. (Malako); d = *Amaranthus lividus* L. (Phak khom); e = *Basella rubra* L. (Phak plang); f = *Sida acuta* Burm. f. (Ya khat bai yao)

Figure 5.4 Diets *of Indotestudo elongata* (cont.); g = *Comphrena celosioides* Mart. (Baan mai ruu roi paa); h = *Sida subcordata* Span. (Ya khat luang); i = *Cyperus* sp. (Kok); j = Mushrooms

Figure 5.4 Diet *of Indotestudo elongata (cont.)*; k = *Oryza sativa*; l = animal excrement; m = Carcass (*Ratus* sp.); n = Earth worm (*Lumbricus terrestris*)

DISSCUSSION

Mating season and mating behavior

The data of mating behaviors and activity patterns in the study area indicated that mating season of *I. elongata* occurred in rainy season. This information agrees with the report of van Dijk (1998) who studied the natural history of the elongated tortoise in a hill forest mosaic in western Thailand. Mating behavior and pink nose of male tortoises were found in early period of rainy season.

The courtship behaviors of elongated tortoises were varied and generally based on multiple signaling systems concerning optical, chemical and auditory signals which were similar to the other tortoises (Sacchi *et al*., 2003). Auffenberg (1977) found that tactile and chemical signals were more important in land tortoises than visual and auditory signals. He stated that shell ramming was the tactile signal and used in both combat and courtship. The correlation between vocalizations and courtship intensity with mounting success were studied in *Testudo marginata* by Sacchi *et al*., (2003). They found that male mounting success did not relate to call duration but male/female size-ratio.

The pattern of mating system of male elongated tortoise was found in the field during study period. It exhibited multiple mating. This pattern might be advantage to the male in sexual selection by increasing male's fitness with mate number (Sacchi *et al*., 2003).

Nesting season

Nesting season of elongated tortoises in this study was similar to the result of Spencer (1987, cited in van Dijk, 1998) and Bourret (1941, cited in van Dijk, 1998). They found that nesting season of this species occurred during October to January and could produce eggs at other times of the year (van Dijk, 1998). In contrast, Dunn (1976, cited in van Dijk, 1998) reported that nesting season of elongated tortoise in captive breeding at Melbourne started from May to July. The evidence of tortoise ovipositing two clutches per year was found in this study which was similar to the report by Zweitz (1988 cited in van Dijk, 1998). It is possible that elongated tortoise produced multiple clutches for multiple proposes such as to decrease the risk of nest predation (Auffenberg, 1979 cited in Pedrono *et al*., 2001), to increase the hatching success (Reid, Rakotobearison, 1989 cited in Pedrono *et al*., 2001), and to increase the fecundity (Hailey and Loumbourdis, 1988 and Pedrono *et al*., 2001)

Clutch size and egg size

Clutch size of elongated tortoise was reviewed and observed by van Dijk (1998). He found that the clutch size of this species varied in each location. Butler and Hull (1996) supported that environmental condition throughout the range might also influence clutch size. In this study, clutch size consisted of 1-9 eggs per clutch, whereas van Dijk (1998) reported that clutch size of this species in hill forest mosaic of western Thailand, varied from

2-5 eggs per clutch. Data analysis indicated that mean of egg length, egg width and egg mass of elongated tortoise were not related with clutch sizes. Several studies showed that clutch size depended on body size of female

Female tortoises at small size usually produced clutch size less than larger ones (Landers, Garner, and McRae, 1980; Turner *et al*., 1986 and Butler and Hull, 1996). This reason was similar to the number of finite egg which were found in the dead female tortoises. Two of three dead female tortoises produced 6 eggs. Their carapace lengths were 25.4 cm and 27.7 cm, respectively. The size of tortoises was medium size which generally found in the village. In contrast, only one egg was found in the body of dead female tortoise with 27.2 cm in carapace length. This might be possible that this dead female tortoise already laid its eggs before dying. In this study, the mean size of eggs of elongated tortoise at Ban Kok Village were smaller than the mean size reported by van Dijk (1998) from other locations. This may be because of the food availability in the study area.

Incubation and hatching success

The emergence of hatchlings in the present study was similar to the research reported by van Dijk (1998) of which hatchlings emerged during early and middle of the rainy season. He assumed that emerged hatchlings did not leave their nest until the rain fall soften the ground. Incubation period of this species was about 117-180 days which differed from other locations. van Dijk (1998) reviewed that at the Minnesota zoo, hatchlings emerged about 96 – 146 days at upper than 20 °C whereas Bank (cited in van Dijk, 1998) found that hatchlings emerged about 98-150 days at 28 - 31.5 °C. In contrast, 69 days and 6-8 weeks were reported by Dunn (1976) and Zweitz (1988) (cited in van Dijk, 1998), respectively. Periods of incubation might cause by soil temperature (Swingland and Coe, 1978). They found that increasing of soil temperature affected the incubation period in the giant tortoise by decreasing of time. This evidence is opposite to the incubation period of ploughshare tortoise (*Geochelone yniphora*), which hatchlings within a nest emerged on the same day or, rarely, over a second day (Pedrono *et al*., 2001).

Hatching success (51.67%) of this study was resembling the studied by Pedrono *et al*. (2001) who observed hatching success (54.6%) of ploughshare tortoise in northwestern Madagascar. The reason of non predator in this study area indicated that successful of reproduction could occur and might increase the population size.

Survival rate of hatchlings

Three months after hatching, survival rate of elongated tortoise hatchling at Ban Kok Village was 67%. However, cause of death for most incidents (29 of 33) could not be identified. Car accident and trampling by cattle were only observed causes of hatchling death. Mortality due to unknown cause might occur from maternal and environmental factors (Brooks et al., 1991) such as energy allocation to eggs and nest site selection by female that could affect to offspring fitness (Brooks et al., 1991: Valenzuela, 2001: Warner, Jorgensen, and Janzen, 2010). Low incubation temperature in the nest might produce weak hatchlings (Roosenburg, 1996: Keller, Diaz-Paniagua, and Andreu, 1998). Dehydration might also be the cause of death as reported in bolson tortoise (*Gopherus flavomarginatus*) by Adest et al. (1989, cited in Butler and Sowell, 1996). Besides, Landers *et al*. (1980, cite in Butler and Sowell, 1996) and Smith (1996, cited in Butler and Sowell, 1996) reported that fire ants (*Solenopsis* spp.) were predators of gopher tortoise hatchling. During the study at Ban Kok village, many ants (*Solenopsis geminata* and *Oecophylla smaragdina*) were observed in the field. They were found to bite the weak tortoises and the dead ones. However, there was no proof of predation by ants in elongated tortoise hatchling. No large predator such as monitor lizard was found in the study area. During the study period, three fresh excrements of adult elongated tortoise were encountered and large numbers of endoparasites (round worms and thread worms) were found in all excrements, hence infection by parasites could not be discarded from a cause of death. Therefore, the cause of mortality in elongated tortoise hatchling should be further investigated in order to increase the survival rate in elongated tortoise hatchling as well as other tortoises.

Diet

Nutphand (1979) and van Dijk (1998) reported that elongated tortoise feed on a wide diversity of plants, fruits, fungi, slugs, carcasses and carnivore scats, whereas earthworm, food particles such as rice and bone, and excrement were observed in this study during tortoise eating. It can be concluded that this species is omnivore and scavenger.

Parasite

Nakpubpha (2002) reported that endoparasites *of I. elongata* in captive at the Chiang Mai Zoo were Ascaris spp., Hook worm, Strongyloides spp., and Oxyurid spp. Whereas, van Dijk (1998) reported that ticks and mites were ectoparasites in elongated tortoise in the wild. Adults of *Amblyomma supinoi* was the largest class of ectoparasites. For the endoparasites of this species were nematode helminthes. In this study, it was found that round worm and thread worms were endoparasites whereas there were not found ectoparasites.

CHAPTER VI

CONSERVATION AND MANAGEMENT PLAN FOR THE ELONGATED TORTOISES AT BAN KOK VILLAGE, KHON KAEN PROVINCE

Elongated tortoise *Indotestudo elongata* is categorized as an endangered species on the IUCN Red List of Threatened Species (IUCN, 2007). Therefore, it is an important species and should receive closely attention. They are uncommon in their natural habitats in Thailand, but at Ban Kok Village, Khon Kaen Province, there are many of them living with the local people in the semi-natural habitat. They have been protected from exploitation by local people because of the belief in spirit, the way of life of the villagers, and no natural predator capable to kill the adults. Thus, the population of them has increased to the number which is much higher than in the wild. Since there are many tortoises in this area, it is well known to tourists and becomes ecotourism site. The carrying capacity of the village environment and the tortoise population size is needed to be investigated. Thus, the study of population characteristics, diets and reproductive data are imperative for understanding its ecology and examining the long term demographic trends of this species under disturbed area. The data are benefit for evaluating the effect of their population in disturbed area and for finding a way to conserve and manage the animal. Besides, data are also benefit to ecotourism and a way to conserve this species in the wild in the future.

The goal of this chapter is to integrate the information from the study on population structure, growth, ontogeny, sexual dimorphism, reproductive biology, diet and biological factors of the elongated tortoise *Indotestudo elongata* at Ban Kok Village, Khon Kaen Province for suggesting conservation and management plan.

Recommendations on conservation and management plan

1. Short term plan: should be conducted by

- Providing the knowledge on ecology and natural history of the elongated tortoise from this study to local people. This can be conducted by organizing the training course.
- Providing information to local people and travel agencies on the proper management of ecotourism. This can also be conducted by organizing the training course.
- Investigating the suitable population size of the elongated tortoise in relation to the carrying capacity of the village environment. Decision making on how large the population size should be and the population control plan should be developed.
- setting up the advisory team who can provide proper information and recommendation to local organizers or administrators.
- drafting the long term conservation and management plan for the tortoise. This can be done by all stakeholders, including academics.

2. Long term plan: should be conducted continuously by:

- Organizing a series of training courses or workshops on the conservation of the tortoise for local people, administrators, travel agency personals and etc.
- Estimating population size of the tortoise in the village area every year. This can be conducted by local people.
- Investigating population structure and sex ratio every three year to see the change in age and sex of the tortoise population
- Recording dead tortoises and the cause of death every month. Each year, the data should be evaluated.
- Conducting detailed study on the food availability and food requirement for the tortoise population. Decision making on whether food should be provided to the tortoises or not can be brainstormed.
- Radio-tracking study to get the information on the behavior and movement of tortoises.
- Distributing knowledge on ecology and biology of the elongated tortoise to local and nearby schools.

- Integrating the culture of local people to the knowledge of ecology which will lead to sustainable conservation.

- Evaluating the conservation and management plan every year. Mitigation should be conducted when problems arise.

CHAPTER VII

CONCLUSION

The elongated tortoise, *Indotestudo elongata*, is an endangered species and is uncommon in natural habitats of Thailand. In contrast, a large population has been found living with the local people at Ban Kok Village, Khon Kaen Province. The coexistence between the people and the tortoises here is interesting to tourism. Therefore, the study on population ecology and reproductive biology of this tortoise species is needed for the purpose of conservation and tourism management.

The results of the study are as follows.

Population structure

1. From the population size survey in 2009, there were 1,195 tortoises living within the study area of 492 ha, including of 396 males, 369 females, and 430 unsexed juveniles. The population density was 2.43 ind. per ha.
2. Size and age structures differed significantly among individuals of this elongated tortoise population. Approximately, 54.48% of the population are adults which are more than 20 years old.

Growth, ontogeny and sexual dimorphism

1. Growth rates of *I. elongate* at Ban Kok Village are more rapid during the juvenile and sub-adult stages and decrease markedly after that.
2. Males reach sexual maturity at a smaller size and less age than do females.
3. The change in size and shell shapes of this species, distinguished by a marked decrease or increase of allometric growth after tortoises reach sexual maturity, lead into sexual dimorphism.
4. Females have larger size and have relatively wider carapace and plastron than males.
5. Fifty one of 119 shell characters are sexually dimorphic. These characters could be the result of sexual selection for fecundity and reproduction.

Reproductive biology

1. From the observation in 2009 and 2010, the reproductive behaviors of elongated tortoise exhibited during May to August.
2. Mating system was polygyny and also exhibited to mate promiscuously.
3. Nesting season occurred between October and March.
4. Mean clutch size was 4.53 ± 2.26 per clutch (1-9, N = 23). Mean egg length was 47.18 ± 2.91 mm (48.8 - 53.09, N = 74). Mean egg diameter was 39.0 ± 2.45 mm (39.37- 45.42, N = 74) and mean egg mass was 43.20 ± 7.5 g (26.2 - 60.18, N = 74).
5. Hatchlings emerged from nests during April through July.
6. Mean incubation period was 157.88 ± 18 days (117-180, N = 49)
7. Hatching success was high.
8. Survival rates of hatchlings were 67% from the 3 months study after hatching (August- October).
9. The causes of mortality for hatchlings were from car accident, trampling by cattle and unknown cause. The cause of mortality due to unknown cause is the most important and should be studied in the future.

Diet

1. Elongated tortoise is omnivorous.
2. They consumed a wide diversity of foods, predominantly herbaceous leaves, fruits, mushroom, grass, earthworm, carcass, food particles and excrement.

Biological factor

1. Nematode helminthes such as round worm and thread worms were observed from feces.
2. No natural predator was found.

From the results of study indicated that elongated tortoise population at Ban Kok Village has not been threatened severely. Adult sex ratio is 1.07:1 which is close to the 1:1 ratio proposed by Fisher (1930). Age and size structures exhibited high number of very young and adult tortoises with low number of juveniles. However, the tortoise is long live animal, thus the adult stage is also high and only a small number of young tortoises in each class may develop to replace the higher class of population. In contrast, adult tortoises have a risk from various accidents such as car accident, fire from burning a rubbish and landscape modification by local people. Therefore, this species should have continuous monitoring both of short term and long term monitoring in order to maintain its population.

REFERENCES

Adest, G. A., Aguirre, G., Morafka, D. J., and Jarchow, J. V. 1989. Bolson tortoise (*Gopherus flavomarginatus*) conservation; I. Life history. Vida Sylvestre Neotrop 2: 7-13. Cited in Butler, J. A., and Sowell, S. 1996. Survivorship and predation of hatchling and yearling gopher tortoises, *Gopherus polyphemus*. Journal of Herpetology 30(3): 455-458.

Anderson, R. A., and Vitt, L. J. 1990. Sexual selection versus alternative causes of sexual dimorphism in teiid lizards. Oecologia 84: 145-157.

Andrew, R. M. 1982. Patterns of growth in reptiles. Cited in Grant, C., and Pough, F. H. Biology of Reptilia Academic Press, New York.

Aranyavalai, V. 1996. Morphometry of brown tortoise *Manouria emys emys* and Burmese black tortoise *Manouria emys phayrei* in Thailand Master's Thesis. Department of Biology, Graduate School, Chulalongkorn University.

Aresco, M. J., and Guyer, C. 1999. Burrow abandonment by gopher tortoises in slash pine plantations of the Conecuh National Forest. Journal of Wildlife Management 63.

Auffenberg, W. 1977. Display behavior in tortoises. American Zoologist 17: 241-250.

Auffenberg, W., and Iverson, J. B. 1979. Demography of terrestrial turtles. Cited in Pedrono, M., Smith, L. L., Sarovy, A., Bourou, R., and Tiandray, H. 2001. Reproductive ecology of the ploughshare tortoise (*Geochelone yniphora*). Journal of Herpetolgy 35(1): 151-156.

Avery, H. W., *et al*. 1993. Roles of diet protein and temperature in the growth and nutritional energetics of juvenile slider turtles, *Trachemys scripta*. Physiological Zoology 66: 902-925.

Ayaz, D., *et al*. 2007. Population estimate and body size of European pond turtles (*Emys orbicularis*) from Pazaragac (Afyonkarahisar/Turkey). Biologia, Bratislava 62(2): 225-227.

Badyaev, A. V. 2002. Growing apart: an ontogenetic perspective on the evolution of sexual size dimorphism. Trends in Ecology & Evolution 17(8): 369-378.

Beaupre, S. J., Duvall, D., and O'leile, J. 1998. Ontogenetic variation in growth and sexual size dimorphism in a Central Arizona population of the Western Diamondback Rattlesnake (*Crotalus atrox*). Copeia 1: 40-47.

Berry, J. F., and Shine, R. 1980. Sexual size dimorphism and sexual selection in turtle (order Testudines). Oecologia 44: 185-191.

Bertolero, A., Carretero, M. A., and Llorente, G. A. 2005. An assessment of the reliability of growth rings counts for age determination in the Hermann's tortoise *Testudo hermanni*. Amphibia-Reptilia 26: 17-23.

Bonnet, X. *et al*. 2001. Sexual dimorphism in steppe tortoises (*Testudo horsfieldii*): influence of the environment and sexual selection on body shape and mobility. Biological Journal of the Linnean Society 72: 357-372.

Bour, R. 1980. Essai sur la taxinomie des Testudinidae actuels (Reptilia, Chelonii). Bulletin of the American Museum of Natural History Paris (4) A(2): 541-546. Cited in Iverson, J.B., Spinks, P.Q., Shaffer, H.B., McCord, W.P. and Das, I. 2001. Phylogenetic relationships among the Asian tortoises of the Genus *Indotestudo* (Reptilia: Testudines: Testudinidae). Hamadryad 26(2): 273.

Bourn, D. M., and Coe, M. J. 1978. The size, structure and distribution of the giant tortoise population of aldabra. Philosophical Transactions of the Royal Society of London. Series B 282: 139-175.

Bourret, R. 1941. Les Tortues de l'Indochine. Bulletin de l'Institut Oceanographique de l'Indochine. Note 38: 1-235. Cited in van Dijk, P. P. 1998. The Natural history of the elongated tortoise, *Indotestudo elongata* (Blyth, 1853) (Reptilia: Testudines) in a hill forest mosaic in western Thailand, with notes on sympatric turtle species Doctoral dissertation. Department of Zoology, Faculty of Science, National University of Ireland.

Brooks , R. J., Bobyn, M. L., Galbraith, D. A., Layfield, J. A., and Nancekivell, E. G. 1991. Maternal and environment influences on growth and survival of emdryonic and hatchling snapping turtles (*Chelydra serpentina*). Canadian Journal of Zoology 69: 2667-2676.

Brooks, R. J., Krawchuk, M. A., Stevens, C., and Koer, N. 1997. Testing the precision and accuracy of age estimation using lines in scutes of *Chelydra serpentine* and *Chrysemys picta*. Journal of Herpetology 31: 521-529.

Brophy, T. R. 2006. Allometry and sexual dimorphism in the snail-eating turtle *Malayemys macrocephala* from the Chao Phraya River Basin of Central Thailand. Chelonian Conservation and Biology 5(1): 159-165.

Brown, G. P., Bishop, C. A., and Brooks, R. J. 1994. Growth rate, reproductive output, and temperature selection of snapping turtles in habitats of different productivity. Journal of Herpetology 28:405-410.

Brown, T. K., Nacy, K. A., and Morafka, D. J. 2005. Costs of growth in tortoises. Journal of Herpetology 39(1): 19-23.

Burke, A. C. 1991. The development and evolution of the turtle body plan: inferring intrinsic aspects of the evolutionary process from experimental embryology. American Zoologist 31:616-627.

Butler, J. A., and Hull, T. W. 1996. Reproduction of the tortoise, *Gopherus polyphemus* in Northeastern Florida. Journal of Herpetology 30(1): 14-18.

Butler, J. A., and Sowell, S. 1996. Survivorship and predation of hatchling and yearling gopher tortoises, *Gopherus polyphemus*. Journal of Herpetology 30(3): 455-458.

Cagle, F. R. 1946. The growth of the slider turtle *Pseudemys scripta elegans*. Am. Midl. Nat 36: 685-729.

Chen Tien-His, and Lue Kuang-Yang. 1999. Population characteristics and egg production of the yellow–maginaed box turtle, *Coura flavomarginata flavomaginata*, in Northern Taiwan. Herpetologiga 55(4): 48-498.

Chen Tien-Hsi and Lue Kuang-Yang. 2002. Growth patterns of the yellow margined box turtle (*Cuora flavomarginata*) in Northern Taiwan. Journal of Herpetology 36(2): 201-208.

CITES, 2005. [On-line]. Available from: http://www.cites.org. [2008, February 26]

Congdon, J. D., and van Loben Sels, R. C. 1991. Growth and body size in Blanding's turtles (*Emydoidea blandingi*): relationships to reproduction. Canadian Journal of Zoology 69:239-245.

Crumly, C. R. 1982. A cladistic analysis of Geochelone using cranial osteology. Journal of Herpetology 16(3): 215-234.

Crumly, C. R. 1984. A hypothesis for the relationship of land tortoise genera (family

Testudinidae). Studia Geologica Salmanticensia, Studia Palaeochelonologica 1: 115-124. Cited in Iverson, J. B., Spinks, P. Q., Shaffer, H. B., McCord, W. P., and Das, I. 2001. Phylogenetic relationships among the Asian tortoises of the Genus *Indotestudo* (Reptilia: Testudines: Testudinidae). Hamadryad 26(2): 272.

Darwin, C. 1871. The descent of man and selection in relation to sex Random, New York.

Das, I. 1991. Colour guide to the turtles and tortoises of the Indian Subcontinent R & A Avon, England. Cited in van Dijk, P. P. 1998. The Natural history of the elongated tortoise, *Indotestudo elongata* (Blyth, 1853) (Reptilia: Testudines) in a hill forest mosaic in western Thailand, with notes on sympatric turtle species Doctoral dissertation. Department of Zoology, Faculty of Science, National University of Ireland.

Das, I. 1995. Turtles and tortoises of India Bombay: Oxford University Press.

Das, I., Dattagupta, B., and Gayen, N. C. 1998. History and catalogue of reptile types of the zoological survey of India. Journal of South Asian Natural History 3(2): 121-172.

Davenport, J., and Scott, C. R. 1993. Individual growth and allometry of young green turtles (*Chelonia mydas* L.). Herpetology Journal 3: 19-25.

Diaz-Paniagua, C., Keller, C., and Andreu, A. C. 2001. Long-term demographic fluctuations of the spur-thighed tortoise *Testudo graeca* in SW Spain. Ecography 24: 707-721.

Dunn, R. W. 1976. Breeding the elongated tortoise *Testudo elongate* at Melbourne Zoo International Zoo Yearbook. 16: 73-74. Cited in van Dijk, P. P. 1998. The Natural history of the elongated tortoise, Indotestudo elongata (Blyth, 1853) (Reptilia: Testudines) in a hill forest mosaic in western Thailand, with notes on sympatric turtle species Doctoral dissertation. Department of Zoology, Faculty of Science, National University of Ireland.

Ernst, C. H., and Barbour, R.W. 1989. Turtles of the world Smithsonian Institution, Washington D.C.

Fairbairn, D. J. 1997. Allometry for sexual size dimorphism: pattern and process in the coevolution of body size in males and females. Annual Review of Ecology and Systematics 28:659-687.

Fisher, R. A. 1930. *The genetical theory of natural selection.* Cited in Lovich, J. E., and Gibbons, J. W. 1990. Age at maturity influences adult sex ratio in the turtle Malaclemys terrapin. Oikos 59: 126-134.

Frazer, N. B., and Ehrhart, L. M.1985. Preliminary growth models for green, *Chelonia mydas*, and loggerhead, *Caretta caretta*, turtles in the wild. Copeia 73-79.

Galbraith, D. A., Brooks, R. J., and Obbard, M. E. 1989. The influence of growth rate on age and body size at maturity in female snapping turtles (*Chelydra serpentina*). Copeia 4: 896-904.

Germano, D. I. 1988. Age and growth histories of desert tortoises using scute annuli. Copia 914-920.

Germano, D. I. 1994. Growth and maturity of North American tortoises in response to regional climates. Canadian Journal of Zoology 72: 918-931.

Germano, D. J. 1998. Scutes andage determination of desert tortoises revisited. Copia 482-484.

Germano, D. J., and Bury, R. B. 1998. Age determination in turtles: evidence of annual deposition of scute rings. Chelonian Conservation and Biology 3: 123-132.

Germano, D. J., Bury, R. B., and Jennings, M. 2000. Growth and population structure of *Emydoidea blandingii* from western Nebraska. Chelonian Conservation and Biology 3:618-625.

Gibbons, J. W. 1970. Reproductive dynamics of a turtle (*Pseudemys scripta*) population in a reservoir receiving heated effluent from a nuclear reactor. Canadian Journal of Zoology 48:881-885.

Gibbons, J. W. 1990. Reproduction in the slider and other species of turtle Cited in Gibbons, J. W., ed. Life history and ecology of the slider turtle Smithsonian. Institution Press, Washington, D.C., U.S.A.

Gibbons, J. W., and Lovich, J. E. 1990. Sexual dimorphism in turtles with emphasis on the slider turtle (*Trachemys scripta*). Herpetological Monographs 4:1-29.

Gould, S. J. 1977. Ontogeny and phylogyny Harvard Univ. Press, Cambridge, Massachusetts.

Hailey, A., and Loumbourdis, N.S. 1988. Egg size and shape, clutch dynamics, and reproductive effort in European tortoises. Canadian Journal of Zoology 66:

1527-1536.

Hailey, A. 1990. Adult survival and recruitment and the explanation of an uneven sex ratio in a tortoise population. Canadian Journal of Zoology 68: 547-555.

Hailey, A., and Coulson, I. M. 1999. The growth pattern of the chelonians. Canadian Journal of Zoology 77: 181-193.

Hailey, A., and Willemsen, R. E. 2000. Population density and adult sex ratio of the tortoise *Testudo hermanni* in Greece: evidence for intrinsic population regulation. Journal of Zoology 251: 325 -338.

Hazard, L. C., Shemanski, D. R., and Nagy, K. A. 2009. Nutritional Quality of Natural Foods of Juvenile Desert Tortoises (*Gopherus agassizii*): Energy, Nitrogen, and Fiber Digestibility. Journal of Herpetology 43(1):38-48.

Hedrick, A. V., and Temeles, E. J. 1989. The evolution of sexual dimorphism in animals: hypotheses and tests. Tree 4(5):136-138.

Hellgren, E. C., Kazmaier, R. T., Ruthven III, D. C., and Synatzske, D. R. 2000. Variation in tortoise life history: demography of *Gopherus berlandieri*. Ecology 81(5): 1297-1310.

Hendrie, D. 1998. Protecting Viet Nams turtles [On-line]. Available from: http://nytts.org/vietnam/protecting_vn_turtles.pdf [2011, May 17]

Henen, B. T., Peterson, C. C., Wallis, I. R., Berry, K. H., and Nagy, K. A. 1998. Effects of climatic variation on field metabolism and water relations of desert tortoises. Oeclogia 117:365-373.

Hulse, A. C. 1976. Growth and morphometrics in *Kinosternon sonoriense* (Chelonia: Kinosternidae). Journal of Herpetology 10: 341-348.

Hulse, A. C. 1982. Reprouction and populationstructure in the turtle, *Kinosternon sonoriense*. The Southwestern Naturalist 27(4): 447-456.

IUCN, 2007. IUCN Red List of Threatened Species. [On-line]. Available from: http://www.iucnredlist.org. [2011, February 11]

Jackson, C. G.,Trotter, T. H., Trotter, J. A., and Trotter, W. 1978. Further observations of growth and sexual maturity in captive desert tortoises (Reptilia: Testudines). Herpetologica 34(2): 225-227.

Jenkins, M. D. 1995. Tortoises and freshwater turtle: the trade in Southeast Asia

Cambridge: Traffic International. Cited in P.P. van Dijk. 1998. The Natural history of the elongated tortoise, *Indotestudo elongata* (Blyth, 1853) (Reptilia: Testudines) in a hill forest mosaic in western Thailand, with notes on sympatric turtle species Doctoral dissertation. Department of Zoology, Faculty of Science, National University of Ireland, 1998.

Jones, R. L., and Hartfield, P. D. 1995. Population size and growth in the turtle *Graptemys oculifera*. Journal of Herpetology 29(3): 426-436.

Judd, F. W., and Rose, F. L. 1983. Population structure, density and movements of the Texas tortoise *Gopherus berlandieri*. The Southwestern Naturalist 28(4): 387-398.

Kabigumila, J. 2000. Growth and carapacial colour variation of the leopard tortoise, *Geochelone paradalis babcocki*, in northern Tanzania. African Journal of Ecology 38: 217-223.

Kabigumila, J. 2001. Sex and age variation in the anal scute of the leopard tortoise, *Geochelone pardalis*, in Serengeti National Park, Tanzania. African Journal of Ecology 39: 223-225.

Kaddour, K. B., EL Mouden, EL. H., Slimani, T., Bonnet, X., and Lagarde, F. 2008. Sexual dimorphism in the greek tortoise: A test of the body shape hypothesis. Chelonian Conservation and Biology 7(1): 21-27.

Kaddour, K. B., Slimani, T, El Mouden, E. H., Lagarde, F., and Bonnet, X. 2006. Population structure, population density and individual catchability of *Testudo graeca* in the central Jbilets (Morocco). Vie ET Milieu 56(1): 49-54.

Kardong, K. V. 2006. Vertebrates: comparative anatomy, function, evolution 4th ed. The McGraw-Hill companies.

Keller, C., Diaz-Paniagua, C., and Andreu, A. C. 1998. Survival rates and causes of mortality of *Testudo graeca* hatchlings in Southwestrn Spain. Journal of Herpetology 32(2): 238-243.

Kenanan, C. 2009, April 20. Village headman, Ban Kok Village, Suan Mon Subdistrict, Mancha Khiri District, Khon Kaen Province. Interview.

Klingenberg, C. P., Neuenschwander, B. E., and Flury, B. D. 1996. Ontogeny and individual variation: analysis of patterned covariance matrices with common principal components. Systematic Biology 45(2): 135-150.

Kozlowski, J. 1992. Optimal allocation of resources to growth and reproduction: implication for age and size at maturity. Trends in Ecology and Evolution 7: 15-19.

Lagarde, F., *et al*. 2001. Sexual size dimorphism in steppe tortoises (*Testudo horsfieldi*): growth, maturity, and individual variation. Canadian Journal of Zoology 79: 1433-1441.

Landers, J. L. 1980. Recent research on the gopher tortoise and its implications. Cite in Butler, J.A., and Sowell, S. 1996. Survivorship and predation of hatchling and yearling gopher tortoises, *Gopherus polyphemus*. Journal of Herpetology 30(3): 455-458.

Landers, J. L. Garner, J. A., and McRae, W. A. 1980. Reproduction of gopher tortoises (*Gopherus polyphemus*) in Southwestern Georgia. Herpetologica 36(4): 353-361. Cited in Butler, J. A., and Sowell, S. 1996. Survivorship and predation of hatchling and yearling gopher tortoises, *Gopherus polyphemus*. Journal of Herpetology 30(3): 455-458.

Lawler, H.E. 2011. A natural history of the desert tortoise, *Gopherus [Xerobates] agassizii*. [On-line]. Available from: http://www.biopark.org/Destort1.html [2011, May 16]

Lee, M. S. Y. 1996. Correlated progression and the origin of turtles. Nature 379: 812-815.

Lindholm, W. A. 1929. Revidiertes Verzeichnis der Gattung der rezenten Schildkroten nebst Notizen zur Nomenklatur einiger Arten. Zool. Anz 81: 275-295. Cited in Iverson, J. B., Spinks, P. Q. Shaffer, H. B. McCord W. P., and Das, I. 2001. Phylogenetic relationships among the Asian tortoises of the Genus *Indotestudo* (Reptilia: Testudines: Testudinidae). Hamadryad 26(2): 272.

Litzgus, J. D., and Brooks, R. J. 1998a. Growth in a cold environment: body size and sexual maturity in a northern population of spotted turtles, *Clemmys guttata*. Canadian Journal of Zoology 76:773-782.

Loehr, V. J. T., Hofmeyr, M. D., and Henen, B. T. 2007. Growing and shrinking in the smallest tortoise, Homopus signatus signatus: the importance of rain. Oecologia 153: 479-488.

Loveridge, A., and Williams, E. E. 1957. : Revision of the African tortoises and turtles of the suborder Cryptodira. Bulletin of the Museum of Comparative Zoology 115: 163-557.

Lovich, J. E., Ernst, C. H., and McBreen, J. F. 1990. Growth, maturity, and sexual dimorphism in the wood turtle, *Clemmys insculpta*. Canadian Journal of Zoology 68: 672-677.

Lovich, J. E., and Gibbons, J. W. 1990. Age at maturity influences adult sex ratio in the turtle Malachemys terrapin. Oikos 59: 126-134.

MacCulloch, R. D., and Secoy, D. M. 1983. Demography, growth, and food of western painted turtles, *Chrysemys picta bellii* (Gray), from southern Saskatchewan. Canadian Journal of Zoology 61:1499-1509.

Mann, G. K. H., O'Riain, M. J., and Hofmeyr, M. D. 2006. Shaping up to fight: sexual selection influences body shape and size in the fighting tortoise (*Chersina angulata*). Journal of Zoology 269: 373-379.

Manthey, U., and Grossmann, W. 1997. *Amphibien und Reptilien Sudostasiens*. Cited in van Dijk, P. P. 1998. The Natural history of the elongated tortoise, Indotestudo elongata (Blyth, 1853) (Reptilia: Testudines) in a hill forest mosaic in western Thailand, with notes on sympatric turtle species Doctoral dissertation. Department of Zoology, Faculty of Science, National University of Ireland.

McKinney, M. L., and McNamara, K. J. 1991. Heterochrony: The evolution of ontogeny Plenum, New York.

McRae, W. A., Landers, J. L., and Cleveland, G. D. 1981. Sexual dimorphism in the gopher tortoise (*Gopher polyphemus*). Herpetologica 37(1): 46-52.

Morafka, D. J. 1994. Neonates: missing links in the life histories of North American Tortoises Cited in Bury, R. B., and D. J. Morafka, D. J., eds. Biology of North American tortoises U.S. Fish and Wildlife Service, Wildlife Research Reports, Washington, D.C., USA.

Mosimann, J. E., and Bider, J. R. 1960. Variation, sexual dimorphism, and maturity in a Quebec population of the common snapping turtle, *Chelydra serpentine*. Canadian Journal of Zoology 38: 19-38.

Munoz, A., and Nicolau, B. 2006. Sexual dimorphism and allometry in the stripe-necked terrapin *Mauremys leprosa*, in Spain. Chelonian conservation and biology 5(1): 87-92.

Mushinsky, H. R., Wilson, D. S, and McCoy, E. D. 1994. Growth and sexual dimorphism of *Gopherus polyphemus* in Central Florida. Herpetologica 50(2): 119-128.

Nakbubpha, K. 2002. A comparative study on the efficacy of albendazole and mebendazole in the elongated tortoise *Indotestudo elongata* at Chiang Mai Zoo. Special problem. Faculty of Veterinary Medicine, Chiang Mai University.

Nutphand, W. 1979. The turtles of Thailand Siamfarm Zoological Garden. Bangkok.

Parmenter, R. R. 1981. Digestive turnover rates in freshwater turtles: the influence of temperature and body size. Comparative Biochemmistry and Physiology 70A: 235-238.

Pedrono, M., Smith, L. L., Sarovy, A., Bourou, R., and Tiandray, H. 2001. Reproductive ecology of the ploughshare tortoise (*Geochelone yniphora*). Journal of Herpetolgy 35(1): 151-156.

Pough, F. H., *et al*. 2004. Herpetology 3rd ed. U.S.A: Pearson Prentice Hall.

Reiber, C. L., Malekpour, S., and McDaniel, M. 1999. Effects of post-hatching maintenance temperature on desert tortoise (*Gopherus agassizii*) shell morphology and thermoregulatory behavior. Journal of Herpetology 3(2):234-240.

Reid, D. L., and Rakotobearison, G. 1989. The captive breeding project for the angonoka *Geochelone yniphora* in Madagascar. Cited in Pedrono, M., Smith, L. L., Sarovy, A., Bourou, R., and Tiandray, H. 2001. Reproductive ecology of the ploughshare tortoise (*Geochelone yniphora*). Journal of Herpetolgy 35(1): 151-156.

Rockwood, L. L. 2006. Introduction to population ecology Blackwell Publishing. USA p. 82.

Roff, D. A. 1992. The evolution of life histories: theory and analysis Chapman and Hall, New York.

Roosenburg, W. M. 1996. Maternal condition and nest site choice: an alternative for the maintenance of environmental sex determination? American Zoologist 36: 157-168.

Roosenburg, W. M., and Kelley, K. C. 1996. The effect of egg size and incubation temperature on growth in the turtle, *Malaclemys terrapin*. Journal of Herpetology 30(2): 198-204.

Rouag, R., Benyacoub, S., and Luca, L. 2007. Population structure and demography of an Algerian population of the Moorish tortoise *Testudo graeca*. Animal Biology 57(3): 267-279.

Sacchi, R., Galeotti, P., Fasola, M., and Ballasina, D. 2003. Vocalizations and courtship intensity correlate with mounting success in marginated tortoises *Testudo marginata*. Behavioral Ecology and Sociobiology 55: 95-102.

Sinervo, B., and Adolph, S. C. 1989. Thermal sensitivity of growth rate in hatchling *Sceloporus* lizards: Environmental, behavioral and genetic aspects. Oecologia 78:411-419.

Shine, R. 1989. Ecological causes for the evolution of sexual dimorphism: a review of the evidence. The Quarterly Review of Biology 64(4): 419-452.

Shine, R. 1990. Proximate determinants of sexual differences in adult body size. Am Nat 135: 278-283.

Smith, M. A. 1931. The fauna of British India, including Ceylon and Burma. Reptilia and Amphibia 1. Loricata, Testudines. London. Cited in Butler, J.A., and Sowell, S. 1996. Survivorship and predation of hatchling and yearling gopher tortoises, *Gopherus polyphemus*. Journal of Herpetology 30(3): 455-458

Smith, L. L. 1996. Survivorship of hatchling gopher tortoises (*Gopherus polyphemus*) in north-central Florida. Cited in Butter, J. A. and Sowell, S. 1996. Survivorship and predation of hatchling and yearling gopher tortoises, *Gopherus polyphemus*. Journal of Herpetology 30(3): 455-458.

Spencer, B. 1987. The elongated tortoise and its management at the Minnesota Zoo. Bulletin of the Chicago Herpetological Society. 23(3): 37-40. Cited in van Dijk, P. P. 1998. The Natural history of the elongated tortoise, Indotestudo elongata (Blyth, 1853) (Reptilia: Testudines) in a hill forest mosaic in western Thailand, with notes on sympatric turtle species Doctoral dissertation. Department of Zoology, Faculty of Science, National University of Ireland.

Spencer, R. J. 2002. Growth patterns of two widely distributed freshwater turtles and a comparison of common methods used to estimate age. Australian Journal of Zoology 2002. 50: 477-490.

Spotila, J . R., and other. 1994. Effects conditions on sex determination, hatching success, and growth of hatchling desert tortoises, *Gopherus agassizii*. Herpetologica Monographs 8:103-116.

Srinarumol, N. 1995. Population biology of the malayan snail-eating turtle *Malayemys subtrijuga* (Schiegel and Müller, 1844) Master's Thesis. Department of Biology, Graduate School, Chulalongkorn University.

St. Clair, R. C. 1998 Pattern of growth and sexual size dimorphism in two species of box turtles with environmental sex determination. Oecologia 115: 501-507.

Stearns, S. C. 1994. The evolution of life histories Oxford Univ. Press, New York.

Stubbs, D., Hailey, A., Pulford, E., and Tyler, W. 1984. The ecology of European tortoise: review of field techniques. Amphibia-Reptilia 63: 57-68.

Suan Mon Subdistrict Administration Organization. 2010. Data basis of Subdistrict Administration Organization of Suan Mon Subdistrict, Mancha Khiri District, Khon Kaen Province [Online]. Available from: http://www.ru.ac.th/tambon/suan_mon/suan_mon1.html [2010, July 28]

Sutthitham, T., Intachakra, T., Verakul, S., and Sanoamuang, L. 1996. The study on ecosystem and planning layout for tourism development at Ban Kok Village, Mancha Khiri District, Khon Kaen Province (in Thai). Khon Kaen: Khon Kaen University. (Mimeographed)

Swingland, I. R., and Coe, M. 1978. The national regulation of giant tortoise populations on Aldabra Atoll: recruitment. Philosophical Transactions of the Royal Society B: Biological Sciences 286: 177- 188.

Thai Meteorological Department. 2010. Climatologically data of Station: 381201-Khon Kaen) and data rain fall of Mancha Khiri District for period 1990 – 2009 Meteorological department (distributor).

Tharapoom, K. 1996. Radio-Telemetry study of home range size and activities of elongated tortoise Indotestudo elongata (Blyth,1853 at Huai Kha Khaeng Wildlife Sanctuary Master's Thesis. Department of Biology, Graduate School, Chulalongkorn University.

Thirakhupt, K., and van Dijk, P. P. 1994. Species diversity and conservation of tortoises of Western Thailand. Natural History Bulletin Siam Society 42: 207-259.

Tomovic L. M., Crnobrnja-Isailovic J. M., Ajtic R. D., Aleksic, I. D., and Djordjevic, S. Z. 2010. When do meadow vipers (Viperaursinii) become sexually dimorphic? Ontogenetic patterns of sexual size dimorphisms. Journal of Zoological Systematics and Evolutionary Research 48(3): 279-282.

Tracy, C. R., and Tracy. C. R. 1995. Estimating age of Desert Tortoises (*Gopherus agassizii*) from scute rings. Copeia (4): 964-966.

Trent, T. T., and Rongstad, O. J. 1974. Home range and survival of cottontail rabbits in southwestern Wisconsin. Journal of Wildlife Management 38(3): 459-472.

Turner, F. B., Hayden, P., Burge, B. L., and Roberson, J. B. 1986. Egg production by the desert tortoise (*Gopherus agassizii*) in California. Herpetologica 42(1): 93-104.

van Dijk, P. P. 1998. The Natural history of the elongated tortoise, *Indotestudo elongata* (Blyth, 1853) (Reptilia: Testudines) in a hill forest mosaic in western Thailand, with notes on sympatric turtle species Doctoral dissertation. Department of Zoology, Faculty of Science, National University of Ireland.

Valenzuela, N. 2001. Maternal effects on life history traits in the Amazonian giant river turtle *Podocnemis expansa*. Journal of Herpetology 35(3): 368-378.

Warner, D. A., Jorgensen, C. F., and Janzen, F. J. 2010. Maternal and abiotic effects on egg mortality and hatchling size of turtles: temporal variation in selection over seven years. Functional ecology 24(4):857-866.

Willemsen, R. E., and Hailey, A. 2003. Sexual dimorphism of body size and shell shape in European tortoises. The Zoological Society of London 260:353-365.

Willemsen, R. E., and Hailey, A. 1999. Variation of adult body size of the tortoise *Testudo hermanni* in Greece: proximate and ultimate causes. Journal of Zoology 248:379–396.

Wilson, D.S. 1991. Estimates of survival for juvenile Gopher tortoses, *Gopher polyphemus*. Journal of Herpetology 25(3): 376-379.

Znari, M., Germanob, D. J., and Mace' J-C. 2005. Growth and population structure of the Moorish Tortoise (*Testudo graeca graeca*) in Westcentral Morocco: possible effects of over-collecting for the tourist trade. Journal of Arid Environments 62: 55–74.

Zuffi, M. A. L., and Plaitano, A. 2007. Similarities and differences in adult tortoises: a morphological approach and its implication for reproduction and mobility between species. Acta Herpetologica 2(2): 79-86.

Zug, G. R. 1991. Age determination in turtles. Collins, J.T. (ed.), Society for the study of amphibians and reptiles. Herpetological Circular 20. Lawrence, KS.

Zug, G. R., Vitt, L. J., and Caldwell, J. P. 2001. Herpetology: an introductory biology of amphibians and reptiles 2nd ed. San Diego: Academic Press.

Zweitz, D. 1988. The elongated tortoise Geochelone (*Indotestudo) elongata* (Blyth, 1853). The Forked Tongue 13(7): 8-9. Cited in van Dijk, P. P. 1998. The Natural history of the elongated tortoise, *Indotestudo elongata* (Blyth, 1853) (Reptilia: Testudines) in a hill forest mosaic in western Thailand, with notes on sympatric turtle species Doctoral dissertation. Department of Zoology, Faculty of Science, National University of Ireland.

APPENDIX

Morphological data of *Indotestudo elongata* for sexual dimorphism

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2)

No.	Sex	CL	Mass	Mass/CL	H	H/CL	CW	CW/CL	NL	NL/CL	NW	NW/CL
11	1	258	1920	7.44	100	0.39	156	0.60	20.54	0.08	10.81	0.04
13	1	275	2740	9.96	105	0.38	173	0.63	24.95	0.09	12.1	0.04
18	1	285	3260	11.44	113	0.40	175	0.61	26.95	0.09	11.53	0.04
20	1	268	2740	10.22	110	0.41	168	0.63	19.18	0.07	8.89	0.03
21 y342	1	231	1980	8.57	102	0.44	151	0.65	20.15	0.09	9.57	0.04
22 y65	1	257	2780	10.82	105	0.41	167	0.65	13.27	0.05	7.96	0.03
23	1	248	2080	8.39	103	0.42	160	0.65	14.8	0.06	7.92	0.03
24	1	218	1580	7.25	100	0.46	139	0.64	22.45	0.10	8.39	0.04
26	1	286	2970	10.38	115	0.40	177	0.62	33.94	0.12	15.37	0.05
28	1	255	2570	10.08	113	0.44	160	0.63	28.52	0.11	13.68	0.05
29	1	277	2970	10.72	113	0.41	166	0.60	22.38	0.08	8.71	0.03
33 y172	1	265	2270	8.57	105	0.40	161	0.61	25.06	0.09	8.01	0.03
34	1	261	2470	9.46	105	0.40	170	0.65	25.44	0.10	9.37	0.04
37	1	275	3140	11.42	110	0.40	173	0.63	23.13	0.08	9.24	0.03
39	1	270	3060	11.33	110	0.41	171	0.63	21.19	0.08	13.35	0.05
41	1	287	3770	13.14	115	0.40	183	0.64	28	0.10	10.65	0.04
50	1	252	2440	9.68	105	0.42	155	0.62	20.76	0.08	7.4	0.03
43	1	245	3050	12.45	115	0.47	172	0.70	26.16	0.11	9.62	0.04
45	1	280	3230	11.54	110	0.39	183	0.65	24.12	0.09	10.83	0.04
46	1	250	1740	6.96	95	0.38	156	0.62	21.69	0.09	5.18	0.02
48	1	277	3040	10.97	120	0.43	171	0.62	25.12	0.09	8.14	0.03
52	1	270	3260	12.07	105	0.39	175	0.65	26.18	0.10	14.48	0.05

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	CL	Mass	Mass/CL	H	H/CL	CW	CW/CL	NL	NL/CL	NW	NW/CL
3	1	290	3340	11.52	213	0.73	185	0.64	26.5	0.09	9.07	0.03
5	1	260	2580	9.92	105	0.40	164	0.63	19.91	0.08	7	0.03
7 y66	1	235	2340	9.96	110	0.47	167	0.71	28.68	0.12	12.68	0.05
8 y 80	1	310.5	4820	15.52	140	0.45	200	0.64	30.7	0.10	11.1	0.04
10	1	280	3020	10.79	110	0.39	176	0.63	23.34	0.08	10.67	0.04
55	1	270	2950	10.93	120	0.44	177	0.66	25.43	0.09	10.61	0.04
53	1	250	2420	9.68	100	0.40	153	0.61	24.65	0.10	12.27	0.05
54 y_09	1	274	2000	7.30	115	0.42	166	0.61	20	0.07	9.5	0.03
59	2	270	3420	12.67	120	0.44	175	0.65	21.31	0.08	14.97	0.06
60	2	260	3400	13.08	123	0.47	171	0.66	24.79	0.10	14.56	0.06
61	2	275	3450	12.55	110	0.40	180	0.65	16.82	0.06	8.13	0.03
57	2	277	3240	11.70	119	0.43	170	0.61	20.81	0.08	9.02	0.03
58	2	277	2740	9.89	110	0.40	184	0.66	23.03	0.08	11.43	0.04
56	2	240	2160	9.00	100	0.42	105	0.44	16.71	0.07	8.56	0.04
62	2	280	2920	10.43	115	0.41	174	0.62	25.02	0.09	11.63	0.04
1	2	283	3100	10.95	112	0.40	184	0.65	28.29	0.10	13.45	0.05
4 (y44)	2	323	5800	17.96	135	0.42	233	0.72	23.72	0.07	15.89	0.05
6	2	264	2720	10.30	105	0.40	173	0.66	22.02	0.08	7.95	0.03
9	2	259	2480	9.58	110	0.42	158	0.61	24.67	0.10	8.90	0.03
12	2	292	3540	12.12	121	0.41	179	0.61	24.53	0.08	9.24	0.03
15	2	310	4100	13.23	130	0.42	198	0.64	23.33	0.08	14.22	0.05
16	2	260	2330	8.96	105	0.40	156	0.60	20.88	0.08	7.47	0.03

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	CL	Mass	Mass/CL	H	H/CL	CW	CW/CL	NL	NL/CL	NW	NW/CL
17(y103)	2	320	5250	16.41	135	0.42	210	0.66	23.39	0.07	9.38	0.03
19(y162)	2	237	1920	8.10	100	0.42	145	0.61	18.38	0.08	10.00	0.04
25 (y336)	2	258	2180	8.45	103	0.40	158	0.61	19.96	0.08	8.80	0.03
27	2	265	2080	7.85	100	0.38	158	0.60	24.63	0.09	14.65	0.06
30	2	276	3550	12.86	118	0.43	173	0.63	17.68	0.06	11.34	0.04
31	2	265	2360	8.91	105	0.40	160	0.60	20.95	0.08	8.49	0.03
32	2	283	2940	10.39	113	0.40	183	0.65	28.70	0.10	9.25	0.03
36	2	274	2420	8.83	110	0.40	168	0.61	24.93	0.09	10.20	0.04
38	2	270	2800	10.37	118	0.44	165	0.61	21.98	0.08	10.89	0.04
40	2	245	1960	8.00	110	0.45	160	0.65	17.37	0.07	7.36	0.03
42	2	285	3400	11.93	119	0.42	177	0.62	19.48	0.07	7.53	0.03
44 y339	2	253	2240	8.85	103	0.41	160	0.63	20.63	0.08	7.55	0.03
47	2	271	2560	9.45	113	0.42	165	0.61	21.87	0.08	10.18	0.04
49 y333	2	270	2800	10.37	115	0.43	183	0.68	19.95	0.07	13.88	0.05
51	2	270	2860	10.59	115	0.43	169	0.63	20.17	0.07	10.96	0.04
2	2	312	3960	12.69	125	0.40	182	0.58	23.74	0.08	10.38	0.03

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	V1L	V1L/CL	V1W	V1W/CL	V2L	V2L/CL	V2W	V2W/CL	V3L	V3L/CL	V3W
11	1	50.35	0.20	47.93	0.19	49.23	0.19	56.37	0.22	46.23	0.18	64.55
13	1	53.45	0.19	52	0.19	48.45	0.18	66.75	0.24	48.45	0.18	73.30
18	1	57.68	0.20	59.17	0.21	49.45	0.17	63.76	0.22	51.45	0.18	70.23
20	1	51.74	0.19	51.66	0.19	48.92	0.18	60.86	0.23	45.97	0.17	66.60
21 y342	1	45.8	0.20	47.46	0.21	41.38	0.18	51.32	0.22	42.92	0.19	60.87
22 y65	1	54.96	0.21	69	0.27	45.35	0.18	50.21	0.20	44.24	0.17	49.13
23	1	45.6	0.18	47.49	0.19	48.41	0.20	58.98	0.24	46.65	0.19	64.08
24	1	44.48	0.20	45.52	0.21	42.93	0.20	49.63	0.23	41.20	0.19	55.81
26	1	53.24	0.19	51.46	0.18	50.78	0.18	65.45	0.23	54.45	0.19	74.90
28	1	52.03	0.20	52.43	0.21	44.90	0.18	58.84	0.23	42.20	0.17	68.65
29	1	54.89	0.20	50.23	0.18	47.25	0.17	58.34	0.21	49.22	0.18	59.56
33 y172	1	51.45	0.19	50.81	0.19	46.41	0.18	58.97	0.22	45.26	0.17	67.12
34	1	52.98	0.20	49.11	0.19	42.06	0.16	59.08	0.23	37.04	0.14	61.62
37	1	54.33	0.20	49.54	0.18	44.26	0.16	60.66	0.22	43.87	0.16	70.28
39	1	54.89	0.20	61.13	0.23	50.37	0.19	68.92	0.26	46.30	0.17	62.81
41	1	56	0.20	53.7	0.19	52.25	0.18	68.35	0.24	51.55	0.18	75.10
50	1	50.83	0.20	47.85	0.19	51.09	0.20	66.83	0.27	41.94	0.17	69.91
43	1	51.66	0.21	51.03	0.21	48.98	0.20	61.51	0.25	45.24	0.18	71.78
45	1	53.33	0.19	49.46	0.18	55.60	0.20	66.60	0.24	43.89	0.16	73.10
46	1	49.06	0.20	44.52	0.18	48.33	0.19	50.48	0.20	44.87	0.18	57.13
48	1	47	0.17	54.99	0.20	53.44	0.19	63.93	0.23	48.55	0.18	71.35
52	1	57.83	0.21	49.89	0.18	44.10	0.16	64.25	0.24	44.89	0.17	72.56

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	V1L	V1L/CL	V1W	V1W/CL	V2L	V2L/CL	V2W	V2W/CL	V3L	V3L/CL	V3W
3	1	58.25	0.20	55.47	0.19	53.29	0.18	67.73	0.23	50.91	0.18	78.54
5	1	52.18	0.20	55.51	0.21	48.02	0.18	56.72	0.22	40.21	0.15	57.51
7 y66	1	48.69	0.21	48.57	0.21	36.62	0.16	47.47	0.20	38.59	0.16	53.94
8 y 80	1	61.41	0.20	61.03	0.20	53.17	0.17	71.69	0.23	55.17	0.18	80.51
10	1	54.49	0.19	53.88	0.19	52.93	0.19	65.54	0.23	48.63	0.17	69.25
55	1	49.49	0.18	50.42	0.19	48.34	0.18	58.84	0.22	45.22	0.17	61.68
53	1	56.04	0.22	49.52	0.20	45.21	0.18	55.58	0.22	40.70	0.16	57.52
54 y_09	1	54.7	0.20	54.73	0.20	50.85	0.19	65.73	0.24	51.30	0.19	75.59
59	2	56.46	0.21	55.83	0.21	54.39	0.20	57.62	0.21	52.29	0.19	75.30
60	2	49.07	0.19	48.05	0.18	53.35	0.21	65.09	0.25	47.64	0.18	79.70
61	2	57.41	0.21	45.03	0.16	49.44	0.18	63.44	0.23	49.83	0.18	73.94
57	2	55.03	0.20	54.80	0.20	53.72	0.19	65.13	0.24	52.37	0.19	78.18
58	2	51.94	0.19	48.03	0.17	50.69	0.18	58.76	0.21	53.24	0.19	72.12
56	2	46.24	0.19	47.54	0.20	45.65	0.19	60.00	0.25	44.10	0.18	64.34
62	2	54.99	0.20	47.67	0.17	52.76	0.19	65.46	0.23	51.98	0.19	78.35
1	2	60.65	0.21	51.88	0.18	54.80	0.19	72.92	0.26	49.46	0.17	81.58
4 (y44)	2	57.46	0.18	56.67	0.18	62.05	0.19	82.45	0.26	62.47	0.19	99.71
6	2	54.46	0.21	55.71	0.21	49.53	0.19	63.49	0.24	47.83	0.18	69.06
9	2		0.20	44.34	0.17	50.39	0.19	59.00	0.23	50.24	0.19	68.55
12	2	58.01	0.20	53.88	0.18	54.94	0.19	70.29	0.24	52.35	0.18	77.69
15	2	59.84	0.19	52.14	0.17	56.45	0.18	69.08	0.22	58.95	0.19	80.68
16	2	49.81	0.19	49.02	0.19	49.80	0.19	58.73	0.23	46.85	0.18	70.32

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	V1L	V1L/CL	V1W	V1W/CL	V2L	V2L/CL	V2W	V2W/CL	V3L	V3L/CL	V3W
17(y103)	2	59.74	0.19	57.95	0.18	56.88	0.18	77.11	0.24	60.96	0.19	99.25
19(y162)	2	41.99	0.18	47.14	0.20	41.16	0.17	53.70	0.23	43.20	0.18	61.37
25 (y336)	2	50.59	0.20	51.91	0.20	48.61	0.19	61.22	0.24	47.80	0.19	68.35
27	2	45.29	0.17	53.98	0.20	53.33	0.20	56.28	0.21	46.15	0.17	63.35
30	2	56.30	0.20	54.16	0.20	51.93	0.19	81.81	0.30	57.87	0.21	84.20
31	2	53.07	0.20	47.97	0.18	48.57	0.18	59.73	0.23	45.88	0.17	67.35
32	2	53.88	0.19	57.28	0.20	53.25	0.19	68.06	0.24	49.89	0.18	75.03
36	2	55.70	0.20	54.02	0.20	50.86	0.19	64.19	0.23	48.74	0.18	72.81
38	2	52.97	0.20	51.24	0.19	51.06	0.19	64.50	0.24	49.98	0.19	72.90
40	2	42.87	0.17	43.18	0.18	41.41	0.17	56.99	0.23	42.00	0.17	67.38
42	2	53.89	0.19	52.60	0.18	52.23	0.18	62.74	0.22	48.15	0.17	72.23
44 y339	2	49.11	0.19	45.77	0.18	47.14	0.19	61.80	0.24	46.35	0.18	69.98
47	2	50.53	0.19	48.87	0.18	48.32	0.18	59.85	0.22	46.70	0.17	69.96
49 y333	2	54.87	0.20	51.19	0.19	52.35	0.19	66.57	0.25	48.81	0.18	77.90
51	2	58.88	0.22	50.85	0.19	51.56	0.19	67.12	0.25	48.58	0.18	76.96
2	2	54.93	0.18	47.89	0.15	56.12	0.18	69.80	0.22	59.09	0.19	85.25

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	V3W/CL	V4L	V4L/CL	V4W	V4W/CL	V5L	V5L/CL	V5W	V5W/CL	SL	SL/CL
11	1	0.25	55.38	0.21	60.50	0.23	66.43	0.26	67.82	0.26	48.23	0.19
13	1	0.27	58.90	0.21	63.65	0.23	77.85	0.28	73.00	0.27	42.70	0.16
18	1	0.25	60.19	0.21	65.60	0.23	80.48	0.28	78.66	0.28	47.83	0.17
20	1	0.25	60.78	0.23	64.40	0.24	76.25	0.28	76.43	0.29	43.13	0.16
21 y342	1	0.26	53.43	0.23	56.27	0.24	65.00	0.28	40.70	0.18	63.20	0.27
22 y65	1	0.19	57.10	0.22	68.21	0.27	78.49	0.31	80.23	0.31	47.56	0.19
23	1	0.26	55.80	0.23	59.07	0.24	65.77	0.27	70.87	0.29	42.33	0.17
24	1	0.26	46.47	0.21	52.41	0.24	53.22	0.24	63.09	0.29	41.27	0.19
26	1	0.26	58.44	0.20	68.66	0.24	73.23	0.26	81.65	0.29	52.24	0.18
28	1	0.27	57.15	0.22	65.41	0.26	73.08	0.29	78.89	0.31	45.22	0.18
29	1	0.22	65.04	0.23	68.15	0.25	74.52	0.27	84.39	0.30	45.81	0.17
33 y172	1	0.25	60.25	0.23	60.92	0.23	68.03	0.26	74.76	0.28	46.91	0.18
34	1	0.24	56.57	0.22	59.80	0.23	74.44	0.29	72.76	0.28	47.39	0.18
37	1	0.26	71.67	0.26	68.11	0.25	76.49	0.28	82.10	0.30	43.13	0.16
39	1	0.23	51.27	0.19	62.81	0.23	62.57	0.23	71.80	0.27	44.77	0.17
41	1	0.26	69.35	0.24	75.60	0.26	84.15	0.29	87.10	0.30	45.45	0.16
50	1	0.28	52.11	0.21	61.95	0.25	55.99	0.22	68.03	0.27	43.07	0.17
43	1	0.29	59.77	0.24	67.46	0.28	76.27	0.31	78.84	0.32	42.63	0.17
45	1	0.26	60.30	0.22	69.76	0.25	84.55	0.30	80.90	0.29	44.38	0.16
46	1	0.23	53.65	0.21	55.81	0.22	64.11	0.26	72.78	0.29	51.55	0.21
48	1	0.26	56.99	0.21	70.22	0.25	49.13	0.18	81.17	0.29	51.15	0.18
52	1	0.27	57.38	0.21	71.75	0.27	80.12	0.30	88.99	0.33	38.98	0.14

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	V3W/CL	V4L	V4L/CL	V4W	V4W/CL	V5L	V5L/CL	V5W	V5W/CL	SL	SL/CL
3	1	0.27	65.06	0.22	72.49	0.25	86.17	0.30	81.30	0.28	42.14	0.15
5	1	0.22	55.02	0.21	57.04	0.22	76.60	0.29	71.27	0.27	41.81	0.16
7 y66	1	0.23	52.80	0.22	53.26	0.23	60.99	0.26	80.61	0.34	46.04	0.20
8 y 80	1	0.26	77.60	0.25	77.73	0.25	83.80	0.27	99.26	0.32	55.53	0.18
10	1	0.25	59.76	0.21	63.66	0.23	79.76	0.28	85.37	0.30	46.02	0.16
55	1	0.23	63.18	0.23	65.24	0.24	71.59	0.27	82.07	0.30	46.33	0.17
53	1	0.23	51.07	0.20	59.83	0.24	68.52	0.27	71.97	0.29	45.95	0.18
54 y_09	1	0.28	59.25	0.22	68.55	0.25	72.93	0.27	76.97	0.28	43.35	0.16
59	2	0.28	55.87	0.21	64.21	0.24	64.13	0.24	73.43	0.27	44.92	0.17
60	2	0.31	60.71	0.23	70.97	0.27	64.39	0.25	84.26	0.32	44.77	0.17
61	2	0.27	59.38	0.22	69.23	0.25	68.83	0.25	85.12	0.31	49.45	0.18
57	2	0.28	58.28	0.21	69.04	0.25	60.83	0.22	71.92	0.26	43.71	0.16
58	2	0.26	50.79	0.18	57.67	0.21	68.09	0.25	82.18	0.30	48.13	0.17
56	2	0.27	51.72	0.22	57.21	0.24	57.24	0.24	70.12	0.29	37.72	0.16
62	2	0.28	56.14	0.20	69.71	0.25	72.23	0.26	80.37	0.29	47.36	0.17
1	2	0.29	57.44	0.20	71.35	0.25	61.19	0.22	79.22	0.28	40.72	0.14
4 (y44)	2	0.31	77.80	0.24	85.16	0.26	67.07	0.21	82.70	0.26	51.05	0.16
6	2	0.26	57.50	0.22	66.10	0.25	59.34	0.22	82.58	0.31	44.30	0.17
9	2	0.26	52.71	0.20	58.72	0.23	57.39	0.22	71.24	0.28	48.05	0.19
12	2	0.27	60.32	0.21	70.77	0.24	57.19	0.20	78.92	0.27	45.50	0.16
15	2	0.26	64.30	0.21	74.79	0.24	75.21	0.24	79.31	0.26	52.05	0.17
16	2	0.27	56.49	0.22	61.24	0.24	56.73	0.22	73.15	0.28	42.74	0.16

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	V3W/CL	V4L	V4L/CL	V4W	V4W/CL	V5L	V5L/CL	V5W	V5W/CL	SL	SL/CL
17(y103)	2	0.31	74.93	0.23	86.05	0.27	80.32	0.25	102.43	0.32	57.45	0.18
19(y162)	2	0.26	48.50	0.20	52.56	0.22	53.39	0.23	59.95	0.25	38.02	0.16
25 (y336)	2	0.26	57.76	0.22	60.65	0.24	58.10	0.23	74.48	0.29	42.65	0.17
27	2	0.24	49.52	0.19	57.13	0.22	58.79	0.22	67.79	0.26	46.95	0.18
30	2	0.31	60.99	0.22	72.62	0.26	58.81	0.21	75.51	0.27	42.68	0.15
31	2	0.25	52.07	0.20	61.20	0.23	65.03	0.25	69.50	0.26	47.70	0.18
32	2	0.27	56.54	0.20	60.66	0.21	52.28	0.18	75.68	0.27	48.05	0.17
36	2	0.27	57.18	0.21	65.57	0.24	62.02	0.23	74.60	0.27	48.72	0.18
38	2	0.27	57.00	0.21	67.47	0.25	59.32	0.22	75.16	0.28	44.04	0.16
40	2	0.28	55.18	0.23	63.87	0.26	61.18	0.25	75.08	0.31	48.17	0.20
42	2	0.25	57.13	0.20	66.28	0.23	58.39	0.20	73.27	0.26	46.77	0.16
44 y339	2	0.28	56.52	0.22	62.60	0.25	60.99	0.24	68.25	0.27	41.49	0.16
47	2	0.26	57.58	0.21	63.36	0.23	68.37	0.25	75.88	0.28	44.91	0.17
49 y333	2	0.29	54.79	0.20	61.37	0.23	60.29	0.22	72.76	0.27	45.11	0.17
51	2	0.29	56.09	0.21	69.13	0.26	66.58	0.25	85.18	0.32	42.58	0.16
2	2	0.27	74.92	0.24	77.33	0.25	72.08	0.23	92.92	0.30	49.19	0.16

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	SW	SW/CL	C1LL	C1LL/CL	C1WL	C1WL/CL	C2LL	C2LL/CL	C2WL	C2WL/CL	C3LL
11	1	73.39	0.28	54.02	0.21	58.39	0.23	52.94	0.21	60.69	0.24	49.08
13	1	90.35	0.33	57.32	0.21	63.83	0.23	54.12	0.20	67.01	0.24	50.83
18	1	82.97	0.29	60.67	0.21	69.07	0.24	58.59	0.21	69.60	0.24	53.43
20	1	77.34	0.29	57.18	0.21	66.04	0.25	52.81	0.20	67.50	0.25	46.35
21 y342	1	68.66	0.30	50.31	0.22	59.92	0.26	44.28	0.19	66.31	0.29	45.94
22 y65	1	50.59	0.20	54.93	0.21	68.25	0.27	50.04	0.19	72.34	0.28	48.12
23	1	73.63	0.30	53.28	0.21	59.80	0.24	46.60	0.19	60.50	0.24	46.51
24	1	68.43	0.31	49.30	0.23	56.04	0.26	42.95	0.20	60.70	0.28	40.74
26	1	79.79	0.28	55.95	0.20	64.46	0.23	53.87	0.19	68.91	0.24	54.58
28	1	75.32	0.30	55.85	0.22	59.66	0.23	51.11	0.20	67.70	0.27	47.80
29	1	82.05	0.30	50.08	0.18	65.34	0.24	51.79	0.19	69.62	0.25	48.15
33 y172	1	80.90	0.31	51.25	0.19	57.90	0.22	48.22	0.18	59.10	0.22	46.72
34	1	80.24	0.31	61.49	0.24	65.77	0.25	49.12	0.19	66.97	0.26	47.87
37	1	90.41	0.33	54.36	0.20	62.12	0.23	52.68	0.19	63.69	0.23	50.17
39	1	74.92	0.28	57.67	0.21	63.49	0.24	52.02	0.19	72.87	0.27	48.06
41	1	90.15	0.31	61.10	0.21	70.00	0.24	59.80	0.21	69.30	0.24	56.95
50	1	69.06	0.27	55.59	0.22	65.60	0.26	54.94	0.22	67.17	0.27	50.84
43	1	86.68	0.35	56.88	0.23	67.19	0.27	54.31	0.22	71.03	0.29	54.00
45	1	95.46	0.34	64.17	0.23	68.07	0.24	54.09	0.19	72.68	0.26	55.76
46	1	73.51	0.29	49.91	0.20	57.84	0.23	45.69	0.18	59.32	0.24	50.95
48	1	85.37	0.31	58.85	0.21	65.22	0.24	51.56	0.19	72.17	0.26	51.44
52	1	79.25	0.29	56.41	0.21	64.99	0.24	52.88	0.20	72.09	0.27	50.95

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	SW	SW/CL	C1LL	C1LL/CL	C1WL	C1WL/CL	C2LL	C2LL/CL	C2WL	C2WL/CL	C3LL
3	1	87.75	0.30	68.83	0.24	72.55	0.25	54.53	0.19	77.12	0.27	58.92
5	1	81.59	0.31	55.33	0.21	61.43	0.24	49.70	0.19	69.07	0.27	43.52
7 y66	1	85.97	0.37	47.63	0.20	57.98	0.25	39.88	0.17	61.07	0.26	48.33
8 y 80	1	99.40	0.32	69.49	0.22	77.19	0.25	63.21	0.20	82.91	0.27	59.92
10	1	83.19	0.30	57.61	0.21	66.15	0.24	56.00	0.20	68.76	0.25	53.81
55	1	84.07	0.31	54.98	0.20	65.51	0.24	53.11	0.20	71.63	0.27	47.73
53	1	75.60	0.30	55.94	0.22	65.07	0.26	46.06	0.18	68.01	0.27	41.75
54 y_09	1	80.08	0.29	62.67	0.23	66.23	0.24	57.28	0.21	73.67	0.27	51.42
59	2	78.46	0.29	67.63	0.25	75.30	0.28	61.79	0.23	82.42	0.31	51.99
60	2	76.42	0.29	62.87	0.24	70.52	0.27	53.67	0.21	77.07	0.30	52.07
61	2	78.56	0.29	59.62	0.22	68.79	0.25	59.51	0.22	75.63	0.28	53.40
57	2	77.93	0.28	56.67	0.20	65.34	0.24	59.62	0.22	78.30	0.28	58.31
58	2	74.11	0.27	55.61	0.20	64.08	0.23	59.21	0.21	69.87	0.25	54.35
56	2	67.53	0.28	51.00	0.21	58.55	0.24	50.39	0.21	63.59	0.26	48.74
62	2	79.01	0.28	62.90	0.22	69.97	0.25	59.87	0.21	75.07	0.27	53.92
1	2	78.42	0.28	64.81	0.23	70.92	0.25	62.59	0.22	74.48	0.26	58.78
4 (y44)	2	88.68	0.27	69.77	0.22	80.40	0.25	79.36	0.25	90.26	0.28	65.69
6	2	72.80	0.28	53.09	0.20	65.26	0.25	54.34	0.21	70.83	0.27	53.40
9	2	77.71	0.30	56.49	0.22	68.14	0.26	51.54	0.20	74.65	0.29	62.54
12	2	79.66	0.27	75.37	0.26	64.19	0.22	80.76	0.28	61.38	0.21	76.32
15	2	84.70	0.27	64.70	0.21	75.52	0.24	68.53	0.22	77.10	0.25	67.23
16	2	77.39	0.30	58.13	0.22	63.69	0.24	57.28	0.22	68.26	0.26	48.59

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	SW	SW/CL	C1LL	C1LL/CL	C1WL	C1WL/CL	C2LL	C2LL/CL	C2WL	C2WL/CL	C3LL
17(y103)	2	92.10	0.29	60.37	0.19	80.49	0.25	67.43	0.21	90.34	0.28	66.38
19(y162)	2	60.93	0.26	48.57	0.20	57.04	0.24	52.85	0.22	64.25	0.27	50.21
25 (y336)	2	71.04	0.28	56.67	0.22	64.97	0.25	57.81	0.22	66.93	0.26	47.82
27	2	76.23	0.29	55.74	0.21	65.99	0.25	55.15	0.21	70.95	0.27	47.66
30	2	78.07	0.28	52.40	0.19	64.88	0.24	62.12	0.23	74.82	0.27	56.77
31	2	77.12	0.29	53.23	0.20	62.76	0.24	52.10	0.20	65.42	0.25	48.23
32	2	84.82	0.30	58.03	0.21	65.68	0.23	59.61	0.21	69.41	0.25	51.35
36	2	74.96	0.27	57.70	0.21	70.12	0.26	55.45	0.20	74.45	0.27	56.16
38	2	73.85	0.27	56.54	0.21	63.74	0.24	59.17	0.22	70.32	0.26	50.21
40	2	76.86	0.31	44.31	0.18	58.84	0.24	52.24	0.21	64.22	0.26	49.15
42	2	81.71	0.29	57.54	0.20	64.60	0.23	59.67	0.21	75.72	0.27	53.13
44 y339	2	72.70	0.29	53.35	0.21	64.41	0.25	55.06	0.22	66.89	0.26	52.29
47	2	74.74	0.28	55.91	0.21	64.96	0.24	55.19	0.20	70.86	0.26	52.23
49 y333	2	79.67	0.30	58.93	0.22	68.37	0.25	57.85	0.21	73.08	0.27	52.27
51	2	71.65	0.27	54.28	0.20	64.20	0.24	52.54	0.19	70.09	0.26	51.00
2	2	85.66	0.27	62.40	0.20	71.81	0.23	67.44	0.22	86.28	0.28	61.96

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	C3LL/CL	C3WL	C3WL/CL	C4LL	C4LL/CL	C4WL	C4WL/CL	C1LR	C1LR/CL	C1WR	C1WR/CL
11	1	0.19	62.01	0.24	50.02	0.19	51.20	0.20	54.56	0.21	59.05	0.23
13	1	0.18	68.44	0.25	54.34	0.20	56.91	0.21	55.73	0.20	63.28	0.23
18	1	0.19	70.39	0.25	59.13	0.21	58.72	0.21	60.48	0.21	66.40	0.23
20	1	0.17	66.54	0.25	58.44	0.22	57.37	0.21	57.24	0.21	65.64	0.24
21 y342	1	0.20	64.11	0.28	50.37	0.22	51.27	0.22	48.28	0.21	60.62	0.26
22 y65	1	0.19	70.87	0.28	62.24	0.24	61.26	0.24	54.30	0.21	69.08	0.27
23	1	0.19	64.03	0.26	47.75	0.19	50.44	0.20	52.68	0.21	54.60	0.22
24	1	0.19	59.25	0.27	43.68	0.20	47.15	0.22	49.73	0.23	52.55	0.24
26	1	0.19	68.45	0.24	54.14	0.19	54.99	0.19	57.74	0.20	61.95	0.22
28	1	0.19	67.14	0.26	53.89	0.21	58.57	0.23	50.12	0.20	58.82	0.23
29	1	0.17	68.76	0.25	53.99	0.19	60.00	0.22	57.35	0.21	65.30	0.24
33 y172	1	0.18	59.28	0.22	50.03	0.19	48.43	0.18	51.24	0.19	55.95	0.21
34	1	0.18	70.08	0.27	52.39	0.20	62.15	0.24	54.09	0.21	42.03	0.16
37	1	0.18	67.76	0.25	59.21	0.22	58.15	0.21	54.03	0.20	61.94	0.23
39	1	0.18	69.22	0.26	52.01	0.19	58.07	0.22	57.37	0.21	66.55	0.25
41	1	0.20	71.00	0.25	63.70	0.22	59.90	0.21	59.25	0.21	67.85	0.24
50	1	0.20	64.98	0.26	47.68	0.19	50.80	0.20	53.34	0.21	62.49	0.25
43	1	0.22	72.61	0.30	57.56	0.23	64.31	0.26	54.27	0.22	64.23	0.26
45	1	0.20	70.25	0.25	57.86	0.21	60.80	0.22	58.93	0.21	65.61	0.23
46	1	0.20	59.32	0.24	48.30	0.19	63.83	0.26	52.59	0.21	48.26	0.19
48	1	0.19	72.63	0.26	51.70	0.19	58.88	0.21	61.58	0.22	65.92	0.24
52	1	0.19	70.69	0.26	56.84	0.21	59.67	0.22	55.69	0.21	65.36	0.24

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	C3LL/CL	C3WL	C3WL/CL	C4LL	C4LL/CL	C4WL	C4WL/CL	C1LR	C1LR/CL	C1WR	C1WR/CL
3	1	0.20	75.70	0.26	58.48	0.20	61.15	0.21	59.47	0.21	74.01	0.26
5	1	0.17	70.60	0.27	55.15	0.21	57.93	0.22	55.76	0.21	62.86	0.24
7 y66	1	0.21	59.57	0.25	48.39	0.21	53.71	0.23	49.93	0.21	59.28	0.25
8 y 80	1	0.19	80.42	0.26	59.64	0.19	64.05	0.21	74.08	0.24	77.36	0.25
10	1	0.19	57.44	0.21	54.02	0.19	59.09	0.21	57.45	0.21	64.18	0.23
55	1	0.18	71.48	0.26	57.82	0.21	58.40	0.22	55.29	0.20	63.12	0.23
53	1	0.17	64.10	0.26	51.54	0.21	53.95	0.22	63.95	0.26	63.54	0.25
54 y_09	1	0.19	69.97	0.26	56.08	0.20	54.13	0.20	60.90	0.22	63.20	0.23
59	2	0.19	78.28	0.29	52.36	0.19	59.65	0.22	73.73	0.27	76.12	0.28
60	2	0.20	74.34	0.29	53.77	0.21	61.83	0.24	58.55	0.23	66.88	0.26
61	2	0.19	71.08	0.26	53.01	0.19	55.96	0.20	69.42	0.25	65.42	0.24
57	2	0.21	70.11	0.25	51.79	0.19	56.09	0.20	56.07	0.20	55.34	0.20
58	2	0.20	71.28	0.26	59.47	0.21	60.66	0.22	55.84	0.20	63.71	0.23
56	2	0.20	60.34	0.25	45.05	0.19	49.95	0.21	50.44	0.21	57.12	0.24
62	2	0.19	74.05	0.26	50.14	0.18	60.76	0.22	58.87	0.21	67.47	0.24
1	2	0.21	71.84	0.25	54.57	0.19	59.84	0.21	63.13	0.22	70.64	0.25
4 (y44)	2	0.20	85.36	0.26	66.57	0.21	60.22	0.19	67.84	0.21	82.79	0.26
6	2	0.20	71.04	0.27	54.96	0.21	59.11	0.22	54.39	0.21	63.41	0.24
9	2	0.24	68.45	0.26	48.06	0.19	54.47	0.21	55.50	0.21	61.74	0.24
12	2	0.26	56.78	0.19	59.44	0.20	56.06	0.19	63.48	0.22	71.80	0.25
15	2	0.22	77.10	0.25	54.14	0.17	63.28	0.20	57.58	0.19	74.37	0.24
16	2	0.19	67.60	0.26	44.66	0.17	54.23	0.21	53.91	0.21	61.55	0.24

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	C3LL/CL	C3WL	C3WL/CL	C4LL	C4LL/CL	C4WL	C4WL/CL	C1LR	C1LR/CL	C1WR	C1WR/CL
17(y103)	2	0.21	84.84	0.27	62.82	0.20	74.88	0.23	60.82	0.19	81.16	0.25
19(y162)	2	0.21	50.58	0.21	44.87	0.19	50.75	0.21	52.07	0.22	56.16	0.24
25 (y336)	2	0.19	63.36	0.25	46.53	0.18	56.80	0.22	56.33	0.22	63.10	0.24
27	2	0.18	64.65	0.24	47.06	0.18	52.26	0.20	56.34	0.21	64.96	0.25
30	2	0.21	73.06	0.26	49.70	0.18	56.55	0.20	51.86	0.19	70.38	0.26
31	2	0.18	65.24	0.25	47.84	0.18	56.07	0.21	52.21	0.20	60.23	0.23
32	2	0.18	68.87	0.24	48.77	0.17	57.77	0.20	59.66	0.21	65.98	0.23
36	2	0.20	71.55	0.26	52.13	0.19	57.80	0.21	58.49	0.21	70.71	0.26
38	2	0.19	65.64	0.24	48.70	0.18	53.94	0.20	52.55	0.19	61.18	0.23
40	2	0.20	64.28	0.26	45.76	0.19	58.26	0.24	48.95	0.20	56.94	0.23
42	2	0.19	70.07	0.25	54.61	0.19	56.69	0.20	54.57	0.19	65.64	0.23
44 y339	2	0.21	66.30	0.26	48.72	0.19	53.65	0.21	53.02	0.21	60.99	0.24
47	2	0.19	69.54	0.26	49.89	0.18	56.56	0.21	54.38	0.20	63.33	0.23
49 y333	2	0.19	72.74	0.27	54.06	0.20	56.70	0.21	58.31	0.22	70.75	0.26
51	2	0.19	67.27	0.25	50.84	0.19	56.68	0.21	53.52	0.20	62.77	0.23
2	2	0.20	79.66	0.26	60.20	0.19	64.05	0.21	62.58	0.20	74.26	0.24

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	C2LR	C2LR/CL	C2WR	C2WR/CL	C3LR	C3LR/CL	C3WR	C3WR/CL	C4LR	C4LR/CL	C4WR
11	1	51.46	0.20	59.17	0.23	49.05	0.19	61.32	0.24	49.09	0.19	48.24
13	1	51.16	0.19	55.28	0.20	49.18	0.18	66.50	0.24	53.05	0.19	57.42
18	1	54.76	0.19	67.14	0.24	50.42	0.18	68.82	0.24	56.00	0.20	57.03
20	1	52.06	0.19	67.00	0.25	47.40	0.18	65.78	0.25	58.92	0.22	55.23
21 y342	1	44.36	0.19	67.32	0.29	44.66	0.19	65.71	0.28	49.14	0.21	49.30
22 y65	1	46.99	0.18	69.07	0.27	49.56	0.19	72.62	0.28	59.97	0.23	60.42
23	1	46.86	0.19	60.23	0.24	45.88	0.19	63.95	0.26	51.04	0.21	51.47
24	1	44.17	0.20	41.22	0.19	40.82	0.19	45.22	0.21	41.71	0.19	51.20
26	1	54.58	0.19	66.27	0.23	53.26	0.19	65.32	0.23	53.90	0.19	53.20
28	1	49.04	0.19	66.70	0.26	45.65	0.18	68.39	0.27	51.27	0.20	55.80
29	1	52.58	0.19	65.57	0.24	49.20	0.18	67.85	0.24	55.12	0.20	57.58
33 y172	1	48.93	0.18	59.19	0.22	48.63	0.18	59.76	0.23	50.03	0.19	48.72
34	1	49.37	0.19	50.05	0.19	50.37	0.19	52.94	0.20	54.05	0.21	41.76
37	1	51.61	0.19	65.40	0.24	52.69	0.19	67.75	0.25	59.55	0.22	57.20
39	1	56.97	0.21	74.09	0.27	48.12	0.18	68.79	0.25	50.02	0.19	57.50
41	1	60.75	0.21	69.50	0.24	56.70	0.20	71.40	0.25	66.40	0.23	61.00
50	1	52.99	0.21	66.23	0.26	49.98	0.20	63.49	0.25	46.37	0.18	50.09
43	1	50.69	0.21	72.16	0.29	54.69	0.22	72.24	0.29	60.89	0.25	59.86
45	1	55.67	0.20	71.86	0.26	54.11	0.19	71.86	0.26	54.84	0.20	61.38
46	1	54.12	0.22	58.80	0.24	48.49	0.19	60.29	0.24	49.11	0.20	63.31
48	1	52.42	0.19	71.75	0.26	52.42	0.19	67.79	0.24	49.94	0.18	56.66
52	1	52.20	0.19	74.64	0.28	43.52	0.16	75.52	0.28	59.73	0.22	65.32

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	C2LR	C2LR/CL	C2WR	C2WR/CL	C3LR	C3LR/CL	C3WR	C3WR/CL	C4LR	C4LR/CL	C4WR
3	1	52.61	0.18	77.63	0.27	58.23	0.20	76.22	0.26	60.16	0.21	57.81
5	1	47.04	0.18	69.96	0.27	45.11	0.17	67.16	0.26	55.70	0.21	57.73
7 y66	1	40.76	0.17	64.13	0.27	46.69	0.20	61.92	0.26	49.57	0.21	53.72
8 y 80	1	61.69	0.20	80.54	0.26	61.83	0.20	82.32	0.27	59.78	0.19	65.81
10	1	56.01	0.20	58.64	0.21	55.74	0.20	65.74	0.23	51.82	0.19	56.62
55	1	52.28	0.19	67.94	0.25	48.97	0.18	72.29	0.27	56.64	0.21	60.08
53	1	47.92	0.19	65.72	0.26	42.13	0.17	68.02	0.27	57.75	0.23	55.44
54 y_09	1	57.91	0.21	73.15	0.27	52.92	0.19	70.15	0.26	55.19	0.20	56.79
59	2	60.46	0.22	82.79	0.31	55.23	0.20	77.82	0.29	52.16	0.19	58.19
60	2	53.89	0.21	76.02	0.29	52.26	0.20	75.04	0.29	54.91	0.21	63.30
61	2	58.76	0.21	75.66	0.28	53.30	0.19	73.88	0.27	53.21	0.19	58.74
57	2	60.41	0.22	78.30	0.28	53.62	0.19	70.11	0.25	48.51	0.18	55.29
58	2	59.48	0.21	69.45	0.25	58.48	0.21	72.37	0.26	50.49	0.18	60.69
56	2	51.26	0.21	61.32	0.26	47.31	0.20	60.57	0.25	44.68	0.19	49.58
62	2	60.13	0.21	74.53	0.27	54.97	0.20	70.34	0.25	51.41	0.18	58.80
1	2	62.37	0.22	75.94	0.27	59.16	0.21	72.01	0.25	51.62	0.18	58.29
4 (y44)	2	75.32	0.23	91.56	0.28	65.35	0.20	85.57	0.26	68.40	0.21	62.23
6	2	54.29	0.21	71.26	0.27	51.59	0.20	70.79	0.27	51.32	0.19	60.83
9	2	53.39	0.21	70.82	0.27	51.33	0.20	67.90	0.26	46.73	0.18	51.20
12	2	59.18	0.20	79.65	0.27	54.97	0.19	77.61	0.27	55.94	0.19	58.34
15	2	45.99	0.15	86.07	0.28	67.10	0.22	78.94	0.25	66.76	0.22	61.18
16	2	57.07	0.22	69.10	0.27	48.56	0.19	68.29	0.26	54.45	0.21	53.91

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	C2LR	C2LR/CL	C2WR	C2WR/CL	C3LR	C3LR/CL	C3WR	C3WR/CL	C4LR	C4LR/CL	C4WR
17(y103)	2	69.75	0.22	92.10	0.29	66.34	0.21	87.20	0.27	52.68	0.16	74.22
19(y162)	2	52.26	0.22	63.96	0.27	48.36	0.20	61.08	0.26	46.53	0.20	50.77
25 (y336)	2	57.40	0.22	66.22	0.26	49.29	0.19	64.82	0.25	48.58	0.19	55.27
27	2	55.24	0.21	68.63	0.26	47.88	0.18	65.56	0.25	46.47	0.18	51.94
30	2	64.84	0.23	74.93	0.27	55.85	0.20	72.64	0.26	48.20	0.17	56.39
31	2	51.23	0.19	65.43	0.25	60.82	0.23	63.80	0.24	46.28	0.17	52.50
32	2	58.84	0.21	66.85	0.24	53.14	0.19	71.20	0.25	47.11	0.17	56.04
36	2	56.03	0.20	73.90	0.27	55.17	0.20	70.11	0.26	49.61	0.18	58.00
38	2	58.96	0.22	70.75	0.26	51.12	0.19	66.52	0.25	50.29	0.19	53.96
40	2	50.33	0.21	65.54	0.27	48.36	0.20	67.27	0.27	48.70	0.20	58.52
42	2	57.23	0.20	73.33	0.26	55.66	0.20	69.91	0.25	53.79	0.19	55.66
44 y339	2	53.00	0.21	66.11	0.26	52.46	0.21	66.45	0.26	46.49	0.18	53.92
47	2	53.09	0.20	71.73	0.26	50.95	0.19	68.95	0.25	51.16	0.19	54.50
49 y333	2	55.25	0.20	78.87	0.29	50.73	0.19	75.84	0.28	53.13	0.20	56.52
51	2	53.40	0.20	70.32	0.26	50.96	0.19	68.71	0.25	50.27	0.19	56.57
2	2	66.90	0.21	81.59	0.26	64.76	0.21	78.00	0.25	55.36	0.18	62.16

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	C4WR/CL	M1LL	M1LL/CL	M1WL	M1WL/CL	M2LL	M2LL/CL	M2WL	M2WL/CL	M3LL	M3LL/CL
11	1	0.19	42.22	0.16	39.78	0.15	31.48	0.12	38.42	0.15	31.15	0.12
13	1	0.21	43.98	0.16	44.80	0.16	36.72	0.13	35.63	0.13	32.26	0.12
18	1	0.20	46.52	0.16	44.75	0.16	36.12	0.13	45.79	0.16	34.24	0.12
20	1	0.21	40.75	0.15	41.97	0.16	28.78	0.11	38.03	0.14	32.42	0.12
21 y342	1	0.21	36.25	0.16	40.22	0.17	25.34	0.11	36.57	0.16	25.60	0.11
22 y65	1	0.24	33.10	0.13	37.75	0.15	27.77	0.11	30.00	0.12	29.89	0.12
23	1	0.21	37.62	0.15	40.00	0.16	32.82	0.13	34.84	0.14	20.56	0.08
24	1	0.23	38.90	0.18	35.62	0.16	27.62	0.13	34.83	0.16	26.33	0.12
26	1	0.19	48.79	0.17	38.61	0.14	32.80	0.11	44.25	0.15	35.73	0.12
28	1	0.22	46.77	0.18	40.27	0.16	34.14	0.13	45.00	0.18	27.39	0.11
29	1	0.21	41.09	0.15	41.95	0.15	32.15	0.12	39.63	0.14	29.67	0.11
33 y172	1	0.18	43.12	0.16	46.13	0.17	46.13	0.17	39.21	0.15	31.27	0.12
34	1	0.16	42.91	0.16	32.42	0.12	29.02	0.11	35.63	0.14	26.30	0.10
37	1	0.21	41.10	0.15	40.39	0.15	30.51	0.11	40.77	0.15	33.84	0.12
39	1	0.21	40.44	0.15	43.23	0.16	31.32	0.12	39.76	0.15	28.00	0.10
41	1	0.21	44.55	0.16	42.65	0.15	33.00	0.11	37.03	0.13	33.31	0.12
50	1	0.20	39.62	0.16	39.82	0.16	30.74	0.12	35.06	0.14	27.16	0.11
43	1	0.24	46.53	0.19	40.49	0.17	28.05	0.11	44.70	0.18	24.54	0.10
45	1	0.22	42.20	0.15	37.21	0.13	30.92	0.11	27.86	0.10	29.27	0.10
46	1	0.25	43.83	0.18	39.34	0.16	32.64	0.13	38.12	0.15	31.63	0.13
48	1	0.20	42.48	0.15	42.28	0.15	37.31	0.13	44.06	0.16	37.21	0.13
52	1	0.24	44.21	0.16	42.43	0.16	36.65	0.14	42.12	0.16	31.43	0.12

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	C4WR/CL	M1LL	M1LL/CL	M1WL	M1WL/CL	M2LL	M2LL/CL	M2WL	M2WL/CL	M3LL	M3LL/CL
3	1	0.20	47.17	0.16	46.26	0.16	35.51	0.12	43.76	0.15	32.81	0.11
5	1	0.22	40.51	0.16	40.80	0.16	27.33	0.11	39.39	0.15	30.32	0.12
7 y66	1	0.23	38.68	0.16	32.10	0.14	26.42	0.11	39.77	0.17	23.53	0.10
8 y 80	1	0.21	51.26	0.17	54.54	0.18	43.46	0.14	50.22	0.16	35.84	0.12
10	1	0.20	45.42	0.16	45.20	0.16	34.08	0.12	47.90	0.17	30.06	0.11
55	1	0.22	43.68	0.16	35.88	0.13	30.85	0.11	41.78	0.15	31.80	0.12
53	1	0.22	40.51	0.16	40.78	0.16	33.22	0.13	40.89	0.16	30.06	0.12
54 y_09	1	0.21	41.61	0.15	41.47	0.15	33.62	0.12	39.30	0.14	27.35	0.10
59	2	0.22	41.75	0.15	51.94	0.19	29.98	0.11	36.63	0.14	28.89	0.11
60	2	0.24	40.32	0.16	43.28	0.17	29.62	0.11	40.08	0.15	28.36	0.11
61	2	0.21	40.55	0.15	43.37	0.16	31.72	0.12	38.86	0.14	26.44	0.10
57	2	0.20	40.65	0.15	44.36	0.16	30.43	0.11	40.95	0.15	27.01	0.10
58	2	0.22	42.39	0.15	38.93	0.14	35.35	0.13	40.25	0.15	28.53	0.10
56	2	0.21	33.80	0.14	36.23	0.15	27.44	0.11	32.01	0.13	26.58	0.11
62	2	0.21	43.18	0.15	40.21	0.14	35.41	0.13	42.45	0.15	33.62	0.12
1	2	0.21	44.93	0.16	37.22	0.13	28.54	0.10	37.66	0.13	31.59	0.11
4 (y44)	2	0.19	52.92	0.16	50.39	0.16	39.18	0.12	47.84	0.15	34.42	0.11
6	2	0.23	44.33	0.17	41.47	0.16	32.58	0.12	40.29	0.15	27.35	0.10
9	2	0.20	41.21	0.16	42.12	0.16	31.63	0.12	36.40	0.14	26.77	0.10
12	2	0.20	46.20	0.16	45.61	0.16	32.12	0.11	41.64	0.14	33.13	0.11
15	2	0.20	43.59	0.14	50.59	0.16	30.07	0.10	39.33	0.13	34.97	0.11
16	2	0.21	39.68	0.15	39.83	0.15	31.20	0.12	37.05	0.14	23.28	0.09

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	C4WR/CL	M1LL	M1LL/CL	M1WL	M1WL/CL	M2LL	M2LL/CL	M2WL	M2WL/CL	M3LL	M3LL/CL
17(y103)	2	0.23	45.17	0.14	47.97	0.15	38.35	0.12	42.76	0.13	25.10	0.08
19(y162)	2	0.21	33.60	0.14	37.46	0.16	30.12	0.13	31.92	0.13	23.62	0.10
25 (y336)	2	0.21	39.94	0.15	42.90	0.17	34.05	0.13	39.40	0.15	30.48	0.12
27	2	0.20	39.89	0.15	41.52	0.16	35.53	0.13	36.92	0.14	30.24	0.11
30	2	0.20	37.80	0.14	45.99	0.17	35.17	0.13	37.97	0.14	30.62	0.11
31	2	0.20	40.12	0.15	37.87	0.14	32.55	0.12	41.10	0.16	28.88	0.11
32	2	0.20	42.64	0.15	41.81	0.15	30.86	0.11	34.08	0.12	34.05	0.12
36	2	0.21	44.38	0.16	42.22	0.15	35.51	0.13	40.12	0.15	31.64	0.12
38	2	0.20	40.33	0.15	39.92	0.15	37.33	0.14	40.21	0.15	32.21	0.12
40	2	0.24	34.42	0.14	36.37	0.15	30.37	0.12	34.58	0.14	25.87	0.11
42	2	0.20	42.04	0.15	39.68	0.14	31.69	0.11	42.52	0.15	27.15	0.10
44 y339	2	0.21	36.34	0.14	38.52	0.15	31.33	0.12	34.49	0.14	26.44	0.10
47	2	0.20	38.88	0.14	42.63	0.16	35.47	0.13	35.50	0.13	28.41	0.10
49 y333	2	0.21	40.08	0.15	43.29	0.16	30.91	0.11	38.37	0.14	28.06	0.10
51	2	0.21	39.86	0.15	44.48	0.16	28.21	0.10	34.29	0.13	27.28	0.10
2	2	0.20	37.77	0.12	44.62	0.14	30.29	0.10	38.28	0.12	32.01	0.10

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M3WL	M3WL/CL	M4LL	M4LL/CL	M4WL	M4WL/CL	M5LL	M5LL/CL	M5WL	M5WL/CL	M6LL
11	1	34.67	0.13	27.90	0.11	40.85	0.16	29.95	0.12	41.78	0.16	32.17
13	1	36.27	0.13	30.75	0.11	39.66	0.14	30.69	0.11	44.83	0.16	34.28
18	1	42.63	0.15	33.17	0.12	45.53	0.16	35.03	0.12	47.30	0.17	36.93
20	1	36.49	0.14	33.43	0.12	41.72	0.16	31.19	0.12	44.31	0.17	32.27
21 y342	1	34.98	0.15	28.32	0.12	34.35	0.15	27.95	0.12	39.49	0.17	30.43
22 y65	1	31.60	0.12	29.36	0.11	49.83	0.19	28.24	0.11	48.52	0.19	28.36
23	1	31.90	0.13	28.17	0.11	38.39	0.15	29.27	0.12	45.00	0.18	29.08
24	1	31.10	0.14	25.26	0.12	33.47	0.15	23.91	0.11	37.23	0.17	23.91
26	1	40.04	0.14	32.88	0.11	43.87	0.15	29.36	0.10	48.77	0.17	31.10
28	1	36.51	0.14	26.33	0.10	44.65	0.18	27.78	0.11	44.98	0.18	34.23
29	1	39.94	0.14	32.22	0.12	43.92	0.16	27.83	0.10	47.45	0.17	29.53
33 y172	1	45.42	0.17	29.17	0.11	39.60	0.15	27.61	0.10	45.90	0.17	27.12
34	1	41.57	0.16	26.50	0.10	43.12	0.17	29.26	0.11	45.72	0.18	28.54
37	1	38.23	0.14	34.02	0.12	44.97	0.16	27.56	0.10	46.85	0.17	30.75
39	1	37.04	0.14	34.66	0.13	45.71	0.17	32.42	0.12	48.84	0.18	36.72
41	1	39.80	0.14	33.93	0.12	45.06	0.16	33.49	0.12	47.79	0.17	35.26
50	1	30.98	0.12	29.41	0.12	41.72	0.17	30.93	0.12	41.59	0.17	37.60
43	1	41.63	0.17	31.55	0.13	46.71	0.19	30.00	0.12	42.10	0.17	34.27
45	1	38.04	0.14	34.49	0.12	43.31	0.15	36.33	0.13	51.93	0.19	34.55
46	1	31.78	0.13	23.83	0.10	32.30	0.13	24.15	0.10	37.52	0.15	26.87
48	1	39.65	0.14	31.37	0.11	47.14	0.17	30.16	0.11	51.12	0.18	34.53
52	1	35.96	0.13	27.54	0.10	42.99	0.16	31.11	0.12	46.47	0.17	33.83

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M3WL	M3WL/CL	M4LL	M4LL/CL	M4WL	M4WL/CL	M5LL	M5LL/CL	M5WL	M5WL/CL	M6LL
3	1	38.53	0.13	33.66	0.12	43.35	0.15	33.48	0.12	44.44	0.15	35.11
5	1	37.44	0.14	33.73	0.13	40.47	0.16	34.03	0.13	42.95	0.17	35.03
7 y66	1	41.40	0.18	29.33	0.12	45.30	0.19	19.47	0.08	45.67	0.19	24.40
8 y 80	1	43.92	0.14	36.50	0.12	49.31	0.16	32.40	0.10	50.63	0.16	37.94
10	1	45.27	0.16	32.30	0.12	49.06	0.18	31.33	0.11	45.11	0.16	34.96
55	1	38.59	0.14	33.61	0.12	38.49	0.14	32.16	0.12	45.24	0.17	33.24
53	1	37.10	0.15	30.08	0.12	42.86	0.17	30.19	0.12	45.30	0.18	27.81
54 y_09	1	35.35	0.13	31.85	0.12	42.43	0.15	30.79	0.11	45.40	0.17	35.85
59	2	34.83	0.13	31.89	0.12	47.06	0.17	32.85	0.12	49.32	0.18	33.56
60	2	44.93	0.17	32.05	0.12	33.93	0.13	33.29	0.13	46.06	0.18	38.41
61	2	38.86	0.14	31.20	0.11	41.93	0.15	32.98	0.12	43.97	0.16	38.34
57	2	36.28	0.13	33.74	0.12	45.37	0.16	35.89	0.13	48.82	0.18	43.94
58	2	35.87	0.13	33.03	0.12	42.22	0.15	37.98	0.14	47.10	0.17	37.10
56	2	29.86	0.12	27.79	0.12	36.03	0.15	30.72	0.13	39.14	0.16	34.56
62	2	36.42	0.13	33.60	0.12	44.30	0.16	30.91	0.11	47.18	0.17	36.87
1	2	47.82	0.17	39.23	0.14	51.92	0.18	35.04	0.12	48.67	0.17	43.16
4 (y44)	2	45.53	0.14	38.94	0.12	53.34	0.17	42.43	0.13	55.17	0.17	49.87
6	2	35.81	0.14	31.05	0.12	42.30	0.16	31.05	0.12	44.63	0.17	33.65
9	2	35.75	0.14	28.11	0.11	43.70	0.17	33.93	0.13	45.27	0.17	39.05
12	2	37.74	0.13	37.20	0.13	44.75	0.15	35.95	0.12	48.13	0.16	39.72
15	2	35.97	0.12	37.88	0.12	52.17	0.17	38.33	0.12	51.71	0.17	41.16
16	2	33.68	0.13	28.47	0.11	36.66	0.14	31.12	0.12	40.43	0.16	37.35

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M3WL	M3WL/CL	M4LL	M4LL/CL	M4WL	M4WL/CL	M5LL	M5LL/CL	M5WL	M5WL/CL	M6LL
17(y103)	2	37.61	0.12	38.06	0.12	50.68	0.16	38.43	0.12	60.67	0.19	44.33
19(y162)	2	30.19	0.13	27.06	0.11	37.60	0.16	31.32	0.13	42.49	0.18	34.19
25 (y336)	2	35.09	0.14	31.54	0.12	41.92	0.16	33.14	0.13	44.36	0.17	36.98
27	2	33.06	0.12	31.45	0.12	30.95	0.12	33.01	0.12	45.61	0.17	36.31
30	2	36.96	0.13	33.75	0.12	43.57	0.16	32.92	0.12	48.46	0.18	38.19
31	2	40.20	0.15	31.87	0.12	44.23	0.17	33.68	0.13	43.78	0.17	37.55
32	2	35.23	0.12	31.78	0.11	48.77	0.17	33.67	0.12	57.85	0.20	36.53
36	2	35.02	0.13	29.71	0.11	42.69	0.16	32.86	0.12	46.02	0.17	37.32
38	2	36.84	0.14	35.01	0.13	43.64	0.16	36.86	0.14	43.64	0.16	39.22
40	2	31.40	0.13	24.98	0.10	37.42	0.15	25.27	0.10	39.47	0.16	30.19
42	2	38.51	0.14	31.77	0.11	48.32	0.17	35.17	0.12	52.74	0.19	39.09
44 y339	2	30.38	0.12	30.88	0.12	39.40	0.16	34.06	0.13	44.88	0.18	35.08
47	2	44.67	0.16	31.48	0.12	49.73	0.18	31.49	0.12	50.64	0.19	34.36
49 y333	2	37.13	0.14	37.24	0.14	45.25	0.17	38.06	0.14	47.38	0.18	39.06
51	2	32.03	0.12	27.60	0.10	42.44	0.16	27.08	0.10	46.16	0.17	29.91
2	2	36.32	0.12	33.16	0.11	46.34	0.15	34.40	0.11	49.70	0.16	38.77

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M6LL/CL	M6WL	M6WL/CL	M7LL	M7LL/CL	M7WL	M7WL/CL	M8LL	M8LL/CL	M8WL	M8WL/CL
11	1	0.12	39.43	0.15	28.77	0.11	41.93	0.16	28.58	0.11	38.84	0.15
13	1	0.12	42.12	0.15	35.93	0.13	48.93	0.18	33.85	0.12	44.61	0.16
18	1	0.13	46.00	0.16	33.25	0.12	45.99	0.16	33.63	0.12	46.39	0.16
20	1	0.12	46.88	0.17	33.06	0.12	45.45	0.17	31.97	0.12	41.62	0.16
21 y342	1	0.13	42.36	0.18	28.51	0.12	42.68	0.18	26.54	0.11	40.67	0.18
22 y65	1	0.11	41.35	0.16	29.88	0.12	45.22	0.18	32.11	0.12	42.02	0.16
23	1	0.12	39.66	0.16	29.58	0.12	42.97	0.17	28.97	0.12	39.63	0.16
24	1	0.11	39.88	0.18	23.91	0.11	39.62	0.18	23.73	0.11	37.00	0.17
26	1	0.11	48.15	0.17	32.65	0.11	48.72	0.17	32.15	0.11	41.14	0.14
28	1	0.13	44.65	0.18	33.16	0.13	46.41	0.18	30.00	0.12	44.86	0.18
29	1	0.11	47.59	0.17	31.26	0.11	49.86	0.18	29.69	0.11	45.55	0.16
33 y172	1	0.10	42.42	0.16	28.19	0.11	42.81	0.16	27.54	0.10	39.21	0.15
34	1	0.11	48.33	0.19	29.52	0.11	45.11	0.17	26.81	0.10	40.53	0.16
37	1	0.11	48.24	0.18	33.56	0.12	48.07	0.17	34.39	0.13	48.50	0.18
39	1	0.14	48.99	0.18	35.72	0.13	49.04	0.18	31.50	0.12	44.81	0.17
41	1	0.12	50.38	0.18	37.24	0.13	50.94	0.18	37.06	0.13	46.18	0.16
50	1	0.15	39.08	0.16	34.86	0.14	40.93	0.16	30.87	0.12	40.05	0.16
43	1	0.14	47.14	0.19	36.19	0.15	41.49	0.17	34.79	0.14	42.87	0.17
45	1	0.12	51.62	0.18	33.10	0.12	53.39	0.19	33.82	0.12	49.16	0.18
46	1	0.11	35.96	0.14	29.90	0.12	37.27	0.15	30.64	0.12	34.88	0.14
48	1	0.12	51.71	0.19	35.94	0.13	51.16	0.18	31.47	0.11	48.18	0.17
52	1	0.13	47.19	0.17	33.48	0.12	47.18	0.17	33.46	0.12	43.69	0.16

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M6LL/CL	M6WL	M6WL/CL	M7LL	M7LL/CL	M7WL	M7WL/CL	M8LL	M8LL/CL	M8WL	M8WL/CL
3	1	0.12	42.81	0.15	33.35	0.12	45.25	0.16	33.15	0.11	45.25	0.16
5	1	0.13	44.63	0.17	30.35	0.12	45.05	0.17	31.33	0.12	42.06	0.16
7 y66	1	0.10	45.86	0.20	27.36	0.12	44.12	0.19	32.85	0.14	44.11	0.19
8 y 80	1	0.12	48.68	0.16	34.97	0.11	52.85	0.17	34.87	0.11	49.69	0.16
10	1	0.12	49.38	0.18	33.32	0.12	46.50	0.17	29.46	0.11	46.04	0.16
55	1	0.12	47.84	0.18	31.16	0.12	48.55	0.18	31.66	0.12	46.27	0.17
53	1	0.11	42.96	0.17	27.31	0.11	47.02	0.19	26.04	0.10	41.22	0.16
54 y_09	1	0.13	45.18	0.16	33.91	0.12	45.14	0.16	32.92	0.12	38.55	0.14
59	2	0.12	51.84	0.19	36.88	0.14	51.65	0.19	31.94	0.12	49.66	0.18
60	2	0.15	40.08	0.15	35.90	0.14	48.12	0.19	33.75	0.13	48.23	0.19
61	2	0.14	45.84	0.17	34.78	0.13	45.88	0.17	33.18	0.12	43.73	0.16
57	2	0.16	49.88	0.18	29.99	0.11	50.98	0.18	30.21	0.11	50.68	0.18
58	2	0.13	48.37	0.17	33.14	0.12	47.46	0.17	39.48	0.14	43.82	0.16
56	2	0.14	43.87	0.18	31.65	0.13	41.03	0.17	25.75	0.11	39.30	0.16
62	2	0.13	44.79	0.16	32.49	0.12	48.05	0.17	32.16	0.11	48.26	0.17
1	2	0.15	48.07	0.17	38.00	0.13	42.06	0.15	32.22	0.11	44.66	0.16
4 (y44)	2	0.15	55.95	0.17	46.06	0.14	52.51	0.16	39.19	0.12	51.54	0.16
6	2	0.13	45.18	0.17	34.78	0.13	46.08	0.17	31.14	0.12	44.21	0.17
9	2	0.15	46.57	0.18	39.47	0.15	44.40	0.17	27.82	0.11	44.58	0.17
12	2	0.14	50.04	0.17	38.56	0.13	48.79	0.17	36.18	0.12	46.52	0.16
15	2	0.13	52.52	0.17	32.58	0.11	51.45	0.17	35.05	0.11	47.45	0.15
16	2	0.14	40.93	0.16	33.74	0.13	40.93	0.16	27.69	0.11	41.77	0.16

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M6LL/CL	M6WL	M6WL/CL	M7LL	M7LL/CL	M7WL	M7WL/CL	M8LL	M8LL/CL	M8WL	M8WL/CL
17(y103)	2	0.14	59.49	0.19	44.74	0.14	59.48	0.19	37.66	0.12	56.00	0.18
19(y162)	2	0.14	44.46	0.19	31.30	0.13	41.60	0.18	28.05	0.12	40.62	0.17
25 (y336)	2	0.14	42.31	0.16	33.77	0.13	46.06	0.18	30.56	0.12	42.83	0.17
27	2	0.14	43.78	0.17	33.16	0.13	45.88	0.17	27.57	0.10	41.85	0.16
30	2	0.14	41.54	0.15	36.91	0.13	48.78	0.18	33.31	0.12	41.06	0.15
31	2	0.14	46.00	0.17	34.94	0.13	44.92	0.17	30.05	0.11	45.58	0.17
32	2	0.13	46.28	0.16	36.28	0.13	55.87	0.20	36.22	0.13	47.44	0.17
36	2	0.14	48.10	0.18	34.91	0.13	45.17	0.16	33.67	0.12	46.36	0.17
38	2	0.15	47.90	0.18	35.22	0.13	47.32	0.18	32.79	0.12	43.78	0.16
40	2	0.12	43.08	0.18	32.18	0.13	41.86	0.17	27.64	0.11	41.86	0.17
42	2	0.14	54.21	0.19	38.12	0.13	54.21	0.19	31.71	0.11	47.18	0.17
44 y339	2	0.14	44.35	0.18	33.14	0.13	44.35	0.18	29.42	0.12	38.61	0.15
47	2	0.13	50.04	0.18	34.89	0.13	44.59	0.16	31.26	0.12	46.94	0.17
49 y333	2	0.14	45.43	0.17	36.84	0.14	48.11	0.18	32.17	0.12	48.21	0.18
51	2	0.11	47.28	0.18	30.48	0.11	47.06	0.17	30.33	0.11	45.77	0.17
2	2	0.12	45.06	0.14	40.05	0.13	44.48	0.14	34.15	0.11	45.76	0.15

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M9LL	M9LL/CL	M9WL	M9WL/CL	M10LL	M10LL/CL	M10WL	M10WL/CL	M11LL	M11LL/CL	M11WL
11	1	31.69	0.12	39.82	0.15	29.90	0.12	38.84	0.15	42.12	0.16	38.84
13	1	35.33	0.13	46.08	0.17	34.29	0.12	43.82	0.16	41.44	0.15	43.46
18	1	34.55	0.12	48.28	0.17	29.14	0.10	46.75	0.16	40.49	0.14	44.00
20	1	36.30	0.14	43.56	0.16	32.24	0.12	42.57	0.16	45.14	0.17	40.14
21 y342	1	28.70	0.12	44.03	0.19	29.89	0.13	42.19	0.18	38.73	0.17	35.77
22 y65	1	32.46	0.13	41.19	0.16	35.24	0.14	37.91	0.15	43.59	0.17	38.41
23	1	99.81	0.40	41.08	0.17	25.84	0.10	36.47	0.15	41.66	0.17	36.18
24	1	23.89	0.11	38.77	0.18	23.91	0.11	37.49	0.17	33.32	0.15	31.49
26	1	39.96	0.14	47.22	0.17	31.68	0.11	45.76	0.16	46.14	0.16	43.06
28	1	29.98	0.12	46.65	0.18	29.40	0.12	46.35	0.18	39.73	0.16	39.64
29	1	33.13	0.12	47.98	0.17	29.60	0.11	44.07	0.16	42.83	0.15	41.60
33 y172	1	31.77	0.12	43.70	0.16	31.99	0.12	41.40	0.16	43.10	0.16	36.27
34	1	27.72	0.11	39.13	0.15	41.10	0.16	41.09	0.16	41.76	0.16	41.03
37	1	34.23	0.12	47.19	0.17	36.56	0.13	45.93	0.17	49.47	0.18	43.78
39	1	31.90	0.12	46.61	0.17	31.25	0.12	46.61	0.17	37.11	0.14	41.84
41	1	37.01	0.13	49.04	0.17	35.48	0.12	47.41	0.17	50.12	0.17	48.77
50	1	31.76	0.13	39.27	0.16	29.89	0.12	38.54	0.15	34.33	0.14	38.34
43	1	33.99	0.14	43.28	0.18	27.09	0.11	43.46	0.18	43.07	0.18	41.61
45	1	29.08	0.10	50.97	0.18	43.33	0.15	47.65	0.17	41.27	0.15	45.40
46	1	28.91	0.12	40.48	0.16	29.90	0.12	39.36	0.16	38.16	0.15	36.25
48	1	33.70	0.12	50.82	0.18	32.31	0.12	49.27	0.18	46.74	0.17	45.65
52	1	37.38	0.14	47.74	0.18	35.82	0.13	45.07	0.17	51.94	0.19	42.21

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M9LL	M9LL/CL	M9WL	M9WL/CL	M10LL	M10LL/CL	M10WL	M10WL/CL	M11LL	M11LL/CL	M11WL
3	1	36.56	0.13	49.91	0.17	33.91	0.12	46.21	0.16	44.96	0.16	42.08
5	1	34.22	0.13	47.73	0.18	23.73	0.09	46.99	0.18	40.63	0.16	45.17
7 y66	1	34.00	0.14	41.66	0.18	26.73	0.11	42.18	0.18	37.51	0.16	38.99
8 y 80	1	38.49	0.12	53.51	0.17	34.88	0.11	58.45	0.19	47.70	0.15	52.28
10	1	34.31	0.12	49.30	0.18	31.48	0.11	45.97	0.16	49.45	0.18	45.35
55	1	35.00	0.13	43.28	0.16	31.80	0.12	46.11	0.17	44.71	0.17	39.29
53	1	27.58	0.11	43.10	0.17	28.03	0.11	40.86	0.16	37.40	0.15	43.45
54 y_09	1	35.64	0.13	42.65	0.16	29.35	0.11	42.12	0.15	43.51	0.16	40.52
59	2	29.61	0.11	51.05	0.19	30.00	0.11	50.09	0.19	39.90	0.15	44.18
60	2	32.11	0.12	44.53	0.17	30.86	0.12	44.54	0.17	36.85	0.14	38.28
61	2	32.55	0.12	48.27	0.18	31.80	0.12	47.77	0.17	43.40	0.16	44.12
57	2	33.62	0.12	47.09	0.17	32.24	0.12	46.90	0.17	43.66	0.16	41.10
58	2	32.57	0.12	47.49	0.17	34.74	0.13	49.99	0.18	55.48	0.20	45.29
56	2	29.57	0.12	41.27	0.17	28.31	0.12	38.71	0.16	35.42	0.15	35.31
62	2	36.28	0.13	48.42	0.17	29.26	0.10	48.85	0.17	41.82	0.15	45.72
1	2	39.71	0.14	44.07	0.16	35.18	0.12	43.31	0.15	37.10	0.13	43.40
4 (y44)	2	38.26	0.12	51.78	0.16	35.19	0.11	52.52	0.16	45.98	0.14	46.49
6	2	30.57	0.12	45.24	0.17	31.59	0.12	45.49	0.17	36.46	0.14	40.55
9	2	32.53	0.13	48.67	0.19	29.76	0.11	48.58	0.19	32.24	0.12	43.57
12	2	36.84	0.13	51.19	0.18	32.36	0.11	49.27	0.17	40.91	0.14	42.75
15	2	37.02	0.12	53.22	0.17	33.81	0.11	47.87	0.15	40.18	0.13	44.02
16	2	26.84	0.10	45.32	0.17	30.42	0.12	43.29	0.17	35.13	0.14	38.54

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M9LL	M9LL/CL	M9WL	M9WL/CL	M10LL	M10LL/CL	M10WL	M10WL/CL	M11LL	M11LL/CL	M11WL
17(y103)	2	41.11	0.13	55.52	0.17	44.01	0.14	55.71	0.17	45.92	0.14	49.76
19(y162)	2	28.34	0.12	38.37	0.16	28.62	0.12	36.09	0.15	31.62	0.13	36.10
25 (y336)	2	31.48	0.12	44.59	0.17	28.10	0.11	42.59	0.17	36.80	0.14	40.24
27	2	31.22	0.12	46.57	0.18	28.32	0.11	44.50	0.17	32.34	0.12	40.05
30	2	34.62	0.13	44.14	0.16	32.29	0.12	41.53	0.15	38.21	0.14	41.53
31	2	31.51	0.12	46.91	0.18	32.38	0.12	44.74	0.17	36.25	0.14	42.97
32	2	25.10	0.09	47.85	0.17	29.35	0.10	45.07	0.16	33.01	0.12	45.50
36	2	32.00	0.12	47.49	0.17	32.27	0.12	47.57	0.17	38.50	0.14	42.84
38	2	31.87	0.12	47.10	0.17	32.27	0.12	44.79	0.17	36.54	0.14	39.54
40	2	25.33	0.10	41.09	0.17	29.48	0.12	40.34	0.16	35.26	0.14	35.83
42	2	30.65	0.11	45.47	0.16	30.28	0.11	44.77	0.16	39.99	0.14	41.07
44 y339	2	29.72	0.12	43.33	0.17	28.91	0.11	41.62	0.16	39.53	0.16	40.36
47	2	34.15	0.13	46.62	0.17	33.57	0.12	41.44	0.15	40.44	0.15	44.51
49 y333	2	36.36	0.13	48.08	0.18	31.36	0.12	46.86	0.17	34.54	0.13	42.84
51	2	29.20	0.11	44.04	0.16	31.61	0.12	43.27	0.16	56.37	0.21	38.96
2	2	35.19	0.11	47.29	0.15	34.07	0.11	48.31	0.15	42.34	0.14	42.86

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M11WL/CL	M1LR	M1LR/CL	MIWR	M1WR/CL	M2LR	M2LR/CL	M2WR	M2WR/CL	M3LR	M3LR/CL
11	1	0.15	41.27	0.16	40.75	0.16	31.45	0.12	39.07	0.15	28.09	0.11
13	1	0.16	41.61	0.15	43.54	0.16	38.63	0.14	38.26	0.14	31.59	0.11
18	1	0.15	49.75	0.17	49.17	0.17	36.17	0.13	47.13	0.17	35.42	0.12
20	1	0.15	43.13	0.16	45.17	0.17	31.36	0.12	39.27	0.15	36.53	0.14
21 y342	1	0.15	35.01	0.15	39.75	0.17	26.18	0.11	36.01	0.16	26.33	0.11
22 y65	1	0.15	36.06	0.14	30.89	0.12	31.87	0.12	33.12	0.13	29.52	0.11
23	1	0.15	39.47	0.16	41.16	0.17	32.68	0.13	35.42	0.14	29.35	0.12
24	1	0.14	38.62	0.18	37.99	0.17	30.22	0.14	35.87	0.16	26.54	0.12
26	1	0.15	49.68	0.17	38.96	0.14	33.85	0.12	43.88	0.15	36.11	0.13
28	1	0.16	42.19	0.17	38.97	0.15	30.75	0.12	39.99	0.16	30.79	0.12
29	1	0.15	40.89	0.15	42.51	0.15	33.39	0.12	39.39	0.14	33.39	0.12
33 y172	1	0.14	40.84	0.15	38.64	0.15	32.94	0.12	40.72	0.15	32.85	0.12
34	1	0.16	40.73	0.16	38.93	0.15	31.90	0.12	42.58	0.16	31.91	0.12
37	1	0.16	43.17	0.16	40.68	0.15	31.32	0.11	41.61	0.15	31.60	0.11
39	1	0.15	37.83	0.14	46.66	0.17	28.59	0.11	36.30	0.13	29.21	0.11
41	1	0.17	45.00	0.16	41.95	0.15	31.02	0.11	39.42	0.14	36.31	0.13
50	1	0.15	38.10	0.15	39.92	0.16	31.61	0.13	33.74	0.13	28.78	0.11
43	1	0.17	45.38	0.19	34.38	0.14	17.08	0.07	43.82	0.18	33.13	0.14
45	1	0.16	41.71	0.15	46.31	0.17	35.85	0.13	40.72	0.15	32.00	0.11
46	1	0.15	41.14	0.16	40.23	0.16	33.33	0.13	37.96	0.15	27.21	0.11
48	1	0.16	37.05	0.13	41.08	0.15	38.24	0.14	42.68	0.15	37.73	0.14
52	1	0.16	44.79	0.17	45.65	0.17	37.21	0.14	41.71	0.15	32.78	0.12

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M11WL/CL	M1LR	M1LR/CL	MIWR	M1WR/CL	M2LR	M2LR/CL	M2WR	M2WR/CL	M3LR	M3LR/CL
3	1	0.15	40.61	0.14	43.08	0.15	28.72	0.10	37.06	0.13	33.01	0.11
5	1	0.17	40.88	0.16	39.69	0.15	31.58	0.12	40.16	0.15	30.50	0.12
7 y66	1	0.17	39.95	0.17	32.71	0.14	26.58	0.11	39.02	0.17	25.17	0.11
8 y 80	1	0.17	50.34	0.16	50.27	0.16	37.20	0.12	50.98	0.16	40.37	0.13
10	1	0.16	45.93	0.16	45.23	0.16	31.37	0.11	46.67	0.17	30.93	0.11
55	1	0.15	43.08	0.16	36.28	0.13	27.20	0.10	41.63	0.15	29.25	0.11
53	1	0.17	40.35	0.16	39.62	0.16	33.94	0.14	40.89	0.16	31.62	0.13
54 y_09	1	0.15	38.82	0.14	42.55	0.16	33.37	0.12	38.02	0.14	30.09	0.11
59	2	0.16	41.06	0.15	46.55	0.17	31.98	0.12	38.17	0.14	30.57	0.11
60	2	0.15	38.61	0.15	43.99	0.17	35.00	0.13	36.96	0.14	31.37	0.12
61	2	0.16	42.42	0.15	42.90	0.16	32.72	0.12	39.18	0.14	26.55	0.10
57	2	0.15	40.05	0.14	44.85	0.16	33.07	0.12	38.74	0.14	27.80	0.10
58	2	0.16	48.22	0.17	41.96	0.15	36.37	0.13	39.78	0.14	29.78	0.11
56	2	0.15	33.60	0.14	39.24	0.16	28.31	0.12	31.34	0.13	26.88	0.11
62	2	0.16	41.99	0.15	40.40	0.14	38.77	0.14	40.89	0.15	31.51	0.11
1	2	0.15	44.85	0.16	43.04	0.15	25.89	0.09	35.79	0.13	29.39	0.10
4 (y44)	2	0.14	50.15	0.16	49.90	0.15	34.06	0.11	39.67	0.12	33.64	0.10
6	2	0.15	44.60	0.17	40.51	0.15	34.91	0.13	39.52	0.15	29.09	0.11
9	2	0.17	41.84	0.16	39.64	0.15	31.62	0.12	40.40	0.16	25.90	0.10
12	2	0.15	45.69	0.16	43.09	0.15	31.66	0.11	40.04	0.14	29.81	0.10
15	2	0.14	44.65	0.14	47.47	0.15	36.46	0.12	39.20	0.13	33.97	0.11
16	2	0.15	40.26	0.15	40.19	0.15	30.36	0.12	37.25	0.14	26.21	0.10

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M11WL/CL	M1LR	M1LR/CL	MIWR	M1WR/CL	M2LR	M2LR/CL	M2WR	M2WR/CL	M3LR	M3LR/CL
17(y103)	2	0.16	50.97	0.16	48.16	0.15	38.91	0.12	48.53	0.15	24.63	0.08
19(y162)	2	0.15	33.30	0.14	37.80	0.16	31.07	0.13	31.67	0.13	26.58	0.11
25 (y336)	2	0.16	39.38	0.15	41.90	0.16	35.78	0.14	39.45	0.15	31.22	0.12
27	2	0.15	41.14	0.16	41.08	0.16	35.74	0.13	38.31	0.14	31.76	0.12
30	2	0.15	41.31	0.15	48.26	0.17	35.58	0.13	37.07	0.13	20.85	0.08
31	2	0.16	41.18	0.16	38.75	0.15	35.30	0.13	41.05	0.15	29.93	0.11
32	2	0.16	43.11	0.15	40.98	0.14	33.34	0.12	36.80	0.13	31.61	0.11
36	2	0.16	43.90	0.16	42.58	0.16	36.91	0.13	39.84	0.15	31.85	0.12
38	2	0.15	39.73	0.15	39.96	0.15	36.86	0.14	39.56	0.15	33.25	0.12
40	2	0.15	34.52	0.14	39.08	0.16	30.60	0.12	35.25	0.14	23.43	0.10
42	2	0.14	44.03	0.15	42.15	0.15	36.31	0.13	43.68	0.15	33.22	0.12
44 y339	2	0.16	35.50	0.14	38.15	0.15	30.35	0.12	34.53	0.14	27.13	0.11
47	2	0.16	38.39	0.14	42.57	0.16	36.67	0.14	41.32	0.15	29.66	0.11
49 y333	2	0.16	41.15	0.15	45.17	0.17	30.23	0.11	38.24	0.14	29.10	0.11
51	2	0.14	41.40	0.15	42.95	0.16	29.41	0.11	34.14	0.13	21.60	0.08
2	2	0.14	40.03	0.13	44.90	0.14	30.10	0.10	34.84	0.11	31.87	0.10

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M3WR	M3WR/CL	M4LR	M4LR/CL	M4WR	M4WR/CL	M5LR	M5LR/CL	M5WR	M5WR/CL	M6LR
11	1	33.46	0.13	29.07	0.11	48.78	0.19	28.82	0.11	40.40	0.16	32.19
13	1	33.48	0.12	31.18	0.11	38.59	0.14	31.62	0.11	45.78	0.17	32.96
18	1	42.42	0.15	34.20	0.12	46.73	0.16	32.67	0.11	45.10	0.16	34.60
20	1	37.96	0.14	33.77	0.13	43.80	0.16	31.46	0.12	44.91	0.17	33.26
21 y342	1	35.26	0.15	29.70	0.13	36.12	0.16	29.70	0.13	38.47	0.17	29.70
22 y65	1	34.86	0.14	27.33	0.11	51.94	0.20	28.69	0.11	49.31	0.19	28.69
23	1	33.16	0.13	29.09	0.12	38.20	0.15	30.06	0.12	45.06	0.18	30.22
24	1	31.65	0.15	24.44	0.11	33.79	0.16	23.42	0.11	37.05	0.17	26.99
26	1	39.83	0.14	32.97	0.12	43.40	0.15	29.90	0.10	45.66	0.16	34.79
28	1	40.15	0.16	26.19	0.10	46.59	0.18	27.52	0.11	46.05	0.18	30.16
29	1	36.93	0.13	32.19	0.12	41.42	0.15	30.99	0.11	47.62	0.17	29.13
33 y172	1	35.00	0.13	29.49	0.11	39.56	0.15	27.61	0.10	45.35	0.17	29.14
34	1	39.84	0.15	29.37	0.11	39.74	0.15	27.78	0.11	46.06	0.18	30.98
37	1	38.83	0.14	32.96	0.12	45.26	0.16	28.62	0.10	46.50	0.17	32.29
39	1	36.42	0.13	35.49	0.13	46.97	0.17	33.83	0.13	49.83	0.18	36.98
41	1	39.62	0.14	35.08	0.12	44.22	0.15	32.21	0.11	47.84	0.17	36.51
50	1	29.87	0.12	29.04	0.12	42.12	0.17	31.82	0.13	42.13	0.17	40.66
43	1	40.30	0.16	28.40	0.12	44.81	0.18	27.12	0.11	46.45	0.19	38.91
45	1	38.55	0.14	32.41	0.12	45.12	0.16	32.41	0.12	48.90	0.17	35.87
46	1	33.88	0.14	30.18	0.12	32.45	0.13	25.65	0.10	35.27	0.14	27.19
48	1	39.67	0.14	31.04	0.11	46.71	0.17	30.63	0.11	51.31	0.19	35.50
52	1	38.79	0.14	32.78	0.12	47.48	0.18	23.96	0.09	50.59	0.19	29.54

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M3WR	M3WR/CL	M4LR	M4LR/CL	M4WR	M4WR/CL	M5LR	M5LR/CL	M5WR	M5WR/CL	M6LR
3	1	36.99	0.13	36.42	0.13	42.52	0.15	34.04	0.12	44.36	0.15	38.66
5	1	37.54	0.14	32.36	0.12	39.62	0.15	30.81	0.12	46.17	0.18	27.36
7 y66	1	39.91	0.17	31.71	0.13	45.59	0.19	25.41	0.11	46.44	0.20	26.05
8 y 80	1	44.93	0.14	37.98	0.12	49.76	0.16	36.53	0.12	51.15	0.16	36.45
10	1	44.76	0.16	32.02	0.11	46.60	0.17	33.49	0.12	45.11	0.16	32.20
55	1	38.12	0.14	34.25	0.13	44.11	0.16	33.33	0.12	39.85	0.15	34.05
53	1	37.39	0.15	30.32	0.12	43.00	0.17	29.13	0.12	45.30	0.18	29.94
54 y_09	1	35.16	0.13	31.33	0.11	41.63	0.15	30.34	0.11	42.64	0.16	35.88
59	2	35.22	0.13	33.58	0.12	47.84	0.18	33.28	0.12	50.43	0.19	36.65
60	2	34.41	0.13	32.22	0.12	43.29	0.17	34.73	0.13	45.47	0.17	41.52
61	2	36.11	0.13	31.14	0.11	41.68	0.15	34.67	0.13	43.77	0.16	38.92
57	2	35.34	0.13	33.03	0.12	44.32	0.16	37.40	0.14	49.22	0.18	40.58
58	2	35.46	0.13	32.01	0.12	43.02	0.16	34.76	0.13	46.58	0.17	36.39
56	2	29.26	0.12	27.96	0.12	35.37	0.15	28.36	0.12	37.67	0.16	32.56
62	2	36.19	0.13	31.07	0.11	42.94	0.15	31.92	0.11	44.61	0.16	37.33
1	2	37.21	0.13	40.31	0.14	46.54	0.16	35.58	0.13	49.97	0.18	44.90
4 (y44)	2	44.27	0.14	43.67	0.14	52.08	0.16	44.79	0.14	56.42	0.17	49.93
6	2	34.38	0.13	31.43	0.12	40.54	0.15	32.89	0.12	44.71	0.17	35.72
9	2	36.35	0.14	28.36	0.11	41.28	0.16	29.60	0.11	41.94	0.16	35.47
12	2	38.31	0.13	34.34	0.12	45.34	0.16	30.95	0.11	48.81	0.17	35.02
15	2	38.87	0.13	37.16	0.12	51.21	0.17	38.68	0.12	50.13	0.16	43.95
16	2	32.77	0.13	29.92	0.12	37.54	0.14	30.89	0.12	40.69	0.16	39.64

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M3WR	M3WR/CL	M4LR	M4LR/CL	M4WR	M4WR/CL	M5LR	M5LR/CL	M5WR	M5WR/CL	M6LR
17(y103)	2	40.53	0.13	39.60	0.12	52.15	0.16	38.58	0.12	56.17	0.18	43.56
19(y162)	2	30.67	0.13	29.24	0.12	37.76	0.16	31.91	0.13	42.52	0.18	34.07
25 (y336)	2	33.91	0.13	32.21	0.12	43.34	0.17	32.86	0.13	44.52	0.17	38.03
27	2	33.82	0.13	33.44	0.13	38.45	0.15	34.58	0.13	44.42	0.17	35.86
30	2	37.19	0.13	36.94	0.13	43.67	0.16	34.74	0.13	49.93	0.18	37.34
31	2	36.16	0.14	31.86	0.12	44.51	0.17	33.89	0.13	46.00	0.17	34.38
32	2	35.50	0.13	35.17	0.12	48.89	0.17	34.98	0.12	56.26	0.20	36.02
36	2	34.81	0.13	31.79	0.12	43.04	0.16	33.72	0.12	46.11	0.17	36.94
38	2	37.15	0.14	34.53	0.13	43.38	0.16	35.36	0.13	44.34	0.16	39.53
40	2	31.23	0.13	23.31	0.10	32.18	0.13	28.28	0.12	42.54	0.17	31.35
42	2	38.76	0.14	19.78	0.07	46.49	0.16	37.14	0.13	51.32	0.18	41.72
44 y339	2	31.04	0.12	31.63	0.13	38.50	0.15	32.17	0.13	45.65	0.18	35.37
47	2	35.73	0.13	31.03	0.11	46.19	0.17	31.33	0.12	47.82	0.18	35.44
49 y333	2	37.06	0.14	35.41	0.13	46.81	0.17	37.07	0.14	48.53	0.18	40.05
51	2	30.95	0.11	26.74	0.10	41.41	0.15	30.51	0.11	45.38	0.17	34.02
2	2	36.24	0.12	35.54	0.11	45.84	0.15	37.20	0.12	48.44	0.16	40.99

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M6LR/CL	M6WR	M6WR/CL	M7LR	M7LR/CL	M7WR	M7WR/CL	M8LR	M8LR/CL	M8WR	M8WR/CL
11	1	0.12	40.48	0.16	31.50	0.12	43.50	0.17	30.64	0.12	38.55	0.15
13	1	0.12	41.64	0.15	32.66	0.12	45.28	0.16	32.70	0.12	42.24	0.15
18	1	0.12	43.94	0.15	32.54	0.11	50.83	0.18	32.63	0.11	47.37	0.17
20	1	0.12	45.36	0.17	33.64	0.13	46.01	0.17	33.46	0.12	42.59	0.16
21 y342	1	0.13	40.75	0.18	29.70	0.13	41.89	0.18	28.11	0.12	40.75	0.18
22 y65	1	0.11	48.25	0.19	32.78	0.13	46.18	0.18	33.61	0.13	41.17	0.16
23	1	0.12	39.72	0.16	28.52	0.12	43.01	0.17	29.98	0.12	38.62	0.16
24	1	0.12	38.02	0.17	27.41	0.13	39.65	0.18	26.91	0.12	36.14	0.17
26	1	0.12	47.05	0.16	35.59	0.12	45.60	0.16	35.25	0.12	41.05	0.14
28	1	0.12	45.30	0.18	30.86	0.12	43.93	0.17	30.00	0.12	47.20	0.19
29	1	0.11	47.34	0.17	31.81	0.11	49.19	0.18	33.76	0.12	42.22	0.15
33 y172	1	0.11	42.79	0.16	29.64	0.11	44.86	0.17	30.39	0.11	38.94	0.15
34	1	0.12	46.35	0.18	31.05	0.12	48.36	0.19	31.05	0.12	44.40	0.17
37	1	0.12	47.78	0.17	34.05	0.12	49.52	0.18	36.21	0.13	46.11	0.17
39	1	0.14	50.67	0.19	34.54	0.13	49.50	0.18	32.48	0.12	44.99	0.17
41	1	0.13	49.30	0.17	38.61	0.13	51.32	0.18	38.23	0.13	49.89	0.17
50	1	0.16	41.06	0.16	39.70	0.16	41.06	0.16	32.59	0.13	38.98	0.15
43	1	0.16	46.66	0.19	33.92	0.14	43.64	0.18	36.63	0.15	44.33	0.18
45	1	0.13	50.59	0.18	33.25	0.12	50.66	0.18	34.92	0.12	53.35	0.19
46	1	0.11	36.09	0.14	29.26	0.12	38.86	0.16	31.16	0.12	35.71	0.14
48	1	0.13	50.29	0.18	34.40	0.12	50.85	0.18	33.59	0.12	49.31	0.18
52	1	0.11	49.89	0.18	35.62	0.13	55.39	0.21	32.94	0.12	50.00	0.19

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M6LR/CL	M6WR	M6WR/CL	M7LR	M7LR/CL	M7WR	M7WR/CL	M8LR	M8LR/CL	M8WR	M8WR/CL
3	1	0.13	45.55	0.16	36.34	0.13	46.22	0.16	37.16	0.13	43.30	0.15
5	1	0.11	43.55	0.17	32.03	0.12	43.94	0.17	32.92	0.13	40.84	0.16
7 y66	1	0.11	46.96	0.20	29.22	0.12	46.47	0.20	33.59	0.14	43.55	0.19
8 y 80	1	0.12	47.82	0.15	37.76	0.12	52.05	0.17	34.41	0.11	49.05	0.16
10	1	0.12	46.58	0.17	32.20	0.12	49.05	0.18	28.60	0.10	47.85	0.17
55	1	0.13	45.80	0.17	30.84	0.11	48.00	0.18	32.57	0.12	44.39	0.16
53	1	0.12	43.26	0.17	32.02	0.13	46.02	0.18	31.43	0.13	43.22	0.17
54 y_09	1	0.13	44.40	0.16	32.10	0.12	43.70	0.16	34.94	0.13	40.11	0.15
59	2	0.14	50.73	0.19	37.48	0.14	48.42	0.18	34.39	0.13	43.30	0.16
60	2	0.16	46.87	0.18	40.42	0.16	47.81	0.18	35.85	0.14	45.62	0.18
61	2	0.14	47.30	0.17	37.08	0.13	46.12	0.17	34.63	0.13	44.14	0.16
57	2	0.15	48.71	0.18	38.81	0.14	49.54	0.18	32.46	0.12	46.45	0.17
58	2	0.13	47.04	0.17	36.34	0.13	46.91	0.17	35.40	0.13	44.93	0.16
56	2	0.14	41.37	0.17	33.25	0.14	40.35	0.17	26.37	0.11	37.50	0.16
62	2	0.13	45.45	0.16	34.81	0.12	45.95	0.16	32.54	0.12	43.32	0.15
1	2	0.16	47.53	0.17	41.76	0.15	46.61	0.16	35.60	0.13	42.00	0.15
4 (y44)	2	0.15	57.34	0.18	48.54	0.15	51.15	0.16	42.61	0.13	51.34	0.16
6	2	0.14	48.01	0.18	35.71	0.14	47.53	0.18	33.17	0.13	43.44	0.16
9	2	0.14	44.63	0.17	35.41	0.14	42.61	0.16	25.14	0.10	42.40	0.16
12	2	0.12	51.12	0.18	38.72	0.13	49.83	0.17	35.20	0.12	46.61	0.16
15	2	0.14	55.61	0.18	39.17	0.13	51.38	0.17	36.04	0.12	47.55	0.15
16	2	0.15	40.15	0.15	36.04	0.14	40.15	0.15	30.49	0.12	39.77	0.15

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M6LR/CL	M6WR	M6WR/CL	M7LR	M7LR/CL	M7WR	M7WR/CL	M8LR	M8LR/CL	M8WR	M8WR/CL
17(y103)	2	0.14	56.23	0.18	43.56	0.14	57.15	0.18	39.90	0.12	57.90	0.18
19(y162)	2	0.14	43.77	0.18	30.16	0.13	41.68	0.18	29.16	0.12	39.32	0.17
25 (y336)	2	0.15	46.70	0.18	38.76	0.15	46.56	0.18	31.51	0.12	44.45	0.17
27	2	0.14	44.52	0.17	34.87	0.13	45.84	0.17	27.45	0.10	40.40	0.15
30	2	0.14	42.62	0.15	37.26	0.14	47.56	0.17	33.01	0.12	42.80	0.16
31	2	0.13	46.00	0.17	32.85	0.12	42.30	0.16	31.05	0.12	42.40	0.16
32	2	0.13	47.20	0.17	37.70	0.13	54.21	0.19	32.69	0.12	46.27	0.16
36	2	0.13	48.42	0.18	35.11	0.13	47.10	0.17	35.90	0.13	45.17	0.16
38	2	0.15	47.79	0.18	36.27	0.13	46.58	0.17	33.75	0.13	45.11	0.17
40	2	0.13	41.72	0.17	31.21	0.13	40.28	0.16	29.18	0.12	41.28	0.17
42	2	0.15	57.05	0.20	40.65	0.14	52.79	0.19	32.97	0.12	47.99	0.17
44 y339	2	0.14	43.72	0.17	31.50	0.12	44.95	0.18	29.64	0.12	39.88	0.16
47	2	0.13	50.72	0.19	33.72	0.12	50.27	0.19	31.18	0.12	47.77	0.18
49 y333	2	0.15	48.53	0.18	36.84	0.14	47.64	0.18	34.52	0.13	47.27	0.18
51	2	0.13	45.38	0.17	34.50	0.13	45.62	0.17	33.71	0.12	45.26	0.17
2	2	0.13	47.47	0.15	42.84	0.14	47.07	0.15	41.55	0.13	47.40	0.15

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M9LR	M9LR/CL	M9WR	M9WR/CL	M10LR	M10LR/CL	M10WR	M10WR/CL	M11LR	M11LR/CL	M11WR
11	1	31.75	0.12	37.89	0.15	29.03	0.11	37.29	0.14	41.45	0.16	37.95
13	1	34.67	0.13	44.01	0.16	36.69	0.13	40.84	0.15	44.02	0.16	43.74
18	1	33.92	0.12	48.18	0.17	31.19	0.11	48.18	0.17	39.49	0.14	46.37
20	1	33.72	0.13	43.82	0.16	34.69	0.13	39.93	0.15	44.42	0.17	41.48
21 y342	1	29.87	0.13	43.01	0.19	28.26	0.12	40.26	0.17	39.56	0.17	36.94
22 y65	1	35.45	0.14	40.94	0.16	47.38	0.18	36.98	0.14	40.23	0.16	39.32
23	1	33.07	0.13	43.04	0.17	30.41	0.12	38.11	0.15	37.82	0.15	37.41
24	1	26.27	0.12	39.53	0.18	25.33	0.12	36.93	0.17	32.70	0.15	31.04
26	1	37.25	0.13	48.29	0.17	31.32	0.11	45.31	0.16	49.91	0.17	42.49
28	1	29.42	0.12	47.72	0.19	31.12	0.12	45.33	0.18	37.03	0.15	43.46
29	1	35.27	0.13	43.98	0.16	32.63	0.12	43.29	0.16	42.95	0.16	42.27
33 y172	1	32.13	0.12	43.12	0.16	33.07	0.12	41.20	0.16	44.63	0.17	39.10
34	1	33.48	0.13	47.42	0.18	29.31	0.11	47.22	0.18	38.39	0.15	47.31
37	1	37.49	0.14	47.57	0.17	37.71	0.14	46.99	0.17	49.93	0.18	47.36
39	1	34.83	0.13	45.94	0.17	32.80	0.12	44.70	0.17	39.36	0.15	43.79
41	1	39.10	0.14	49.94	0.17	36.60	0.13	46.87	0.16	56.45	0.20	48.92
50	1	31.74	0.13	40.86	0.16	31.57	0.13	38.88	0.15	36.18	0.14	39.02
43	1	30.70	0.13	47.02	0.19	47.45	0.19	45.70	0.19	40.85	0.17	44.13
45	1	38.73	0.14	48.66	0.17	53.92	0.19	51.63	0.18	51.11	0.18	51.05
46	1	32.15	0.13	39.14	0.16	32.89	0.13	40.68	0.16	36.20	0.14	34.50
48	1	33.58	0.12	52.68	0.19	32.69	0.12	48.81	0.18	43.10	0.16	45.95
52	1	37.41	0.14	51.58	0.19	35.33	0.13	46.92	0.17	49.67	0.18	48.87

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M9LR	M9LR/CL	M9WR	M9WR/CL	M10LR	M10LR/CL	M10WR	M10WR/CL	M11LR	M11LR/CL	M11WR
3	1	37.22	0.13	44.58	0.15	36.27	0.13	43.89	0.15	45.37	0.16	39.99
5	1	31.42	0.12	46.83	0.18	26.06	0.10	45.87	0.18	40.32	0.16	42.42
7 y66	1	36.97	0.16	43.29	0.18	30.32	0.13	43.90	0.19	39.51	0.17	40.39
8 y 80	1	38.19	0.12	55.19	0.18	36.43	0.12	55.33	0.18	51.60	0.17	52.33
10	1	32.79	0.12	48.80	0.17	31.28	0.11	48.73	0.17	46.46	0.17	42.91
55	1	35.08	0.13	45.50	0.17	30.49	0.11	46.10	0.17	44.74	0.17	46.18
53	1	33.63	0.13	45.11	0.18	31.67	0.13	42.11	0.17	39.13	0.16	45.23
54 y_09	1	36.46	0.13	41.12	0.15	30.71	0.11	40.16	0.15	45.89	0.17	41.16
59	2	31.10	0.12	53.06	0.20	30.63	0.11	50.93	0.19	38.56	0.14	46.47
60	2	32.23	0.12	44.38	0.17	30.61	0.12	42.15	0.16	42.33	0.16	37.75
61	2	33.09	0.12	48.29	0.18	32.87	0.12	47.12	0.17	44.02	0.16	44.44
57	2	30.13	0.11	46.29	0.17	31.50	0.11	45.86	0.17	42.36	0.15	40.70
58	2	34.68	0.13	48.48	0.18	33.56	0.12	48.26	0.17	41.76	0.15	42.44
56	2	30.67	0.13	40.57	0.17	28.24	0.12	36.26	0.15	33.20	0.14	36.89
62	2	35.80	0.13	45.10	0.16	32.80	0.12	46.63	0.17	41.32	0.15	45.73
1	2	42.81	0.15	73.74	0.26	34.05	0.12	42.92	0.15	39.94	0.14	39.92
4 (y44)	2	45.26	0.14	50.92	0.16	35.75	0.11	51.42	0.16	43.42	0.13	45.67
6	2	33.05	0.13	44.52	0.17	32.63	0.12	42.81	0.16	36.35	0.14	39.10
9	2	31.57	0.12	48.74	0.19	29.24	0.11	46.56	0.18	32.07	0.12	44.89
12	2	33.89	0.12	50.92	0.17	30.64	0.10	49.69	0.17	39.16	0.13	45.25
15	2	38.00	0.12	50.21	0.16	35.99	0.12	45.46	0.15	40.14	0.13	43.77
16	2	27.90	0.11	45.08	0.17	33.09	0.13	44.57	0.17	36.02	0.14	39.49

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M9LR	M9LR/CL	M9WR	M9WR/CL	M10LR	M10LR/CL	M10WR	M10WR/CL	M11LR	M11LR/CL	M11WR
17(y103)	2	42.47	0.13	58.56	0.18	41.14	0.13	56.43	0.18	50.05	0.16	49.99
19(y162)	2	28.33	0.12	38.03	0.16	29.07	0.12	35.68	0.15	31.19	0.13	37.31
25 (y336)	2	33.52	0.13	45.42	0.18	33.40	0.13	43.76	0.17	38.01	0.15	41.74
27	2	33.39	0.13	44.08	0.17	30.70	0.12	43.12	0.16	30.46	0.11	39.14
30	2	34.46	0.12	42.30	0.15	29.95	0.11	40.42	0.15	37.74	0.14	35.71
31	2	31.50	0.12	44.83	0.17	26.13	0.10	44.43	0.17	36.57	0.14	44.99
32	2	33.17	0.12	47.56	0.17	31.58	0.11	42.60	0.15	34.26	0.12	42.60
36	2	34.06	0.12	48.02	0.18	33.17	0.12	47.61	0.17	38.50	0.14	41.28
38	2	35.52	0.13	46.38	0.17	32.79	0.12	44.30	0.16	36.42	0.13	40.61
40	2	27.80	0.11	41.28	0.17	31.29	0.13	38.68	0.16	40.31	0.16	37.12
42	2	33.17	0.12	45.81	0.16	29.57	0.10	43.05	0.15	38.97	0.14	37.59
44 y339	2	29.67	0.12	44.17	0.17	30.76	0.12	41.03	0.16	40.14	0.16	41.69
47	2	32.08	0.12	47.83	0.18	35.06	0.13	47.04	0.17	41.75	0.15	43.45
49 y333	2	34.88	0.13	48.75	0.18	31.00	0.11	47.28	0.18	36.85	0.14	43.00
51	2	33.17	0.12	42.86	0.16	36.36	0.13	42.89	0.16	44.34	0.16	39.42
2	2	39.78	0.13	47.17	0.15	38.69	0.12	49.08	0.16	43.56	0.14	44.69

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M11WR/CL	PL	PL/CL	PW	PW/CL	ANTL	ANTL/CL	ANTW	ANTW/CL	POSL	POSL/CL
11	1	0.15	217.20	0.84	139.75	0.54	57.03	0.22	99.06	0.38	74.70	0.29
13	1	0.16	223.00	0.81	155.25	0.56	57.00	0.21	107.59	0.39	75.41	0.27
18	1	0.16	237.31	0.83	55.15	0.19	66.20	0.23	109.25	0.38	86.80	0.30
20	1	0.15	231.80	0.86	151.30	0.56	65.95	0.25	100.90	0.38	75.65	0.28
21 y342	1	0.16	199.50	0.86	131.55	0.57	59.76	0.26	90.97	0.39	66.54	0.29
22 y65	1	0.15	211.35	0.82	145.95	0.57	58.60	0.23	100.30	0.39	72.40	0.28
23	1	0.15	217.20	0.88	140.60	0.57	60.55	0.24	96.53	0.39	75.57	0.30
24	1	0.14	193.25	0.89	121.85	0.56	53.26	0.24	87.55	0.40	66.84	0.31
26	1	0.15	250.70	0.88	152.70	0.53	68.80	0.24	117.30	0.41	89.45	0.31
28	1	0.17	217.45	0.85	139.35	0.55	60.40	0.24	101.65	0.40	72.60	0.28
29	1	0.15	224.65	0.81	143.80	0.52	71.74	0.26	45.23	0.16	15.72	0.06
33 y172	1	0.15	228.20	0.86	136.65	0.52	62.15	0.23	104.40	0.39	84.25	0.32
34	1	0.18	224.50	0.86	148.50	0.57	60.90	0.23	105.10	0.40	82.50	0.32
37	1	0.17	223.90	0.81	156.60	0.57	62.75	0.23	104.35	0.38	73.00	0.27
39	1	0.16	234.65	0.87	153.70	0.57	60.05	0.22	107.80	0.40	77.35	0.29
41	1	0.17	250.60	0.87	157.30	0.55	72.80	0.25	110.20	0.38	86.15	0.30
50	1	0.15	209.15	0.83	143.80	0.57	51.20	0.20	104.25	0.41	69.85	0.28
43	1	0.18	221.10	0.90	155.60	0.64	62.85	0.26	111.90	0.46	74.10	0.30
45	1	0.18	234.60	0.84	158.60	0.57	60.20	0.22	114.70	0.41	80.55	0.29
46	1	0.14	204.80	0.82	140.20	0.56	56.87	0.23	94.48	0.38	70.88	0.28
48	1	0.17	236.25	0.85	151.20	0.55	60.62	0.22	109.15	0.39	76.20	0.28
52	1	0.18	223.00	0.83	166.95	0.62	61.90	0.23	113.60	0.42	81.30	0.30

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M11WR/CL	PL	PL/CL	PW	PW/CL	ANTL	ANTL/CL	ANTW	ANTW/CL	POSL	POSL/CL
3	1	0.14	243.25	0.84	160.00	0.55	74.50	0.26	105.54	0.36	78.93	0.27
5	1	0.16	217.00	0.83	148.00	0.57	54.98	0.21	101.30	0.39	80.36	0.31
7 y66	1	0.17	213.15	0.91	147.55	0.63	58.14	0.25	101.67	0.43	80.52	0.34
8 y 80	1	0.17	260.70	0.84	181.15	0.58	74.80	0.24	125.35	0.40	93.20	0.30
10	1	0.15	228.45	0.82	152.20	0.54	64.90	0.23	110.50	0.39	77.10	0.28
55	1	0.17	241.15	0.89	156.50	0.58	66.40	0.25	117.30	0.43	85.50	0.32
53	1	0.18	218.35	0.87	138.85	0.56	57.45	0.23	100.00	0.40	74.55	0.30
54 y_09	1	0.15	241.80	0.88	154.60	0.56	68.40	0.25	105.90	0.39	80.70	0.29
59	2	0.17	238.00	0.88	161.70	0.60	61.40	0.23	109.05	0.40	76.60	0.28
60	2	0.15	229.30	0.88	150.15	0.58	59.85	0.23	110.00	0.42	72.10	0.28
61	2	0.16	237.10	0.86	157.65	0.57	59.75	0.22	111.70	0.41	81.90	0.30
57	2	0.15	230.85	0.83	159.65	0.58	58.80	0.21	109.20	0.39	75.20	0.27
58	2	0.15	226.75	0.82	167.20	0.60	58.80	0.21	106.70	0.39	73.65	0.27
56	2	0.15	205.60	0.86	135.60	0.57	54.10	0.23	94.10	0.39	66.85	0.28
62	2	0.16	231.30	0.83	157.10	0.56	61.95	0.22	104.00	0.37	75.45	0.27
1	2	0.14	237.20	0.84	166.40	0.59	62.60	0.22	112.40	0.40	69.75	0.25
4 (y44)	2	0.14	282.05	0.87	200.55	0.62	72.98	0.23	133.68	0.41	90.64	0.28
6	2	0.15	222.40	0.84	156.25	0.59	60.30	0.23	104.46	0.40	67.84	0.26
9	2	0.17	218.05	0.84	154.90	0.60	51.18	0.20	102.73	0.40	67.95	0.26
12	2	0.15	257.25	0.88	159.95	0.55	65.73	0.23	109.90	0.38	82.25	0.28
15	2	0.14	258.55	0.83	181.00	0.58	70.48	0.23	124.24	0.40	85.73	0.28
16	2	0.15	219.40	0.84	143.25	0.55	57.39	0.22	99.90	0.38	66.60	0.26

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	M11WR/CL	PL	PL/CL	PW	PW/CL	ANTL	ANTL/CL	ANTW	ANTW/CL	POSL	POSL/CL
17(y103)	2	0.16	290.00	0.91	187.30	0.59	80.85	0.25	128.85	0.40	99.60	0.31
19(y162)	2	0.16	195.35	0.82	36.00	0.15	24.82	0.10	26.30	0.11	21.47	0.09
25 (y336)	2	0.16	222.25	0.86	144.00	0.56	58.30	0.23	111.40	0.43	68.90	0.27
27	2	0.15	221.90	0.84	139.55	0.53	57.35	0.22	100.35	0.38	70.60	0.27
30	2	0.13	242.85	0.88	162.85	0.59	64.90	0.24	114.35	0.41	80.65	0.29
31	2	0.17	231.80	0.87	142.25	0.54	55.30	0.21	98.50	0.37	77.50	0.29
32	2	0.15	247.60	0.87	165.50	0.58	62.70	0.22	118.90	0.42	83.50	0.30
36	2	0.15	247.45	0.90	152.25	0.56	68.50	0.25	104.90	0.38	79.40	0.29
38	2	0.15	226.85	0.84	147.25	0.55	56.00	0.21	102.55	0.38	71.90	0.27
40	2	0.15	195.20	0.80	139.70	0.57	51.10	0.21	94.50	0.39	61.25	0.25
42	2	0.13	247.65	0.87	160.65	0.56	59.25	0.21	116.95	0.41	83.00	0.29
44 y339	2	0.16	207.85	0.82	143.25	0.57	56.30	0.22	97.62	0.39	65.73	0.26
47	2	0.16	217.45	0.80	147.90	0.55	58.00	0.21	100.85	0.37	63.25	0.23
49 y333	2	0.16	228.45	0.85	167.10	0.62	61.80	0.23	115.65	0.43	73.75	0.27
51	2	0.15	232.05	0.86	153.35	0.57	61.15	0.23	108.00	0.40	78.25	0.29
2	2	0.14	250.80	0.80	166.35	0.53	67.25	0.22	110.40	0.35	81.60	0.26

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	POSW	POSW/CL	MPL	MPL/CL	ANW	ANW/CL	MA	MA/CL	MAL	MAL/CL	MAR
11	1	119.06	0.46	188.75	0.73	59.53	0.23	39.61	0.15	18.20	0.07	19.25
13	1	128.51	0.47	196.50	0.71	62.41	0.23	52.27	0.19	22.30	0.08	26.41
18	1	132.70	0.47	210.60	0.74	81.00	0.28	42.22	0.15	20.56	0.07	18.71
20	1	128.00	0.48	204.25	0.76	64.92	0.24	45.28	0.17	20.24	0.08	20.55
21 y342	1	109.65	0.47	176.20	0.76	57.84	0.25	33.61	0.15	13.83	0.06	15.47
22 y65	1	122.35	0.48	194.25	0.76	60.40	0.24	48.54	0.19	24.49	0.10	25.80
23	1	117.10	0.47	188.05	0.76	62.73	0.25	39.21	0.16	12.32	0.05	15.12
24	1	102.25	0.47	172.75	0.79	61.90	0.28	30.76	0.14	11.73	0.05	13.29
26	1	129.40	0.45	221.60	0.77	75.20	0.26	41.10	0.14	14.29	0.05	19.50
28	1	122.10	0.48	183.40	0.72	73.78	0.29	39.11	0.15	19.19	0.08	19.35
29	1	13.87	0.05	200.50	0.72	13.10	0.05	19.21	0.07	18.20	0.07	15.20
33 y172	1	119.55	0.45	196.70	0.74	75.41	0.28	47.94	0.18	18.28	0.07	18.65
34	1	119.25	0.46	195.85	0.75	64.07	0.25	42.87	0.16	13.25	0.05	16.02
37	1	130.60	0.47	198.85	0.72	64.81	0.24	50.63	0.18	22.59	0.08	24.18
39	1	133.65	0.50	210.60	0.78	63.94	0.24	52.55	0.19	17.69	0.07	17.33
41	1	136.30	0.47	222.60	0.78	76.10	0.27	39.90	0.14	17.25	0.06	20.10
50	1	124.15	0.49	188.50	0.75	55.20	0.22	56.05	0.22	21.00	0.08	23.60
43	1	129.30	0.53	193.20	0.79	68.24	0.28	44.36	0.18	21.46	0.09	27.37
45	1	132.20	0.47	203.77	0.73	72.95	0.26	51.05	0.18	19.62	0.07	13.94
46	1	111.65	0.45	176.70	0.71	63.03	0.25	45.71	0.18	15.87	0.06	17.17
48	1	127.10	0.46	209.60	0.76	49.20	0.18	49.20	0.18	23.32	0.08	23.46
52	1	132.10	0.49	198.55	0.74	66.85	0.25	42.87	0.16	19.24	0.07	17.68

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	POSW	POSW/CL	MPL	MPL/CL	ANW	ANW/CL	MA	MA/CL	MAL	MAL/CL	MAR
3	1	136.16	0.47	214.40	0.74	71.79	0.25	46.08	0.16	19.53	0.07	20.09
5	1	121.96	0.47	194.80	0.75	74.39	0.29	44.96	0.17	15.07	0.06	16.82
7 y66	1	133.75	0.57	181.15	0.77	76.83	0.33	55.24	0.24	18.40	0.08	18.40
8 y 80	1	154.55	0.50	207.65	0.67	78.49	0.25	53.86	0.17	19.00	0.06	19.00
10	1	135.15	0.48	205.60	0.73	73.40	0.26	37.91	0.14	23.54	0.08	24.14
55	1	135.40	0.50	205.50	0.76	73.96	0.27	49.82	0.18	16.47	0.06	17.44
53	1	120.65	0.48	189.75	0.76	64.89	0.26	43.79	0.18	18.00	0.07	18.43
54 y_09	1	128.15	0.47	213.15	0.78	70.35	0.26	41.45	0.15	16.00	0.06	17.25
59	2	133.29	0.49	212.65	0.79	59.60	0.22	47.80	0.18	15.75	0.06	15.20
60	2	127.80	0.49	206.70	0.80	67.05	0.26	42.70	0.16	16.40	0.06	16.40
61	2	134.95	0.49	209.40	0.76	63.15	0.23	50.10	0.18	15.35	0.06	15.35
57	2	130.40	0.47	27.85	0.10	71.13	0.26	56.35	0.20	18.65	0.07	18.65
58	2	128.00	0.46	206.40	0.75	55.03	0.20	52.41	0.19	13.32	0.05	13.51
56	2	113.10	0.47	185.40	0.77	55.10	0.23	49.05	0.20	19.65	0.08	19.65
62	2	131.20	0.47	208.60	0.75	52.86	0.19	50.78	0.18	18.54	0.07	18.54
1	2	143.90	0.51	213.80	0.76	60.97	0.22	58.43	0.21	17.85	0.06	18.48
4 (y44)	2	154.64	0.48	256.20	0.79	82.22	0.25	62.16	0.19	29.65	0.09	30.49
6	2	103.38	0.39	202.25	0.77	58.16	0.22	48.43	0.18	14.77	0.06	16.09
9	2	122.90	0.47	196.95	0.76	66.31	0.26	51.00	0.20	19.80	0.08	26.62
12	2	129.30	0.44	229.70	0.79	62.15	0.21	53.52	0.18	16.22	0.06	17.28
15	2	156.25	0.50	230.15	0.74	73.57	0.24	62.67	0.20	28.17	0.09	33.13
16	2	118.30	0.46	157.70	0.61	59.49	0.23	51.17	0.20	11.82	0.05	13.90

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	POSW	POSW/CL	MPL	MPL/CL	ANW	ANW/CL	MA	MA/CL	MAL	MAL/CL	MAR
17(y103)	2	160.30	0.50	245.20	0.77	72.06	0.23	55.05	0.17	21.74	0.07	7.47
19(y162)	2	21.47	0.09	179.70	0.76	41.30	0.17	41.30	0.17	41.54	0.18	41.64
25 (y336)	2	121.70	0.47	202.10	0.78	63.60	0.25	43.49	0.17	15.75	0.06	15.47
27	2	113.20	0.43	195.40	0.74	54.34	0.21	57.33	0.22	18.79	0.07	16.93
30	2	130.98	0.47	216.55	0.78	63.37	0.23	53.16	0.19	17.43	0.06	16.18
31	2	122.85	0.46	112.65	0.43	59.70	0.23	54.47	0.21	14.39	0.05	13.91
32	2	143.00	0.51	226.00	0.80	68.39	0.24	49.04	0.17	12.77	0.05	14.47
36	2	128.15	0.47	215.60	0.79	66.81	0.24	48.63	0.18	7.60	0.03	8.75
38	2	123.05	0.46	203.30	0.75	53.47	0.20	52.87	0.20	21.10	0.08	21.64
40	2	117.10	0.48	173.34	0.71	65.55	0.27	50.24	0.21	12.47	0.05	11.13
42	2	136.80	0.48	221.75	0.78	64.33	0.23	52.33	0.18	19.35	0.07	18.88
44 y339	2	118.11	0.47	187.05	0.74	60.50	0.24	51.89	0.21	18.67	0.07	19.95
47	2	123.45	0.46	196.40	0.72	58.30	0.22	57.60	0.21	19.69	0.07	19.69
49 y333	2	137.80	0.51	205.60	0.76	64.74	0.24	56.25	0.21	19.74	0.07	19.74
51	2	126.05	0.47	205.30	0.76	58.65	0.22	47.60	0.18	12.40	0.05	13.30
2	2	135.60	0.43	219.40	0.70	69.59	0.22	69.57	0.22	21.86	0.07	21.86

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	MAR/CL	BLL	BLL/CL	BLR	BLR/CL	GLL	GLL/CL	GWL	GWL/CL	HLL	HLL/CL
11	1	0.07	96.30	0.37	87.65	0.34	28.99	0.11	23.97	0.09	51.04	0.20
13	1	0.10	101.15	0.37	101.15	0.37	20.02	0.07	18.84	0.07	51.15	0.19
18	1	0.07	105.00	0.37	105.00	0.37	38.15	0.13	21.64	0.08	55.70	0.20
20	1	0.08	101.55	0.38	101.55	0.38	24.98	0.09	22.07	0.08	52.34	0.20
21 y342	1	0.07	91.00	0.39	91.00	0.39	26.60	0.12	20.85	0.09	52.33	0.23
22 y65	1	0.10	97.35	0.38	97.35	0.38	25.16	0.10	18.84	0.07	51.75	0.20
23	1	0.06	89.90	0.36	91.90	0.37	32.59	0.13	20.95	0.08	55.09	0.22
24	1	0.06	86.70	0.40	86.70	0.40	26.00	0.12	19.14	0.09	43.85	0.20
26	1	0.07	111.90	0.39	111.90	0.39	32.60	0.11	24.33	0.09	56.20	0.20
28	1	0.08	189.00	0.74	189.00	0.74	37.00	0.15	22.01	0.09	53.00	0.21
29	1	0.05	96.65	0.35	96.65	0.35	30.97	0.11	21.28	0.08	54.72	0.20
33 y172	1	0.07	96.65	0.36	96.65	0.36	35.84	0.14	24.46	0.09	50.02	0.19
34	1	0.06	101.60	0.39	101.60	0.39	36.55	0.14	25.61	0.10	53.51	0.21
37	1	0.09	105.80	0.38	105.80	0.38	30.84	0.11	21.41	0.08	55.45	0.20
39	1	0.06	115.70	0.43	115.70	0.43	29.72	0.11	22.91	0.08	51.49	0.19
41	1	0.07	113.05	0.39	108.70	0.38	34.25	0.12	22.20	0.08	58.10	0.20
50	1	0.09	107.25	0.43	107.25	0.43	25.48	0.10	19.29	0.08	47.14	0.19
43	1	0.11	98.65	0.40	96.90	0.40	26.60	0.11	18.82	0.08	54.02	0.22
45	1	0.05	106.75	0.38	106.75	0.38	42.80	0.15	27.50	0.10	51.94	0.19
46	1	0.07	88.85	0.36	88.85	0.36	30.54	0.12	20.70	0.08	46.81	0.19
48	1	0.08	101.65	0.37	101.65	0.37	38.87	0.14	27.54	0.10	55.90	0.20
52	1	0.07	103.15	0.38	98.50	0.36	38.09	0.14	23.36	0.09	50.06	0.19

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	MAR/CL	BLL	BLL/CL	BLR	BLR/CL	GLL	GLL/CL	GWL	GWL/CL	HLL	HLL/CL
3	1	0.07	107.50	0.37	107.50	0.37	37.63	0.13	25.25	0.09	59.31	0.20
5	1	0.06	98.16	0.38	98.16	0.38	30.94	0.12	19.59	0.08	47.25	0.18
7 y66	1	0.08	87.75	0.37	87.75	0.37	33.18	0.14	18.96	0.08	50.67	0.22
8 y 80	1	0.06	121.45	0.39	119.20	0.38	39.72	0.13	22.45	0.07	64.03	0.21
10	1	0.09	105.35	0.38	105.35	0.38	31.97	0.11	23.38	0.08	56.22	0.20
55	1	0.06	101.50	0.38	101.50	0.38	30.85	0.11	23.80	0.09	57.65	0.21
53	1	0.07	95.75	0.38	95.75	0.38	34.45	0.14	18.82	0.08	48.96	0.20
54 y_09	1	0.06	108.95	0.40	107.00	0.39	30.45	0.11	24.20	0.09	55.85	0.20
59	2	0.06	119.25	0.44	119.25	0.44	35.50	0.13	25.35	0.09	51.45	0.19
60	2	0.06	113.95	0.44	112.55	0.43	26.51	0.10	17.93	0.07	51.67	0.20
61	2	0.06	118.70	0.43	118.70	0.43	23.65	0.09	22.17	0.08	51.34	0.19
57	2	0.07	114.15	0.41	115.45	0.42	33.17	0.12	21.09	0.08	50.07	0.18
58	2	0.05	117.00	0.42	117.00	0.42	32.00	0.12	21.20	0.08	51.90	0.19
56	2	0.08	104.25	0.43	104.25	0.43	27.72	0.12	20.65	0.09	48.05	0.20
62	2	0.07	115.62	0.41	113.30	0.40	28.68	0.10	21.18	0.08	51.44	0.18
1	2	0.07	120.45	0.43	118.50	0.42	37.17	0.13	22.83	0.08	51.23	0.18
4 (y44)	2	0.09	143.40	0.44	143.40	0.44	42.50	0.13	27.82	0.09	61.88	0.19
6	2	0.06	113.80	0.43	113.80	0.43	33.62	0.13	20.01	0.08	48.11	0.18
9	2	0.10	109.00	0.42	104.60	0.40	35.88	0.14	21.62	0.08	53.38	0.21
12	2	0.06	126.30	0.43	126.30	0.43	33.15	0.11	24.22	0.08	53.26	0.18
15	2	0.11	121.80	0.39	121.80	0.39	32.04	0.10	23.97	0.08	63.93	0.21
16	2	0.05	110.00	0.42	110.00	0.42	27.74	0.11	19.26	0.07	49.91	0.19

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	MAR/CL	BLL	BLL/CL	BLR	BLR/CL	GLL	GLL/CL	GWL	GWL/CL	HLL	HLL/CL
17(y103)	2	0.02	137.75	0.43	137.75	0.43	46.18	0.14	31.98	0.10	59.21	0.19
19(y162)	2	0.18	100.30	0.42	100.30	0.42	45.71	0.19	66.86	0.28	76.75	0.32
25 (y336)	2	0.06	110.55	0.43	110.55	0.43	23.27	0.09	22.17	0.09	51.04	0.20
27	2	0.06	105.55	0.40	105.55	0.40	34.26	0.13	24.01	0.09	48.32	0.18
30	2	0.06	123.35	0.45	123.35	0.45	31.77	0.12	20.81	0.08	57.41	0.21
31	2	0.05	112.65	0.43	112.65	0.43	34.10	0.13	21.60	0.08	47.87	0.18
32	2	0.05	122.80	0.43	119.65	0.42	26.00	0.09	22.13	0.08	55.72	0.20
36	2	0.03	116.30	0.42	116.30	0.42	29.88	0.11	24.85	0.09	57.35	0.21
38	2	0.08	114.00	0.42	112.60	0.42	22.95	0.09	19.01	0.07	51.68	0.19
40	2	0.05	98.15	0.40	94.30	0.38	24.02	0.10	20.08	0.08	45.49	0.19
42	2	0.07	118.95	0.42	120.75	0.42	26.92	0.09	20.82	0.07	52.96	0.19
44 y339	2	0.08	108.45	0.43	102.70	0.41	32.26	0.13	21.70	0.09	47.70	0.19
47	2	0.07	121.40	0.45	119.85	0.44	31.45	0.12	21.65	0.08	49.52	0.18
49 y333	2	0.07	112.50	0.42	100.00	0.37	27.63	0.10	23.30	0.09	53.04	0.20
51	2	0.05	110.60	0.41	110.60	0.41	28.85	0.11	28.40	0.11	50.70	0.19
2	2	0.07	126.35	0.40	126.35	0.40	35.62	0.11	23.16	0.07	57.62	0.18

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	HWL	HWL/CL	PELL	PELL/CL	PEWL	PEWL/CL	ABLL	ABLL/CL	ABWL	ABWL/CL	FELL
11	1	43.35	0.17	43.15	0.17	68.08	0.26	69.50	0.27	70.45	0.27	50.91
13	1	45.47	0.17	44.13	0.16	73.75	0.27	76.43	0.28	82.15	0.30	56.51
18	1	47.79	0.17	43.50	0.15	76.20	0.27	73.30	0.26	81.89	0.29	61.39
20	1	44.73	0.17	47.60	0.18	74.03	0.28	41.77	0.16	75.50	0.28	55.84
21 y342	1	40.56	0.18	41.41	0.18	66.41	0.29	64.10	0.28	68.82	0.30	46.74
22 y65	1	44.12	0.17	35.28	0.14	75.45	0.29	73.85	0.29	73.68	0.29	54.50
23	1	43.91	0.18	38.59	0.16	70.25	0.28	68.23	0.28	72.79	0.29	49.47
24	1	37.89	0.17	36.51	0.17	61.60	0.28	65.70	0.30	61.69	0.28	45.02
26	1	51.45	0.18	45.63	0.16	76.08	0.27	78.62	0.27	78.24	0.27	58.99
28	1	45.02	0.18	43.09	0.17	67.22	0.26	63.69	0.25	72.12	0.28	52.20
29	1	43.85	0.16	45.98	0.17	73.16	0.26	65.06	0.23	71.67	0.26	55.36
33 y172	1	44.72	0.17	39.34	0.15	68.84	0.26	71.71	0.27	70.16	0.26	56.51
34	1	46.47	0.18	43.10	0.17	72.83	0.28	76.49	0.29	73.88	0.28	61.84
37	1	46.65	0.17	42.58	0.15	73.57	0.27	74.17	0.27	84.18	0.31	51.39
39	1	47.12	0.17	45.86	0.17	74.02	0.27	86.83	0.32	78.54	0.29	57.94
41	1	46.60	0.16	49.60	0.17	80.35	0.28	78.65	0.27	85.45	0.30	59.80
50	1	44.33	0.18	41.99	0.17	73.32	0.29	76.44	0.30	75.80	0.30	51.17
43	1	46.06	0.19	42.22	0.17	74.27	0.30	75.60	0.31	57.54	0.23	55.16
45	1	52.91	0.19	46.05	0.16	78.49	0.28	77.59	0.28	82.00	0.29	57.47
46	1	40.87	0.16	36.53	0.15	65.92	0.26	63.25	0.25	68.11	0.27	48.47
48	1	45.47	0.16	49.88	0.18	70.95	0.26	72.62	0.26	76.66	0.28	52.51
52	1	45.98	0.17	55.82	0.21	82.10	0.30	74.25	0.28	76.74	0.28	56.31

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	HWL	HWL/CL	PELL	PELL/CL	PEWL	PEWL/CL	ABLL	ABLL/CL	ABWL	ABWL/CL	FELL
3	1	48.16	0.17	44.96	0.16	78.32	0.27	78.72	0.27	83.21	0.29	55.13
5	1	42.73	0.16	45.51	0.18	71.97	0.28	74.65	0.29	76.27	0.29	58.01
7 y66	1	42.91	0.18	34.88	0.15	72.28	0.31	65.21	0.28	76.03	0.32	55.82
8 y 80	1	51.81	0.17	53.57	0.17	84.16	0.27	85.16	0.27	94.43	0.30	63.53
10	1	46.73	0.17	49.23	0.18	78.03	0.28	78.51	0.28	78.46	0.28	57.53
55	1	48.55	0.18	44.23	0.16	78.70	0.29	83.23	0.31	79.80	0.30	57.99
53	1	42.53	0.17	42.60	0.17	66.59	0.27	70.39	0.28	71.14	0.28	51.41
54 y_09	1	45.95	0.17	48.40	0.18	71.85	0.26	83.60	0.31	78.60	0.29	54.00
59	2	47.80	0.18	46.90	0.17	76.50	0.28	89.75	0.33	81.00	0.30	57.90
60	2	48.33	0.19	46.87	0.18	76.81	0.30	88.42	0.34	78.18	0.30	51.68
61	2	48.12	0.17	46.82	0.17	78.22	0.28	87.77	0.32	79.95	0.29	60.77
57	2	48.94	0.18	46.05	0.17	78.77	0.28	88.51	0.32	81.94	0.30	56.26
58	2	46.20	0.17	43.00	0.16	78.55	0.28	84.23	0.30	84.29	0.30	58.32
56	2	42.01	0.18	39.98	0.17	68.83	0.29	73.72	0.31	71.14	0.30	48.72
62	2	47.80	0.17	46.35	0.17	74.61	0.27	82.09	0.29	80.28	0.29	57.40
1	2	50.16	0.18	50.78	0.18	82.12	0.29	84.30	0.30	86.31	0.30	59.59
4 (y44)	2	60.39	0.19	63.25	0.20	90.08	0.28	109.05	0.34	100.72	0.31	70.29
6	2	45.73	0.17	46.05	0.17	75.92	0.29	81.68	0.31	78.65	0.30	51.34
9	2	46.56	0.18	45.17	0.17	75.25	0.29	85.09	0.33	77.76	0.30	52.29
12	2	49.02	0.17	53.47	0.18	79.84	0.27	98.38	0.34	92.23	0.32	61.84
15	2	57.27	0.18	54.16	0.17	91.39	0.29	92.00	0.30	90.71	0.29	67.42
16	2	45.19	0.17	45.87	0.18	71.02	0.27	83.33	0.32	72.74	0.28	52.24

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	HWL	HWL/CL	PELL	PELL/CL	PEWL	PEWL/CL	ABLL	ABLL/CL	ABWL	ABWL/CL	FELL
17(y103)	2	55.28	0.17	57.42	0.18	92.33	0.29	94.66	0.30	94.48	0.30	55.41
19(y162)	2	70.18	0.30	44.24	0.19	48.30	0.20	18.08	0.08	34.13	0.14	33.21
25 (y336)	2	45.36	0.18	48.60	0.19	72.12	0.28	79.08	0.31	74.00	0.29	50.37
27	2	44.29	0.17	46.41	0.18	68.64	0.26	77.69	0.29	70.26	0.27	51.14
30	2	50.19	0.18	41.43	0.15	79.79	0.29	91.79	0.33	84.78	0.31	60.20
31	2	42.98	0.16	47.30	0.18	70.85	0.27	81.54	0.31	73.55	0.28	55.66
32	2	54.48	0.19	43.94	0.16	80.05	0.28	98.90	0.35	84.60	0.30	66.30
36	2	56.77	0.21	48.00	0.18	75.02	0.27	83.42	0.30	77.82	0.28	59.27
38	2	44.93	0.17	41.70	0.15	71.92	0.27	80.13	0.30	77.19	0.29	53.45
40	2	41.50	0.17	45.45	0.19	68.22	0.28	72.54	0.30	69.09	0.28	48.26
42	2	49.51	0.17	51.90	0.18	79.86	0.28	94.12	0.33	81.98	0.29	59.91
44 y339	2	42.88	0.17	56.11	0.22	70.65	0.28	73.72	0.29	74.29	0.29	50.36
47	2	46.34	0.17	45.35	0.17	76.47	0.28	78.46	0.29	75.24	0.28	51.47
49 y333	2	48.04	0.18	49.95	0.19	81.03	0.30	83.50	0.31	85.39	0.32	58.54
51	2	47.35	0.18	40.65	0.15	77.45	0.29	85.45	0.32	78.65	0.29	66.30
2	2	52.74	0.17	45.51	0.15	81.36	0.26	89.92	0.29	83.73	0.27	60.71

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	FELL/CL	FEWL	FEWL/CL	ANLL	ANLL/CL	ANWL	ANWL/CL	GLR	GLR/CL	GWR	GWR/CL
11	1	0.20	51.73	0.20	28.78	0.11	35.49	0.14	30.31	0.12	25.00	0.10
13	1	0.21	57.09	0.21	29.43	0.11	37.84	0.14	24.95	0.09	20.38	0.07
18	1	0.22	55.13	0.19	36.96	0.13	44.35	0.16	36.17	0.13	21.79	0.08
20	1	0.21	55.03	0.21	3.66	0.01	36.19	0.14	31.06	0.12	22.26	0.08
21 y342	1	0.20	98.22	0.43	27.92	0.12	32.68	0.14	27.10	0.12	22.74	0.10
22 y65	1	0.21	56.61	0.22	21.71	0.08	37.05	0.14	30.39	0.12	23.00	0.09
23	1	0.20	49.67	0.20	37.68	0.15	37.12	0.15	32.01	0.13	20.95	0.08
24	1	0.21	45.42	0.21	25.03	0.11	34.20	0.16	30.69	0.14	22.66	0.10
26	1	0.21	57.13	0.20	40.42	0.14	43.47	0.15	35.20	0.12	24.33	0.09
28	1	0.20	54.64	0.21	31.29	0.12	41.43	0.16	38.15	0.15	22.01	0.09
29	1	0.20	51.26	0.19	26.56	0.10	39.44	0.14	39.38	0.14	24.79	0.09
33 y172	1	0.21	54.98	0.21	38.19	0.14	39.48	0.15	37.68	0.14	24.07	0.09
34	1	0.24	55.84	0.21	34.83	0.13	36.57	0.14	33.21	0.13	22.79	0.09
37	1	0.19	58.76	0.21	32.93	0.12	42.57	0.15	31.25	0.11	25.31	0.09
39	1	0.21	58.25	0.22	23.25	0.09	38.68	0.14	32.06	0.12	24.24	0.09
41	1	0.21	61.60	0.21	31.20	0.11	42.90	0.15	42.55	0.15	25.00	0.09
50	1	0.20	57.24	0.23	28.00	0.11	39.63	0.16	29.09	0.12	19.29	0.08
43	1	0.23	59.14	0.24	37.76	0.15	40.37	0.16	29.96	0.12	18.82	0.08
45	1	0.21	56.98	0.20	35.11	0.13	39.24	0.14	42.80	0.15	27.50	0.10
46	1	0.19	48.10	0.19	33.10	0.13	33.26	0.13	33.15	0.13	21.15	0.08
48	1	0.19	57.89	0.21	34.84	0.13	38.49	0.14	39.03	0.14	27.54	0.10
52	1	0.21	62.43	0.23	33.21	0.12	44.32	0.16	34.97	0.13	27.58	0.10

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	FELL/CL	FEWL	FEWL/CL	ANLL	ANLL/CL	ANWL	ANWL/CL	GLR	GLR/CL	GWR	GWR/CL
3	1	0.19	60.00	0.21	33.09	0.11	38.54	0.13	42.15	0.15	24.71	0.09
5	1	0.22	53.96	0.21	29.80	0.11	40.79	0.16	32.08	0.12	20.58	0.08
7 y66	1	0.24	62.08	0.26	41.82	0.18	35.68	0.15	34.28	0.15	17.82	0.08
8 y 80	1	0.20	33.14	0.11	45.31	0.15	45.58	0.15	45.72	0.15	26.64	0.09
10	1	0.21	54.88	0.20	33.26	0.12	42.41	0.15	30.77	0.11	23.33	0.08
55	1	0.21	60.17	0.22	36.76	0.14	40.00	0.15	31.61	0.12	23.80	0.09
53	1	0.21	53.38	0.21	32.12	0.13	39.06	0.16	36.44	0.15	18.83	0.08
54 y_09	1	0.20	57.00	0.21	28.75	0.10	39.60	0.14	31.50	0.11	22.85	0.08
59	2	0.21	61.50	0.23	25.90	0.10	40.45	0.15	36.95	0.14	25.35	0.09
60	2	0.20	60.21	0.23	29.15	0.11	40.16	0.15	31.15	0.12	20.47	0.08
61	2	0.22	61.46	0.22	34.67	0.13	41.36	0.15	24.55	0.09	25.15	0.09
57	2	0.20	59.55	0.21	28.17	0.10	39.95	0.14	36.56	0.13	22.73	0.08
58	2	0.21	59.01	0.21	26.02	0.09	36.62	0.13	33.70	0.12	21.20	0.08
56	2	0.20	52.77	0.22	26.59	0.11	36.82	0.15	27.72	0.12	20.65	0.09
62	2	0.21	61.61	0.22	29.65	0.11	34.51	0.12	31.75	0.11	23.69	0.08
1	2	0.21	60.99	0.22	23.92	0.08	34.37	0.12	39.46	0.14	22.52	0.08
4 (y44)	2	0.22	68.58	0.21	33.03	0.10	50.74	0.16	44.90	0.14	26.45	0.08
6	2	0.19	57.58	0.22	23.19	0.09	37.69	0.14	36.11	0.14	23.09	0.09
9	2	0.20	53.25	0.21	21.53	0.08	38.27	0.15	36.45	0.14	19.79	0.08
12	2	0.21	56.69	0.19	30.16	0.10	37.98	0.13	31.85	0.11	24.22	0.08
15	2	0.22	64.76	0.21	27.36	0.09	46.38	0.15	35.32	0.11	27.75	0.09
16	2	0.20	51.55	0.20	18.98	0.07	34.25	0.13	32.42	0.12	22.93	0.09

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	FELL/CL	FEWL	FEWL/CL	ANLL	ANLL/CL	ANWL	ANWL/CL	GLR	GLR/CL	GWR	GWR/CL
17(y103)	2	0.17	67.51	0.21	40.87	0.13	47.69	0.15	40.15	0.13	26.40	0.08
19(y162)	2	0.14	23.32	0.10	41.14	0.17	35.21	0.15	43.31	0.18	67.38	0.28
25 (y336)	2	0.20	53.65	0.21	22.54	0.09	39.19	0.15	30.68	0.12	23.89	0.09
27	2	0.19	50.53	0.19	26.29	0.10	35.80	0.14	37.58	0.14	26.49	0.10
30	2	0.22	64.63	0.23	27.94	0.10	42.32	0.15	32.79	0.12	20.57	0.07
31	2	0.21	51.17	0.19	29.59	0.11	40.63	0.15	29.66	0.11	21.60	0.08
32	2	0.23	64.77	0.23	27.19	0.10	43.44	0.15	23.97	0.08	22.13	0.08
36	2	0.22	57.20	0.21	29.12	0.11	40.84	0.15	32.29	0.12	26.25	0.10
38	2	0.20	54.12	0.20	27.14	0.10	36.28	0.13	24.46	0.09	19.01	0.07
40	2	0.20	51.97	0.21	20.16	0.08	38.94	0.16	26.18	0.11	22.14	0.09
42	2	0.21	63.05	0.22	32.81	0.12	41.54	0.15	27.59	0.10	20.82	0.07
44 y339	2	0.20	51.92	0.21	23.96	0.09	38.26	0.15	32.26	0.13	21.70	0.09
47	2	0.19	55.27	0.20	20.75	0.08	37.29	0.14	32.42	0.12	21.65	0.08
49 y333	2	0.22	60.62	0.22	23.73	0.09	40.72	0.15	29.00	0.11	25.24	0.09
51	2	0.25	56.75	0.21	31.59	0.12	39.16	0.15	28.85	0.11	28.40	0.11
2	2	0.19	61.87	0.20	26.44	0.08	42.20	0.14	38.66	0.12	23.16	0.07

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	HLR	HLR/CL	HWR	HWR/CL	PELR	PELR/CL	PEWR	PEWR/CL	ABLR	ABLR/CL	ABWR
11	1	50.72	0.20	43.35	0.17	45.68	0.18	68.08	0.26	70.88	0.27	70.45
13	1	51.11	0.19	44.48	0.16	45.06	0.16	73.75	0.27	76.43	0.28	79.20
18	1	55.70	0.20	47.79	0.17	43.50	0.15	76.20	0.27	75.35	0.26	77.16
20	1	52.34	0.20	44.73	0.17	48.41	0.18	74.03	0.28	41.77	0.16	75.50
21 y342	1	50.89	0.22	41.97	0.18	41.41	0.18	46.47	0.20	64.29	0.28	65.70
22 y65	1	47.11	0.18	44.12	0.17	36.22	0.14	72.66	0.28	73.85	0.29	78.33
23	1	52.31	0.21	43.91	0.18	34.23	0.14	73.34	0.30	68.23	0.28	72.79
24	1	43.85	0.20	37.89	0.17	37.74	0.17	61.60	0.28	65.70	0.30	62.07
26	1	56.20	0.20	51.49	0.18	48.25	0.17	75.60	0.26	78.62	0.27	58.99
28	1	53.00	0.21	45.02	0.18	43.63	0.17	67.22	0.26	63.69	0.25	72.12
29	1	43.85	0.16	54.72	0.20	45.98	0.17	73.16	0.26	65.06	0.23	71.67
33 y172	1	50.02	0.19	44.72	0.17	47.52	0.18	68.84	0.26	71.71	0.27	70.16
34	1	52.70	0.20	46.47	0.18	43.10	0.17	72.83	0.28	76.49	0.29	73.88
37	1	53.07	0.19	45.69	0.17	45.10	0.16	73.57	0.27	74.17	0.27	84.18
39	1	51.49	0.19	47.23	0.17	45.86	0.17	76.12	0.28	86.83	0.32	78.54
41	1	58.15	0.20	45.00	0.16	49.60	0.17	78.40	0.27	81.35	0.28	80.20
50	1	47.14	0.19	45.36	0.18	41.99	0.17	75.29	0.30	76.44	0.30	75.80
43	1	54.02	0.22	47.30	0.19	42.22	0.17	74.27	0.30	75.60	0.31	57.54
45	1	51.94	0.19	52.91	0.19	46.05	0.16	78.49	0.28	77.59	0.28	82.00
46	1	46.81	0.19	40.87	0.16	36.93	0.15	62.48	0.25	64.41	0.26	72.86
48	1	55.90	0.20	45.47	0.16	49.88	0.18	70.95	0.26	75.39	0.27	76.66
52	1	43.29	0.16	53.04	0.20	41.32	0.15	81.46	0.30	74.25	0.28	82.55

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	HLR	HLR/CL	HWR	HWR/CL	PELR	PELR/CL	PEWR	PEWR/CL	ABLR	ABLR/CL	ABWR
3	1	59.01	0.20	47.18	0.16	47.71	0.16	80.43	0.28	77.85	0.27	83.21
5	1	47.18	0.18	42.41	0.16	43.54	0.17	71.97	0.28	74.65	0.29	75.20
7 y66	1	50.67	0.22	42.91	0.18	39.40	0.17	75.46	0.32	67.06	0.29	76.14
8 y 80	1	61.43	0.20	53.41	0.17	51.73	0.17	85.63	0.28	84.19	0.27	91.10
10	1	56.24	0.20	46.73	0.17	49.23	0.18	78.03	0.28	78.51	0.28	78.46
55	1	57.65	0.21	48.55	0.18	44.23	0.16	78.70	0.29	83.23	0.31	79.80
53	1	48.96	0.20	42.53	0.17	46.04	0.18	68.80	0.28	70.39	0.28	71.14
54 y_09	1	55.85	0.20	45.95	0.17	48.40	0.18	71.85	0.26	83.60	0.31	78.60
59	2	52.45	0.19	49.00	0.18	46.90	0.17	76.50	0.28	89.75	0.33	81.00
60	2	51.61	0.20	48.33	0.19	46.87	0.18	78.43	0.30	88.42	0.34	78.18
61	2	49.98	0.18	49.57	0.18	46.82	0.17	79.60	0.29	93.08	0.34	59.00
57	2	50.07	0.18	48.94	0.18	46.05	0.17	78.77	0.28	88.51	0.32	81.94
58	2	51.90	0.19	46.20	0.17	43.00	0.16	78.55	0.28	84.23	0.30	86.91
56	2	48.05	0.20	42.01	0.18	42.68	0.18	68.83	0.29	73.72	0.31	71.14
62	2	51.44	0.18	47.80	0.17	46.35	0.17	76.49	0.27	82.09	0.29	80.28
1	2	50.48	0.18	51.01	0.18	50.74	0.18	83.94	0.30	84.72	0.30	85.73
4 (y44)	2	59.59	0.18	57.22	0.18	64.46	0.20	94.30	0.29	112.26	0.35	101.01
6	2	48.11	0.18	45.73	0.17	46.05	0.17	75.92	0.29	81.68	0.31	80.29
9	2	52.28	0.20	46.00	0.18	46.95	0.18	76.50	0.30	85.09	0.33	79.10
12	2	53.26	0.18	48.12	0.16	51.76	0.18	79.15	0.27	98.38	0.34	92.23
15	2	58.17	0.19	56.00	0.18	54.16	0.17	91.39	0.29	92.00	0.30	94.47
16	2	49.91	0.19	45.19	0.17	45.87	0.18	71.89	0.28	85.46	0.33	72.74

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	HLR	HLR/CL	HWR	HWR/CL	PELR	PELR/CL	PEWR	PEWR/CL	ABLR	ABLR/CL	ABWR
17(y103)	2	66.23	0.21	55.28	0.17	57.42	0.18	99.63	0.31	97.90	0.31	97.87
19(y162)	2	76.75	0.32	70.18	0.30	44.24	0.19	48.30	0.20	18.89	0.08	32.33
25 (y336)	2	51.04	0.20	45.36	0.18	48.60	0.19	74.16	0.29	79.08	0.31	74.00
27	2	46.12	0.17	44.62	0.17	46.41	0.18	68.64	0.26	77.69	0.29	71.91
30	2	57.41	0.21	50.19	0.18	41.48	0.15	82.77	0.30	91.79	0.33	84.78
31	2	47.87	0.18	42.98	0.16	47.30	0.18	70.85	0.27	81.54	0.31	73.55
32	2	55.72	0.20	54.43	0.19	50.45	0.18	81.96	0.29	98.90	0.35	84.60
36	2	57.35	0.21	56.77	0.21	49.91	0.18	75.02	0.27	86.72	0.32	77.81
38	2	51.68	0.19	44.93	0.17	41.70	0.15	71.92	0.27	85.16	0.32	75.40
40	2	42.11	0.17	41.50	0.17	39.89	0.16	68.22	0.28	72.54	0.30	69.61
42	2	52.60	0.18	50.43	0.18	51.90	0.18	79.86	0.28	97.68	0.34	81.98
44 y339	2	46.34	0.18	42.88	0.17	46.91	0.19	70.65	0.28	73.72	0.29	74.29
47	2	49.52	0.18	46.34	0.17	45.35	0.17	76.47	0.28	78.46	0.29	75.24
49 y333	2	53.04	0.20	48.04	0.18	49.95	0.19	81.03	0.30	83.50	0.31	84.00
51	2	50.85	0.19	47.35	0.18	45.30	0.17	77.45	0.29	85.45	0.32	78.65
2	2	57.63	0.18	51.19	0.16	45.51	0.15	85.13	0.27	93.15	0.30	87.23

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	ABWR/CL	FELR	FELR/CL	FEWR	FEWR/CL	ANLR	ANLR/CL	ANWR	ANWR/CL	HUW	HUW/CL
11	1	0.27	50.81	0.20	49.85	0.19	21.95	0.09	38.19	0.15	138	0.53
13	1	0.29	55.57	0.20	57.09	0.21	28.89	0.11	37.84	0.14	149	0.54
18	1	0.27	61.32	0.22	60.31	0.21	31.65	0.11	44.35	0.16	160	0.56
20	1	0.28	55.24	0.21	55.03	0.21	31.24	0.12	38.22	0.14	155	0.58
21 y342	1	0.28	46.74	0.20	50.18	0.22	27.92	0.12	32.68	0.14	141	0.61
22 y65	1	0.30	54.50	0.21	56.61	0.22	21.71	0.08	36.18	0.14	152	0.59
23	1	0.29	50.77	0.20	50.36	0.20	37.68	0.15	34.58	0.14	140	0.56
24	1	0.28	45.02	0.21	45.42	0.21	25.03	0.11	34.20	0.16	128	0.59
26	1	0.21	58.99	0.21	57.13	0.20	38.08	0.13	43.47	0.15	158	0.55
28	1	0.28	52.20	0.20	54.64	0.21	31.29	0.12	41.43	0.16	140	0.55
29	1	0.26	55.36	0.20	51.26	0.19	26.56	0.10	39.44	0.14	150	0.54
33 y172	1	0.26	56.51	0.21	52.72	0.20	38.19	0.14	39.48	0.15	142	0.54
34	1	0.28	60.94	0.23	55.84	0.21	33.44	0.13	36.57	0.14	147	0.56
37	1	0.31	51.39	0.19	58.76	0.21	30.27	0.11	40.20	0.15	156	0.57
39	1	0.29	59.84	0.22	59.64	0.22	23.25	0.09	38.68	0.14	170	0.63
41	1	0.28	59.80	0.21	54.40	0.19	31.20	0.11	42.90	0.15	164	0.57
50	1	0.30	51.17	0.20	57.24	0.23	25.85	0.10	38.37	0.15	147	0.58
43	1	0.23	55.16	0.23	56.74	0.23	26.89	0.11	40.37	0.16	158	0.64
45	1	0.29	57.47	0.21	56.98	0.20	31.57	0.11	39.24	0.14	166	0.59
46	1	0.29	48.47	0.19	51.13	0.20	33.10	0.13	33.26	0.13	135	0.54
48	1	0.28	55.89	0.20	57.89	0.21	34.84	0.13	38.49	0.14	155	0.56
52	1	0.31	59.01	0.22	62.43	0.23	36.05	0.13	41.98	0.16	170	0.63

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	ABWR/CL	FELR	FELR/CL	FEWR	FEWR/CL	ANLR	ANLR/CL	ANWR	ANWR/CL	HUW	HUW/CL
3	1	0.29	56.21	0.19	56.54	0.19	31.18	0.11	43.34	0.15	167	0.58
5	1	0.29	57.61	0.22	55.76	0.21	29.80	0.11	40.79	0.16	154	0.59
7 y66	1	0.32	55.82	0.24	62.08	0.26	41.82	0.18	46.18	0.20	155	0.66
8 y 80	1	0.29	63.03	0.20	64.81	0.21	45.97	0.15	43.15	0.14	175	0.56
10	1	0.28	51.68	0.18	54.88	0.20	30.69	0.11	42.41	0.15	160	0.57
55	1	0.30	57.08	0.21	58.11	0.22	36.76	0.14	40.00	0.15	162	0.60
53	1	0.28	51.41	0.21	53.38	0.21	32.12	0.13	39.06	0.16	145	0.58
54 y_09	1	0.29	56.45	0.21	57.00	0.21	28.75	0.10	39.60	0.14	165	0.60
59	2	0.30	57.90	0.21	61.15	0.23	27.20	0.10	40.20	0.15	169	0.63
60	2	0.30	52.71	0.20	60.21	0.23	29.15	0.11	40.16	0.15	163	0.63
61	2	0.21	61.46	0.22	61.46	0.22	32.23	0.12	41.36	0.15	170	0.62
57	2	0.30	52.43	0.19	57.64	0.21	28.17	0.10	39.95	0.14	170	0.61
58	2	0.31	59.44	0.21	59.01	0.21	25.96	0.09	35.46	0.13	155	0.56
56	2	0.30	48.72	0.20	52.77	0.22	22.98	0.10	36.24	0.15	137	0.57
62	2	0.29	57.40	0.21	61.61	0.22	27.76	0.10	36.19	0.13	166	0.59
1	2	0.30	57.27	0.20	64.64	0.23	20.55	0.07	39.14	0.14	182	0.64
4 (y44)	2	0.31	69.92	0.22	68.58	0.21	32.33	0.10	50.74	0.16	210	0.65
6	2	0.30	53.04	0.20	59.35	0.22	21.41	0.08	37.69	0.14	161	0.61
9	2	0.31	52.71	0.20	53.08	0.20	19.78	0.08	40.42	0.16	157	0.61
12	2	0.32	61.84	0.21	56.69	0.19	30.16	0.10	37.98	0.13	169	0.58
15	2	0.30	66.34	0.21	64.76	0.21	22.77	0.07	48.32	0.16	179	0.58
16	2	0.28	53.52	0.21	51.55	0.20	18.98	0.07	34.25	0.13	150	0.58

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	ABWR/CL	FELR	FELR/CL	FEWR	FEWR/CL	ANLR	ANLR/CL	ANWR	ANWR/CL	HUW	HUW/CL
17(y103)	2	0.31	69.22	0.22	71.99	0.22	45.49	0.14	48.76	0.15	200	0.63
19(y162)	2	0.14	32.12	0.14	23.32	0.10	41.14	0.17	35.23	0.15	143	0.60
25 (y336)	2	0.29	50.37	0.20	53.65	0.21	22.54	0.09	39.19	0.15	150	0.58
27	2	0.27	51.14	0.19	50.53	0.19	26.29	0.10	35.80	0.14	153	0.58
30	2	0.31	60.20	0.22	64.63	0.23	27.94	0.10	42.32	0.15	165	0.60
31	2	0.28	57.62	0.22	51.17	0.19	29.59	0.11	38.73	0.15	150	0.57
32	2	0.30	66.30	0.23	64.77	0.23	27.19	0.10	43.44	0.15	166	0.59
36	2	0.28	60.04	0.22	57.20	0.21	29.12	0.11	44.03	0.16	159	0.58
38	2	0.28	53.45	0.20	54.12	0.20	27.14	0.10	36.28	0.13	152	0.56
40	2	0.28	49.14	0.20	51.97	0.21	20.61	0.08	38.94	0.16	150	0.61
42	2	0.29	59.91	0.21	63.05	0.22	32.81	0.12	42.54	0.15	167	0.59
44 y339	2	0.29	50.36	0.20	51.92	0.21	19.30	0.08	39.37	0.16	149	0.59
47	2	0.28	51.47	0.19	55.27	0.20	20.75	0.08	37.29	0.14	158	0.58
49 y333	2	0.31	58.54	0.22	63.01	0.23	21.72	0.08	44.00	0.16	165	0.61
51	2	0.29	66.30	0.25	56.75	0.21	31.59	0.12	36.90	0.14	164	0.61
2	2	0.28	62.64	0.20	61.87	0.20	28.89	0.09	42.15	0.14	179	0.57

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	ABW	ABW/CL	FEW	FEW/CL	TL	TL/CL	TW	TW/CL
11	1	152	0.59	156	0.60	63.70	0.25	24.14	0.09
13	1	160	0.58	173	0.63	70.22	0.26	26.80	0.10
18	1	167	0.59	175	0.61	75.42	0.26	33.25	0.12
20	1	157	0.59	168	0.63	71.14	0.27	26.66	0.10
21 y342	1	148	0.64	151	0.65	45.03	0.19	22.55	0.10
22 y65	1	151	0.59	167	0.65	66.33	0.26	38.93	0.15
23	1	145	0.58	160	0.65	55.69	0.22	19.77	0.08
24	1	139	0.64	139	0.64	50.63	0.23	25.04	0.11
26	1	169	0.59	177	0.62	62.15	0.22	25.71	0.09
28	1	150	0.59	160	0.63	68.32	0.27	29.40	0.12
29	1	160	0.58	166	0.60	55.33	0.20	31.98	0.12
33 y172	1	150	0.57	161	0.61	74.17	0.28	35.89	0.14
34	1	158	0.61	170	0.65	58.97	0.23	28.81	0.11
37	1	167	0.61	173	0.63	60.47	0.22	28.75	0.10
39	1	170	0.63	171	0.63	62.45	0.23	35.06	0.13
41	1	174	0.61	183	0.64	72.36	0.25	31.10	0.11
50	1	153	0.61	155	0.62	54.76	0.22	31.27	0.12
43	1	172	0.70	172	0.70	75.59	0.31	31.94	0.13
45	1	178	0.64	183	0.65	53.58	0.19	23.81	0.09
46	1	152	0.61	156	0.62	41.54	0.17	26.77	0.11
48	1	160	0.58	171	0.62	65.73	0.24	29.66	0.11
52	1	180	0.67	175	0.65	64.12	0.24	31.81	0.12

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	ABW	ABW/CL	FEW	FEW/CL	TL	TL/CL	TW	TW/CL
3	1	183	0.63	185	0.64	59.34	0.20	21.81	0.08
5	1	162	0.62	164	0.63	80.42	0.31	31.41	0.12
7 y66	1	158	0.67	167	0.71	66.75	0.28	26.29	0.11
8 y 80	1	192	0.62	200	0.64	63.30	0.20	29.88	0.10
10	1	167	0.60	176	0.63	79.04	0.28	33.33	0.12
55	1	166	0.61	177	0.66	75.26	0.28	27.66	0.10
53	1	150	0.60	153	0.61	62.40	0.25	28.48	0.11
54 y_09	1	165	0.60	166	0.61	75.10	0.27	30.16	0.11
59	2	170	0.63	175	0.65	51.67	0.19	29.30	0.11
60	2	173	0.67	171	0.66	61.84	0.24	32.85	0.13
61	2	175	0.64	180	0.65	46.26	0.17	36.39	0.13
57	2	176	0.64	170	0.61	54.06	0.20	36.62	0.13
58	2	182	0.66	184	0.66	56.30	0.20	31.96	0.12
56	2	144	0.60	145	0.60	59.88	0.25	32.69	0.14
62	2	181	0.65	174	0.62	59.83	0.21	28.90	0.10
1	2	184	0.65	180	0.64	66.01	0.23	27.17	0.10
4 (y44)	2	223	0.69	210	0.65	57.03	0.18	20.44	0.06
6	2	173	0.66	173	0.66	70.66	0.27	30.84	0.12
9	2	166	0.64	158	0.61	50.57	0.20	37.64	0.15
12	2	179	0.61	177	0.61	50.03	0.17	25.24	0.09
15	2	189	0.61	197	0.64	47.76	0.15	37.73	0.12
16	2	156	0.60	158	0.61	58.66	0.23	43.74	0.17

Morphological data of *Indotestudo elongata* for sexual dimorphism studied (Male = 1, Female = 2) (cont.)

No.	Sex	ABW	ABW/CL	FEW	FEW/CL	TL	TL/CL	TW	TW/CL
17(y103)	2	200	0.63	210	0.66	62.84	0.20	44.80	0.14
19(y162)	2	150	0.63	145	0.61	56.39	0.24	23.70	0.10
25 (y336)	2	158	0.61	158	0.61	55.17	0.21	29.06	0.11
27	2	158	0.60	158	0.60	64.40	0.24	35.25	0.13
30	2	173	0.63	173	0.63	54.69	0.20	32.01	0.12
31	2	155	0.58	160	0.60	57.17	0.22	32.42	0.12
32	2	172	0.61	183	0.65	63.81	0.23	36.61	0.13
36	2	165	0.60	168	0.61	52.10	0.19	37.93	0.14
38	2	161	0.60	165	0.61	49.99	0.19	35.51	0.13
40	2	160	0.65	160	0.65	36.12	0.15	22.97	0.09
42	2	182	0.64	177	0.62	46.48	0.16	22.33	0.08
44 y339	2	155	0.61	160	0.63	57.17	0.23	32.42	0.13
47	2	161	0.59	165	0.61	51.50	0.19	37.86	0.14
49 y333	2	183	0.68	183	0.68	41.73	0.15	29.79	0.11
51	2	170	0.63	169	0.63	51.16	0.19	36.01	0.13
2	2	182	0.58	180	0.58	46.50	0.15	37.29	0.12

BIOGRAPHY

Mrs Kanlaya Sriprateep was born on November, 29, 1969 at Samutprakarn Province. She received Bachelor Degree from Department of Biology, Faculty of Science, Burapha University in 1992. From 1992-1994, she worked at Department of Anatomy, Faculty of Science, Mahidol University as a scientist in Cell and Electron Microscope Laboratory. She furthered her study on Master Program in Zoology at Department of Biology, Faculty of Science, Chulalongkorn University in 1995. She has worked at Department of Biology, Faculty of Science, Khon Kaen University since 1996. Later on, she received Master of Science in Earth science from Department of Geology, Faculty of Science, Chulalongkorn University in 2005. She has continued her study for Ph. D. degree in Biological Science program, Faculty of Science, Chulalongkorn University scince 2005.