MORPHOMETRICS OF TRUNCATE-SNOUTED BORROWING FROG (*Glyphoglossus molussus* Günther, 1868) IN THAILAND

CHALIDA LAOJUMPON

A thesis submitted in partial fulfillment of the requirements for

the degree of Master in Biology

Mahasarakham University

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คณะกรรมการสอบวิทยานิพนธ์ ได้พิจารณาวิทยานิพนธ์ของนางสาวชนิดา เพ็ชรโรจน์ แล้วเห็นสมควรรับเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาการศึกษามหาบัณฑิต สาขาวิชาการวิจัยการศึกษา ของมหาวิทยาลัยมหาสารคาม

คณะกรรมการสอบวิทยานิพนธ์

.... ประธานกรรมการ
(ผศ.ดร.ชวลิต ชูกำแพง) (กรรมการบัณฑิตศึกษาประจำคณะ)

.... กรรมการ
(อาจารย์ ดร.ญาณภัทร สีหะมงคล) (ประธานกรรมการควบคุมวิทยานิพนธ์)

.... กรรมการ
(อาจารย์ ดร.บุษบา จริงบำรุง) (กรรมการควบคุมวิทยานิพนธ์)

.... กรรมการ
(ผศ.ดร.กนกพร ทองสอดแสง) (ผู้ทรงคุณวุฒิ)

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....
(รศ.ดร.ประวิต เอราวรรณ์)
คณบดีคณะศึกษาศาสตร์

....
(ศ.ดร.ประดิษฐ์ เทอดทูล)
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วันที่...๒๓...เดือน...มีนาคม...พ.ศ. 2555

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Chalida Laojumpon

ชื่อเรื่อง	มอร์โฟเมตริกของอึ่งเพ้า (***Glyphoglossus molussus*** **Günther, 1868)** ในประเทศไทย
ผู้วิจัย	นางสาวชลิดา เหล่าจุมพล
ปริญญา	วิทยาศาสตรมหาบัณฑิต สาขาวิชา ชีววิทยา
กรรมการควบคุม	ผู้ช่วยศาสตราจารย์ ดร. คมศร เลาห์ประเสริฐ อาจารย์ ดร. สุรเวช สุธีธร
มหาวิทยาลัย	มหาวิทยาลัยมหาสารคาม ปีที่พิมพ์ 2555

บทคัดย่อ

อึ่งเพ้า (*Glyphoglossus molossus*) เป็นสัตว์สะเทินน้ำสะเทินบก)ประจำถิ่นของประเทศกัมพูชา ลาว พม่า ไทย และ เวียดนาม สัตว์สะเทินน้ำสะเทินบกชนิดนี้แพร่กระจายในพื้นที่ส่วนใหญ่ของประเทศไทย ยกเว้นในเขตภาคใต้ ในการศึกษานี้ อึ่งเพ้าจำนวน 309 ตัว จาก 21 พื้นที่ ในภาคเหนือ ภาคกลางและภาคตะวันออกเฉียงเหนือ ถูกรวบรวมในช่วงเดือน เมษายนถึง เดือนมิถุนายน พ.ศ. 2553 เพื่อนำมาใช้ในการศึกษาความแปรผันทางสัณฐานวิทยา ด้วยวิธี traditional และ geometric morphometrics ผลจากการศึกษาด้วยวิธี geometric morphometrics ปรากฏภาวะสองรูปแบบทางเพศทั้งในด้านขนาดและรูปร่าง ขณะที่ การศึกษาด้วยวิธี traditional morphometrics ไม่พบความแตกต่างระหว่างเพศ แต่ปรากฏความแตกต่างทั้งขนาด และรูปร่างในประชากรแต่ละภูมิภาค ในเรื่องของขนาดพบว่า ความกว้างของหัว และความยาวของรยางค์มีความสัมพันธ์กับขนาดของร่างกาย ยิ่งไปกว่านั้นยังพบว่า ขนาดของร่างกายจะเพิ่มขึ้นในพื้นที่อุณหภูมิสูงและมีความชื้นน้อย ประเด็นเรื่องรูปร่างพบว่า สิ่งกีดขวางการกระจายทางภูมิศาสตร์ เป็นปัจจัยที่มีอิทธิพลสูงสุดในการแบ่งแยกประชากรในเขตภาคตะวันออกเฉียงเหนือออกจากประชากรในเขตภูมิภาคอื่นๆ ผลการศึกษานี้สอดคล้องกับ ผลการวิเคราะห์ด้วยวิธี geometric morphometrics ซึ่งพบว่า รูปร่างของกะโหลกและตาของอึ่งเพ้าในภาคเหนือและภาคกลางมีรูปร่างที่ค่อนข้างกว้างมากกว่ากะโหลกจากเขตภาคตะวันออกเฉียงเหนือ

คำสำคัญ : ความแปรผันทางสัณฐานวิทยา; อึ่งเพ้า; *Glyphoglossus molossus*; ประเทศไทย

TITLE	Morphometrics of Truncate-snouted Burrowing Frogs (*Glyphoglossus molossus* Günther, 1868) in Thailand
CANDIDATE	Miss Chalida Laojumpon
DEGREE	Master degree of science program in Biology
ADVISORS	Asst. Prof.Komsorn Lauprasert, Ph.D. Suravech Suteethorn, Ph.D.
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ABSTRACT

Truncate-snouted burrowing frog (*Glyphoglossus molossus*) is a native amphibian in Cambodia, Lao PDR, Myanmar, Thailand and Vietnam. This species widely distributes throughout the most part of Thailand except southern part. Three thousand and nine Truncate-snouted burrowing frogs from twenty one localities, belonging to the northern, northeastern and central parts of Thailand were collected during April to March 2010 for studying their morphological variations using traditional and geometric morphometrics techniques. Result of geometric morphometrics analysis present sexual dimorphism in both of size and shape. Meanwhile, traditional morphometrics did not find significantly differences between the sexes but variations in shape and size between regions were found. In case of size, head wide and limb part related to body size. Moreover, body size were increased in high temperature and low precipitation. In case of shape, biogeographic barriers are the greatest influence which separated the northeastern Truncate-snouted burrowing frog from the other regions. This results according to results of geometric morphometrics analysis which indicated that cranium shape of Truncate-snouted burrowing frog from north and central region rather wide than that from the northeastern region.

Keywords: Morphological variation; Truncate-Snouted Burrowing Frog; *Glyphoglossus molossus*; Thailand.

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CHAPTER 1

INTRODUCTION

1.1 Background

Understanding the physical structure of an organism is a prerequisite to understanding its phylogenetic relationships, behavior, and relationship with the environment (Duellman and Trueb, 1994). Thus, qualitative and quantitative analyses of the relationships between morphological variations and ecological factors have become increasingly widespread in the last decade (Claude et al., 2004). Although morphological study has been a basic tool in biology for many centuries, it has many limitations because the results are mainly qualitative data from descriptive methods which can sometimes not be clear and difficult to understand (Richtsmeier et al., 2002, Adams et al., 2004). Because of this problem, morphologists try to develop numerous methods to study the morphological characters of organisms such as morphometric methods. Several researches indicate that amphibians show a high level of morphological variation especially in the cranium (Duellman and Trueb, 1994; Meijden et al., 2007 and Amor et al., 2009). Thus, they are a very good model for studying the effects of environment on morphological variation.

In Thailand, 137 species of amphibians were reported by The Royal Forest Department (Nabhitabhata and Chan-ard, 2005). Unfortunately, the status, of many species, has been classified as at risk under the IUCN Red List of Threatened Species because of the influence of climate changes and habitat fragmentation as well as a lack of knowledge about ecological, behavioral, and taxonomic data (Bickford, 2010). This problem also includes *Glyphoglossus molossus*, a native amphibian of Cambodia, Lao People's Democratic Republic, Myanmar, Thailand, and Vietnam (Nabhitabhata and Chan-ard, 2005). Recently, this animal was close to being classified as a threatened species under IUCN because of the affects of forest degradation and over harvesting for food during the breeding seasons by local people (Dijk and Chan-ard, 2004). However, biological reports of this species are still rare. Additionally, there is no other published study focusing on morphological variation. Thus the aim of this study was to investigate morphological variation in terms of sexual dimorphism and geographic variation, with the implementation of multivariate statistics.

1.2 Objectives

The research aims to assess the morphological variation in the skull of Truncate-snouted burrowing frog from different geographic areas in Thailand.

1.3 Scope of the Research

This research will study skull shape in of Truncate-snouted burrowing frog from different geographic areas in Thailand. Specimens were collected from museum collections in Faculty of Science, Mahasarakham University and field collection during April to July 2010 from different geographic areas of Thailand. All specimens were preserved and preparation in Biological laboratory, Faculty of Science, Mahasarakham University. All specimens were asseses morphological variation using traditional and Geometric morphometrics methods.

1.4 Significance of the Research

The result from this research will provide:

1.4.1 Improvement knowledge about morphological data of Truncate-snouted burrowing frog in Thailand

1.4.2 Understanding about sex relationships and morphological variation in skull of Truncate-snouted burrowing frog from different geographic areas in Thailand.

1.5 Definition of Terms

The terminology used in this study is defined as follow:

1.5.1 Truncate-Snouted Burrowing Frog is common name of *Glyphoglossus molossus.*

1.5.2 Morphometrics is a technique of taxonomic analysis using measurements of the form of organisms (Dictionary.com)

1.5.4 Geometric morphometrics (GM) is morphometric methods, often based on Cartesian coordinates of landmarks, which retain all geometric information in the data throughout an analysis (Slice, 2007).

1.5.5 Cartesian coordinates is a method of defining the location of points on a plane by their distances from two fixed perpendicular straight lines (axes) (Slice, 2007).

CHAPTER 2

LITERATURE REVIEW

To achieve this research, a literature review is necessary for understanding of:

2.1 *Glyphoglossus molossus*

2.1.1 Taxomomic data

2.1.2 Biology of *Glyphoglossus molossus*

2.1.3 Historical research about *Glyphoglossus molossus* in Thailand

2.1.4 General information of frog skulls

2.2 Introduction to Geometric morphometrics

2.3 Geography of Thailand

2.1 *Glyphoglossus molossus*

2.1.1 Taxonomic data (Frost et al., 2006)

Kingdom: Animalia

Phylum: Chordata

Class: Amphibia

Order: Anura

Family: Micohylidae

Subfamily: Micohylinae

Genus: *Glyphoglossus*

Species: *Glyphoglossus molossus* Günther, 1868

2.1.2 Biology of *Glyphoglossus molossus*

Truncate-snouted burrowing frog or *G. molossus* (Figure 2.1 A-B) is a big burrowing frog with black, brown or gray color on dorsal and lateral areas of body. The skin on the legs is covered by small brown or orange spots, ventral skin is whitish to yellow, partially clouded. The skin on the body wrinkles, sometimes granulation is present. It has a very short and convex head. Strongly truncate jaw, blunt snout, small eyes, heavy upper eyelid, tympanums are hidden. It has short arms and legs. Fingers do not have disc-shape pads at tips. Third-fourth toes are webbed (Chan-ard, 2003; Nutphund, 2001; Taylor, 1962).

A tadpole of *G. molossus* (Figure 2.1 C-E) is free swimming with a small terminal mouth. The mouth does not expand to quiet curve, roll and fold in or out from mouth cavity. The mouth does not have denticles (Inthara et al., 2005).

Taylor (1962) defined the diagnostic characters of *Glyphoglossus molossus* in "The Amphibian Fauna of Thailand" following:

1) Head are very short and convex crown
2) Eyes are small
3) Mouth are transverse and very narrow
4) Space between and behind the inner nostrils is even without papillae
5) One papilla in the median line of the hinder part of the palate.
6) Tongue are long
7) Tympanum hidden
8) Eustachian tubes are small
9) Limbs are short
10) Toes are broadly webbed metatarsus with a large, compressed, cutting shovel-like prominence.

G. molossus lives in deciduous forest (Chan-ard, 2003). Normally, they burrow themselves into sandy soil near permanent or temporary ponds (Taksintum et al., 2009; Taylor, 1962). The tadpoles resided in lentic water-middle from water surface (Inthara et al., 2005). This species breeds in seasonal or temporary deep rain pools (Dijk and Chan-ard, 2010). Ecological data of *G. molossus* in Thailand is very rare and needed indeed for conservational management.

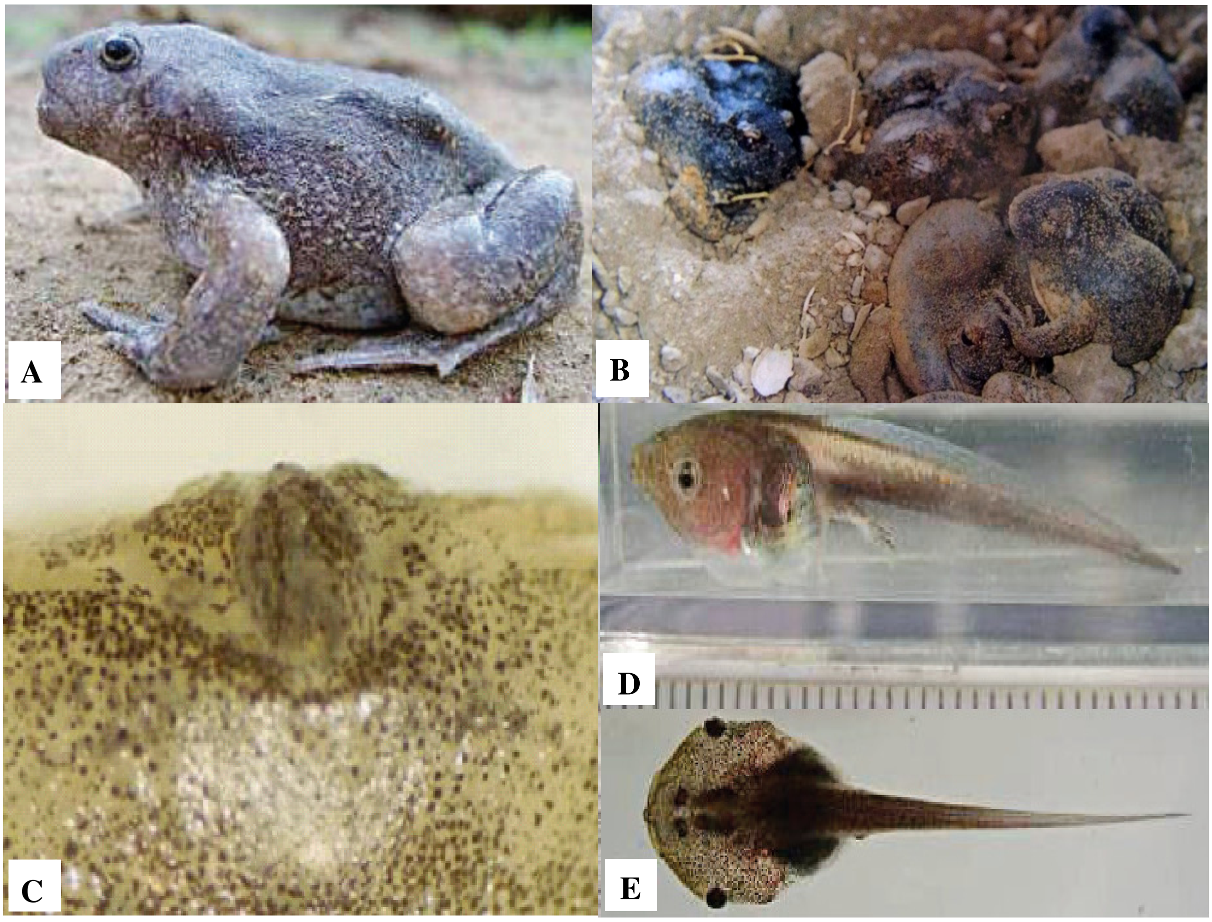


Figure 2.1 Photographs of *G. molossus*: Adults (**A**) (Taksintum *et al.,* 2009), a group of *G. molossus* from market (**B**) (Nutphund, 2001), mouth part structure of tadpole (**C**), Tadpole in lateral view (**D**) (Taksintum *et. al.,* 2009) and tadpole in dorsal view (**E**) (Inthara *et. al.,* 2005).

G. molossus is a member of the Family Microhylidae. The early Micohylids were present in Gondwana (Meijden et al., 2007). The only fossil of this Family is Gastrophhryne, found in Florida, U.S.A. and dispersed to Asia since 52 million year ago (Duellman and Trueb, 1994). Due to the suitable environment, the highest number of species is found in Madagasgar and Asian regions. The systematic studies of Microhylidae phylogeny by nuclear genes indicate that the Truncate-snouted burrowing frog is a member of Microhylinae. It is in the same clade as Calluella guttulata. This clade is a sister group of the genus Microhyla. *G. molossus* is found only in Asia (Meijden et al., 2007). Phylogeny of this species is shown in Figure 2.2.

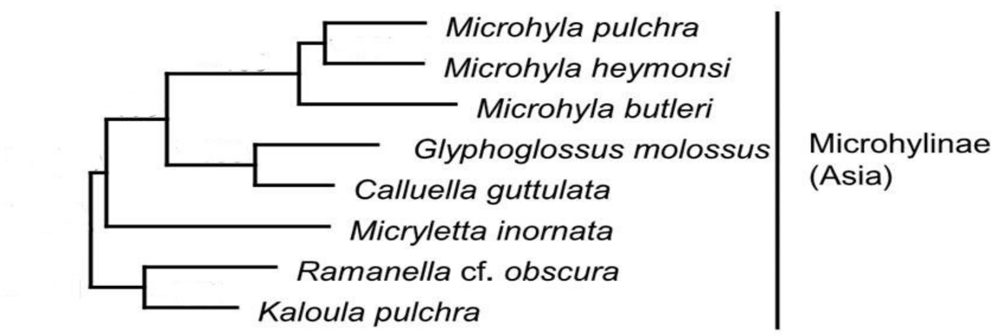


Figure 2.2 Phylogenatic tree of *G. molossus* (Meijden *et al.,* 2007).

Anura in the Family Micohylidae have a large distribution from America, Africa, Madagascar, India, northernmost Australia to Southeast Asia (Meijden et al., 2007). However, *G. molossus* distributed only in southern Lao People's Democratic Republic, northern and central of Myanmar, mainland Thailand, Cambodia and Vietnam (Dijk and Chan-ard, 2004). In Thailand, this species can be found in all parts of the country except in the southern part (Nabhitabhata and Chan-ard, 2005, Inthara et al., 2005). A map of the range of this species is shown in Figure 2.3-2.4.

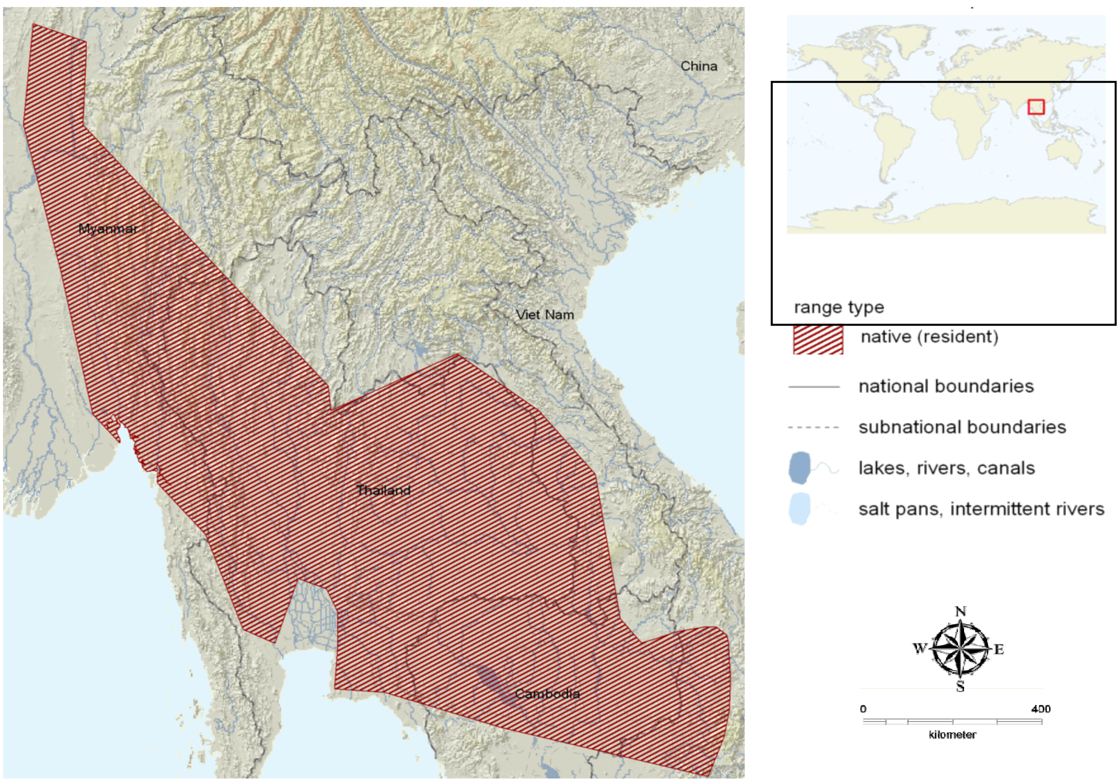


Figure 2.3 Range maps of *G. molossus* (Dijk and Chan-ard, 2010).

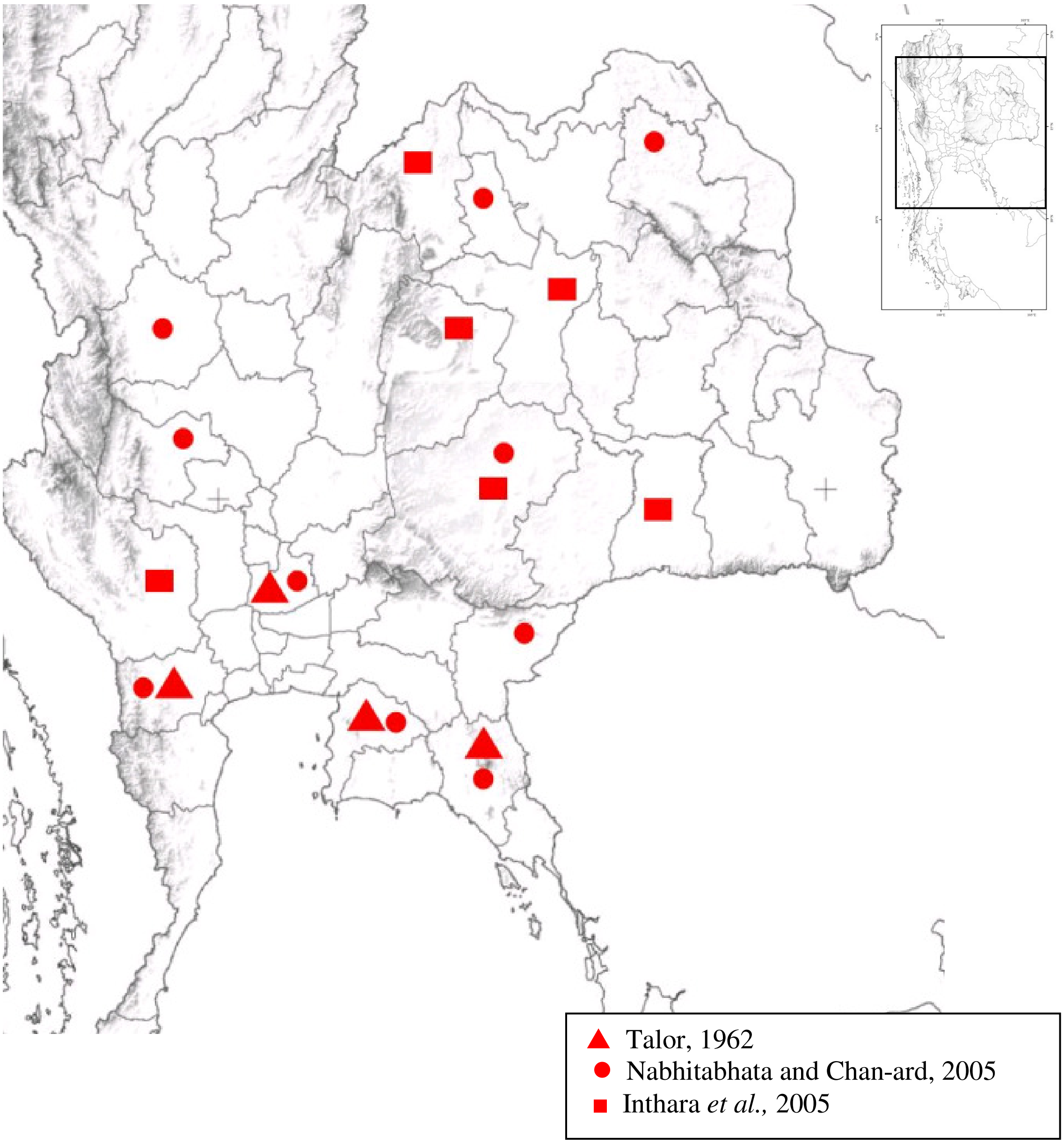


Figure 2.4 Locality of *G. molossus* in Thailand

IUCN define the status of Truncate-snouted burrowing frog as Near Threatened (NT) because this species is in significant decline (at a rate of less than 30% over ten years) (Dijk and Chan-ard, 2010). However, it is commonly found in markets especially, in breeding seasons (Taylor, 1962; Dijk and Chan-ard, 2010). Thus, it is being over-harvested for food throughout its range, making the species close to qualifying for Vulnerable (VU) status in the future (Dijk and Chan-ard, 2010)

2.1.3 Historical research about *Glyphoglossus molussus* in Thailand

Most of research about *G. molossus* in Thailand is only as a part of checklists of the amphibian fauna which present external morphology and their locality. The oldest report was presented in 1917 by Dr. Malcolm A. Smith, who studied amphibians of Thailand between 1915-1927 and discovered 53 species of amphibians around the country, but the first report which explained information about its distribution was in 1962 by Edward H. Taylor. That report described general morphology and indicated that *G. molossus* was commonly found in Chantaburi, Ratchaburi, Chon Buri and Phra Nakhon Si Ayutthaya Province (Taylor, 1962). All of report after Taylor (1962) indicated that, distribution areas of *G. molossus* was increase (Nabhitabhata and Chan-ard, 2005).

A few research concerning *G. molossus* has been found, such as research about karyotypes in *G. molossus* (Donsakul and Rangsiruji, 2005). The report of mouth part structures and distribution of some tadpoles from Thailand that presented the morphology, habitat and distribution of *G. molossus* tadpoles (Inthara et al., 2005) and the report about diversity of Anuran and habitat type of *G. molossus* Tadpoles (Taksintum et al., 2009).

2.2 General information about anura skull

Skull is the most important organ in all vertebrates because it is the set of the central nervous system and primary sense organ (Kardong, 2006). In term of evolution, skull shape becomes broad and flat whereas number of cranial elements were reduce, (Liem et. al., 2001). Especially, the numbers of cranial elements in anura are less than in other amphibians (Trueb, 1993). The pattern of anura skulls is highly diverse; it is difficult to make generalizations about characters (Duellman and Trueb, 1994). However, the braincase of all anurans can be thought of as T-shape box (Figure 2.5). The leg of the T extends posteriorly from the nasal region to the auditory region, while the audinary capsules is at the head of T. The neurocranium of the anurans includes 5 important bones including one sphenethmoid, paired prootics and exocipitals (Duellman and Trueb, 1994). The basioccipital region is absent, occipital condyles are borne on the exoccipital, Mesethmoid bones are absent, Ethmoid region unossified, the frontal and paretal bones are fused (Liem et al., 2001). The palate is poorly developed and dentition is reduced or lost in the mandible (Kardong and Zaliska, 2002). Teeth are usually present on the maxilla, premaxilla, and often on the vomer. The skull roof may be co-ossified (fused) with the overlying skin (Poungh et al., 2001).

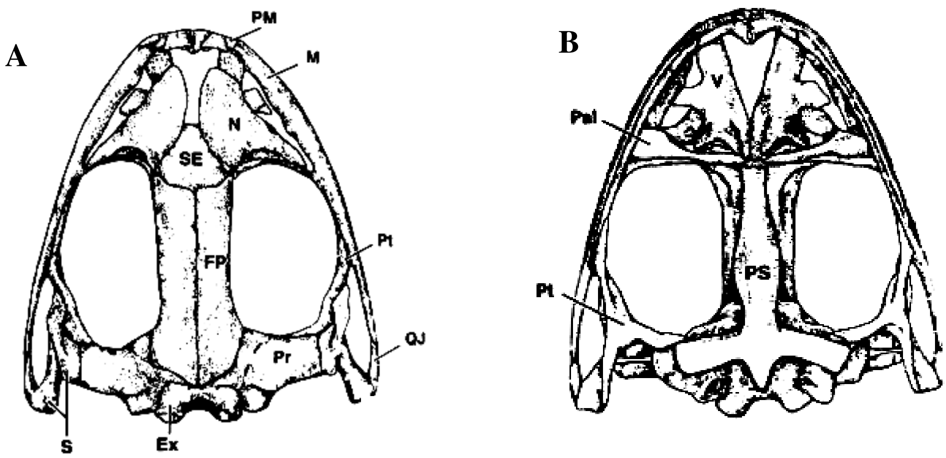


Figure 2.5 Skull of *Leptodactylus bolivianus* in dorsal (**A**) and ventral views (**B**) (Pough *et al.,* 2001)
Abbreviations: Ex, exoccipital; **FP**, frontoparietal; **M**, maxilla; **N**, Nasal; **Pal**, palatine; **PM**, premaxilla; **Pr**, prootic; **Pt**, pterigoid; **PS**, parasphenoid; **QJ**, quadratojugal; **S**, squamosal; **SE**, sphenethmoid; **V**, vomer (Duellman and Trueb, 1994).

Scale of vertebrate skull can be approached from many perspectives (Emerson and Bramble, 1993). In case of anuran, Trueb (1993) suggested that cranial diversity in non aquatic anurans (non pipip frog) is unrelated to body or organism size but correlated to life habits (for example Bufo that live in arid environment tend to have hyper-ossified skulls. While, anurans that live in stream inhabitants tend to have hypo-ossified crania.) and life history patterns (shape changes in cranial components related to reduction generally reflect the ontogenetic trajectory of the development of the element). Moreover, biomechanical models predict that in frogs a wide skull and long jaws will be important determinants of prey size (Emerson and Bramble, 1993).

2.3 Introduction to Geometric Morphometrics

Morphology is a fundamental part of biological research. Over century, biologist, palaeontologist and archaeologist have classified organisms by the descriptions of their morphological forms(Richtsmeier et al., 2002). Traditionally, qualitative and quantitative data were used in descriptive methods, but recently, biologists have begun to transition from a descriptive field to a quantitative science. (Adams et al., 2004). A lot of quantitative sciences were used in morphological study, especially the method called "Morphometrics". Rohlf (1990) suggested that morphometrics are the quantitative description, analysis and interpretation of shape variation in organism. Morphometrics developed by biometricians in 1960 (Richtsmeier et al., 2002). This method is combined with multivariate statistical analyses to sets of quantitative variables such as length, width and height (Adams et al., 2004). However, traditional morphometrics has a lot of limitations, especially with regard to geometrical topics because geometrics data cannot preserved by traditional morphometrics methods (Adams et al., 2004). Because of this limit a new method "Morphometrics revolution or Geometric morphometrics" was developed. (Slice, 2007; Adams et al., 2004).

Geometric morphometrics (GM) was developed by David Kendall and others statisticians (Slice, 2007). The objective of geometrics morphometrics assesses the variation in shape of organism. This technique assesses the distribution of "landmarks" (points described by a tightly defined set of rules, for example the suture between 2 bones.) (Slice, 2007; Adams et al., 2004; Richtsmeier et al., 2002). A result of this method was present in graphical map. This method can be preserved geometric data by figure which easy to explained (Adams et al., 2004). Currently, the number of publications about geometric morphometrics has increased, especially in evolution topic for example: Geometric morphometric differences between Panstrongylus geniculatus from field and laboratory (Jaramillo et al., 2002), Ecological correlation and evolutionary divergence in the skull of turtles (Claude et al., 2004) and Geographic variation in the long-nosed snake, Rhinocheilus lecontei (Colubridae): beyond the subspecies debate (Manier, 2004). In case of amphibian, few geometric researches in tadpole were found for example: studies of ontogeny, phylogeny and morphology in anuran larvae (Larson, 2002 and 2005).

2.4 Geography of Thailand

The distribution patterns of amphibians depend on rain and geography. Thus, the pattern of geographic regions in Thailand is the most important data for understand about Truncate-snouted burrowing frog distribution in Thailand. Thailand is located between 5° 37 and 20°27 N and between 97° 22' and 105° 37' E. The country shares borders with Burma in the west and north, Laos and Cambodia in east and the Gulf of Thailand in the south. A south-ward peninsular stretches to the Malaysian border, Andaman Sea in the west and Gulf of Thailand in the east. The total area is about 513,115 km2 (Khedari et al., 2002).

Much of the northern part of the country is mountainous. Most of the mountains extend along the Myanmar border towards the Kra Isthmus and Maylay Peninsula. These high mountains are incised by steep river valleys with upland areas. A series of rivers from these mountains, including the Ping, Wang, Yom and Nan fuse into the Chao Phaya River on the central plain of the country. The central plain is a lowland area with the Chao Phaya and its tributaries. All rivers in the central plain run into the Gulf of Thailand. The northeastern part of the country is a region of low hills and shallow lakes called Khorat Plateau. This region is bordered to the west by Phetchabun Mountain and to the east by the Mekong River. The plateau consists of two main plains separated by the Phu Phan mountains (Department of mineral resources, 2007). The northern part called Sakon Nakhon plain while, the southern part called Khorat plain. The southern portion of the Thailand is part of a narrow peninsula bounded to the north by the Kra Isthmus. The western part has steeper coasts, while on the eastern side river plains dominate. The middle of the southern part consists of two main area separated by several mountains which extend from north to south. The eastern coast is the Gulf of Thailand while the western coast connects with the Andaman Sea (Khedari et al., 2002, Demartment of mineral resources, 2007)..

Concerning climate, Thailand is influenced by Asian monsoon climate, where there is a reversal of wind direction between the summer and winter (Lekakul and Mcneely, 1978). There are two major air streams affecting the climate of Thailand: the northeast monsoon and the southwest monsoon. The northeast monsoon, which begins from November to February, brings cool and dry air from the Siberian anti-cyclone to the major part of Thailand. While, the southwest monsoon brings humid air from the Indian Ocean to Thailand from June to September (Khedari et al., 2002). The seasons of the country include winter, rainy, and summer seasons (Nutphund, 2001). The winter season receive the northeast monsoon, occurring from mid October to mid- February. The driest month of the year is December. The rainy season is affected by the southwest monsoon, from August to mid-October. Abundant rainfall also occurs from August to October. The summer season is about three months, from mid-February to mid-May. The hottest month is usually in April (Khedari et al., 2002).

A lot of concept about the geographic region of Thailand were developed such as Köppen is classified climate in Thailand as a tropical monsoon climate (Am) and tropical savanna climate (Aw) (Figure 2.6 A). (Khedari et al., 2002). However, The Thai Metrological Department divides Thailand into 5 climate zones based on maximum and minimum values of air temperature and relative humidity including the Northern, Northeast, Central, Southern and Eastern Regions (Figure 2.6 B).

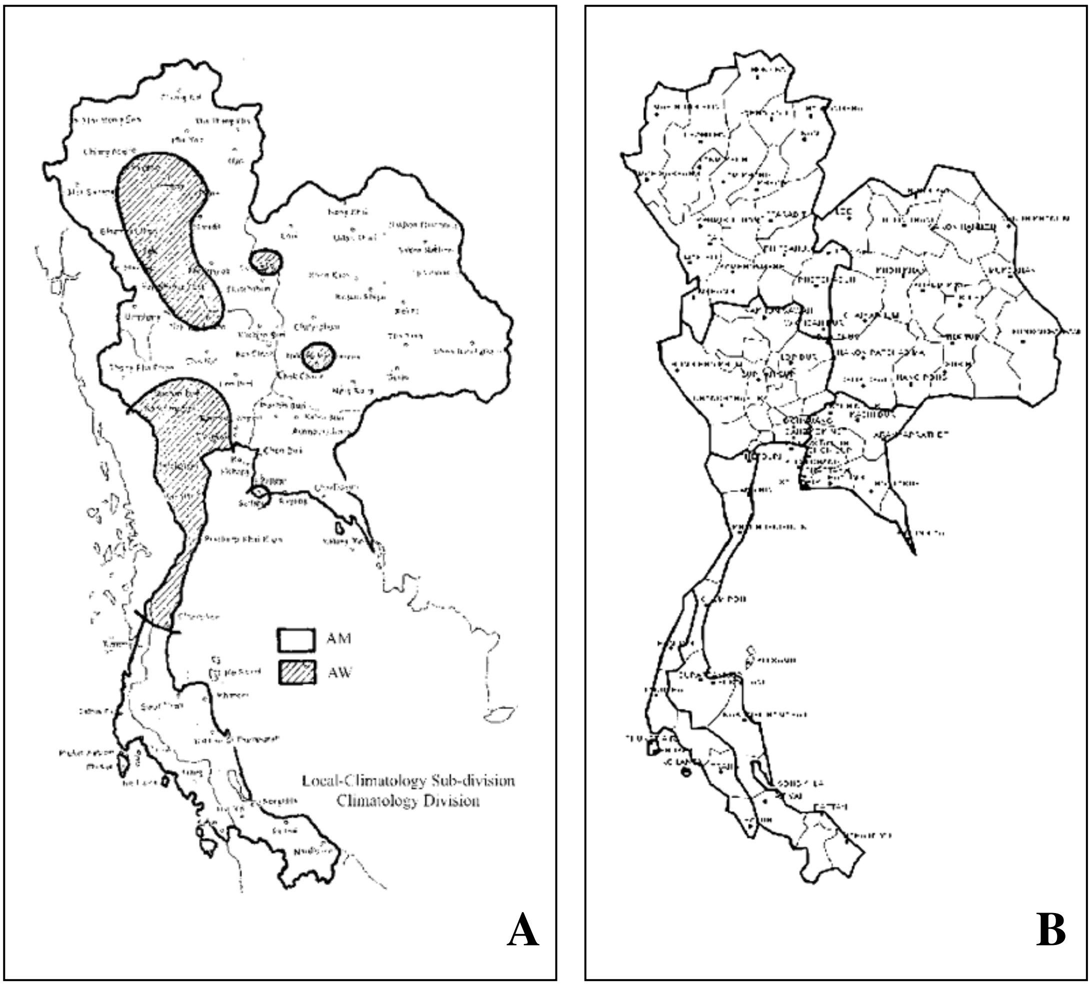


Figure 2.6 climate zones of Thailand (Khedari et al., 2002) : Köppen concept **(A)**, The Thai Metrological Department concept **(B)**

CHAPTER 3

MATERIAL AND METHODS

This chapter is arranged as follows:

3.1 Study areas

3.2 Instruments and chemicals

3.3 Methods

3.1 Study areas

The study areas of this study were chosen using a random from ecological technique (Krebs, 1992). These areas will be the sample sites for *Glyphoglossus molossus* in Thailand. They include 21 different locations from 16 Provinces in different geographic regions around the country, except the southern part because this species is absent from this part. All locations in this study are shown in Figure 3.1. and Table 3.1

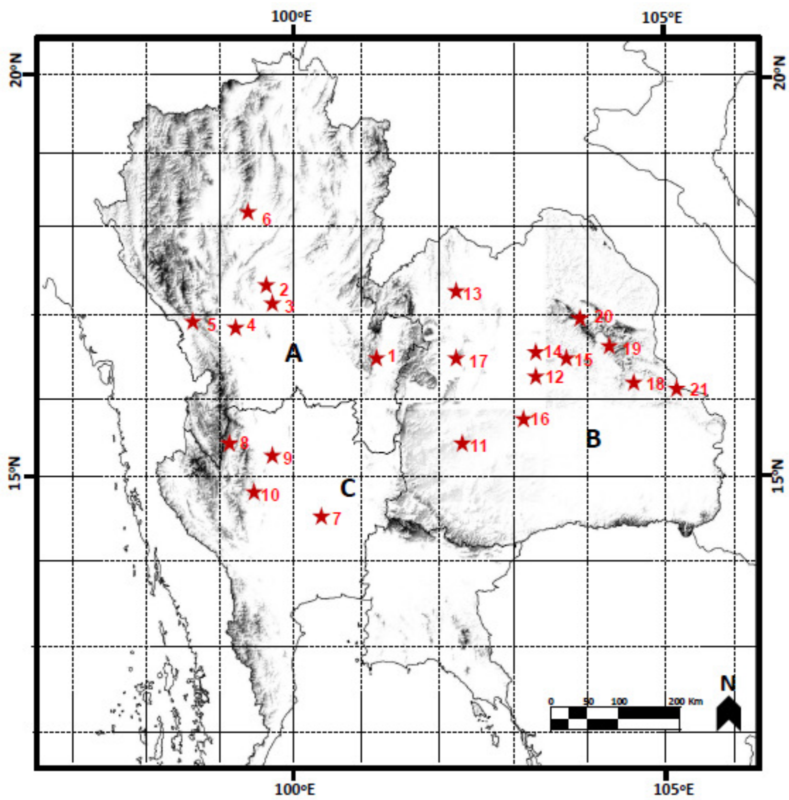


Figure 3.1 map of sampling localities

Table 3.1 Sample localities of *G. molossus* in Thailand.

On.	Province	On.	Province
1	Wicharn Buri, Phetchabun	12	Kantharawichai, Maha Sarakharm
2	Thung Sa riuam, Sukhothai	13	Nong Wua Sao, Udonthanee
3	Sri Sam Rong, Sukhothai	14	Khammalasai, Kalasin
4	Ban Tak, Tak	15	Meung, Kalasin
5	Mae Ra Mat, Tak	16	Satuk, Bureerum
6	Mea Phrink, Lamphang	17	Phu Phaman, Khon Khaen
7	Meung, Lomburee	18	Meung, Mukdahan
8	Lan Sang, Uthaithanee	19	Phu Phan, Sakonnakhon
9	Meung, Uthaithanee	20	Song Daw, Sakonnakhon
10	Dan Chang, Suphanburee	21	Khammarat, Ubonratchathanee
11	Phathai, Nakhorn Ratchasima		

3.2 Instruments and chemicals

In this study, the experiments is planned to divide into 2 parts as the following:

A. Instruments and chemicals in field survey

1.) Vernier calipers
2.) Glass bottles
3.) 70 % Ethyl alcohol
4.) GPS

B. instruments and chemicals in Laboratory

1.) 3% KOH solution
2.) Distilled water
3.) Plastic bags
4.) Digital camera
5.) Instruments for surgery
6.) Scale bar
7.) Beakers
8.) Pipettes

3.3 Methods

3.3.1 Field methods

Glyphoglossus molossus were collected from 16 Provinces during April to May 2010. All of specimens from North and Central region, Nakhon Ratchasima, Udon Thani, and Buri Ram Provinces were collected in May 2010. Specimens from Mukdahan and Sakon Nakhon, were collected in April 2010. In the other hand, specimens from Ubon Ratchathani, Khon Kean, Maha Sarakham and Kalasin were collected in March 2010.

3.3.2 Laboratory methods

This method includes the following process:

3.3.2.1 Preservation

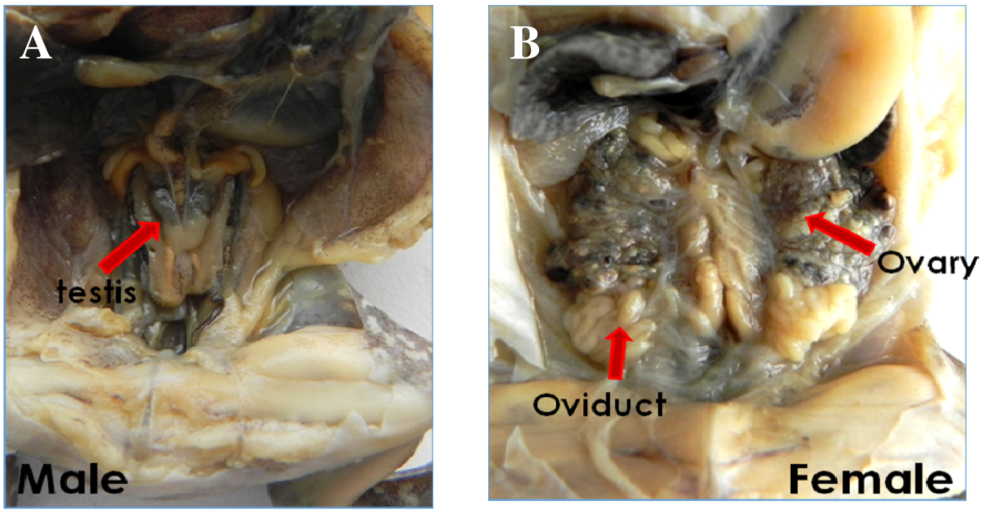
3.3.2.2 Morphometrics study

1) Traditional morphometrics

2) Geometrics morphometrics

3.3.2.1 Preservation

Specimens from the field were preserved in 70% ethanol; their sex was determined by checking from the reproductive organs (testis and ovary) and vocal sac (triangular blackish skin on the floor of the mouth) which only present in the male (Dullman and Trube, 1986; Khonsue 2004).



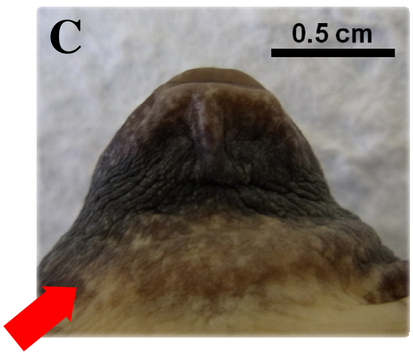


Figure 3.2 Photograph of reproductive organs and external morphology of *G. molossus*, reproductive organs of male (**A**), reproductive organs of female (**B**) and Triangle blackish skin presents in male (**C**).

3.3.2.2 Morphometrics study

1) Traditional morphometrics

1.1) Measurements

Khonsue (2004) mentioned that the minimum size of an adult of *G. molossus* is 35 mm SVL. Thus, only specimens larger than 35 mm SVL were included in the analyses. Eight characters were measured (mainly following Vieira et al., 2008), using digital calipers with an accuracy of 0.01 mm, and were recorded as follows (Fig. 2). :

1) Snout-vent length (SVL)
2) Head width (HW)
3) Head length (HL)
4) Internarial distance (IND)
5) Eye-nostril (END)
6) Eyes distance (EN)
7) Tibia length (TL)
8) Forelimb length (FL)

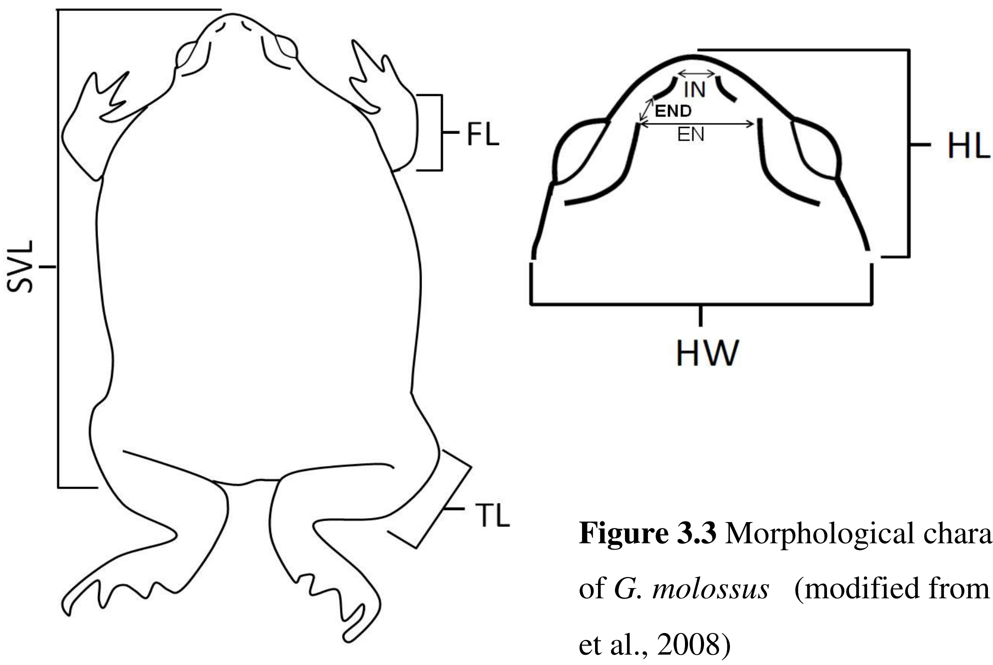


Figure 3.3 Morphological characters of *G. molossus* (modified from Vieira et al., 2008)

1.2) Statistical analysis

All of measurement and landmark data were analyses by univariate and multivariate statistics with traditional morphometrics and Geometric morphometrics. All of traditional morphometrics were computed with PAST (Hammer et al., 2001).Whereas, Geometric morphometrics were computed with R (R Development Core Team , 2011).

1.2.1) Normality

Normality of the data was determined using Shapiro-Wilks test. When non-normally distributed, the data was log-transformed to reduce deviations from normality and distortion effects caused by allometric relationships.

1.2.2) Sexual dimorphism

Total samples from each region were compared by Student's t-test and also subjected to principal component analysis (PCA).

1.2.3) Geographic variation

Population means were compared by multivariate analysis of variance (MANOVA) to verify whether the samples and sexes from among the groups differed in overall size. Since significant variations between the sexes and samples were not observed (Table 2). Thus, we pooled males and females in subsequent analyses. The significance of differences among groups for size-corrected values of measurements was tested by means of one-way ANOVAs ($p < 0.05$ as significant). Size-corrected measurements were also subjected to PCA, with subsequent ANOVA on PC1 and PC2 scores. Finally, we used Dicriminant analysis (DA) by the first stepwise methods to grouping samples and create the functions which maximized the probability of correct classification. All of the statistical analyses were performed using the program PAST (Hammer et al., 2001).

1.2.4) Relation between morphometric and environment

The relation between Mean of body size (SVL) and physical factors (latitude, temperature, humidity and total of rainfall) was appreciated and present by bar graph.

1.2.5) Relation between morphometric variables

The relation between variables was appreciated using correlation coefficient (R) which range from -1.0 to +1.0. The closer r is to +1 or -1.

The more closely the two variables are related. The closer r is to 0, the less are the variables related. This means there is no relationships. Significance of the correlation coefficient is given by F tests.

2) Geometric morphometrics

2.1) *Glyphoglossus molossus* skull preparation

The captured specimens will preserve in 70% alcohol in a glass bottle labeled with the date, location of collection and collectors. All of them will store at Department of Biology, Faculty of Science, Mahasarakham University. Skin and muscles of all specimens will remove by surgery instruments. The specimens then will clean with 3% KOH solution in 24 hours. After cleaning, the skulls will be placed in drying oven for two days (Vieira et al., 2008).

2.2) Morphometric methods

2.2.1) Digitalizing configurations: The skulls will be photographed for digitization in dorsal views, using Nikon D300 camera. A total of 34 morphological landmarks (Figure 3.3) were selected for each specimen. The landmark coordinate values were capture in two dimensions using TPSDIG version 1.18, a free access computer software program available on the Internet which develop by Rohlf (1990).

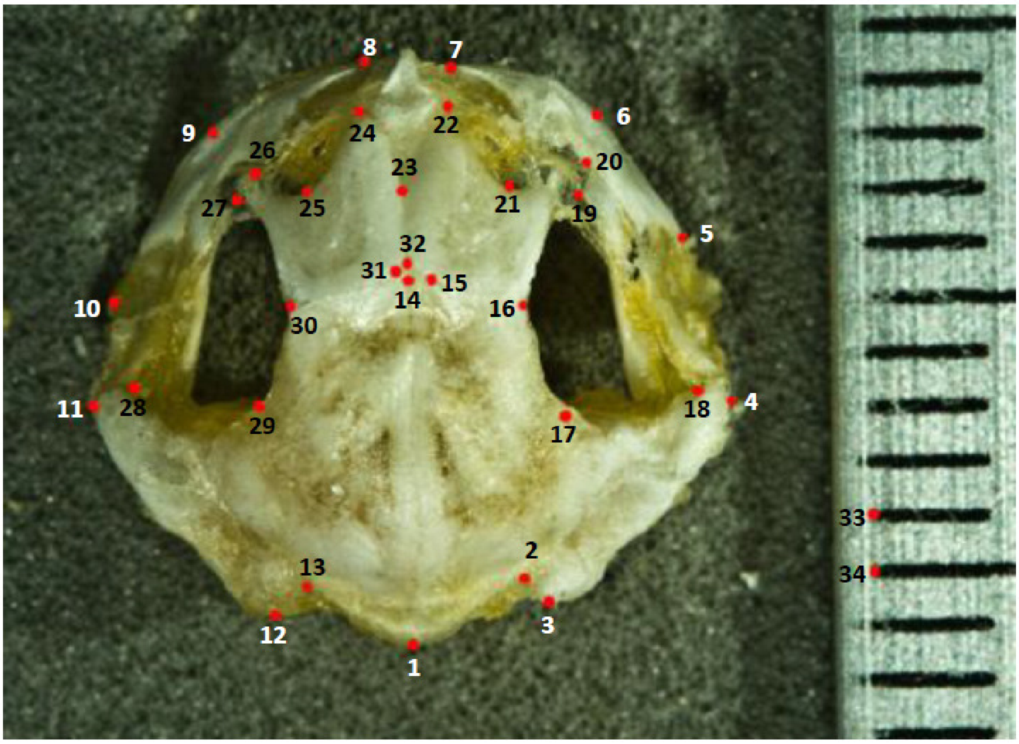


Figure 3.4 Locations of landmarks on skull of *G. molossus* in this study.

2.2.2) Procrustes Superimposition: The set of landmarks from each specimen builds a simplified shape termed a "figure" (Vieira et al., 2008). Procrustes superimpositions involves 3 steps (Richtsmeier et al., 2002) which are:

1) Fix one of the mean forms in a particular orientation and call it the references object.

2) Translation (differences in position), scaling (variation in size) and rotate (differences in orientation) the other mean from so that it matches the reference object according to some criterion. The size of each specimen is an overall size calculated using all the landmarks (i.e. the square root of the sum of the squared deviations of landmarks from the centre of the figure). The shape is defined by Procrustes residuals, which are the deviations of landmarks from the mean shape.

3) Study the magnitude and direction of differences between forms at each landmark. It is commonly stated that differences in rotation, translation and scaling of forms are removed or eliminated by superimposition.

2.2.3) Statistical Analysis:

Statistical analyses will be performed using R 2.12.0 Statistical analyses in this research including these statistics.

A) Normally distributions tests: This study will use Shapiro-wilk (Vieira et al., 2008).

B) Variation test: The statistics for t variation patterns in this study is Principal Components Analysis (PCA).

CHAPTER 4

RESULTS

This chapter consists of the following topics:

4.1 General information of *G. molossus* specimens

4.2 Traditional morphometrics analysis

4.3 Geometric morphometrics analysis

4.1 General information of *G. molossus* specimen

A total of 309 adult specimens of *G. molossus* were collected from three geographic regions (Northern, Central and Northeastern) during field trips from April to May 2010 (study sites and Number of specimen were showed in Table 4.1.

Table4.1 General information of *G. molossus* in this study

No.	Abbreviations of Locality	Latitude	Longtitude	Range of temperature, precipitation and humidity from 1971-2000			Sample number		
				T. (°C)	P.(mm)	H.(%)	M.	F.	Un.
North									
1	WB	16-17	101-102	26.96	1106	72	4	4	
2	TS	17-18	98-99				8	11	
3	SS	17-18	98-99				34	3	
4	BT	16-17	99-100				2	1	
5	MR	17-18	98-99				10	7	
6	MP	18-19	99-100				20	7	
Central									
7	ML	14-15	100-101	28.00	1091.85	72.5	18	1	
8	LS	16-17	99-100				11	3	1
9	MU	16-17	99-100				7	4	
10	DC	14-15	99-100				5	5	
Northeastern (Khorat Basin)									
11	PT	15-16	102-103	26.90	1208.32	71.2	20	2	
12	KT	16-17	103-104				-	10	
13	NW	17-18	102-103				8	8	
14	KM	16-17	103-104				5	1	
15	MK	16-17	103-104				5	4	
16	ST	15-16	103-104				9	1	4
17	PM	16-17	102-103				2	-	
Northeastern (Sakon Nakhon Basin)									
18	MM	16-17	104-105	26.46	1562.8	72.66	11	5	
19	PP	17-18	104-105				12	-	1
20	SD	17-18	103-104				9	5	
21	KR	16-17	105-106				11	10	
	Total						**211**	**92**	**6**

*The climatic data including mean temperature, total of rain fall, and percent of humidity in each locality were collected from the records of Meteorogical Department from 1971-2010.

4.2 Traditional morphometrics analysis

4.2.1 Sexual dimorphism

Comparison means between sexes indicated that most of measured characters of male are smaller than female among regions. However, results of *t-test* in each region indicated that they are no sexual dimorphism. All of descriptive statistic and *t-test* in each region are summarized in Table 4.2. This result according with PCA scatter plot which shows overlapped between sexes among regions (Figure 4.1 A-D).

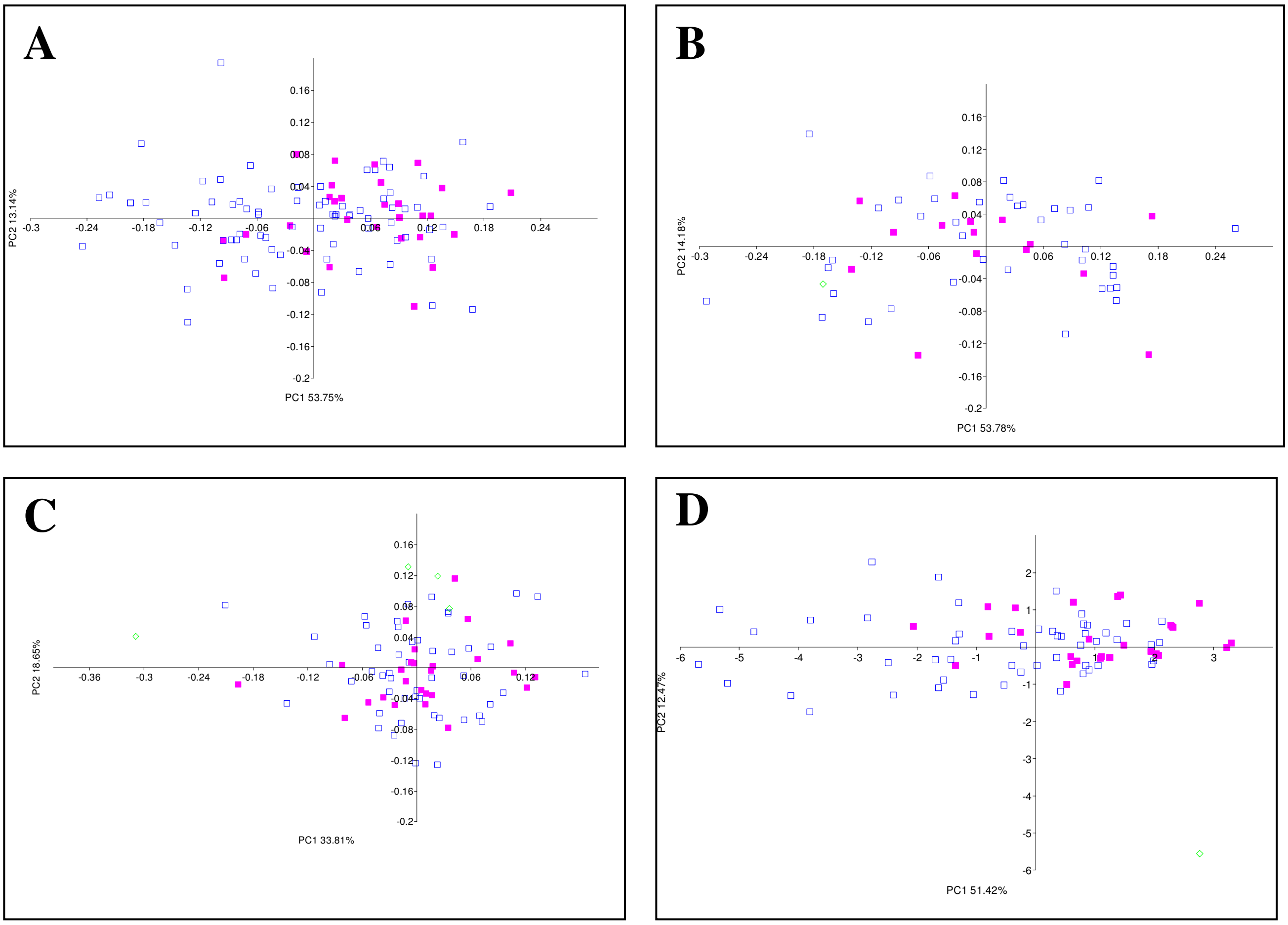


Figure 4.1 Scatterplot of Principle Component Scores (PC1 and PC2) between males and females of *G. molossus* from all study areas in A, Northern; B, Central; C, Khorat basin and D, Sakon Nakhon basin.
Abbreviations: ■, female; □, male; ◇, unknown

Table 4.2 Descriptive statistics of 7 character ratios *t-test* between male and female of *G. molossus* among of three regions (p< 0.001, ns, non-significant).

Character	NORTH				CENTRAL				NORTHEASTERN							
									Khorat Basin				SaKhon Nakhon Basin			
	Mean+SE (range)				**Mean+SE (range)**				**Mean+SE (range)**				**Mean+SE (range)**			
	Male (n=83)	Female (n=29)	***F***	**p-value**	Male (n=41)	Female (n=13)	***F***	**p-value**	Male (n=49)	Female (n=26)	***F***	**p-value**	Male (n=43)	Female (n=20)	***F***	**p-value**
SVL	61.14±0.75 (46.52-94.89)	65.33±0.94 (50.63-81.88)	4.308	0.70	59.78±1.29 (40.73-79.03)	58.32±1.26 (50.07-67.69)	5.305	0.221	62.91±0.77 (52.57-73.73)	64.16±1.08 (53.76-76.53)	0.221	0.348	55.07±0.94 (41.03-66.53)	60.80±1.20 (53.97-72.96)	2.272	0.898
HW	15.79±0.12 (12.9-20.0)	16.32±0.20 (14.80-18.90)	0.010	0.029	15.73±0.16 (13.10-17.80)	15.39±0.23 (13.60-16.50)	0.452	1.019	16.46±0.15 (14.50-18.80)	16.63±0.18 (15.00-18.80)	1.019	0.465	15.20±0.20 (12.00-17.20)	15.97±0.20 (14.30-17.70)	2.676	0.971
HL	10.16±0.17 (5.39-15.20)	10.73±0.18 (8.97-12.26)	2.672	0.013	9.63±0.17 (7.90-12.61)	9.49±0.25 (8.30-11.05)	0.156	0.051	11.51±0.18 (9.38-14.90)	11.72±0.24 (9.64-14.21)	0.051	0.486	9.96±0.23 (7.22-14.48)	10.90±0.26 (9.22-13.20)	0.574	0.005
IND	4.94±0.55 (3.86-6.64)	5.13±0.06 (4.52-5.69)	2.963	0.014	4.81±0.08 (3.66-5.90)	5.03±0.19 (3.97-6.69)	0.029	3.241	4.63±0.07 (3.77-5.90)	4.81±0.07 (3.65-5.33)	3.241	0.081	4.48±0.06 (3.48-5.46)	4.60±0.07 (4.08-5.54)	2.494	0.201
END	2.16±0.03 (1.58-2.98)	2.28±0.04 (1.83-2.74)	1.465	0.027	2.39±0.05 (1.67-3.25)	2.32±0.05 (1.99-2.99)	1.333	0.075	2.48±0.03 (2.11-3.24)	2.50±0.05 (2.01-3.23)	0.075	0.849	2.27±0.05 (1.14-2.90)	2.48±0.06 (2.20-3.11)	1.345	0.016
EN	8.04±0.08 (6.19-9.89)	8.56±0.08 (6.18-10.06)	6.117	0.165	7.86±0.13 (6.54-10.75)	7.47±0.22 (6.15-9.21)	0.674	5.261	8.28±0.07 (7.45-9.87)	7.87±0.13 (6.42-9.04)	5.261	0.012	7.76±0.15 (5.28-9.77)	8.31±0.14 (7.23-9.38)	5.367	0.008
TL	21.88±0.18 (17.12-25.87)	22.76±0.35 (19.22-26.80)	0.106	0.036	21.53±0.45 (14.69-30.26)	20.13±0.44 (18.00-23.45)	4.919	0.004	21.83±0.34 (11.29-25.89)	22.72±0.42 (16.84-26.53)	0.004	0.118	20.34±0.22 (16.66-22.82)	22.05±0.32 (19.45-24.37)	0.173	0.010
FL	10.53±0.13 (7.79-13.56)	11.11±0.24 (7.82-13.07)	0.083	0.049	10.07±0.23 (6.56-12.99)	10.14±0.82 (7.94-19.45)	0.369	0.192	11.21±0.22 (8.71-17.60)	10.85±0.24 (8.49-13.46)	0.192	0.301	9.84±0.18 (6.57-12.09)	10.25±0.31 (8.00-13.08)	0.065	0.274

4.2.2 Relation between body size and physical factors

Comparison between body size and environment; latitude, mean temperature, percent of humidity and total of rainfall indicated that body size of *G. molossus* is unrelated to latitude but correlated to degree of temperature (direct variation), total of rainfall and percent of humidity (inverse variation) (Figure 4.2 A-D).

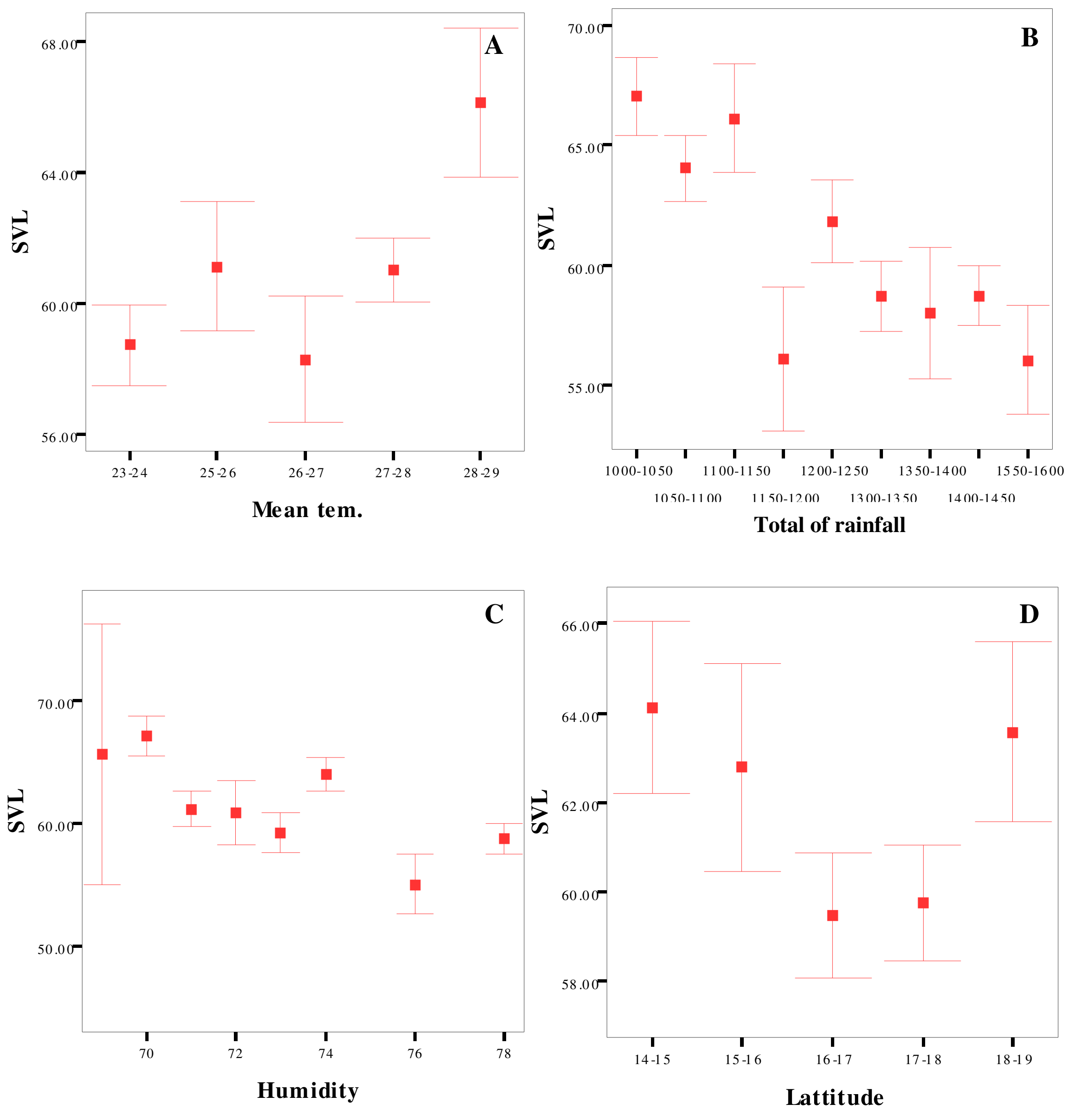


Figure 4.2 Relationship between body size of *G. molossus* and environment (Mean of temperature (A), Total of rainfall (B), Humidity (C), and Latitude (D))

4.2.4 Relation between morphometric variables

Correlation among morphometric measurements showed that most variables are significantly and positively correlated (Table 4.3; Fig.4.3) because during growth most of the variables are related to size. However, IND showed low coefficients of correlation of correlation with HL and END. This result suggested that IND develop rather independent from head length and other head organism.

Table 4.3 Coefficients of correlation between continuous variables and boxes color of signicance

variables	logsvl	loghw	loghl	logind	logend	logen	logtl	logfl
SVL	1.000^{ns}	0.711***	0.277***	0.429***	0.366***	0.543***	0.705***	0.467***
HW		1.000^{ns}	0.314***	0.379***	0.360***	0.470***	0.636***	0.474***
HL			1.000^{ns}	0.172**	0.203***	0.428***	0.220***	0.242***
IND				1.000^{ns}	0.185**	0.400***	0.452***	0.314***
END					1.000^{ns}	0.374***	0.278***	0.245***
EN						1.000^{ns}	0.453***	0.438***
TL							1.000^{ns}	0.423***
FL								1.000

,*** For 0<p<0.001; highly significant

, ** For 0.01<p<0.01; significant

, * For 0.05<p<0.1; significant

, ns For 0.1<p<1; not significan

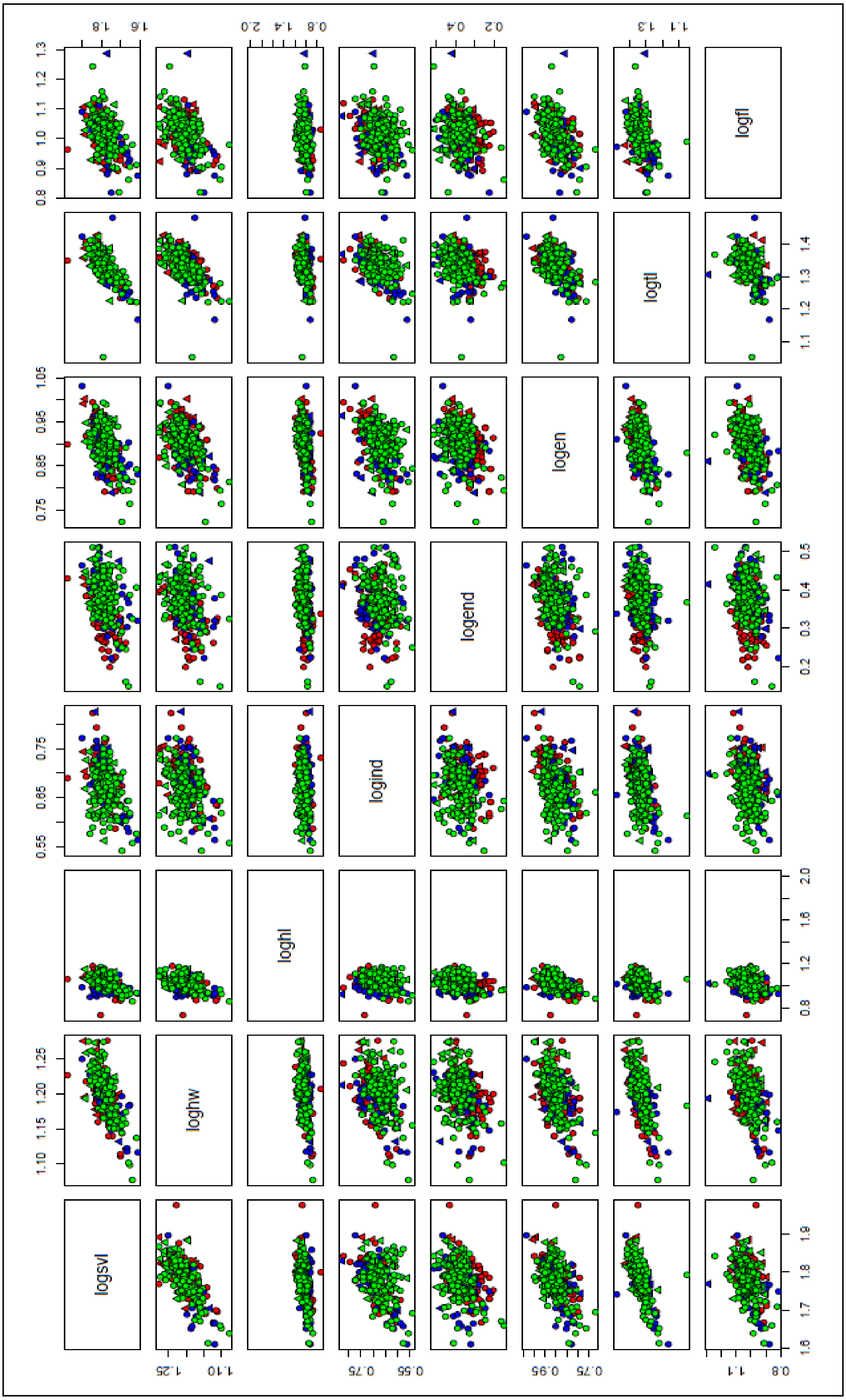


Figure 4.3 Correlation between each variable

4.2.3 Geographic Variation

4.2.3.1 MANOVA test

Results of MANOVA showed significantly different among regions in SVL, HL, IND, END and FL (Wilks' lamda=0.614, p<0.000; univariate results all with p< 0.001) but did not show significant differences between sexes (Table 4.4). This result indicated that there was no significant interaction between sex and locality; therefore, males and females were pooled for subsequent analysis (one-way ANOVA, PCA and DFA analysis).

Table 4.4 MANOVA of morphometric characters of *G. molossus* from Thailand (computed using alpha = 0.001, * : significant, ns: no significant)

Character	***F***		
	Locality	**Sex**	**Locality*Sex**
SVL	9.014*	9.152	4.11
HW	3.876	5.866	2.61
HL	7.340*	3.324	1.74
IND	11.392*	5.177	0.35
END	6.893*	1.662	1.61
EN	3.258	0.871	7.30
TL	4.343	7.095	6.74
FL	7.802*	1.288	2.09

4.2.3.2 Morphological variation within region

Results of the principal component analysis (PCA) showed that populations sampled in northern region could be combined into one group (Figure 4.4). Central region could be separated into two groups (group LS-MU and group ML) with along PC1 axis (explained 53. 78% of variance) whereas group DC overlap between two groups (Figure 4.5). In case of the northeastern regions, although some overlap area between Khorat and Sakon Nakhon Basin was found (Figure 4.7).but they rather separated into two groups along PC1 axis (explained 47.39 % of variance) (Figure 4.8)

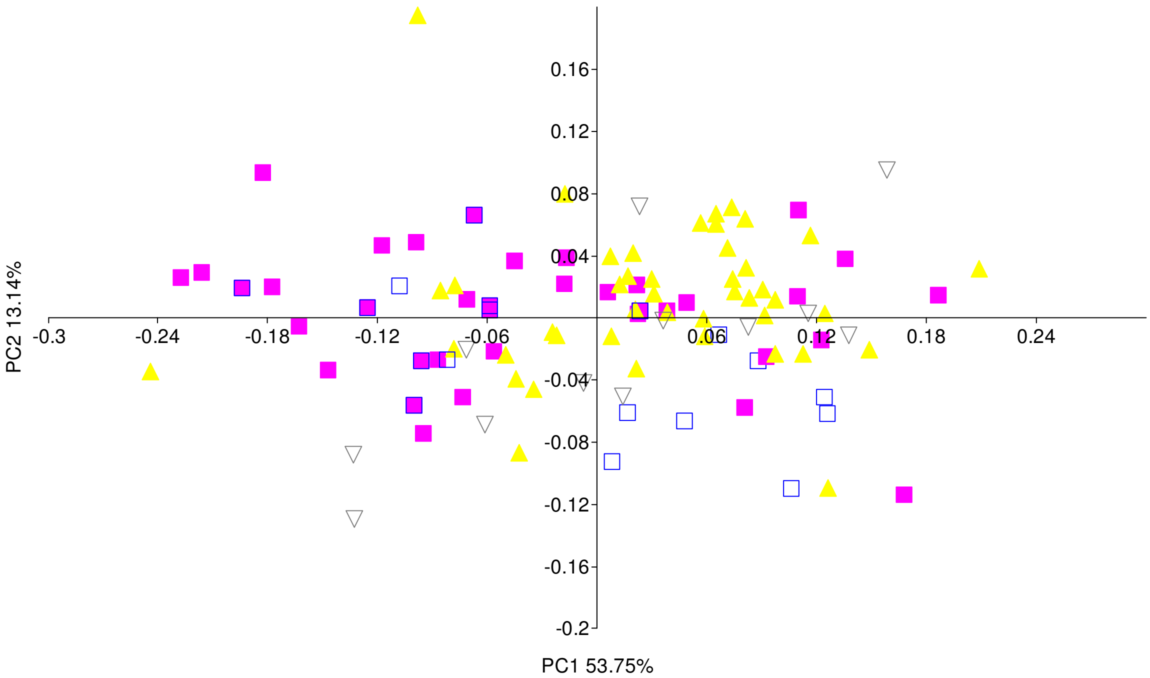


Figure 4.4 Scatterplot of Principle Component Scores (PC1 and PC2) for *G. molossus* from Northern Thailand. □:WB, ■:TS-SS, ▽: BT, △: MR-MP

Table 4.5 Factor loadings of analyzed morphometric characters on principal components for *G. molossus* from North of Thailand.

Variables	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7
SVL	0.3843	0.0095	-0.0341	0.2644	0.4719	-0.4497	-0.5228
HW	0.2000	-0.0208	0.0323	0.1682	0.3488	0.5015	0.4435
HL	0.4653	-0.6964	0.2621	-0.4742	-0.0195	0.0154	0.0051
IND	0.2877	-0.0775	0.0515	0.4699	-0.4112	0.5451	-0.4572
END	0.4457	0.2890	-0.7358	-0.3730	-0.0089	0.1572	-0.0123
EN	0.3989	0.0571	-0.0101	0.2895	-0.5577	-0.4673	0.4384
FL	0.2568	0.0043	0.0680	0.3679	0.4181	0.0088	0.3529
TL	0.2990	0.6494	0.6167	-0.3128	-0.0155	0.0755	-0.0626
% of variance	53.76	13.14	12.21	7.66	5.99	3.27	2.28

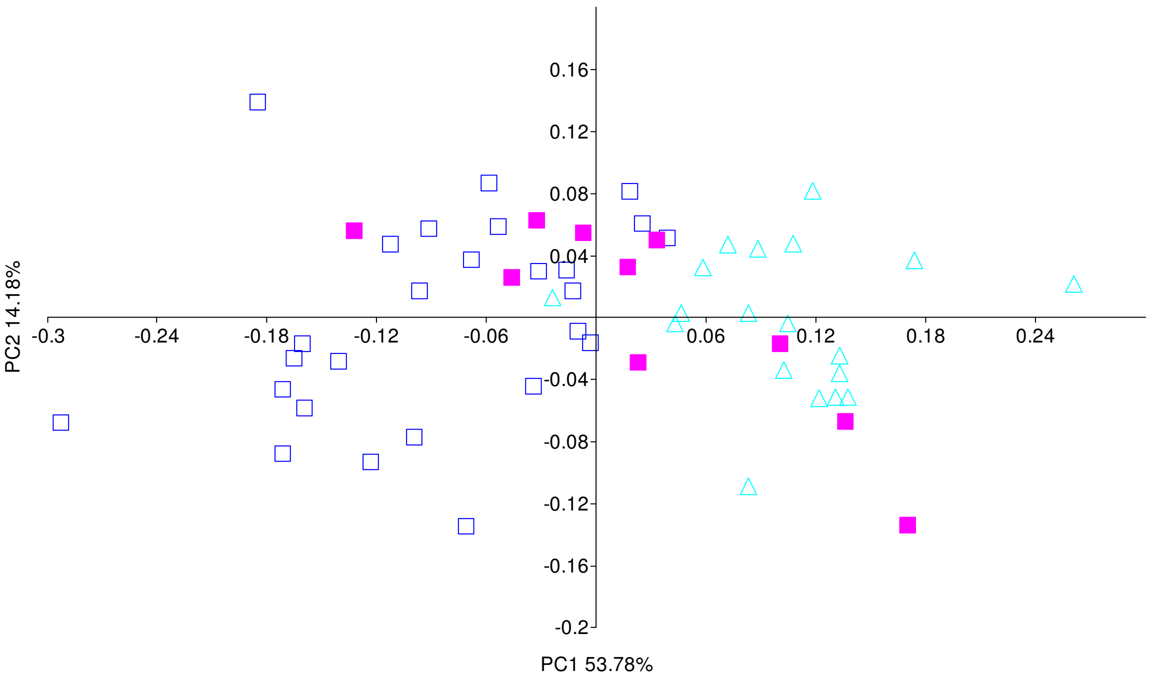


Figure 4.5 Scatterplot of Principle Component Scores (PC1 and PC2) for *G. molossus* from Central Thailand. △: ML, □: LS-MU, ■: DC

Table 4.6 Factor loadings of analyzed morphometric characters on principal components for *G. molossus* from Central of Thailand.

Variables	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7
SVL	0.4501	0.2366	-0.2691	0.0430	-0.2838	-0.2259	0.4724
HW	0.2017	0.0772	-0.0013	0.1097	-0.0132	-0.1382	0.5851
HL	0.0670	0.1465	0.56400	0.7333	0.2421	0.1214	0.0991
IND	0.3397	0.4324	-0.0537	0.1298	-0.5092	0.4531	-0.4011
END	0.3076	-0.7100	-0.4153	0.4439	-0.0174	0.1267	-0.117
EN	0.2628	0.1631	-0.2287	-0.2298	0.6502	0.5892	0.1611
FL	0.4117	0.2466	-0.1102	0.0538	0.4131	-0.5881	-0.4726
TL	0.5511	-0.3716	0.6080	-0.4229	-0.0877	0.0286	-0.0227
% of variance	53.78	14.18	11.16	8.03	5.35	4.49	2.24

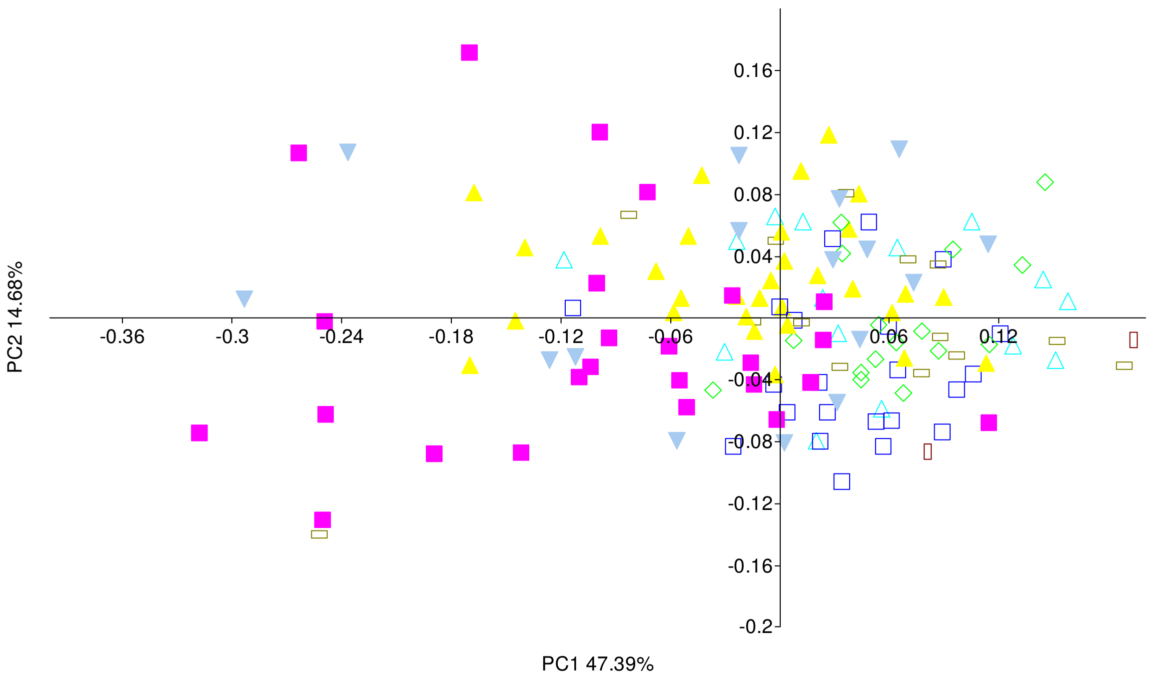


Figure 4.6 Scatterplot of Principle Component Scores (PC1 and PC2) for *G. molossus* from Northeastern Thailand. □: PT, ▽: KL, ◇: NW, △: KM-MK, ▭ : ST, ▯: PP, ▼: MM, ■:PP-SD, ▲:KR

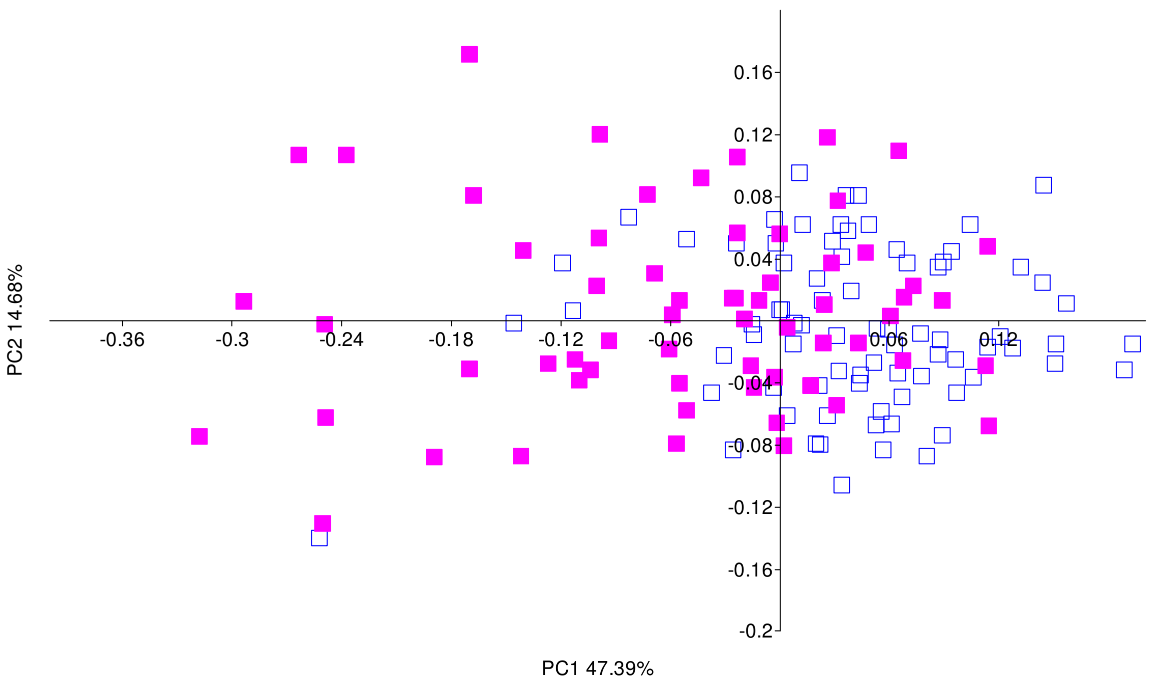


Figure 4.7 Scatterplot of Principle Component Scores (PC1 and PC2) for *G. molossus* from Northeastern Thailand. **Abbreviations:** ■, Sakon Nakhorn basin □, Khorat basin

Table 4.7 Factor loadings of analyzed morphometric characters on principal components for *G. molussus* from Northeastern of Thailand.

Variables	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7
SVL	0.8295	-0.2422	-0.3225	0.0421	-0.0888	-0.1495	-0.1831
HW	0.8683	-0.1480	-0.1612	-0.1562	-0.0061	-0.1383	-0.2683
HL	0.7375	-0.0655	0.2689	0.4020	-0.2774	-0.2657	0.2594
IND	0.5199	0.6226	0.3652	-0.3835	-0.2139	-0.0512	-0.0886
END	0.5171	0.6286	-0.2889	0.3887	0.3197	0.0204	-0.0089
EN	0.7572	-0.1591	0.3091	0.2370	-0.0697	0.4767	-0.1321
TL	0.7358	0.0033	-0.4201	-0.3182	-0.1122	0.2134	0.3493
FL	0.6846	-0.2234	0.3561	-0.2086	0.5331	-0.0902	0.1274
% of variance	47.39	14.68	9.22	6.58	4.68	3.95	4.20

4.2.3.3 Morphological variation between regions

1) Analysis of variance (one-way ANOVA) Analysis

One-way ANOVA showed that there were significant differences in HL, IND and END of character among the three regions (Table 4.8). A result from Post Hoc Tests presents significant differences between North and Central region in 2 character; IND and END, significant differences between North and Northeastern region in 3 character HL, IND and END. Central region is significant different from Northeastern region only HL. Whereas, Northeastern region significant differences from other region in IND.

Table 4.8 Descriptive statistics of 8 characters to mean snout-vent length and Analysis of Variance of samples' morphological characters (significant differences (p < 0.01) among each region are indicated by differences in superscript letter

Characters	Mean ± SE (Minimum-Maximum)			ANOVA	
	North (N:112) (M:83, F: 29)	Central (N:55) (M: 41, F:13, Un: 1)	Northeastern (N: 87) (M:92, F:46 Un: 4)	F	*p*
SVL	62.24(a)± 0.62 (46.52 - 94.89)	59.24(a)± 1.02 (40.73-79.03)	60.75(a)± 0.39 (40.73-94.89)	4.691	0.010
HW	15.89(a)± 0.10 (12.90 – 18.90)	15.62(a)± 0.13 (13.10 – 17.80)	15.89(a)± 0.06 (12.00 – 18.90)	1.734	0.178
HL	10.24(a)± 0.13 (5.39 – 15.13)	9.59(a)± 0.14 (7.90 – 12.61)	10.48(b)± 0.08 (5.39 – 15.13)	15.419	0.000
IND	4.97(a)± 0.04 (3.86-6.64)	4.85(ab)± 0.08 (3.66 – 6.69)	4.79(b)± 0.02 (3.48-6.69)	16.385	0.000
END	2.19(a)± 0.08 (1.58 - 2.93)	2.37(bc)± 0.04 (1.67 – 3.25)	2.33(bc)± 0.01 (1.41 – 3.25)	16.410	0.000
EN	8.03(a)± 0.08 (6.18- 10.06)	7.75(a)± 0.11 (6.15 – 10.75)	7.98(ab)± 0.04 (5.28 – 10.75)	2.723	0.067
TL	22.05(a)± 0.16 (17.12 - 26.80)	21.12(a)± 0.37 (14.69-30.26)	21.62(a)± 0.12 (11.29 – 30.26)	4.551	0.011
FL	10.66(a)± 0.12 (7.79 - 13.56)	10.04(a)± 0.26 (6.56 – 19.45)	10.52(a)± 0.08 (6.56 – 19.45)	4.780	0.009

2) Principle components analysis

Results from PCA analysis in among group were present the efficiently values of each variables in PC1-PC8 loading. The first three principle components explained 73.77 % of the total variability (Table 4.7). For PC1, forelimb length (FL) showed the highest positive loadings. On the other hand, Eye-nostril distance (END) showed the highest nagative loading for PC2 (Table 4.9). Although, scatterplot of PCA shows overlap areas in among regions but the Central region rather separated from other regions along PC1 axis. Meanwhile, the Northeastern region was separated from other regions along PC2. Meanwhile, the Central and Northern group were separated from Northeastern region (among Khorat and Sakon Nakhon Basin) along the PC2 axis (Fig.4.8).

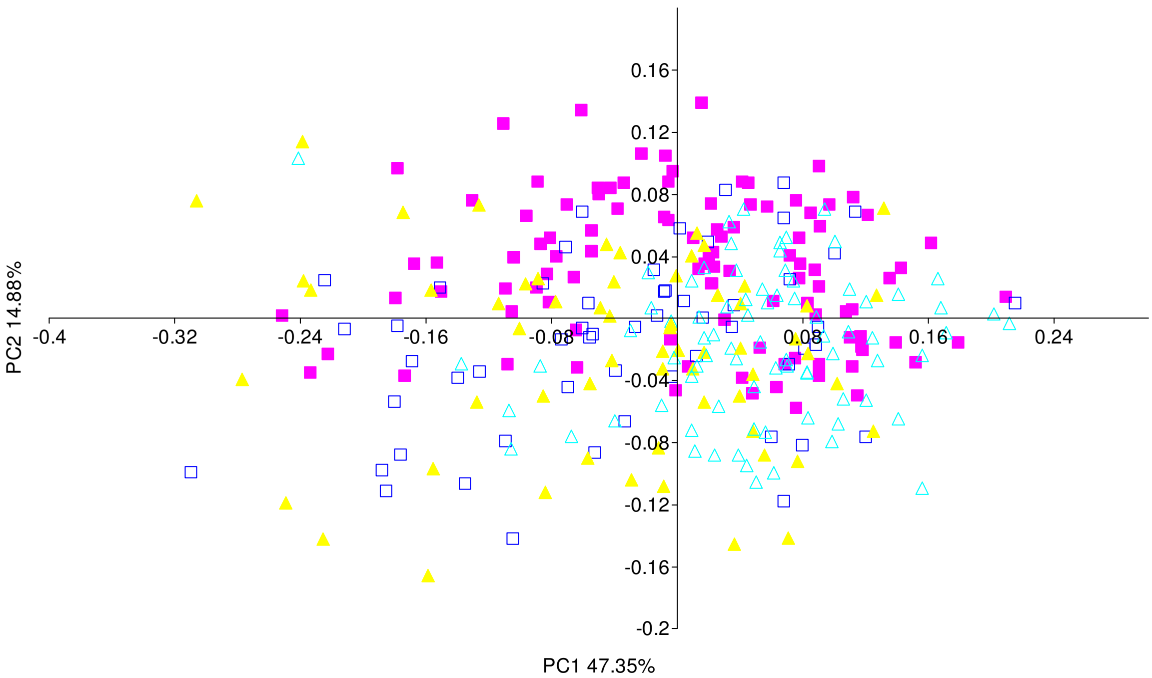


Figure 4.8 Scatterplot of Principle Component Scores (PC1 and PC2) for *G. molussus* from Thailand. ■: Northern region, □: Central region, △: Khorat basin ▲: Sakhon Nakhon basin

Table 4.9 Factor loadings of analyzed morphometric characters on principal components for *G. molussus* from Thailand.

Variables	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7
SVL	0.4080	0.1404	0.0562	0.3334	-0.4223	0.0080	-0.6421
HW	0.2401	0.0684	0.0034	0.1056	-0.2177	0.0651	-0.1104
HL	0.3976	-0.1154	-0.8543	-0.2238	0.0129	0.1989	0.0656
IND	0.2524	0.1874	0.0634	0.4203	0.7739	0.3363	-0.0897
END	0.3906	-0.8413	0.3448	-0.0833	0.0544	0.0980	0.0276
EN	0.3437	0.0354	-0.0688	0.0883	0.2360	-0.8969	0.0855
TL	0.3221	0.1844	0.1216	0.3773	-0.3343	0.1374	0.7449
FL	0.4239	0.4291	0.3530	-0.7027	0.0694	0.1009	0.0115
% of variance	47.35	14.88	11.54	9.91	6.75	4.70	3.01

3.) Discriminant function analysis (DFA)

Functions at group centriod are shown in Figure 4.8. Two discriminant functions were recognized in the analysis. All characters showed significance for both the test function 1 through 2, 2 through 3 and 3 (Wilk's Lambda 0.373, 0.698 and 0.928 *P* 0.000, 0.000 and 0.000 respectively). Function 1 explained 68.0 % of the variance, while function 2 explained 25.8 % of Variance. The scatter plot of DFA analysis was retrieved separately for among locality. Although this analysis showed that some overlap in function1 but Function 2 quite separated the Northeastern group (both of Khorat and Sakon Nakhon basin population) from North and Central groups (Fig 4.9).

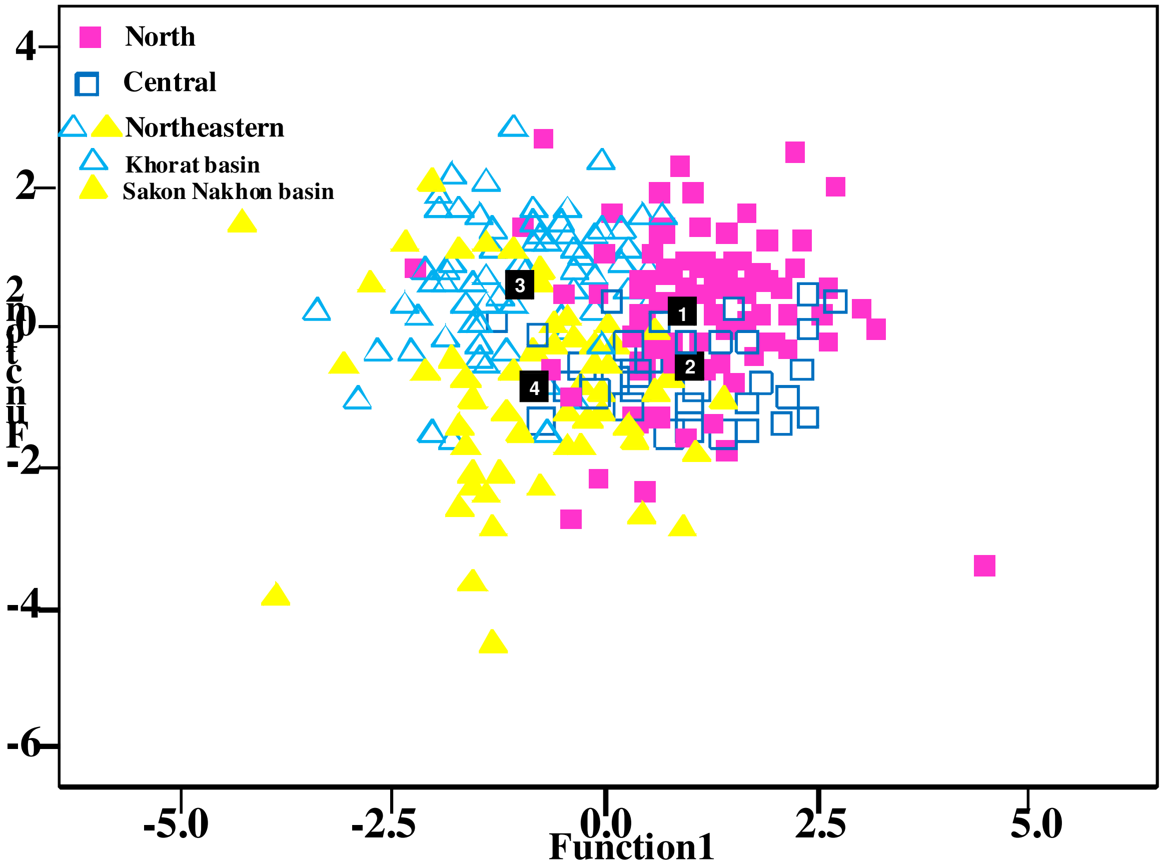


Figure 4.9 Canonical discriminant plot for *G. molussus* from Thailand

4.3 Geometric morphometrics analysis

4.3.1 Skull description

A description of the skeleton based on specimens in this study is given in this section (Fig 4.10).

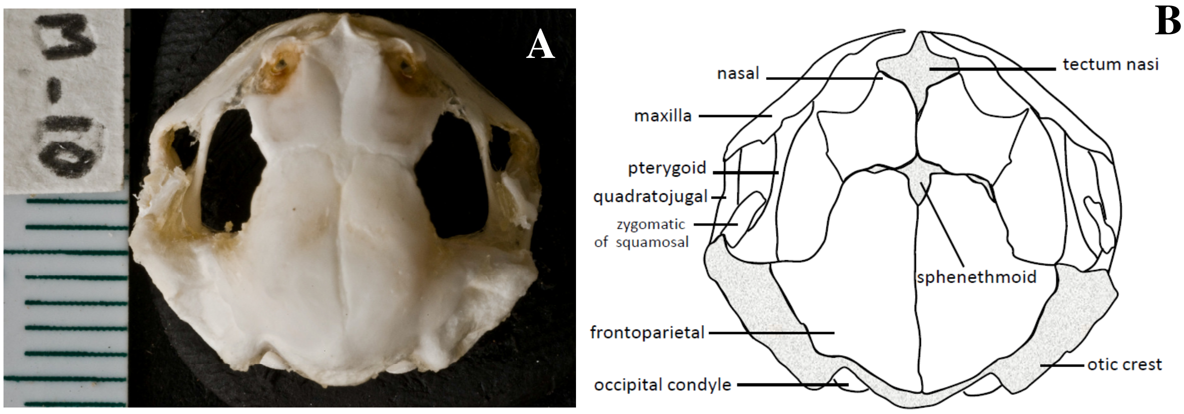


Figure 4.10 Skull of *Glyphoglossus molossus* in dorsal view. Photograph (**A**) and drawing (**B**)

Cranium Shape and Proportion:

Maxillary Arcade: the upper jaw is complete and formed by premaxillae, maxillae, and quadratojugal. The maxilla subtends approximately less than 50% of the total length of the skull; Pterygoid rather slender and long. Each pterygoid possesses well-developed both anterior and posterior end. Quadratojugals are rather short and straightly. The anterior tip is slightly overlapped by the maxilla laterally. Each quadratojugal also articulates with the venterior tip of the squamosal.

Nasal Capsules: the septomaxilla is rather distinguished, adjacent with nasal bones. The anterolateral borders of each nasal are rather concave whereas posteromedially of these bones are adjadent with both of sphenethmoid and frontoparietals bone.

Frontoprietal: dermal roofing bone is about 50 or more than 50% of its length. The lateral border is convex, and posterior portion is expanded and rounded. Anteriorly, the frontoparietal cover on some part of spenethmoid. Medially, the anteriorly border present separated from each frontoparietal whereas, most part of the frontoparietals are narrowly separated from one another.

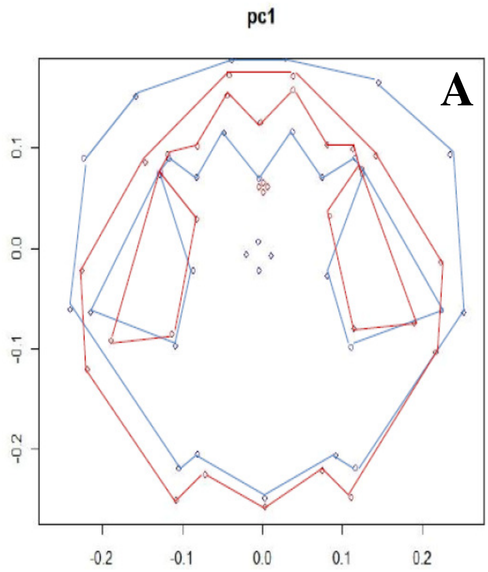
Endocranial Braincase: the endocranial braincase is composed of pairs of cartilage replacement (endochondal) bones; sphenethmoid, prootics and exoccipitals. The degree of ossification of the otic capsule (prootics and exoccipitals) and sphenethmoid differ in the sample, from full ossified to incompletely ossifiled. All of these bones covered by frontoparietals and nasal dorsally. Sphenethmoid is dorsally visible in the space between the nasals and frontoparietals. Dorsally of each exoccipital bears a well-developed otic crest. The occipital condyles have moderately distinct stalks and have curved articular surfaces that face posteromedially.

4.3.2 Patterns of variation

4.3.2.1 Skull pattern

PCA analysis shows skull variation along pc1 and pc2 axis.

PC1 (Fig. 4.11) shows that the minimum (highest negative) character is rather wide and short skull as same as orbit shape which rater short and wide more than the maximum (highest positive) character. Distant between posterior border of maxilla and otic crest of minimum is longer than maximum character. Distant between each orbit of maximum character is less than minimum character. The anterolateral borders of nasal bone in minimum character are more concave than maximum character. Sphenethmoid is dorsally visible in the space between the nasals and frontoparietals in minimum character but absent in maximum character. The otic crest of maximum character is stronger than minimum character.



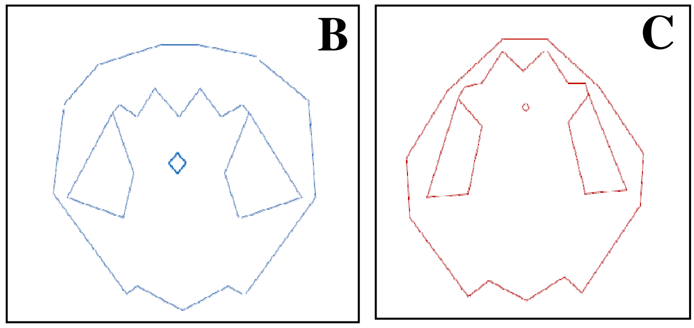


Figure 4.11 reconstructed configurations to the extreme difference along pc1 axis. Extreme minimum and maximum character along pc1 axis (A), minimum (B), maximum (C)

PC2 (Fig. 4.12) shows that the minimum (highest negative) character is rather narrow and longer than the maximum (highest positive) character. Distant between posterior border of maxilla and otic crest of minimum is longer than maximum character. The orbit shape of minimum rater long and narow more than the maximum (highest positive) character, distant between each orbit of maximum character is less than minimum character. The anterolateral borders of nasal bone in minimum character are concave as same as maximum character. Sphenethmoid is dorsally visible in the space between the nasals and frontoparietals in minimum character but absent in maximum character. The otic crest of than minimum character is stronger maximum character.

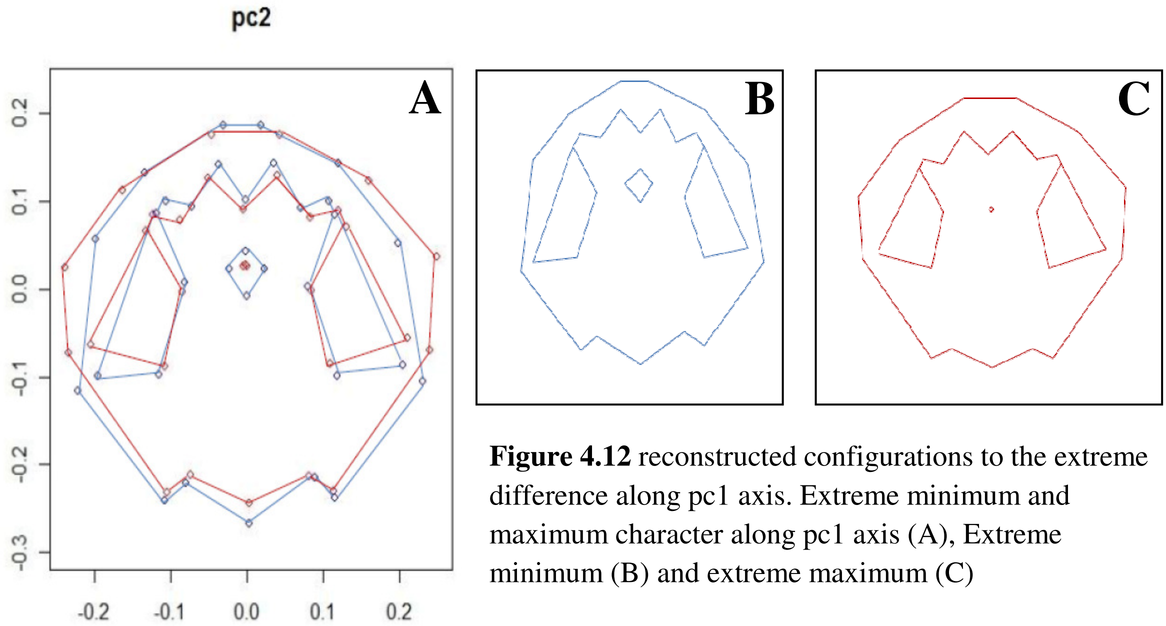


Figure 4.12 reconstructed configurations to the extreme difference along pc1 axis. Extreme minimum and maximum character along pc1 axis (A), Extreme minimum (B) and extreme maximum (C)

4.3.2.2 Pattern of variation

Size and shape variation were found in this study. In case of size, results of ANOVA indicated that size were significant different in both of sex and locality. Meanwhile, MANOVA found that there is a sex dimorphism and locality effect, but no interaction between sex and locality (Table 4.10).

Scatter pot of PCA analysis presented that some overlap area in among regions. However most of northeastern population is rather separated from among regions along both on PC1 and PC2 axis. Most of north and central population present on negative zone in PC1 and positive zone of PC2. Meanwhile, most of northeastern population present on positive zone in PC1 and negative zone of PC2 (Fig 4.12). This result according with discriminant analysis separated G. molossus of Thailand in to two groups (North and Central group and Northeastern group) (Fig 4.13).

Table 4.10 Assessment of the morphological variation

Size variation: ANOVA of individual centroid size					
Factor	*df*	Sum of squares	Mean of squares	*F*	*P*
Sex	1	52.19	52.187	6.13351	0.01381*
Locality	2	65.50	32.751	3.8502	0.02234*
Sex*Locality	2	53.99	26.996	3.1736	0.04327*

Shape variation: MANOVA of shape principle components						
Factor	*df*	Pillai	*F*	*df num*	*df den*	*P*
Sex	1	0.26266	1.4249	60	240	0.03345*
Locality	2	1.11347	5.0449	120	482	$< 10^{-16}$***
Sex*Locality	2	0.38959	0.9717	120	482	0.56715
Residuals	299					

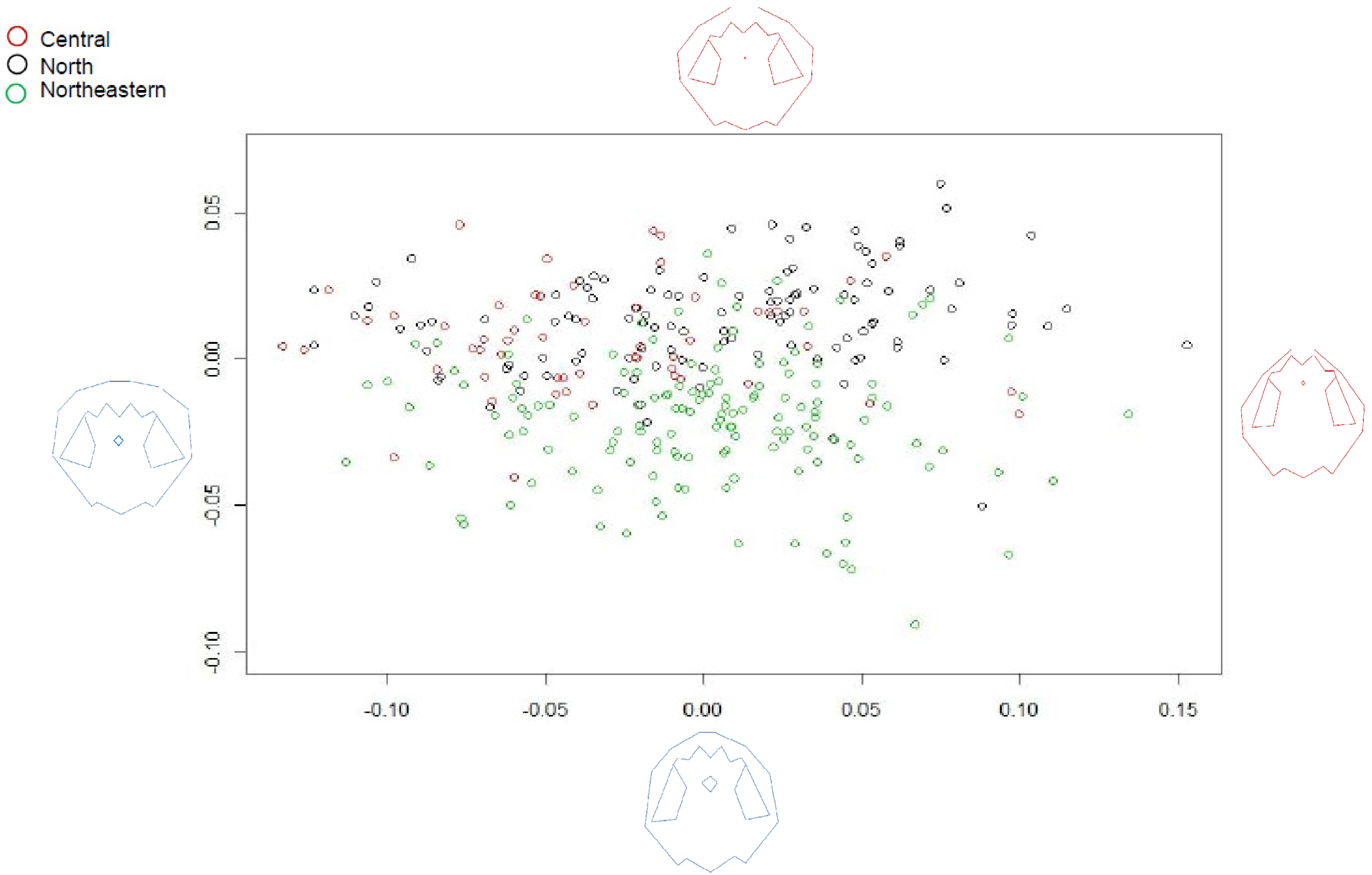


Figure 4.13 scatter port of principal components analysis in among regions for *Glyphogossus molossus* skull in dorsal view.

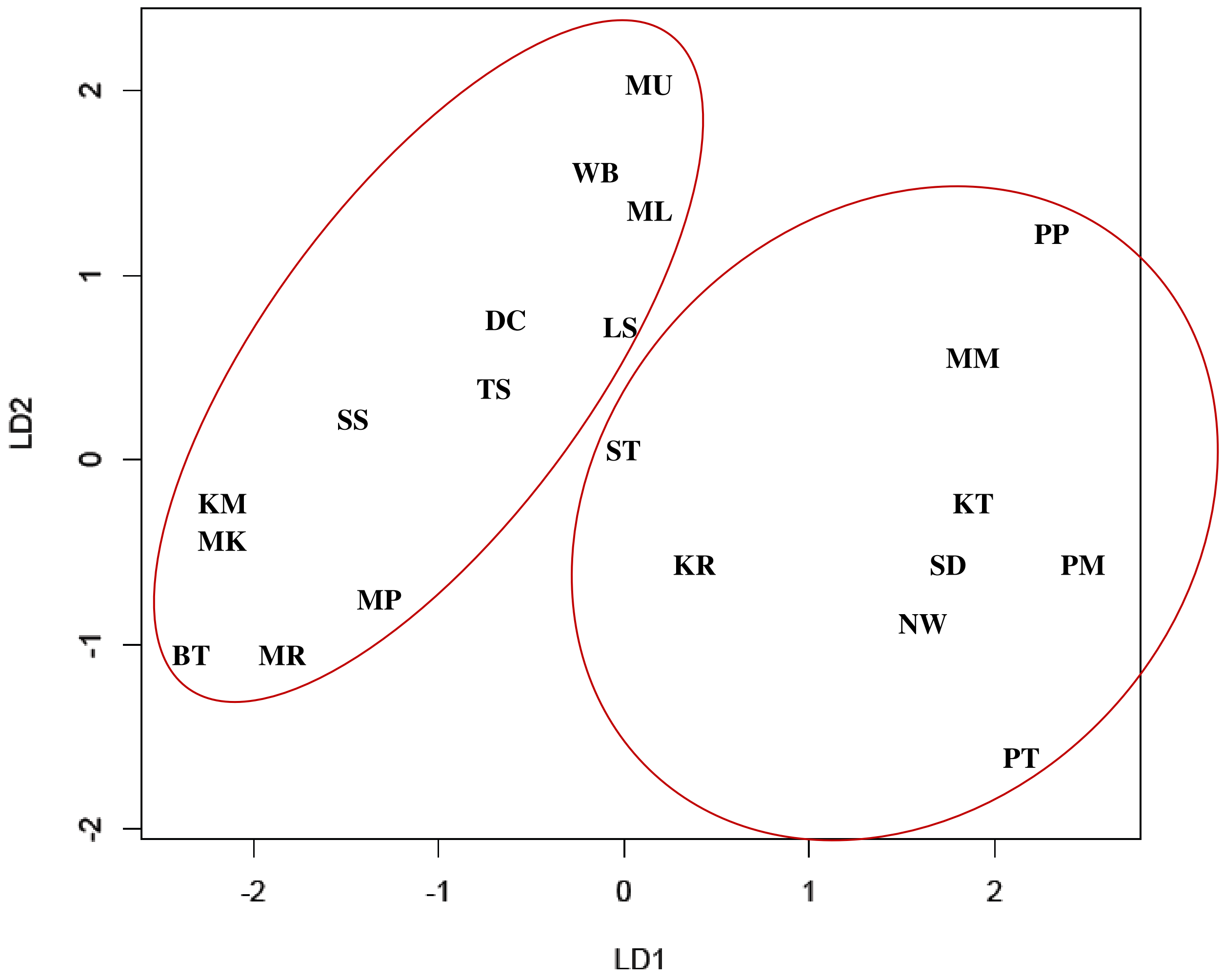


Figure 4.134scatter port of discriminant analysis of shape coordinates

CHAPTER 5

DISCUSSION AND CONCLUSION

5.1 Discussion

5.1.1 Sexual Dimorphism

Sexual dimorphism of amphibian were found in several morphological characters such as body size, forelimb size and shape, skin texture, cloacal modifications and coloration (Duellman and Trueb, 1994). In this study, the results of t-test from each region indicated that there is no sexual dimorphism in *G. molossus*, from Thailand, in size and shape point of views. Observation, coloration differences between sexes were found; males had a triangular blackish piece of skin on the floor of the mouth (vocal sac). This results support Khonsue (2004) suggested that triangular blackish on the floor of the mouth were found only adult males of *G. molossus* in breeding season. Concerning coloration between sexes, males of many species of amphibians develop pigmented vocal sac during the breeding season. Many species of anuran, the throats of male become gray or black (Duellman and Trueb, 1994). Scztatecsny et al., (2010) found that, coloration differences in anuran unrelated to the body size but related with environment and mating behavior. Thus, comparisons of coloration between sexes and mating behavior of *G. molossus* should be studied in the future.

5.1.2 Relation between body size and physical factors

Because of amphibians are ectotherm and have a permeable body covering. Thus, they are more sensitive with environment than other tetrapod. In this study, relationship between body size and environments were test. The results of body size comparison in differences environment factors indicated that body size of *G. molossus* in Thailand is unrelated to latitude but related to temperature humidity and total of rainfall. Bergmann's rule predicts that body size within species were increases with latitude and decrease with temperature. In case of this study, the results of relationship between temperature and body size in this study converse Bergman's rule. Although, several studies indicated that endothermic animals are support this rules (Ashton, 2002;

Belk and Houston, 2002; Ashton and Feldman, 2003; Cvetkovic et al, 2005; Kingsolver and Huey, 2008) but many ectotherms have been found both of follow and converse this rule (Laugen et al., 2005). Concerning pattern of body size in differences temperature area were explained by heat balance hypothesis; thermoregulator and thermoconformes; thermoragulator states that larger animal would be suitable in cold environment due to their reduced surface to volume ratios and greater heat conservation potentials. In the other hand, thermoconformers suggested that smaller animal would be suitable in cold environment as their greater surface to volume ratios allow them to have shorter heating time (Ashton, 2002; Miguel et al., 2007). Normally, the ability of animal to make physiological and/or behavioural adjusted to obtain heat (thermolagulators) were found in endotherms. In the other hand many species amphibian do not behaviorally thermoraguleted (Adums and Church, 2008) because the difficulties these animals have in reaching active body temperatures might leave them with insufficient time for foraging or reproduction in the short activity windows available in cold regions. in contrast, smaller sizes would favors a rapid heating, thus allowing the animals to take advantage of these short time segments in which benign environmental conditions allow them to be active (Ashton, 2002; Laugen et al., 2005; Miguel et al., 2007). In case of precipitation factor (humidity and total of rainfall), this study found that, body size of *G. molossus* were increased in dry area. This result supports many previous researches which indicated that larger individual have better desiccation to tolerance than smaller individual (Laugen et al., 2005; Miguel et al., 2007; Chen and Lu, 2011). Moreover, Márquez et al., (2009) found that post metamorphic amphibian were increased body size in low desiccation because in high desiccation pond which high competition, individuals who have smaller sizes and shorter legs would have lower survival probabilities. This appears to be the best explanation for our finding.

5.1.3 Relation between morphometric variables

Significantly correlations among morphometric measurements indicated that during growth head and limb size of *G. molossus* developed with body size. However, the less correlation between internarial distance (IND) and eye-nostril distand (END) as well as less correlation between Internarial distance and head length (HL), indicated that size of head organism independent from head size. This result supported previous researches which indicated that cranial components may be unrelated to the size of organism (Emerson and Bramble, 1993; Trueb, 1993; Amor et al., 2009).

5.1.4 Geographic Variation

The result confirmed significant geographical variation in both the size and shape of *G. molossus* in Thailand. In this study, size variation was found in both of within and between regions. In case of variation within region, although mean temperature of Lampang and Tak lower than Phetchabun and Sukhothai but they also have higher precipitation. This probably reason which found that populations sampled in northern could not separated into two groups. In contrast central region could be clearly separated into two groups (Lomburi and Uthai Thani), Lomburi had larger body size than Uthai Thani because high temperature and dry environment were found in Lomburi. In case of northeastern region, although temperature of all province rather less differences but total rainfall of Sakon Nakhon Basin quite higher than Khorat Basin. This appears to be the best explanation for our findings, in that the most of sample from Sakon Nakhon smaller than Khorat Basin. Therefore, this could cause the sample from Sakon Nakhon to evolve a smaller body size.

In case of variation between regions, although some overlap area was found but all of statistic analysis shows that both of size and shape variation were found. For size variation, PCA analysis shows that most of sample from central region and Sakon Nakhon basin were characterized from the most of sample from north and central regions along PC1 axis. This results because of high temperature (in central region) and high precipitation (in Sakon Nakhon basin).

Concerning shape variation, the northern and central regions were separated from the northeastern region along the PC2 axis. Several characters related to head size and shape especially Eye-nostril distance (END) showed the highest nagative loading for PC2. Therefore, these characters are strongly variable and could be used for preliminary identification and separation of the northern and central *G. molossus* from the Northeastern group. The result is similar to previous reports on several amphibians which found morphological variations in amphibians' heads from different locations (Babik et al., 2000; Morrison and Hero, 2003; Taminaga et al., 2005 and Amor et al., 2009). Emerson and Bramble (1993) indicated that head morphology trait of amphibians were varied independently of body size. Moreover, many adaptive explanations for head variation have been found during the developmental stages (Blouing and Brown, 2000) and due to genetic variation in adults (Vieira et al., 2008). These reports suggest that head variation is probably not only due to geography but also affected by genetics and age. Thus, G. molussus should be studied using genetic techniques and skeletochronology which could explain the shape variation in this animal in the future.

Although, the result of discriminant function analysis (DFA) showed some overlap between frogs from different samples, the northeastern group was separated from the other regions along function 1. Additionally, the samples from the northeastern group can be visibly divided into the Khorat Basin and Sakon Nakhon Basin along function 2 with little overlap. In case of geographic structure, the Northeastern region is divided from the other regions by the Phetchabun, Dong Pha Ya Yen and Sankampeang mountain ranges, whereas the Khorat Basin is separated from the Sakon Nakhon Basin by the Phu Phan range. These mountain ranges are important physical factor or geographic barriers that can cause genetic isolation and phenotypic divergence (Schauble 2004 and Futuyma 2005).

5.1.5 Geometric morphometrics analysis

Observation in this study found that, cranium of *G. molossus* consists of maxilla subtends approximately less than 50% of the total length of the skull, whereas frontopraietal bone is about 50 or more than 50% of its length. The degree of ossification of the otic capsule (prootics and exoccipitals) and sphenethmoid differ in the sample, from full ossified to incompletely ossifiled.

All of statistics analysis confirmed significant variation in case of size, size and geographical variation. Scatter pot of discriminant analysis separated *G. molossus* from Thailand in to two groups (Noth and Central group and Northeastern group). This result according with PCA analysis presented that most of north and central sample present on negative zone in PC1 and positive zone of PC2 which the cranium character shows that rather short and wide skull similarly shape of eyes (short and wide). Meanwhile, most of northeastern population present on positive zone in PC1 and negative zone of PC2. The cranium character shows that rather narrow and wide and long as same as shape of eyes which rather long and narrow.

Result of traditional morphometrics shows morphological variation in both of size and shape. Geometric morphometrics results support both of shape and size variation Moreover, sexual dimorphism in both of size and shape were present in geometric morphometrics analysis. Geometric morphometrics analysis also separated sample from northeastern region from among regions by eyes character probably because of shape of cranium organism and cranium shape are unrelated with body size (Emerson and Bramble, 1993). This result could be more evident which indicated that biogeographic barrier is the strongly factor which increased genetic isolation between population.

5.2 Conclusions

The morphological study of *G. molossus* from Thailand reveals that Sexual dimorphism in both of size and shape was not found in external character but present in skull. Meanwhile, variations in shape and size between regions were found. This study indicated that environment is the strongly factor for morphological variation in both of size and shape. In case of size, the greatest influencing factor is temperature and precipitation. Body size increased in high temperature and low precipitation. On the other hand, biogeographic barriers are the strongest factor relating to shape variation of *G. molossus.* Results above according with Geometric morphometrics which found that head organism variation in among regions.

5.3 Recommendation

Although this analysis indicates that the pattern of morphometric variation in *G. molossus* of Thailand probably results from physical factors. However, some overlap area was found. This results probably that, *G. molossus* is one of anuran member which commonly found in local market thus human carrying probably the factor which reduced genetic isolated process. Moreover, although this study could be present morphological variation in *G. molossus* of Thailand in both of size and shape but morphological differentiation in animals is thought to be influenced not only by environmental but also by genetic and age factors. Thus, genetic and skeletochronology studies are need.

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APPENDIX

SPECIMENS AND MORPHOLOGICAL DATA

NO.	PIC. No.	ID	LOCA LITY	SEX	SVL	HW	HL	IND	END	EN	TL	FL
1	001	PB01	1	1	62.49	15.80	12.41	4.98	2.22	7.41	20.02	9.44
2	002	PB02	1	1	58.75	18.90	12.30	4.78	2.48	7.40	22.97	9.78
3	003	PB03	1	2	66.72	18.78	12.26	5.65	2.50	8.44	25.89	8.37
4	004	PB04	1	2	58.61	15.86	11.46	5.11	2.42	8.33	19.56	9.26
5	005	PB05	1	1	65.00	16.25	12.38	5.04	2.16	8.58	23.99	11.85
6	006	PB06	1	2	66.49	18.33	11.91	5.69	2.56	8.57	26.80	9.50
7	007	PB07	1	2	65.82	16.47	11.29	4.94	2.26	8.00	25.50	11.21
8	008	PB09	1	1	94.89	16.86	11.55	4.89	2.69	7.93	22.35	9.18
9	009	TS02	1	1	67.10	16.27	11.98	6.21	2.84	9.55	24.23	11.94
10	010	TS05	1	2	67.65	15.07	11.63	5.61	2.54	9.11	22.37	13.07
11	011	TS06	1	1	65.87	15.24	11.75	5.11	2.53	8.88	22.89	12.07
12	012	TS07	1	1	54.61	13.81	10.59	4.69	1.95	8.11	19.85	9.60
13	013	TS08	1	1	65.12	16.60	12.89	4.76	2.45	8.65	20.07	10.46
14	014	TS09	1	2	63.92	15.57	12.19	5.38	2.37	9.13	20.61	11.32
15	015	TS11	1	1	60.77	15.92	12.40	5.44	2.67	9.25	21.78	11.37
16	016	TS12	1	1	70.36	17.32	15.13	5.21	2.52	9.11	23.38	10.10
17	017	TS13	1	2	60.18	14.86	11.07	4.71	2.16	8.10	21.76	12.45
18	018	TS20	1	1	61.08	15.67	9.92	5.79	2.20	7.21	22.51	11.18
19	019	SS02	1	1	67.80	17.65	10.10	5.29	2.13	8.16	24.40	11.09
20	020	SS03	1	1	64.14	17.06	10.58	5.44	2.12	7.60	23.55	11.57
21	021	SS05	1	1	52.84	15.25	8.66	4.74	1.85	7.59	19.88	8.51
22	022	SS06	1	1	53.58	15.23	8.67	4.96	1.89	7.40	20.33	11.39
23	023	SS07	1	1	57.68	15.33	9.98	4.51	2.12	6.70	19.89	11.00
24	024	SS08	1	1	60.15	16.53	9.89	4.86	2.07	7.43	22.57	11.43
25	025	SS09	1	1	61.29	17.09	9.41	5.31	2.14	7.01	21.94	11.53
26	026	SS10	1	1	48.98	13.93	8.41	4.72	2.01	6.61	17.71	9.72
27	027	SS11	1	2	64.97	16.36	10.05	5.28	2.74	9.31	23.06	12.02
28	028	SS12	1	1	61.32	15.91	9.13	4.96	1.90	7.16	21.81	8.30
29	029	SS13	1	1	56.79	15.95	9.56	4.63	2.31	7.64	21.27	8.93
30	030	SS14	1	1	55.47	15.42	9.45	4.37	1.65	6.97	20.78	11.31
31	031	SS15	1	1	58.68	15.85	9.88	4.68	1.91	7.27	21.51	11.12
32	032	SS16	1	1	57.20	15.56	9.56	4.91	2.07	7.21	21.46	10.52
33	033	SS17	1	1	62.43	17.05	9.99	5.12	2.22	8.30	23.04	10.42
34	034	SS18	1	1	56.33	16.27	9.58	4.72	1.94	7.81	21.35	11.89
35	035	SS19	1	1	53.71	15.64	8.40	4.09	1.68	6.19	19.98	10.39
36	036	SS20	1	2	61.51	14.75	9.18	4.83	1.84	7.43	21.23	9.30
37	037	SS21	1	2	61.30	15.43	9.46	4.69	1.99	7.46	21.63	7.82
38	038	SS22	1	1	52.50	14.92	7.85	4.58	2.17	7.23	19.60	7.89
39	039	SS23	1	1	53.34	14.85	7.39	3.86	2.02	6.62	19.82	10.71

SPECIMENS AND MORPHOLOGICAL DATA

NO.	PIC. No.	ID	LOCALITY	SEX	SVL	HW	HL	IND	END	EN	TL	FL
40	040	SS24	1	1	57.43	14.43	8.69	4.15	2.32	8.01	20.43	10.76
41	041	SS25	1	1	55.08	15.24	8.72	4.31	2.13	6.62	19.82	10.71
42	042	SS26	1	1	60.62	17.27	9.78	5.18	2.26	8.68	22.98	10.15
43	043	SS27	1	1	57.85	15.82	9.44	4.73	1.92	7.47	21.16	9.41
44	044	SS28	1	1	49.60	12.90	7.69	4.30	2.12	6.30	17.12	8.73
45	045	SS29	1	1	50.15	13.00	7.35	4.32	2.08	6.94	18.53	8.42
46	046	DL01	1	2	65.85	17.52	11.70	5.19	2.23	9.15	24.98	12.25
47	047	DL02	1	1	69.70	17.54	9.65	6.64	2.61	9.89	22.41	13.18
48	048	DL03	1	1	61.22	16.52	11.47	5.41	2.61	8.25	21.73	11.00
49	049	MP01	1	2	65.80	15.60	10.54	4.66	2.14	8.33	22.05	11.97
50	050	MP02	1	1	57.33	14.28	11.11	5.06	1.74	8.67	22.43	9.39
51	051	MP03	1	1	68.90	16.08	14.00	5.65	2.32	8.61	23.64	9.92
52	052	MP05	1	2	78.13	18.87	11.99	5.54	2.71	9.81	22.78	12.80
53	053	MP06	1	2	76.91	15.70	11.67	5.05	2.59	10.06	24.42	10.34
54	054	MP07	1	1	64.83	15.72	12.33	5.45	2.12	9.04	22.92	12.12
55	055	MP08	1	1	62.39	15.94	10.28	5.47	1.76	8.63	23.81	11.34
56	056	MP10	1	2	66.72	16.30	11.68	5.18	2.59	9.50	22.30	11.38
57	057	MP11	1	2	67.20	16.85	12.00	5.65	2.12	9.42	23.05	11.80
58	058	MP13	1	2	67.12	16.28	10.61	5.51	2.36	9.31	21.93	11.41
59	059	MP14	1	1	66.10	15.08	10.55	4.79	2.64	8.73	22.45	9.96
60	060	MP15	1	1	67.66	16.51	10.28	5.06	2.04	7.91	23.65	11.68
61	061	MP16	1	2	60.84	14.90	10.21	5.47	1.83	8.16	20.38	11.23
62	062	MP17	1	1	68.64	16.87	10.78	5.33	2.05	9.22	23.68	12.08
63	063	MP18	1	1	65.41	14.47	10.21	5.33	2.04	8.61	22.25	11.14
64	064	MP19	1	1	65.80	16.93	10.64	4.93	2.00	8.61	22.77	11.62
65	065	MP20	1	1	65.09	15.04	9.57	5.43	1.90	7.98	23.63	9.04
66	066	LP02	1	1	54.43	14.63	9.17	4.61	2.03	8.05	20.71	10.44
67	067	LP03	1	2	66.39	14.80	9.60	4.98	2.18	8.32	23.24	11.45
68	068	LP04	1	1	67.69	16.67	10.09	4.86	2.62	8.05	24.01	12.09
69	069	LP05	1	1	63.96	15.96	10.58	5.05	2.21	8.56	22.10	13.56
70	070	LP06	1	2	64.10	16.38	9.44	4.88	2.21	8.60	23.68	10.59
71	071	LP07	1	2	64.56	16.79	10.83	5.37	2.40	8.15	22.98	11.63
72	072	LP08	1	2	67.21	16.61	9.91	4.97	2.36	8.02	24.43	12.61
73	073	LP09	1	1	62.33	15.33	9.06	4.84	2.11	7.15	21.33	8.90
74	074	LP11	1	1	66.34	16.60	9.64	5.11	2.51	8.21	22.40	11.67
75	075	LP12	1	1	68.38	17.09	10.48	5.31	2.67	8.87	22.52	10.41
76	076	LP13	1	1	67.76	15.36	10.62	5.41	2.22	8.99	22.88	12.30
77	077	LP14	1	1	63.48	15.38	10.68	5.27	2.15	8.16	23.27	10.05
78	078	LP15	1	1	63.93	15.83	9.70	4.53	2.25	8.15	22.73	11.28

SPECIMENS AND MORPHOLOGICAL DATA

NO.	PIC. No.	ID	LOCALITY	SEX	SVL	HW	HL	IND	END	EN	TL	FL
79	079	LP16	1	1	57.50	13.81	8.68	4.68	2.09	8.11	21.00	9.58
80	080	LP17	1	1	68.36	16.96	10.17	4.79	2.46	8.98	23.98	9.48
81	081	LP18	1	2	61.30	15.72	8.97	4.71	2.02	8.27	22.16	12.60
82	082	LP19	1	1	63.19	15.73	10.39	4.59	2.22	7.39	24.54	11.55
83	083	LP20	1	1	58.61	15.61	9.88	4.93	1.92	8.41	19.98	9.93
84	084	LP21	1	1	66.83	15.58	10.06	4.48	2.93	8.00	23.15	11.65
85	085	LP22	1	2	69.90	16.65	10.80	5.21	2.39	8.82	23.82	10.85
86	086	LP23	1	1	65.75	15.64	10.77	4.79	1.88	6.65	23.54	11.69
87	087	LP24	1	1	63.18	16.11	5.39	5.39	2.18	8.39	22.60	10.75
88	088	LP25	1	2	69.74	16.38	9.69	5.15	2.40	8.40	25.55	11.27
89	089	LP26	1	1	46.52	13.22	8.38	4.04	1.83	6.63	18.75	8.15
90	090	LP27	1	1	59.92	15.54	10.40	5.88	2.77	8.47	20.97	10.81
91	091	LP28	1	1	65.40	16.30	11.05	4.93	2.77	8.66	23.25	12.45
92	092	LP29	1	1	59.69	15.94	9.94	5.08	1.84	7.93	23.26	9.74
93	093	SS12	1	1	61.32	15.91	9.13	4.96	1.90	7.16	21.81	8.30
94	094	SS14	1	1	55.47	15.42	9.45	4.37	1.65	6.97	20.78	11.31
95	095	SS15	1	1	58.68	15.85	9.88	4.68	1.91	7.27	21.51	11.12
96	096	SS16	1	1	57.20	15.56	9.56	4.91	2.07	7.21	21.46	10.52
97	097	SS19	1	1	53.71	15.64	8.40	4.09	1.68	6.19	19.98	10.39
98	098	SR20	1	1	61.51	14.75	9.18	4.83	1.84	7.43	21.23	9.30
99	099	SR24	1	1	57.43	14.43	8.69	4.15	2.32	8.01	20.43	10.76
100	100	SR25	1	1	55.08	15.24	8.72	4.31	2.31	6.79	20.97	9.40
101	101	SR26	1	1	60.62	17.27	9.78	5.18	2.26	8.68	22.98	10.16
102	102	SR27	1	1	57.85	15.82	9.44	4.73	1.92	7.47	22.16	9.41
103	103	TT03	1	2	64.78	17.82	9.45	4.52	2.50	7.84	20.56	11.81
104	104	TT05	1	1	56.58	15.85	11.08	5.13	1.58	8.19	19.99	10.54
105	105	TT06	1	1	51.42	14.60	10.74	4.94	1.80	7.23	19.63	7.79
106	106	TT08	1	1	61.07	15.04	10.99	4.15	1.67	6.18	19.89	9.48
107	107	TT15	1	1	63.40	16.02	11.23	4.90	2.42	7.15	22.54	9.47
108	108	TT17	1	2	50.63	15.87	10.70	4.75	1.85	7.76	19.22	11.21
109	109	TT18	1	2	64.04	16.88	10.22	5.17	1.87	8.19	23.68	9.86
110	110	TT19	1	2	66.41	15.98	10.68	5.15	2.23	8.27	20.45	11.00
111	111	TT22	1	1	75.28	16.53	12.45	4.93	2.42	8.27	25.60	12.00
112	112	LS02	2	2	58.93	16.13	11.05	5.27	2.16	8.74	22.32	9.24
113	113	LS04	2	1	50.72	15.27	12.61	4.83	1.76	7.96	20.16	10.14
114	114	LS06	2	1	57.45	14.88	11.86	4.77	2.39	8.18	19.16	7.79
115	115	LS08	2	1	55.07	14.94	10.32	4.52	2.18	8.14	30.26	9.38
116	116	LS10	2	1	60.41	15.74	11.80	5.34	2.30	8.83	20.75	9.93
117	117	LS11	2	1	48.30	14.86	9.75	4.10	2.56	6.82	17.20	9.13
118	118	LS12	2	1	46.19	13.26	8.07	4.40	2.01	7.03	17.97	9.04

SPECIMENS AND MORPHOLOGICAL DATA

NO.	PIC. No.	ID	LOCALITY	SEX	SVL	HW	HL	IND	END	EN	TL	FL
119	119	LS13	2	3	48.75	14.12	9.09	4.10	2.40	7.15	17.30	7.69
120	120	LS14	2	2	50.07	14.20	9.10	3.97	2.09	7.26	18.00	9.06
121	121	LS15	2	2	50.72	13.56	8.35	4.05	2.99	7.44	19.42	9.30
122	122	LS16	2	1	44.77	15.29	9.57	4.10	2.14	7.14	17.90	8.48
123	123	LS17	2	1	45.43	15.23	8.78	3.80	2.32	8.00	17.81	8.28
124	124	LS18	2	1	40.73	13.08	8.48	3.66	2.09	6.77	14.69	7.48
125	125	LS19	2	1	46.34	13.11	9.54	3.87	2.39	6.56	17.46	8.80
126	126	LS20	2	1	48.85	15.72	10.00	4.07	2.45	7.30	17.55	9.57
127	127	SP01	2	1	58.81	16.53	10.93	4.83	2.21	7.08	23.99	9.00
128	128	SP02	2	1	66.24	16.43	11.18	5.83	3.02	6.78	23.21	10.02
129	129	SP03	2	1	61.91	16.49	10.08	4.33	2.35	6.78	22.25	11.05
130	130	SP04	2	1	64.92	16.67	11.51	4.97	3.13	7.34	24.97	11.57
131	131	SP05	2	2	55.51	14.43	8.84	5.04	1.99	6.15	18.98	7.94
132	132	SP06	2	2	58.84	15.63	10.49	5.00	2.60	7.25	20.26	19.45
133	133	SP07	2	2	58.17	15.40	10.59	5.64	2.19	7.31	19.39	8.88
134	134	SP08	2	1	58.85	16.91	10.79	4.90	2.05	7.51	23.19	10.91
135	135	SP09	2	2	61.09	16.45	10.27	5.07	2.15	7.59	20.19	10.59
136	136	SP10	2	2	58.67	15.67	9.82	4.90	2.20	7.31	19.20	9.16
137	137	UT01	2	1	56.23	14.05	8.41	4.52	1.67	7.66	19.94	6.56
138	138	UT02	2	1	58.87	16.13	10.01	4.95	2.22	7.55	19.50	9.23
139	139	UT03	2	1	56.19	15.14	9.38	4.46	2.46	6.89	20.52	9.89
140	140	UT05	2	2	58.67	15.64	9.66	4.90	2.57	7.89	20.42	9.02
141	141	UT06	2	1	58.46	15.80	8.69	4.87	2.16	7.58	19.52	7.57
142	142	UT07	2	2	58.71	15.87	8.30	4.65	2.22	6.97	18.75	8.06
143	143	UT08	2	1	61.11	15.96	9.54	4.71	1.99	7.68	19.28	9.02
144	144	UT15	2	2	58.56	15.67	9.21	4.65	2.20	7.42	22.19	9.78
145	145	UT16	2	1	58.45	15.46	9.25	4.31	1.90	6.54	19.65	8.57
146	146	UT23	2	2	62.62	15.17	9.42	5.58	2.28	6.65	19.24	9.45
147	147	UT24	2	1	58.20	15.82	9.18	4.95	2.46	7.74	19.79	9.85
148	148	LB01	2	1	65.02	17.02	10.43	4.43	3.25	7.44	21.79	10.79
149	149	LB02	2	1	54.43	14.63	9.17	4.61	2.03	8.05	20.71	10.79
150	150	LB04	2	1	66.90	16.65	9.78	5.31	2.70	8.21	22.73	12.03
151	151	LB05	2	1	68.65	16.89	8.90	4.73	2.79	8.92	23.24	12.03
152	152	LB06	2	1	66.65	16.89	8.90	4.73	2.79	8.76	23.74	11.88
153	153	LB07	2	1	62.94	16.81	9.34	5.26	2.11	8.21	23.27	11.92
154	154	LB08	2	1	64.03	16.25	10.43	5.39	2.20	8.71	23.24	11.92
155	155	LB09	2	1	66.22	15.75	9.99	5.63	2.11	8.92	24.74	11.59
156	156	LB10	2	1	66.32	16.10	9.70	5.65	2.22	7.32	22.01	11.04
157	157	LB11	2	1	72.33	16.89	7.90	4.74	2.53	8.41	24.27	10.70
158	158	LB12	2	1	67.02	16.29	7.96	5.21	2.53	8.39	22.78	10.43

SPECIMENS AND MORPHOLOGICAL DATA

NO.	PIC. No.	ID	LOCALITY	SEX	SVL	HW	HL	IND	END	EN	TL	FL
159	159	LB13	2	1	69.24	16.85	9.16	4.80	2.83	7.59	23.99	11.57
160	160	LB14	2	1	79.03	17.78	9.67	5.90	2.91	10.75	26.50	12.34
161	161	LB15	2	1	64.81	15.67	8.76	5.21	2.58	8.81	22.38	12.99
162	162	LB16	2	1	63.09	15.51	9.11	5.66	2.54	8.12	23.02	9.45
163	163	LB17	2	2	67.69	16.33	8.38	6.69	2.57	9.21	23.45	11.95
164	164	LB18	2	1	64.62	15.41	8.73	4.59	2.32	8.11	23.18	10.60
165	165	LB19	2	1	62.92	15.98	8.38	4.92	2.58	8.92	21.82	9.55
166	166	LB20	2	1	64.62	15.12	8.85	5.44	3.03	8.94	22.88	10.08
167	167	KJ01	3	2	75.71	18.16	11.58	5.33	2.75	8.87	25.06	11.53
168	168	KJ02	3	2	68.57	18.77	12.19	5.33	2.74	8.70	25.75	10.89
169	169	KJ03	3	2	62.97	16.55	11.44	5.19	2.22	8.13	22.92	11.99
170	170	KJ04	3	2	65.36	17.77	11.37	5.21	2.66	8.74	26.53	13.46
171	171	KJ05	3	2	58.89	16.15	10.99	4.70	2.13	7.95	22.96	12.38
172	172	KJ06	3	1	62.74	15.28	10.28	4.67	2.21	8.29	20.02	10.17
173	173	KJ07	3	1	62.95	16.22	10.71	4.76	2.37	8.59	23.56	10.50
174	174	KJ08	3	1	70.46	17.69	11.68	5.10	2.55	8.38	25.89	11.83
175	175	KJ09	3	1	53.25	14.92	9.42	4.00	2.33	7.71	20.53	8.71
176	176	KJ10	3	1	61.47	17.82	11.08	5.62	2.91	8.75	24.05	10.79
177	177	KJ11	3	1	58.06	15.43	10.20	4.75	2.58	7.82	21.44	9.73
178	178	KJ12	3	1	56.72	16.06	10.12	5.44	2.85	8.43	23.93	11.79
179	179	KJ13	3	1	57.96	15.94	9.38	4.19	2.92	8.00	21.91	10.76
180	180	KJ14	3	1	59.57	15.64	10.76	4.80	2.53	8.48	21.85	10.82
181	181	KJ15	3	1	61.16	15.89	11.06	5.29	2.62	7.66	22.12	9.43
182	182	KR01	4	1	58.86	16.13	8.89	4.26	2.59	8.21	20.85	11.17
183	183	KR02	4	1	57.91	16.35	10.31	4.94	2.44	9.09	20.83	9.67
184	184	KR03	4	2	63.77	17.69	11.32	4.91	2.53	9.38	24.26	12.29
185	185	KR04	4	1	52.83	14.14	8.98	4.08	2.42	7.11	18.78	7.93
186	186	KR05	4	2	55.17	15.86	10.61	4.45	2.46	8.78	21.44	11.10
187	187	KR06	4	2	58.26	15.72	9.54	4.30	2.40	7.46	21.47	10.10
188	188	KR07	4	1	59.87	16.91	11.98	5.46	2.41	9.77	20.93	10.20
189	189	KR08	4	2	57.64	16.06	11.47	4.35	3.11	8.40	21.66	9.16
190	190	KR09	4	2	61.05	16.24	10.14	4.77	2.24	9.10	22.01	9.17
191	191	KR10	4	1	56.48	15.94	10.12	5.30	2.64	8.75	20.53	9.90
192	192	KR11	4	1	61.54	17.10	10.35	4.72	2.38	7.78	21.85	9.70
193	193	KR12	4	2	57.56	15.03	9.87	4.51	2.75	8.38	20.50	8.80
194	194	KR13	4	2	55.14	14.54	9.63	4.44	2.22	7.30	19.45	8.00
195	195	KR14	4	2	61.46	16.26	10.80	4.75	2.49	9.16	22.82	12.15
196	196	KR15	4	1	50.38	14.41	9.17	4.29	1.93	7.10	19.75	9.21
197	197	KR17	4	1	60.28	16.00	8.84	5.17	2.27	8.63	22.21	11.69
198	198	KR18	4	2	61.70	16.44	10.47	4.78	2.65	9.11	24.37	11.17

SPECIMENS AND MORPHOLOGICAL DATA

NO.	PIC. No.	ID	LOCALITY	SEX	SVL	HW	HL	IND	END	EN	TL	FL
199	199	KR19	4	1	59.32	15.89	9.37	4.89	2.18	8.55	21.59	9.00
200	200	KR20	4	1	65.84	16.84	11.59	4.66	2.72	9.17	21.20	11.39
201	201	KR21	4	2	57.73	15.18	9.22	4.48	2.36	7.23	22.14	8.41
202	202	KR22	4	1	57.54	15.53	9.75	4.40	2.34	8.17	21.18	8.88
203	203	MD01	4	2	65.70	16.51	13.20	4.91	2.85	8.99	22.19	10.55
204	204	MD02	4	1	58.74	16.38	12.60	4.26	2.03	7.85	21.83	11.09
205	205	MD03	4	2	53.97	14.34	12.12	4.69	2.60	7.93	19.80	9.63
206	206	MD05	4	1	61.11	15.83	12.80	4.21	2.72	8.75	21.16	9.93
207	207	MD06	4	2	59.41	14.56	12.72	4.63	2.20	8.74	21.34	11.48
208	208	MD07	4	2	71.13	16.29	12.85	4.08	3.02	7.90	23.50	8.48
209	209	MD08	4	1	66.53	17.17	11.25	4.78	2.48	8.99	21.51	8.83
210	210	MD09	4	1	61.22	16.61	14.48	3.81	2.70	8.81	21.01	10.29
211	211	MD10	4	1	65.84	15.95	14.39	4.14	2.27	8.83	21.57	9.25
212	212	MH06	4	2	62.50	15.90	10.20	5.12	2.83	8.45	22.23	9.79
213	213	MH07	4	1	57.08	14.16	9.20	4.02	2.04	7.46	20.96	9.43
214	214	MHo1	4	1	43.52	11.95	7.22	3.61	2.11	6.51	16.77	9.52
215	215	MHo2	4	1	59.91	15.53	10.06	4.12	2.03	7.63	20.18	11.41
216	216	MHo3	4	1	41.03	13.71	8.62	3.77	2.55	6.95	16.66	8.14
217	217	MHo4	4	1	55.37	15.59	9.67	4.59	2.90	8.11	22.69	9.14
218	218	MHo5	4	1	51.40	14.62	10.07	4.01	2.04	8.70	20.34	9.14
219	219	MA01	3	2	62.03	16.65	10.25	5.09	2.59	6.92	23.59	10.87
220	220	MA02	3	2	65.28	16.66	11.46	4.97	2.35	7.42	24.27	8.49
221	221	MA03	3	2	64.09	16.29	10.86	4.93	2.53	7.43	24.91	10.52
222	222	MA04	3	2	56.38	16.64	10.41	4.72	2.56	6.89	19.57	9.61
223	223	MA05	3	2	62.17	16.38	10.84	5.13	2.80	7.30	22.56	8.99
224	224	MA06	3	2	56.69	16.19	10.27	4.23	2.09	6.42	16.84	8.82
225	225	MA07	3	2	64.70	16.08	11.16	4.60	2.25	7.09	22.60	9.78
226	226	MA09	3	2	65.06	18.00	9.99	5.11	2.38	7.07	22.12	10.14
227	227	MA10	3	2	56.87	16.08	11.38	4.56	2.82	7.51	24.50	10.59
228	228	MA11	3	2	66.61	18.09	9.64	4.72	2.93	7.33	24.78	9.89
229	229	KK01	3	1	62.42	18.19	10.98	5.00	2.31	7.63	22.25	14.45
230	230	KK02	3	1	69.64	17.63	10.29	4.96	3.24	8.33	23.32	17.60
231	231	PT01	3	1	68.57	17.52	10.34	4.46	2.66	8.70	22.80	13.66
232	232	PT02	3	1	63.71	16.28	11.67	4.55	2.13	9.16	21.01	10.77
233	233	PT03	3	1	72.12	16.58	11.47	4.38	2.32	7.82	24.47	12.94
234	234	PT04	3	1	68.65	17.33	11.38	4.39	2.34	8.40	24.57	10.81
235	235	PT05	3	1	73.73	18.84	12.25	4.11	2.64	8.43	24.32	11.20
236	236	PT06	3	1	61.78	16.13	11.39	4.48	2.39	8.10	21.26	10.23
237	237	PT07	3	1	65.22	16.01	11.01	4.06	2.43	7.90	22.28	9.84
238	238	PT08	3	2	70.28	16.78	10.97	4.55	2.25	8.11	21.75	12.12

SPECIMENS AND MORPHOLOGICAL DATA

NO.	PIC. No.	ID	LOCALITY	SEX	SVL	HW	HL	IND	END	EN	TL	FL
239	239	PT09	3	1	61.70	16.46	10.67	3.97	2.88	8.11	21.80	10.66
240	240	PT10	3	1	67.87	16.73	10.00	4.32	2.17	8.65	21.82	10.20
241	241	PT11	3	1	69.35	17.07	12.17	4.40	2.18	7.50	21.95	12.28
242	242	PT12	3	1	65.25	17.31	9.46	4.09	2.23	8.75	21.53	11.52
243	243	PT13	3	1	66.24	16.36	10.38	4.12	2.14	8.97	22.34	11.62
244	244	PT14	3	1	67.85	16.49	10.32	4.05	3.03	8.53	23.74	11.99
245	245	PT15	3	1	68.87	17.19	11.04	4.13	2.56	8.40	22.66	10.98
246	246	PT16	3	2	60.94	16.06	11.45	3.65	2.01	8.55	21.66	10.56
247	247	PT17	3	1	64.06	16.95	11.36	4.45	2.31	7.90	19.96	11.47
248	248	PT18	3	1	67.66	16.97	12.10	4.93	2.37	9.66	20.89	11.81
249	249	PT19	3	1	70.57	18.19	10.48	3.88	2.11	7.45	23.44	12.56
250	250	PT20	3	1	72.60	17.42	11.27	3.77	2.25	8.04	25.88	11.29
251	251	PT21	3	1	62.08	15.24	11.52	4.10	2.33	7.57	11.29	9.76
252	252	PT22	3	1	66.00	15.11	10.67	4.13	3.09	7.98	20.28	11.60
253	253	NS01	3	1	61.73	14.65	12.69	4.60	2.82	7.75	19.89	10.32
254	254	NS02	3	2	71.84	18.28	12.99	4.21	2.47	8.21	21.54	10.17
255	255	NS03	3	1	63.29	16.60	14.90	4.60	2.30	8.59	24.53	9.97
256	256	NS04	3	2	76.53	15.62	14.19	4.66	2.81	8.04	22.98	10.68
257	257	NS05	3	1	56.85	14.80	12.22	5.54	2.57	8.43	21.44	10.17
258	258	NS06	3	1	63.62	15.87	14.09	4.40	2.45	7.85	21.06	11.07
259	259	NS07	3	1	57.09	15.79	12.50	4.62	2.30	7.81	21.69	10.46
260	260	NS08	3	1	62.92	15.84	13.93	5.46	2.60	8.95	23.35	9.53
261	261	NS09	3	2	61.46	16.06	12.81	4.49	2.48	8.48	21.53	10.81
262	262	NS10	3	2	62.92	15.03	12.36	5.12	2.36	8.02	19.31	12.13
263	263	NS11	3	1	60.23	18.06	14.11	5.02	2.16	8.14	22.80	10.53
264	264	NS12	3	1	56.49	14.50	12.46	3.88	2.15	7.91	20.31	10.60
265	265	NS13	3	2	67.45	15.82	12.62	5.04	2.26	7.91	22.61	10.49
266	266	NS14	3	2	62.00	16.07	14.21	4.99	2.55	8.28	22.80	12.11
267	267	NS15	3	2	63.84	15.75	12.62	4.78	2.27	7.55	22.46	11.34
268	268	NS20	3	2	65.78	15.87	13.31	4.74	3.23	8.70	25.01	10.80
269	269	SD01	4	2	55.72	16.67	10.34	4.70	2.20	8.22	21.60	11.18
270	270	SD02	4	1	53.72	16.54	10.07	4.60	2.20	7.33	21.37	10.30
271	271	SD04	4	1	53.93	16.18	10.56	4.30	2.39	7.67	20.67	12.09
272	272	SD05	4	1	60.63	16.05	10.29	4.94	2.54	8.50	21.28	11.07
273	273	SD06	4	2	65.51	16.97	11.43	4.18	2.20	7.90	23.58	10.31
274	274	SD08	4	2	54.14	15.07	9.60	4.42	2.02	7.62	19.80	9.90
275	275	SD09	4	2	72.96	17.09	11.09	5.54	2.32	8.37	23.38	13.08
276	276	SD10	4	1	53.95	14.14	9.92	4.82	2.02	7.62	19.80	9.90
277	277	SD11	4	1	59.74	16.16	10.37	4.69	2.10	8.30	22.82	11.33
278	278	SD12	4	1	52.05	15.19	8.68	4.42	1.82	7.85	19.09	10.58

SPECIMENS AND MORPHOLOGICAL DATA

NO.	PIC. No.	ID	LOCALITY	SEX	SVL	HW	HL	IND	END	EN	TL	FL
279	279	SD15	4	1	61.27	15.21	10.78	5.14	2.38	8.27	21.68	11.29
280	280	SD16	4	1	55.87	15.54	10.07	4.72	2.13	8.10	19.60	10.74
281	281	SD17	4	1	58.05	15.88	9.27	4.80	2.45	8.86	20.15	10.38
282	282	SD18	4	2	65.51	16.97	11.43	4.18	2.20	7.90	23.58	10.31
283	283	SN10	4	1	56.12	15.13	10.11	4.61	2.06	8.16	20.87	10.95
284	284	SN1	4	1	50.01	14.47	9.63	4.89	2.24	6.61	20.59	11.25
285	285	SN3	4	1	51.19	14.47	9.57	4.59	2.71	6.40	19.81	6.57
286	286	SN4	4	1	51.00	14.42	9.09	4.53	2.88	6.70	20.24	10.88
287	287	SN5	4	1	49.53	13.94	7.63	4.58	1.96	5.28	19.21	9.20
288	288	SN6	4	1	48.22	14.60	9.81	5.03	2.82	6.20	20.75	9.17
289	289	SN8	4	1	44.89	12.55	8.40	4.15	2.44	5.80	16.74	8.02
290	290	SN9	4	1	45.68	12.65	9.22	4.40	1.41	6.22	19.03	7.26
291	291	SN17	4		56.12	15.31	100.11	4.61	2.06	10.96	20.88	10.95
292	292	SN11	4	1	47.21	14.93	8.21	4.00	1.76	7.79	19.90	10.12
293	293	SN12	4	1	46.82	14.38	9.07	4.23	1.45	6.66	18.48	9.33
294	294	SN13	4	1	49.17	14.30	8.18	3.48	1.78	6.98	17.66	9.14
295	295	SN14	3	1	56.50	14.45	9.92	4.51	2.22	7.54	20.66	8.77
296	296	ST02	3	1	56.54	16.34	11.77	4.89	2.55	8.65	19.35	9.26
297	297	ST04	3	1	53.12	14.81	9.89	4.90	2.56	7.55	18.23	9.38
298	298	ST05	3	1	60.26	16.85	12.89	5.90	2.70	9.01	22.47	13.63
299	299	ST06	3	1	61.39	18.82	13.77	5.48	2.72	9.87	22.03	13.89
300	300	ST07	3	1	56.01	16.53	13.48	5.06	2.40	9.04	20.32	12.14
301	301	ST08	3	1	58.25	17.16	12.84	4.95	2.61	8.60	20.15	12.45
302	302	ST10	3	3	51.42	14.65	12.63	5.20	2.94	8.65	19.35	10.68
303	303	ST11	3	2	53.76	16.77	13.39	5.26	2.56	9.04	20.12	13.05
304	304	ST13	3	1	56.47	16.24	12.93	5.13	2.25	8.04	21.27	11.06
305	305	ST14	3	1	65.75	16.34	11.19	4.67	2.35	7.64	21.99	10.08
306	306	ST15	3	3	54.48	14.81	13.24	5.21	2.83	8.13	20.25	12.07
307	307	ST16	3	3	60.54	16.04	12.36	4.66	3.01	8.36	18.54	12.77
308	308	ST17	3	3	44.48	12.98	10.50	4.35	1.44	6.71	15.79	9.90
309	309	ST19	3	1	52.57	14.51	11.77	4.77	2.41	7.96	19.87	11.22

SPECIMENS AND MORPHOLOGICAL DATA

NO.	PIC. No.	logsvl	Log hw	Log hl	Log ind	Log end	Log en	lotl	Log fl
1	001	1.79581052	1.19865709	1.093771781	0.69722934	0.34635297	0.869818208	1.301464073	0.974972
2	002	1.76900787	1.2764618	1.089905111	0.6794279	0.39445168	0.86923172	1.361160995	0.9903389
3	003	1.82425604	1.27369559	1.08849047	0.75204845	0.39794001	0.926342447	1.41313205	0.9227255
4	004	1.76797172	1.20030318	1.059184618	0.7084209	0.38381537	0.920645001	1.29136885	0.966611
5	005	1.81291336	1.21085337	1.092720645	0.70243054	0.33445375	0.933487288	1.380030248	1.0737184
6	006	1.82275633	1.26316246	1.075911761	0.75511227	0.40823997	0.932980822	1.428134794	0.9777236
7	007	1.81835788	1.2166936	1.052693942	0.69372695	0.35410844	0.903089987	1.40654018	1.0496056
8	008	1.97722045	1.22685757	1.062581984	0.68930886	0.42975228	0.899273187	1.349277527	0.9628427
9	009	1.82672252	1.21138755	1.078456818	0.7930916	0.45331834	0.980003372	1.384353414	1.0770043
10	010	1.8302678	1.17811325	1.065579715	0.74896286	0.40483372	0.959518377	1.349665984	1.1162756
11	011	1.81868766	1.18298497	1.070037867	0.7084209	0.40312052	0.948412966	1.359645793	1.0817073
12	012	1.73727218	1.14019368	1.02489596	0.67117284	0.29003461	0.909020854	1.297760511	0.9822712
13	013	1.81371439	1.22010809	1.110252917	0.67760695	0.38916608	0.937016107	1.302547372	1.0195317
14	014	1.80563677	1.19228861	1.086003706	0.73078228	0.37474835	0.960470778	1.314077992	1.0538464
15	015	1.78368924	1.20194306	1.093421685	0.7355989	0.42651126	0.966141733	1.338057875	1.0557605
16	016	1.84732583	1.23854789	1.179838928	0.71683772	0.40140054	0.959518377	1.368844507	1.0043214
17	017	1.77945218	1.17201881	1.044147621	0.67302091	0.33445375	0.908485019	1.337658891	1.0951694
18	018	1.78589903	1.195069	0.996511672	0.76267856	0.34242268	0.857935265	1.352375495	1.0484418
19	019	1.83122969	1.24674471	1.004321374	0.72345567	0.3283796	0.911690159	1.387389826	1.0449315
20	020	1.80712896	1.23197903	1.024485668	0.7355989	0.32633586	0.880813592	1.371990911	1.0633334
21	021	1.72296281	1.18326984	0.937517892	0.67577834	0.26717173	0.880241776	1.29841638	0.9299296
22	022	1.72900271	1.1826999	0.938019097	0.69548168	0.2764618	0.86923172	1.308137379	1.0565237
23	023	1.76102525	1.18554215	0.999130541	0.65417654	0.32633586	0.826074803	1.298634783	1.0413927
24	024	1.77923563	1.21827285	0.995196292	0.68663627	0.31597035	0.870988814	1.353531559	1.0580462
25	025	1.78738962	1.23274206	0.973589623	0.72509452	0.33041377	0.845718018	1.341236623	1.0618293
26	026	1.69001878	1.14395112	0.924795996	0.673942	0.30319606	0.820201459	1.248218561	0.9876663
27	027	1.81271287	1.2137833	1.002166062	0.72263392	0.43775056	0.968949681	1.362859303	1.0799045
28	028	1.78760215	1.20167018	0.960470778	0.69548168	0.2787536	0.854913022	1.338655666	0.9190781
29	029	1.75427187	1.20276069	0.980457892	0.66558099	0.36361198	0.883093359	1.32776749	0.9508515
30	030	1.74405817	1.18808437	0.975431809	0.64048144	0.21748394	0.843232778	1.317645543	1.0534626
31	031	1.76849011	1.20002927	0.994756945	0.67024585	0.28103337	0.861534411	1.33264041	1.0461048
32	032	1.75739603	1.19200959	0.980457892	0.69108149	0.31597035	0.857935265	1.331629718	1.0220157
33	033	1.79539333	1.23172438	0.999565488	0.70926996	0.34635297	0.919078092	1.362482475	1.0178677
34	034	1.75073975	1.21138755	0.981365509	0.673942	0.28780173	0.892651034	1.329397879	1.0751819
35	035	1.73005515	1.19423675	0.924279286	0.61172331	0.22530928	0.791690649	1.300595484	1.0166155
36	036	1.78894573	1.16879202	0.962842681	0.68394713	0.26481782	0.870988814	1.326949994	0.9684829
37	037	1.78746047	1.18836593	0.975891136	0.67117284	0.29885308	0.872738827	1.335056519	0.8932068
38	038	1.7201593	1.17376882	0.894869657	0.66086548	0.33645973	0.859138297	1.292256071	0.897077
39	039	1.72705301	1.17172645	0.868644438	0.5865873	0.30535137	0.820857989	1.29710365	1.0297895

SPECIMENS AND MORPHOLOGICAL DATA

NO.	PIC. No.	logsvl	loghw	loghl	logind	logend	logen	logtl	logfl
40	040	1.75913882	1.15926633	0.939019776	0.6180481	0.36548798	0.903632516	1.310268367	1.0318123
41	041	1.74099393	1.18298497	0.940516485	0.63447727	0.3283796	0.820857989	1.29710365	1.0297895
42	042	1.78261593	1.23729234	0.990338855	0.71432976	0.35410844	0.938519725	1.361350024	1.006466
43	043	1.76230336	1.19920648	0.974971994	0.67486114	0.28330123	0.873320602	1.325515663	0.9735896
44	044	1.69548168	1.11058971	0.88592634	0.63346846	0.32633586	0.799340549	1.23350376	0.9410142
45	045	1.70027094	1.11394335	0.866287339	0.63548375	0.31806333	0.84135947	1.267875419	0.9253121
46	046	1.81855578	1.2435341	1.068185862	0.71516736	0.34830486	0.961421094	1.397592434	1.0881361
47	047	1.84323278	1.24402959	0.984527313	0.82216808	0.41664051	0.995196292	1.350441857	1.1199154
48	048	1.78689333	1.21801004	1.059563418	0.73319727	0.41664051	0.916453949	1.337059726	1.0413927
49	049	1.81822589	1.1931246	1.022840611	0.66838592	0.33041377	0.920645001	1.343408594	1.0780942
50	050	1.75838194	1.15472821	1.045714059	0.70415052	0.24054925	0.938019097	1.350829274	0.9726656
51	051	1.83821922	1.20628604	1.146128036	0.75204845	0.36548798	0.935003151	1.373647472	0.9965117
52	052	1.89281782	1.2757719	1.078819183	0.74350976	0.43296929	0.991669007	1.35755372	1.10721
53	053	1.88598281	1.19589965	1.067070856	0.70329138	0.41329976	1.002597981	1.38774566	1.0145205
54	054	1.81177602	1.19645254	1.090963077	0.7363965	0.32633586	0.95616843	1.360214613	1.0835026
55	055	1.79511499	1.20248832	1.011993115	0.73798733	0.24551267	0.936010796	1.376759395	1.0546131
56	056	1.82425604	1.2121876	1.067442843	0.71432976	0.41329976	0.977723605	1.348304863	1.0561423
57	057	1.82736927	1.22659991	1.079181246	0.75204845	0.32633586	0.974050903	1.36267093	1.071882
58	058	1.82685195	1.2116544	1.025715384	0.7411516	0.372912	0.968949681	1.341038632	1.0572856
59	059	1.82020146	1.17840134	1.02325246	0.68033551	0.42160393	0.941014244	1.351216345	0.9982593
60	060	1.83033199	1.21774707	1.011993115	0.70415052	0.30963017	0.898176483	1.373831145	1.0674428
61	061	1.78418921	1.17318627	1.009025742	0.73798733	0.26245109	0.911690159	1.30920418	1.0503798
62	062	1.83657727	1.22711508	1.032618761	0.72672721	0.31175386	0.964730921	1.374381698	1.0820669
63	063	1.81564415	1.16046853	1.009025742	0.72672721	0.30963017	0.935003151	1.347330015	1.0468852
64	064	1.81822589	1.22865696	1.026941628	0.69284692	0.30103	0.935003151	1.357363031	1.0652061
65	065	1.81351427	1.17724784	0.980911938	0.73479983	0.2787536	0.902002891	1.373463722	0.9561684
66	066	1.73583833	1.16524433	0.962369336	0.66370093	0.30749604	0.90579588	1.316180099	1.0187005
67	067	1.82210267	1.17026172	0.982271233	0.69722934	0.33845649	0.920123326	1.366236124	1.0588055
68	068	1.83052451	1.2219356	1.003891166	0.68663627	0.41830129	0.90579588	1.38039216	1.0824263
69	069	1.80590846	1.20303289	1.024485668	0.70329138	0.34439227	0.932473765	1.344392274	1.1322597
70	070	1.80685803	1.2143139	0.974971994	0.68841982	0.34439227	0.934498451	1.374381698	1.024896
71	071	1.80996352	1.2250507	1.034628457	0.72997429	0.38021124	0.911157609	1.361350024	1.0655797
72	072	1.8274339	1.22036963	0.996073654	0.69635639	0.372912	0.904174368	1.387923467	1.1007151
73	073	1.79469713	1.18554215	0.957128198	0.68484536	0.32428246	0.854306042	1.328990855	0.94939
74	074	1.82177547	1.22010809	0.984077034	0.7084209	0.39967372	0.914343157	1.350248018	1.0670709
75	075	1.8349291	1.23274206	1.020361283	0.72509452	0.42651126	0.94792362	1.352568386	1.0174507
76	076	1.8309734	1.18639122	1.026124517	0.73319727	0.34635297	0.953759692	1.35945602	1.0899051
77	077	1.80263692	1.18695634	1.028571253	0.72181062	0.33243846	0.911690159	1.366796383	1.0021661
78	078	1.8057047	1.19948091	0.986771734	0.6560982	0.35218252	0.911157609	1.356599436	1.0523091
79	079	1.75966784	1.14019368	0.938519725	0.67024585	0.32014629	0.909020854	1.322219295	0.9813655

SPECIMENS AND MORPHOLOGICAL DATA

NO.	PIC. No.	logsvl	loghw	loghl	logind	logend	logen	logtl	logfl
80	080	1.83480205	1.22942585	1.007320953	0.68033551	0.39093511	0.953276337	1.379849179	0.9768083
81	081	1.78746047	1.19645254	0.952792443	0.67302091	0.30535137	0.91750551	1.345569756	1.1003705
82	082	1.80064836	1.19672872	1.016615548	0.66181269	0.34635297	0.868644438	1.389874558	1.062582
83	083	1.76797172	1.1934029	0.994756945	0.69284692	0.28330123	0.924795996	1.300595484	0.9969492
84	084	1.82497146	1.19256745	1.002597981	0.65127801	0.46686762	0.903089987	1.364550995	1.0663259
85	085	1.84447718	1.22141424	1.033423755	0.71683772	0.3783979	0.945468585	1.376941757	1.0354297
86	086	1.81789576	1.19423675	1.032215703	0.68033551	0.27415785	0.822821645	1.371806459	1.0678145
87	087	1.80057962	1.20709554	0.731588765	0.73158877	0.33845649	0.923761961	1.354108439	1.0314085
88	088	1.84348194	1.2143139	0.986323777	0.71180723	0.38021124	0.924279286	1.407390904	1.0519239
89	089	1.66763971	1.12123146	0.923244019	0.60638137	0.26245109	0.821513528	1.273001272	0.9111576
90	090	1.7775718	1.19145101	1.017033339	0.76937733	0.44247977	0.92788341	1.32159843	1.0338257
91	091	1.81557775	1.2121876	1.043362278	0.69284692	0.44247977	0.937517892	1.366422957	1.0951694
92	092	1.77590158	1.20248832	0.997386384	0.70586371	0.26481782	0.899273187	1.36660971	0.988559
93	093	1.78760215	1.20167018	0.960470778	0.69548168	0.2787536	0.854913022	1.338655666	0.9190781
94	094	1.74405817	1.18808437	0.975431809	0.64048144	0.21748394	0.843232778	1.317645543	1.0534626
95	095	1.76849011	1.20002927	0.994756945	0.67024585	0.28103337	0.861534411	1.33264041	1.0461048
96	096	1.75739603	1.19200959	0.980457892	0.69108149	0.31597035	0.857935265	1.331629718	1.0220157
97	097	1.73005515	1.19423675	0.924279286	0.61172331	0.22530928	0.791690649	1.300595484	1.0166155
98	098	1.78894573	1.16879202	0.962842681	0.68394713	0.26481782	0.870988814	1.326949994	0.9684829
99	099	1.75913882	1.15926633	0.939019776	0.6180481	0.36548798	0.903632516	1.310268367	1.0318123
100	100	1.74099393	1.18298497	0.940516485	0.63447727	0.36361198	0.831869774	1.32159843	0.9731279
101	101	1.78261593	1.23729234	0.990338855	0.71432976	0.35410844	0.938519725	1.361350024	1.0068937
102	102	1.76230336	1.19920648	0.974971994	0.67486114	0.28330123	0.873320602	1.345569756	0.9735896
103	103	1.81144094	1.2509077	0.975431809	0.65513843	0.39794001	0.894316063	1.31302311	1.0722499
104	104	1.75266294	1.20002927	1.04453976	0.71011737	0.19865709	0.913283902	1.300812794	1.0228406
105	105	1.71113207	1.16435286	1.031004281	0.69372695	0.25527251	0.859138297	1.2929203	0.8915375
106	106	1.78582792	1.17724784	1.040997692	0.6180481	0.22271647	0.790988475	1.298634783	0.9768083
107	107	1.80208926	1.20466251	1.050379756	0.69019608	0.38381537	0.854306042	1.352953912	0.97635
108	108	1.70440793	1.20057693	1.029383778	0.67669361	0.26717173	0.889861721	1.283753383	1.0496056
109	109	1.80645132	1.22737244	1.009450896	0.71349054	0.27184161	0.913283902	1.374381698	0.9938769
110	110	1.82223348	1.20357677	1.028571253	0.71180723	0.34830486	0.91750551	1.310693312	1.0413927
111	111	1.87667961	1.21827285	1.095169351	0.69284692	0.38381537	0.91750551	1.408239965	1.0791812
112	112	1.77033644	1.20763437	1.043362278	0.72181062	0.33445375	0.941511433	1.34869419	0.965672
113	113	1.70517924	1.18383904	1.100715087	0.68394713	0.24551267	0.900913068	1.304490528	1.006038
114	114	1.75929003	1.17260293	1.074084689	0.67851838	0.3783979	0.912753304	1.282395505	0.8915375
115	115	1.74091508	1.1743506	1.013679697	0.65513843	0.33845649	0.910624405	1.480868924	0.9722028
116	116	1.78110884	1.19700473	1.071882007	0.72754126	0.36172784	0.945960704	1.317018101	0.9969492
117	117	1.68394713	1.17201881	0.989004616	0.61278386	0.40823997	0.833784375	1.235528447	0.9604708
118	118	1.66454796	1.12254352	0.906873535	0.64345268	0.30319606	0.846955325	1.254548077	0.9561684
119	119	1.68797462	1.1498347	0.958563883	0.61278386	0.38021124	0.854306042	1.238046103	0.8859263

SPECIMENS AND MORPHOLOGICAL DATA

NO.	PIC. No.	logsvl	loghw	loghl	logind	logend	logen	logtl	logfl
120	120	1.69957759	1.15228834	0.959041392	0.59879051	0.32014629	0.860936621	1.255272505	0.9571282
121	121	1.70517924	1.13225969	0.921686475	0.60745502	0.47567119	0.871572936	1.288249226	0.9684829
122	122	1.65098709	1.18440749	0.980911938	0.61278386	0.33041377	0.853698212	1.252853031	0.9283959
123	123	1.65734274	1.1826999	0.943494516	0.5797836	0.36548798	0.903089987	1.250663919	0.9180303
124	124	1.60991441	1.11660774	0.928395852	0.56348109	0.32014629	0.830588669	1.167021796	0.8739016
125	125	1.66595603	1.11760269	0.979548375	0.58771097	0.3783979	0.816903839	1.242044239	0.9444827
126	126	1.68886457	1.19645254	1	0.60959441	0.38916608	0.86332286	1.244277121	0.9809119
127	127	1.76945118	1.21827285	1.038620162	0.68394713	0.34439227	0.850033258	1.380030248	0.9542425
128	128	1.82112032	1.21563756	1.048441804	0.76566855	0.48000694	0.831229694	1.36567514	1.0008677
129	129	1.7917608	1.21722066	1.003460532	0.6364879	0.37106786	0.831229694	1.347330015	1.0433623
130	130	1.81237851	1.2219356	1.061075324	0.69635639	0.49554434	0.86569606	1.397418542	1.0633334
131	131	1.74437123	1.15926633	0.946452265	0.70243054	0.29885308	0.788875116	1.278296208	0.8998205
132	132	1.76967266	1.19395898	1.020775488	0.69897	0.41497335	0.860338007	1.306639441	1.2889196
133	133	1.76469906	1.18752072	1.02489596	0.7512791	0.34044411	0.863917377	1.287577809	0.948413
134	134	1.76974647	1.22814361	1.033021445	0.69019608	0.31175386	0.875639937	1.365300749	1.0378248
135	135	1.78597013	1.2161659	1.011570444	0.70500796	0.33243846	0.880241776	1.305136319	1.024896
136	136	1.76841609	1.195069	0.992111488	0.69019608	0.34242268	0.863917377	1.283301229	0.9618955
137	137	1.74996808	1.14767632	0.924795996	0.65513843	0.22271647	0.88422877	1.299725154	0.8169038
138	138	1.76989404	1.20763437	1.000434077	0.6946052	0.34635297	0.877946952	1.290034611	0.9652017
139	139	1.74965903	1.18012588	0.972202838	0.64933486	0.39093511	0.838219222	1.312177356	0.9951963
140	140	1.76841609	1.19423675	0.984977126	0.69019608	0.40993312	0.897077003	1.310055738	0.9552065
141	141	1.76685881	1.19865709	0.939019776	0.68752896	0.33445375	0.879669206	1.290479813	0.8790959
142	142	1.76871208	1.20057693	0.919078092	0.66745295	0.34635297	0.843232778	1.273001272	0.906335
143	143	1.78611228	1.20303289	0.979548375	0.67302091	0.29885308	0.88536122	1.28510703	0.9552065
144	144	1.76760107	1.195069	0.96425963	0.66745295	0.34242268	0.870403905	1.346157302	0.9903389
145	145	1.76678452	1.18920949	0.966141733	0.63447727	0.2787536	0.815577748	1.293362555	0.9329808
146	146	1.79671306	1.18098558	0.974050903	0.7466342	0.35793485	0.822821645	1.284205068	0.9754318
147	147	1.76492298	1.19920648	0.962842681	0.6946052	0.39093511	0.888740961	1.296445794	0.9934362
148	148	1.81	1.23095956	1.018284308	0.64640373	0.51188336	0.871572936	1.33825723	1.0330214
149	149	1.73583833	1.16524433	0.962369336	0.66370093	0.30749604	0.90579588	1.316180099	1.0330214
150	150	1.82542612	1.22141424	0.990338855	0.72509452	0.43136376	0.914343157	1.356599436	1.0802656
151	151	1.83664054	1.22762965	0.949390007	0.67486114	0.4456042	0.950364854	1.366236124	1.0802656
152	152	1.82380015	1.22762965	0.949390007	0.67486114	0.4456042	0.942504106	1.375480715	1.0748164
153	153	1.79892674	1.22556771	0.970346876	0.72098574	0.32428246	0.914343157	1.366796383	1.0762763
154	154	1.8063835	1.21085337	1.018284308	0.73158877	0.34242268	0.940018155	1.366236124	1.0762763
155	155	1.82098918	1.19728056	0.999565488	0.75050839	0.32428246	0.950364854	1.393399695	1.0640834
156	156	1.82164452	1.20682588	0.986771734	0.75204845	0.34635297	0.864511081	1.342620043	1.0429691
157	157	1.85931847	1.22762965	0.897627091	0.67577834	0.40312052	0.924795996	1.385069776	1.0293838
158	158	1.82620442	1.21192108	0.900913068	0.71683772	0.40312052	0.923761961	1.35755372	1.0182843
159	159	1.84035706	1.22659991	0.961895474	0.68124124	0.45178644	0.880241776	1.380030248	1.0633334

SPECIMENS AND MORPHOLOGICAL DATA

NO.	PIC. No.	logsvl	loghw	loghl	logind	logend	logen	logtl	logfl
160	160	1.89779198	1.24993176	0.985426474	0.77085201	0.46389299	1.031408464	1.423245874	1.0913152
161	161	1.81164202	1.195069	0.942504106	0.71683772	0.41161971	0.944975908	1.349860082	1.1136092
162	162	1.79996053	1.1906118	0.959518377	0.75281643	0.40483372	0.909556029	1.362105319	0.9754318
163	163	1.83052451	1.21298618	0.923244019	0.82542612	0.40993312	0.96425963	1.370142847	1.0773679
164	164	1.81036695	1.18780264	0.941014244	0.66162341	0.36548798	0.909020854	1.365113432	1.0253059
165	165	1.79878871	1.20357677	0.923244019	0.6919651	0.41161971	0.950364854	1.338854746	0.9800034
166	166	1.81036695	1.17955179	0.946943271	0.7355989	0.48144263	0.951337519	1.35945602	1.0034605
167	167	1.87915325	1.25911584	1.063708559	0.72672721	0.43933269	0.94792362	1.398981067	1.0618293
168	168	1.83613415	1.27346427	1.086003706	0.72672721	0.43775056	0.939519253	1.410777233	1.0370279
169	169	1.79913369	1.218798	1.058426024	0.71516736	0.34635297	0.910090546	1.360214613	1.0788192
170	170	1.81531204	1.24968743	1.055760465	0.71683772	0.42488164	0.941511433	1.42373725	1.1290451
171	171	1.77004155	1.20817253	1.040997692	0.67209786	0.3283796	0.900367129	1.360971884	1.0927206
172	172	1.79754451	1.18412335	1.011993115	0.66931688	0.34439227	0.918554531	1.301464073	1.007321
173	173	1.79899573	1.21005085	1.029789471	0.67760695	0.37474835	0.933993164	1.372175286	1.0211893
174	174	1.84794264	1.24772783	1.067442843	0.70757018	0.40654018	0.923244019	1.41313205	1.0729847
175	175	1.72631961	1.17376882	0.974050903	0.60205999	0.36735592	0.887054378	1.312388949	0.9400182
176	176	1.78866321	1.2509077	1.04453976	0.74973632	0.46389299	0.942008053	1.381115081	1.0330214
177	177	1.76387703	1.18836593	1.008600172	0.67669361	0.41161971	0.893206753	1.331224781	0.9881128
178	178	1.75373622	1.20574554	1.005180513	0.7355989	0.45484486	0.925827575	1.378942699	1.0715138
179	179	1.76312838	1.20248832	0.972202838	0.62221402	0.46538285	0.903089987	1.340642378	1.0318123
180	180	1.7750276	1.19423675	1.031812271	0.68124124	0.40312052	0.928395852	1.339451441	1.0342273
181	181	1.78646748	1.2011239	1.043755127	0.72345567	0.41830129	0.88422877	1.344785123	0.9745117
182	182	1.76982026	1.20763437	0.948901761	0.6294096	0.41329976	0.914343157	1.319106059	1.0480532
183	183	1.76275356	1.21351776	1.013258665	0.69372695	0.38738983	0.958563883	1.31868927	0.9854265
184	184	1.80461642	1.24772783	1.053846427	0.69108149	0.40312052	0.972202838	1.384890797	1.0895519
185	185	1.72288061	1.15044941	0.953276337	0.61066016	0.38381537	0.851869601	1.273695588	0.8992732
186	186	1.74170298	1.20030318	1.025715384	0.64836001	0.39093511	0.943494516	1.331224781	1.045323
187	187	1.76537048	1.19645254	0.979548375	0.63346846	0.38021124	0.872738827	1.331832044	1.0043214
188	188	1.77720926	1.22814361	1.078456818	0.73719264	0.38201704	0.989894564	1.320769228	1.0086002
189	189	1.76072397	1.20574554	1.059563418	0.63848926	0.49276039	0.924279286	1.335658452	0.9618955
190	190	1.78568567	1.21058602	1.006037955	0.67851838	0.35024802	0.959041392	1.342620043	0.9623693
191	191	1.75189469	1.20248832	1.005180513	0.72427587	0.42160393	0.942008053	1.312388949	0.9956352
192	192	1.78915749	1.23299611	1.01494035	0.673942	0.37657696	0.890979597	1.339451441	0.9867717
193	193	1.76012079	1.17695898	0.994317153	0.65417654	0.43933269	0.923244019	1.311753861	0.9444827
194	194	1.74146676	1.16256441	0.983626287	0.64738297	0.34635297	0.86332286	1.288919606	0.90309
195	195	1.78859256	1.21112054	1.033423755	0.67669361	0.39619935	0.961895474	1.35831564	1.0845763
196	196	1.70225816	1.15866398	0.962369336	0.63245729	0.28555731	0.851258349	1.2955671	0.9642596
197	197	1.78017324	1.20411998	0.946452265	0.71349054	0.35602586	0.936010796	1.346548559	1.0678145
198	198	1.79028516	1.21590181	1.019946682	0.6794279	0.42324587	0.959518377	1.386855529	1.0480532
199	199	1.77320114	1.2011239	0.971739591	0.68930886	0.33845649	0.931966115	1.334252642	0.9542425

SPECIMENS AND MORPHOLOGICAL DATA

NO.	PIC. No.	logsvl	loghw	loghl	logind	logend	logen	logtl	logfl
200	200	1.81848982	1.22634209	1.064083436	0.66838592	0.4345689	0.962369336	1.326335861	1.0565237
201	201	1.76140156	1.18127177	0.964730921	0.65127801	0.372912	0.859138297	1.345177617	0.924796
202	202	1.75996986	1.19117146	0.989004616	0.64345268	0.36921586	0.912222057	1.325925956	0.948413
203	203	1.81756537	1.21774707	1.120573931	0.69108149	0.45484486	0.953759692	1.346157302	1.0232525
204	204	1.76893394	1.2143139	1.100370545	0.6294096	0.30749604	0.894869657	1.339053736	1.0449315
205	205	1.73215242	1.15654915	1.08350262	0.67117284	0.41497335	0.899273187	1.29666519	0.9836263
206	206	1.78611228	1.19948091	1.10720997	0.6242821	0.4345689	0.942008053	1.325515663	0.9969492
207	207	1.77385955	1.16316137	1.104487111	0.66558099	0.34242268	0.941511433	1.329194415	1.0599419
208	208	1.85205281	1.21192108	1.108903128	0.61066016	0.48000694	0.897627091	1.371067862	0.9283959
209	209	1.82301752	1.2347703	1.051152522	0.6794279	0.39445168	0.953759692	1.33264041	0.9459607
210	210	1.78689333	1.22036963	1.160768562	0.58092498	0.43136376	0.944975908	1.322426052	1.0124154
211	211	1.81848982	1.20276069	1.158060794	0.61700034	0.35602586	0.945960704	1.333850145	0.9661417
212	212	1.79588002	1.20139712	1.008600172	0.70926996	0.45178644	0.926856709	1.346939463	0.9907827
213	213	1.75648396	1.15106325	0.963787827	0.60422605	0.30963017	0.872738827	1.321391278	0.9745117
214	214	1.63868889	1.07736791	0.858537198	0.5575072	0.32428246	0.813580989	1.224533063	0.9786369
215	215	1.77749932	1.19117146	1.002597981	0.61489722	0.30749604	0.882524538	1.304921162	1.0572856
216	216	1.61310152	1.13703745	0.935507266	0.57634135	0.40654018	0.841984805	1.221674997	0.9106244
217	217	1.74327452	1.19284612	0.985426474	0.66181269	0.462398	0.909020854	1.355834496	0.9609462
218	218	1.71096312	1.16494737	1.003029471	0.60314437	0.30963017	0.939519253	1.308350949	0.9609462
219	219	1.79260178	1.22141424	1.010723865	0.70671778	0.41329976	0.840106094	1.372727941	1.0362295
220	220	1.81478015	1.221675	1.059184618	0.69635639	0.37106786	0.870403905	1.385069776	0.9289077
221	221	1.80679027	1.21192108	1.035829825	0.69284692	0.40312052	0.870988814	1.396373728	1.0220157
222	222	1.75112507	1.22115332	1.01745073	0.673942	0.40823997	0.838219222	1.291590826	0.9827234
223	223	1.79358087	1.2143139	1.035029282	0.71011737	0.44715803	0.86332286	1.353339095	0.9537597
224	224	1.75350646	1.20924685	1.011570444	0.62634037	0.32014629	0.807535028	1.226342087	0.9454686
225	225	1.81090428	1.20628604	1.047664195	0.66275783	0.35218252	0.850646235	1.354108439	0.9903389
226	226	1.81331406	1.25527251	0.999565488	0.7084209	0.37657696	0.849419414	1.344785123	1.006038
227	227	1.75488323	1.20628604	1.056142262	0.65896484	0.45024911	0.875639937	1.389166084	1.024896
228	228	1.82353943	1.25743857	0.984077034	0.673942	0.46686762	0.865103975	1.394101302	0.9951963
229	229	1.79532376	1.2598327	1.04060234	0.69897	0.36361198	0.882524538	1.347330015	1.1598678
230	230	1.84285876	1.24625231	1.012415375	0.69548168	0.51054501	0.920645001	1.367728546	1.2455127
231	231	1.83613415	1.2435341	1.014520539	0.64933486	0.42488164	0.939519253	1.357934847	1.1354507
232	232	1.80420761	1.2116544	1.067070856	0.6580114	0.3283796	0.961895474	1.322426052	1.0322157
233	233	1.85805572	1.21958453	1.059563418	0.64147411	0.36548798	0.893206753	1.388633969	1.1119343
234	234	1.83664054	1.23879856	1.056142262	0.64246452	0.36921586	0.924279286	1.390405156	1.0338257
235	235	1.86764423	1.2750809	1.088136089	0.61384182	0.42160393	0.925827575	1.385963571	1.049218
236	236	1.7908479	1.20763437	1.056523724	0.65127801	0.3783979	0.908485019	1.32756326	1.0098756
237	237	1.81438079	1.20439133	1.041787319	0.60852603	0.38560627	0.897627091	1.347915187	0.9929951
238	238	1.84683175	1.22479196	1.040206628	0.6580114	0.35218252	0.909020854	1.337459261	1.0835026
239	239	1.79028516	1.21642983	1.028164419	0.59879051	0.45939249	0.909020854	1.338456494	1.0277572

SPECIMENS AND MORPHOLOGICAL DATA

NO.	PIC. No.	logsvl	loghw	loghl	logind	logend	logen	logtl	logfl
240	240	1.83167785	1.22349594	1	0.63548375	0.33645973	0.937016107	1.338854746	1.0086002
241	241	1.84104647	1.23223352	1.085290578	0.64345268	0.33845649	0.875061263	1.341434525	1.0891984
242	242	1.81458052	1.23829707	0.975891136	0.61172331	0.34830486	0.942008053	1.33304403	1.0614525
243	243	1.82112032	1.2137833	1.016197354	0.61489722	0.33041377	0.952792443	1.349083169	1.0652061
244	244	1.83154985	1.21722066	1.013679697	0.60745502	0.48144263	0.930949031	1.375480715	1.0788192
245	245	1.83803008	1.23527588	1.042969073	0.61595005	0.40823997	0.924279286	1.355259906	1.0406023
246	246	1.78490245	1.20574554	1.058805487	0.56229286	0.30319606	0.931966115	1.335658452	1.0236639
247	247	1.80658693	1.2291697	1.055378331	0.64836001	0.36361198	0.897627091	1.300160537	1.0595634
248	248	1.83033199	1.22968184	1.08278537	0.69284692	0.37474835	0.984977126	1.31993844	1.0722499
249	249	1.84862012	1.2598327	1.020361283	0.58883173	0.32428246	0.872156273	1.369957607	1.0989896
250	250	1.86093662	1.24104815	1.051923916	0.57634135	0.35218252	0.905256049	1.412964272	1.0526939
251	251	1.79295171	1.18298497	1.061452479	0.61278386	0.36735592	0.87909588	1.052693942	0.9894498
252	252	1.81954394	1.17926446	1.028164419	0.61595005	0.48995848	0.902002891	1.307067951	1.064458
253	253	1.79049628	1.16583762	1.103461622	0.66275783	0.45024911	0.889301703	1.298634783	1.0136797
254	254	1.85636632	1.26197619	1.113609151	0.6242821	0.39269695	0.914343157	1.333245699	1.007321
255	255	1.8013351	1.22010809	1.173186268	0.66275783	0.36172784	0.933993164	1.389697548	0.9986952
256	256	1.88383171	1.19368103	1.151982395	0.66838592	0.44870632	0.905256049	1.361350024	1.0285713
257	257	1.75473047	1.17026172	1.087071206	0.74350976	0.40993312	0.925827575	1.331224781	1.007321
258	258	1.80359366	1.20057693	1.148910993	0.64345268	0.38916608	0.894869657	1.323458367	1.0441476
259	259	1.75656004	1.19838213	1.096910013	0.66464198	0.36172784	0.892651034	1.336259552	1.0195317
260	260	1.79878871	1.19975518	1.143951116	0.73719264	0.41497335	0.951823035	1.368286885	0.9790929
261	261	1.78859256	1.20574554	1.10754913	0.65224634	0.39445168	0.928395852	1.33304403	1.0338257
262	262	1.79878871	1.17695898	1.092018471	0.70926996	0.372912	0.904174368	1.285782274	1.0838608
263	263	1.77981286	1.25671775	1.149527014	0.70070372	0.33445375	0.910624405	1.357934847	1.0224284
264	264	1.75197157	1.161368	1.095518042	0.58883173	0.33243846	0.898176483	1.307709923	1.0253059
265	265	1.82898195	1.19920648	1.101059355	0.70243054	0.35410844	0.898176483	1.354300562	1.0207755
266	266	1.79239169	1.20601588	1.152594078	0.69810055	0.40654018	0.918030337	1.357934847	1.0831441
267	267	1.80509288	1.19728056	1.101059355	0.6794279	0.35602586	0.877946952	1.351409752	1.0546131
268	268	1.81809387	1.20057693	1.124178055	0.67577834	0.50920252	0.939519253	1.398113692	1.0334238
269	269	1.74601111	1.2219356	1.014520539	0.67209786	0.34242268	0.914871818	1.334453751	1.0484418
270	270	1.730136	1.21853551	1.003029471	0.66275783	0.34242268	0.865103975	1.329804522	1.0128372
271	271	1.73183042	1.20897852	1.023663918	0.63346846	0.3783979	0.884795364	1.315340477	1.0824263
272	272	1.78268757	1.20547504	1.012415375	0.69372695	0.40483372	0.929418926	1.327971624	1.0441476
273	273	1.8163076	1.22968184	1.05804623	0.62117628	0.34242268	0.897627091	1.372543801	1.0132587
274	274	1.73351825	1.17811325	0.982271233	0.64542227	0.30535137	0.881954971	1.29666519	0.9956352
275	275	1.86308483	1.23274206	1.044931546	0.74350976	0.36548798	0.922725458	1.368844507	1.1166077
276	276	1.73199145	1.15044941	0.996511672	0.68304704	0.30535137	0.881954971	1.29666519	0.9956352
277	277	1.77626522	1.20844136	1.015778756	0.67117284	0.32221929	0.919078092	1.35831564	1.0542299
278	278	1.71642073	1.18155777	0.938519725	0.64542227	0.26007139	0.894869657	1.280805928	1.0244857
279	279	1.78724788	1.18212921	1.032618761	0.71096312	0.37657696	0.91750551	1.336059278	1.0526939

SPECIMENS AND MORPHOLOGICAL DATA

NO.	PIC. No.	logsvl	loghw	loghl	logind	logend	logen	logtl	logfl
280	280	1.74717867	1.19145101	1.003029471	0.673942	0.3283796	0.908485019	1.292256071	1.0310043
281	281	1.76380222	1.2008505	0.967079734	0.68124124	0.38916608	0.947433722	1.30427505	1.0161974
282	282	1.8163076	1.22968184	1.05804623	0.62117628	0.34242268	0.897627091	1.372543801	1.0132587
283	283	1.74911766	1.17983893	1.004751156	0.66370093	0.31386722	0.911690159	1.319522449	1.0394141
284	284	1.69905685	1.16046853	0.983626287	0.68930886	0.35024802	0.820201459	1.313656347	1.0511525
285	285	1.70918513	1.16046853	0.980911938	0.66181269	0.43296929	0.806179974	1.296884476	0.8175654
286	286	1.70757018	1.15896526	0.958563883	0.6560982	0.45939249	0.826074803	1.306210508	1.0366289
287	287	1.69486833	1.14426277	0.882524538	0.66086548	0.29225607	0.722633923	1.283527365	0.9637878
288	288	1.68322721	1.16435286	0.991669007	0.70156799	0.45024911	0.792391689	1.317018101	0.9623693
289	289	1.65214961	1.09864373	0.924279286	0.6180481	0.38738983	0.763427994	1.223755454	0.9041744
290	290	1.6597261	1.10209053	0.964730921	0.64345268	0.14921911	0.793790385	1.279438788	0.8609366
291	291	1.74911766	1.18497519	2.000477461	0.66370093	0.31386722	1.039810554	1.319730494	1.0394141
292	292	1.674034	1.17405981	0.914343157	0.60205999	0.24551267	0.891537458	1.298853076	1.0051805
293	293	1.67043141	1.15775889	0.957607287	0.62634037	0.161368	0.823474229	1.266701967	0.9698816
294	294	1.69170021	1.15533604	0.912753304	0.54157924	0.25042	0.843855423	1.246990699	0.9609462
295	295	1.75204845	1.15986785	0.996511672	0.65417654	0.34635297	0.877371346	1.315130317	0.9429996
296	296	1.7523558	1.21325205	1.070776463	0.68930886	0.40654018	0.937016107	1.286680969	0.966611
297	297	1.72525807	1.17055506	0.995196292	0.69019608	0.40823997	0.877946952	1.260786669	0.9722028
298	298	1.78002913	1.22659991	1.110252917	0.77085201	0.43136376	0.954724791	1.351603072	1.1344959
299	299	1.78809763	1.27461962	1.13893394	0.73878056	0.4345689	0.994317153	1.343014497	1.1427022
300	300	1.74826557	1.21827285	1.129689892	0.70415052	0.38021124	0.95616843	1.307923704	1.0842187
301	301	1.76529593	1.23451728	1.108565024	0.6946052	0.41664051	0.934498451	1.30427505	1.0951694
302	302	1.71113207	1.16583762	1.101403351	0.71600334	0.46834733	0.937016107	1.286680969	1.0285713
303	303	1.73045926	1.22453306	1.126780577	0.72098574	0.40823997	0.95616843	1.303627976	1.1156105
304	304	1.75181779	1.21058602	1.111598525	0.71011737	0.35218252	0.905256049	1.32776749	1.0437551
305	305	1.81789576	1.21325205	1.048830087	0.66931688	0.37106786	0.883093359	1.342225229	1.0034605
306	306	1.7362371	1.17055506	1.121887985	0.71683772	0.45178644	0.910090546	1.306425028	1.0817073
307	307	1.78204242	1.20520436	1.092018471	0.66838592	0.4785665	0.922206277	1.26810973	1.1061909
308	308	1.64816478	1.11327469	1.021189299	0.63848926	0.15836249	0.82672252	1.19838213	0.9956352
309	309	1.72073798	1.16166741	1.070776463	0.67851838	0.38201704	0.900913068	1.298197867	1.0499929

BIOGRAPHY

BIOGRAPHY

Name Chalida Laojumpon

Date of brith 17 August 1989

Place of birth Maha Sarakham

Institution attended

1998 Graduated primary school from Amnat Charoen Kindergarten School, Amnat Charoen Province

2004 Graduated secondary school from Kalasinpitayasan School, Kalasin Province

2008 Bachelor of Science (first class honours) in Biology program, Biology Department, Faculty of Science, Mahasarakham University, Mahasarakham Province

2011 Master of Science in Biology program, Biology Department, Faculty of Science, Mahasarakham University, Mahasarakham Province

Position and Work Place

Biology Department, Faculty of Science, Mahasarakham University, Mahasarakham Province

Contact address

45 Tumbon Phon Thong, Merk District, Kalasin Province 46000

Resarch grants & awards

Honorable Mention Oral presentation Award in The 4th Science research conference. Naresuan University, Thailand.12-13 March 2012.

Research output

Laojumpon, C., Suteethorn' S. and Lauprasert, K. (2012). Morphological Variation of Truncate-Snouted Burrowing Frog (*Glyphoglossus molossus*) of Thailand. The 4th Science research conference, 12-13 March, 2012, Naresuan University, Thailand.