MORPHOLOGY AND FORAGING ECOLOGY OF THE TOKAY GECKO
Gekko gecko (Linnaeus, 1758)

Miss Anchalee Aowphol

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science in Zoology
Department of Biology
Faculty of Science
Chulalongkorn University
Academic Year 2002
ISBN 974-17-2470-5

สัณฐานวิทยาและนิเวศวิทยาการหากินของตุ๊กแกบ้าน *Gekko gecko* (Linnaeus, 1758)

นางสาว อัญชลี เอาผล

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต

สาขาวิชาสัตววิทยา ภาควิชาชีววิทยา

คณะวิทยาศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

ปีการศึกษา 2545

ISBN 974-17-2470-5

MORPHOLOGY AND FORAGING ECOLOGY OF THE TOKAY GECKO

Gekko gecko (Linnaeus, 1758)

Miss Anchalee Aowphol

A Thesis Submitted in Partial Fulfillment of the Requirements

for the Degree of Master of Science in Zoology

Department of Biology

Faculty of Science

Chulalongkorn University

Academic Year 2002

ISBN 974-17-2470-5

Thesis Title	MORPHOLOGY AND FORAGING ECOLOGY OF THE TOKAY GECKO *Gekko gecko* (Linnaeus, 1758)
By	Miss Anchalee Aowphol
Field of Study	Zoology
Thesis Advisor	Assistant Professor Kumthorn Thirakhupt, Ph.D.
Thesis Co-advisor	Jarujin Nabhitabhata

Accepted by the Faculty of Science, Chulalongkorn University in Partial Fulfillment of the Requirements for the Master's Degree

.... Dean of Faculty of Science

(Associate Professor Wanchai Phothiphichitr, Ph.D.)

THESIS COMMITTEE

.... Chairman

(Professor Siriwat Wongsiri, Ph.D.)

.... Thesis Advisor

(Assistant Professor Kumthorn Thirakhupt, Ph.D.)

.... Thesis Co-advisor

(Jarujin Nabhitabhata)

.... Member

(Assistant Professor Putsatee Pariyanonth)

.... Member

(Art-ong Pradatsundarasar, Ph.D.)

T 140322

อัญชลี เอาผล : สัณฐานวิทยาและนิเวศวิทยาการหากินของตุ๊กแกบ้าน *Gekko gecko* (Linnaeus, 1758). MORPHOLOGY AND FORAGING ECOLOGY OF THE TOKAY GECKO *Gekko gecko* (Linnaeus, 1758) อาจารย์ที่ปรึกษา: ผศ. ดร. กำธร ธีรคุปต์ อาจารย์ที่ปรึกษาร่วม: นาย จารุจินต์ นภีตะภัฏ จำนวน 101 หน้า ISBN 974-17-2470-5

การศึกษาความแตกต่างของลักษณะทางสัณฐานวิทยาของตุ๊กแกบ้าน *Gekko gecko* เพศผู้ เพศเมียและตัวก่อนถึงวัยเจริญพันธุ์จากจังหวัดสระบุรีพบว่า ตุ๊กแกบ้านแต่ละกลุ่มมีความแตกต่างของลักษณะทางสัณฐานวิทยาอย่างมีนัยสำคัญ ($p < 0.05$)โดยลักษณะความยาวตาและความกว้างหางสามารถแยกความแตกต่างระหว่างตุ๊กแกบ้าน เพศผู้ เพศเมียและตัวก่อนถึงวัยเจริญพันธุ์ได้ ส่วนระยะห่างระหว่างรูจมูก ระยะห่างระหว่างตา ความยาวจากตาถึงหู ความยาวรูหู ความยาวระหว่างโคนขาหน้าถึงโคนขาหลัง ความยาวมือและความกว้างนิ้วเท้าที่ 4 สามารถแยกความแตกต่างระหว่างตุ๊กแกบ้านวัยเจริญพันธุ์และก่อนถึงวัยเจริญพันธุ์ได้ ตุ๊กแกบ้านวัยเจริญพันธุ์มีลักษณะที่แตกต่างระหว่างเพศที่เห็นได้ชัดเจนเช่น ขนาดตัว ความกว้างหัว และความกว้างหาง ส่วนการวิเคราะห์ด้วย Discriminant Function Analysis ได้สมการ 2 สมการที่สามารถใช้ในการทำนายเพศ และวัยของตุ๊กแกบ้านด้วย

ผลการศึกษานิเวศวิทยาการหาอาหารของตุ๊กแกบ้านบริเวณที่พักอาศัยในสวนสัตว์เปิดเขาเขียว เขตรักษาพันธุ์สัตว์ป่าเขาเขียว-เขาชมภู่ จังหวัดชลบุรี ในช่วงเดือนกรกฎาคม 2544 ถึงเดือนมิถุนายน 2545 พบว่าอุณหภูมิ ความชื้นสัมพัทธ์ และปริมาณแมลง มีผลต่อจำนวนและกิจกรรมของตุ๊กแกบ้าน ตุ๊กแกบ้านมีช่วงเวลาการหากินระหว่าง 17:00 น. ถึง 09:00 น.โดยมีจำนวนตัวที่ออกมาหากินสูงสุดในช่วง 18:00 น. ถึง 20:00 น. และ จำนวนตัวที่กลับเข้าที่หลบซ่อนสูงสุดในช่วง 04:00 น. ถึง 07:00 น. อาหารหลักของตุ๊กแกบ้านได้แก่ แมลงในอันดับ Lepidoptera, Orthoptera และ Coleoptera โดยตุ๊กแกบ้านเพศผู้ เพศเมียและตัวก่อนถึงวัยเจริญพันธุ์ซึ่งมีขนาดตัวและขนาดหัวแตกต่างกัน แต่กินเหยื่อขนาดไม่แตกต่างกัน

พฤติกรรมการหาอาหารได้แก่ ช่วงเวลาการออกหากิน เวลาที่เคลื่อนที่ ความพยายามในการจับเหยื่อ ความสำเร็จในการจับเหยื่อ ขนาดเหยื่อที่บริโภค ระยะทางที่ใช้หากิน ไม่แตกต่างระหว่างตุ๊กแกบ้านเพศผู้ เพศเมียและตัวก่อนถึงวัยเจริญพันธุ์ แต่พฤติกรรมการหาอาหารดังกล่าวของตุ๊กแกบ้านเพศผู้มีแนวโน้มที่หลากหลายกว่ากลุ่มอื่น สำหรับความหลากหลายของพฤติกรรมการหาอาหารในตุ๊กแกบ้านแต่ละตัวพบว่ามีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ ผลการศึกษาครั้งนี้พบว่าพฤติกรรมการหาอาหารของตุ๊กแกบ้านสอดคล้องกับข้ออธิบายของ optimal foraging theory

ภาควิชา......ชีววิทยา..............................ลายมือชื่อนิสิต............อัญชลี เอาผล....................

สาขาวิชา...สัตววิทยา..............................ลายมือชื่ออาจารย์ที่ปรึกษา..........กำธร ธีรคุปต์..........

ปีการศึกษา..2545..............................ลายมือชื่ออาจารย์ที่ปรึกษาร่วม.......................

##4272480723 : MAJOR ZOOLOGY

KEY WORDS :TOKAY GECKO / *Gekko gecko* / MORPHOLOGY / FORAGING ECOLOGY

ANCHALEE AOWPHOL : MORPHOLOGY AND FORAGING ECOLOGY OF THE TOKAY GECKO *Gekko gecko* (Linnaeus, 1758). THESIS ADVISOR: ASST. PROF. KUMTHORN THIRAKHUPT, Ph.D., THESIS CO-ADVISOR: JARUJIN NABHITABHATA, M.Sc. 101 pp. ISBN 974-17-2470-5

Morphological differences among males, females, and juveniles of *Gekko gecko,* collected from Saraburi Province, were studied. It was found that there were significant differences among groups in various characters ($p < 0.05$). Eye length and tail width could separate males, females, and juveniles from each other, whereas internasal distance, interorbital distance, eye to ear length, ear length, axilla to groin length, hand length, and toe IV width could separate adults from juveniles. *G. gecko* exhibited sexual dimorphism in some characters such as body size, head width, and tail width. Discriminant Function Analysis was used and the result provided two equations for predicting sexes and ages of *G. gecko*.

The study on the foraging ecology of *G. gecko* was conducted at the residential complex, Khao Khiao Open Zoo, Khao Khiao-Khao Chomphu Wildlife Sanctuary, Chon Buri Province during July 2001 to June 2002. It was found that temperature, humidity, and insect abundance could affect the number and activity of foraging *G. gecko*. Foraging time was between 5 pm to 9 am. The peak of emergence time was between 6 pm to 8 pm and the peak of retreating time was between 4 am to 7 am. Major food items of *G. gecko* were insects in the Order Lepidoptera, Orthroptera and Coleoptera. Prey sizes of males, females, and juveniles were not significantly different, indicating that the prey size did not depend on the body size and head size of the geckos.

The foraging behavior of *G. gecko*; foraging period, time moving, foraging attempt, foraging success, prey size consumed, and foraging distance did not vary among groups of males, females, and juveniles. However, males' foraging behaviors tended to be more variable than the others. In addition, the variations in foraging behavior among individuals were found. All foraging strategies of *G. gecko* observed in this study could be explained by the optimal foraging theory.

Department........Biology ....Student's signature....A. Aowphol.........................

Field of study...Zoology..................Advisor's signature....K. Thirakhupt..........

Academic year...2002....................Co-advisor's signature....J. Nabhitabhata..........

ACKNOWLEDGEMENTS

I wish to express my sincere gratitude to my thesis advisor, Assistance Professor Dr. Kumthorn Thirakhupt, for his care, supports, encouragement, and invaluable advice throughout my study in the Department of Biology. I am also grateful to my thesis co-advisor Ajan Jarujin Nabhitabhata, for his invaluable guidance and suggestion.

I would like to express my grateful thank to Professor Dr. Siriwat Wongsiri, chairman of the thesis committee. I also would like to express my appreciation to Assistance Professor Putsatee Pariyanonth, a member of thesis committee for kind guidance in many ways. I am also grateful to Dr. Art-ong Pradatsundarasar for invaluable advice and much help especially on providing textbooks and articles.

I wish to express my thanks to the Plant Genetics Conservation Project under the Royal Initiative of Her Royal Highness Princess Maha Chakri Sirindhorn, Mr. Pornchai Chuthamas and staffs of Khao Khiao Open Zoo for many helps in filed research at Khoa Khiao Open Zoo.

I am grateful to Professor Yehudah L. Werner, Professor Hidetoshi Ota, Professor Aaron Bauer, Mr. Olivier Pauwels and Mr. Wolfgang Grossmann for invaluable advice and providing articles.

I would like to express my special thanks to Dr. Wachira Kitimasak and Ajan Noppadon Kitana for their "big brothers" in the encouragement and helping hand in many ways.

I must thank many other persons including Dr. Wichase Khonsue, Mr. Thawit Poopradit, Mr. Thongchai Ngamprasertwong, Miss Watcharaporn Kaewdee, Mr. Komsorn Lauprasert, Miss Sansareeya Wangkulangkul, Miss Varanya Aranyavalai, and Mr. Saran Keithmaleesatti.

I would like to thank my friends and colleagues, who assisted in data collection of this study: Miss Tassanee Eamkamon, Miss Malai Pornjak, Miss Cheeraporn Pornsri and Miss Porntip Thongchart.

I am grateful to the scholarship awarded by the Development and Promotion of Science and Techonolgy Talents Project of Thailand (DPST) for my study at Chulalongkorn University.

This work was supported by the TRF/BIOTEC Special Program for Biodiversity Research and Training grant BRT T_144022.

Finally, I would like to express my deepest gratitude to my family for their love, encouragement, and supports.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (cont.)

LIST OF FIGURES (cont.)

CHAPTER 1

INTRODUCTION

Geckos belong to the lizard group, which is the largest group of Class Reptilia. They are classified in Family Gekkonidae, and found in tropical and temperate zones of the world. They live in various habitats such as moist forest, dry forest, arid land, and residential area. In Thailand, some species (e.g. *Gekko gecko*, *Hemidactylus frenatus* and *Cosymbotus platyurus*) have become common animals in houses. (Taylor, 1963; Cogger, 1994; Zug, 2001).

The Genus *Gekko* Laurenti, 1768 consists of 28 species and distributes in temperate to tropical Asia and western Oceanian Islands (Grossman and Ulber, 1990; Ota and Nabhitabhata, 1991; Kluge, 1993; Ota *et al.*, 1995). In Thailand, there are 5 species; *G. gecko*, *G. monarchus*, *G. petricolus*, *G. smithii*, and *G. siamensis* (Chan-ard *et al.*, 1999). *G. gecko* is the only one species of genus *Gekko*, which is found throughout Thailand including in the big cities. This species lives in houses as well as in forests. It feeds mainly on insects, but sometimes eats some vertebrates such as smaller lizards.

Morphological variations often occur in animals within and between sexes and among age groups such as body size, coloration and other traits (Bury, 1979; Molina-Borja *et al.*, 1997). These differences are important in individuals' survivorship and social interactions (Bury, 1979; Pough, 2001). In many animal species, males and females may differentially allocate resources to reproduction and growth and result in differences in morphological traits between the sexes (sexual dimorphism). For *G. gecko*, the differences between sexes are sometimes not immediately noticeable. Therefore, a detailed study on morphological characters was conducted in this study.

Many animals spend most of the time gathering for food and successful foraging techniques are assumed to be adapted as they help to increase their survival and reproduction. Hence, the study of foraging behavior could be a key to understand animal survival strategies. Many species of lizards have been used as models for studying the foraging behavior in the field (e. g. Perry *et al.*, 1990; Werner *et al.*, 1997; Cooper *et al.*, 2001). Among lizards, two major modes of foraging behavior are recognized: active (wide) foraging and sit-and-wait (ambush) foraging (Pianka, 1966; Huey and Pianka, 1981; Cooper, 1994). Geckos have been considered as sit-and-wait foragers, but from recent reviews, they are also active predators. Moreover, many species of geckos are often found to live in man-made environments. They should have high adaptability in foraging behavior. Therefore, the information on *G. gecko* living in man-made environment and how the optimal foraging theory can explain the cost and benefit of its foraging behavior is interesting to study.

The optimal foraging theory helps biologist understand foraging behavior of animals. It explains that animals will behave in ways that maximize net energy gain or the benefit/cost ratio. For examples, animals try to collect more food with less time, or catch larger foods instead of smaller ones with the same period of time, or reduce various time and energy expenses while foraging. Based on this concept, the study of foraging ecology *G. gecko* living in man-made environment was determined.

This study will provide basic knowledge on morphological differences between sexes and ages as well as to understand the foraging ecology of *G. gecko* living in a man-made environment.

Objectives

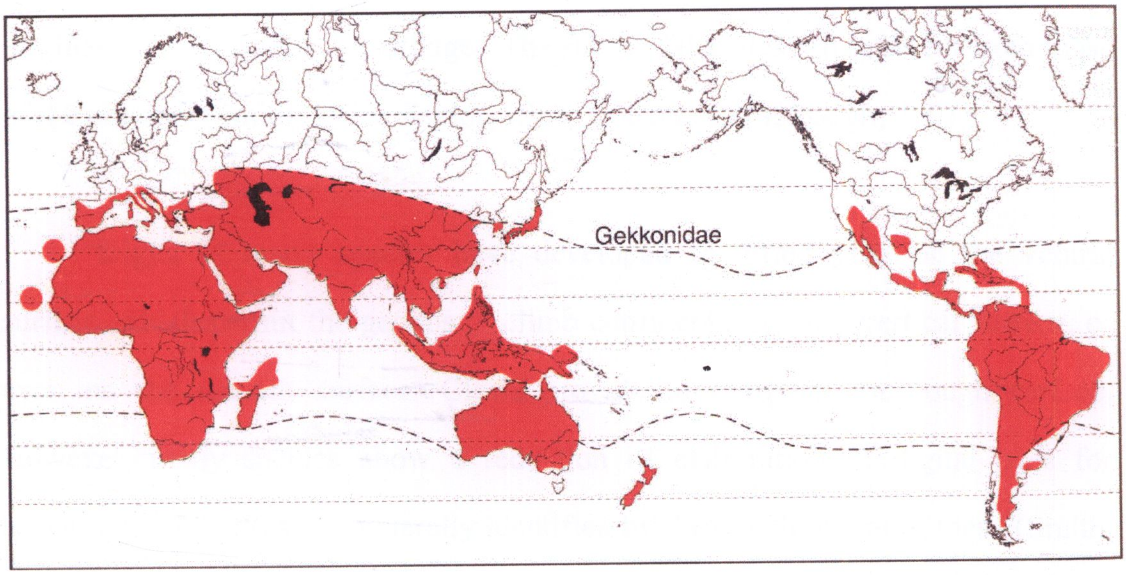
1. To study morphological differences among males, females, and juveniles of *G. Gecko*.
2. To study the foraging ecology of *G. gecko* living in the residential complex, Khao Khiao Open Zoo, Khao Khiao-Khao Chomphu Wildlife Sanctuary, Chon Buri Province.
3. To determine whether geckos' foraging behavior is in accordance with the prediction from the optimal foraging theory.

CHAPTER 2

LITERATURE REVIEW

2.1 Classification

Geckos are classified in Class Reptilia, Order Squamata, Family Gekkonidae. It is a large and diverse group of lizards. This family consists of four subfamilies: Gekkoninae, Diplodactylinae, Eublepharinae, and Pygopodinae, but the latter two groups are sometimes separated into family Eublepharidae and Pygopodidae, respectively. They are found throughout the tropical and warm temperate region of the world (Figure 2-1). In Thailand, there are 2 subfamilies: Gekkoninae and Eublepharinae. (Smith, 1935; Taylor, 1963; Cogger, 1994; Chan-ard *et al.*, 1999; Pough, 2001; Zug, 2001)



Figture 2-1 Distribution of Family Gekkonidae (Zug, 2001).

2.1.1 Characteristics of Family Gekkonidae

The body of geckos is soft and covered dorsally and ventrally by small granular scales that are occasionally interspread with tubercles (Smith, 1935; Zug, 2001). The scales of the body are usually juxtaposed. The limbs are well developed and pentadactyl (except in pygopods). These taxa have a pectoral girdle with T-shape or cluciform interclavicles and angular clavicles. The lidless eyes are covered by a transparent spectacle, but geckos in subfamily Eublepharinae still retain eyelid. The pupil is a vertical slit, or a vertical series of pinhole opening in daylight. The broad, flat tongue is often used to clean the eyes. Males of many species have small grandular pores in scales situated at the anterior of the vent (or called preanal pores), but some species have long continuous series at the underside of the tight (or called femeral pores). The number of pores is individual variation. Tail is highly autotomic. The skin of many species is fragile and useful for caudal defensive mechanism. The tail, when is broken off, is regenerated in weeks to months. The reproduced part rarely resembles the original tail. It contains a cartilage. The subcaudal scales are different from those of the old one. (Smith, 1935; Taylor, 1963; Cogger, 1994; Pough, 2001)

Digits of many species have developed modified pads on the ventral surface, which permit the geckos to climb confidentially on a vertical surface, or even on the smooth surface. Claws provide to cling on the rough surface. However, many species show a reduction of elaboration of digital pads for terrestriality. Geckos are generally identified by the development of toes. (Smith, 1935; Taylor, 1963; Pough, 2001)

Most geckos are oviparous and some are viviparous. These species have only one or two eggs per clutch. The eggshells are hardened when they expose to air. Eggs are placed in nooks and crannies or plastered on a surface such as rock and wall or kept under leaves. Parthenogenesis occurs in some geckos such as *Hemidactylus garnotii* and *Lepidodactylus lugubris*. Most of these species have diploid and polyploid forms. (Taylor, 1963, Pough, 2001; Zug, 2001)

Geckos have vocal communication whereas other lizards are often silent. There are many types of call such as territorial call, courtship call, and distress call. Males of many species often vocalize to defend their own territory and sometimes attract females. Moreover, common names of some species are derived from their vocalization such as sound "Tokaa" of the Tokay *G. gecko*. (Pough, 2001; Zug, 2001)

2.1.2 *Gekko gecko*

Figure 2-2 *Gekko gecko*

G. gecko is a member of the subfamily Gekkoninae. It is a large commensal and forest species. The well-known traits of this lizard are loud vocalization and aggressive behavior. Head is rather large in proportion to body, and covered with small polygonal scales. Body is typically gray, blue-gray or violet-gray above, spotted all over with brick red and whitish-gray. Tail is banded with the same color pattern, but the tail of juvenile is distinctly banded with blue and white colors. Digit has a slight basal web, each cover below with widened undivided lamellae. Claws arise from terminal portion. Inner finger and toe lack claws and distal joint. Male has a wide-angle series of preanal pores from 10 to

24. Two eggs are plastered on a surface in a fairly dark place. Several individuals may lay eggs closely. Tokay gecko is highly territorial, especially in male. (Smith, 1935; Taylor, 1963)

This species is widespread from northeastern India, southern China, Indochina, Indoaustralian Archipelago and Philippines. Furthermore, they were introduced into the United States. (Smith, 1935; Taylor, 1963; Zhao and Edler, 1993)

2.2 Morphological differences

Morphological variations occur in animals within and between sexes and among age groups such as body size, coloration and other traits (Bury, 1979; Molina-Borja *et al.*, 1997). These differences are important in individual survivorship and also social interactions e.g. fighting, courtship (Bury, 1979; Pough, 2001).

The differences in morphology between ages occur in some species of lizards. For example, nuchal crest character of *Physignathus cocincinus* is different among age groups (Angsirijinda, 1999). For *G. gecko*, the tail of the adult has the same color as the body, whereas the juvenile has transverse blue and white bands (Taylor, 1963).

Males and females of many animal species exhibit differences in the reproductive organs, but some animals have the differences in morphological traits (sexual dimorphism: SD) or body size (Sexual size dimorphism: SSD) between sexes. Two main types of explanations for the evolution of sexual dimorphism have been proposed: sexual selection and intraspecific niche divergence (Shine, 1989). There are three major hypotheses of the sexual dimorphism in organism that are mentioned by Darwin (1889); Slatkins (1984), Shine (1989) and (1990) as the following:

1) The female fecundity hypothesis: females are larger because larger body size is associated with increased number or size of eggs.

2) The competition avoidance hypothesis: differences in head and mouth size and differences in microhabitat usage result in decrease intersexual competition for resource.

3) The sexual selection hypothesis: males are larger because large male size is favored in male-male disputes over breeding territories.

Within lacertids, variations in morphology and color have been also reported. Some characters are important in species recognition, intersexual competition, territorial defense and mate choice. Sexual size dimorphism often occurs in many species of lizards. Males may attain larger size than females in some cases, whereas females are larger than males in others. In some aggressive and territorial lizards, sexual size dimorphism is also represented in head size such as in *Cordylus macropholis*, and *Gallotia galloti*. (Molina-Borja *et al.*, 1997; Mouton, Flemming, and Neiuwoudt, 2000; Zug, 2001).

Sexual dimorphism in geckos is also presented by other prominent characteristics as the following:

1. Adult males usually have preanal and/or femeral pores. Some species lack these pores in both sexes. The pores appear in a continuous row on the underside of the femur, which is meeting in preanal region, and the number of

pores is subject to individual variations. These pores in females are usually small and non-functional. (Smith, 1935; Taylor, 1963; Ota *et al.*, 1995)

2. The base of tail, which is the position of hemipenes, is swollen. However, this is not always a reliable guide (Smith, 1935).

3. Some species have a large cloacal spur on each side. A single cloacal spur is larger in male than that of female such as in *Gekko chinensis*, *G. palmatus* and *G. siamensis* (Grossman and Ulber, 1990; Ota and Nabhitabhata, 1991; Ota *et al.*, 1995).

2.3 Foraging behavior

2.3.1 Optimality theory and foraging theory

Optimality theory is the essence of an evolutionary approach to animal behavior. All behavior is the production of selection for traits that contribute to most individual fitness (Orient, 1971, cited in Alcock, 1975: 265).

For foraging behavior, it can be explained by optimal foraging theory. This theory explains that animals behave in ways that maximize net energy gain or the benefit/cost ratio. For examples, animals collect more food in less time, or catch larger foods in the same time more than require taking smaller ones, or reducing various time and energy expenses (Alcock, 1975).

2.3.2 Foraging mode

Foraging behavior of lizards is usually described in terms of foraging mode. The foraging modes are characterized into 2 types: sit-and-wait (or ambush) foraging and widely (or active) foraging (Pianka, 1966; Huey and Pianka, 1981).

Sit-and-wait foraging species use a perch to scan their surrounding and making swift forays to grab passing preys. They spend a little time and energy for searching prey and most energy is spent for capturing and handling. Their prey types are mobile and large sizes. For defensive mechanism, animals in this group usually have cryptic morphology and coloration that preys and predator could not detect them easily. However, when crypsis fails, they flee in high speed. (Huey and Pianka, 1981; Vitt and Price, 1982; Perry *et al.* 1990; Zug, 2001)

Widely foraging species search throughout the habitat for stationary (or even hidden) preys visually and by tongue-flicking to locate chemical cues. They expend most energy for searching, and have high captured rates. Their prey types are sedentary and small sizes. For defensive mechanism, they have usually toxic skin or high speed of running for escapes. Females of widely foraging species carry smaller relative clutch masses than do sit-and-wait females. (Huey and Pianka; Vitt and Price, 1982; Perry *et al.* 1990; Zug, 2001)

There are many measures to determine these foraging modes. The quantification of percent time moving (PTM) and movement per minute (MPM) have been used to establish the type of foraging modes, especially in lizards. Widely foraging species have high value of MPM and PTM, whereas sit-and-wait foragers have low value of MPM and PTM. Moreover, some authors used the proportion of attacks on prey discovered while moving (PAM) to assist in foraging mode assessment. (Huey and Pianka, 1981; Perry *et al.*, 1990; Werner *et al.*, 1997; Cooper, *et al.* 2001)

Foraging behavior of lizard families have been defined as containing either sit-and-wait foraging or widely foraging (Cooper, 1994), but most insectivorous lizards and some higher taxa appear to have only one foraging mode such as sit-and-wait foraging in Iguanians and widely foraging in Varanoidea. However, both foraging modes occur in a few families, notably Lacertidae, Gekkonidae, Scincidae and Pygodidae (Huey and Pianka, 1981; Perry *et al.*, 1990; Cooper, 1994; Web and Shine, 1994; Werner *et al.*, 1997 and Cooper and Whiting, 2000).

Some lizards groups have intrageneric variations in foraging modes. Perry et al. (1990) reported on three lacertid lizards in Genus *Acanthodactylus* in that *Acanthodactylus scutellatus* is a sit and wait forager whereas *A. boskianus* and *A. schreiberi* are widely foraging predators. Cooper and Whitting (2000) studied foraging behavior of scincinid lizards in Genus *Mabuya* in southern Africa. Like the large majority of skinks, *Mabuya striata sparsa*, *M. sulcata* and *M. variegata* are active foragers that have high value of MPM, PTM, and mean speed but relatively low speed while moving. In contrast, *M. acutilabris* and *M. spilogaster* are sit-and-wait foragers having low MPM, PTM and higher average speed while moving.

Geckos have traditionally been considered as sit-and-wait foragers, but some authors reported that many geckos are also widely foraging species or use mixed strategy.

Vitt and Price (1982) reviewed eighteen species of geckos from literatures. All were reported to be sit-and-wait foragers. Most sit-and-wait species have large relative clutch masses (RCM), whereas widely foraging species have small

RCM. However, geckos have small RCM when compare to sit-and-wait lizards of other families.

Vitt (1990) pointed out that among sympatric tropical caatinga lizards, geckos differ from typical sit-and-wait species in possessing continual rather than seasonal reproduction.

Werner, Okada, Ota, Perry, and Tokunaga (1997) studied the foraging modes of three species of tropical nocturnal gekkonids. Foraging mode of *Gekko hokouensis*, *G. japonicus* and *Teratoscincus roborowskii* revealed that by the measure of MPM, indicating that they are sit-and-wait predators. However, *G. hokouensis* is widely foraging species when it was measured by PTM. Moreover, individuals of three species also appear to fluctuate between these two foraging tactics. Therefore, these views support the notion that geckos should not be considered strict sit-and-wait species.

Stanner *et al.* (1998) studied the foraging mode of *G. gecko* in Thailand and concluded that this species clearly behave as sit-and-wait predator, although its activity varie between nights.

2.3.3 Foraging ecology

Lizards, especially in the geckos, have been used as models for studying the foraging ecology in the field. They are studied in both natural habitat and man-made environments.

Bustard (1968) studied the ecology of the Australian gecko, *Gehyra variegata*. Male geckos are territorial thoughout the year and usually occur with one or more females. Foraging away from the microhabitat is restricted to about three hours after dark and is often stopped by the fall in temperature. Feeding is restricted up to six to seven months of the year. The main food items in order of importance are Coleoptera, Araneida, Isoptera, Orthoptera, and Dictyloptera. Growth is rapid during the warm weather.

Perry (1996) reported the intraspecific variation in foraging behavior and diet of the lizard, *Anolis polylepis*. Males are significantly larger and heavier than females, but eat the smaller items and have lower stomach volumes, despite possessing longer and wider heads. The diet of males, females, and juveniles are also significantly different taxonomically. Males are more sedentary than females and juveniles.

Petren and Case (1996) studied exploitation competition between two species, which lived in buildings. A native gecko, *L. lugubris*, declined numerically when *H. frenatus* invaded into their habitats throughout the Pacific. These two species showed nearly complete diet overlap. They foraged in the lighted area due to the high insect abundance, including the same peak of foraging time. The invader had a variety of species specific traits such as larger body size, faster running speed, and reduced intraspecific interference while foraging. Moreover, the clump resource can also increase interspecific competition.

Werner (1998) reported on the preliminary study of foraging mode and commented on competition of sympatric house geckos living in a house in the Tahiti. From a small sample, *Gehyra mutilata* and *L. lugubris* are sit-and-wait foragers, whereas *Gehyra oceania* and *H. frenatus* may be sit-and-wait foragers. However, *L. lugubris* sometimes hunts more actively. All four species are known as opportunistic insectivorous, with largely overlapping list of prey types. These species tend to share activity cycles, but not fully syntopic.

Vitt *et al.* (2000) studied ecology of two spherodactyline geckos, *Gonatodes hasemani* and *G. humeralis* in Brazil, which are coexistence. Both species live in the same habitat, but are different in their microhabitats. They are strikingly similar in time of activity, body temperature, prey size, and even prey types. However, the relatively minor differences in diet may reflect differences in prey availability in the microhabitat used by these two lizards. Moreover, niche differences between these *Gonatodes* species may be mediated by predators.

Werner and Chou (2002) studied ecology of the Arrhythmic Equatorial gecko, *Cnemaspis kendallii*, in the nature reserve of Singapore. This species is active abroad both day and night, with a foraging mode is extremely sit-and-wait strategy. Its small eye is typically of diurnal gecko. The oviposition season extends at least over September- December, and possibly over the whole year.

2.3.4 Diet

Animals in family Gekkonidae are predominately insectivorous. A few species are frugivorous and nectivorous. Many species are predators of vertebrates.

Smith (1935) reported that *G. gecko* feeds on insects, mice, and even snakes. It has been credited with fighting off attacking snakes such as *Chrysopelea.*

Pianka (1986) noted that geckos consume nocturnal arthropods, for example, scorpions, crickets, roaches and moths. Some species are termite specialists such as *Diplodactylus conspicillatus.*

Bauer (1990) reviewed that many species (about 3-4% of known species) of geckos are vertebrate predators. They feed on small birds, mammals and lizards such as skinks and lacertids, including small geckos. For example, *G. gecko* feeds on *H. frenatus* and *C. platyurus*. *Cyrtodactylus cavernicolus*, a Bornean cave-dwelling gecko, feeds upon a baby swiftlets, which fell from the nest on cave walls. However, some species have become frugivorous or nectivorous e.g. *Rhacodatylus* in New Caledonia, *Hoplodactylus* in New Zealand and *Phelsuma* in the Mascarene Islands.

Saenz (1996) studied the stomach content of the Mediterranean geckos, *Hemidactylus turcicus*. The most important prey items were in order Orthoptera, Lepidoptera, and Isopoda. The greatest different of diets occurred between the smallest and largest size groups of geckos. A significant positive correlation was found between gecko size and prey size. Differences in the diets are found in the geckos which inhabit different microhabitats.

CHAPTER 3

METHODOLOGY

3.1 Morphological study

Ninety-seven *G. gecko* specimens were collected in Banyang Subdistrict, Saohai District, Saraburi Province, Thailand. Each specimen was measured for twenty-three morphological characters (Figure 3-1), using a vernier caliper. The reprodutive organ, testis or ovary, was checked by abdominal dissection in order to determine the sexual maturity. The specimens were preserved and deposited in Chulalongkorn University Museum of Zoology.

Morphological characters measured in this study were:

1. Snout-vent length (SVL): length from the tip of snout to the vent
2. Head length (HL): length from posterior edge of mandible to the tip of snout
3. Head width (HW): maximal head width
4. Head depth (HD): maximal head depth
5. Internasal distance (INO): distance between nostril across crown of head
6. Interorbital distance (IOD): distance between orbit across crown of head
7. Snout-eye length (SEL): length from the tip of snout to anterior border of orbit
8. Eye length (EYL): length from anterior eye border to posterior eye border
9. Eye to ear (EEL): length from posterior eye border to anterior ear border
10. Ear Length(EAL): length of the longest axis of the ear opening
11. Snout-arm length (SAL): length from the tip of snout to anterior margin of base of right of right forelimb

12. Axilla-groin length (AGL):distance between forelimb to hind limb
13. Upper arm length (UAL): length from the shoulder joint to the elbow joint
14. Fore arm length (FAL): length from the elbow joint to the center of metacarpus
15. Hand length (HaL): length from the center of metacarpus to the tip of toe IV (claw excluded)
16. Upper leg length (ULL): length from the hip joint to the knee joint
17. Lower leg length (LLL): length from knee joint to the center of metatarsus
18. Foot length (FL): length of the center of metatarsus to the tip of toe IV (claw excluded)
19. Toe IV length (TIVL): distance from junction between right toe III and IV to the tip of toe IV (claw excluded)
20. Toe IV width (TIVW): breadth of right toe IV at widest of point
21. Scansor length (SCL): length of scansor series under right toe IV
22. Tail width (TW): tail width at base
23. Tail depth (TD): tail depth at base

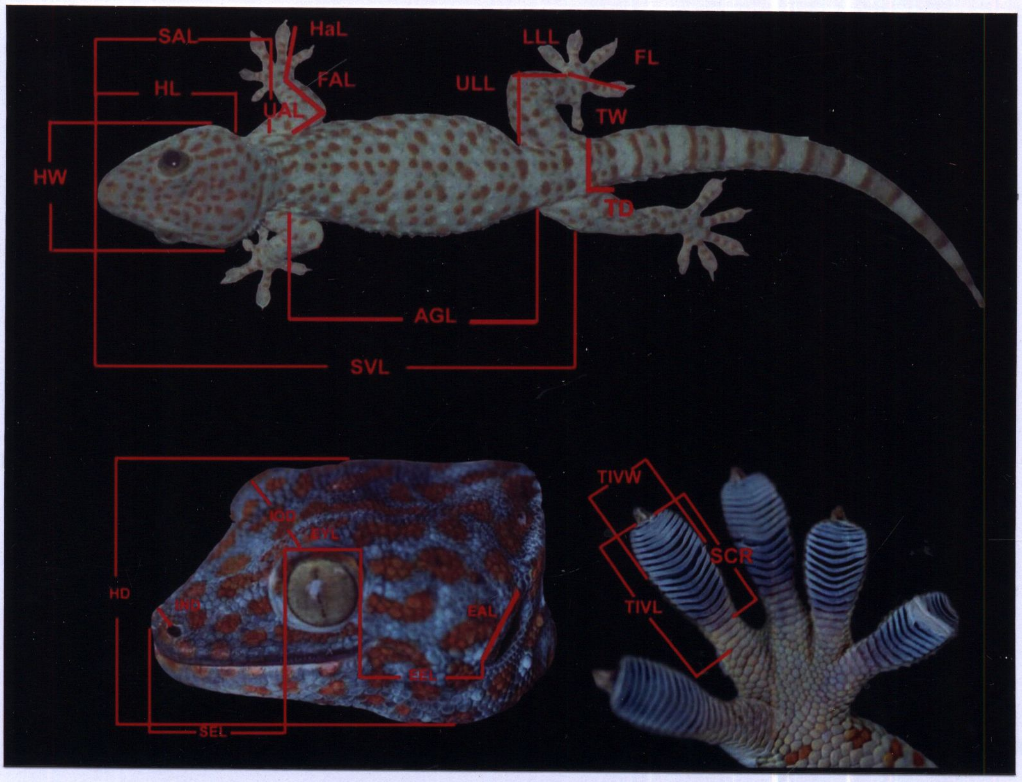


Figure 3-1 Morphological characters which were measured in this study

Data analysis

1. Mean comparison

The recorded morphological characters were transformed into relative quantity to snout-vent length. The mean of relative parameters were compared for each morphological trait among males, females and juveniles using Analysis of Variance (ANOVA). Mean of SVL of males and females were compared using Student's t-test, and the probability of $p \leq 0.05$ was considered to be significantly different.

2. Discriminant Function Analysis

All morphological characters were analyzed using Discriminant Function Analysis to separate geckos into three groups i.e. male, female, and juvenile and equations for prediction were created.

All statistical analysis was carried out in SPSS version 10.0 for Windows.

3.2 Foraging ecology

3.2.1 Study site

The study was conducted at a residential complex for visitors in the Khao Khiao Open Zoo, Khao Khiao–Khao Chomphu Wildlife Sanctuary, Chon Buri Province (Figure 3-2, and 3-3). It is located at 101° 04′ 10.7″ N and 13° 12′ 44.3″ E. The area is approximately 1000 m^2, which are partly surrounded by deciduous forest. There are four buildings in which geckos' holes are located (Figure 3-4 to 3-6). The fluorescent lights around the buildings are always turned on overnight. Total monthly rainfall ranged from 0.0 mm in December 2001 to 281.8 mm in October 2001. Mean monthly temperatures ranged from 26.4 °C to 30.5 °C and mean relative humidity varied from 63% in December 2001 to 82% in October 2001. The weather in November through April was dry, whereas May through October was wet. A monthly climatic data were shown in figure 3-7.

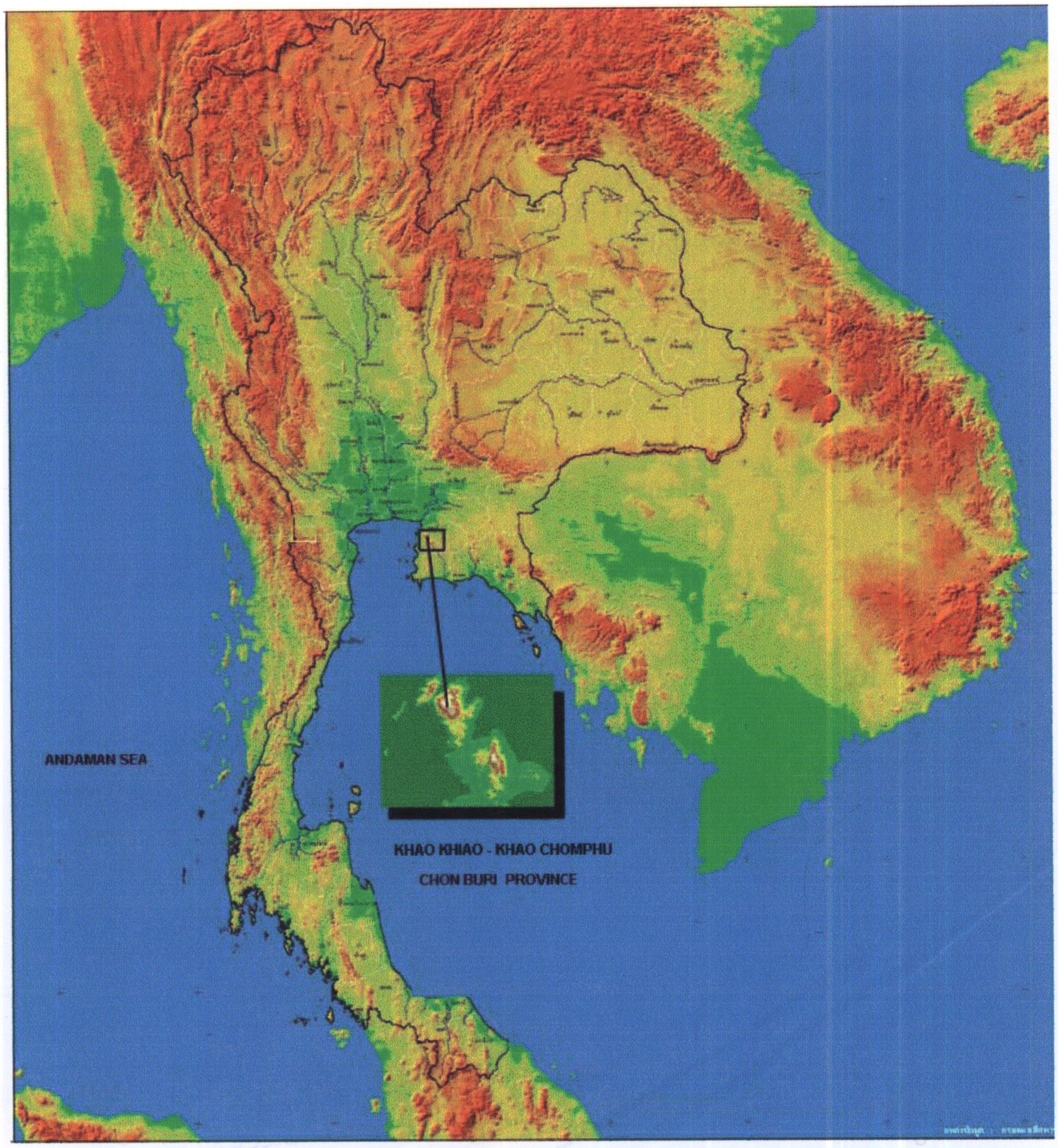


Figure 3-2 Location of Khao Khiao Open Zoo, Khao Khiao-Khao Chomphu Wildlife Sanctuary, Chon Buri Province

(Modified from http://www.eric.chula.ac.th/gisthai/map-galery/national/land.html)

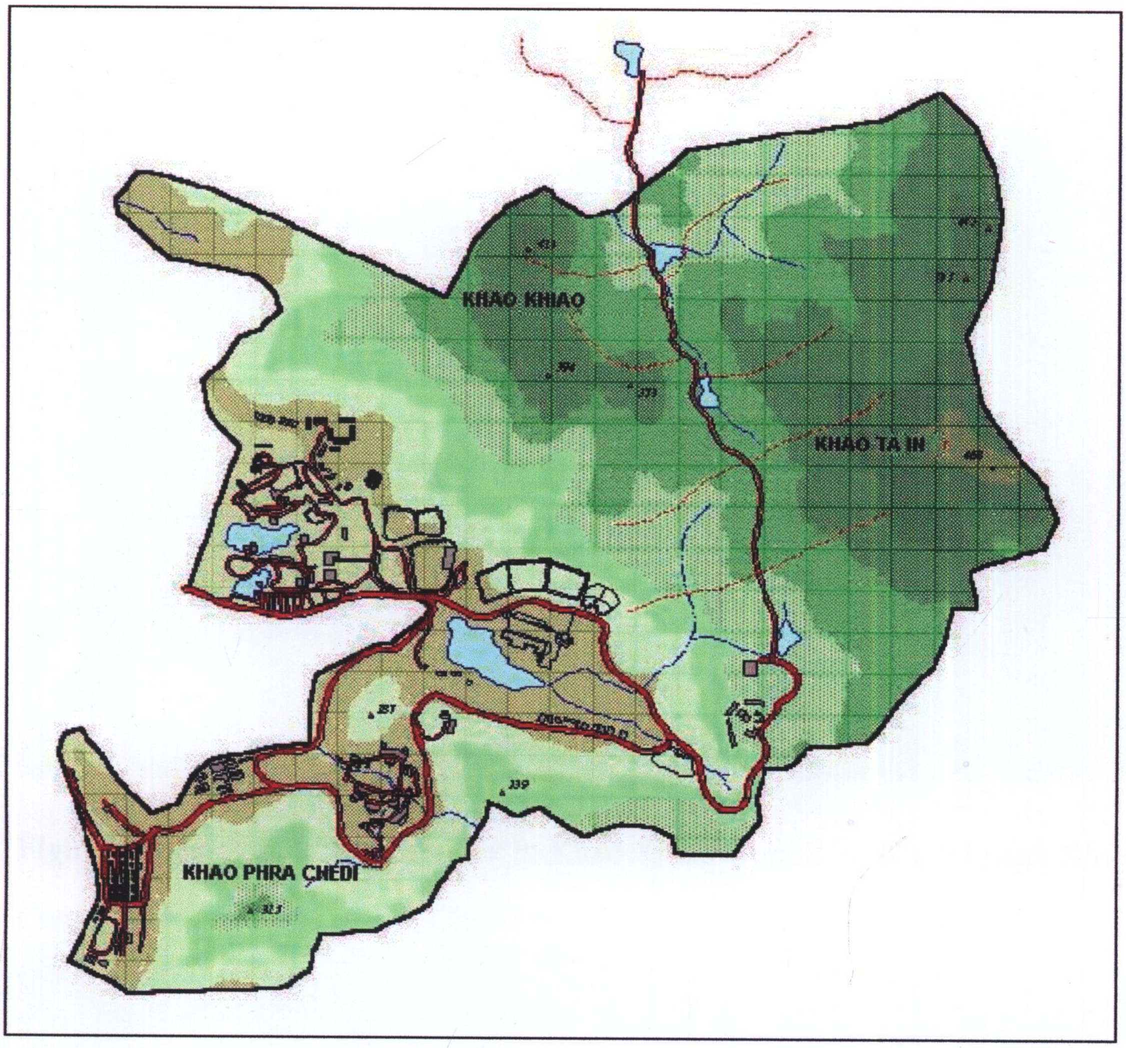


Figure 3-3 Map of Khao Khiao Open Zoo, Khao Khiao-Khao Chomphu Wildlife Sanctuary, Chon Buri Province (Source: the Plant Genetics Conservation Project under the Royal Initiative of Her Royal Highness Princess Maha Chakri Sirindhorn)

Figure 3-4 The residential complex in Khao-Khiao Open Zoo, Khao Khiao–Khao Chomphu Wildlife Sanctuary, Chon Buri Province

Figure 3-5 The complex for visitors in Khao Khiao Open Zoo, Khao Khiao-Khao Chomphu Wildlife Sanctuary, Chon Buri Province

Figure 3-6 An entrance of *G. gecko* at the residential complex in Khao Khiao Open Zoo, Khao Khiao–Khao Chomphu Wildlife Sanctuary, Chon Buri Province

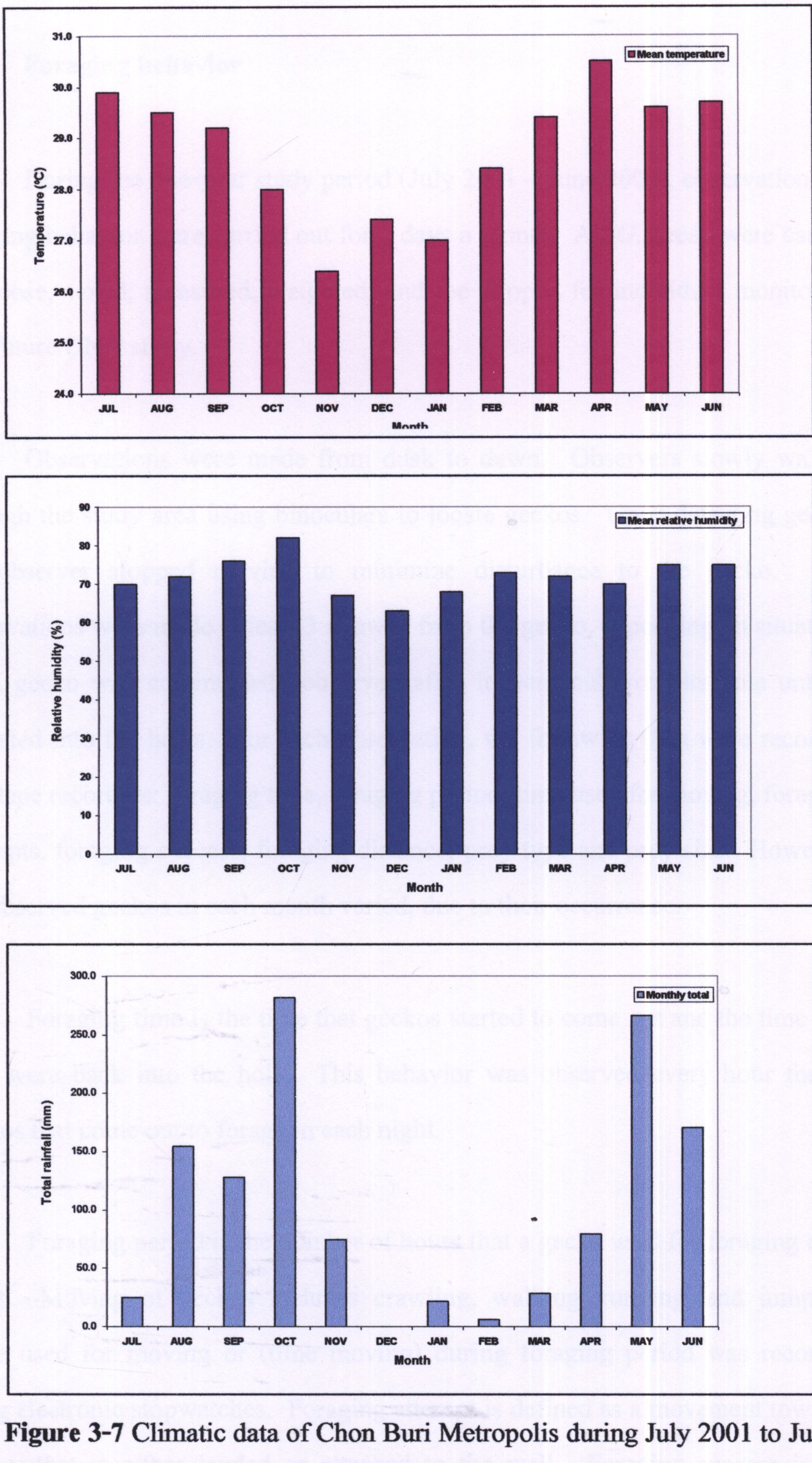


Figure 3-7 Climatic data of Chon Buri Metropolis during July 2001 to June 2002 (Meteorological Department, 2002)

3.2.2 Foraging behavior

During the one-year study period (July 2001 – June 2002), observations on foraging behavior were carried out for 7 days a month. All *G. gecko* were caught by noose, sexed, measured, weighted, and toe-clipped for individual monitoring and future DNA study.

Observations were made from dusk to dawn. Observers slowly walked through the study area using binoculars to locate geckos. Upon detecting gecko, the observer stopped moving to minimize disturbance to the gecko. The observations were made at least 3 m away from the gecko, depending on situation. Each gecko was continuously observed after it went out from its hole until it retreated into the holes. For each observation, the following data were recorded into tape recorders: foraging time, foraging period, time used for moving, foraging attempts, foraging success, foraging distance, prey type and prey size. However, the observed geckos in each month varied, due to their occurrence.

Foraging time is the time that geckos started to come out and the time that they were back into the hole. This behavior was observed every hour for all geckos that come out to forage in each night.

Foraging period is the number of hours that a gecko used for foraging each night. Moving of geckos includes crawling, walking, running, and jumping. Time used for moving or (time moving) during foraging period was recorded using electronic stopwatches. Foraging attempt is defined as a movement towards a prey that is either landed or attached to the wall. Foraging success is the percentage of foraging attempts that were successful. Foraging distance is the longest distance from the hole to the spot where a gecko foraged each night of which it was visually estimated during the observation. Prey sizes were estimated visually and prey types were identified.

Environmental factors i.e. air temperature, relative humidity and insect abundance were recorded every hour. Air temperature and relative humidity were recorded using a thermohygrometer. Insect abundance was estimated visually at the lighted area around the fluorescent light, and was devided into 6 scales as follows:

0 = none; no insect

1 = very low; less than 5 individuals.m^{-2}

2 = low; 5-10 individuals.m^{-2}

3 = medium; 11-20 individuals.m^{-2}

4 = high; 21-30 individuals.m^{-2}

5 = very high; more than 30 individuals.m^{-2}

Data analysis

1. Correlation

The relationship between the number of foraging geckos and ecological factors, the relationship between body size, head size, and prey size and the relationship between foraging behavior and insect abundance were analyzed by bivariate method. Significant corrrelation was considered from probability $p \leq 0.01$.

2. Variation in foraging parameters

Mean, standard deviation (SD), and the coefficient of variation (CV) of foraging parameters in each group and individuals were calculated. The coefficient of variation is simply the standard deviation express as a percentage of mean.

Geckos were compared for variations in foraging among males, females, and juveniles, and among individuals using Kruskal-Wallis test.

Calculations were performed on computer by Microsoft Excel for window XP. Statistical analysis was performed on computer by SPSS for window release version 10.0.

CHAPTER 4

RESULTS AND DISCUSSION

1. Morphological differences

The body size of adult males, adult females and juveniles ranged from 124.7 to 193.0 mm, 97.0 to 151.3 mm, 63.2 to 95.6 mm, respectively (figure 4-1). The mean SVL of adult males (164.24 ± 14.49 mm; N=39), adult females (131.69 ± 11.27 mm; N=43) and juveniles (77.69 ± 9.46; N=15) was significantly different ($p < 0.05$).

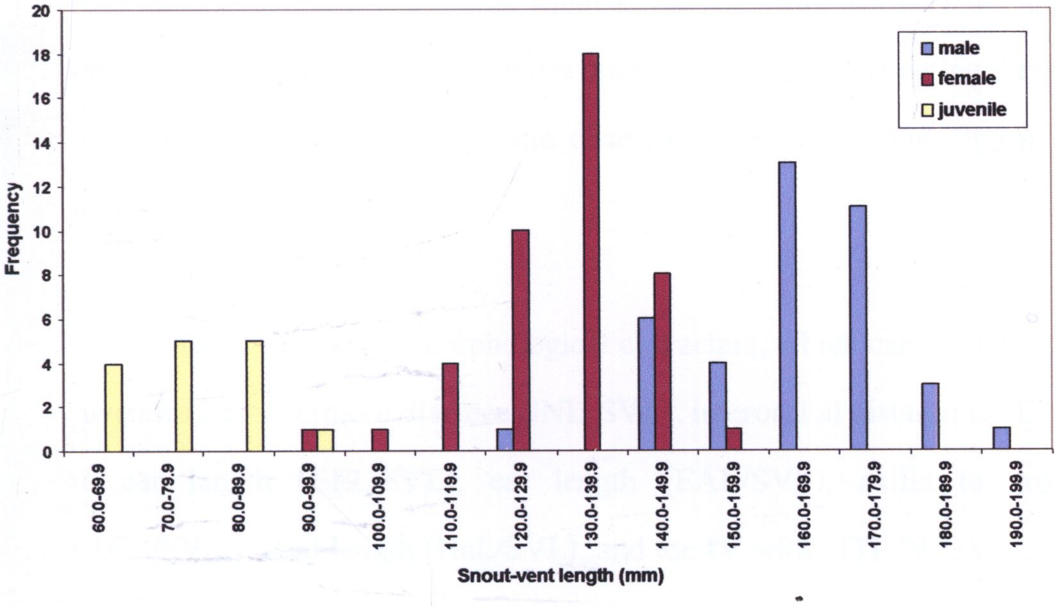


Figure 4-1 Histogram of body size distributions of males, females and juveniles of *G. gecko*, from Saraburi Province.

When all morphological characters were transformed into relative quantity to snout-vent length, the means of transformed characters were compared among groups using Analysis of Variance (ANOVA) (Table 4-1). The results showed that eight morphological characters were not significantly different among males, females and juveniles i.e. snout to arm length (SAL/SVL), upper arm length (UAL/SVL), fore arm length (FAL/SVL), upper leg length (ULL/SVL), lower leg length (LLL/SVL), foot length (FL/SVL), toe IV length (TIVL/SVL), and Scansor row length (SCL/SVL).

Males, females and juveniles of *G. gecko* displayed two morphological characters with significantly different among groups ($p < 0.05$) i.e. eye length (EYL/SVL), and tail width (TW/SVL). Eyes of juveniles were relatively larger than those of females and males, whereas the tail width of males was greater than others. The bigger eyes of juveniles could be useful for detecting their predators as well as their preys. From the observation, juveniles had higher speed for escaping.

Adults had seven morphological characters, which can separate them from juveniles i.e. internasal distance (IND/SVL), interorbital distance (IOD/SVL), eye to ear length (EEL/SVL), ear length (EAL/SVL), axilla to groin length (AGL/SVL), hand length (HaL/SVL), and toe IV width (TIVW/SVL). Eye to ear length, axilla to groin length, hand length, and toe IV width of adults were proportionally greater than those of juveniles, whereas internasal distance, interorbital distance, and ear length of juveniles were relatively greater than those of adults.

Table 4-1 Means of morphological characters of *G. gecko*; differences in superscript letters indicate the character is significantly different at $p \leq 0.05$.

Morphological characters (%)	**Mean ± SD**		
	Male (n=39)	**Female (n=43)**	**Juvenile (n=15)**
HL/SVL	27.77 ± 1.35^{a}	28.26 ± 1.43^{ab}	29.00 ± 2.42^{b}
HD/SVL	14.05 ± 1.41^{a}	13.07 ± 1.33^{b}	12.40 ± 1.35^{b}
HW/SVL	21.26 ± 1.92^{a}	20.14 ± 1.55^{b}	21.40 ± 1.84^{a}
IND/SVL	2.97 ± 0.28^{a}	3.19 ± 0.45^{a}	3.60 ± 0.51^{b}
IOD/SVL	14.18 ± 1.18^{a}	14.62 ± 1.10^{a}	15.27 ± 1.16^{b}
SEL/SVL	10.62 ± 0.81^{a}	11.16 ± 0.69^{b}	11.53 ± 1.06^{b}
EYL/SVL	5.54 ± 0.51^{a}	6.37 ± 0.72^{b}	7.47 ± 0.64^{c}
EEL/SVL	10.74 ± 0.85^{a}	10.37 ± 0.76^{a}	9.53 ± 0.83^{b}
EAL/SVL	4.28 ± 0.69^{a}	4.40 ± 0.54^{a}	5.20 ± 0.56^{b}
SAL/SVL	37.33 ± 3.30^{a}	37.74 ± 2.00^{a}	39.00 ± 3.76^{a}
AGL/SVL	49.77 ± 3.17^{a}	50.70 ± 3.76^{a}	45.57 ± 3.16^{b}
UAL/SVL	14.97 ± 1.39^{a}	15.02 ± 1.24^{a}	15.27 ± 2.22^{a}
FAL/SVL	12.36 ± 1.16^{a}	12.74 ± 1.27^{a}	13.00 ± 1.00^{a}
HaL/SVL	11.29 ± 0.98^{a}	11.26 ± 1.12^{a}	10.67 ± 0.62^{b}
ULL/SVL	15.36 ± 1.78^{a}	15.84 ± 2.16^{a}	15.40 ± 2.20^{a}
LLL/SVL	14.33 ± 1.31^{a}	14.44 ± 1.20^{a}	14.67 ± 1.76^{a}
FL/SVL	14.16 ± 0.89^{a}	13.81 ± 0.88^{a}	14.27 ± 1.34^{a}
T4L/SVL	10.10 ± 0.97^{a}	10.05 ± 1.08^{a}	10.20 ± 1.15^{a}
T4W/SVL	3.72 ± 0.46^{a}	3.56 ± 0.50^{a}	3.13 ± 0.35^{b}
SCL/SVL	7.51 ± 0.91^{a}	7.83 ± 1.06^{a}	7.53 ± 0.83^{a}
TD/SVL	7.00 ± 0.92^{a}	6.05 ± 0.90^{b}	5.67 ± 1.05^{b}
TW/SVL	8.85 ± 0.90^{a}	8.12 ± 0.79^{b}	7.46 ± 0.83^{c}

Males showed five characters, which significantly differed from females and juveniles ($p < 0.05$) i.e. head depth (HD/SVL), snout to eye length (SEL/SVL), eye length, tail depth (TD/SVL), and tail width. Head depth, tail depth, and tail width of males were greater than the others, whereas juveniles and females have greater snout to eye length, and eye length.

Females differed from males and juveniles in three characters ($p < 0.05$) i.e. head width, eye length, and tail width. Female geckos have the smallest head width in relation to SVL, whereas other characters were intermediate between males and juveniles.

For adult males and females, the body size of adult males was significantly larger than that of adult females ($p < 0.05$). Six morphological chracters showed significantly different between the sexes ($p < 0.05$) i.e. head depth, head width, snout to eye length, eye length, tail depth, and tail width. These results indicated that *G. gecko* has sexual size dimorphism. Moreover, adult males could be distinguished from adult females by having prominent preanal pores as shown in figure 4-5.

Sexual dimorphic traits of *G. gecko* can be divided into 2 groups.

1. Male geckos have larger head size and tail size i.e. head depth, head width, tail depth and tail width.

2. Female geckos have larger snout to eye length and eye length

The results demonstrated that there were significant differences between males and females in head size and tail size. Larger head size in males has been suggested to have a role in interspecific competition, territorial defense and mate choice. The tail thickness of the male was larger than that of the female. This is probably because of the increasing in size of the hemipenes, which is located in the base of the tail. Moreover, the bigger tail could be useful for copulation. For territory defense, *G. gecko* displayed aggressive behavior by knocking the tail against the wall when it encountered other geckos and this behavior was also observed in this study. In species where there is a high degree of territoriality and polygenous breeding system, male-bias dimorphism is usually expected.

Figure 4-2 A male *G. gecko* (SVL = 168.0 mm)

Figure 4-3 A female *G. gecko* (SVL = 139.6 mm)

Figure 4-4 A juvenile *G. gecko* (SVL = 77.6 mm)

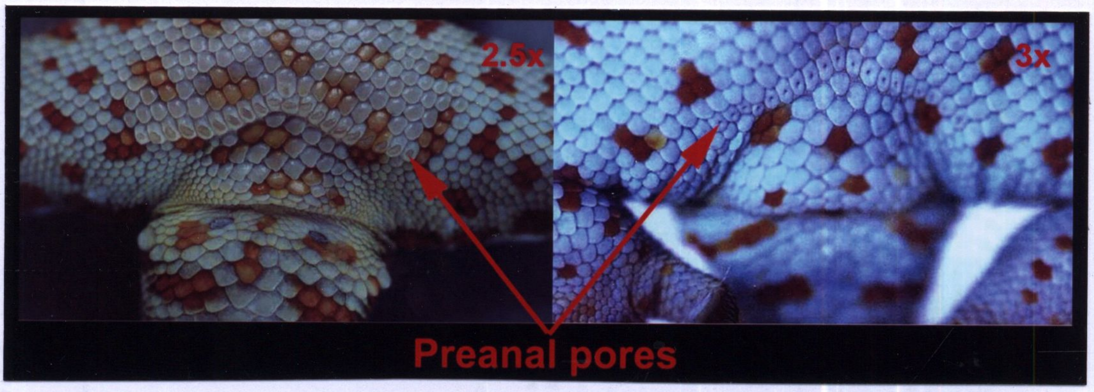


Figure 4-5 Preanal pores of: a male (left) and a female (right)

Canonical discriminant functions were analysed using twenty-three morphological characters. The results showed that *G. gecko* can be devided into three groups i.e. male, female, and juvenile as shown in figure 4-6.

The equation for the prediction was employed using Discriminant Function Analysis. Two equations for the prediction were created as shown in equation 4-1 and 4-2. The Y_1 and Y_2 value were plotted in the territorial map (Figure 4-7). Each area of the map represented each group of *G. gecko*. A group centriod point in the area indicated the accuracy of identification. When the Y_1 and Y_2 value were plotted in the territorial map, an intersection of Y_1 and Y_2 showed the group of that specimen.

$Y_1 = 0.177HL-0.310HW+0.612EyL+0.027AGL+0.173ULL+0.631TW-15.750$ 4-1

$Y_2 = 0.081HL-0.309HW-1.227EyL-0.132AGL+0.021ULL+0.278TW-3.672$ 4-2

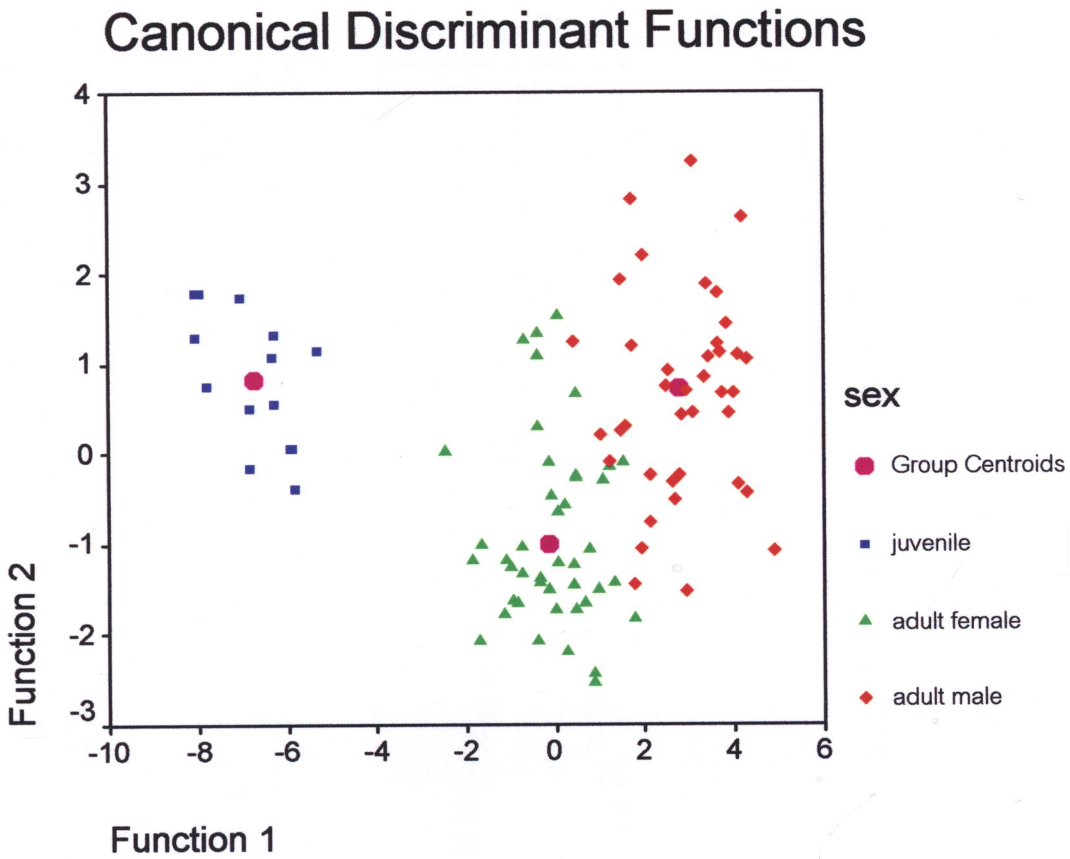
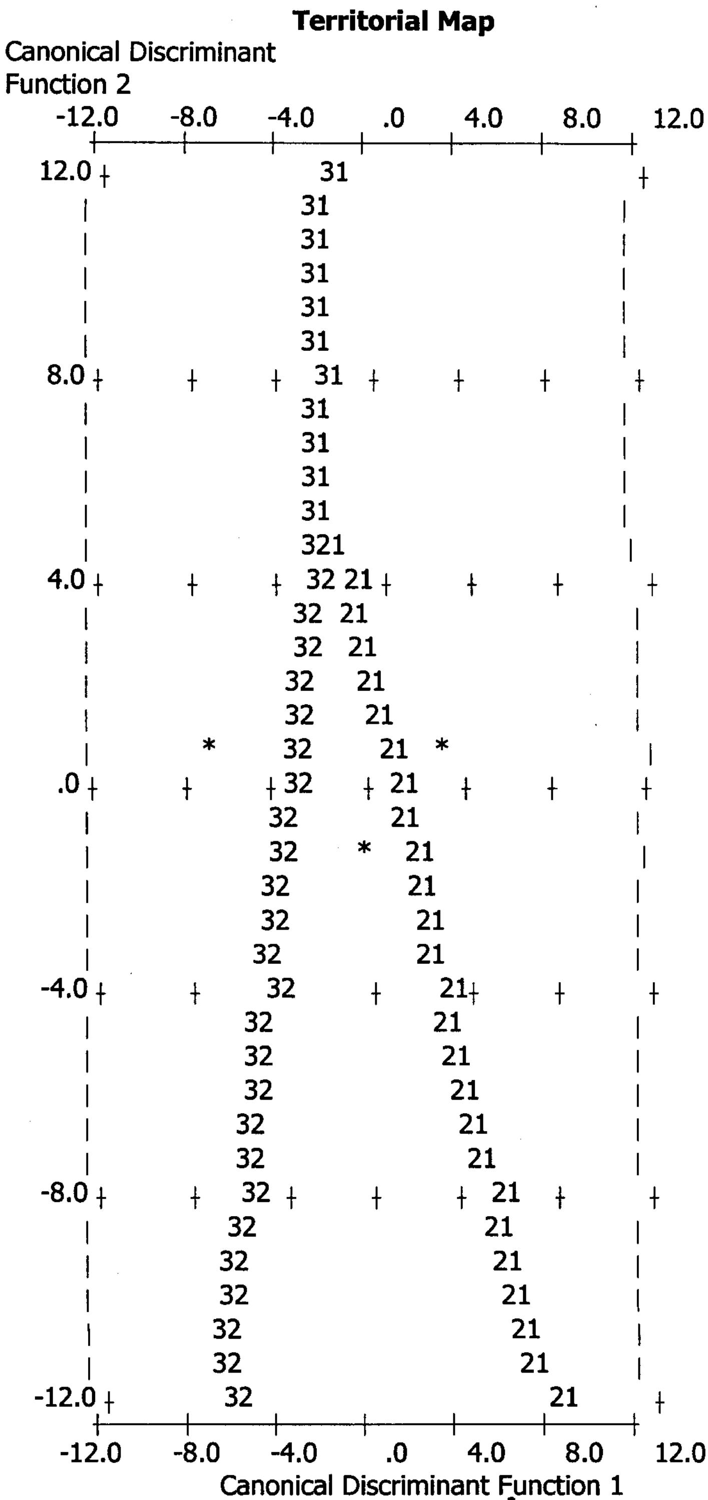


Figure 4-6 Canonical Discriminant Functions, showing the seperation of males, females, and juveniles of *G. gecko* by group centroids.



Symbols used in territorial map

```
Symbol  Group  Label
------  -----  --------------------

1       0  adult male
2       1  adult female
3       2  juvenile
*          Indicates a group centroid
```

Figure 4-7 Territorial map of morphological characters of *G. gecko*.

4.2 Foraging ecology

4.2.1 Presence and absence of *G. gecko* in the study area

From the seven days observation in each month, it was found that each gecko did not come out from its hiding place to feed everyday. On average, only 11.82±3.76 individuals were seen foraging on the wall of the building per night.

G. gecko was marked during April, 2001 to August, 2002. Thirty-two individuals were marked before the beginning of the study. Beacuase new individuals were present in every month throughout the study period, marking was continued, and a total of ninety-two individuals were marked. From this number, only a few individuals were seen regularly during one-year study period and the data collection could be done only for geckos that were present. Besides hiding under the roof of the building, the presence and absence of marked and unmarked individuals at the time of observation could be due to birth, death or movement to and from the forested area around the building.

4.2.2 Relationships between the number of foraging geckos and ecological factors

The number of foraging *G. gecko* observed at the building fluctuated throughout the year. The maximum number was 15.00 ± 2.52 individuals in August and then gradually declined to the minimum number at 6.00 ± 3.27 individuals in November and slightly rose up to the second peak in February. When the mean numbers of each month were compared using ANOVA, the significant difference was found ($p < 0.05$). However, there was no significant different among the means of October, November and December. The monthly different in the number of foraging geckos could be due to climatic factors and food availability during that time.

Relationships between the number of geckos and ecological factors i.e. temperature, relative humidity, amount of rainfall, and insect abundance were shown in figures 4-8 to 4-11, respectively. The mean temperature was highest in August, and then decreased to the lowest point in November. The mean relative humidity decreased to the minimum level in November and rose up to the highest point in May. The amount of rainfall was highest in October, which was in late rainy season, whereas the minimum amount of rainfall was in December, which was at the beginning of dry season. Insect abundance reached to the peak in August, decreasing to the lowest level in November, and slightly increasing again to the second peak in April. Table 4-2 shows relationships between the number of geckos and ecological factors. Results indicated that the number of geckos was significantly correlated with the mean temperature, the mean relative humidity, and the mean insect abundance, but insignificantly correlated with the amount of rainfall.

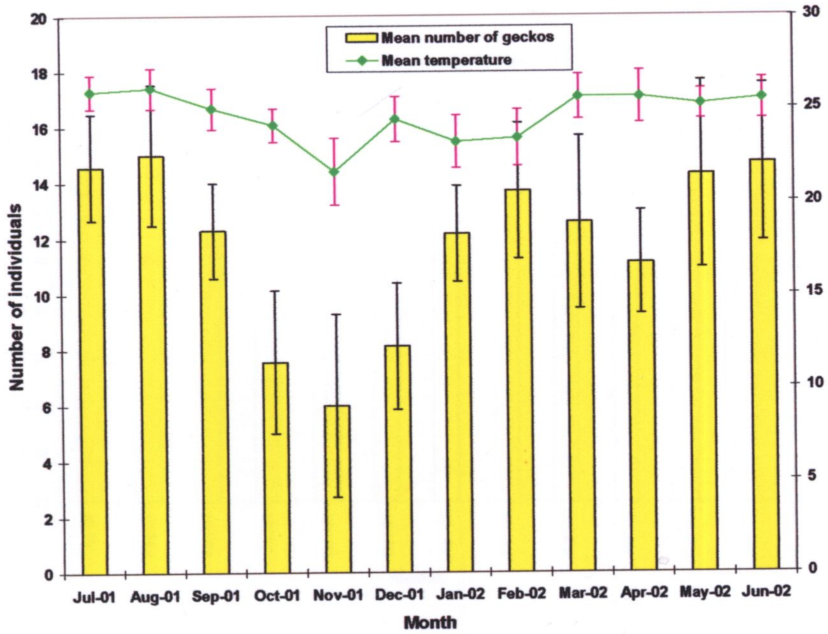


Figure 4-8 Relationship between the number of foraging *G. gecko* in each month and temperature (mean ± SD; R= 0.458; $p < 0.01$)

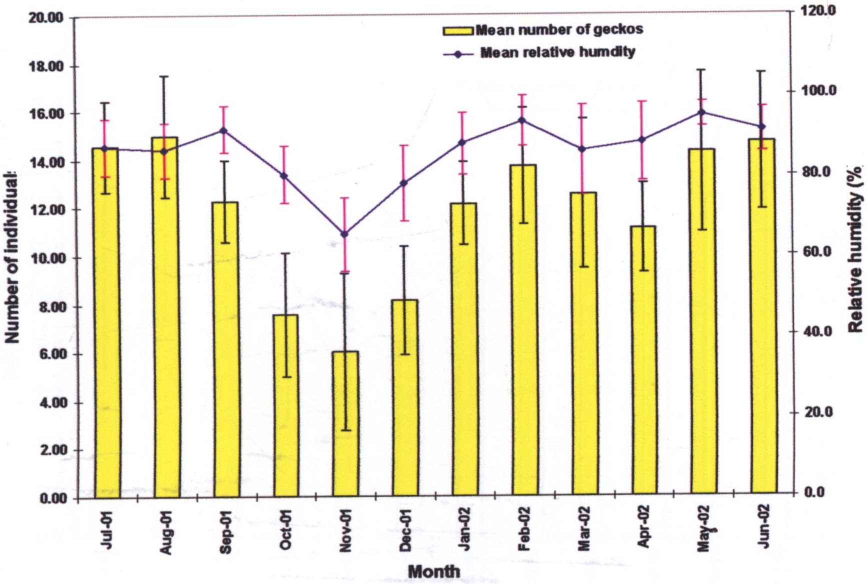


Figure 4-9 Relationship between the number of foraging *G. gecko* in each month and relative humidity (mean ± SD; R=0.289; $p < 0.01$).

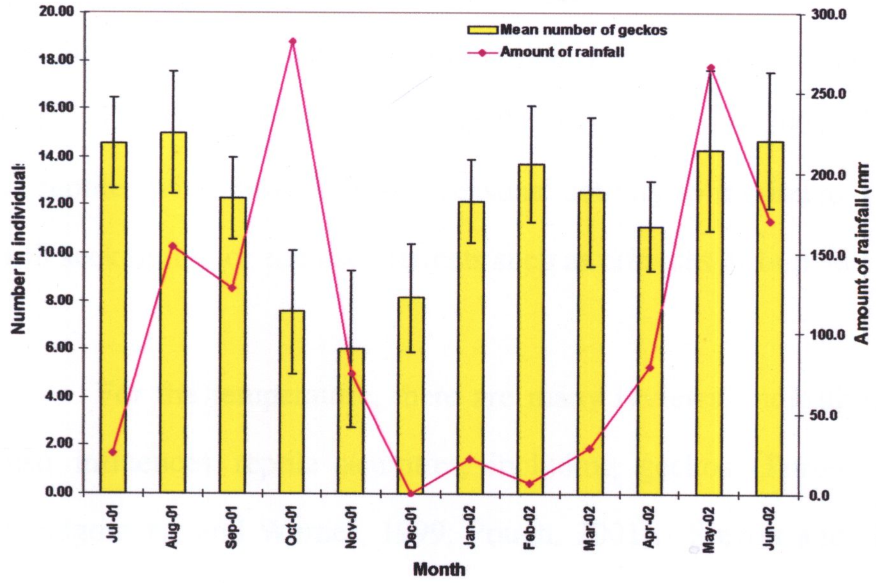


Figure 4-10 Relationship between the number of foraging *G. gecko* in each month and amount of rainfall (mean ± SD; R=0.028; $p > 0.05$)

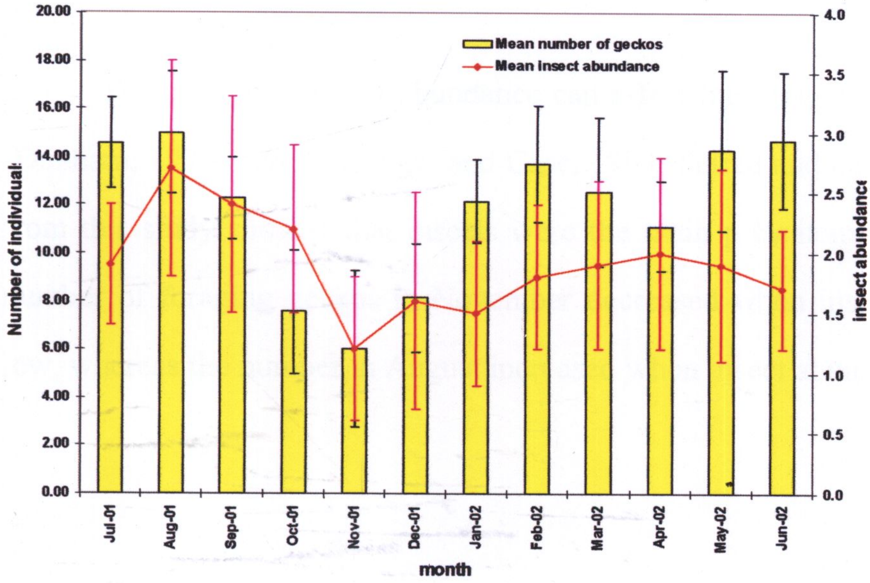


Figure 4-11 Relationship between the number of foraging *G. gecko* in each month and insect abundance (mean ± SD; R=0.289; $p < 0.01$)

It could be inferred that *G. gecko* decreased their foraging activity when the humidity in the air was low, probably for minimizing water loss from the body. This result is consistent with the review of Zug (2001) in that most species of reptiles will adjust daily and seasonal activity to minimize water loss and they will seek humid or enclosed retreats such as crevices or burrows while inactive.

For the temperature, there are many reviews, indicating that temperature also influences reptile activities, including geckos (Porter, 1972; Angilletta, Montgomery, and Werner, 1999; Pough, 2001). Sievert and Hutchinson (1988) mentioned that *G. gecko* has thermoregulartory behavior. It likely utilizes differences in microhabitat to maintain a prefered body temperature and may have been adapted for utilization of human habitations, which may provide a variety of microenvironments for behavioral thermoregulation. In this study, it was found that *G. gecko* foraging activity was also affected by the change of temperature.

The change of insect abundance can affect the foraging activity of geckos (Dunham, 1978; Petren, Bolger, and Case, 1993; Petren and Case, 1998). Results from this study showed that insects were the main prey item of *G. gecko*. The number of foraging geckos in November decreased when insect abundance was low, whereas the number in August increased when insect abundance was high.

Table 4-2 Spearman's coefficient of rank correlation relating the number of geckos and ecological factors i.e. temperature, relative humidity, amount of rainfall and insect abundance.

	Number of geckos	Temperature	Relative humidity	Amount of rainfall	Insect abundance
Number of geckos	1.000				
Temperature	0.458** (0.000)	1.000			
Relative humidity	0.289** (0.008)	-0.033 (0.767)	1.000		
Amount of rainfall	0.028 (0.802)	0.281** (0.010)	0.388** (0.000)	1.000	
Insect abundance	0.289** (0.008)	0.402** (0.000)	0.306** (0.005)	0.437** (0.001)	1.000

Remark: numbers in parentheses represent p-value

** Correlation is significant at 0.01 level (2-tailed).

4.2.3 Foraging behavior

4.2.3.1 Foraging time

All foraging *G. gecko* were recorded for the times of emergence and retreating from and into the cover during the observation period. The activity time of all individuals, which included both observed and unobserved geckos, ranged from 5 pm to 9 am. The peak of the time of emergence was between 6 pm to 8 pm, whereas the peak of the time of retreating was between 4 to 7 am as shown in figures 4-12, and 4-13. When data of each month were considered, peaks of the time of emergence and the time of retreating were similar to those of the pooled data (Figures 4-14, and 4-15). In the study site, the light was regularly turned on at 6 pm and turned off at 6 am. In some occasions, geckos came out before the light was turned on or before insect food was available. Sometimes, they went back into the hiding place whether insect food was available or not. Therefore, insect abundance should not be the only one crucial factor that determines the foraging time of geckos. For nocturnal geckos, many species are more active within a few hours after sunset such as *H. frenatus* and *L. lugubris* and this may result from high insect activity during that time as commented by Petren and Case (1996). However, the activity time of geckos could depend on an endogenous rhythm (Underwood, 1992, cited in Werner, 1998:94) and is also affected by illumination and temperature (Sievert and Hutchinson, 1988; Petren and Case, 1993; Werner, 1998). In addition, Werner *et al.* (1997) noted that the nocturnal gecko, *Gekko japonicus* was less active than usual during the foraging observations in Japan due to the rainy and cool weather.

The foraging time of geckos, which was observed foraging behavior, ranged from 6 pm to 9 am as shown in figures 4-16 and 4-17. The activity time of each group; males, females and juveniles, had similar pattern. Most geckos usually came out in the early evening, but a few males were observed to come out later until 3 am. For retreating time, females and juveniles tended to go back into the hiding place earlier than males. A few males were found to forage until the late morning at 9 am. From the observation, the foraging time of males ranged from 6 pm to 9 am, whereas that of females and juveniles ranged from 6 pm to 7 am. In general, males, as a group, spend longer period of time for foraging than females and juveniles.

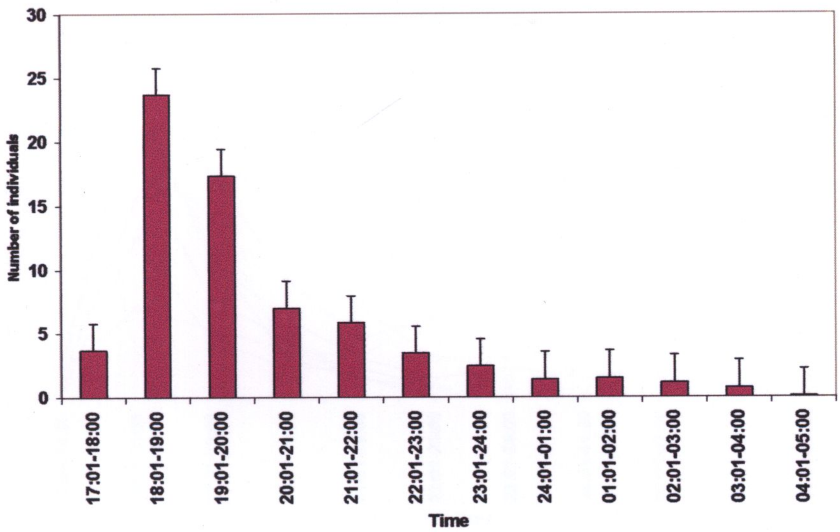


Figure 4-12 Emergence times of all *G. gecko* individuals at the residential complex, Khao Khiao Open Zoo, Khao Khiao-Khao Chomphu Wildlife Sanctuary, Chon Buri Province. The mean number of geckos that came out for foraging at various time intervals was demonstrated.

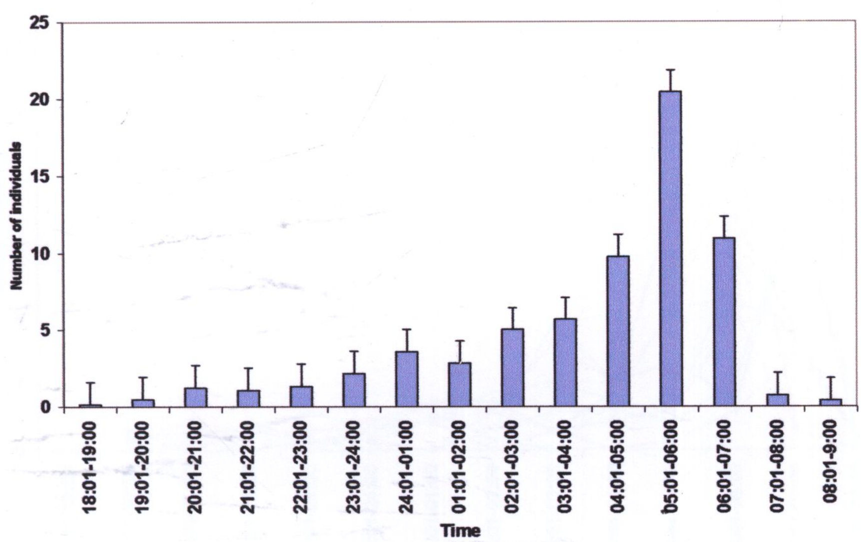


Figure 4-13 Retreating times of all *G. gecko* individuals at the residential complex, Khao Khiao Open Zoo, Khao Khiao-Khao Chomphu Wildlife Sanctuary, Chon Buri Province. The mean number of geckos that came out for foraging at various time intervals was demonstrated.

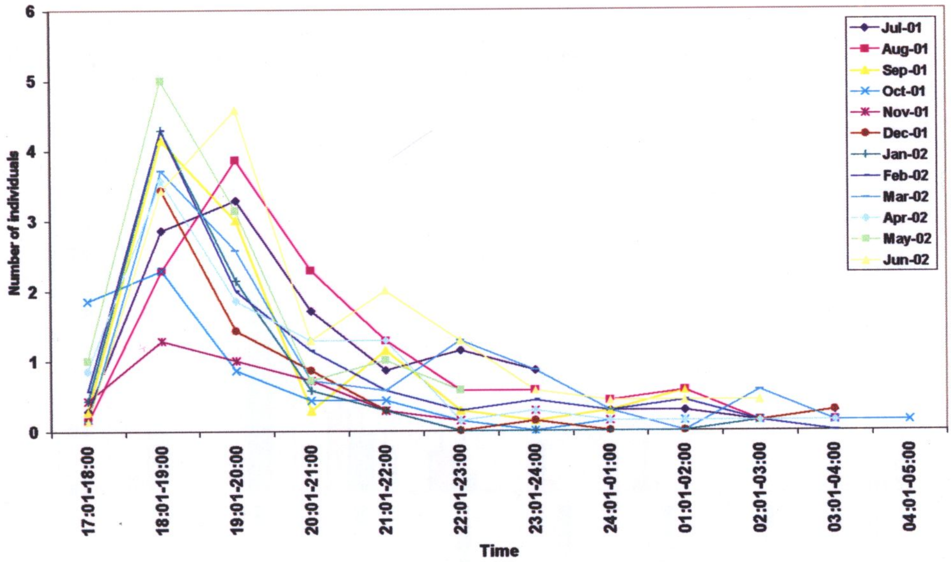


Figure 4-14 Monthly averages of emergence times of all *G. gecko* individuals in each month at the residential complex, Khao Khiao Open Zoo, Khao Khiao-Khao Chomphu Wildlife Sanctuary, Chon Buri Province. The mean number of geckos that came out for foraging at various time intervals was demonstrated.

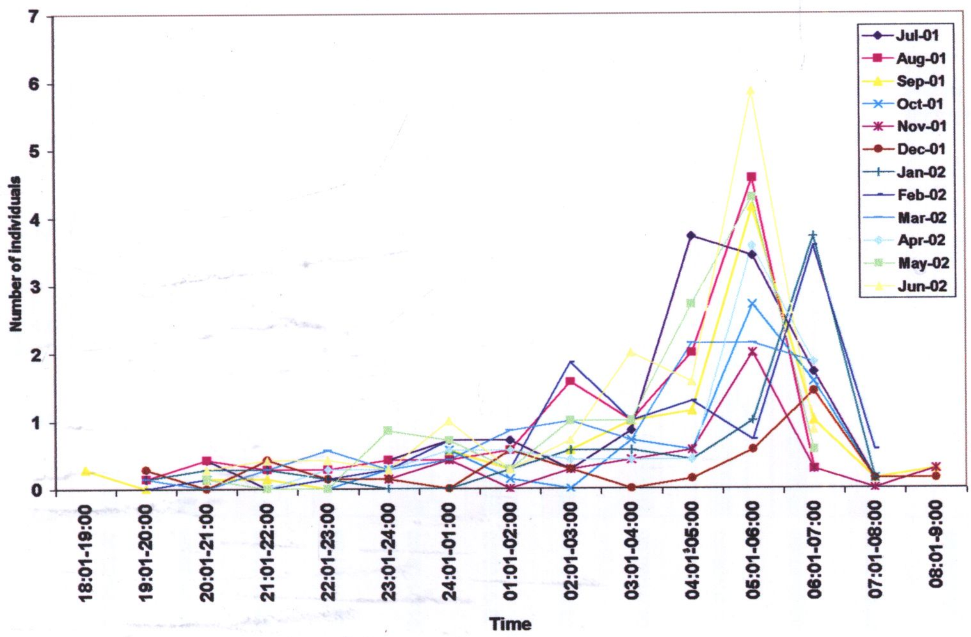


Figure 4-15 Monthly averages of retreating times of all *G. gecko* individuals in each month at the residential complex, Khao Khiao Open Zoo, Khao Khiao-Khao Chomphu Wildlife Sanctuary, Chon Buri Province. The mean number of geckos that came out for foraging at various time intervals was demonstrated.

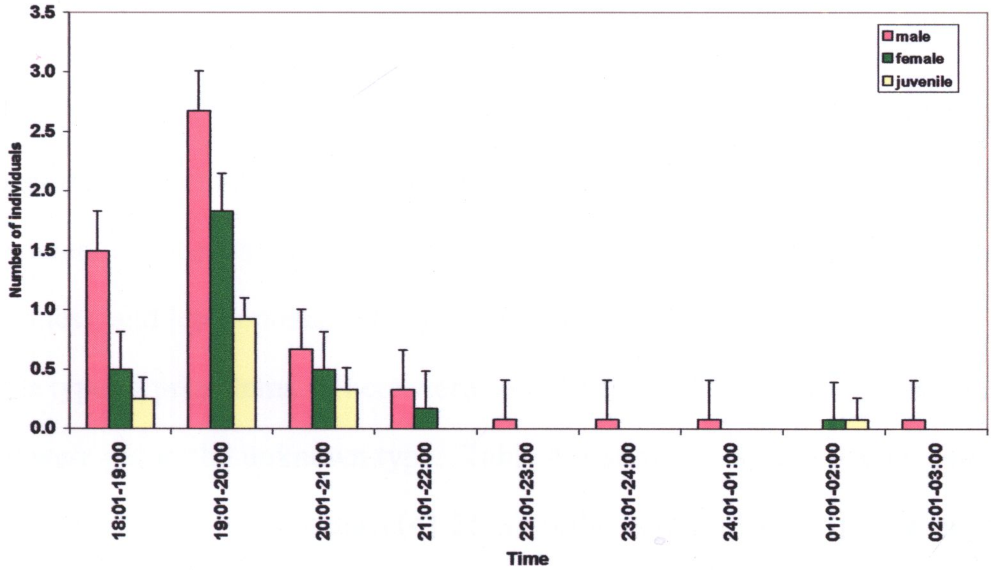


Figure 4-16 Emergence times of *G. gecko* at the residential complex, Khao Khiao Open Zoo, Khao Khiao-Khao Chomphu Wildlife Sanctuary, Chon Buri Province. Data were from individuals which foraging behaviors were observed. The mean number of geckos that came out for foraging at various time intervals was demonstrated.

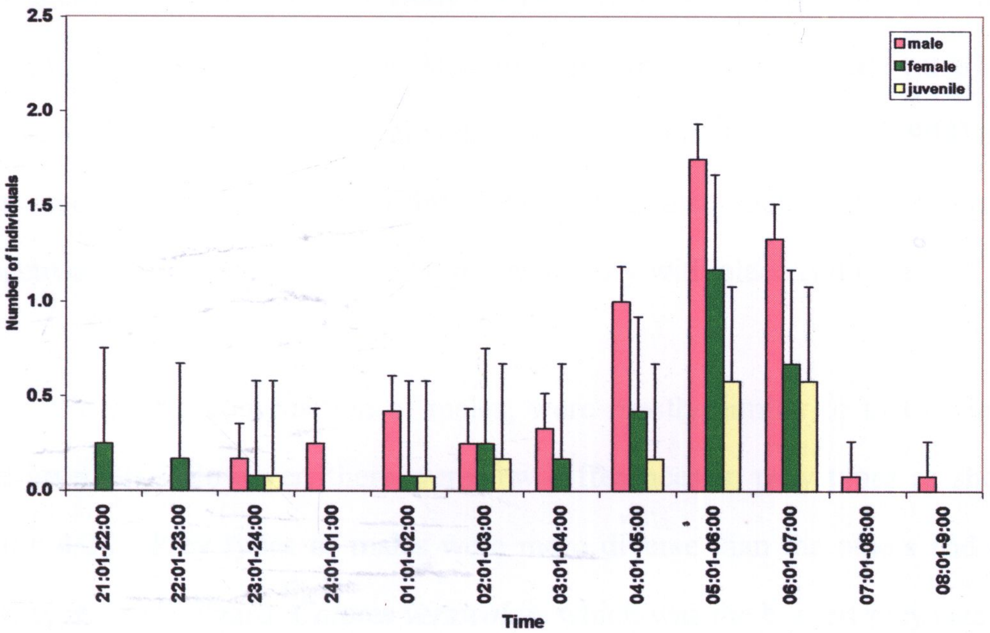


Figure 4-17 Retreating time of *G. gecko* at the residential complex, Khao Khiao Open Zoo, Khao Khiao-Khao Chomphu Wildlife Sanctuary, Chon Buri Province. Data were from individuals which foraging behaviors were observed. The mean number of geckos that came out for foraging at various time intervals was demonstrated.

4.3.3.2 Diet

Diets of *G. gecko* consisted of many groups of insects i.e. odonatans (dragonflies), orthopterans (grasshoppers and crickets), hemipterans (bugs), coleopterans (beetles), lepidopterans (moths), hymenopterans (bees), isopterans (termites), and lepidopteran larvae. The vertebrate such as *Calotes versicolor* was also a type of prey items. There were some preys that could not be identified, and they were put in the unknown type. Table 4-3 shows food items of *G. gecko* from the observation. Lepidopterans (41.26%), orthopterans (13.18%) were major diets of this geckos throughout the year. However, in April, May, and June, isopterans were the common diet due to much greater abundance in the habitat at that time. It can be concluded that preys caught by *G. gecko* were different due to the different composition of insect abundance during that time. This finding is consistency with the previous study by Bustard (1968), who mentioned that the composition of food items of the Australian gecko *Gehyra variegata* varied during the year, depending on insect abundance in the habitat. Werner (1998) studied four species of geckos in Tahiti, and noted that they were opportunistic insectivorous, in which their food types were vary with place and time.

Prey type composition of males, were mostly similar to that of females, and juveniles. However, there were few differences in prey types as shown in figure 4-18. Prey types of males were more diverse than the others and one of prey types was a lizard, *Calotes versicolor*, which was the biggest prey size in this study. Prey type of females was the lowest in diversity, whereas that of juveniles differed from the others i.e. odonatans. The main prey items in order of importance among males, females and juveniles were different. The major prey items of males were lepidopterans (39.87%), orthropterans (20.28%), and coleopterans (7.84%), whereas those of females were lepidopterans (33.08%), isopterans (27.07%), and orthropterans (9.02%). For the juveniles, the main food items were isopterans (40.32%), lepidopetrans (30.86%), and orthopterans (4.84%). This is compatible with the study of Saenz (1996) in that the major diet of the Mediteraranean gecko, *Hemidactylus turcicus*, differed among males, females, and juveniles. During the time that the number of termite alates was high, geckos often ignored other insects, especially small ones flying around the light. Termite alates may carry higher level of nutrient than other insects and appeared to be poor fliers, which were easy for geckos to capture. This result is consistency with the study of Petren and Case (1996), which noted that *L. lugubris* and *H. frenatus* prefered termite alates when this prey type was available in the study area.

The size of prey items ranged from 0.5 -7 cm of which the size of 1-2 cm (70%), 2-3 cm (13%) and 0.5-1 cm (11%) were the most abundance, respectively. Prey size of males, females and juveniles ranged from 0.5-7 cm (average ± SD; 1.58 ± 0.94 cm), 0.5-4 cm (1.53 ± 0.58 cm), and 0.5-5 cm (1.74 ± 0.85 cm), respectively. When prey size among males, females, and juveniles were analyzed using Kruskal-Wallis test, it was found that prey size among groups were not significantly different ($p > 0.05$). It can be concluded that males, females, and juveniles can consume preys of the same size. Although the mean of prey sizes of males was smaller than the juveniles' mean, males consumed both a wider range of prey size and more diverse prey types than those of the others.

Table 4-3 Food items of *G. gecko*, as observed within seven days of each month, at the residential complex, Khao Khiao Open Zoo, Khao Khiao – Khao Chomphu Wildlife Sanctuary, Chon Buri Province.

Prey type	Estimated prey size (cm)	Percentage of prey items												Overall percent of prey items
		Jul-01	Aug-01	Sep-01	Oct-01	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	
Odonatan	4-5		7.14										3.64	0.86
Orthropteran	0.5-5	33.33	35.71	16.67	18.75		37.50	25.00	6.67	4.08	3.13	16.28		13.18
Hemipteran	1-2						6.25							0.29
Coleopteran	0.5-3			2.78	6.25		6.25	8.33	13.33	2.04	15.63	3.49	10.91	6.02
Lepidopteran	0.5-5	46.67	28.57	69.44	37.50	100.00	12.50	25.00	73.33	77.55	40.63	27.91	14.55	41.26
Hymenopteran	1-2						6.25			2.04		3.49		1.43
Isopteran	1-2										15.63	34.88	63.64	20.06
Lepidopteran larva	2-3		7.14				6.25							0.57
Vertebrate	7			2.78										0.29
Unknown	0.5-2	20.00	21.43	8.33	37.50		25.00	41.67	6.67	14.29	25.00	13.95	7.27	16.05
Overall	0.5-7	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

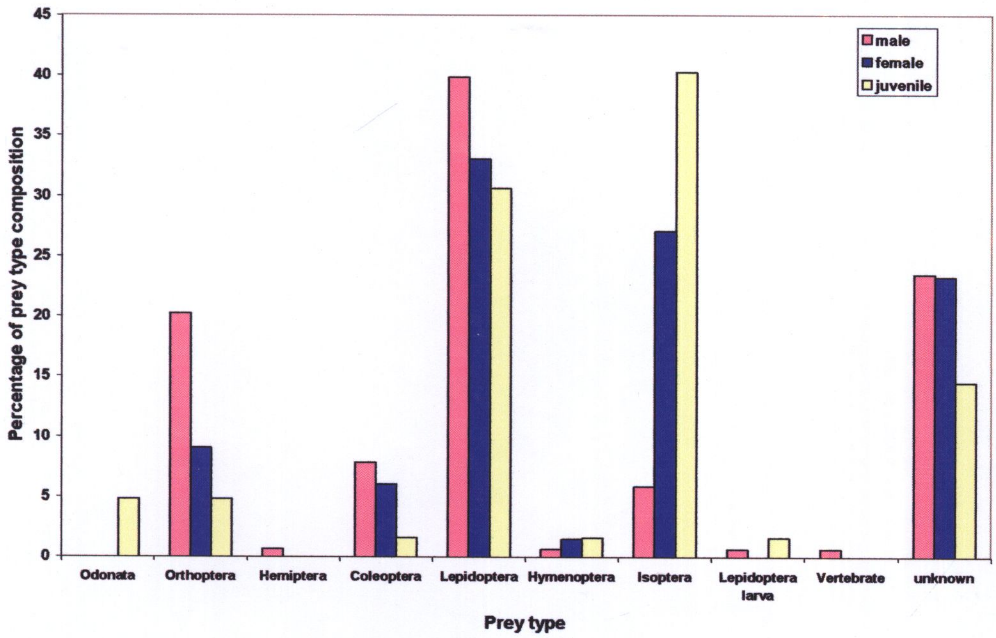


Figure 4-18 Percentage of prey type composition of males, females, and juveniles inhabiting the residential complex, Khao Khiao Open Zoo, Khao Khiao-Khao Chomphu Wildlife Sanctuary, Chon Buri Province.

Figure 4-19 *G. gecko* was eating a grasshopper.

Figure 4-20 *G. gecko* was eating a beetle.

Figure 4-21 *G. gecko* was eating a moth.

Figure 4-22 *G. gecko* was eating *Calotes versicolor*.

4.2.3.3 Relationship between predator size and prey size

Considering the body size of observed *G. gecko*, it ranged from 131.10 - 170.00 mm, 122.20 - 152.00 mm, and 65.90 - 99.50 mm for adult males, adult females and juveniles, respectively. Means SVL of adult males (152.23 ± 12.14 mm; N=13), adult females (138.35 ± 10.42 mm; N=8) and juveniles (85.90 ± 11.28; N=6) were significantly different ($p < 0.05$). When the relationships between body size, head size and prey size were analyzed, it was found that prey size of all groups did not correlate to body size, and head size ($p > 0.05$) as shown in table 4-5. This may be because the food resource in the habitat is always limited to geckos. Therefore, geckos will try to eat preys at all sizes that they can capture in the foraging area. This finding is consistency with the study of Perry (1996), who reported that male *A. polylepis*, having larger body size, ate smaller preys than those of females. However, this result is contrary to the finding of Saenz (1996), in which the body size of the Mediterranean gecko *H. turticus* was significantly correlated to prey sizes. The larger prey items were eaten more frequently by larger geckos.

Table 4-4 Head sizes of observed *G. gecko* at the residential complex in Khao Khiao Open Zoo, Khao Khiao–Khao Chomphu Wildlife Sanctuary, Chon Buri Province.

	Head size (mean ± SD)	
	Head length (mm)	**Head width (mm)**
Male (13)	42.37 ± 2.86	32.24 ± 3.56
Female (8)	38.30 ± 3.51	29.60 ± 3.56
Juvenile (6)	24.78 ± 3.15	18.18 ± 2.46

Table 4-5 Spearman's coefficient of rank correlation relating predator size and prey size.

	Snout-vent length	**Head width**	**Head length**
Prey size	-0.059 (0.273)	-0.032 (0.550)	-0.057 (0.295)

Remark: Numbers in parentheses represent p-value.

4.2.3.4 Variation in foraging among males, females, and juveniles

Six foraging behaviors of males, females and juveniles were compared. Individuals observed at least three times during the study period were selected for the analysis. Means, ranges, and coefficients of the variations in foraging period, time moving, foraging attempt, foraging success, prey size, and foraging distance of each group were shown in table 4-6. The variations in foraging parameters among males, females and juveniles were analysed by Kruskal-Wallis test. It was found that there were no significant differences among them in all foraging parameters ($p > 0.05$), indicating that variations among groups were low and the foraging behavior does not depend on the sex and age.

When the range of each foraging parameter was considered, some differences were found among groups. The foraging period of males, females, and juveniles ranged from 3:40 – 12:43 h (mean ± SD= 9:01 ± 2:23 h), 1:05 – 11:18 h (8:41 ± 2:56 h), and 4:11 – 11:31 h (8:56 ± 2:15 h), respectively. Although the means of the foraging period were not significantly different, the foraging period of females tended to be shorter than other groups. The observation showed that many male geckos were outside their hiding place until later than 7 am. A few stayed outside until 9 am. All females and juveniles returned to their holes before 7 am or before sunrise.

Time moving of males, females, and juveniles ranged from 0.74 - 207.29 $sec.h^{-1}$ (29.17 ± 36.22), 1.69 – 70.55 $sec.h^{-1}$ (24.42 ± 20.42), and 0.49 - 62.50 $sec.h^{-1}$ (24.23 ± 21.68), respectively. Even though there was no difference in this parameter among groups ($p > 0.05$), the ranges and the means showed that some males were more active during foraging period than the others. The time moving during foraging of these geckos was very low. They spent most of the time waiting rather than searching for preys. When an insect landed on or attached to the wall near to the gecko, the gecko that was stationary either crawled in slow movement or moved in high speed to strike the prey. Therefore, it could be suggested that *G. gecko* is not an active, but rather a sit-and-wait predator. This result is consistent with the study of Stanner et al. (1998), who mentioned that the level of *G. gecko* activity was low, including time moving. Its mode of foraging seemed to be like the animals that were catagorized as sit-and-wait predators (Huey and Pianka, 1981; Perry et al. 1990; Zug, 2001).

The ranges of foraging attempt among males, females, and juveniles were different. Females tended to have capture rate (range = 0.00 – 6.28 attempts. h^{-1}) more than males (range = 0.00 – 2.55 attempts. h^{-1}), and juveniles (range = 0.00-3.09 attempts. h^{-1}), but the mean percentage of foraging success of females (65.96 ± 33.32 % captures) was lower than that of males (70.78 ± 31.18 % captures), and juveniles (74.19 ± 30.39 % captures). Due to their lower foraging success, females should attempt to capture more preys within the same period of time to gain sufficient energy. Moreover, foraging attempt may also depend on food availability in the habitat.

The ranges of foraging distance of males, females, and juveniles were 0.10 – 38.50 m (mean ± SD = 8.04 ± 9.07), 0.10 – 24.50 m (5.21 ± 5.48), and 0.10 – 16.50 m (4.81 ± 4.80), respectively. Males tended to forage at the longest distance from the hole, whereas juveniles foraged nearest to the hole. The short foraging distance of juveniles may be useful for their escapes because they can retreat rapidly into their

Table 4-6 Variations in foraging behavior among males, females, and juveniles of *G. gecko*, inhabiting the residential complex, Khao Khiao Open Zoo, Khao Khiao-Khao Chomphu Wildlife Sanctuary, Chon Buri Province. Data were collected during July, 2001 to June, 2002. The symbol * indicates the maximum percent of variation in each foraging parameter.

Foraging parameters	Male (n=9)		Female (n=4)		Juvenile (n=4)		Total (n=17)		P-value
	Mean SD (Range)	CV	Mean SD (Range)	CV	Mean SD (Range)	CV	Mean SD (Range)	CV	
Foraging period (hour : min)	9:01 2:23 (3:40-12:43)	26.53*	8:41 2:56 (1:05-11:18)	24.42	8:56 2:15 (4:11-11:31)	24.23	8:54 2:31 (1:05-12:43)	28.31	0.894
Time moving (sec per hour)	29.17 36.22 (0.74-207.29)	124.17*	24.42 20.42 (1.69-70.55)	83.62	24.23 21.68 (0.49-62.50)	89.48	26.92 29.93 (0.49-207.29)	111.21	0.989
Foraging attempt (attempts per hour)	0.41 0.53 (0.00-2.55)	129.27	0.73 1.18 (0.00-6.28)	161.64	0.47 0.78 (0.00-3.09)	165.96*	0.52 0.82 (0.00-6.28)	158.72	0.150
Foraging success (%captures)	70.78 31.18 (0.00-100.00)	44.05	65.96 33.32 (0.00-100.00)	50.52*	74.19 30.39 (0.00-100.00)	40.96	69.54 31.60 (0.00-100.00)	45.44	0.727
Foraging distance (m)	8.04 9.07 (0.1-38.5)	112.81*	5.21 5.48 (0.1-24.5)	105.18	4.81 4.80 (0.1-16.5)	99.79	6.65 7.63 (0.1-38.5)	114.74	0.430
Prey size (cm)	1.58 0.94 (0.5-7)	59.49*	1.53 0.58 (0.5-3.5)	37.91	1.74 0.85 (0.5-4.5)	48.85	1.58 0.80 (0.5-7)	45.14	0.265

holes if they encounter predators. For prey size, the preys of all groups were not significantly different in size, but there were some individual geckos that ate preys in wider range of size such as gecko no. 4, and no. 30.

Considering the coefficient of variation (CV), the high CV indicates that the data has high variability. Comparing the variations among foraging parameters, the total CV of foraging attempt of geckos was highest; therefore, foraging attempt should be more variable among groups. In contrast, the total CV of the foraging period was lowest. Thus, the foraging period was less variable among groups. For the comparison among groups, the highest CV in most foraging parameters i.e. foraging period, time moving, foraging distance, and prey size was found in males. Females had the highest CV in foraging success whereas juveniles had the highest CV in foraging attempt. It can be concluded that males' foraging behaviors were more variable than the others.

4.2.3.5 Individual variation in foraging

For the analysis of the individual variation in foraging behavior, individual data of at least six observations were compared, using Kruskal-Wallist test. The significant difference was found in every foraging parameter, indicating that there is individual variation within the observed geckos ($p < 0.05$). In addition, when the CV in each foraging parameter was considered, it was found that some individuals had higher variation than the others (Table 4-7). However, individual variations in some parameters were low i. e. foaging period and prey size. Some individuals had high variation in several parameters such as the gecko no. 30, and the gecko no. 4. The male gecko (no. 30) had high variations in time moving, foraging attempt, foraging success, and prey size. The male gecko no. 4 had high variations in time moving, and prey size. This finding is consistency with the previous studies that reported on the foraging behavior of *Gekko japonicus* and *Teratoscincus roborowskii.* Some individuals of these two species appeared to be very stationary, sometimes throughout the whole observation time whereas other individuals were very active (Werner *et al.*, 1997). For *G. gecko*, Stanner *et al.* (1998) studied the adult gecko brifely at Pathumthani Province, reporting that each individual behaved variably. On the first night, it was very stationary and moved only 40 cm, but on the second night it was very active and moved nearly 50 m. This report showed that the same individual can behave variably. When the similar-sized geckos of the same sex were compared, it was found that there were variations between individuals in some parameters. For instance, the male gecko no. 39 (SVL = 170.0 mm; initial weight = 120 g; ending weight = 170 g), and the male gecko no. 4 (SVL = 168.0 mm; initial weight = 130 g; ending weight = 160 g) were compared on their foraging parameters using Mann-Witney U test. There were significant differences in foraging period, time moving, foraging attempt, and foraging success ($p < 0.05$). Although these geckos performed differently in foraging, their body weight also increased in the similar rate. This study indicated that individual *G. gecko* has variations in foraging techniques. These strategies should have benefits for their survival and reproduction in heterogeneous habitats or in the man-made environment.

Table 4-7 Individual variations in foraging of *G. gecko*, inhabiting the residential complex, Khao Khiao Open Zoo, Khao Khiao-Khao Chomphu Wildlife Sanctuary, Chon Buri Province. Data were collected during July, 2001 to June, 2002. The symbol * indicates the maximum percentage of variation in each foraging parameter.

Individuals (no. of observations)	Sex	SVL	Foraging period (Hour:min)			Time moving (sec per hour)			Foraging attempts (attempts per hour)			Foraging success (% captures)			Foraging distance (m)			Prey size (cm)		
			Mean (Range)	SD	CV	Mean (Range)	SD	CV	Mean (Range)	SD	CV	Mean (Range)	SD	CV	Mean (Range)	SD	CV	Mean (Range)	SD	CV
1 (10)	female	152.0	8:42 (2:56-11:27)	2:45	31.61	18.74 (1.69-51.07)	18.27	97.49	0.52 (0.00-1.66)	0.54	103.85	66.25 (0.00-100.00)	36.53	55.14	5.41 (0.1-18.0)	5.17	95.56	1.32 (0.5-2.5)	0.51	38.64
4 (9)	male	168.0	10:23 (6:51-11:46)	1:39	15.88	22.74 (1.10-77.54)	25.96	114.16	0.41 (0.00-1.19)	0.46	112.20	73.18 (50.00-100.00)	18.19	24.86	7.23 (0.2-21.5)	7.63	105.53	1.8 (0.5-4.5)	1.08	60.00
8 (11)	female	136.1	9:11 (3:18-11:18)	2:45	29.96	37.84 (2.71-70.55)	21.79	57.58	1.39 (0.11-6.28)	1.78	128.06	65.10 (16.67-100.00)	25.96	39.88	6.38 (2.0-14.5)	4.03	63.17	1.54 (0.5-2.5)	0.46	29.87
9 (12)	male	146.2	10:25 (6:34-11:36)	1:18	12.58	9.44 (1.46-24.72)	7.21	76.38	0.21 (0.00-0.67)	0.21	100.00	78.24 (0.00-100.00)	41.65	53.23	3.78 (0.1-15.0)	4.05	107.14	1.17 (0.5-2.5)	0.69	58.97
21 (6)	male	141.6	9:09 (4:51-12:44)	3:02	33.19	18.79 (3.50-26.35)	8.33	44.33	0.11 (0.00-0.34)	0.14	127.27	58.33 (0.00-100.00)	52.04	89.22	3.48 (0.2-5.0)	1.83	52.59	1.50 (0.5-2.5)	0.82	54.67

Table 4-7 Individual variations in foraging of *G. gecko*, inhabiting the residential complex, Khao Khiao Open Zoo, Khao Khiao-Khao Chomphu Wildlife Sanctuary, Chon Buri Province. Data were collected during July, 2001 to June, 2002. The symbol * indicates the maximum percentage of variation in each foraging parameter. (continued)

Individuals (no. of observations)	Sex	SVL	Foraging period (Hour:min)			Time moving (sec per hour)			Foraging attempts (attempts per hour)			Foraging success (% captures)			Foraging distance (m)			Prey size (cm)		
			Mean (Range)	SD	CV	Mean (Range)	SD	CV	Mean (Range)	SD	CV	Mean (Range)	SD	CV	Mean (Range)	SD	CV	Mean (Range)	SD	CV
30 (6)	male	146.4	9:31 (5:25-11:45)	2:11	22.92	8.88 (0.74-35.32)	13.25	149.21*	0.03 (0.00-0.19)	0.08	266.67*	50.0 (0.00-100.00)	70.71	141.42*	1.57 (0.1-5.5)	2.06	131.21*	3.33 (0.5-7)	3.33	100.00*
35 (6)	juvenile	91.7	9:44 (6:00-11:31)	1:56	19.92	17.89 (2.98-42.06)	15.58	87.09	0.64 (0.00-3.09)	1.22	190.63	92.50 (83.33-100.00)	8.77	9.48	5.07 (0.9-16.5)	5.90	116.37	1.72 (1.5-2.5)	0.42	24.42
38 (8)	female	122.2	8:26 (1:05-10:32)	3:10	37.56	13.75 (2.11-44.31)	13.21	96.07	0.26 (0.09-0.92)	0.28	107.69	77.08 (0.00-100.00)	36.66	47.56	1.69 (0.1-4.0)	1.51	89.35	1.61 (0.5-2.5)	0.60	37.27
39 (6)	male	170.0	6:33 (3:40-10:19)	2:55	44.58*	89.53 (37.21-207.29)	63.44	71.68	1.18 (0.69-1.75)	0.40	33.90	81.18 (46.15-100.00)	21.19	26.10	20.71 (0.3-38.5)	14.11	68.13	1.39 (0.5-2.5)	0.53	38.13
40 (8)	male	151.3	7:08 (4:35-9:46)	1:49	25.49	42.17 (2.42-88.97)	32.72	77.59	0.34 (0.00-0.88)	0.33	97.06	74.45 (0.00-38.97)	38.97	52.34	14.51 (0.3-25.5)	9.49	65.40	1.97 (1.5-3.5)	0.74	37.56
	***P*-value**		0.015			0.001			0.001			0.003			0.006			0.004		

4.2.4 Correlation between insect abundance and foraging behavior

Observation during this study showed that insects were the major food item of *G. gecko*. The insects were attracted by the fluorescent light, located around the building in the study area. Foraging geckos were found in higher number at the lighted area than the unlighted area. This agrees with the study on the dispersion of small common species of geckos living in the building i. e. *H. frenatus* and *L. lugubris* of Petren, Bolger, and Case (1993), and Petren, and Case (1996). Moreover, Petren, and Case (1996) mentioned that the competition of the two sympatric geckos was strongest when the lights were present due to the high insect segregration. The larger species, *H. frenatus*, was more efficient in foraging success, and depleted insect available to the small species, *L. lugubris*. In this study, when the relationships between foraging parameters and the insect abundance were considered, it was found that time moving, foraging attempt, foraging success, and foraging distance were highly correlated with the insect abundance ($p < 0.01$) whereas foraging period and prey size were not correlated (Table 4-8).

Table 4-8 Spearman's coefficient of rank correlation relating insect abundance and foraging parameters

	Insect abundance	Foraging Period	Moving Time	Foraging attempts	Foraging success	Foraging distance	Prey size
Insect abundance	1.000						
Foraging period	-0.078 (0.381)	1.000					
Time moving	0.345** (0.000)	-0.096 (0.279)	1.000				
Foraging attempt	0.346** (0.000)	-0.031 (0.729)	0.765** (0.000)	1.000			
Foraging success	0.284** (0.002)	-0.20 (0.819)	0.711** (0.000)	0.937** (0.000)	1.000		
Foraging distance	0.250** (0.004)	0.046 (0.605)	0.732** (0.000)	0.626** (0.000)	0.602** (0.000)	1.000	
Prey size	0.071 (0.519)	-0.179 (0.100)	-0.060 (0.581)	-0.103 (0.335)	-0.143 (0.189)	-0.061 (0.576)	1.000

Remark: numbers in parentheses represent p-value

* Correlation is significant at 0.05 level (2-tailed)

** Correlation is significant at 0.01 level (2-tailed).

4.2.5 Explanations concerning with the predictions from the optimal foraging theory

Many authors pointed out that the prey availability or prey density in the habitat could affect predator activities because predators could gain energy only from foraging. They have to make decisions and expend their time and energy for foraging activity, and this will also include the risk to expose to both harsh physical conditions and their predators. Therefore, they should behave in the ways that could maximize their net energy gain. This view is in accordance with the optimal foraging theory of which the aim is to explain why particular patterns of foraging behavior have been favored by natural selection. However, the optimal foraging theory sometimes could not be applied to all foraging decisions of every predator as suggested by Pianka (1983), and Townsend, Harper, and Begon (2000).

In this study, *G. gecko* tended to behave in the ways that accorded with the predictions from the optimal foraging theory. From the data, when the insect abundance was relatively high, which was the rare case in the study area, geckos changed their habits from sit-and-wait to active foragers by moving more frequently towards the prey, foraging at longer distance from the hole and were more successful in prey captures. For these foraging behaviors, it could be interpreted that geckos could increase their net energy intake when their prey density was higher.

For the foraging period and prey size, the significant correlation of each parameter with insect abundance was not found ($p > 0.05$), indicating that the foraging period did not depend on food abundance and there was no prey size selection in observed geckos. In this case, it could be explained as follows. Firstly, the insect availability in the habitat was always low, and secondly, because predators in the study area such as predatory birds, cats and dogs were in low number and could result in *G. gecko* to learn that the risk was low. From this study, geckos were seen to forage singly and each individual showed the tendency to have its own foraging area, indicating some degrees of intraspecific competition for food. In addition, from the observation of about one hundred nights, there was no evidence to confirm that *G. gecko* had been eaten or captured by any predators in the study area. Therefore, they might learn to behave in the ways that suit the situation by spending their foraging time as long as possible and try to eat most preys that they encountered in order to maximize their net energy gains. All foraging strategies mentioned above would help them to gather enough food for their survival in the man-made environment. In contrary, when food was low or when the climatic condition was not favorable, geckos were observed to be strictly sit and wait foragers or stayed inside the building. This strategy would benefit them in the way that they could save their energy loss. The comparative study on the relationship between foraging period and insect abundance in the natural habitat, especially with low and high predation rates, is interesting to be investigated to test the prediction of the optimal foraging theory.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

5.1.1 Morphological differences

G. gecko showed significant differences in various morphological characters between sexes and ages. The important sexual dimorphic traits were head and tail characters. Head characters could play an important role in both inter- and intra- specific competition for food and reproduction. Tail characters could be important for reproduction, including territory defense. Other trait, which could be used to seperate the sexes, was prominent preanal pores in the male.

Morphological differences between adults, and juveniles were displayed in several characters. Some larger characters, in proportion to snout-vent length, of juveniles such as ear length, eye length, and interorbital distance could be useful for detecting their predators as well as their preys.

5.1.2 Foraging ecology

1. The number of foraging *G. gecko* found in the study area related to the ecological factors such as temperature, humidity, and insect abundance. The activity of geckos decreased when temperature and humidity was low. The

change of insect abundance in the habitat played an important role to the foraging activity of geckos.

2. *G. gecko* is a nocturnal feeder. Its foraging time was between 5 pm and 9 am. The peak of emergence time was between 6 pm and 8 pm, whereas the peak of retreating time was between 4 am and 7 am. For geckos that the foraging behavior was observed, females and juveniles returned to the hiding place earlier than males and a few males were found to forage until 9 am.

3. The major food item of *G. gecko* was insects. The common prey items were in Orders Lepidoptera, Orthroptera, and Coleoptera. The prey composition varied throughout the year, depending on insect diversity in the habitat. The sizes of prey items ranged from 0.5 -7 cm of which the size of 1-2 cm (70%) was the most common. Overall, prey sizes of males, females, and juveniles were not different. It indicated that males, females, and juveniles consumed preys of varying sizes without partitioning and this could be because food abundance in the habitat was always low.

4. Foraging period, moving time, foraging attempt, foraging success, prey size consumed, and foraging distance were not different among males, females, and juveniles. Therefore, the foraging behavior of *G. gecko* living in the study area should not depend on the sex and age. However, the foraging attempt of geckos was the most diverse among groups, while foraging period was the least diverse.

Males tended to have the highest variation in most foraging behaviors i.e. foraging period, moving time, foraging distance, and prey size, indicating that males had higher variability in foraging than females, and juveniles.

5. The individual variation in foraging behavior was found in this study. Similar-sized geckos of the same sex performed differently in some parameters. However, variations among individuals in some parameters such as foraging period and prey size consumed were low as indicated by CV values. Individual variations in foraging behavior should have benefits for the survival and reproduction of the species.

6. Under the low pressure from predators and limited food, foraging behaviors of *G. gecko* living in the study area could be explained by the optimal foraging theory. In general, they became more generalized and active when food was high to maximize energy intake and were stationary when food was low to minimize energy loss.

5.2 Recommendations

1. To understand more about the flexibility and adaptability of *G. gecko* in foraging behavior, more detailed study in both natural and man-made habitats of this species at individual level should be conducted.

2. In many areas of Thailand, this species is vulnerable because local people hunt many of them for export every year. Therefore, captive breeding and sustainable management program should be considered in advance to satisfy conservation and economic purposes.

REFERENCES

Alcock, J. 1975. Animal behavior: an evolutionary approach. Massachusetts: Sinauer Associates, Inc.

Angsirijinda, W. 1999. Ecology and morphology of green water dragon *Physignathus cocincinus* in Thailand. Master's thesis, Department of Biology, Graduate School, Chulalongkorn University.

Angilletta, M. J., Montgomery, L. G. and Werner, Y. L. 1999. Temperature preference in geckos: Diel variation in juveniles and adults. Herpetologica 55(2):212-222.

Bauer, A. M. 1990. Gekkonid lizard as prey of invertebrates and predators of vertebrate. Herpetological Review 21: 83-87.

Bury, R. B. 1979. Population ecology of freshwater turtles. In Harless, M. and Morlock, H. (eds.). Turtles perspectives and research, pp. 571-602. New York: John-Wiley&Sons.

Bustard, H. R. 1968. The ecology of the Australian gecko, *Gehyra variegata*, in northern New South Wales. Journal of Zoology, London (1968): 113-138.

Chan-ard, T., Grossman, W., Gumpreht, A. and Schulz, K. D. 1999. Amphibians and reptiles of Penninsular Malaysia and Thailand. German: Bushmaster Publication.

Cogger, H. G. 1994. Reptiles and amphibians of Australia. 5th ed. New York: Constock, Cornell.

Cooper, W. E. Jr. 1994. Prey chemical discriminant, foraging mode, and phylogeny. In Vitt, L. J. and Pianka, E. R. (eds). Lizard ecology: historical and experimental perspectives, pp. 95-116. New Jursy: Princeton University Press.

Cooper, W. E. Jr., Vitt, L. J., Caldwell, J. P. and Fox, S. F. 2001. Foraging modes of some American lizards: relationships among measurement variables and discreteness of modes. Herpetologica 57(1): 65-76.

Cooper, W. E. Jr. and Whiting, M. J. 2000. Ambush and active foraging modes oth occur in the Scincid Genus *Mabuya*. Copeia 2000(1):112-118.

Darwin, C. 1889. The descent of man, and selection in relation to sex. 2 nd ed. New York: D. Appleton and Company. pp. 207-260, 330-358.

Dunham, A. E. 1978. Food availability as a proximate factor influencing individual growth rates in the Iguanid Lizard Sceloporus merriami. Ecology 59(4): 770-778.

Ehrlich, P. F. and Roughgarden, J. 1987. The science of ecology. NewYork: MacMillan Publishing Company.

Grossman, W. and Ulber, T. 1990. Ein neuer Geckos aus zentral-Thailand: *Gekko siamensis* sp. Nov. (Reptilia: Sauria: Gekkonidae). Sauria 12(3): 9-18.

Hanley, K. A., Bolger, D. T., and Case, T. J. 1994. Comparative ecology of sexual and asexual gecko species (*Lepidodactylus*) in French Polynesia. Evolutionary Ecology 8: 438-454.

Huey, R. B. and Pianka, E. R. 1981. Ecological consequences of foraging mode. Ecology 54: 991-999.

Jessen, T. A., Congdon, J. D., Fischer, R. U., Estes, R., Kling, D. and Edmans, S. 1995. Morphological charateristics of the lizards *Anolis carolinensis* from South Carolina. Herpetologica 51 (4): 401-411.

Kluge, A. G. 1993. Gekkonoid lizard taxonomy. California: International Gecko Society.

McLaughlin, R. L. 1989. Search modes of birds and lizards: evidence for alternative movement patterns. American Naturalist. 133: 654-670.

Molina-Borja, M., Padrón-Fumero, M. and Alfonso-Martín, T. M. 1997. Intrapopulation variability in morphology, coloration, and body size in two races of the Lacertid lizard, *Gallotia galloti*. Journal of Herpetology 31(4):499-507.

Mouton, P. N., Flemming, A. F. and Nieuwoudt, C. J. 2000. Sexual dimorphism and sex ratio in a terrestrial girdles lizard, *Cordylus macropholis*. Journal of Herpetology 34(3): 379-386.

Orient, G. H. 1971. Ecological aspects of behavior. In Farmer, D. S., and King, J. (eds.). Avian Biology, Vol. 1. New York: Academic Press, p. 265. Cited in Alcock, Animal behavior: an evolutionary approach. Massachusetts: Sinauer Associates, Inc., 1975.

Ota, H., Lau, M. W., Weidenhöfer, T., Yasukawa, and Bogadek, A. 1995. Taxonomic review of the geckos allied to *Gekko chinensis* Gray, 1842 (Gekkonidae: Reptilia) from China and Vietnam. Tropical Zoology 8: 181-196.

Ota, H. and Nabhitabhata , J. 1991. A new species of *Gekko* (Gekkonidae: Squamata) from Thailand. Copeia 2: 503-509.

Perry, G. 1996. The evolution of sexual dimorphism in the lizard *Anolis polylepis* (Iguania): evidence from intraspecific variation in foraging behavior and diet. Canadian Journal of Zoology 74: 1238-1245.

Perry, G., Lampl, I., Lerner, A., Rothenstein, D., Shani, E., Sivan, N. and Werner, Y.L. 1990. Foraging mode in lacertid lizards: variation and correlates. Amphibia-Reptilia 11: 373-384.

Petren, K., Bolger, D. T. and Case, T. J. 1993. Mechanism in competitive success of an invading sexual gecko over an asexual native. Science 29: 354-358.

Petren, K. and Case, T. J. 1996. An experimental demonstration of exploitation competition in an ongoing invasion. Ecology 77(1): 118-132.

Petren, K. and Case, T. J. 1998. Habitat structure determines competition intensity and invasion success in gecko lizards. Proceedings of the National Academy of Sciences of the United States of America 95: 11739-11744.

Pianka, E. R. 1966. Convexity, desert lizards and spatial heterogeneity. Ecology 47: 1055-1059.

Pianka, E. R. 1983. Evolutionary ecology. NewYork: Harper & Row.

Pianka, E. R. 1986. Ecology and natural history of desert lizards: analysis of the ecological niche and community structure. New Jursey: Princeton University Press.

Porter, K. R. 1972. Herpetology. Philadelphia, London, Toronto: W. B. Saunders Company.

Pough, F. H., Andrew, R. M., Cadle, J. E., Crump, M. L., Savitzky, A. H. and Wells, K. D. 2001. Herpetology. 2nd ed. New Jursy: Prentice Hall.

Radder, R. S., Shanbhang, B. A. and Saidapur, S. K. 2001. Ontogeny of sexual size dimorphism in the tropical garden lizard, *Calotes versicolor* (Daud.). Journal of Herpetology 35(1): 156-160.

Rohlf, F. J. 1990. Morphometrics. Annual Review of Ecology and Systematics 21: 299-316.

Saenz, D. 1996. Dietary overview of *Hemidactylus turticus* with possible implications of food partitioning. Journal of Herpetology 30(4): 461-466.

Shine, R. 1989. Ecological causes for the evolution of sexual dimorphism; a review of the evidence. Quarterly Review of Biology 64(4): 419-461.

Shine, R. 1990. Proximate determination of sexual differences in adult body size. American Naturalist 135(2): 278-283.

Sievert, L. M. and Hutchinson, V. H. 1988. Light versus heat: thermoregulatory behavior in a nocturnal lizard (*Gekko gecko*). Herpetologica 44(3): 266-273.

Slatkin, M. 1984. Ecological causes of sexual dimorphism. Evolution 38 (3): 622-630.

Smith, M. A. 1935. The fauna of British India including Ceylon and Burma: reptilia and amphibia. Vol. 2: Sauria. London: Taylor and Francis Ltd.

Sokal, R. R. and Rohlf, F. J. 1995. Biometry. 3 rd ed. New York: W. H. Freeman and Company.

Stanner, M., Thirakhupt, K., Werner, N. and Werner, Y. L. 1998. Observations and comments on the tokay in Thailand and China as predator as prey (Reptilia: Sauria: Gekkonidae *Gekko gecko*). Dactylus 3(2): 69-84.

Taylor, E. H. 1963. The lizards of Thailand. The University of Kansas Science Bulletin 44(14): 687-1077.

Townsend, C. R., Harper, J. L. and Begon, M. 2000. Essentials of ecology. Massachusets: Blackwell Science, Inc.

Underwood, H. 1992. Endogenous rhythms. In Gans, C. and Crews, D. (eds.). Biology of reptilia. Vol. 18. Chicago, London: University of Chicago Press, p. 94. Cited in Werner, Y. L. Prelimilinary observations on foraging mode in a community of house geckos on Tahiti and a comment on competition. Tropical Ecology 39(1): 89-96. 1998.

Vitt, L. J. 1981. Lizard reproduction: habitat specificity and constrains on relative clutch mass. American Naturalist 117: 506-514.

Vitt, L. J. 1990. The influence of foraging mode and phylogeny on seasonality of tropical lizard reproduction. Papeis Avulsos de Zoologia (Museu de Zoologia da Universidade de Sao Paulo) 37: 107-123.

Vitt, L. J. and Price, H. J. 1982. Ecological and evolutionary determinants of relative clutch mass in lizards. Herpetologica 38: 237-255.

Vitt, L. J., Souza, R. A., Sartorius, S. S., Avila-Pires, T. C. S. and Espósito, M. C. 2000. Comparative ecology of sympatric *Gonatodes* (Squamata: Gekkonidae) in the Western Amazon of Brazil. Copeia 2000(1): 83-95.

Webb, J. K., and Shine, R. 1994. Feeding habit and reproductive biology of Australian pygopodid lizards of the genus Aprasia. Copeia 1994: 390-398.

Werner, Y. L. 1998. Prelimilinary observations on foraging mode in a community of house geckos on Tahiti and a comment on competition. Tropical Ecology 39(1): 89-96.

Werner, Y. L., Bouskila, A., Davies, S. J. J. F. and Werner, N. 1997. Observations and comments on active foraging in geckos. Russian Journal of Herpetology 4(1): 34-39.

Werner, Y. L., Okada, S., Ota, H., Perry, G. and Tokuraga, S. 1997. Varied and fuctuating foraging mode in nocturnal lizard of family Gekkonidae. Asiatic Herpetological Research 7: 153-167.

Werner, Y. L. and Chou, L. M. 2002. Observation on the Ecology of the arrhymic equatorial gecko *Cnemapis kendallii* in Singapore (Sauria: Gekkonidae). Raffles Bulletin of Zoology 50(1): 185-196.

Wymann, M. N. and Whiting, M. 2002. Foraging ecology of rainbow skinks (*Mabuya maraitifer*) in Southern Africa. Copeia 2002(4): 943-957.

Zhao, E. M. and Edler, K. 1993. Herpetology of China. Michigan: Thomson-Shore.

Zug, G. R., Vitt, L. J. and Caldwell, J. P. 2001. Herpetology: an introduction biology of amphibians and reptiles. 2nd ed. San Francisco, New York, Boston, London, Sydney, Tokyo: Academic Press.

Appendix I

(Morphological data)

Morphological data of *G. gecko* collected from Saraburi Province

No.	Morpholgical characters																						
	SVL	HL	HD	HW	IND	IOD	SEL	EYL	EEL	EAL	SAL	AGL	UAL	FAL	HaL	ULL	LLL	FL	TIVL	TIVW	SCL	TD	TW
1	68.9	20.3	9.3	15.2	2.8	9.9	8.6	4.9	6.6	4.1	26.1	29.8	10.3	9.5	7.2	9.6	9.9	7.7	5.0	2.3	5.0	5.6	5.5
2	70.6	23.0	7.6	15.7	2.9	10.7	7.1	5.1	7.6	3.5	29.6	36.7	15.5	10.3	7.2	12.3	11.5	11.2	6.8	2.7	6.3	4.0	6.4
3	120.4	37.6	15.8	30.0	4.8	19.0	15.6	9.7	13.0	4.4	41.0	68.4	19.6	17.8	14.8	17.7	20.6	18.0	12.0	4.1	8.4	7.9	10.6
4	134.8	37.0	19.5	28.0	3.6	18.0	15.0	9.0	12.8	5.0	47.4	70.0	14.5	15.0	15.9	24.5	23.0	19.6	10.8	4.5	10.3	8.8	9.9
5	77.6	18.0	8.8	15.5	3.0	12.3	9.4	5.7	7.4	3.6	27.3	37.7	8.7	11.0	8.8	14.2	11.0	10.9	7.3	2.5	5.6	5.7	5.7
6	147.2	43.4	15.6	28.9	4.7	20.5	15.4	9.5	15.0	6.3	55.5	72.5		16.7	12.0	17.4	19.0	16.5	12.3	4.5	9.0	8.8	12.0
7	122.4	35.0		26.3	4.5	17.6	13.6	9.9	14.7	4.8	46.9	57.9	19.4	13.5	13.3	22.0	20.0	17.2	10.8	4.0	8.8	8.0	11.0
8	173.3	52.5	26.6	39.4	5.4	25.6	21.4	9.9	20.4	6.9	69.2	90.0	18.0	16.3	15.8	22.5	26.5	28.9	16.2	6.5	10.7	13.3	16.4
9	139.6	42.7	18.0	31.6	5.2	19.8	15.4	9.8	16.0	5.8	47.2	67.2	17.0		16.0	16.7	19.9	20.0	14.0	5.0	9.4	8.3	12.3
10	115.8	37.0	18.2	26.1	3.7	14.7	13.6	8.0	12.7	5.9	42.3	54.3	15.6	15.4	14.1	18.0	17.8	15.8	10.6	3.8		8.4	11.3
11	143.6	42.7	25.2	33.8	4.0	19.2	16.0	9.1	17.7	7.7	41.1	68.4	23.3	20.0	14.3	18.0	20.3	20.5	13.3	4.6	8.7	14.4	16.0
12	124.7	37.7	15.0	26.8	5.0	17.0	15.5	7.6	11.8	7.6	44.8	63.0	20.7	16.0	14.7	20.8	18.0	17.6	11.5	4.0	8.3	9.0	12.4
13	193.0	49.0	27.7	47.0	4.7	21.6	18.8	11.9	18.4	5.6	56.5	98.7	23.6	22.3	17.0	24.8	23.6		13.7	5.4	10.8	13.4	16.0
14	142.9	39.5	19.6	32.3	4.8	21.3	15.8	8.9	16.3	4.9	46.9	73.8	23.3	15.8	15.2	25.8	17.9	18.7	11.4	5.2	9.8	9.7	12.5
15	142.2	42.6	21.1	32.6	4.9	21.4	17.8	8.9	15.9	6.9	63.8	71.6	18.2	18.3	18.7	21.8	21.5	21.4	15.4	5.3	11.9	11.9	14.1

Morphological data of *G. gecko* collected from Saraburi Province (Cont.)

No.	Morpholgical characters																					
	SVL	HL	HD	HW	IND	IOD	SEL	EYL	EEL	EAL	SAL	AGL	UAL	FAL	HaL	ULL	LLL	FL	TIVL	TIVW	SCL	TD	TW
16	154.9	41.9	18.1	31.3	4.5	21.1	16.3	7.7	15.2	6.9	66.1	91.0	19.7	17.6	17.7	22.1	22.2	22.4	14.9	5.5	13.3	12.4	14.5
17	178.5	48.0	25.5	38.0	4.0	25.8	19.2	9.7	19.7	7.8	66.8	90.3	21.6	19.5	20.8	22.7	19.4	24.2	16.7	6.4	14.7	15.0	17.0
18	165.5	45.4	25.5	36.1	5.0		15.2	10.6	18.7	7.8	52.7	78.6	23.8	17.8	18.3	32.4	26.8	26.0	17.9	5.6	10.6	10.8	13.9
19	131.0	36.0	19.0	28.4	4.0	20.0	14.3	8.0	14.0	5.4	46.8	80.6	20.0	19.5	17.3	22.2	19.1	19.8	15.4	3.6	12.0	10.0	11.3
20	118.3	31.5	16.1	19.9	3.9	16.0	12.5	7.6	11.0	4.8	46.2	58.2	16.9	16.4	10.9	20.1	17.9	16.5	12.0	4.1	8.3	10.0	7.8
21	131.0	36.6	17.7	26.6	4.4	18.7	14.7	9.0	13.3	6.7	54.2	66.0	20.0	18.3	17.0	22.0	17.3	17.6	12.7	4.4	10.4	9.9	10.8
22	163.5	47.3	23.5	37.2	4.5	22.5	19.1	8.9	17.0	7.2	66.7	90.0	26.4	22.4	21.2	25.5	22.0	24.0	16.3	6.2	12.2	12.7	16.2
23	65.7	21.2	9.7	17.0	2.8	8.8	8.0	5.6	6.1	3.4	25.3	31.5	10.0	8.8	7.4	9.4	9.4	8.9	6.4	2.2	5.4	4.9	5.3
24	127.5	35.8	17.9	25.0	4.0	21.1	13.8	9.0	13.0	5.5	50.8	70.4	21.3	17.9	12.7	19.1	19.0	17.6	11.7	4.9	9.9	8.9	11.6
25	67.9	20.6	8.8	15.8	2.4	11.7	8.0	4.9	6.2	3.2	20.7	31.5	10.3	9.0	7.2	9.4	10.9	9.8	7.2	2.4	4.6	4.4	5.5
26	87.3	23.0	11.5	19.5	3.0	13.0	8.1	5.9	8.5	4.9	32.7	34.9	13.6	11.6	9.3	12.0	13.6	11.3	8.5	2.5	5.3	5.5	6.4
27	167.4	49.1	25.4	41.7	5.0	26.4	17.2	8.9	19.1	6.5	58.7	87.6	26.6	21.0	17.6	27.7	24.9	24.4	18.0	6.6	13.6	14.2	16.6
28	164.8	46.4	21.1	33.4	5.3	25.0	17.0	8.5	17.4	9.1	58.6	87.2	24.6	18.9	19.4	22.7	23.8	22.4	18.2	6.4	10.6	12.3	15.0
29	160.4	43.5	23.0	36.6	4.8	23.0	16.6	9.3	16.6	6.6	60.9	82.9	24.8	22.4	19.0	25.0	21.9	23.3	17.6	7.2	13.2	10.0	15.3
30	174.9	47.8	22.5	34.0	5.8	24.2	18.9	9.0	17.9	7.4	62.3	92.9	26.6	20.0		24.9	22.7	26.4	18.2	5.3	10.8	12	15.5

Morphological data of *G. gecko* collected from Saraburi Province (Cont.)

No.	Morpholgical characters																					
	SVL	HL	HD	HW	IND	IOD	SEL	EYL	EEL	EAL	SAL	AGL	UAL	FAL	HaL	ULL	LLL	FL	TIVL	TIVW	SCL	TD	TW
31	184.9	49.8	26.8	41.9	5.2	27.0	20.0	9.3	23.0	6.9	70.2	96.0	27.9	24.5	20.9	27.4	25.3	26.8	19.0	7.5	11.3	13.0	16.7
32	137.1	39.9	20.0	27.2	4.5	21.2	14.9	8.0	15.7	6.7	52.2	79.6	19.8	18.2	14.9	15.0	19.0	19.2	14.9	5.8	11.9	8.9	12.5
33	146.0	39.8	18.1	28.0	5.0	21.8	15.5	7.9	13.6	6.6	55.2	68.2	21.2	16.9	15.4	19.6	19.0	19.3	13.6	5.4	8.8	7.3	12.3
34	176.1	44.4	26.2	35.1	4.8	27.2	16.6	9.3	19.4	6.4	62.9	81.8	27.0	20.6	20.5	27.7	25.6	22.8	17.9	7.1	12.4	12.4	16.4
35	129.4	35.7	17.6	24.9	4.6	20.2	12.4	8.2	13.1	5.8	49.4	67.8	18.3	16.3	16.0	19.0	19.5	17.6	11.8	4.9	10.6	8.0	10.6
36	141.5	36.7	17.9	27.1	3.9	20.8	14.9	7.4	14.4	6.0	49.0	64.7	21.7	18.4	16.2	20.5	21.8	19.2	15.3	4.6	9.0	8.7	11.8
37	86.9	25.0	11.6	19.0	2.9	13.6	9.8	6.1	7.8	4.3	36.0	38.0	12.2	10.0	9.1	12.3	11.2	12.6	8.6	2.7	6.2	4.0	6.3
38	144.4	39.7	20.1	31.4	4.5	22.7	16.3	9.4	14.6	6.4	55.5	69.6	22.7	17.8	18.0	25.0	20.8	19.6	14.7	5.6	10.0	9.1	12.7
39	164.2	46.2	28.2	39.9	5.2	23.9	17.7	10.3	20.8	6.1	62.5	85.0	25.7	21.8	20.0	26.2	28.8	23.7	17.4	6.7	13.6	11.4	15.4
40	139.4	38.0	22.0	29.2	4.0	18.5	14.8	7.3	14.2	4.3	55.0	70.8	19.6	17.7	18.6	19.6	19.8	18.5	15.4	5.1	10.7	9.6	12.5
41	145.0	38.8	19.2	30.0	4.4	21.5	15.6	9.3	14.3	5.9	56.5	74.8	19.9	16.9	14.1	23.8	19.4	17.8	11.8	5.0	7.7	10.4	10.8
42	182.9	46.8	26.7	41.7	5.9	25.5	18.3	9.3	18.9	6.2	65.6	83.3	26.3	22.3	22.5	24.7	24.6	24.9	20.4	6.7	14.9	13.4	15.7
43	174.5	47.6	27.2	42.7	4.6	26.0	17.8	9.5	18.3	8.2	71.6	93.9	28.3	21.7	21.5	29.6	23.4	24.8	17.2	6.9	12.4	12.7	16.6
44	132.6	37.4	16.9	25.6	4.8	21.2	16.2	8.6	15.3	5.9	48.5	68.8	20.7	18.0	15.5	22.8	19.6	18.4	14.3	5.2	11.0	8.2	11.0
45	171.4	48.1	24.0	36.6	5.0	22.3	17.9	9.4	18.9	7.7	63.7	81.7	26.6	20.9	20.8	26.7	27.6	24.4	18.0	6.4	13.0	10.7	15.6

Morphological data of *G. gecko* collected from Saraburi Province (Cont.)

No.	Morpholgical characters																					
	SVL	HL	HD	HW	IND	IOD	SEL	EYL	EEL	EAL	SAL	AGL	UAL	FAL	HaL	ULL	LLL	FL	TIVL	TIVW	SCL	TD	TW
46	157.3	44.4	23.7	31.4	4.6	22.1	17.4	8.8	18.3	6.6	63.0	84.0	23.6	16.3	17.1	25.0	21.7	20.2	16.3	6.4	12.4	8.8	12.0
47	144.4	42.4	19.4	30.4	4.2	20.0	16.7	9.0	15.8	6.4	52.2	71.2	22.7	18.4	17.2	22.5	20.7	20.4	17.0	5.4	10.9	9.2	12.0
48	131.5	38.1	14.0	23.6	3.5	18.5	14.4	8.0	13.8	6.9	46.3	64.8	18.6	14.7	14.7	21.3	19.3	17.9	11.2	4.8	10.9	6.5	9.6
49	129.5	35.7	18.3	26.6	4.4	21.7	13.8	8.2	13.3	4.8	49.1	69.2	20.6	13.1	14.9	18.7	19.3	18.6	14.0	5.5	10.8	8.3	10.8
50	123.4	33.6	14.5	23.5	4.0	18.8	13.3	8.0	13.5	4.8	48.6	61.8	19.9	15.3	15.5	20.5	17.5	19.0	12.5	4.6	10.7	6.2	9.5
51	131.4	34.1	15.8	24.6	3.6	17.7	13.5	8.0	12.9	6.0	48.7	67.7	20.1	15.6	13.4	17.4	17.2	16.9	12.7	4.4	10.8	7.2	10.9
52	127.0	34.2	13.3	21.4	3.8	18.4	13.6	7.1	11.6	6.1	46.7	57.8	18.4	14.0	14.6	24.2	16.5	17.3	12.4	4.5	9.8	7.6	9.7
53	162.3	41.9	18.8	30.8	4.6	22.4	16.4	8.1	16.5	7.2	60.1	77.6	26.3	20.4	18.6	28.0	22.3	23.9	16.8	5.3	12.6	10.0	12.0
54	119.0	34.4	15.4	22.6	4.1	17.3	14.2	7.3	12.2	5.3	48.1	62.9	20.4	17.3	15.8	22.1	18.6	18.1	13.8	4.4	10.9	6.8	10.4
55	180.7	47.6	22.5	35.9	5.8	22.6	17.3	9.4	16.6	7.7	71.2	86.4	27.3	22.3	19.7	26.8	24.6	23.9	15.6	6.1	14.0	10.2	15.2
56	121.8	32.7	16.7	23.0	4.0	17.7	13.3	8.6	13.1	4.9	42.4	62.0	18.4	14.7	13.0	26.2	18.5	15.7	12.0	4.0	7.7	7.7	9.3
57	142.0	40.7	18.9	28.0	4.2	22.5	16.0	8.6	15.2	7.0	57.6	66.2	22.7	19.0	17.4	21.7	20.1	20.9	15.0	5.5	11.0	8.5	12.5
58	172.7	47.9	25.5	37.3	5.4	25.1	18.0	9.0	18.4	6.4	65.1	80.1	25.6	21.2	19.2	29.0	23.0	24.0	18.0	6.6	12.6	12.6	16.4
59	151.3	40.7	16.2	30.0	4.2		16.0	9.1	15.0	7.0	52.8	74.7	21.3	18.6	15.0	20.0	19.2	19.8	13.0	5.5	11.8	8.0	12.0
60	137.5	37.9	18.9	27.6	4.3	20.4	15.6	9.0	14.6	7.0	51.3	66.8	21.0	17.2	17.0	21.1	17.7	19.0	12.0	5.0	11.8	6.3	10.0

Morphological data of *G. gecko* collected from Saraburi Province (Cont.)

No.	Morpholgical characters																					
	SVL	HL	HD	HW	IND	IOD	SEL	EYL	EEL	EAL	SAL	AGL	UAL	FAL	HaL	ULL	LLL	FL	TIVL	TIVW	SCL	TD	TW
61	106.5	30.7	14.0	22.2	4.8	17.2	13.8	7.9	10.7	4.5	43.9	56.0	17.0	12.6	12.2	19.1	14.8	15.3	11.4	4.0	8.5	5.8	9.0
62	139.5	43.6	18.8	27.0	4.8	20.9	15.8	9.0	14.8	7.4	53.8	73.6	21.8	17.0	15.7	23.5	19.4	18.7	14.9	5.5	10.3	8.3	10.5
63	136.6	38.0	18.0	28.8	4.4	20.5	14.9	8.5	15.6	6.6	52.9	71.6	21.6	18.6	15.8	22.0	21.2	19.9	15.2	4.8	9.1	8.9	9.4
64	178.9	48.3	26.2	35.9	5.3	25.0	18.8	9.4	19.4	7.7	63.9	82.4	24.8	23.2	17.0	25.9	26.0	23.4	17.5	6.4	12.6	11.2	14.6
65	86.0	24.1	10.3	18.6	3.0	14.2	10.5	6.6	7.9	4.4	38.0	39.9	12.8	11.1	9.4	12.9	12.0	13.6	9.1	3.0	6.9	4.2	6.4
66	160.0	40.9	20.5	30.5	4.9	23.6	16.4	8.7	15.5	7.7	61.6	77.0	24.3	19.2	15.6	30.2	22.1	22.6	15.6	5.0	11.4	10.3	12.6
67	81.0	22.9	9.9	15.6	3.3	12.2	9.9	6.5	6.2	4.1	31.3	35.7	11.6	11.5	8.5	10.2	12.0	11.0	7.9	2.6	5.7	4.2	6.3
68	129.1	37.0	16.2	26.2	3.7	18.1	14.4	8.3	12.7	6.0	49.0	64.6	19.0	13.8	14.8	17.3	16.0	17.5	13.1	4.5	10.0	6.9	9.3
69	177.5	47.9	25.8	36.7	6.0	22.3	18.0	9.3	18.0	8.2	64.2	85.2	27.7	22.6	20.0	25.5	24.3	24.4	18.1	6.5	12.0	13.8	15.7
70	146.7	39.1	18.0	30.5	4.7	22.7	15.0	8.6	15.9	5.3	55.5	75.8	20.9	16.7	14.4	21.4	18.6	20.5	12.6	5.0	11.8	8.4	11.6
71	95.6	26.8	13.7	21.0	3.1	13.0	10.9	6.4	9.2	5.0	34.9	42.2	14.3	10.6	10.0	16.6	14.6	14.0	9.3	3.1	8.2	4.5	6.8
72	85.7	24.3	10.2	18.7	3.0	13.0	10.4	5.9	8.7	4.3	33.6		13.5	10.0	9.7	15.6	12.5	12.2	8.3	2.6	6.6	4.0	5.3
73	163.3	46.0	23.6	36.7	5.4	27.4	17.4	9.5	16.6	5.9	58.7	82.7	24.3	21.3	17.2	23.8	24.0	21.0	15.7	6.4	13.3	12.5	14.7
74	162.0	44.8	25.3	35.0	5.0	26.4	17.1	9.5	17.5	7.1	64.9	79.7	26.4	22.1	20.4	19.7	23.9	23.3	16.4	6.8	13.4	13.4	17.0
75	132.6	36.3	14.4	24.3	4.5	18.8	13.0	7.7	13.3	5.0	45.8	57.7	20.7	16.9	13.2	22.6	19.0	16.8	13.0	4.4	9.4	6.7	10.0

Morphological data of *G. gecko* collected from Saraburi Province (Cont.)

No.	Morpholgical characters																						
	SVL	HL	HD	HW	IND	IOD	SEL	EYL	EEL	EAL	SAL	AGL	UAL	FAL	HaL	ULL	LLL	FL	TIVL	TIVW	SCL	TD	TW
76	143.6	38.4	17.5	28.1	4.2	19.2	15.3	9.5	15.5	6.0	51.0	67.0	21.0	20.2	14.3	23.0	20.4	19.3	13.6	4.8	13.8	7.7	9.0
77	146.3	40.1	20.6	26.7	3.7	18.6	16.0	8.8	15.9	5.4	53.8	73.0	23.2	19.4	15.6	20.9	23.0	19.9	12.9	5.1	11.2	10.5	12.2
78	97.0	29.8	10.8	18.3	3.0	15.6	11.4	7.3	9.3	4.9	36.6	41.3	14.9	12.7	10.3	15.6	16.2	12.7	8.8	3.3	7.7	5.0	8.6
79	154.7	42.9	18.8	28.2	4.7	21.4	15.6	8.8	16.6	6.0	60.0	80.8	24.0	22.1	15.1	23.9	22.5	22.5	17.8	6.3	13.7	9.5	12.9
80	169.5	50.1	23.7	34.0	5.2	25.0	17.2	9.9	20.3	8.2	62.8	89.0	26.9	21.8	18.1	27.2	23.1	24.0	18.3	6.7	14.0	11.2	14.5
81	79.6	24.6	9.6	15.5	2.9	11.6	9.1	5.6	6.8	3.4	33.0	36.5	12.0	10.2	8.2	11.5	11.0	11.9	8.9	2.7	6.5	3.5	5.6
82	113.8	32.3	15.8	22.8	3.9	16.8	13.6	8.1	11.8	6.0	47.9	61.0	18.4	17.2	13.7	22.0	16.7	16.3	13.0	4.5	9.9	6.9	8.8
83	127.7	36.3	16.8	26.1	4.2	18.3	14.7	8.5	12.9	6.3	52.0	67.8	20.6	16.4	14.1	19.2	17.9	17.2	14.4	4.4	12.0	7.1	9.7
84	130.5	37.0	18.0	28.0	3.9	18.7	14.3	9.3	14.1	5.8	48.7	76.3	19.4	16.8	16.3	21.9	19.5	19.5	14.5	4.8	11.7	8.4	11.4
85	132.7	38.1	16.2	25.6	4.1	17.3	14.2	8.2	13.3	6.4	53.1	65.4	19.7	18.4	13.6	19.8	18.8	19.1	13.3	4.6	10.6	6.3	11.0
86	161.9	46.9	23.3	36.6	4.7	20.2	17.2	9.0	17.8	6.8	60.7	77.0	26.6	20.7	19.3	21.9	27.0	23.0	17.0	5.7	15.1	10.2	14.1
87	154.4	42.8	18.9	30.2	4.7	20.9	16.6	9.6	15.2	5.8	54.5	71.5	23.7	19.5	18.7	22.3	24.3	20.0	14.9	4.6	11.9	9.6	12.7
88	177.1	50.6	25.0	38.5	5.2	22.4	18.8	10.3	18.7	9.2	76.7	82.5	26.9	20.5	20.1	28.8	26.0	22.9	17.8	6.0	13.9	13.5	14.2
89	134.9	40.9	17.4	26.6	4.5	18.0	15.2	8.5	13.9	6.4	54.5	65.5	20.9	17.1	14.3	21.4	20.9	17.7	14.7	5.0	11.6	9.1	11.3
90	169.9	46.5	21.1	34.0	4.4	24.2	17.2	9.7	17.4	8.4	62.9	77.5	25.3	22.4	17.6	30.2	23.4	23.8	17.6	6.5	13.9	12.0	12.0

Morphological data of *G. gecko* collected from Saraburi Province (Cont.)

No.	Morpholgical characters																					
	SVL	HL	HD	HW	IND	IOD	SEL	EYL	EEL	EAL	SAL	AGL	UAL	FAL	HaL	ULL	LLL	FL	TIVL	TIVW	SCL	TD	TW
91	138.2	39.5	17.4	27.4	4.6	19.4	15.3	7.9	14.5	5.7	53.4	71.9	20.5	18.0	17.2	22.0	19.9	20.6	14.7	5.4	12.0	7.2	11.3
92	140.8	40.2	18.6	25.5	3.9	18.0	15.2	8.2	14.8	5.5	53.5	63.7	21.7	19.0	16.4	23.3	20.2	21.0	15.6	5.4	13.0	8.5	11.1
93	77.0	23.3	8.0	14.7	2.8	11.2	9.7	5.9	7.2	4.4	33.1	34.6	11.7	10.1	9.6	13.6	14.9	12.0	9.6	2.2	5.3	4.0	5.3
94	170.4	46.9	24.3	32.2	4.6	22.4	16.4	8.9	19.4	6.4	59.9	78.1	26.3	19.2	21.2	24.5	23.6	23.8	19.1	6.6	13.6	10.7	13.4
95	72.3	21.6	7.6	14.7	2.5	10.8	8.2	5.5	6.4	3.9	26.1	30.2	10.7	8.9	8.1	8.6	8.3	10.5	7.8	2.2	5.8	3.6	4.8
96	133.0	38.1	18.0	29.0	4.7	21.3	15.9	7.8	16.0	6.3	49.8	64.1	22.0	17.4	16.5	22.3	20.7	20.4		4.9	11.0	7.8	12.2
97	63.2	19.0	8.6	13.2	2.2	10.5	7.9	5.3	6.8	3.5	28.0	31.0	10.0	8.0	7.2	11.7	8.6	8.3	6.9	2.1	4.6	3.6	5.6

Appendix II

(Foraging data)

Number of foraging geckos in each month

Date	Month											
	Jul-01	Aug-01	Sep-01	Oct-01	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02
1	16	16	13	7	0	7	11	17	13	13	11	18
2	15	18	11	5	9	5	13	14	8	11	19	16
3	17	15	14	5	9	8	10	12	9	9	15	9
4	14	18	11	8	4	7	14	12	13	13	10	14
5	14	12	11	11	7	10	14	13	14	9	14	16
6	15	14	15	6	8	12	11	17	17	10	13	15
7	11	12	11	11	5	8	10	11	14	13	18	15
average	14.57	15.00	12.29	7.57	6.00	8.14	11.86	13.71	12.57	11.14	14.29	14.71
SD	1.90	2.52	1.70	2.57	3.27	2.27	1.72	2.43	3.10	1.86	3.35	2.81

Comparison of the number of foraging geckos in each month

Oneway

Test of Homogeneity of Variances

frequency

Levene Statistic	df1	df2	Sig.
.655	11	72	.775

ANOVA

frequency

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	716.893	11	65.172	10.214	.000
Within Groups	459.429	72	6.381		
Total	1176.321	83			

Post Hoc Tests

frequency

Duncan[a]

		Subset for alpha = .05			
MONTH	N	1	2	3	4
November-01	7	6.00			
October-01	7	7.57			
December-01	7	8.14			
April-02	7		11.14		
January-02	7		11.86	11.86	
September	7		12.29	12.29	12.29
March-02	7		12.57	12.57	12.57
February-02	7		13.71	13.71	13.71
May-02	7			14.29	14.29
July-01	7			14.57	14.57
June-02	7			14.71	14.71
August	7				15.00
Sig.		.138	.093	.070	.086

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 7.000.

Number of prey individuals of *G. gecko*, as observed within seven days of each month at the residential complex, Khao Kheow Open Zoo, Khao Kheow – Khao Chomphu Wildlife Sanctuary, Chonburi Province.

Prey type	Estimated Prey size (cm)	Number of prey individuals												Number of individual prey items	% of individuals prey items
		Jul-01	Aug-01	Sep-01	Oct-01	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02		
Odonatan	4-5		1										2	3	0.86
Orthropteran	0.5-5	5	5	6	3		6	3	1	2	1	14	0	46	13.18
Hemipteran	1-2						1							1	0.29
Coleopteran	0.5-3			1	1		1	1	2	1	5	3	6	21	6.02
Lepidopteran	0.5-5	7	4	25	6	3	2	3	11	38	13	24	8	144	41.26
Hymenopteran	1-2						1			1		3		5	1.43
Isopteran	1-2										5	30	35	70	20.06
Lepidopteran larva	2-3		1				1							2	0.57
Vertebrate	7			1										1	0.29
Unknown	0.5-2	3	3	3	6		4	5	1	7	8	12	4	56	16.05
Overall	0.5-7	15	14	36	16	3	16	12	15	49	32	86	55	349	100.00

Mean, standard deviation and range of individual data in foraging of all *G. gecko*

Individuals (no. of observations)	Sex	SVL	Foraging period (Hour:min)		Time moving (sec per hour)		Foraging attempts (attempts per hour)		Foraging success (% captures)		Foraging distance (m)		Prey size (cm)	
			Mean (Range)	SD	Mean (Range)	SD	Mean (Range)	SD	Mean (Range)	SD	Mean (Range)	SD	Mean (Range)	SD
1 (10)	female	152.0	8:42 (2:56-11:27)	2:45	18.74 (1.69-51.07)	18.27	0.52 (0.00-1.66)	0.54	66.25 (0.00-100.00)	36.53	5.41 (0.1-18.0)	5.17	1.32 (0.5-2.5)	0.51
4 (9)	male	168.0	10:23 (6:51-11:46)	1:39	22.74 (1.10-77.54)	25.96	0.41 (0.00-1.19)	0.46	73.18 (50.00-100.00)	18.19	7.23 (0.2-21.5)	7.63	1.8 (0.5-4.5)	1.08
7 (1)	male	160.0	4:44 (4:44)	-	2.54 2.54	-	0.00 (0.00)	-	-	-	0.30 (0.30)	-	-	-
8 (11)	female	136.1	9:11 (3:18-11:18)	2:45	37.84 (2.71-70.55)	21.79	1.39 (0.11-6.28)	1.78	65.10 (16.67-100.00)	25.96	6.38 (2.0-14.5)	4.03	1.54 (0.5-2.5)	0.46
9 (12)	male	146.2	10:25 (6:34-11:36)	1:18	9.44 (1.46-24.72)	7.21	0.21 (0.00-0.67)	0.21	78.24 (0.00-100.00)	41.65	3.78 (0.1-15.0)	4.05	1.17 (0.5-2.5)	0.69

Mean, standard deviation and range of individual data in foraging of all *G. gecko* (Cont.)

Individuals (no. of observations)	Sex	SVL	Foraging period (Hour:min)		Time moving (sec per hour)		Foraging attempts (attempts per hour)		Foraging success (% captures)		Foraging distance (m)		Prey size (cm)	
			Mean (Range)	SD	Mean (Range)	SD	Mean (Range)	SD	Mean (Range)	SD	Mean (Range)	SD	Mean (Range)	SD
11 (1)	female	146.3	6:26 (6:26)	-	67.93 (67.93)	-	0.31 (0.31)	-	100.00 (100.00)	-	0.70 (0.70)	-	3.00 (1.5-4.5)	2.12
19 (3)	juvenile	87.2	7:43 (4:11-12:44)	3:04	55.72 (46.61-62.50)	8.20	0.69 (0.00-1.67)	0.87	21.43 (0.00-42.86)	30.31	7.00 (4.5-9.0)	2.29	1.00 (0.5-1.5)	0.71
20 (1)	male	155.0	7:11 (7:11)	-	3.48 (3.48)	-	0.00 (0.00)	-	-	-	1.20 (1.20)	-	-	-
21 (6)	male	141.6	9:09 (4:51-12:44)	3:02	18.79 (3.50-26.35)	8.33	0.11 (0.00-0.34)	0.14	58.33 (0.00-100.00)	52.04	3.48 (0.2-5.0)	1.83	1.50 (0.5-2.5)	0.82
22 (3)	female	145.8	7:29 (2:05-10:40)	4:02	22.56 (4.32-42.38)	19.08	0.22 (0.00-0.56)	0.30	25.00 (0.00-50.00)	35.36	9.60 (0.3-24.5)	13.04	3.5 (3.5)	0.00

Mean, standard deviation and range of individual data in foraging of all *G. gecko* (Cont.)

Individuals (no. of observations)	Sex	SVL	Foraging period (Hour:min)		Time moving (sec per hour)		Foraging attempts (attempts per hour)		Foraging success (% captures)		Foraging distance (m)		Prey size (cm)	
			Mean	SD (Range)	Mean	SD (Range)	Mean	SD (Range)	Mean	SD (Range)	Mean	SD (Range)	Mean	SD (Range)
24 (4)	juvenile	88.3	8:37	2:42 (4:35-10:12)	25.35	28.30 (0.49-62.38)	0.33	0.43 (0.00-0.89)	58.34	11.79 (50.00-66.67)	3.83	3.17 (0.3-6.5)	2.10	1.34 (1.5-4.5)
27 (2)	male	160.0	7:46	1:09 (6:57-8:34)	49.43	63.79 (4.32-94.53)	0.43	0.61 (0.00-0.86)	16.67	-	2.05	1.77 (0.8-3.3)	0.5	- (0.5)
28 (2)	female	140.4	5:43	2:37 (3:52-7:34)	8.00	5.15 (4.36-11.64)	0.26	0.37 (0.00-0.52)	50.0	-	1.80	2.12 (0.3-3.3)	1.5	- (1.5)
29 (3)	male	131.1	8:26	2:54 (5:12-10:47)	41.79	26.71 (11.93-63.43)	0.79	0.20 (0.58-0.97)	55.56	29.40 (22.22-77.78)	8.27	5.83 (4.8-15.0)	1.9	1.08 (0.5-4.5)
30 (6)	male	146.4	9:31	2:11 (5:25-11:45)	8.88	13.25 (0.74-35.32)	0.03	0.08 (0.00-0.19)	50.0	70.71 (0.00-100.00)	1.57	2.06 (0.1-5.5)	3.33	3.33 (0.5-7)

Mean, standard deviation and range of individual data in foraging of all *G. gecko* (Cont.)

Individuals (no. of observations)	Sex	SVL	Foraging period (Hour:min)		Time moving (sec per hour)		Foraging attempts (attempts per hour)		Foraging success (% captures)		Foraging distance (m)		Prey size (cm)	
			Mean (Range)	SD	Mean (Range)	SD	Mean (Range)	SD	Mean (Range)	SD	Mean (Range)	SD	Mean (Range)	SD
33 (5)	juvenile	99.5	8:52 (5:52-11:01)	1:54	12.06 (0.68-21.70)	8.37	0.25 (0.00-0.64)	0.26	90.18 (75.00-100.00)	12.16	3.96 (0.1-15.0)	6.23	1.64 (0.5-4.5)	1.34
35 (6)	juvenile	91.7	9:44 (6:00-11:31)	1:56	17.89 (2.98-42.06)	15.58	0.64 (0.00-3.09)	1.22	92.50 (83.33-100.00)	8.77	5.07 (0.9-16.5)	5.90	1.72 (1.5-2.5)	0.42
38 (8)	female	122.2	8:26 (1:05-10:32)	3:10	13.75 (2.11-44.31)	13.21	0.26 (0.09-0.92)	0.28	77.08 (0.00-100.00)	36.66	1.69 (0.1-4.0)	1.51	1.61 (0.5-2.5)	0.60
39 (6)	male	170.0	6:33 (3:40-10:19)	2:55	89.53 37.21-207.29	63.44	1.18 (0.69-1.75)	0.40	81.18 (46.15-100.00)	21.19	20.71 (0.3-38.5)	14.11	1.39 (0.5-2.5)	0.53
40 (8)	male	151.3	7:08 (4:35-9:46)	1:49	42.17 (2:42-88.97)	32.72	0.34 (0.00-0.88)	0.33	74.45 (0.00-38.97)	38.97	14.51 (0.3-25.5)	9.49	1.97 (1.5-3.5)	0.74

Mean, standard deviation and range of individual data in foraging of all *G. gecko* (Cont.)

Individuals (no. of observations)	Sex	SVL	Foraging period (Hour:min)		Time moving (sec per hour)		Foraging attempts (attempts per hour)		Foraging success (% captures)		Foraging distance (m)		Prey size (cm)	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
			(Range)		(Range)		(Range)		(Range)		(Range)		(Range)	
43 (2)	female	124.8	6:55	5:41	55.00	24.14	0.46	0.64	70.00	-	29.05	31.47	1.21	0.49
			(2:54-10:56)		(37.93-72.07)		(0.00-0.91)				97.0-51.5)		(0.5-1.5)	
52 (4)	male	143.7	9:53	0:37	35.26	36.23	1.03	1.15	72.22	4.81	5.63	3.90	1.47	0.78
			(9:24-10:42)		(4.21-81.28)		(0.00-2.55)		(66.67-75.0)		(2.5-11.0)		(0.5-4.5)	
56 (3)	male	139.2	7:20	1:45	13.28	15.57	0.06	0.11	100.00		10.00	11.26	0.5	-
			(5:19-8:23)		(3.37-31.22)		(0.00-0.19)				(3.5-23.0)			
80 (1)	male	166.5	5:42	-	170.35	-	3.16	-	77.78		5.50		2.19	0.95
			(5:42)		(170.35)		(3.16)				(5.50)		(1.5-3.5)	
85 (2)	juvenile	82.8	9:44	1:08	8.79	0.72	0.17	0.24	33.33		0.55	0.21	2.5	-
			(8:56-10:32)		(8.29-10.32)		(0.00-0.34)				(0.4-0.7)		(2.5)	

Mean, standard deviation and range of individual data in foraging of all *G. gecko* (Cont.)

Individuals (no. of observations)	Sex	SVL	Foraging period (Hour:min)		Time moving (sec per hour)		Foraging attempts (attempts per hour)		Foraging success (% captures)		Foraging distance (m)		Prey size (cm)	
			Mean (Range)	SD	Mean (Range)	SD	Mean (Range)	SD	Mean (Range)	SD	Mean (Range)	SD	Mean (Range)	SD
89 (1)	juvenile	65.9	10:14 (10:14)	-	18.86 (18.86)	-	0.59 (0.59)	-	100.00	-	3.50 (3.50)		1.90 (0.5-2.5)	0.89
91 (1)	female	139.2	10:37 (10:37)	-	13.56 (13.56)	-	0.38 (0.38)	-	100.00	-	1.30 (1.30)		0.5 (0.5)	0.0

Foraging data of individuals

Individual number	Sex	Month	Foraging period	Moving time	Foraging attempt per hour	Foraging success per hour	Foraging distance (m)
1	Female	July-01	8.32	5.81	0.12	0	1
		August-01	5.92	2.82	0	0	0.1
		September-01	2.93	3.98	0	0	0.3
		October-01	9.9	19.02	0.81	0.4	4
		December-01	10.92	8.85	0.18	0.18	5.5
		January-02	6.93	29.09	1.15	1.15	5.4
		February-02	8.78	26.19	0.34	0.11	5.4
		March-02	11.13	55.99	0.54	0.54	7.2
		April-02	11.27	75.44	0.44	0.36	18
		May-02	10.87	85.12	1.66	1.1	7.2
4	Male	July-01	6.85	43.07	0.58	0.29	6.5
		August-01	8.55	39.38	0.23	0.23	3
		September-01	11.53	1.88	0	0	3.7
		October-01	10.48	7.95	0	0	1.5
		December-01	10.85	1.84	0	0	0.2
		January-02	11.58	2.73	0	0	0.2
		March-02	11.52	129.23	0.78	0.52	21.5
		April-02	11.77	80.59	1.19	0.85	13.5
		May-02	10.38	30.34	0.87	0.67	15
7	Male	July-01	4.73	4.23	0	0	0.3
8	Female	July-01	9.48	53.78	0.63	0.11	14.5
		August-01	9.67	72.93	0.21	0.21	5
		September-01	10.93	101.07	1.65	1.01	6.6
		October-01	10.1	38.45	0.69	0.4	7

Foraging data of individuals (Cont.)

Individual number	Sex	Month	Foraging period	Moving time	Foraging attempt per hour	Foraging success per hour	Foraging distance (m)
8	Female	December-01	9.42	8.85	0.11	0.11	2
		January-02	10.7	4.52	0.28	0.19	4
		February-02	11.3	59	0.53	0.35	3.3
		March-02	11.08	117.59	0.63	0.45	5.3
		April-02	3.3	70.71	2.12	1.21	4
		May-02	10.72	64.54	2.15	0.65	13.5
		June-02	4.3	102.33	6.28	5.58	5
9	Male	July-01	10.32	6.14	0.19	0.1	3.7
		August-01	10.28	2.43	0	0	0.1
		September-01	9.87	13.68	0.1	0.1	2
		October-01	11.52	10.56	0	0	2
		November-01	11.03	8.76	0.18	0.09	4.5
		December-01	10.63	18.34	0.09	0.09	0.4
		January-02	11.15	6.43	0.18	0.09	3.5
		February-02	11.6	20.55	0.17	0	2.5
		March-02	10.52	41.2	0.67	0.57	15
		April-02	6.57	34.77	0.61	0.61	6.7
		May-02	10.9	20.03	0.28	0.18	4.6
		June-02	10.58	5.98	0.09	0.09	0.4
11	Female	July-01	6.43	113.21	0.31	0.31	0.7
19	Juvenile	July-01	9.2	104.17	0	0	4.5
		August-01	4.18	77.69	1.67	0.72	9
		September-01	9.75	96.75	0.41	0	7.5
20	Male	October-01	7.18	5.8	0	0	1.2

Foraging data of individuals (Cont.)

Individual number	Sex	Month	Foraging period	Moving time	Foraging attempt per hour	Foraging success per hour	Foraging distance (m)
21	Male	November-01	4.85	5.84	0	0	0.2
		December-01	7.33	39.55	0.14	0	5
		March-02	7.62	40.26	0	0	2.5
		April-02	10.62	29.51	0	0	4.5
		May-02	12.72	43.91	0.16	0.16	4.7
		June-02	11.8	28.81	0.34	0.25	4
22	Female	July-01	9.72	34.99	0.1	0	4
		August-01	2.08	7.2	0	0	0.3
		September-01	10.67	70.63	0.56	0.28	24.5
24	Juvenile	July-01	10.08	103.97	0.89	0.6	6.5
		August-01	4.58	53.82	0.44	0.22	2
		September-01	9.62	10.4	0	0	6.5
		October-01	10.2	0.82	0	0	0.3
27	Male	July-01	6.95	157.55	0.86	0.14	3.3
		September-01	8.57	7.2	0	0	0.8
28	Female	August-01	3.87	19.4	0.52	0.26	0.3
		January-02	7.57	7.27	0	0	3.3
29	Male	July-01	5.2	83.33	0.58	0.38	15
		August-01	10.78	105.72	0.83	0.19	5
		September-01	9.3	19.89	0.97	0.75	4.8
30	Male	July-01	5.42	1.23	0	0	0.1
		September-01	10.53	58.86	0.19	0.19	5.5
		October-01	9.85	9.48	0	0	0.5
		November-01	9.12	2.56	0	0	0.6

Foraging data of individuals (Cont.)

Individual number	Sex	Month	Foraging period	Moving time	Foraging attempt per hour	Foraging success per hour	Foraging distance (m)
30	Male	December-01	10.38	3.21	0	0	0.5
		February-02	11.75	13.48	0	0.17	2.2
33	Juvenile	August-01	7.65	30.72	0.13	0.13	1
		September-01	9.93	13.26	0.1	0.1	2.5
		October-01	10.15	19.21	0.39	0.3	1.2
		November-01	5.87	1.14	0	0	0.1
		March-02	11.02	36.16	0.64	0.54	15
35	Juvenile	August-01	10	27.83	0.1	0.1	1.5
		September-01	10.47	51.59	0.57	0.48	6
		November-01	10.75	4.96	0.09	0.09	0.9
		December-01	6	16.11	0	0	3.7
		May-02	9.7	70.1	3.09	2.68	16.5
		June-02	11.52	8.25	0	0	1.8
38	Female	August-01	9.5	17.72	0.11	0.11	0.8
		November-01	8.88	15.76	0.23	0.11	0.1
		December-01	7.1	9.62	0.14	0.14	3.7
		January-02	9.98	3.51	0.1	0.1	0.3
		February-02	1.08	73.85	0.92	0.92	4
		April-02	10.35	25.28	0.29	0.19	0.6
		May-02	10.53	26.9	0.09	0	2
		June-02	10.08	10.74	0.2	0.2	2
39	Male	September-01	7.42	62.02	1.75	0.81	0.3
		December-01	9.47	81.51	1.16	1.06	11.5
		March-02	3.67	166.82	0.82	0.82	16

Foraging data of individuals (Cont.)

Individual number	Sex	Month	Foraging period	Moving time	Foraging attempt per hour	Foraging success per hour	Foraging distance (m)
39	Male	April-02	4.07	345.49	1.48	1.23	26
		May-02	10.32	159.29	1.16	0.78	38.5
		June-02	4.37	80.15	0.69	0.69	32
40	Male	July-01	7.3	75.11	0.14	0	4.5
		August-01	4.58	123.27	0.44	0.44	20.5
		October-01	5.83	19.14	0.51	0.34	16
		December-01	9.77	27.47	0.1	0.1	6.3
		February-02	6.6	4.04	0	0	0.3
		April-02	5.67	148.24	0.88	0.71	23
		May-02	9.35	119.79	0.64	0.64	20
		June-02	8	45.21	0	0	25.5
42	Female	July-01	2.88	49.13	0.35	0.35	12.5
43	Female	January-02	2.9	63.22	0	0	7
		April-02	10.93	120.12	0.91	0.64	51.5
52	Male	October-01	10.7	14.17	0.28	0.19	6
		December-01	9.98	7.01	0	0	2.5
		February-02	9.43	78.45	1.27	0.95	3
		March-02	9.4	135.46	2.55	1.91	11
56	Male	October-01	5.32	52.04	0.19	0.19	23
		November-01	8.32	5.61	0	0	3.5
		March-02	8.38	8.75	0	0	3.5
80	Male	May-02	5.7	283.92	3.16	2.46	5.5
85	Juvenile	May-02	8.93	13.81	0.34	0.11	0.7
		June-02	10.53	15.51	0	0	0.4

Foraging data of individuals (Cont.)

Individual number	Sex	Month	Foraging period	Moving time	Foraging attempt per hour	Foraging success per hour	Foraging distance (m)
89	Juvenile	June-02	10.23	31.43	0.59	0.59	3.5
91	Female	June-02	10.62	22.61	0.38	0.38	1.3

Biography

Miss Anchalee Aowphol was born on the 4th of September, 1976 in Saraburi Province. She recieved her bachelor's degree of science in biology in 1998 from the Department of Biology, Faculty of Science, Chulalongkorn University. She continued her graduate study for master's degree of science in Zoology at the same institute in 1999. She was awarded the Scholarship from the Development and Promotion of Science Talents program (DPST) throughout her study at Chulalongkorn University.