京都大学教育研究振興財団助成事業
成　果　報　告　書

令和6 年　7月　5日

公益財団法人京都大学教育研究振興財団
会 長　藤　　洋 作　様

所属部局・研究科　理学研究科

職 名・学 年　博士課程二年

氏　　名　柳 拓明

助成の種類	**令和6年度　・　国際研究集会発表助成**	
研究集会名	Snake Ecology Group Ⅶ, SSAR 2024	
発表形式	□ 招待 ・ □ 口頭 ・ ■ ポスター ・ □ その他(	
発表題目	The specialization of the head morphology and the feeding behavior in earthworm eating snakes. Is the climbing ability related to the different dietary dietary patterns between two bird-eating snakes?	
開催場所	アメリカ・ウィスコンシン州・ウィンター、ミシガン州・アナーバー	
渡航期間	2024 年 6 月 21 日　～　2024 年 7 月 4 日	
成果の概要	**タイトルは「成果の概要／報告者名」として、A4版2000字程度・和文で作成し、添付して下さい。「成果の概要」以外に添付する資料　□ 無　□ 有(　　)**	
会計報告	交付を受けた助成金額	350000円
	使用した助成金額	350000円
	返納すべき助成金額	0円
	助成金の使途内訳	費　目 / 金額(円)
		航空運賃 252,700
		宿泊費 61,290
		滞在費
		学会参加費 39,778
		その他
		以上に助成金を充当
当財団の助成について	(今回の助成に対する感想、今後の助成に望むこと等お書き下さい。助成事業の参考にさせていただきます。) 初めての国際学会で様々な研究者と出会う機会になり、とても有意義であった。今回は2つの学会に参加したため、滞在期間が長く、金額的には少し足りなかったがとても助かった。	

成果概要 /柳　拓明

今回の出張では 6 月 22 日から 25 日まで Snake Ecology Group（ウィスコンシン州ウィンター)、27 日から 30 日まで SSAR（ミシガン州アナーバー）の学会にそれぞれ参加した。Snake Ecology Group はヘビ類の生態をテーマにした非常に専門性の高い学会であり、SSAR は爬虫・両生類学を中心としたより規模の大きい学会であった。Snake Ecology Group では、私の博士課程の研究テーマであるリュウキュウアオヘビの頭部形態や捕食行動をテーマに発表した。一方、SSAR ではサブテーマで行っていたアオダイショウとシマヘビの登攀能力の比較について発表した。発表時間はどちらも一時間程しかなく、ディベイトできる機会は限られていたが、その後の懇親会で多くの研究者と意見交換することができた。英語で相手の質問を聞いたり答えたりすることが難しく、上手く意思疎通できないときもあったが、非常に良い経験ができた。さらに申請者の研究室の共同研究者とも会うことができ、今後の研究方針についても議論することができた。

日本ではヘビ類の生態を中心に活動している研究者はほとんどいないが、アメリカにはたくさんのヘビ研究者がおり、保全活動なども盛んに行われていることを知った。特に SNS などを活発に利用して一般市民に情報を公開しつつ寄付を募って保全や研究活動を実施している研究室が多かったのが印象的であった。日本ではヘビ類などのマイナーな生物の保全や基礎研究は遅れているが、それらの重要性を理解してもらうためにも一般市民との情報共有がとても大切だと改めて感じた。

また、学会には付属のエクスカーションや博物館見学、オークションなどもあり、他の研究者たちと共にそれらを楽しむことができた。エクスカーションでは学会会場周辺でヘビ類を始めとする生物を探し、大きなカミツキガメやシシバナヘビなども見ることがでた。アメリカは世界一爬虫・両生類の研究が盛んな国であるため、多くの爬虫・両生類の行動や形態の機能、系統関係などが明らかになっており、それらを実際に現地で観察できたことは今後研究を進めていく上でも大きな財産になるだろう。博物館見学ではアメリカの種だけでなくアジアやオーストラリアに生息する希少な種の標本も拝見することができ、大きな感銘を受けた。私はこれまでの研究活動で国内の様々な博物館を訪れたが、多くの博物館で標本の管理がずさんであり、状態の悪いものや紛失して見つからないものなどが多々あった。我が国の研究水準を高め、国際的に活躍できる研究者を増やすためにも博物館を充実させていくことは重要であると感じた。オークションでは入手が難しい爬虫両生類の専門書を安価で購入することができた。今後はこれらの本を用いて輪読会を実施し、研究室のメンバーと共に互いに知識を高め合いたいと考えている。

穴を掘るために鼻先が尖っている
シシバナヘビ

【発表内容】

Snake Ecology Group

The specialization of the head morphology and the feeding behavior in earthworm-eating snakes.

Yanagi Hiroaki (Kyoto university)

Introduction

Predators have head morphology and feeding behavior adapted to their feeding habits (Lillywhite, 2014). Snakes are interesting subjects for the study of foraging traits because they have no limbs and swallow their prey whole (Mori and Vincent, 2008). In snakes, earthworm-eating habits have evolved independently many times. However, specialization of feeding traits for earthworms has been poorly studied.

Cyclophiops is a group of earthworm-eating snakes. Recent molecular phylogenetic analysis revealed that *Cyclophiops* is included in *Ptyas*, a vertebrate-eating group (Figueroa et al., 2016). Earthworm feeding habits probably have evolved multiple times in the *Ptyas* clade. Therefore, comparison of foraging traits among these species provides a better understanding of their adaption to the earthworm-eating habits.

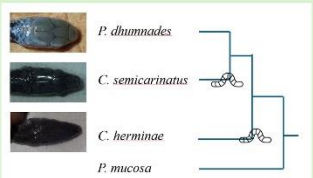


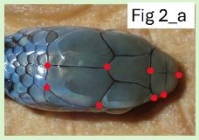
Fig 1. Phylogenetic relationship and head morphology in *Cyclophiops* and *Ptyas*

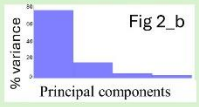
I compared head morphology of *Cyclophiops* and *Ptyas* (Fig. 1) and observed feeding behavior of *C. semicarinatus* in captivity.

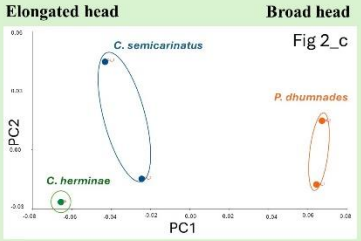
Study of head morphology

Materials and methods

- Two juveniles of *P. dhumnades,* two juveniles of *C. semicarinatus* and a juvenile of *C. herminae* were examined.
- Landmarks were placed between the scales of the snake's head (Fig. 2a).
- Compared the head morphology by geometric morphometrics and principal component analysis.







Results

The two species of *Cyclophiops* and *P. dhumnades* were clearly discriminated by PC1 (Fig. 2c).
PC1 was primarily associated with variations in the position of the nasal tip and the width of the head.
Cyclophiops has a long nose and thin head. On the other hand, *Ptyas* has short nose and wide head.

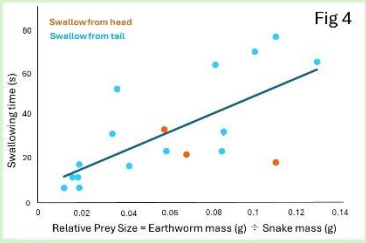
Discussion

Cyclophiops searches for earthworms by thrusting the head beneath the leaf litter layer. The elongated head shape is considered to be adaptive for this foraging behavior. However, the shape likely restricts the gape size, limiting to swallow large prey whole.
In the future, I will increase the sample size and use CT scan to compare the skull morphology.

Study of feeding behavior

Materials and methods

- Recorded 20 predation by five adults of *C. semicarinatus* in captivity
- Analyzed first bite position, swallowing time and swallowing direction
- Breeding environment: 23–28 °C, 60 cm × 30 cm



Results

The bite position when captured would be random (Fig. 3; p=0.522). Swallowing time would correlate with the relative prey size. *Cyclophiops semicarinatus* is able to swallow earthworms very quickly (Fig. 4).

In the typical swallowing style of snakes, they use reciprocating, unilateral cycles of protraction and retraction of the palatomaxillary arches to rachet themselves forward over their prey (pterygoid walk) (Kley and Brainerd, 2002). During swallowing, *C. semicarinatus* dose not move the palatomaxillary arches much and shakes the head with opening mouth (Mov. 1).

Discussion

Because an earthworm has little ability to escape and resist, *C. semicarinatus* would not need to hold it tightly during swallowing. I predict that *C. semicarinatus* glide forward over the earthworm in the neck region by not holding.

Acknowledgements: I would like to thank The Kyoto University Foundation for providing the travel funding that enable me to attend this conference.

SSAR

Is the climbing ability related to the different dietary patterns between two bird-eating snakes?

Yanagi Hiroaki (Kyoto University)

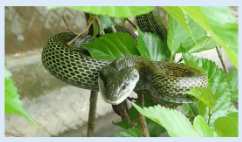
Introduction

Predators are necessary to have an appropriate locomotion ability for foraging habit.
The difference of locomotion ability would affect dietary patterns.

Two bird eating snakes are present in the main islands of Japan: *Elaphe climacophora* and *E. quadrivirgata.* The former is a specialist that feeds on endotherms and preys on various birds. On the other hand, the latter is a generalist that feeds on ectotherms and endotherms, including birds, but only those nest on the ground (Hamanaka et al., 2014).

I hypothesized that *E. climacophora* has superior climbing ability than *E. quadrivirgata*.

Materials and Methods



E. climacophora

E. quadrivirgata

Experiment 1: Adult snakes were allowed to climb the corner of the laboratory walls (210 cm) and their maximum heights they reached were measured.

- Eight individuals of *E. climacophora* and seven individuals of *E. quadrivirgata* were used.
- The corner of the wall was made at an inside angle of 60 degrees and sandpaper was installed to prevent slipping.

Experiment 2: Adult snakes were allowed to climb the tree trunk (*Cedrus libani*) and their climbing speed was measured.

- Five individuals were used for each species.
- The speed was calculated based on the time it took to climb one meter.

Experiment 3: Hatchling snakes were allowed to climb the corner of the laboratory walls (40 cm) and their maximum heights they reached were measured.

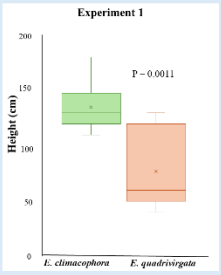
- Nine individuals were used for each species.
- The corner of the wall was made at an inside angle of 90 degrees and sandpaper was installed to prevent slipping.

Results

Experiment 1

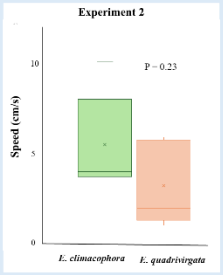
Elaphe climacophora was able to climb significantly higher than *E. quadrivirgata* (p=0.0011).

Both species attempted to climb with hooking the keels on the lateral ridge of the ventral scales on sandpaper. However, *E. quadrivirgata* was less able to support its body than *E. climacophora*, either taking longer to climb or falling during the process.



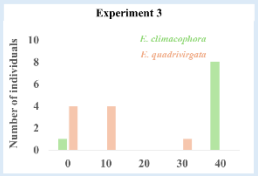
Experiment 2

Elaphe climacophora climbed the tree faster on average than *E. quadrivirgata*, but no significant differences was found (p=0.23).



Experiment 3

The maximum height climbed by *E. climacophora* was significantly higher than that of *E. quadrivirgata* (p = 0.0013).



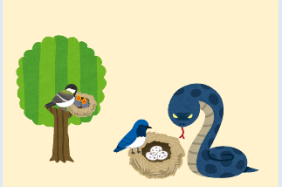
Discussion

The results indicate that *E. climacophora* has the superior climbing ability than *E. quadrivirgata.*

Because the differences were also observed in hatchlings, the superior climbing ability of *E. climacophora* would be an innate trait.

In morphological aspects, the well-developed lateral ridge keels on the ventral scales (Matsui and Mori, 2021), which *E. quadrivirgata* does not have, would cause the difference of the climbing ability between the two snake species.

Because *E. quadrivirgata* is not adept at climbing, the snake probably would not be able to access to bird eggs and nestlings on trees and thus exploits only birds that nest on or near the ground.



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