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Research Article

NEW DISTRIBUTION RECORDS AND MORPHOLOGICAL INSIGHTS OF *Lygosoma angeli* (Smith, 1937) IN SOUTHERN VIETNAM

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ABSTRACT

This study reports new locality record of three specimens of Lygosoma angeli (Smith 1937) from Bu Gia Map National Park, Dong Nai Province, southern Vietnam. Notably, this site is geographically closer to the only known record in Cambodia than to any previously documented localities in Vietnam. This study also provides expanded morphological data, including both meristic and mensural characters, as well as color descriptions. Some variations in mensural characters, particularly head width and head depth, were observed in the three specimens compared with previously published data. Additionally, this study discusses the species' potential distribution based on "Research Grade" public observations on iNaturalist, which suggests a broader range in Vietnam and Cambodia. Finally, the need for genetic analysis is highlighted to clarify population-level diversity and to assess the possibility of a distinct species occurring in the western part of the Mekong region.

Keywords: iNaturalist; *Lygosoma angeli;* New distribution

1. Introduction

The genus *Lygosoma* (Hardwick & Gray, 1827) is a diverse genus formerly widespread across Asia and Africa. Recent taxonomic revisions have restricted the genus to 16 species,

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all of which occur in Southeast Asia, except for *L. singha* (Taylor, 1950) in Sri Lanka (Freitas et al., 2018; Taylor, 1950). Four species are currently recognized in Vietnam: *L. angeli* (Smith 1937), *L. boehmei* Ziegler, Schmitz, Heidrich, Vu & Nguyen, 2007, *L. corpulentum* Smith 1921, and *L. siamense* Siler, Heitz, Davis, Freitas, Aowphol, Termprayoon & Grismer, 2018 (Poyarkov et al., 2023).

Lygosoma angeli was originally described from a specimen from "Trang-Bom, Bien-Hoa" (now Trang Bom, Dong Nai Province) (Smith, 1937). The species is currently known to occur in Vietnam, Cambodia, Laos, and Thailand (Uetz et al., 2024). However, its distribution remains poorly understood, perhaps due to its burrowing behavior, which allows it to evade detection (Neang et al., 2015). In Vietnam, the species has been documented only in Dong Nai and Ba Ria – Vung Tau Province (now belonging to Ho Chi Minh City) (Geissler et al., 2011).

Citizen science platforms like iNaturalist have become valuable tools for biodiversity research, enabling users to record, share, and identify species observations (Cecco et al., 2021; Mesaglio & Callaghan, 2021; Tran et al., 2024). Understanding species distribution is critical for conservation assessment and biogeography studies, particularly for poorly known or data-deficient species. By leveraging such data and recent field surveys, new records of *L. angeli* from Bu Gia Map National Park in Dong Nai Province are presented, along with expanded morphological data and additional records from Dak Lak and Tay Ninh provinces.

2. Materials and methods

Three adult specimens (BGM 001-003) were collected by Khuong on 19th October 2024, beneath rock and leaf litter layers in the evergreen forest of the Bu Gia Map Botanic Garden, Bu Gia Map National Park (12°04'23.0"N, 107°09'21.0"E; 402 m a.s.l.). The specimens were preserved in 70% ethanol in the zoological collection of Bu Gia Map National Park.

Identification was based on the meristic and mensural characters described by Geissler et al. (2011) and Siler et al. (2018). Measurements taken using a digital caliper with a precision of 0.1 mm. Paired meristic counts are given as left/right values. Additional, morphological traits not previously recorded include midbody width (MBW: measured from lateral surface to opposing lateral edge at midpoint of axilla–groin region), midbody depth (MBD: measured from ventral surface to dorsal surface at midpoint of axilla–groin region), tail width (TW: measured at widest section of tail posterior to hemipenis bulge), tail depth (TD: measured from ventral to dorsal surface of tail at the same point as tail width), eye diameter (ED: at widest point), eye–narial distance (END: from anterior margin of eye to posterior margin of nares), snout length (SNL: from anterior margin of eye to tip of snout), internarial distance (IND: from dorsal aspect between most laterally distal edges of nares),

frontal length, frontoparietal length (Figure 1), axilla–groin scale-row count (AGSR: number of scale rows counted between posterior edge of forelimb insertion and anterior edge of hindlimb insertion), and finger III lamellae count (F3lam: number of enlarged, undivided lamellae beneath Finger III).

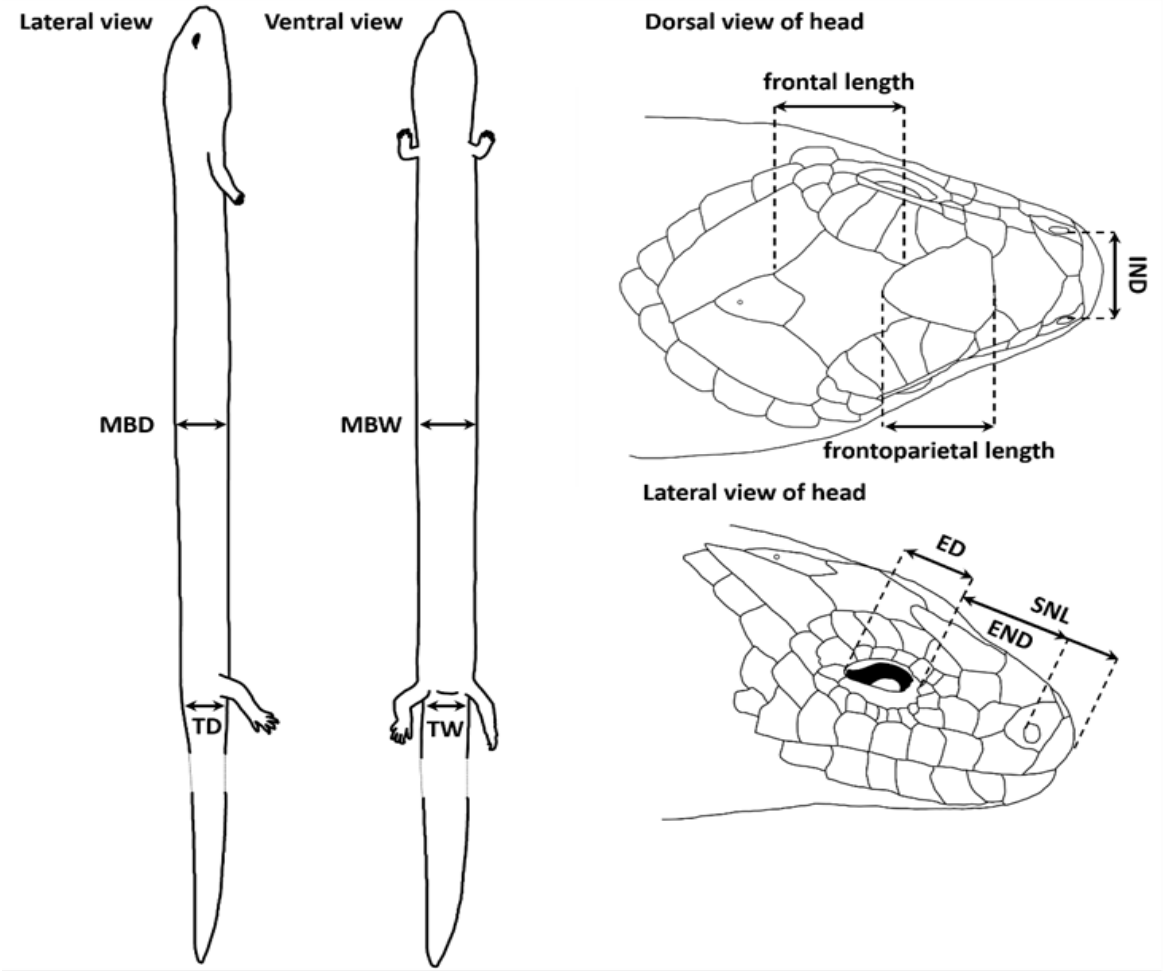

Figure 1. *Illustrations of mensural characters not previously recorded for L. angeli*

To generate the distribution map, data from our findings were combined with iNaturalist records (https://www.inaturalist.org/, accessed on 30 November 2024) and previously published data from Bobrov (1992), Teynié (2004), Geissler et al. (2011), Cota et al. (2011), Neang et al. (2015), and Le et al. (2021). Maps were created using QGIS and enhanced with PowerPoint and Relief Map (Figure 2). Only "Research Grade" and identifiable, recognizable iNaturalist observations were included (https://www.inaturalist.org/observations?taxon_id=38104. Accessed on 30 November 2024).

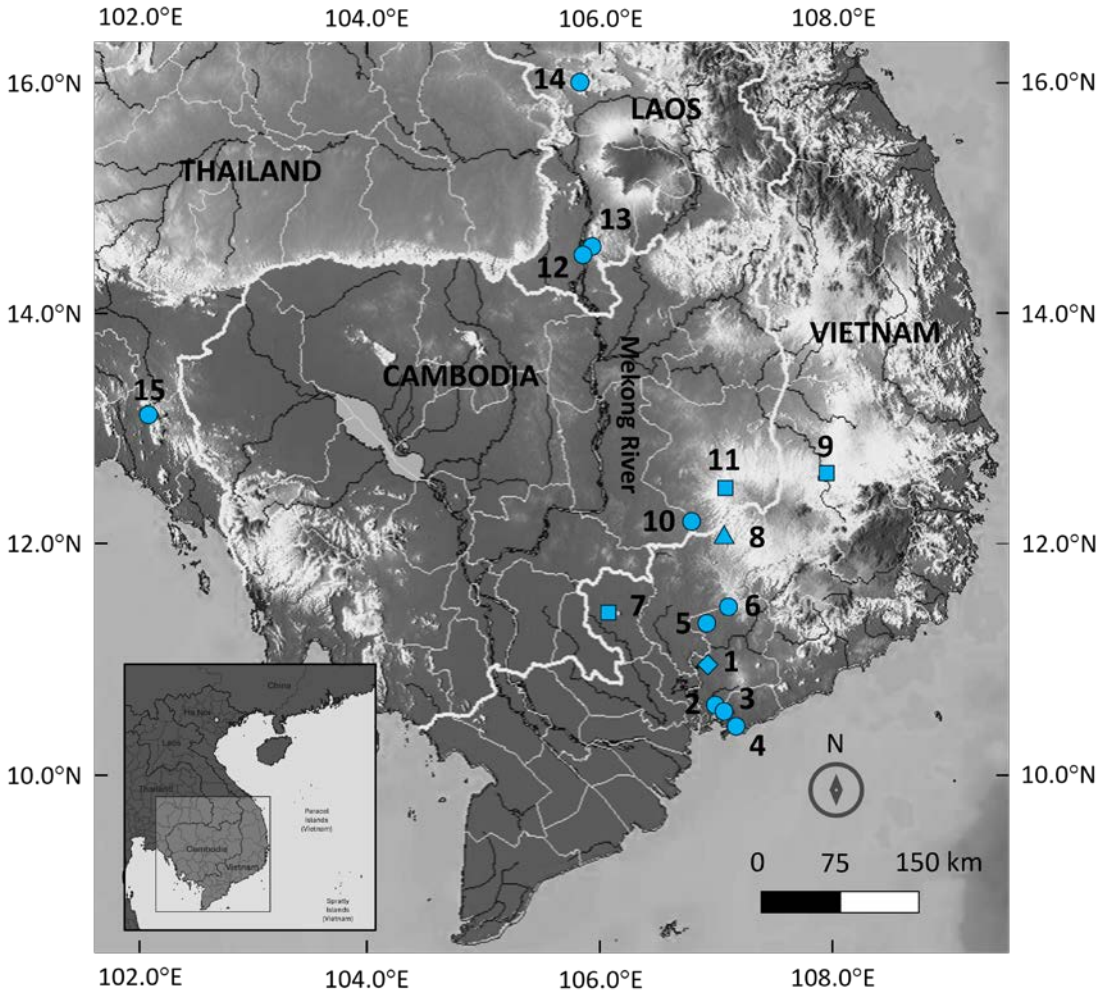

Figure 2. *Map showing distribution of Lygosoma angeli from literature (circle), iNaturalist (square), and new records (triangle). Vietnam: 1 = type locality (diamond), Trang Bom, Dong Nai Province; 2 = Thi Vai Mountain, Ba Ria – Vung Tau Province (now Ho Chi Minh City); 3 = Nui Dinh, Ba Ria – Vung Tau Province (now Ho Chi Minh City); 4 = Minh Dam Mountain, Ba Ria – Vung Tau Province (now Ho Chi Minh City); 5 = Ma Da Nature Reserve, Dong Nai Province; 6 = Cat Tien National Park, Dong Nai Province; 7 = iNaturalist (68600132), Ba Den Mountain, Tay Ninh Province; 8 = Bui Gia Map National Park, Binh Phuoc Province (now Dong Nai Province); 9 = iNaturalist (180730123), Buon Ma Thuoc City, Dak Lak Province. Cambodia: 10 = Seima Biodiversity Conservation Area, Mondulkiri Province; 11 = iNaturalist (119585171), Saen Monourom, Cambodia. Laos: 12 = Xepian NBCA, Champasak Province; 13 = Xe Paine, Champasak, Laos; 14 = Nam Phak River, Dong Hua Xao NBCA. Thailand: 15 = Khao Soi Dao Wildlife Sanctuary, Chanthaburi Province.*

3. Results and discussion

Identification: Morphological examinations confirmed that three specimens matched the description of *Lygosoma angeli* by Smith (1937) and Geissler et al. (2011). The morphological characteristics of the specimens have been summarized in Table 1S. However, the population exhibits several measurement differences from the description provided by Geissler et al. (2011), most notably in head width (6.4-7.9 mm and 7.1 ± 0.5 mm vs 4.8-6.2 mm and 5.6 ± 0.5 mm); head depth (5.9-7.2 mm and 6.5 ± 0.4 mm vs 4.0-4.8 mm and 4.4 ± 0.4 mm).

Color in life (Figure 3): The dorsum is light brown with black dots at the base of each scale, edged in cream, forming a reticulated pattern.

Figure 3. *An adult Lygosoma angeli (ITBCZ 11185) in life*

Color in preservative: The dorsum is light brown; the basal black blotch is visible on each scale; and the ventral side is much lighter with smaller blotches.

Since the redescription by Geissler et al. (2011), *L. angeli* has been verified in Vietnam and Laos, with additional potential records from eastern Cambodia and central Vietnam. This hypothesis was later supported by the findings of Neang et al. (2015) and by the results of the present study (see Figure 2). Records from eastern Thailand (Cota et al., 2011) suggest a broader distribution across Cambodia. However, the absence of documented sightings from central Cambodia may be due to the species' secretive behavior and rarity (Geissler et al., 2011). The variations observed in the specimens of this study are likely due to microenvironmental factors, such as temperature, precipitation, and latitude, which have driven adaptive morphological changes (Calsbeek et al., 2006; Wei et al., 2018).

Despite nearly 90 years having passed since the original description of *L. angeli*, genetic data for the species remain entirely unavailable. It is also possible that the previously recorded populations may harbor cryptic species. Additionally, the Mekong River has been proposed as a significant biogeographic barrier for some animal taxa (Meijaard & Groves,

2006; Tantrawatpan et al., 2011). For herpetofauna, Geissler et al. (2015) concluded that the Mekong Delta functions as a biogeographical barrier for amphibian species in southern Indochina. Currently, no clear evidence demonstrates that the Mekong River acts as a biogeographical barrier for reptiles. However, some studies show that some reptile species exhibit genetic and species-level divergence between the west and east of the Mekong River. For instance, *Sphenomorphus annamiticus* exhibits clear genetic differentiation between populations in the west and east of the Mekong River (Grismer et al., 2021). Another case is observed in *Calotes mystaceus* complex, where *C. mystaceus* is distributed west of the Mekong River, while its sister species, *C. bachae*, is restricted to the east (Hartmann et al., 2013). These factors give rise to the hypothesis that the populations of *L. angeli* in Thailand (western of the Mekong) and those in Vietnam, Laos, and eastern Cambodia (eastern of the Mekong) probably represent two distinct species, with the Mekong River serving as a biogeographic barrier separating them.

4. Conclusion

In this study, a new record of *Lygosoma angeli* is reported from Bu Gia Map National Park, Dong Nai Province, Vietnam, together with an expansion of the species' morphological dataset based on three specimens from the park. In addition, the species' potential distribution is discussed using public observations on iNaturalist, which suggest a broader range in Vietnam and Cambodia, and the study highlights the need for genetic data to clarify population-level diversity. Therefore, further field research and genetic analysis of *Lygosoma angeli* populations, especially from type series (MNHN-RA 1937.0021, in Paris Museum) of new voucher in type locality should be conducted to show a comprehensive look on all population of the species.

❖ ***Conflict of Interest:*** *Authors have no conflict of interest to declare.*

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GHI NHẬN MỚI VỀ PHÂN BỐ VÀ HIỂU BIẾT VỀ HÌNH THÁI CỦA *Lygosoma angeli* (Smith, 1937) PHÍA NAM VIỆT NAM

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TÓM TẮT

Nghiên cứu này báo cáo ghi nhận địa điểm mới từ ba mẫu vật Lygosoma angeli (Smith, 1937) tại Vườn Quốc gia Bù Gia Mập, tỉnh Đồng Nai, miền Nam Việt Nam. Đáng chú ý, vị trí này có khoảng cách địa lí gần hơn với ghi nhận duy nhất được biết đến tại Campuchia so với các địa điểm khác ở Việt Nam. Nghiên cứu này cũng cung cấp dữ liệu hình thái mở rộng, bao gồm các đặc điểm đo đếm mới, cùng với mô tả về màu sắc. Các đặc điểm hình thái đo đạc, đặc biệt là chiều rộng và chiều sâu đầu đã ghi nhận ở ba mẫu vật có một số khác biệt so với dữ liệu đã biết. Ngoài ra, chúng tôi thảo luận về tiềm năng phân bố của loài dựa trên các quan sát công khai đạt chuẩn "Research Grade" trên nền tảng iNaturalist, đưa ra phạm vi phân bố rộng hơn ở Việt Nam và Campuchia. Hơn nữa, việc nhấn mạnh các nghiên cứu di truyền để làm rõ sự đa dạng ở cấp độ quần thể và đánh giá khả năng hiện diện một quần thể loài riêng biệt ở phía Tây sông Mekong là cần thiết.

Từ khóa: iNaturalist; phân bố mới; *Lygosoma angeli*

APPENDIX

Table 1S. *Morphological comparison of Lygosoma angeli between data provided by Geissler et al. (2011) and this study's specimens*

Morphological characteristics	**ITBCZ 11185**	**ITBCZ 11186**	**ITBCZ 11187**	***L. angeli* (n=6) (Geissler et al., 2011)**
SVL	88.1	86.4	111.7	76-112 (97.3 ± 12.6)
AGD	68.1	65.6	89.2	55,8-85,4 (71.7 ± 10.7)
SFlL	17.3	16.6	20.4	15,9-21,4 (18.5 ± 2.2)
MBW	7.4	7.6	9.4	-
MBD	7.2	6.8	7.0	-
TaL	76,3(*)	87.7	76,0(*)	55.4-86.3

(* regenerated)				(67.9 ± 14.0)
TW	5.9	5.6	6.7	-
TD	5.1	4.6	6.4	-
HL	10.8	9.9	12.1	9,4-12,1 (10.5 ± 1.0)
HW	7.1	6.4	7.9	4,8-6,2 (5.6 ± 0.5)
HD	6.5	5.9	7.2	4,0-4,8 (4.4 ± 0.4)
ED	1.6	1.6	1.8	-
END	2.7	2.7	3.2	-
SNL	3.7	3.7	5.1	-
IND	1.9	1.7	2.3	-
Frontal length	2.4	2.2	2.8	-
Frontoparietal length	2.4	2.6	2.8	-
FlL: from axilla to palm	4.5	3.9	5.1	4,3-5,5 (4.9 ± 0.4)
FLL: forelimb length	5.7	6.1	6.3	-
HlL: from groin to palm	5.9	5.9	6.9	6,4-8,4 (7.4 ± 0.7)
HLL: hind-limb length	8.8	9.7	10.2	-
Head	indistinct from neck	indistinct from neck	indistinct from neck	indistinct from neck
Snout	short and obtuse	short and obtuse	short and obtuse	short and obtuse
Rostral	wider than high, visible from above	wider than high, visible from above	wider than high, visible from above	wider than high, visible from above
Lower eyelid	Scaly, separated from the supralabials by a row of small scales	Scaly, separated from the supralabials by a row of small scales	Scaly, separated from the supralabials by a row of small scales	scaly, with 4 enlarged transparent scales, separated from the supralabials by a row of small scales
MBSR	29	29	30	30
Dorsal scales	smooth	smooth	smooth	smooth
PVSR	115	116	116	107-115
AGSR	95	87	94	-
V: ventrals	112	118	118	112-123
Finger III lamellae count	4/4	5/5	6/5	-
Finger IV lamellae count	4/4	5/5	6/6	5

Toe IV lamellae count	6/6	7/7	7/7	6-7
Nasal	in contact with rostral, first supralabial, anterior loreal and supranasal	in contact with rostral, first supralabial, anterior loreal and supranasal	in contact with rostral, first supralabial, anterior loreal and supranasal	in contact with rostral, first supralabial, anterior loreal and supranasal
Loreals	2/2	2/2	2/2	2, anterior higher
Supranasal	in contact	in contact	in contact	in contact
Presuboculars	3/3	3/3	3/3	3
Postsuboculars	3/3	3/3	3/3	3
Frontonasal	wider than long, in contact with supranasal anterior loreal, prefrontal, frontal	wider than long, in contact with supranasal anterior loreal, prefrontal, frontal	wider than long, in contact with supranasal anterior loreal, prefrontal, frontal	wider than long, in contact with supranasal anterior loreal, prefrontal, frontal
Prefrontal	small, widerly separate by frontal and touching both loreals	small, widerly separate by frontal and touching both loreals	small, widerly separate by frontal and touching both loreals	small, widerly separate by frontal and touching both loreals
Frontal	as long as frontoparietal, as wide as long, narrowing posteriorly, in contact with frontaonasals, frefrontal, first and second supraoculars and frontoparietal	as long as frontoparietal, as wide as long, narrowing posteriorly, in contact with frontaonasals, frefrontal, first and second supraoculars and frontoparietal	as long as frontoparietal, as wide as long, narrowing posteriorly, in contact with frontaonasals, frefrontal, first and second supraoculars and frontoparietal	as long as frontoparietal, as wide as long, narrowing posteriorly, in contact with frontaonasals, frefrontal, first and second supraoculars and frontoparietal
Frontoparietal	single, wider than long, bordered posteriorly by parietals an interparietal	single, wider than long, bordered posteriorly by parietals an interparietal	single, wider than long, bordered posteriorly by parietals an interparietal	single, wider than long, bordered posteriorly by parietals an interparietal
Interparietal	small, narrowing posteriorly and bordered by two parieltals and frontoparietal and a small transparent spot in the posterior angle	small, narrowing posteriorly and bordered by two parieltals and frontoparietal and a small transparent spot in the posterior angle	small, narrowing posteriorly and bordered by two parieltals and frontoparietal and a small transparent spot in the posterior angle	small, narrowing posteriorly and bordered by two parieltals and frontoparietal and a small transparent spot in the posterior angle

Parietal	in contact behind the interparietal, lateroposterior margin of parietal bordered by 4-5 scales	in contact behind the interparietal, lateroposterior margin of parietal bordered by 3-5 scales	in contact behind the interparietal, lateroposterior margin of parietal bordered by 4 scales	in contact behind the interparietal, lateroposterior margin of parietal bordered by 4-5/4-5 scales
Primary temporals	2/2	2/2	2/2	2
Secondary temporals	2/2	2/2	2/2	3
Tympanum	deeply sunk	deeply sunk	deeply sunk	deeply sunk
Postsuboculars	3/3	3/3	3/3	3
Nuchals	absent	absent	absent	absent
Mental	wider than long, round anteriorly, in contact with postmental and first infralabial on each side	wider than long, round anteriorly, in contact with postmental and first infralabial on each side	wider than long, round anteriorly, in contact with postmental and first infralabial on each side	wider than long, round anteriorly, in contact with postmental and first infralabial on each side
Postmentral	single, in contact with first infralabials and anterior portion of second infralabials	single, in contact with first infralabials and anterior portion of second infralabials	single, in contact with first infralabials and anterior portion of second infralabials	single, in contact with first infralabials and anterior portion of second infralabials
Chin shields	2 pairs, first pair in contact medially or separated by a small scale, second pair separated by one scale, both pairs in contact with infralabials	2 pairs, first pair in contact medially or separated by a small scale, second pair separated by one scale, both pairs in contact with infralabials	2 pairs, first pair in contact medially or separated by a small scale, second pair separated by one scale, both pairs in contact with infralabials	2 pairs, first pair in contact medially or separated by a small scale, second pair separated by one scale, both pairs in contact with infralabials
supralabial count (**SL**)	7/7	7/7	7/7	7, 4th-5th below eye
infralabial count (**IFL**)	6/6	6/6	6/6	6-7
superciliary count (**SC**)	5/5	5/5	7/5	5-6
supraocular count (**SO**)	4/4	4/4	4/4	4, second and third widest
External ear	open	opening with a small lobule	opening with a small lobule	opening with a small lobule
precloacal scales	6	6	6	6, slightly enlarged