

# Complete descriptions of all reptiles



Peter Uetz  
VCU Life Sciences  
Richmond, VA

JMIH, 15 July 2023

# Reptile diversity



Barbados Threadsnake (*Tetracheilostoma carlae*)



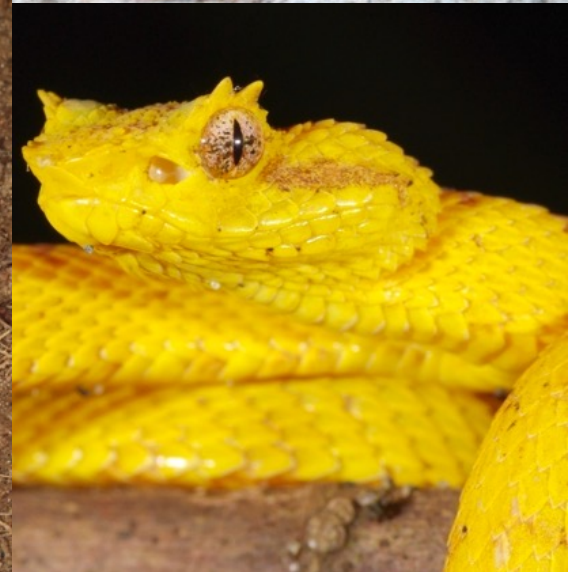
Invasive python, Everglades



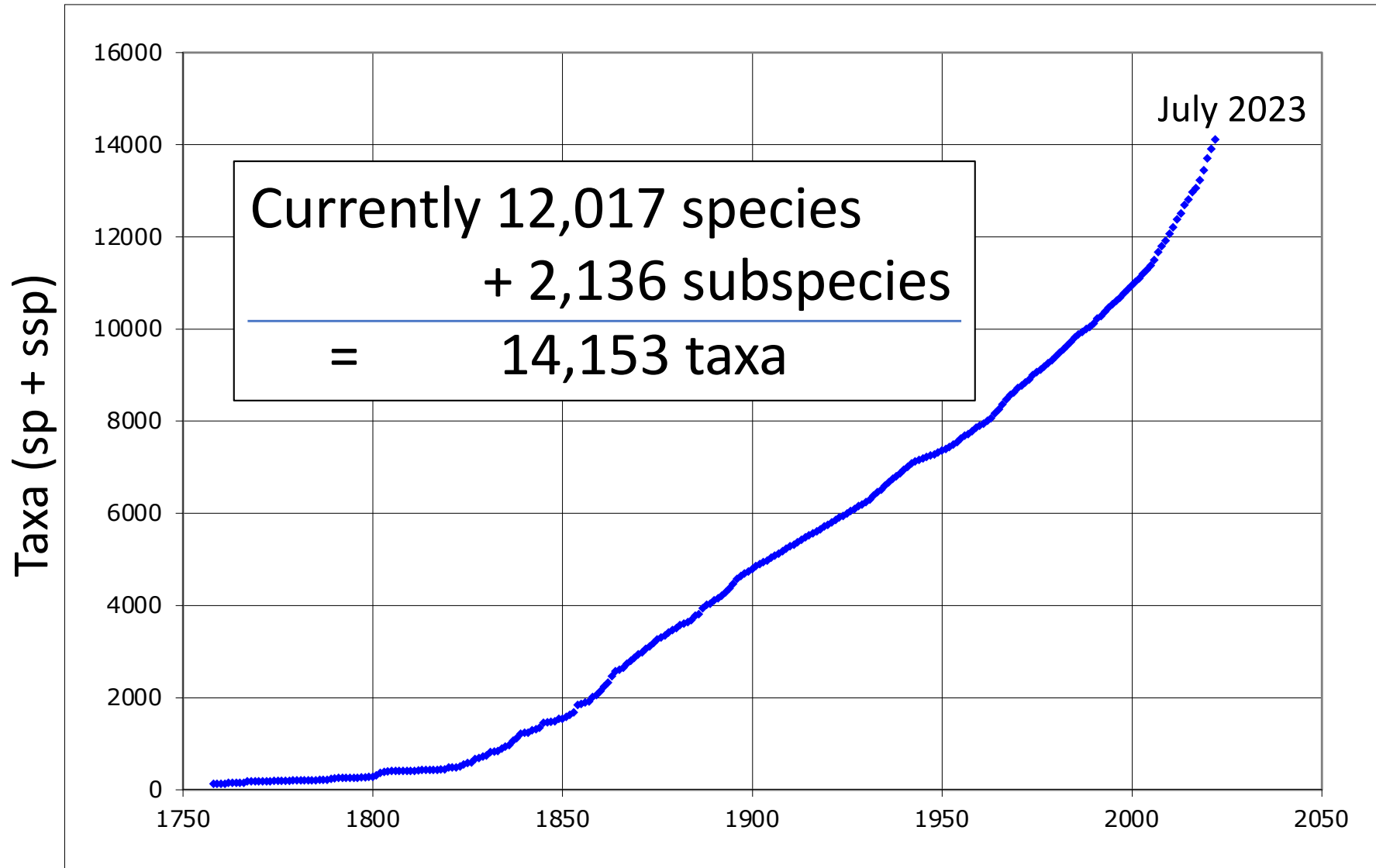
*Brookesia micra* GLAW et al. 2012

<https://www.scmp.com/news/world/united-states-canada/article/3005087/snake-hunters-capture-largest-python-florida> / <http://www.spiegel.de/wissenschaft/natur/0,1518,569766,00.html>

# Reptile diversity



# Species (+ssp.) diversity



# 14,153 taxa in ~6,300 publications



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## Article

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### The original descriptions of reptiles

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### The original descriptions of reptiles and their subspecies

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# Collecting reptile species descriptions



# Extracting reptile species descriptions

Diagnosis.—*Crotalus triseriatus armstrongi* can be distinguished by its pale gray, reddish brown, brownish yellow, or yellowish green ground color from *C. t. triseriatus* which has a dark gray or dark grayish brown dorsum. In *C. t. armstrongi* the body blotches tend to be as wide or wider than long while in *C. t. triseriatus* the blotches are usually longer than wide. *Crotalus t. armstrongi* further differs from *C. t. triseriatus* in that males (N=3) generally have fewer ventrals and subcaudals, 130-138 (134.3) and 24-26 (25.3), respectively, as compared to 136-151 (144.0) and 26-34 (29.2), respectively. *Crotalus t. armstrongi* can be distinguished from *C. t. aquilus* by having a distinct postocular stripe, a proportionally smaller rattle, and in males possessing fewer ventrals (the number usually exceeding 145 in *C. t. aquilus*). *Crotalus t. armstrongi* females (N=6) generally have fewer ventrals, 138-146 (142.0), and more subcaudals, 22-25 (23.5) than female *C. t. aquilus* which have 143-160 (151.7) ventrals and 17-23 (20.4) subcaudals. The only other rattlesnake with which *C. t. armstrongi* may be confused is *C. pusillus*, but it may be easily distinguished from this form by its having fewer ventrals and subcaudals, fewer pterygoid teeth, and canthals that fail to make contact with each other.

+ BHL etc.

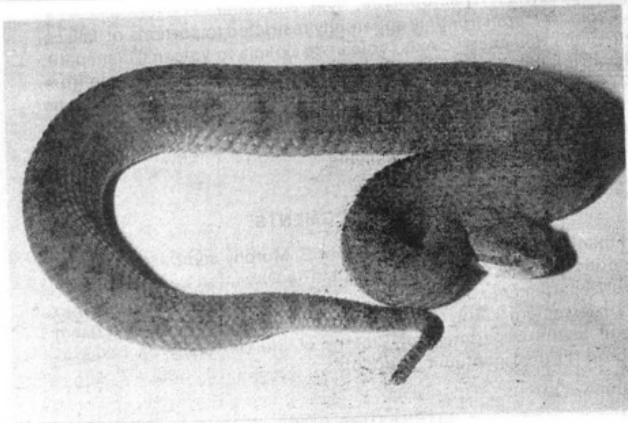


Figure 1: *Crotalus triseriatus armstrongi*, holotype, UTA R-6258, photographed while alive.

# Extracting reptile species descriptions

Diagnosis.—*Crotalus triseriatus armstrongi* can be distinguished by its pale gray, reddish brown, brownish yellow, or yellowish green ground color from *C. t. triseriatus* which has a dark gray or dark grayish brown dorsum. In *C. t. armstrongi* the body blotches tend to be as wide or wider than long while in *C. t. triseriatus* the blotches are usually longer than wide. *Crotalus t. armstrongi* further differs from *C. t. triseriatus* in that males (N=3) generally have fewer ventrals and subcaudals, 130-138 (134.3) and 24-26 (25.3), respectively, as compared to 136-151 (144.0) and 26-34 (29.2), respectively. *Crotalus t. armstrongi* can be distinguished from *C. t. aguilus* by having a distinct postocular stripe, a proportionally smaller rattle, and in males possessing fewer ventrals (the number usually exceeding 145 in *C. t. aguilus*). *Crotalus t. armstrongi* females (N=6) generally have fewer ventrals, 138-146 (142.0), and more subcaudals, 22-25 (23.5) than female *C. t. aguilus* which have 143-160 (151.7) ventrals and 17-23 (20.4) subcaudals. The only other rattlesnake with which *C. t. armstrongi* may be confused is *C. pusillus*, but it may be easily distinguished from this form by its having fewer ventrals and subcaudals, fewer pterygoid teeth, and canthals that fail to make contact with each other.

Traits

	1	2	3	4	5	6
Species 1						
Species 2						
...						

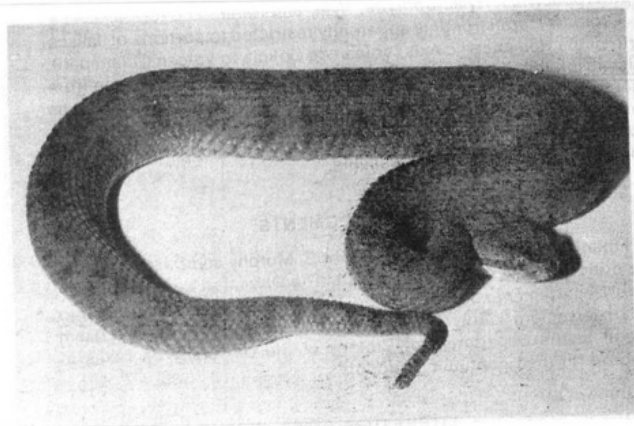
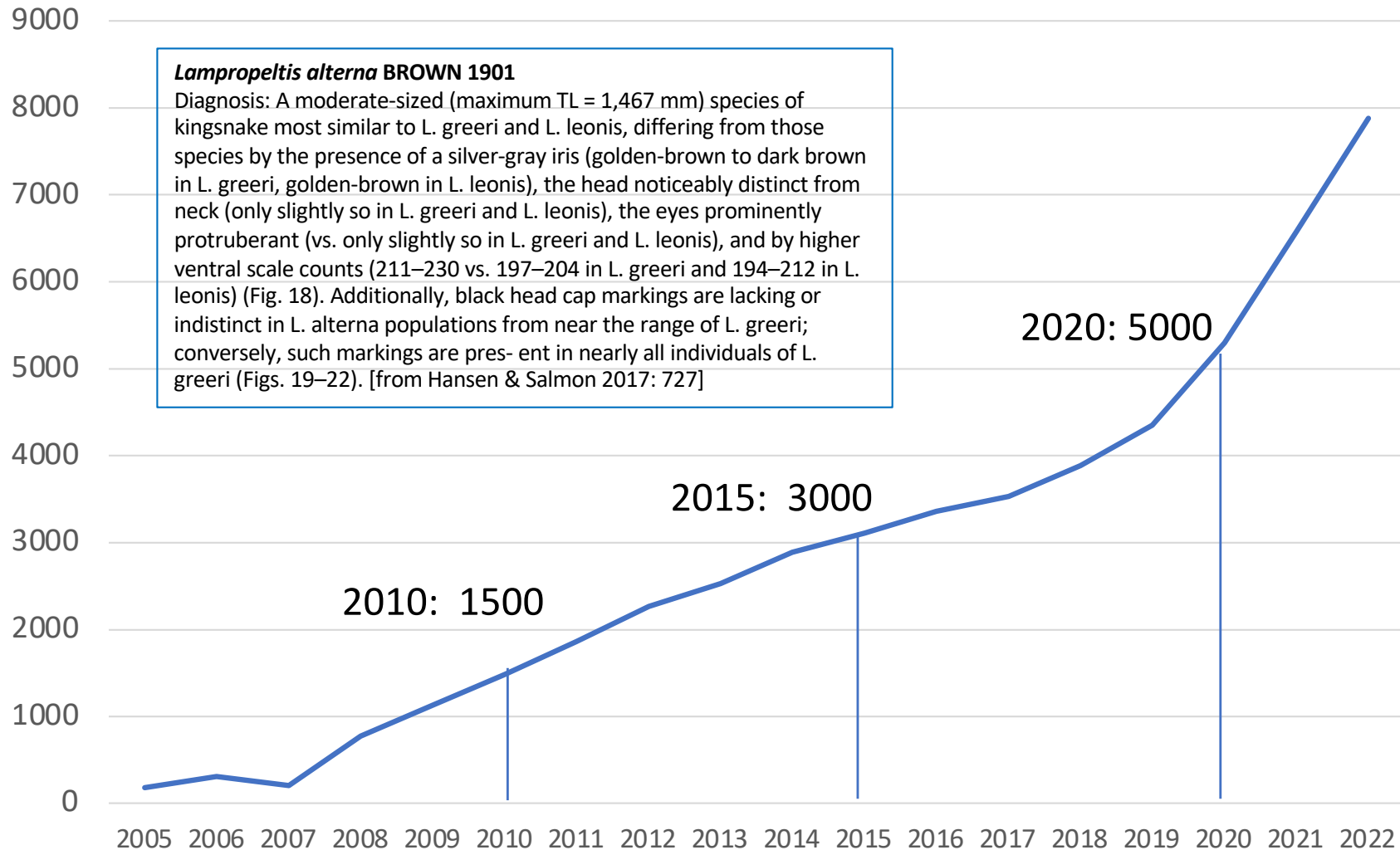


Figure 1: *Crotalus triseriatus armstrongi*, holotype, UTA R-6258, photographed while alive.

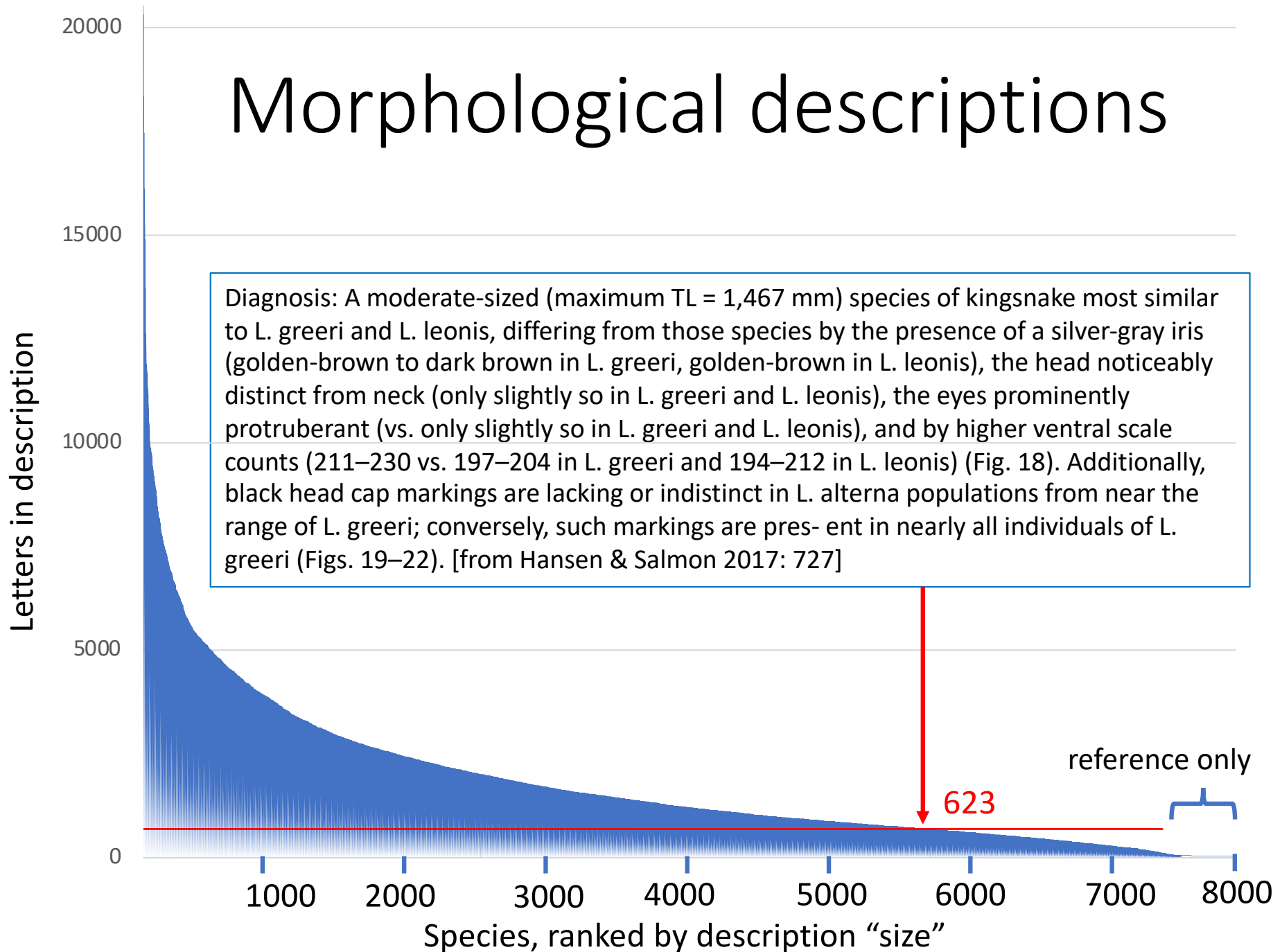




# Species descriptions



# Morphological descriptions



# 1. Text-mining of reptile species descriptions

Diagnosis. *Crotalus triseriatus armstrongi* can be distinguished by its pale gray, reddish brown, brownish yellow, or yellowish green ground color from *C. t. triseriatus* which has a dark gray or dark grayish brown dorsum. In *C. t. armstrongi* the body blotches tend to be as wide or wider than long while in *C. t. triseriatus* the blotches are usually longer than wide. *Crotalus t. armstrongi* further differs from *C. t. triseriatus* in that males (N=3) generally have fewer ventrals and subcaudals, 130-138 (134.3) and 24-26 (25.3), respectively, as compared to 136-151 (144.0) and 26-34 (29.2), respectively. *Crotalus t. armstrongi* can be distinguished from *C. t. aguilus* by having a distinct postocular stripe, a proportionally smaller rattle, and in males possessing fewer ventrals (the number usually exceeding 145 in *C. t. aguilus*). *Crotalus t. armstrongi* females (N= 6) generally have fewer ventrals, 1~8-146~142.0), and more subcaudals, 22-25 (23.5) than female *C. t. aguilus* which have 143-160 (151.7) ventrals and 17-23 (20.4) subcaudals. The only other rattlesnake with which *C. t. armstrongi* may be confused is *C. pusillus*, but it may be easily distinguished from this form by its having fewer ventrals and subcaudals, fewer pterygoid teeth, and canthals that fall to make contact with each other (Campbell 1979: 366).

## Traits

	1	2	3	4	5	6
Species 1						
Species 2						
...						



A red arrow points from the text to a laptop displaying the website 'THE REPTILE DATABASE'. The website interface includes a search bar and navigation links for 'Lizards', 'Snakes', and 'Turtles'.

# 1. Text-mining of reptile species descriptions

Diagnosis. *Crotalus triseriatus armstrongi* can be distinguished by its pale gray, reddish brown, brownish yellow, or yellowish green ground color from *C. t. triseriatus* which has a dark gray or dark grayish brown dorsum. In *C. t. armstrongi* the body blotches tend to be as wide or wider than long while in *C. t. triseriatus* the blotches are usually longer than wide. *Crotalus t. armstrongi* further differs from *C. t. triseriatus* in that males (N=3) generally have fewer ventrals and subcaudals, 130-138 (134.3) and 24-26 (25.3), respectively, as compared to 136-151 (144.0) and 26-34 (29.2), respectively. *Crotalus t. armstrongi* can be distinguished from *C. t. aguilus* by having a distinct postocular stripe, a proportionally smaller rattle, and in males possessing fewer ventrals (the number usually exceeding 145 in *C. t. aguilus*). *Crotalus t. armstrongi* females (N= 6) generally have fewer ventrals, 1~8-146~142.0), and more subcaudals, 22-25 (23.5) than female *C. t. agullus* which have 143-160 (151.7) ventrals and 17-23 (20.4) subcaudals. The only other rattlesnake with which *C. t. armstrongi* may be confused is *C. pusillus*, but it may be easily distinguished from this form by its having fewer ventrals and subcaudals, fewer pterygoid teeth, and canthals that fall to make contact with each other (Campbell 1979: 366).

Traits

	1	2	3	4	5	6
Species 1						
Species 2						
...						



# Sorting out morphological terms

## Example

Diagnosis: The new species can be diagnosed based on a combination of the following morphological characters: 1) body size moderate, **SVL** 55.5–60.9 mm in males, 55.9–60.2 mm in females; 2) tail long, **TAL** 195.8–223.5% **SVL** in males, 186.1–194.8% in females; 3) **HW** 66.2–75.4% **HL**; 4) **HLL** 73.0–80.3% **SVL**; 5) nuchal and dorsal crests developed on moderate skin folds; 6) **MD** 37–48; 7) **F4S** 13–16; 8) **T4S** 18–24; 9) **PTS** 2–4; 10) **PTY** 3–6; 11) **PRS** 4–8; 12) subocular regions and chin pale Pink [Color 242] in most individuals; 13) dorsolateral stripes jagged and Cream Color [Color 12] in males, narrow and Sulphur Yellow [Color 80] or indistinct in females; 14) ventral body uniform Pale Pinkish Buff [Color 3] to Pale Sulfur Yellow [Color 92]; 15) gular spots always present in males, Pinkish Flesh Color [Color 253] to Lilac [Color 222], either as Sulphur Yellow [Color 80] gular spots or Sulphur Yellow [Color 80] reticulated stripes in females (Wang et al. 2021).



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## A dictionary of abbreviations used in reptile descriptions

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# Describing diversity by photo



*Bitis nasica*  
Gabon  
© Laurent C  
Ichirio@hotmail.com



*Bitis parviocula*  
© Paul Freed  
herps2apes@gmail.com



*Bothrochilus*  
© Paul Freed  
herps2apes@gmail.com



*Apostolepis arenaria*  
Brazil  
© Mauro Teixeira Junior



*Lampropeltis elapsoides*  
© Paul Freed  
herps2apes@gmail.com

# Describing diversity by photo

	<u>Photos (%)</u>
12,017 species	6,328 (52)
4,059 snakes	2,202 (54)
7,569 lizards	3,832 (51)
361 turtles	271 (75)
27 crocodiles	22 (82)

# Describing diversity by photo



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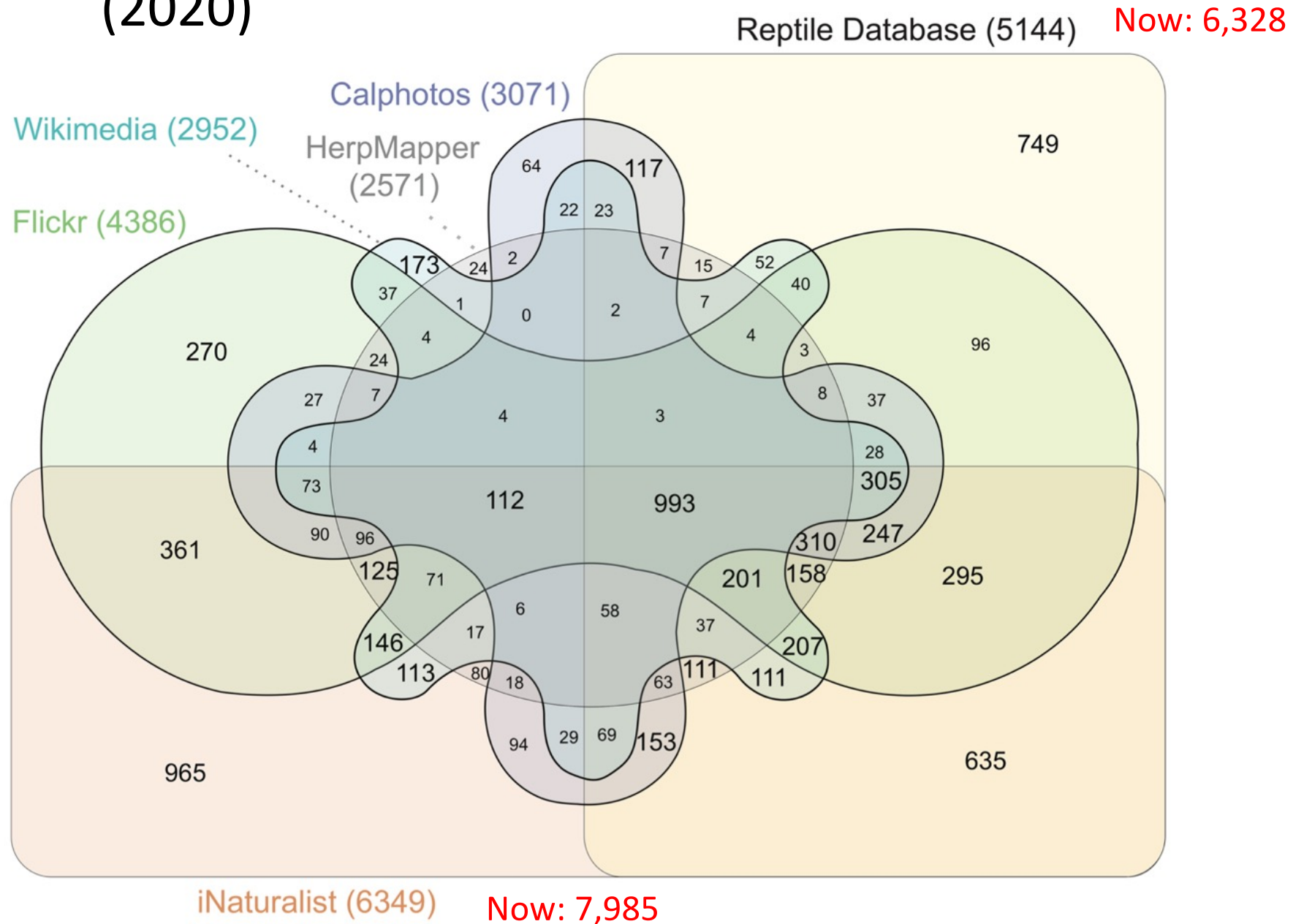
### **An inventory of online reptile images**

BENJAMIN MICHAEL MARSHALL<sup>1\*</sup>, PAUL FREED<sup>2</sup>, LAURIE J. VITT<sup>3</sup>, PEDRO BERNARDO<sup>4</sup>,  
GERNOT VOGEL<sup>5</sup>, SEBASTIAN LOTZKAT<sup>6</sup>, MICHAEL FRANZEN<sup>7</sup>, JAKOB HALLERMANN<sup>8</sup>,  
RICHARD D. SAGE<sup>9</sup>, BRIAN BUSH<sup>10</sup>, MARCELO RIBEIRO DUARTE<sup>11</sup>, LUCIANO JAVIER AVILA<sup>12</sup>,  
DAVID JANDZIK<sup>13</sup>, BORIS KLUSMEYER<sup>14</sup>, BRAD MARYAN<sup>15</sup>, JIŘÍ HOŠEK<sup>16</sup> & PETER UETZ<sup>17\*</sup>



# Species overlap across repositories

(2020)



# The reference image database



*Zootoca vivipara* (© Daniel Jablonski)



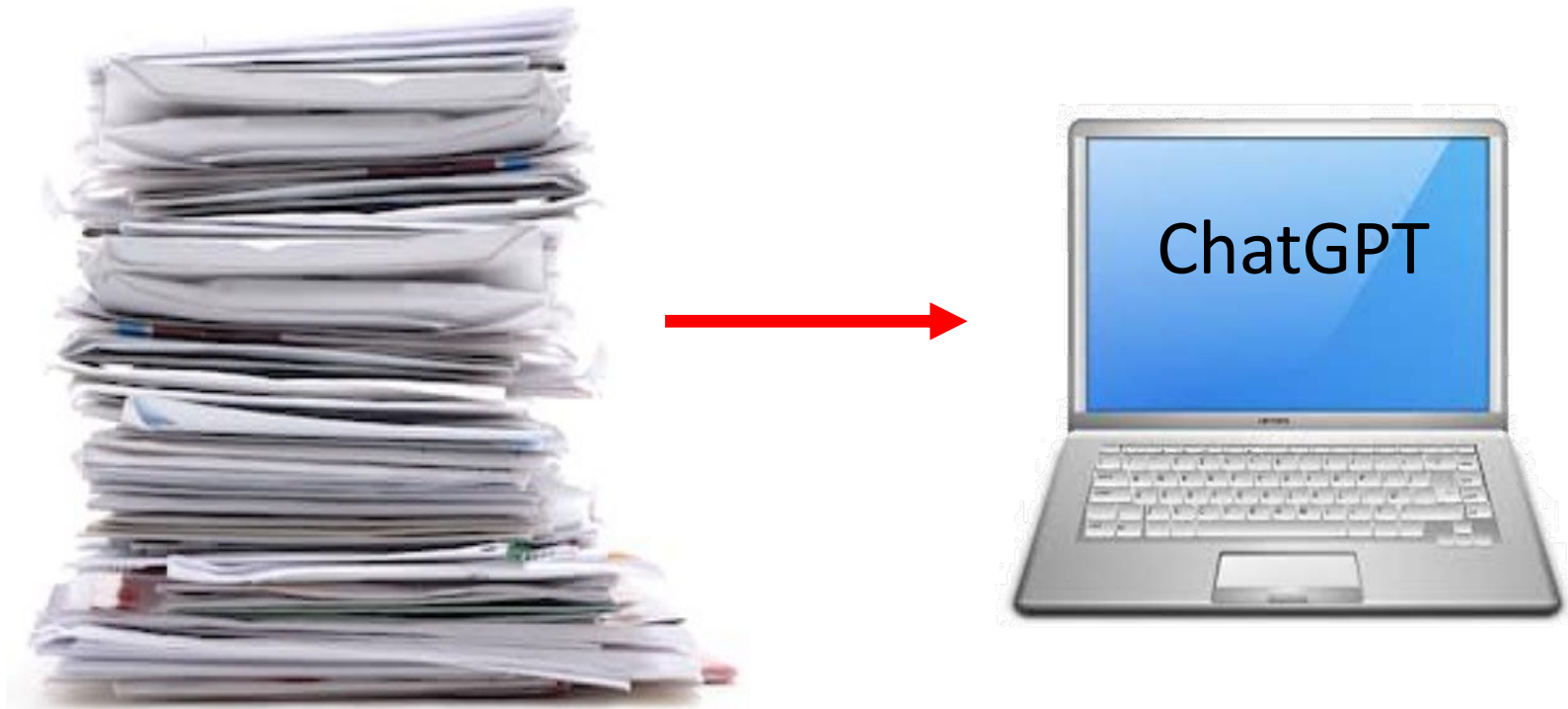
# The reference image database

## The first 1000 species



*Zootoca vivipara* (ZSM 2003/2006)

# Reptile descriptions are text



# How much des ChatGPT know?

*Query: How many descriptions or diagnoses of reptiles do you have?*

“As an AI language model, **I don't have a predetermined number of descriptions or diagnoses of reptiles.** However, **I can generate descriptions** and provide information about various reptile species based on the knowledge I've been trained on. If you have any specific reptile in mind, feel free to ask, and I'll do my best to provide you with relevant information.”

# How much des ChatGPT know?

*Can you give me descriptions or diagnoses for the currently accepted species of **laltris**?*

“I'm sorry, but **I couldn't find any information** on a reptile species called "laltris" in my training data”

# How much des ChatGPT know?

*Can you give me descriptions or diagnoses for the currently accepted species of **Anomalepis**?*

“Certainly! Anomalepis is a genus of snake that belongs to the family Anomalepididae. Within this genus, there is currently only one recognized species:

*Anomalepis aspinosus* (Saw-scaled Shieldtail):

**Description:** The *Anomalepis aspinosus*, commonly known as the Saw-scaled Shieldtail, is a small, non-venomous snake found in parts of southern India and Sri Lanka. It has a distinct appearance with a cylindrical body and a short, blunt tail. The head is small and slightly flattened, while the eyes are relatively large. The scales on its body are smooth and glossy, arranged in distinctive overlapping patterns. The coloration of this species can vary but generally consists of shades of brown or gray, sometimes with darker markings or speckles.

**Diagnosis:** *Anomalepis aspinosus* can be identified by its **unique characteristics**, including its **small size, cylindrical body, blunt tail, and distinctive scale patterns**. It is important to note that this species is non-venomous, making it harmless to humans.”

# How much des ChatGPT know?

*Can you give me descriptions or diagnoses for the currently accepted species of **Anomalepis**?*

“I apologize for the confusion, but as of my knowledge cutoff in September 2021, **there are no recognized or accepted species within the genus Anomalepis**. Anomalepis is a genus of snake that has undergone taxonomic revisions, and the species previously assigned to this genus have been reclassified into other genera or groups.

If there have been any recent taxonomic changes or newly recognized species within the genus Anomalepis since September 2021, I may not have that information. It's always a good idea to consult up-to-date scientific literature or resources for the most accurate and current information regarding the taxonomy and species descriptions of Anomalepis or any other reptilian genus..”



# How much des ChatGPT know?

**Query:** *Can you give me ventral scale counts for the species of Lampropeltis?*

“Certainly! Lampropeltis is a genus of nonvenomous colubrid snakes commonly known as kingsnakes and milk snakes. There are multiple species within the genus Lampropeltis, and here are the **ventral scale counts for some of the recognized species:**

1. *Lampropeltis alterna* (Gray-banded Kingsnake):  
Ventral Scale Count: Typically ranges from 167 to 189.
2. *Lampropeltis californiae* (California Kingsnake):  
Ventral Scale Count: Usually between 194 and 221.
3. *Lampropeltis getula* (Eastern Kingsnake):  
Ventral Scale Count: Usually falls between 204 and 230.
4. *Lampropeltis mexicana* (Mexican Kingsnake):  
Ventral Scale Count: Generally ranges from 199 to 235.
5. *Lampropeltis triangulum* (Milk Snake):  
Ventral Scale Count: Typically falls between 189 and 228.

# How much des ChatGPT know?

**Query:** *Can you give me ventral scale counts for all species of the genus Lampropeltis?*

Certainly! Here are the ventral scale counts for the currently recognized species within the genus *Lampropeltis*:

1. *Lampropeltis alterna* (Gray-banded Kingsnake):  
Ventral Scale Count: Typically ranges from 167 to 189.
2. *Lampropeltis californiae* (California Kingsnake):  
Ventral Scale Count: Usually between 194 and 221.
3. *Lampropeltis calligaster* (Prairie Kingsnake):  
Ventral Scale Count: Typically falls between 203 and 236.
4. *Lampropeltis getula* (Eastern Kingsnake):  
Ventral Scale Count: Usually ranges from 204 to 230.
5. *Lampropeltis holbrooki* (Speckled Kingsnake):  
Ventral Scale Count: Generally falls between 189 and 214.
6. *Lampropeltis mexicana* (Mexican Kingsnake):  
Ventral Scale Count: Typically ranges from 199 to 235.
7. *Lampropeltis pyromelana* (Sonoran Mountain Kingsnake):  
Ventral Scale Count: Usually between 188 and 204.
8. *Lampropeltis ruthveni* (Louisiana Kingsnake):  
Ventral Scale Count: Typically falls between 201 and 220.
9. *Lampropeltis triangulum* (Milk Snake):  
Ventral Scale Count: Generally ranges from 189 to 228.

# Comparing species with ChatGPT: *Ialtris*

Query: Compare the following 4 species and put their characters in a tab-delimited table with species in columns and characters in rows:

**DESCRIPTION of *Ialtris agyrtes*:** Maximum SVL 576 mm; 19 scale rows at midbody; dorsal scales smooth; ventrals 160-175 in females (males unknown); subcaudals 57--63 in females; anal divided; 1 loreal; 1 preocular, usually 2 postoculars; supralabials usually 7, infralabials usually 9. Dorsum brown to tan without pattern in adults; a cream to white line from angle of jaws completely around snout, bordered above by dark brown (less well bordered below); venter patternless or with moderately heavy stippling, white anteriorly grading to pale buffy posteriorly and on underside of tail; **chin and throat longitudinally streaked with brown; in juveniles, upper surface of head rich brown; dorsal ground dull tan with 40 (on each side) vertically elongate bars each about 3 scales high and 1 scale long, more or less symmetrically arranged and continuing onto upper surface of tail; lower 3 scale rows grayish and paler than rest of dorsum; white postocular line; subcaudals immaculate pale gray** (Schwartz & Henderson 1991: 614).

**DESCRIPTION of *Ialtris dorsalis*:** Maximum SVL 990 mm; 19 dorsal scale rows at midbody; dorsal scales smooth; ventrals 179-191 in males, 180-192 in females; subcaudals 99-115 in males, 98-109 in females; 1 preocular, **usually 2** postoculars; supralabials usually 7; infralabials usually 9; dorsal pattern extremely variable, from very dark, due to **extensive black pigmentation**, to olive or gray with prominent single or paired black blotches or zigzag middorsal band anteriorly, to **"salt-and-pepper" black and yellow, or more or less uniformly gray or brown posteriorly**; some specimens give impression of being longitudinally striped (Île de la Tortue); head usually (barely discernible in some specimens) with a prominent, black W, the arms of W beginning behind eyes and extending onto neck, the angulate central portion of W extending anteriorly between parietal scales and with accessory transverse bar on frontal and supraoculars; venter bluish gray or brown, with or without dark markings anteriorly on chin and throat. (Schwartz & Henderson 1991: 614).

**DESCRIPTION of *Ialtris haetianus*:** Maximum SVL 305 mm; ventrals 132-144; subcaudals 45-54 in males, 40-51 in females; **ventrals + subcaudals 178-193 in males, 174-191 in females**; dorsal scale rows at midbody 19; dorsal scales without apical pits; supralabials usually 7; infralabials usually 8; loreal absent; preoculars usually 1/1; postoculars usually 2/2; **temporals usually 1+2 (rarely 1 + 1)**; head short, blunt; eye relatively large. Dorsal ground color tan to dark brown; dorsum patternless, strongly lineate, or with scattered, pale, paramedian dorsal dots (**each encompassing 3-4 dorsal scales**) **outlined with dark brown or black**; venter ontogenetically variable: orange in juveniles to black in full adults, intermediate stages with intermediate conditions (Schwartz & Henderson 1991: 598).

**DESCRIPTION of *Ialtris parishi*:** Maximum SVL 745 mm; 19 dorsal scale rows at midbody; dorsal scales smooth; ventrals 163-167 in males, 163-172 in females; subcaudals 77 in 1 male, unknown for females; 1 preocular; postoculars strongly modally 2; supralabials 7; infralabials usually 9; dorsal pattern of 39-48 light, vertical bars or blotches on brown to reddish brown ground color; head unpatterned but with a fine cream to white vitta, bordered above by dark brown, **extending from ventrolateral portion of eye across supralabials 4-7 to end at angle of jaws**; venter yellow to yellow-orange with gray, brown, or black squares or rectangles on each scale giving venter a bilineate pattern and **underside of tail a unilineate pattern; ventral pattern may be faint or distinct**; chin speckled with black (Schwartz & Henderson 1991: 615).

# Comparing species with ChatGPT: *Ialtris*

Query: Compare the following 4 species and put their characters in a tab-delimited table with species in columns and characters in rows:

**DESCRIPTION of *Ialtris agyrtes*:** Maximum SVL 576 mm; 19 scale rows at midbody; dorsal scales smooth; ventrals 160-175 in females (males unknown); subcaudals 57--63 in females; anal divided; 1 loreal; 1 preocular, usually 2 postoculars; supralabials usually 7, infralabials usually 9. Dorsum brown to tan without pattern in adults; a cream to white line from angle of jaws completely around snout, bordered above by dark brown (less well bordered below); venter patternless or with moderately heavy stippling, white anteriorly grading to pale buffy posteriorly and on underside of tail; **chin and throat longitudinally streaked with brown; in juveniles, upper surface of head rich brown; dorsal ground dull tan with 40 (on each side) vertically elongate bars each about 3 scales high and 1 scale long, more or less symmetrically arranged and continuing onto upper surface of tail; lower 3 scale rows grayish and paler than rest of dorsum; white postocular line; subcaudals immaculate pale gray** (Schwartz & Henderson 1991: 614).

**DESCRIPTION of *Ialtris dorsalis*:** Maximum SVL 990 mm; 19 dorsal scale rows at midbody; dorsal scales smooth; ventrals 179-191 in males, 180-192 in females; subcaudals 99-115 in males, 98-109 in females; 1 preocular, **usually 2** postoculars; supralabials usually 7; infralabials usually 9; dorsal pattern extremely variable, from very dark, due to **extensive black pigmentation**, to olive or gray with prominent single or paired black blotches or zigzag middorsal band anteriorly, to **"salt-and-pepper" black and yellow, or more or less uniformly gray or brown posteriorly**; some specimens give impression of being longitudinally striped (Île de la Tortue); head usually (barely discernible in some specimens) with a prominent, black W, the arms of W beginning behind eyes and extending onto neck, the angulate central portion of W extending anteriorly between parietal scales and with accessory transverse bar on frontal and supraoculars; venter bluish gray or brown, with or without dark markings anteriorly on chin and throat. (Schwartz & Henderson 1991: 614).

**DESCRIPTION of *Ialtris haetianus*:** Maximum SVL 305 mm; ventrals 132-144; subcaudals 45-54 in males, 40-51 in females; **ventrals + subcaudals 178-193 in males, 174-191 in females**; dorsal scale rows at midbody 19; dorsal scales without apical pits; supralabials usually 7; infralabials usually 8; loreal absent; preoculars usually 1/1; postoculars usually 2/2; **temporals usually 1+2 (rarely 1 + 1)**; head short, blunt; eye relatively large. Dorsal ground color tan to dark brown; dorsum patternless, strongly lineate, or with scattered, pale, paramedian dorsal dots (**each encompassing 3-4 dorsal scales**) **outlined with dark brown or black**; venter ontogenetically variable: orange in juveniles to black in full adults, intermediate stages with intermediate conditions (Schwartz & Henderson 1991: 598).

**DESCRIPTION of *Ialtris parishi*:** Maximum SVL 745 mm; 19 dorsal scale rows at midbody; dorsal scales smooth; ventrals 163-167 in males, 163-172 in females; subcaudals 77 in 1 male, unknown for females; 1 preocular; postoculars strongly modally 2; supralabials 7; infralabials usually 9; dorsal pattern of 39-48 light, vertical bars or blotches on brown to reddish brown ground color; head unpatterned but with a fine cream to white vitta, bordered above by dark brown, **extending from ventrolateral portion of eye across supralabials 4-7 to end at angle of jaws**; venter yellow to yellow-orange with gray, brown, or black squares or rectangles on each scale giving venter a bilineate pattern and **underside of tail a unilineate pattern; ventral pattern may be faint or distinct**; chin speckled with black (Schwartz & Henderson 1991: 615).

Characters	<i>Ialtris agyrtes</i>	<i>Ialtris dorsalis</i>	<i>Ialtris haetianus</i>	<i>Ialtris parishi</i>
SVL (mm)	Up to 576	Up to 990	Up to 305	Up to 745
Scale rows at midbody	19	19	19	19
Dorsal scales	Smooth	Smooth	Without apical pits	Smooth
Ventrals (females)	160-175	180-192	-	163-172
Ventrals (males)	-	179-191	132-144	163-167
Subcaudals (females)	57-63	98-109	40-51	-
Subcaudals (males)	-	99-115	45-54	77 (1 male)
Anal	Divided	-	-	-
Loreal	1	-	Absent	-
Preocular	1	1	1/1	1
Postocular	Usually 2	2	2/2	Strongly modally 2
Supralabials	Usually 7	Usually 7	7	7
Infralabials	Usually 9	Usually 9	8	Usually 9
Dorsal pattern	Brown to tan without pattern in adults	Extremely variable, ranging from very dark to gray or brown with prominent single or paired black blotches or zigzag middorsal band	<del>Brown</del> Tan to dark brown, patternless, lineate, or with scattered pale paramedian dorsal dots	39-48 light vertical bars or blotches on brown to reddish brown ground color
Head pattern	A cream to white line from angle of jaws completely around snout, bordered above by dark brown (less well bordered below)	Prominent black W shape; <b>W-pattern beginning behind eyes and extending onto neck, central portion of W extends anteriorly between parietal scales</b>	<b>W-pattern beginning behind eyes and extending onto neck, central portion of W extends anteriorly between parietal scales</b>	Unpatterned, fine cream to white vitta bordered above by dark brown
Venter	Patternless or with moderately heavy stippling, white anteriorly grading to pale buffy posteriorly and on underside of tail	Bluish gray or brown, with or without dark markings anteriorly on chin and throat	Orange in juveniles to black in full adults	Venter yellow to yellow-orange with gray, brown, or black squares or rectangles on each scale, giving a bilineate pattern
Additional Distinctions	-	Some specimens give impression of being longitudinally striped	Head short, blunt; eye relatively large	Chin speckled with black

Red values are in wrong rows or columns

# Comparing species with ChatGPT: *Anomalepis*

## Query:

Compare the characters of the following 4 species, with their characters in rows and the species in columns: [all inputs are diagnoses]

**Species 1 (aspinosus):** Teeth in both upper and lower jaws. Nostril between two nasals; dorsal scales 320-343 from rostral to terminal scute of tail. Scale rows about middle of body 24-26, frontal with area about that of a prefrontal; four upper and three lower labials. No trace of a spine on terminal plate. Scales with minute pits, usually single. (Taylor 1939: 92)

**Species 2 (colombia):** *Anomalepis colombia* is distinguished from its congeners by having 31/29/27 scales in rows around anterior / midbody / posterior body, and 387 scales on dorsal middle row (vs. 26/24/22 and 283 scales in *A. aspinosus*; 26/26/24 and 304–308 in *A. flavapices*; and 25–26/22–24/21–23 and 277–312 *A. mexicanus*). (MARRA-SANTOS & REIS 2019)

**Species 3 (flavapices):** This species can be distinguished from all other members of the genus by the absence of brown pigment on the yellowish white head and end of the tail, and by the number of scale rows from the rostral to the tail tip, which are 304-308. It is distinguished from all species except *aspinosus* by the number of scale rows around the body which is 26. (Peters 1957: 3)

**Species 4 (mexicana):** A tiny uniformly glossy brown snake, without enlarged ventral scales and with the minute eyes hidden under the head scales. (Savage 2002: 554).

# Comparing species with ChatGPT: *Ialtris*

## Query:

Compare the characters of the following 4 species, with their characters in rows and the species in columns: [all inputs are diagnoses]

**Species 1 (*aspinosus*):** Teeth in both upper and lower jaws. Nostril between two nasals; dorsal scales 320-343 from rostral to terminal scute of tail. Scale rows about middle of body 24-26, frontal with area about that of a prefrontal; four upper and three lower labials. No trace of a spine on terminal plate. Scales with minute pits, usually single. (Taylor 1939: 92)

**Species 2 (*colombia*):** *Anomalepis colombia* is distinguished from its congeners by having 31/29/27 scales in rows around anterior / midbody / posterior body, and 387 scales on dorsal middle row (vs. 26/24/22 and 283 scales in *A. aspinosus*; 26/26/24 and 304–308 in *A. flavapices*; and 25–26/22–24/21–23 and 277–312 *A. mexicana*). (MARRA-SANTOS & REIS 2019)

**Species 3 (*flavapices*):** This species can be distinguished from all other members of the genus by the absence of brown pigment on the yellowish white head and end of the tail, and by the number of scale rows from the rostral to the tail tip, which are 304-308. It is distinguished from all species except *aspinosus* by the number of scale rows around the body which is 26. (Peters 1957: 3)

**Species 4 (*mexicana*):** A tiny uniformly glossy brown snake, without enlarged ventral scales and with the minute eyes hidden under the head scales. (Savage 2002: 554).

Characters	<i>aspinosus</i>	<i>colombia</i>	<i>flavapices</i>	<i>mexicana</i>
Teeth	Present	-	-	-
Nostril position	Between two nasals	-	-	-
Dorsal scales	320-343 from rostral to terminal scute of tail	-	-	-
Scale rows (around middle of body)	24-26	-	26	-
Frontal scale area	About size of prefrontal	-	-	-
Upper labial scales	4	-	-	-
Lower labial scales	3	-	-	-
Terminal plate spine	Absent	-	-	-
Pitted scales	Usually single	with minute pits	-	-
Scale counts (Anterior/Midbody/Posterior)	26/24/22	31/29/27	26/26/24	25-26/22-24/21-23
Dorsal middle row scale count	283	387	304-308	277-312
Head and tail coloration	-	-	Absence of brown pigment on yellowish white	-
Scale count (Rostral to tail tip)	-	-	304-308	-
Scale rows (around body)	-	-	26	-
Enlarged ventral scales	-	-	-	Absent
Eye position	-	-	-	Minute eyes hidden under head scales

Red values missing from output table (output had gaps instead); blue values are in wrong rows or duplicated in extra rows

# Comparing species with ChatGPT: *Dendragama*

Query: Compare the following 4 species and put their characters in a table with species in columns and characters in rows:

**Diagnosis:** The following combination of characters distinguishes *Dendragama bouleengeri* from its congeners: (1) enlarged scales below eye separated from supralabials by continuous row of small lorilabials; (2) enlarged tympanic scale intermediate in size (7–14% of head length) and set far back on head (orbit–meatus 24–32% of head length); (3) sublabial tubercular scales 0–3, usually 1, in front of postrectral modified scale; (4) gulars small, 30–38; (5) dorsal crest of 11–18 projecting scales, serrate with obvious gaps between enlarged projecting scales; (6) dorsolateral crest of more or less continuous posttympanic and dorsolateral series; (7) scales around midbody 62–84; (8) scales of lower flanks heterogeneous in size, smooth to feebly keeled; (9) ventrals heavily keeled, 50–63; (10) no white sublabial stripe extending from below eye to level of ear, however 1–3 white spots usually present in this region; (11) most specimens with prominent black prescapular blotch edged posteriorly in white; (12) proximal half of tail with 7–9 dark brown or green bands; (13) buccal epithelium and tongue yellow or orange [Harvey et al. 2017: 83]

**Diagnosis:** The following combination of characters distinguishes *Dendragama australis* from its congeners: (1) enlarged scales below eye broadly contacting supralabials; (2) enlarged tympanic scale relatively small (6–10% of head length) and set relatively close to eye (orbit–meatus 21–36% of head length); (3) sublabial tubercular scales 3–5, usually 4, in front of postrectral modified scale; (4) gulars large, 15–30; (5) dorsal crest of 19–37 projecting scales, serrate and continuous along back without obvious gaps; (6) dorsolateral crest broken: posttympanic series of enlarged, modified scales straight or curving upward, dorsolateral series curving downward; (7) scales around midbody 61–94; (8) scales of lower flanks heterogeneous; (9) ventrals smooth or very feebly keeled, 44–60 from preaxial border of arm to vent; (10) sharp white stripe or line of broken white spots on sublabials from level of eye to below or behind ear; (11) brown band on neck, but large black prescapular blotch absent; (12) proximal half of tail with 8–13 dark brown or green bands; (13) buccal epithelium and tongue yellow or orange. (Harvey et al. 2017) –

**Diagnosis:** The following combination of characters distinguishes *Dendragama dioidema* from its congeners: (1) enlarged scales below eye broadly contacting supralabials; (2) tympanum relatively large (11–16% of head length) and close to eye (orbit–meatus 23–29% of head length); (3) sublabial tubercular scales 0–2, usually 1, in front of postrectral modified scale; (4) gulars large, 16–22; (5) dorsal crest of 9–19 projecting scales, serrate with obvious gaps between enlarged projecting scales; (6) dorsolateral crest of more or less continuous posttympanic and dorsolateral series; (7) scales around midbody 57–77; (8) scales of lower flanks heterogeneous in size, smooth to feebly keeled; (9) ventrals smooth or very feebly keeled, 49–63; (10) no white sublabial stripe; however, one or two white or pale yellow spots usually present in area below rictus and ear; (11) no distinctive prescapular blotch edged posteriorly in white; band crossing neck interrupted by narrow white or yellow line; (12) proximal half of tail with 6–10 dark brown or green bands; (13) buccal epithelium cream, tongue pink to red. (Harvey et al. 2017)

**Diagnosis:** *Dendragama schneideri* is a species reaching at least 201 mm in total length (SVL) and distinguished from congeners by the following characters: (1) midbody scales 58–67; (2) dorsal scales heterogeneous across flanks (Fig 6); (3) strongly keeled white/yellow scales randomly distributed along flanks (more numerous and distinct in females); (4) ventral scales 48–59; (5) banding pattern along flanks often muddled, but typically vertical when present; (6) mouth and tongue pink to red in life; (7) narrow, vertical black stripes across dorsal crest, limbs, digits and most of tail; (8) female color in life dark brown, yellow and black with amber coloration on underside, while males green and lacking amber coloration along ventral surface; (9) dorsal and nuchal crest clearly separated by 5–9 dorsal scales; (10) dorsal crest serrate, extending to base of the tail, comprised of 23–31 projecting, triangular scales; (11) a series of 3–4 enlarged tubercles present along the chin of males and females; (12) A series of 12–18 strongly keeled, white/yellow femoral spines present (combined count on both sides) (Shaney et al. 2020).

Characters	<i>Dendragama bouleengeri</i>	<i>Dendragama australis</i>	<i>Dendragama dioidema</i>	<i>Dendragama schneideri</i>
(1) Enlarged scales below eye	Separated from supralabials by continuous row of small lorilabials	Broadly contacting supralabials	Broadly contacting supralabials	
(2) Enlarged tympanic scale	Intermediate in size (7–14% of head length), set far back on head (orbit–meatus 24–32% of head length)	Relatively small (6–10% of head length), set relatively close to eye (orbit–meatus 21–36% of head length)	Relatively large (11–16% of head length), close to eye (orbit–meatus 23–29% of head length)	
(3) Sublabial tubercular scales	0–3, usually 1, in front of postrectral modified scale	3–5, usually 4, in front of postrectral modified scale	0–2, usually 1, in front of postrectral modified scale	
(4) Gulars	Small, 30–38	Large, 15–30	Large, 16–22	
(5) Dorsal crest	11–18 projecting scales, serrate with obvious gaps between enlarged projecting scales	19–37 projecting scales, serrate and continuous along back without obvious gaps	9–19 projecting scales, serrate with obvious gaps between enlarged projecting scales	
(6) Dorsolateral crest	More or less continuous posttympanic and dorsolateral series	Broken: posttympanic series of enlarged, modified scales straight or curving upward, dorsolateral series curving downward	More or less continuous posttympanic and dorsolateral series	
(7) Scales around midbody	62–84	61–94	57–77	58–67
(8) Scales of lower flanks	Heterogeneous in size, smooth to feebly keeled	Heterogeneous	Heterogeneous in size, smooth to feebly keeled	Dorsal scales heterogeneous across flanks
(9) Ventrals	Heavily keeled, 50–63	Smooth or very feebly keeled, 44–60 from preaxial border of arm to vent	Smooth or very feebly keeled, 49–63	Ventral scales 48–59
(10) White sublabial stripe	No white sublabial stripe extending from below eye to level of ear, however 1–3 white spots usually present in this region	Sharp white stripe or line of broken white spots on sublabials from level of eye to below or behind ear	No white sublabial stripe; however, one or two white or pale yellow spots usually present in area below rictus and ear	
(11) Prominent black prescapular blotch	Most specimens with prominent black prescapular blotch edged posteriorly in white	Large black prescapular blotch absent	No distinctive prescapular blotch edged posteriorly in white; band crossing neck interrupted by narrow white or yellow line	
(12) Proximal half of tail bands	7–9 dark brown or green bands	8–13 dark brown or green bands	6–10 dark brown or green bands	
(13) Buccal epithelium and tongue color	Yellow or orange	Yellow or orange	Buccal epithelium cream, tongue pink to red	Mouth and tongue pink to red
		amber coloration on underside		yellow and black with amber coloration on underside
(14) Additional Male Color (Life)		Green and lacking amber coloration along ventral surface		males green and lacking amber coloration along ventral surface
(15) Dorsal and nuchal crest separation				Dorsal and nuchal crest clearly separated by 5–9 dorsal scales
(6, 5, 10) Dorsal crest extension and composition	Extends to base of the tail, comprised of 23–31 projecting, triangular scales	Extends to base of the tail, comprised of 23–31 projecting, triangular scales	Extends to base of the tail, comprised of 23–31 projecting, triangular scales	Dorsal crest serrate, extending to base of the tail, comprised of 23–31 projecting, triangular scales
(11) Chin tubercles	Series of 3–4 enlarged tubercles in males and females		Series of 2–4 enlarged tubercles in males and females	A series of 3–4 enlarged tubercles present along the chin of males and females
(12) Femoral spines				A series of 12–18 strongly keeled, white/yellow femoral spines present (combined count on both sides)

Red values total made up!

# Conclusions

- LLMs will turn taxonomy / science upside down within 5 years.
- We and ChatGPT (OpenAI etc) got work to do, e.g. we need to write code to validate ChatGPT output on a large scale.
- Will scientific databases be superfluous in 5 years?
- No. LLMs won't have access to all literature / data for some time
- LLMs won't be able to reason any time soon (e.g. synonymies; but can use our synonymies 😊 )
- Their ability to analyze images (count scales etc.) will depend on sufficient training data (such as our reference image data 😊 )



# Please help and submit:

- Photos (5,600 species to go!)
- Descriptions (4,000 species to go!)
- Any other data
- Your experience with ChatGPT 😊



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