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RESEARCH ARTICLE

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Preliminary Study on Morphology, Meristics, and Morphometric Variations of Javan Spitting Cobra *Naja sputatrix* Boie, 1827 and Sumatran Spitting Cobra *Naja sumatrana* Müller, 1890

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Abstract

Cobras are venomous snakes from Elapidae Family widespread in Asia and Africa, including Indonesia. There are two species of cobras in Indonesia, the one being is Javan spitting cobra (*Naja sputatrix* Boie, 1827) and other is Sumatran spitting cobra (*Naja sumatrana* Müller, 1890). In Indonesia, *N. sputatrix* distributions are in Java, Bali, and Nusa Tenggara, meanwhile *N. sumatrana* spread across Sumatra and Kalimantan. Wide distribution means that there are also potentially wide variations in morphology, meristic, and morphometric characters. This research was conducted to determine variations of Javan and Sumatran spitting cobra with morphology, meristic, and morphometric characterization. Total number of 16 samples (N. sputatrix = 8, N. sumatrana = 8) were examined and measured. Visual observation focused on coloration and hood characteristics. Meristic observation uses head, dorsal, ventral, and subcaudal scalation. Morphometric observation measures SVL, TL, Tail, and HW. We found that hood morphology varies greatly between *N. sputatrix* and *N. sumatrana*. *N. sumatrana* differs between Sumatran and Borneo population. Morphometric variation is being less prominent with morphometric description that matches with previous literatures and researches.

Keywords: Cobra; Hood; Meristic; Morphology; Morphometry; Variation

Introduction

True cobras (*Naja*) classified as venomous snake derived from the Elapidae family. As now, 33 living species of *Naja* distributed across from Africa to Asia[1]. The capability of cobras to adapt at environmental changes helps this species to be known for its wide distribution[2]. In the past, the taxonomy of *Naja* genus was baffled, due to quite large morphological variations it has. Until 1990, most researchers still considered Asian cobras to be a single species (*Naja naja*) with various subspecies distributed in certain areas[3]. Eventually the conclusion was reached that Naja Asia has various different species, including *N. sputatrix* and *N. sumatrana*. According to Laing[4] these two species are classified in

the subgenus *Naja*. *N. sumatrana* can be further classified into two subspecies, namely *N. sumatrana sumatrana* with in Sumatra and the Malayan Peninsula distribution. Meanwhile, *N. sumatrana* miolepis distributed in Borneo and the islands south of the Philippines[5,6].

Naja spp. or cobras had a wide and diverse range of prey including from small mammals, amphibians and reptiles[7,8]. This is one of the reasons why cobras are among the most common venomous snakes found in human areas. From all living cobra species, two of them can be found in Indonesia, namely the Javan spitting cobra or *N. sputatrix* Boie, 1827 and the Sumatran spitting cobra or *N. sumatrana* Müller, 1890. Both these cobras are labeled as true spitting cobra pointing their ability of spitting venom towards their potential predator[9,10]. *N. sputatrix* generally lives in lowland areas up to an altitude of 600 meters above sea level. Island of Java-Bali, West Nusa Tenggara and East Nusa Tenggara (Lombok, Alor, Sumbawa, Komodo, Flores and Lembata became the distributed area of this snake[11]. This terrestrial snake can be found in various habitats, from forests, grasslands, areas around rivers and rice fields, to villages and other disturbed habitats[12]. Even urban environments such as cities and universities, especially those with green open spaces[13–16].

N. sumatrana shares many habitat characteristics with *N. sputatrix*. Distribution of this snake are Malayan Peninsula (Southern Thailand-Singapore), Sumatra Island, Borneo, Palawan and Calamian Islands. *N. sumatrana* can also be found in disturbed habitats such as oil palm plantations and Institut Teknologi Sumatra (ITERA). The wide distribution of *N. sputatrix* and *N. sumatrana* indicates these species are able to live in numerous ecosystem conditions, so there must be potential for differences in physical characteristics. Physical characteristics that frequently studied in snakes are morphology, meristic, and morphometric.

Snake morphological characters, for example body coloration, can differ from one population to another depending on geographic location[17]. Snake color itself have plenty of functions such as thermoregulation, camouflage, and aposematism[18,19]. Meristic characters used as the identification key to determining accurate species classification can also experience slight differences at scale level. In meristic case there can be anomaly number of scales or asymmetric shape, this anomaly due to embryonic disturbances caused by environmental disturbances[20,21]. Meanwhile, morphometric studies can be used as evidence of phenotypic evolution[22]. This study aims to determine the morphology, meristic and morphometry variations of *N. sputatrix* and *N. sumatrana*.

Materials and methods

Study area

Samples consisted of 16 cobras acquired from relocated individuals in local settlements and wild catch from several different area and islands of Indonesia. After capturing, samples were sent to Yogyakarta. Two of the samples are dead samples, and the rest are living samples. Species identification has been done with snake's origin. More about used samples can be seen as in **Table 3 and 4**.

Procedures

Measuring hood and hood patterns

Hood patterns documented with DSLR camera (Canon EOS 1300D). We defined hood in cobras as part of snake's anterior which enlarged when snakes erecting their body. Observation focused on front part (ventral) and back part (dorsal) of the hood. Hood length was counted start from gular scales

added by first ventral scale down to last ventral scale where side-enlarged hood could be distinguished visually from other.

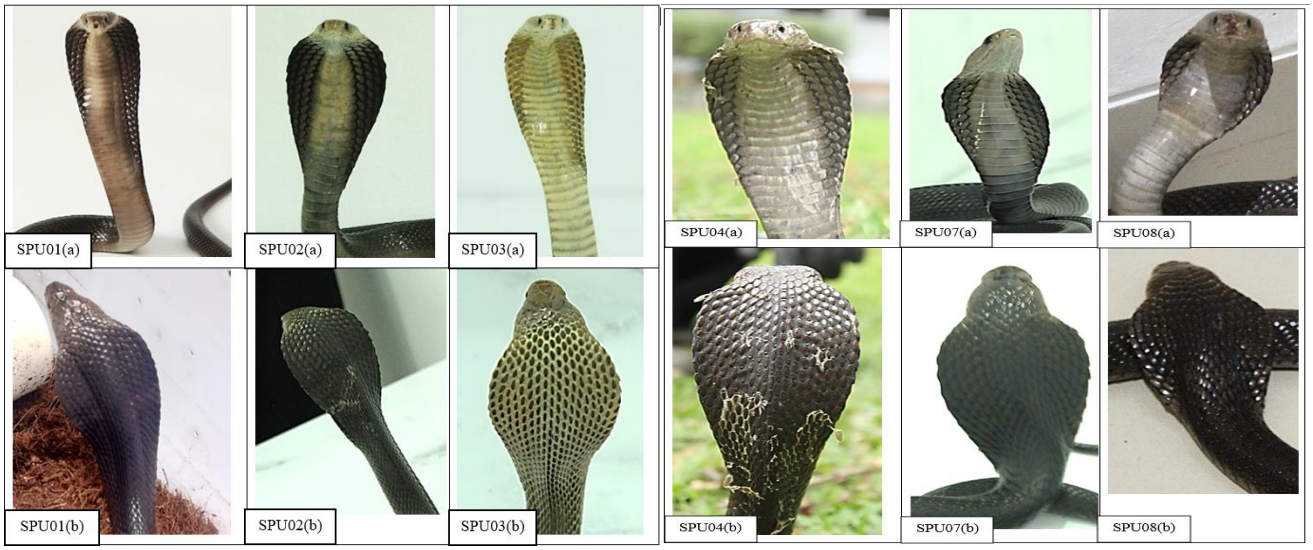

Figure 1. a) ventral and b) dorsal of hood appearances of several samples (SPU01-08) of *N. sputatrix*.

Morphometric measurement

Morphometric measurements included total length (TL), snout-vent length (SVL), tail length, and head width (HW). Measurement tool was simply installed by attaching 150 cm long measurement tape onto ceramic table. In order to obtain data about snake length, two types of transparent acrylic tubes (length 53 cm, inner diameter 2.8 cm and length 102 cm, inner diameter 3.8 cm) were used. Snake trapped by directing to enter the tube by head first. When the snake's head almost reached the end of the tube, the end closed immediately. Then, tube was aligned with measuring tape. The posterior end of the snake body protruding from the tube was straightened to obtain the total length. The tail was straightened to get tail length data. SVL data could be acquired by subtracting total length from tail length. Head width was obtained from measuring the posterior part of the snake's head using callipers.

Meristic counting

On dead specimens, meristic counted directly from scales needed for identification. There were 16 scales needed for meristic characters, explained in **Table 3 and 4**. In living specimens, meristic counting could be done with one or combination of three methods: 1) counted from snake's shed skin (only could be done if shed skin is complete), 2) counted from taken photos and videos, and 3) counted directly from the snake (only can be done in head escalations). Counting could be done manually with tally counter or using ImageJ application.

Data analysis

The results of morphology, meristic, and morphometric data will be analysed descriptively with the tables.

Results

Hood morphology

Despite there were 16 samples used in this preliminary study, we only documented 13 hood morphologies due to one specimen being dead (SPU05), two specimens (SPU06 and SUM03) could not be photographed because they kept reluctantly spreading their hood after has been provoked numerous times. The specimen SUM02 also being dead with a photograph displayed hooding position when the specimen was alive. Hood shape was determined by scalation while the hood length determined by numbers of gular scales plus ventral scales from first ventral to the last ventral scale which enlarged in both or one of the lateral bodies (**Figure 1 and 2, Table 1**).

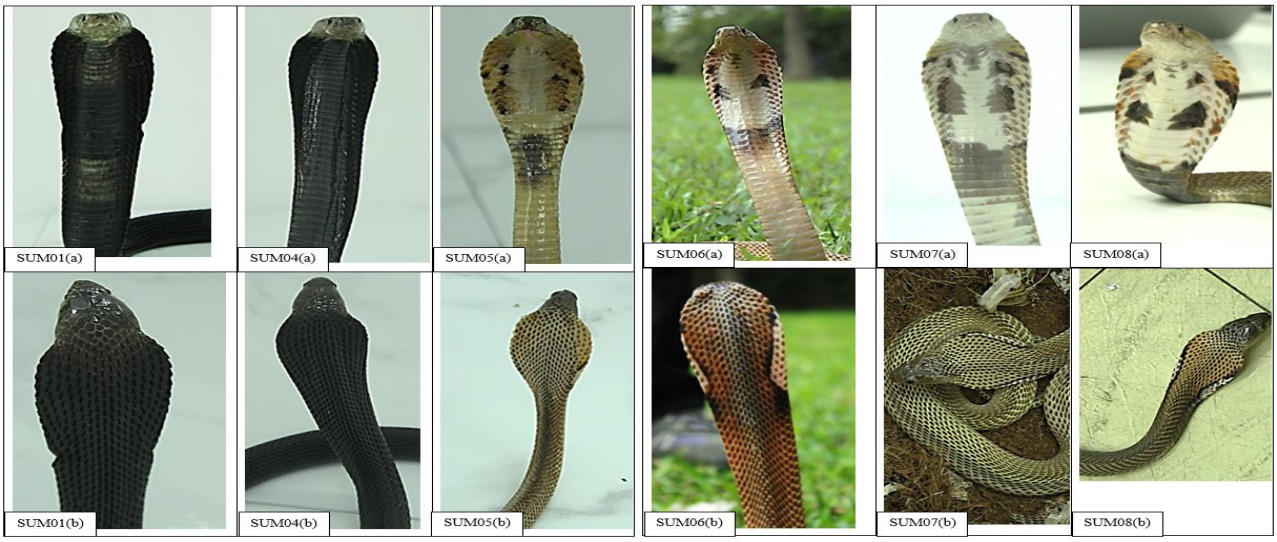

Figure 2. a) ventral and b) dorsal of hood appearances of several samples (SPU01-08) of *N.sumatrana*.

Table 1. Hood morphology of captured samples.

Code	Hood Length	Left Side	Right Side
SPU01	29	29	21
SPU02	22	22	21
SPU03	27	27	20
SPU04	20	20	18
SPU07	18	18	16
SPU08	15	15	14
SUM01	42	42	36
SUM02	27	27	22
SUM03	20	20	19
SUM04	39	39	30
SUM05	21	21	19
SUM06	30	30	21
SUM07	31	31	23
SUM08	19	19	18

Morphometric data

Morphometric data was shown as below. Several morphometric data did not measure properly because of snake's nature, such as tail condition, which explained in more detail in discussion (**Table 2**).

Table 2. Morphometric data of captured samples.

	Morphometric				
Code	**Total Length**	**Snout-Vent Length**	**Tail Length**	**Head Width**	**Tail Condition**
SPU01	118	101	17	3.4	Intact
SPU02	112	95.5	16.5	2.6	Intact
SPU03	108	93	15	2.5	Intact
SPU04	124	114	10	3.5	Severed
SPU05	126	110	16	3.6	Intact
SPU06	125	107	18	3.5	Intact
SPU07	65	53	12	1.9	Intact
SPU08	123	106	17	3.5	Intact
SUM01	126	116.5	9.5	3.2	Severed
SUM02	130	119	11	3.6	Severed
SUM03	101	89	12	2.8	Intact
SUM04	97	84.5	12.5	2.8	Intact
SUM05	85	74.5	10.5	2	Severed
SUM06	121	105	16	3	Intact
SUM07	112.5	100.5	12	2.5	Severed
SUM08	117	98.5	18.5	2.5	Intact

Meristic counting

Meristic counting data were shown in **Table 3 and 4** below:

Table 3. Meristic counting on *N. sputatrix*

Scale	**Specimen**							
Code	**SPU01**	**SPU02**	**SPU03**	**SPU04**	**SPU05**	**SPU06**	**SPU07**	**SPU08**
Rostral	1	1	1	1	1	1	1	1
Supralabial (contact orbit)	7 (3, 4)	7 (3, 4)	7 (3, 4)	7 (3, 4)	7 (3, 4)	7 (3, 4)	7 (3, 4)	7 (3, 4)
Infralabial	8	8	9	8	9	8	9	8
Nasal	2	2	2	2	2	2	2	2
Preocular	1	1	1	1	1	1	1	1
Postocular	3	3	3	3	3	3	3	3
Supraocular	1	1	1	1	1	1	1	1
Internasal	1	1	1	1	1	1	1	1
Prefrontal	1	1	1	1	1	1	1	1
Frontal	1	1	1	1	1	1	1	1
Parietal	1	1	1	1	1	1	1	1
Temporal anterior	2	2	2	2	2	2	2	2
Temporal posterior	4	4	4	4	4	4	4	4
Midbody dorsal	21	18	18	19	18	21	20	19
Ventral	165	186	157	180	179	175	169	159
Caudal	45	46	55	49	73	48	52	48

Table 4. Meristic counting on *N. sumatrana*.

Scale	Specimen							
Code	**SPU01**	**SPU02**	**SPU03**	**SPU04**	**SPU05**	**SPU06**	**SPU07**	**SPU08**
Rostral	1	1	1	1	1	1	1	1
Supralabial (contact orbit)	7 (3, 4)	7 (3, 4)	7 (3, 4)	7 (3, 4)	7 (3, 4)	7 (3, 4)	7 (3, 4)	7 (3, 4)
Infralabial	8	8	8	7	7	9	8	8
Nasal	2	2	2	2	2	2	2	2
Preocular	1	1	1	1	1	1	1	1
Postocular	3	3	3	3	3	3	3	3
Supraocular	1	1	1	1	1	1	1	1
Internasal	1	1	1	1	1	1	1	1
Prefrontal	1	1	1	1	1	1	1	1
Frontal	1	1	1	1	1	1	1	1
Parietal	1	1	1	1	1	1	1	1
Temporal anterior	2	2	2	2	2	2	2	2
Temporal posterior	4	4	4	4	4	4	4	4
Midbody dorsal	18	16	16	18	18	17	18	16
Ventral	182	187	181	191	191	183	184	201
Caudal	25	43	44	43	39	53	36	52

Discussion

Various species that are relatively widely distributed (intercontinental, inter archipelagic, large islands, and others) have the potential to have wide variations in their various characteristics. Three of the characteristics frequently observed in reptiles, especially Serpentes, are morphology, meristic, and morphometric. On the research related to hood morphology, variations in the shape and length of the hood in *N. sputatrix* and *N. sumatrana* were found. *N. sumatrana* has variations in body and hood coloration which are quite contrasting between populations from Sumatra and Borneo. The hood on cobras is aposematic mechanism to scare away potential predators. The hood makes them appear larger and more threatening[23]. There's also automimicry phenomenon shown in the hood of India cobra (*N. naja*) which gives some kind of *false eyes* located on the ventral and dorsal of the hood[24].

Among 16 cobra specimens, there were found the tendency of asymmetrical hood with the left side always being longer than the right side. Based on observations, the degree of hood asymmetry in *N. sumatrana* tended to be greater than *N. sputatrix* according to the difference of expanded scales on each anterior side of the body. Whether the symmetry of the hood affects the aposematic and/or automimicry function needs further research. Considering that *N. sputatrix* and *N. sumatrana* are also true spitting cobras, it is not yet known whether this form of symmetry affects their spitting ability. One of the specimens (SUM01) had a concave-shaped scar located on the left side of the middle portion of the hood, possibly representing a failed predation attempt in the past.

In terms of body coloration, *N. sputatrix* varied from blackish brown, milk chocolate, to yellowish brown (*sulphur cobra*) with the ventral part of the body generally being lighter colours than the dorsum. The head, especially the infralabial and supralabial, is also lighter in colour than the dorsum. In the

sulphur color variation, the colour difference between labial and body are not very visible. Meanwhile, in terms of motives and patterns on the back of the hood, *N. sputatrix* tended to have a more homogeneous pattern and the same colour as the posterior dorsal body[25]. However, many variations in the form of a V-like or a *faint saddle* pattern that cannot be seen except at close range. It is possible that this variation is a neoteny character because the young *N. sputatrix* usually hatch with the common, clearer pattern. In front hood (ventral side) of N. sputatrix, the first few scales can be the same or different colour as the rest of the ventral scales. In different colour variation, the first few scales are brighter colour like pseudo-orange or reddish than the rest of it. Front hood (ventral side) does not have any pattern.

The *N. sumatrana* population in Borneo has darker coloration than the Sumatran one and *N. sputatrix* populations, namely bluish-metallic black, with no pattern on the anterior or posterior, ventral or dorsal. Head, especially around the rostrum, supralabial and mandible, has lighter colour than the body. There is a variation of neoteny which is similar to *N. sputatrix* but on the body, namely the presence of faint, sparse striped pattern which is a remnant of the individual's character when they were young. This striped pattern is more clearly found on the ventral part of the body. The colour of the hood of Borneo *N. sumatrana* does not differ from the colour of the dorsal and ventral body. The hood is narrow and extends downwards[26,27].

The population of *N. sumatrana* in Sumatra had lighter color, like yellowish brown with gradation sometimes light orange. The ventral part is lighter colour than the dorsal. This population also has the same variation of neoteny as the Borneo population, namely the presence of faint, sparse stripes along the dorsal and ventral body. This change in colour pattern or disappearance of stripes is a feature also observed in *N. mandalayensis*[28] and also *N. fuxi*[1]. The hood of *N. sumatrana* in Sumatran population has the most dramatic coloration and pattern. The dorsal hood has a pair of bright colour patterns that extend laterally at the back half of the hood. The ventral hood is white or yellow in colour with a single black band along 7-10 scales located below the hood border. Around the centre of the hood there is a pair of large, asymmetrical black blotch 2-6 scales long, with other additional black spots distributed varying depending on the individual.

The pattern of a pair of main black blotches on the ventral part of the hood of *N. sumatrana* in Sumatran population is quite interesting because at first glance it is similar to the condition of *N. naja* in South Asia. They have same pattern and only in *N. naja*, the pattern is more rounded and symmetrical so it is more looks like eyes. It is possible that, if the pair of asymmetrical black patterns found on *N. sumatrana* function as false eyes to intimidate potential predators. This pattern could evolve into a pattern that is more symmetrical and more similar to real eyes.

It is still not known for certain why the populations of *N. sumatrana* in Borneo and Sumatra have such contrasting colours. It could be that the black colour in Borneo population is a melanistic variation of the Sumatran population which was favoured by natural selection on the island of Borneo. This advantage could be related to the function of thermoregulation, considering that snakes are poikilothermic animals that need heat from sunlight. Additionally, it may also be related to cryptic coloration which makes black individuals more difficult to detect visually than other colors. Furthermore, this colour also matches the post-fire forest/swamp landscape[18]. In general, snakes with plain colour patterns or without many lines, spots and blotches are generally snakes that rely on background camouflage and will try to escape quickly if their position is known[26]. Cobras generally do

this and they will only stand up and spread their hoods if they feel cornered and forced to defend themselves with other methods[6].

The cobra's body in general are often described as *robust* with a relatively short tail and a head that can be distinguished from the neck, with the snake's overall body size being moderate to relatively large[27]. Based on snake morphometric measurement, the data about total length, tail length, SVL and head width were obtained. Some morphometric measurements commonly performed such as head length and eye width, could not be carried out due to most of the specimens were live specimens: SPU04, SUM01, SUM02, SUM05, and SUM07 had partially broken tails so that maximum measurements could not be taken. The severed tail of these snake could be indicated that these snakes have survived predation efforts, both from local and invasive predators such as cats and dogs; also, may indicates that these snakes have had confrontations with humans. Many people tend to kill snake in sight, especially venomous ones. According to the World Health Organization (WHO) in the Guideline of the Management of Snakebites[28], *N. sputatrix* and *N. sumatrana* are classified as Category I venomous snakes means they have venom that has the potential to kill humans and are often found in human areas. Sexual dimorphism can be seen between male cobras and female cobras, for example tail length, head length, and differences in body size when they reach 2-3 years of age[29]. Due to limited characteristics of the study samples to measure, the morphometric tables do not have sufficient data to confirm the sexual dimorphism phenomenon. From the results of meristic calculations, it is known that the ventral scales and dorsal scales in the middle of the body can be used to differentiate between *N. sputatrix* and *N. sumatrana* (outside of geographical area and coloration). The ventral scales of *N. sumatrana* tended to be more abundant than those of *N. sputatrix*. In contrast, the middle dorsal scales of *N. sputatrix* are more abundant than *N. sumatrana*. Most of the samples had general characteristics except for specimens SUM04 (supralabial and infralabial scales) and SUM05 (infralabial scales). In SUM04, there are only 6 supralabial scales with only scale III contacts with the orbit, whereas usually for *N. sumatrana* there are 7 supralabial scales with scales III and IV contact with the orbit. In both SUM04 and SUM05, there are only 7 infralabial scales, while generally *N. sumatrana* has 8-9 infralabial scales. The exact reason why the number of SUM04 and SUM05 scales is less than usual is not yet known.

Conclusions

The differences between *N. sputatrix* and *N. sumatrana* are quite significant in hood morphology, namely from variations in colouring, pattern and symmetry of the hood. Further study needed to determine why several colorations occurred in same species. Morphometrically, there are no striking variations in the two species and there is no correlation between head width and SVL. Incomplete morphometric conditions such as a broken tail and defects in the hood are signs of a harsh life in the wild and/or potential conflict with humans, considering their intersecting habitats. Snake meristic tend to be consistent with existing literature, but there are some anomalous findings. The combination of colouring variations, patterns and symmetry of the hood with meristics can be used to differentiate between *N. sputatrix* and *N. sumatrana*.

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Conflicts of Interest

The authors declare no conflict of interest

References

1. Ratnarathorn N, Nadolski B, Sumontha M, et al. An expanded description, natural history, and genetic variation of the recently described cobra species *Naja fuxi* Shi et al., 2022. *Vertebr Zool*. 2023;73:257-276. doi:10.3897/vz.73.e89339
2. Yap MKK, Tan NH, Sim SM, Fung SY. Toxicokinetics of *Naja sputatrix* (Javan spitting cobra) venom following intramuscular and intravenous administrations of the venom into rabbits. *Toxicon*. 2013;68:18-23. doi:10.1016/j.toxicon.2013.02.017
3. Wuster W. *Population evolution of the asiatic cobra* (*Naja naja*) *species complex*. University of Aberdeen; 1990.
4. Laing AVP. *A multilocus phylogeny of the cobra clade elapids*. [*Theses*]. Bangor University; 2018.
5. Sy EY, Ong BKC. Equatorial spitting cobra *Naja sumatrana* on Pangulasian Island, Palawan Province, Philippines. Southeast Asia Vertebr Rec. 2020;25-26.
6. Young BA, Kardong KV. The functional morphology of hooding in cobras. *J Exp Biol*. 2010;213(9):1521-1528. doi:10.1242/jeb.034447
7. Layloo I, Smith C, Maritz B. Diet and feeding in the Cape Cobra, *Naja nivea*. *African J Herpetol*. 2017;66(2):147-153. doi:10.1080/21564574.2017.1388297
8. Corlett RT. Vertebrate carnivores and predation in the oriental (Indomalayan) region. *Raffles Bull Zool*. 2011;59(2):325-360.
9. Abdullah NAH, Rusmili MRA, Zainal Abidin SA, et al. Isolation and characterization of a2-eptx-nsm1a, a secretory phospholipase a2 from Malaysian spitting cobra (*Naja sumatrana*) venom. *Toxins (Basel)*. 2021;13(12):1-17. doi:10.3390/toxins13120859
10. Abdurrauf M. Penanganan trauma mata akibat semburan bisa ular. *J Kedokt Syiah Kuala*. 2016;16(3):181-184.
11. Das I. *A Field Guide to the Reptiles of South-East Asia*. New Holland Publisher; 2010.
12. Rusli N. *Panduan Bergambar Ular Jawa*. Indonesia Herpetofauna Foundation; 2020.
13. Patria MP, Kholis N, Amarasinghe AAT, et al. A citizen science survey of urban snakes at the Campus of Universitas Indonesia. *Herpetol Conserv Biol*. 2022;17(2):433-441.
14. Wibowo A, Basukriadi A, Nurdin E. Applications of convex polygon and kernel density analyses to model the home ranges of equatorial spitting cobra *Naja sputatrix* (boie, 1827) in green areas of Universitas Indonesia Campus, West Java. *Zoo Indones 2022*. 2022;31(2):121-131.
15. Yudha DS, Eprilurahman R, Asti HA, et al. *Keanekaragaman Amfibi Dan Reptil di Kampus Universitas Gadjah Mada*. UGM Press; 2022.
16. Khoerunisa I, Kusrini MD, Mardiasturi A. Diversity of snake rescued from residential areas in Greater Jakarta Metropolitan Area, Indonesia. *Media Konserv*. 2021;26(3):231-238. doi:10.29244/medkon.26.3.231-238
17. Lattanzio MS, Buontempo MJ. Ecogeographic divergence linked to dorsal coloration in eastern hog-nosed snakes (*Heterodon platirhinos*). *Herpetologica*. 2021;77(2):134-145. doi:10.1655/Herpetologica-D-19-00031.1
18. Caro T, Koneru M. Towards an ecology of protective coloration. *Biol Rev*. 2021;96(2):611-641. doi:10.1111/brv.12670
19. Koneru M, Caro T. Animal coloration in the anthropocene. *Front Ecol Evol*. 2022;10(April):1-18. doi:10.3389/fevo.2022.857317
20. Chowdhury MAW, Islam MR, Auawal A, et al. On the occurrence of persian gulf sea snake,

Hydrophis lapemoides (Gray, 1849) (Reptilia, Squamata, Elapidae, Hydrophiinae), along the Coast of Bangladesh. *Check List*. 2021;17(4):1075-1080. doi:10.15560/17.4.1075

21. Faraghi S, Kami HG, Mohammadi Z. Asymmetry study of meristic characters of head in Schmidt's whip snake (*Dolichophis schmidti*) and large whip snake (Dolichophis jugularis) in north of Iran. *J Anim Environ*. 2020;12(3):105-114. doi:https://doi.org/10.22034/aej.2020.111133
22. Esquerré D, Donnellan S, Brennan IG, et al. Phylogenomics, biogeography, and morphometrics reveal rapid phenotypic evolution in pythons after crossing Wallace's Line. *Syst Biol*. 2020;69(6):1039-1051. doi:10.1093/sysbio/syaa024
23. Shi SC, Vogel G, Ding L, et al. Description of a new cobra (*Naja laurenti*, 1768; Squamata, Elapidae) from China with designation of a neotype for *Naja atra*. *Animals*. 2022;12(24). doi:10.3390/ani12243481
24. Suryamohan K, Seshagiri S. *Naja naja* (Indian Cobra). *Trends Genet*. 2020;36(10):804-806. doi:10.1016/j.tig.2020.06.007
25. Slowinski JB, Wuster W. A new cobra (Elapidae : *Naja*) from Myanmar (Burma). *Herpetologica*. 2000;56(2):257-270. doi:180.245.133.225
26. Allen WL, Baddeley R, Scott-Samuel NE, et al. The evolution and function of pattern diversity in snakes. *Behav Ecol*. 2013;24(5):1237-1250. doi:10.1093/beheco/art058
27. Cox N, Young BE, Bowles P, et al. A global reptile assessment highlights shared conservation needs of tetrapods. *Nature*. 2022;605(7909):285-290. doi:10.1038/s41586-022-04664-7
28. World Health Organization. Management of snakebites (WHO 2nd Ed) 2016. *Guidel Manag snakebites, 2nd Ed*. Published online 2016:vi, 140 p.
29. Singchat W, Kraichak E, Tawichasri P, et al. Dynamics of telomere length in captive Siamese cobra (*Naja kaouthia*) related to age and sex. *Ecol Evol*. 2019;9(11):6366-6377. doi:10.1002/ece3.5208