

BIOMA: Berkala Ilmiah Biologi

Available online: <https://ejournal.undip.ac.id/index.php/bioma/index>

Diversity and distribution of viper snakes (Viperidae) in Yogyakarta

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ABSTRACT

Research on venomous snake's diversity in Yogyakarta has been conducted. Previous research showed that there were 3 species of viper snakes in Yogyakarta. Viper snakes are highly venomous with hemotoxin venom. Viper's snakebite cases occurred in Bantul, Kulon Progo and Gunungkidul while antivenom is not yet available in Indonesia. The research aim was to determine species and distribution of viper snakes in Yogyakarta. Sampling used were VES, transect and time search methods. Sampling was carried out twice a day. Four species of viper snakes were found in Yogyakarta: *Trimeresurus albolabris*, *Trimeresurus insularis*, *Craspedocephalus puniceus*, and *Calloselasma rhodostoma*. Shannon-Wiener Diversity Index (H') in forested hill was 0.264; in forested lowland was 0, and in human settlement in lowland was 0.318. Distribution of vipers in Yogyakarta is uneven, mostly found in forested areas and rivers with riparian vegetation, particularly *Trimeresurus albolabris*. *Craspedocephalus puniceus* distribution was on montane forest with cool temperatures. *Calloselasma rhodostoma* distribution was on submontane karst with quite hot temperatures. These research provide most up-to-date data on viper's species diversity and distribution. This result can be a reference for ministry of health to produce and evenly distribute specific antivenom especially for vipers, and for health services and hospitals to prepare antivenom when snakebite accident occur.

Keywords: Venomous; snakes; species; habitat.

1. INTRODUCTION

Research on snakes' diversity in the Special Region of Yogyakarta (DIY = Daerah Istimewa Yogyakarta) Province has been conducted by lecturers and students from the Laboratory of Animal Systematics, Faculty of Biology, Universitas Gadjah Mada (UGM). Research was conducted in riverine areas and conservation areas such as research in 2012 along the Code River, in 2013 along the Opak River, in 2013 in the Sermo Wildlife Sanctuary, in 2014 along the Gadjah Wong River, in 2015 along the Winongo River, in 2016 along the Tambakbayan River, in 2018 in the Paliyan Wildlife Sanctuary (Yudha, et al, 2015; 2016a; 2016b; 2018; 2022; 2024). Additionally, snake diversity exploration was conducted in the Mudal Kulon Progo and Gunung Kidul areas (Prasintaningrum et al, 2017; Ayu et al, 2020; Saputro et al, 2020). Several unpublished snake diversity exploration activities were also conducted in several areas of Yogyakarta.

Previous research provides information on snake species belonging to the Viperidae family in Yogyakarta, i.e., *Trimeresurus albolabris*, *Trimeresurus insularis* and *Craspedocephalus puniceus*. *Trimeresurus insularis* is known to be distributed only in the eastern part of Indonesia, not in the Java Island region, especially in central and western Java. Several explorations show that *Trimeresurus insularis* is also found in the central area of Java Island, especially in the Central Java and DIY regions (Hanifa et al, 2016; Maharani, 2016; Faz, 2017; Ramadhani, 2018; Asti et al, 2018; Saliyo et al, 2018; Saktyari & Geraldhy, 2018; Ramadhani et al, 2018; Kennedi, 2018; Yudha, 2019; Stiana, 2019; Irwanjasgoro, 2019; Aulan, 2019; Ramadhani, 2020; Ramadhan et al, 2021; Gusli, 2021).

These three viper species found in Yogyakarta are a highly venomous snakes with hemotoxin-type venom. Several cases of snakebites from these vipers have occurred in the Yogyakarta region, especially in Bantul, Kulon Progo, and Gunung Kidul, whereas antivenom for this venom type is not yet available in Indonesia (Maharani, 2016; Asti et al, 2018; Ramadhani et al. 2018; Saliyo et al, 2018; Irwanjasgoro, 2019; Stiana, 2019; Yudha, 2019).

Data about viper snakes' habitat and distribution in Yogyakarta were scattered and not well documented. Meanwhile viper snakes' habitat is greatly reduced by human expansion specially to build a settlement. Land

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Received: 24 August 2025, Accepted: 8 February 2026

Cite this article as: Yudha et al, (2026) BIOMA: Berkala Ilmiah Biologi, 28(1): 73-79

clearing for settlements has reduced vipers' natural habitat and forced them to adapt to human residential areas (Barnes & Knierim, 2019). This adaptation can lead to human-viper snakes' conflict such as snakebite accident which can be fatal to human. This study is expected to provide up-to-date information and additional data about viper snakes species and its distribution. This updated and more comprehensive database can serve as a reference for further research, particularly those related to snakebite accidents and the production and distribution of antivenom to hospitals. The objectives of this study are: to identify viper snakes' species in Yogyakarta; to determine the distribution of Viper snake species in Yogyakarta; and to provide more complete database on the distribution of Viper snake species in Yogyakarta.

2. MATERIAL AND METHODS

2.1 Study area

This research was conducted in the Province of Yogyakarta Special Region (**Figure 1**). Sampling locations were determined based on habitat potential, previous research results, information from residents and snake rescue volunteers.

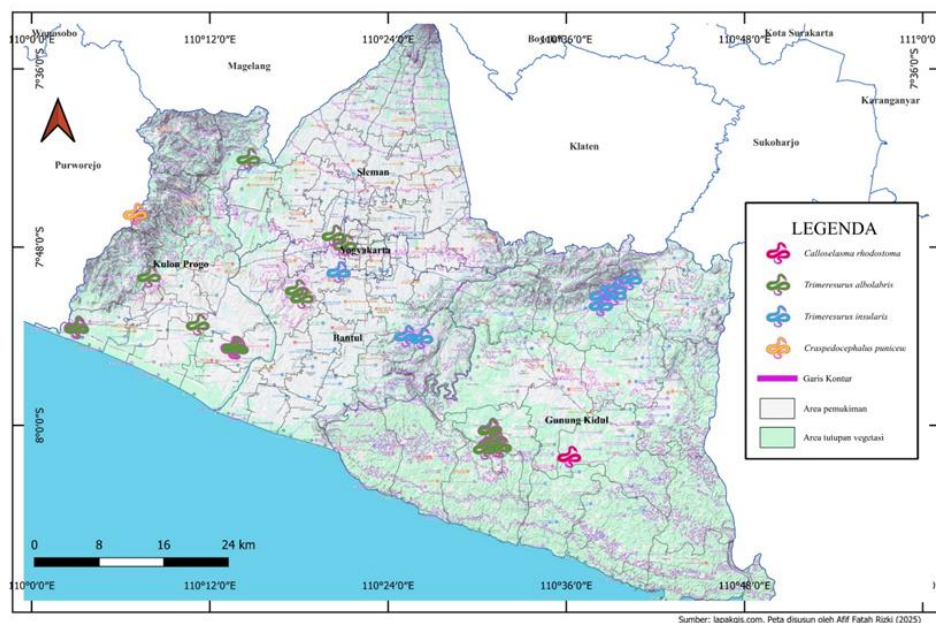


Figure 1. Sampling location and diversity map of viper snakes in Yogyakarta.

Sampling locations were divided into three parts based on the viper snakes' habitat type and its potential habitat, since snakes do not recognize administrative boundaries. Snakes only perceive differences in habitat type as limits to their distribution. Three parts of sampling locations were: Forested Hills (FH); Forested Lowlands (FL), and Human Settlement in Lowland areas (HSL). The term "forested" in the sampling location parts in our research means area with dense vegetation especially trees and undergrowth.

The Forested Hills sampling locations were in Girimulyo and Kalibawang part of Kulon Progo Regency; Paliyan, Nglipar, Ngawen and Semanu part of Gunungkidul Regency; and Pajangan, Imogiri and Dlingo part of Bantul Regency. The Forested Lowlands sampling locations were in Lendah, Temon, Pengasih and Panjatan part of Kulon Progo Regency; and Kasihan part of Bantul Regency. Afterwards the Human Settlement in Lowland areas sampling locations were in Wirobrajan part of City of Yogyakarta; Gamping part of Sleman Regency; and Kasihan part of Bantul Regency.

2.2 Materials

Materials used in the study were: snake gloves; snake hooks; snake grab-sticks, wheat sacks, boots, GPSMap Garmin 64s and captured living viperid snakes. Snake gloves, snake hooks, and snake grab-sticks were used as safety tools to capture the snakes; wheat sacks used as a temporary snake container to bring the

snakes from field study to the laboratory; boots used as a safety tool when hunting the snakes; GPSMap Garmin 64s used to record location of snakes captured.

2.3 Visual Encounter Survey, Transect and Time Search

Sampling employed were combination of several methods, i.e.: VES (Visual Encounter Survey), Transects walks, and Time-constrained Search. Visual Encounter Survey used to actively search snakes in the study area. Transects walks applied along the river and forested lowland area sampling. We use transect of 500 m long in the study area. Meanwhile Time-constrained Search used to delimit the time to search the snakes in the study area. Sampling carried out at night starting at 07.00 pm until 11.00 pm (four hours on Time Search method). Each viper snakes observed were directly caught and put it in the wheat sacks, and then we tag the location using GPSMap Garmin 64s. All captured vipers were immediately placed in wheat sacks to be taken to the Laboratory of Animal Systematics, Faculty of Biology for morphological identification. Data analyzed in this research only for captured and identified in the laboratory. After identification, the snakes were released to the location where they were once captured.

2.4 Data analysis

Data on snakes' diversity and number of individuals in each sampling location were tabulated (**Table 1**). Snakes' diversity in each sampling location is calculated using the Shannon-Wiener Diversity Index (H').

Shannon-Wiener index:

$$H' = - \sum p_i \ln p_i \quad (1)$$

where H' is Shannon-Wiener Diversity Index, p_i is proportion of individuals of species, shannon-Wiener Index categories (Botejue and Wattavidanage, 2012) are $H' < 1$ for low species diversity, $1 \leq H' \leq 3$ for moderate species diversity, $H' > 3$ for High species diversity. The Shannon-Wiener Diversity Index was used to calculate species diversity (Bibi and Ali, 2013).

3. RESULTS AND DISCUSSION

During research, four species of snakes belonging to the Viperidae family were identified. These four species were: *Trimeresurus albolabris* (White-lipped Tree Viper), *Trimeresurus insularis* (White-lipped Island pitviper), *Craspedocephalus puniceus* (Flat-nosed pitviper), and *Calloselasma rhodostoma* (Malayan Pit Viper) (**Table 1**).

Table 1. Diversity, Number of individuals, Sampling Location and Distribution of Viper Snakes in Yogyakarta.

Species	Number of individuals on each sampling location			Total
	FH	FL	HSL	
<i>Trimeresurus albolabris</i>	16	23	2	41
<i>Trimeresurus insularis</i>	8	—	1	9
<i>Craspedocephalus puniceus</i>	2	—	—	2
<i>Calloselasma rhodostoma</i>	2	—	—	2
Total	28	23	3	54

Description: FH = Forested Hills; FL = Forested Lowlands; HSL = Human Settlement in Lowland areas.

Forested hills areas, especially in Kulon Progo and Gunungkidul Regencies, have the largest number of viper species with 4 species, followed by the forested lowland areas in Kulon Progo and Bantul Regencies, with two ilangspecies (Figure 1, Table 1). The diversity of viper species at three different sampling locations, based on the Shannon-Wiener Index, also yielded similar index values except for forested lowland sampling location. The forested hill sampling location had an H' index value of 0.264. This indicates that viper species diversity in the forested hill location is "low," meaning that few viper species dominated the community in the same habitat.

Furthermore, it can be interpreted that the forested hill area is dominated by one viper species i.e., *Trimeresurus albolabris* (Figure 2, Table 1).

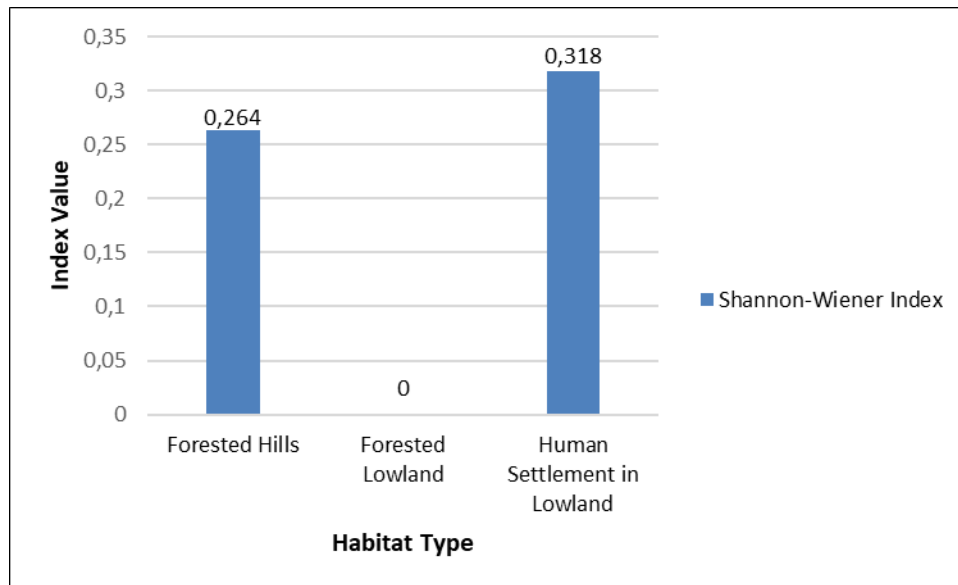


Figure 2. Shannon-Wiener Diversity Index of viper species in Yogyakarta.

Meanwhile, Shannon-Wiener Index at the forested lowland sampling location has an index value of $H' = 0$. This can be interpreted that there is only one species of viper snake at the forested lowland location. An index value of 0 also means that there is no diversity of viper snake in that area. One viper snake in forested lowland area was *Trimeresurus albolabris* (Figure 3).



Figure 3. Viper snake species *Trimeresurus albolabris* found in Yogyakarta.

Shannon-Wiener Index at the human settlement lowland area was $H' = 0.318$. This indicates that the diversity of viper snake species in the lowland residential area is "low," meaning that there was only small number of viper snake species (less than three species) in the area and none species dominated the community because each species population was low, less than 3 individuals (Table 1).

Based on the number of individuals encountered, *Trimeresurus albolabris* was the most frequently encountered in the Yogyakarta Special Region (DIY) in general, with a total of 41 individuals (Table 1). *Trimeresurus albolabris* was most frequently found in forested lowland areas with 23 individuals, followed by 16 individuals

in forested hill areas. Meanwhile viper species from the same genus but different species i.e., *Trimeresurus insularis* was most frequently found in forested hill areas with 8 individuals (Table 1).

Presence of *Trimeresurus albolabris* and *Trimeresurus insularis* in forested lowland and forested hill areas in our study is in accordance with their habitat preferences, i.e., forested areas near rivers at an altitude of 60 to 3000 meters above sea level and associated with trees (Das, 2010).

In a lowland human settlement area, two individuals of *Trimeresurus albolabris* and one individual of *Trimeresurus insularis* were found. These three viper snakes individuals were found near human settlements and were rescued by a snake volunteer team. The three individuals were likely escaped captive individuals, as the area is not a natural habitat for these viper species (Das, 2010). The term rescue refers to save the snakes from human habitation to prevent their killing and to relocate them to an uninhabited area.

Two individuals of *Craspedocephalus puniceus* were found in a relatively high hilly area (approximately 600 meters above sea level) with shady trees and relatively cool and humid air temperatures (24 to 26° C). This area is located in Girimulyo, Kulon Progo Regency (Figure 1, Table 1). This viper species was not found in the Gunungkidul hills, as the area tends to have hot and dry temperatures, in contrast to the cool and humid Girimulyo area. Meanwhile, *Calloselasma rhodostoma* was found in a forested karst hilly area (approximately 200 meters above sea level) with relatively hot and humid temperatures (30 to 32° C). This area is located in Paliyan and Semanu, Gunungkidul Regency. Two individuals of the *Calloselasma rhodostoma* were found in this forested karst hilly area. This viper species was not found in the forested hills of Girimulyo, because Girimulyo tends to have a cool and wet temperature, in contrast to the hot and dry Paliyan area. Previous studies about snakes in Yogyakarta has never found *Calloselasma rhodostoma* species. This problem probably due to its cryptic lifestyle. *Calloselasma rhodostoma* are nocturnal and terrestrial species, and associated with dense underbrush and rocky area, therefore this viper species were difficult to observe (Das, 2010).

Forested hill areas of Gunungkidul and Bantul Regencies are home to two similar viper species, *Trimeresurus albolabris* and *Trimeresurus insularis*. Both species exhibit similar behavior: they are arboreal and nocturnal. Furthermore, they share common prey: frogs, lizards, geckos, birds, and small mammals such as rodents (Das, 2010). However, based on Das (2010) and our research, there is a slight difference: *Trimeresurus albolabris* can be found even when its habitat is disturbed by human activity, such as near plantations and agricultural areas meanwhile *Trimeresurus insularis* is naturally found away from human activity areas.

This up-to-date data on viper species diversity and distribution in the Province of Yogyakarta (Figure 1, Table 1) can be a good reference for health services and hospitals to prepare first aid and antivenom when snakebite accident occurs. Furthermore, this up-to-date data can be used by environmental services and forestry services to understand venomous snakes' especially viper snakes' distribution and habitat in Yogyakarta in order to prevent or reduce land clearing. Land clearing can reduce viper snakes' habitat and those snakes will enter into human settlement to forage, this activity can generate human-snake conflict such as snakebite accident.

4. CONCLUSION

There were four species of viper snakes belonging to the Viperidae family in the Yogyakarta, i.e.: *Trimeresurus albolabris* (White-lipped Tree Viper), *Trimeresurus insularis* (White-lipped Island pit-viper), *Craspedocephalus puniceus* (Flat-nosed pit-viper), and *Calloselasma rhodostoma* (Malayan pit-viper). Shannon-Wiener Diversity Index (H') in forested hill was low; in forested lowland there was no diversity of viper snake because only one species found, and in human settlement in lowland was low.

The distribution of vipers in Yogyakarta is uneven, mostly found in forested areas with riparian vegetation, particularly around rivers, as these are suitable habitats for vipers particularly *Trimeresurus albolabris*. *Craspedocephalus puniceus* was found in hilly areas with shady trees and cool, humid temperatures. Meanwhile *Caloselasma rhodostoma* was found in karst hills with relatively hot and dry temperatures.

This up-to-date and more complete data on the species diversity and distribution of vipers in the Yogyakarta can be a reference for health services and hospitals to prepare first aid and antivenom in the event of a snakebite

accident. This data can also be a good reference for environmental services and forestry services in order to conserve areas for viper snake species.

ACKNOWLEDGMENT

We would like to express our gratitude to the Head of the Faculty of Biology, Universitas Gadjah Mada, for providing research funding through the 2024 Lecturer-Student Collaboration Grant program.

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