Journal of Biotechnology and Natural Science
Vol. 2, No. 2, December 2022, pp. 70-76

ISSN 2808-2508

Morphometric Variations of *Chalcorana chalconota* (Schlegel, 1837) in Four Populations in Jatimulyo Kulon Progo

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ARTICLE INFO

Article history
Received: December 1th 2022
Revised: December 7th 2022
Accepted: December 9th 2022

Keywords
Kedung Banteng
Kedung Pedut
Kembang Soka
Mudal River
MVSP

ABSTRACT

Jatimulyo is an ecotourism area consisting of several areas, each of which has a different height and abiotic factors. This can affect the morphometric character of frogs including *Chalcorana chalconota*. Research on specific morphometric variations of *Chalcorana chalconota* in Jatimulyo ecotourism has never been conducted. The purpose of this study was to analyze the distinguishing character of four frog populations as well as analyze the morphometric variation of the *Chalcorana chalconota* frog in Jatimulyo ecotourism. The research samples were taken using *the visual encounter survey* method and direct collection in the field in all four populations. Morphometric measurements use 32 characters. The measurement data obtained were analyzed using the *Kruskall-Wallis test* followed by UPGMA to see dissimilarity using the MVSP 3.1 program. The results showed that of the 32 characters observed and analyzed, there were nine characters that had a $p<0.05$ value which means it is significant to distinguish the four populations. The nine characters are (HW), (TD), (MFE), (MBE), (HAL), (LAL), (FOL), (IN), (MTL). LK, DT, JMMD, JMMB, JIN, PMD, PBR, PTJ4, PTM. *The frog Chalcorana chalconota* population of Kembang Soka has a high morphometric similarity with the population of Kedung Pedut. The Mudal River Population and the Bull Kedung Population have a considerable morphometric similarity with the Soka Flower and Pedut Flower Populations. This study can be concluded that the morphometric variation of *Chalcorana chalconota* in Jatimulyo ecotourism is influenced by altitude factors.

How to Cite: Aini, K., Hanifuddin, A., S., & Suwartiningsih N. (2022). Morphometric Variations of Chalcorana chalconota (Schlegel, 1837) in Four Populations in Jatimulyo Kulon Progo. Journal of Biotechnology and Natural Science, 2(2), 70-76.

1. Introduction

Indonesia is one of the centers of biodiversity in the world so it is called a megabiodiversity country (Triyono, 2013). One of the high biodiversity owned by Indonesia is amphibian diversity (Siahaan, 2019). Amphibians themselves are fauna that have an important role, including in the food chain, ecosystem balance and as an indicator of environmental damage (Yani, 2015). Indonesia has two orders of three orders in Amphibians, namely the Order of Gymnophiona and the Order of Anura (Setiawan *et al*., 2016). Anura in Indonesia reaches 450 types or 11% of all types in the world (Huda, 2018).

One type of amphibian found in Indonesia is *Chalcorana chalconota.* This frog is unique because it has a high tolerance for habitat changes such as moist habitats to dry habitats (Fauzi *et al*., 2021). In nature, this frog acts as prey to snakes, as well as a predator of many types of insects so that it can act as a natural enemy (Rohman *et al*., 2021). Several studies have found *Chalcorana chalconota* including in Berambai waterfall, Samarinda (Jasmaldi et al., 2019), in the Natural Tourism Park Area, Bogor (Fauzi et al., 2021); on the Pelus River, Banyumas (Puspitasari et al., 2021); and in seven springs in Malang (Rohman *et al*., 2021).

Research comparing the morphometric *Chalcorana chalconota* has also been conducted with samples from Banten, West Java, Central Java, and East Java (Praimbodo *et al.*, 2021). The results of this study showed that frogs from all four regions did not have far morphometric differences. Morphometric research is important to see the variations caused by environmental pressures, migration and isolation between populations (Praimbodo *et al.*, 2021).

Research on *Chalcorana chalconota* from the Special Region of Yogyakarta (DIY) has never been carried out. One of the places in DIY that *Chalcorana chalconota* can be found in Jatimulyo Kulon Progo. Jatimulyo is an ecotourism area consisting of several areas, such as the Mudal River, Kembang Soka, Kedung Pedut, and Kedung Banteng, each of which has a different height and abiotic factors (Mustofa *et al*., 2021). This can affect the morphometric character of frogs including *Chalcorana chalconota*.

Some of the studies that have been conducted in Jatimulyo include amphibian diversity on Mount Kelir, Jatimulyo (Qurniawan and Trijoko, 2012) and Herpetofoana diversity in Jatimulyo (Musthofa *et al.*, 2021). Research on specific morphometric variations of Chalcorana chalconota in Jatimulyo has never been carried out *Chalcorana chalconota* was chosen because it can be found in ecotourism areas and can be an environmental bioindicator. In fact, this research is important to determine morphometric differences due to different environmental conditions among areas within the Jatimulyo ecotourism area.The purpose of this study was to analyze the distinguishing character of four populations of Chalcorana chalconota frogs in Jatimulyo Kulon Progo ecotourism and analyze morphometric variations of morphometric variations of four populations of *Chalcorana chalconota* frogs in Jatimulyo Kulon Progo ecotourism.

2. Methods

2.1. Tools & Materials

The tools used in this study are gloves, boots, jar, paraffin boards, google earth application serves to find out the height of each population, the identification book, small aquariums, head lamps, calipers, digital soil analyzer tester serves to measure parameters, namely temperature, humidity and soil pH, thermometers, GPS, hygrometers, cellphone cameras.The materials used for this study are *Chalcorana chalconota*, *plastic clips*, chloroform, cotton, and 70% ethanol.

2.2. Study Area

The Study was condocted in jatimulyo . Sampling sites using purposive sampling method consisted 4 areas based on the different type of geographical location namely a Mudal River Area, a Kembang Soka, a Kedung Pedut, and a Kedung Banteng.

2.3. Data Collection

Frog sampling is carried out at night at 18.00-23.00 WIB. using the *Visual Encounter Survey* (VES) method at predetermined hours with four areas. Each region was taken five individuals of male frogs as a sample. The capture of frog samples is carried out by direct hands. The observed abiotic parameters include pH, water temperature, air temperature, humidity and altitude. The samples obtained were put into plastic *clips* or into a plastic plastic box to be taken to the Ecology and Systematic Laboratory of Ahmad Dahlan University to ascertain the type using the Identification book and observed morphometric variations.

2.4. Morphometric Character Measurements

Morphometric characteristics are measured with *a digital caliper* of 32 morphometric characters (referring to Figure 1) referring to Tjong *et al*. (2013) as shown in Table 1.

Table 1. Morphometric character of the Frog

No	Character	No	Character
1	SVL: Body length	17	IN: Inter Nares Distance
2	HL: Head length	18	EL: Eye diameter
3	HW: Head width	19	IOD: Inter Orbita Distance
4	STL: Distance from muzzle to tympanum	20	UEW: Eyelid width
5	MSL: Muzzle length	21	HAL: Manus to digiti length
6	SL: Distance from nose to muzzle	22	LAL: Branchium length
7	MSL: Eye to muzzle distance	23	FAL: Long Antebranchium
8	NTL: Nose distance to tympanum	24	HLL: Length of hind legs
9	EN: Eye to nose distance	25	THIGHL: the length of the femur (the distance between the cloaca distal femur
10	TEL: eye distance to tympanum	26	UEL: Eyelid length
11	DT: diameter tympanum	27	TL: Tibia Legth
12	ETL1: Mandibular eye distance	28	TFOL: Length from metatarsus to fingertips to four hind legs
13	MFE: Eye distance to back mandible	29	FOL: Length from tarsus to four hind legs
14	MBE: Eye distance to front mandibles	30	F3L: Finger length to the three front legs
15	1FL: Length of the first finger of the front foot	31	MTI: Ankle length
16	4TL: Length of the toes to the four hind legs	32	1TL: Length of finger to one hind leg

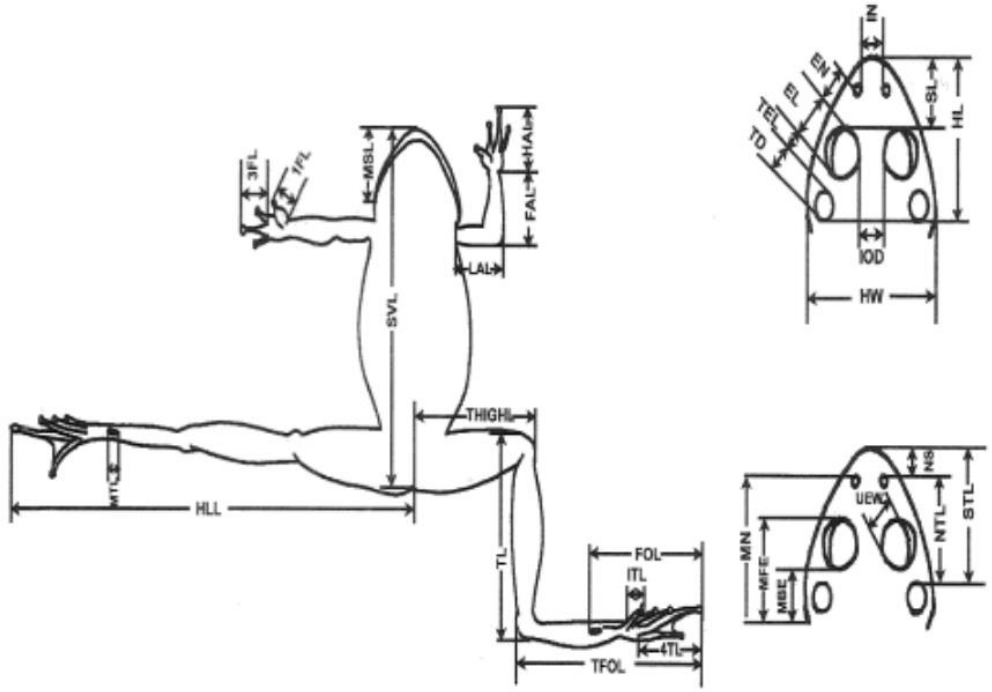

Fig. 1. Amphibian morphometric measurements (Tjong *et al.*, 2013)

2.5. Data Analysis

The measurement data obtained were each analyzed using the Kruskall-Wallis Test to see each of the characters that significantly distinguished the four populations. Data analysis for the similarity between conducted with UPGMA to see populations using the MVSP 3.1 program.

3. Results and Discussion

The results showed that of the 32 characters observed and analyzed, there were nine characters that had a $p<0.05$ value which means it is significant to distinguish the four

populations. The nine characters are LK, DT, JMMD, JMMB, JIN, PMD, PBR, PTJ4, PTM with averages, ranges and significance values can be seen in Table 2.

Table 2. Distinguishing Character of Four Populations of *Chalcorana chalconota* Frogs in the Jatimulyo, Kulon Progo Area

Character	Average ± std				Range	*p*
	Young Riverl	Soka Flower	Pedut Hood	Kedung Banteng		
SVL	1,00 ±0,00	1,00 ±0,00	1,00 ±0,00	1,00 ±0,00	1,00 - 1,00	1.000
HL	0,41 ±0,02	0,42 ±0,02	0,41 ±0,03	0,43 ±0,00	0,41 – 0,42	1,16
HW	0,25 ±0,02	0,27 ±0,03	0,28 ±0,02	0,28 ±0,02	0,25 – 0,29	0,41*
STL	0,30 ±0,05	0,29 ±0,02	0,31 ±0,03	0,34 ±0,03	0,30 – 0,32	1,42
MSL	0,37 ±0,02	0,39 ±0,02	0,40 ±0,03	0,41 ±0,01	0,38 – 0,41	2,06
SL	0,06 ±0,00	0,06 ±0.01	0,06 ±0,01	0,07 ±0,01	0,06 – 0,06	4,44
MSL	0,16 ±0,01	0,15 ±0,03	0,17 ±0,01	0,17 ±0,01	0,15 – 0,17	2,46
NTL	0,25 ±0,03	0,25 ±0,02	0,26 ±0,06	0,22 ±0,02	0,24 – 0,25	1,72
EN	0,11 ±0,02	0,11 ±0,01	0,08 ±0,02	0,10 ±0,02	0,08 – 0,12	1,27
TEL	0,02 ±0,00	0,02 ±0,01	0,02 ±0,00	0,02 ±0,00	0,02 – 0,03	1,46
TD	0,09 ±0,01	0,09 ±0,01	0,09 ±0,01	0,11 ±0,01	0,09 – 0,10	0,39*
ETL	0,33 ±0,02	0,35 ±0,02	0,34 ±0,03	0,34 ±0,01	0,33 – 0,35	1,79
MFE	0,11 ±0,01	0,18 ±0,10	0,25 ±0,02	0,28 ±0,02	0,13 – 0,27	0,07*
MBE	0,22 ±0,03	0,25 ±0,02	0,12 ±0,01	0,14 ±0,01	0,12 – 0,25	0,01*
IN	0,10 ±0,00	0,09 ±0,01	0,08 ±0,01	0,08 ±0,01	0,08 – 0,10	0,44*
EL	0,11 ±0,02	0,12 ±0,02	0,11 ±0,02	0,10 ±0,01	0,10 – 0,12	3,64
IOD	0,08 ±0,02	0,11 ± 0,06	0,07 ±0,00	0,09 ±0,01	0,07 – 0,10	1,43
UEW	0,13 ±0,01	0,14 ±0,01	0,13 ±0,02	0,15 ±0,01	0,13 – 0,14	1,46
HAL	0,26 ±0,03	0,28 ±0,02	0,26 ±0,02	0,22 ±0,01	0,25 – 0,27	0,16*
LAL	0,18 ± 0,02	0,19 ±0,03	0,20 ±0,03	0,23 ±0,01	0,19 – 0,21	0,17*
FAL	0,24 ±0,07	0,22 ±0,02	0,22 ±0,04	0,20 ±0,01	0,21 – 0,23	3,00
HLL	1,65 ±0,09	1,70 ±0,04	1,72 ±0,09	1,75 ±0,03	1,67 – 1,74	2,93
THIGHL	0,45 ±0,05	0,45 ±0,03	0,46 ±0,03	0,51 ±0,01	0,46 – 0,47	0,70
TL	0,08 ±0,03	0,07 ±0,01	0,07 ± 0,01	0,08 ±0,01	0,07 – 0,08	4,62
TFOL	0,53 ±0,03	0,55 ±0,02	0,52 ±0,05	0,55 ±0,01	0,52 – 0,55	4,97
FOL	0,58 ±0,13	0,50 ±0,02	0,50 ±0,03	0,48 ±0,02	0,47 – 0,56	3,09
F3L	0,55 ±0,12	0,73 ±0,02	0,74 ±0,06	0,78 ±0,01	0,60 – 0,81	0,03*
1FL	0,17 ±0,05	0,23 ±0,06	0,23 ±0,04	0,21 ±0,03	0,18 – 0,24	258
UEL	0,12 ±0,03	0,14 ±0,03	0,11 ±0,03	0,12 ±0,01	0,11 – 0,14	374
4TL	0,46 ±0,08	0,44 ±0,04	0,45 ±0,04	0,43 ±0,01	0,43 – 0,46	608
MTL	0,05 ±0,00	0,06 ±0,01	0,04 ±0,01	0,06 ±0,01	0,05 – 0,06	021*
1TL	0,15 ±0,02	0,17 ±0,01	0,14 ±0,02	0,12 ±0,04	0,13 – 0, 16	058

The results showed that there was a significant morphometric character, namely the head character in the form of (HD): head width, (TD): tympanum diameter, (MBE): front mandibular eye distance, (MFE): back mandibular eye distance, (IN); internares distance, (HAL): Length of manus to digiti, (LAL): length of branchium, (FOL): Length from tarsus to 4th leg of the back, (MTL): length of ankle.

From the nine characters, there are six head characters and three leg characters that can distinguish the characteristics of the four populations. The six morphometric characters found on the head are (HW): head width, (TD): tympanum diameter, (MBE): rear mandibular eye distance, (JMMD): mandibular eye distance for the front, (IN): internares distance, (LAL): branchium length. The three morphometric characters of the foot are (HAL): Length of manus to digiti, (PTJ4): Length of tarsus to toes to the four hind legs, (MTL): Length of ankles.

According to Rekamunandar (2012), morphometrics for each individual often show different measurement results. Some of the things that affect it are age, gender, sufficient food, living environment, and altitude. According to Zug et al. (1975) on Bufo in England, states that larger toads are found in more heterogeneous, wetter, and climatically more extreme areas. Castelano *et al*. (1999) states that frogs living in the highlands show significant differences in body size than frogs living at low altitudes.

The MBE, IN and HAL characters in the Mudal River population showed the highest value while the Kedung Banteng population showed the lowest value. The height of the Mudal River is the highest, while the height of the Bull Hood is the lowest (Table 4). MBE and IN characters are head characters, while HAL is front limb characters. According to Tarkhnishvili et al. (1999), that frogs living in the highlands showed a significant difference in body size from low-altitude populations, where frogs living in the highlands had larger sizes. This is because the plateau in this study has warmer water temperatures (23°C) and higher humidity (10 %) (Table 4). Warmer water temperatures and high humidity may lead to longer distances between the eyes and the front mandibles (MBE), the development of manus digiti (HAL) length and wider internares (IN) distances.

While the characters HL, TD, MFE, LAL, FOL, and MTL show the largest value in the population with the lowest height, namely the population of Kedung Banteng, while the lowest value at the top altitude is the Mudal River. It is in accordance with Castelano *et al*. (1998) which states that frogs living in lowlands are larger in size because they tolerate environmental temperatures better and grow faster during the pre-adult stage.

Table 3. Abiotic and altitude factors

Population	Altitude (Masl)	Water Temperature (°C)	Air Temperature (°C)	Soil Moisture (%)	Ph Air
Mudal River	646	23	25	10	7
Kembang soka	563	23	25	8	7
Kedung pedut	435	22	25	9	7
Kedung banteng	274	22	25	9	7

The results showed that the *frog Chalcorana chalconota* population of Kembang Soka has a high morphometric similarity with the population of Kedung Pedut. The Mudal River Population and the Kedung Banteng Population have a considerable morphometric similarity with the Kembang Soka and Kedung Pedut populations. The morphometric variations of four populations of *Chalcorana chalconota* frogs in Jatimulyo Kulon Progo Ecotourism form clusters as shown in Figure 2.

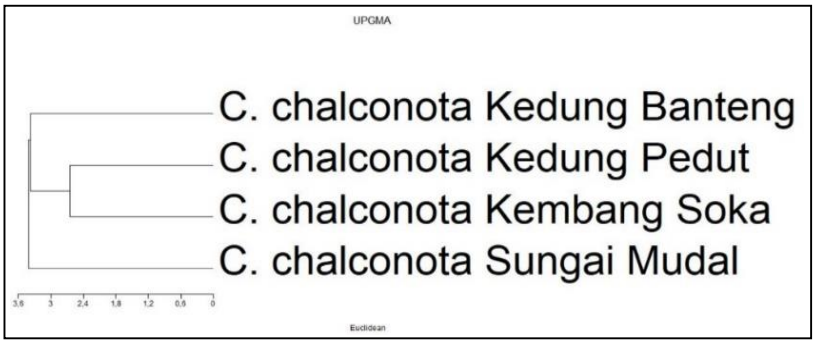

Fig. 2. Morphometric Variations of Four Chalcorana chalconota Frog Populations in Jatimulyo, Kulon Progo Ecotourism

The frog C*halcorana chalconota* from Kembang Soka population with an altitude of 563 meters above sea level has a high morphometric similarity with the population from Kedung Pedut with an altitude of 435 with a disimilarity value of 2,646 (Table 5). This can be seen from the morphometric similarities, among others, in the character (LK: head width), (TD: tympanum diameter), (MBE: front mandibular eye distance), (MFE: back mandibular eye distance), (IN: internares distance), (HAL: Manus to digiti length), (LAL: Branchium length), (FOL: Length

from tarsus to 4th leg of the back), (MTL: length of ankle). This morphometric similarity is also caused by the condition of Kembang Soka and Kedung Pedut which have similarities in terms of environmental factors such as habitat conditions. In addition, Kembang Soka and Kedung Pedut are one river flow from the Mudal River. Kedung Pedut and Kembang Soka are the same stream originating from the Mudal River. This is similar to the results of the research of Tjong *et al.* (2013) which states that morphometric similarities can result from environmental factors and habitat conditions.

The disimilarity value obtained in the Mudal River and Kedung Banteng was 3,464 (Table 5). Sungai Mudal is located in the top or highest population compared to other populations with an altitude of 646 meters above sea level, while Kedung Banteng is located in the bottom population with an altitude of 274 meters above sea level. Kutrup (2006). states that altitudes such as lowlands can affect morphometric variation. Morphometric variations can also be caused by habitat conditions. Altitude has an effect on the climate including temperature. Geographical circumstances and habitat conditions form the natural selection indicated on the differentiation of characters. Kutrup (2006) examined kinship relationships in green toads *(Fejervarya cancrivora)* derived from lowland and highland populations in the Mediterranean region and found variations in morphometric carkters.

Table 4. Morphobimetric Distance Matrix of Four Chalcorana chalconota Frog Populations in Mulyo teak ecotourism

Population	Mudal River	Kembang Soka	Kedung Pedut	Kedung Banteng
Mudal River	0,000			
Kembang Soka	3,464	0,000		
Kedung Pedut	3,317	2,646	0,000	
Kedung Banteng	3,464	3,162	3,606	0,000

4. Conclusion

The conclusions of this study is that there are nine distinguishing characters of the *Chalcorana chalconota* frog from the four populations, namely (HW), (TD), (MFE), (MBE), (HAL), (LAL), (FOL), (IN), (MTL) and the frog Chalcorana chalconota from kembang soka population has a high morphometric similarity with the Kedung Pedut population. The Mudal River Population and the Kedung Banteng Population have a considerable morphometric similarity with the kembang soka and kedung pedut Populations.

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