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Research Article

Morphological Variation of *Malayopython reticulatus* (Schneider, 1801) from Several Population in Indonesia

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ABSTRACT

Reticulated python (*Malayopython reticulatus*) is a widely distributed snake covering throughout Southeast Asia and almost all of Indonesia archipelago and divided into several subspecies based on morphological variation and its locality. Morphological variation data of *M. reticulatus* from Indonesia population has never been done thoroughly. This study aims to determine the morphological variations based on 21 meristic and 3 morphometric characters from several populations in Indonesia. The data was collected from the Museum Zoologicum Bogoriense (MZB) Cibinong, Indonesia and other additional collections that are carried out from June to July 2018 and then analyzed by Principal Component Analysis (PCA) to determine the population grouping. The result showed a high variation on the scale range of anterior prefrontal, posterior prefrontal, frontal, parietal, preocular, postocular, loreal, temporal, upper labial, lower labial, and dorsal scales. Ventral and subcaudal scales in male and female specimens show high variation in the total scale count, the ratio comparison of tl: SVL measurement, indicated the sexual dimorphism. Prefrontal (anterior-posterior) and frontal scales show high variation and difficult to distinguish between each locality at the subspecies level and suggest it to be intra-specific variation. There is no significant grouping were found between populations from data on morphological variations.

Keywords: Malayopython reticulatus, morphological variation, intra-specific variation, Indonesia

Introduction

Reticulated python (*Malayopython reticulatus*, Schneider, 1801) is a large constrictor snake of Pythonidae family that's widely distributed throughout Southeast Asia and almost all of Indonesia archipelago [1]. The widespread of this species give rises to morphological and genetic variations given by many factors such as population isolation, geographical barrier, evolutionary process and also the influence of the environment and its habitat. The variation is then used as a comparing reference (diagnostic character) for distinguishing a species [2]. Morphological variations are observed based on phenetic characters including color patterns, specific characteristics of species, patterns, and body size ratios, and meristical characters such as scale ranges [3]. These variations are further analyzed, to determine the existence of significant differences between species or sub-species.

M. reticulatus is divided into 3 subspecies based on its locality, namely *M. reticulatus reticulatus* (Greater Sunda), *M. reticulatus saputrai* (Selayar Island), and *M. reticulatus jampeanus* (Tanahjampea Island). Two subspecies recently recognized (*M. reticulatus saputrai* and *M. reticulatus jampeanus*) by having a few specific morphological variations that only subspecies posse-

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Table 1. *M. reticulatus* specimens observed from several populations in Indonesia, collection of Museum Zoologicum Bogoriense (MZB) LIPI and several additional specimens

No.	ID. Number	Population	Locality
1.	MZB. Ophi. 5287	**Sumatera**	Dalas, Southern Lampung
2.	MZB. Ophi. 201		F. Krakatau Island, Lampung
3.	MZB. Ophi. 4680		F. Krakatau Island, Lampung
4.	MZB. Ophi. 2412		Saraya, Southeast Aceh
5.	MZB. Ophi. 1692		Tiwi River, Kota Tua, Riau
6.	MZB. Ophi. 2192		Bengkalis, Riau
7.	MZB. Ophi. 2936	**Jawa**	Pangandaran, West Java
8.	MZB. Ophi. 197		Cikopo, West Java
9.	MZB. Ophi. 4681		Cikopo, West Java
10.	MZB. Ophi. 5286		Malang, East Java
11.	MZB. Ophi. 2152	**Kalimantan**	Hilir Village, Southern Barito, Central Kalimantan
12.	MZB. Ophi. 1906		Pontianak, West Kalimantan
13.	MZB. Ophi. 1457		Banjarmasin, South Kalimantan
14.	MZB. Ophi. 5884		Lumbis River, Nunukan, North Kalimantan
15.	MZB. Ophi. 3020		TNKM Kragan, Nunukan, East Kalimantan
16.	MZB. Ophi. 3121		Marang, Sangkulirang, East Kalimantan
17.	MZB. Ophi. 5785	**NTB**	Kawinda Toi, Sumbawa Island
18.	MZB. Ophi. 5589	**Maluku**	Saunulu, Central Maluku
19.	MZB. Ophi. 1951		Saunulu, Central Maluku
20.	MZB. Ophi. 4481		North Halmahera, North Maluku
21.	MZB. Ophi. 4482		North Halmahera, North Maluku
22.	MZB. Ophi. 194		West Seram Island, Maluku
23.	MZB. Ophi. 200		Timor Island, Maluku
24.	MZB. Ophi. 1558	**Sulawesi**	Anca Danau Lindu, Central Sulawesi
25.	MZB. Ophi. 3221		Dampala River, Morowali, Central Sulawesi
26.	MZB. Ophi. 2895		Goa Keramat, Tawaeli, Donggala, Central Sulawesi
27.	MZB. Ophi. 1762		Tomodo, Lindu Valley, Central Sulawesi
28.	MZB. Ophi. 2297		Marowo, Tojo Una-Una, Central Sulawesi
29.	MZB. Ophi. 1657		Jompi, Raha, Muna Island, Southeast Sulawesi
30.	MZB. Ophi. 4682		Jompi, Raha, Muna Island, Southeast Sulawesi
31.	MZB. Ophi. 2041		Latimojong Mountain, Luwu, South Sulawesi
32.	MZB. Ophi. 3436		Selayar Island, Southern Sulawesi Arhipelago
33.	MZB. Ophi. 3223		Tanahjampea Island, Southern Sulawesi Archipelago
34.	MZB. Ophi. 3437		Kalaotoa Island, Southern Sulawesi Archipelago
35.	S.Voucher. 020		Karompa Island, Southern Sulawesi Archipelago
36.	S.Voucher. 021		Kalaotoa Island, Southern Sulawesi Archipelago
37.	S.Voucher. 022		Kalaotoa Island, Southern Sulawesi Archipelago
38.	S.Voucher. 023		Madu Island, Southern Sulawesi Archipelago

ssed from certain locality [4]. These differences are based on the shape of the anterior-posterior prefrontal scales, yet are still confused to inclusively categorizes it as geographical or intraspecific variations, also as diagnostic characters. Thus, examining more specimens of *M. reticulatus* from several population in Indonesia is needed.

Therefore, we present an overview of morphological characters of *M. reticulatus* to address several problems, to wit: 1) the tendency of other morphological characters from several of *M. reticulatus* populations, 2) to verifying the diagnostic characters of *M. reticulatus* especially on subspecies level, 3) the grouping of *M. reticulatus* population in Indonesia.

Material and Methods

Specimens observation

All of 38 specimens of *M. reticulatus* from several populations in Indonesia were obtained from the collection of the Museum Zoologicum Bogoriense (MZB) that are observed during July-September 2018 and few additional specimens that are collected on July - Agustus 2013 and April - May 2014 (Table 1). Morphological variations were observed by meristic and morphometric

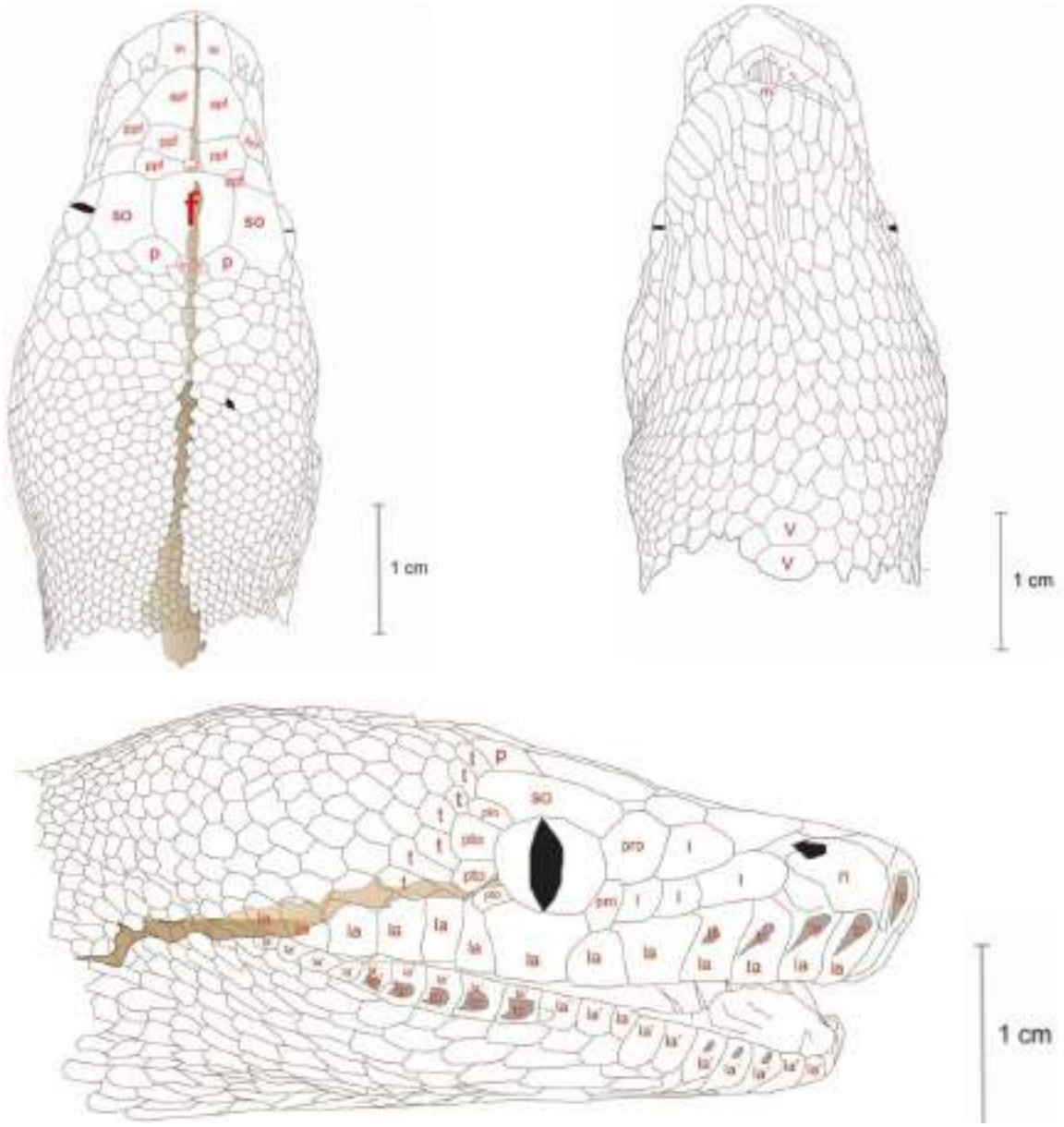

Figure 3. Meristical character on head scalation of *M. reticulatus* specimens that are observed. Abbrevation as follows: rostral (r), internal (i), anterior prefrontal (apf), posterior prefrontal (ppf), frontal (f), supraocular (so), parietal (p), interparietal (ip), preocular (pro), postocular (pso), loreal (l), temporal (t), upper labial (la), upper labial contacting orbit (lao), lower labial (la'), anterior upper thermal pits (tp), posterior lower thermal pits (tp'), mental (m), ventral (v). Scale bars = 1 cm. (illustrated by Luhur Septiadi).

characters.

Measurement of meristic, morphometric characters, and analysis

Morphometric characters are observed by 3 characters, as follows: a total of length (ToL), tail length (tl), and snout-vent length (SVL). Then, 21 meristic characters observed by scales counting, as follows: rostral (r), internasal (i), anterior prefrontal (apf), posterior prefrontal (ppf), frontal (f), supraocular (so), parietal (p), interparietal (ip), preocular (pro), postocular (pso), loreal (l), temporal (t), upper labial (la), upper labial contacting orbit (lao), lower labial (la'), anterior upper thermal pits (tp), posterior lower thermal pits (tp'), mental (m), dorsal midbody scales (d), ventral (v), and subcaudal (sc) (Figure 1), the characters used are according to Auliya [4] with standard measurement and scale counting following Lilywhite & Wray [5]. Male and female specimens were differenti-

Table 2. Measurement of meristic characters and morphometric ratios of *M. reticulatus* (♂=14, ♀=24).

Characters	Population										
	Sumatera		Jawa		Kalimantan		NTB	Maluku		Sulawesi	
	♂ (n=1)	♀ (n=5)	♂ (n=1)	♀ (n=3)	♂ (n=2)	♀ (n=4)	♂ (n=1)	♂ (n=4)	♀ (n=2)	♂ (n=5)	♀ (n=10)
r	1	1	1	1	1	1	1	1	1	1	1
i	2	2	2	2	2	2	2	2	2	2	2
apf	2	2-4	2	2	2	2	2	2	2	2-3	2
ppf	7	6-10	9	7-8	8	7-8	8	5-9	6	1-8	4-9
f	1	1-2	2	1-2	2	1-2	1	1-2	1	1	1-2
so	2	2	2	2	2	2	2	2	2	2	2
p	2	2-3	2	2	2	2	2	2	2-3	2	2
ip	1	2-3	1	3-5	2	2-4	2	1-3	2-3	1-2	1-3
pro	2	2	2	2	2	2-3	2	2	2	2	2
pso	2-4	4	3	4	3-5	3-4	4	2-4	3	2-4	2-4
l	3	3-5	5	4-5	2-4	2-6	4	3-4	4	2-6	3-4
t	4-5	6-8	7	6-7	7-8	6-8	6-7	5-7	5-7	5-7	4-8
La	14	13-14	13	13-14	14	12-13	13	12-14	13-14	12-15	11-13
Lao	7	7	7	7	7-8	7	7	7	7	7-8	6-8
la'	22	21-23	21-22	21-23	22-24	21	22	21-22	22	19-25	19-24
Tp	5	5-6	5	5	5	5	5	5	5	4-6	5
tp'	6	5-6	5	5	6	5	5	5	5	5-7	5-7
m	1	1	1	1	1	1	1	1	1	1	1
d	66	65-76	66	61-77	73-74	63-72	69	67-77	78-69	67-90	66-87
v	319	310-319	320	301-311	312-320	316-318	314	284-322	320-333	300-343	294-341
Sc	89	87-100	94	87-93	89-95	87-96	96	84-91	90-95	87-94	83-94
tl:Tol	0.17:1	0.14:1	0.14:1	0.12:1	0.14:1	0.13:1	0.14:1	0.14:1	0.12:1	0.13:1	0.12:1
SVL:Tol	0.83:1	0.86:1	0.86;1	0.88:1	0.86:1	0.87:1	0.86:1	0.86:1	0.88:1	0.86:1	0.87:1
tl:SVL	0.20:1	0.16:1	0.16:1	0.14:1	0.16:1	0.15:1	0.16:1	0.16:1	0.13:1	0.15:1	0.14:1

ated to avoid bias due to sexual dimorphism on snakes, ToL, tl, SVL are converted into ratio. The results of morphometric and meristic character measurement were compared with previous studies. The data were further analysed using Principal Component Analysis (PCA), which compared the biggest variance (PC) from the data available.

Results and Discussion

Morphological characters of M. reticulatus from several population

The analysis showed the high variation on the scale range of anterior prefrontal, posterior prefrontal, frontal, parietal, preocular, postocular, loreal, temporal, upper labial, lower labial, and dorsal, ventral and subcaudal scales (Table 2). The obtained meristic character shows the intraspecific variations of the total number of scales that vary between specimens from several populations. The varying number of scales might be correlated to habitat use and environmental conditions that cause adaptation. This adaptation is done to prevent excess water loss in the body. A large number of scales might indicate habitats with high humidity, whereas fewer scales might indicate a drier habitat [6]. Reduction of dorsal scales might also be affected by the development of the cutaneous muscle system and cost-cutaneous muscles located below the skin as a result of the evolution of rectilinear locomotion [7].

Meristic characters do not show the sexual dimorphism based on the number of ventral and subcaudal scales due to the high variation. Male specimens have a range of 84-96 on subcaudal scales, and a range of 284-343 on ventral scales. Whereas in the female specimens, the total range is 83-100 on subcaudal scales and the total range is 294-341 on ventral scales. The measurement of the morphometric ratio tail length (tl): snout-vent length (SVL) from each population shows that the average ratio of tail length of the male specimens is longer than the average ratio of tail length of female specimens (Table 2). According to Kerfoot [7], ventral scales attach to the cost-cutaneous

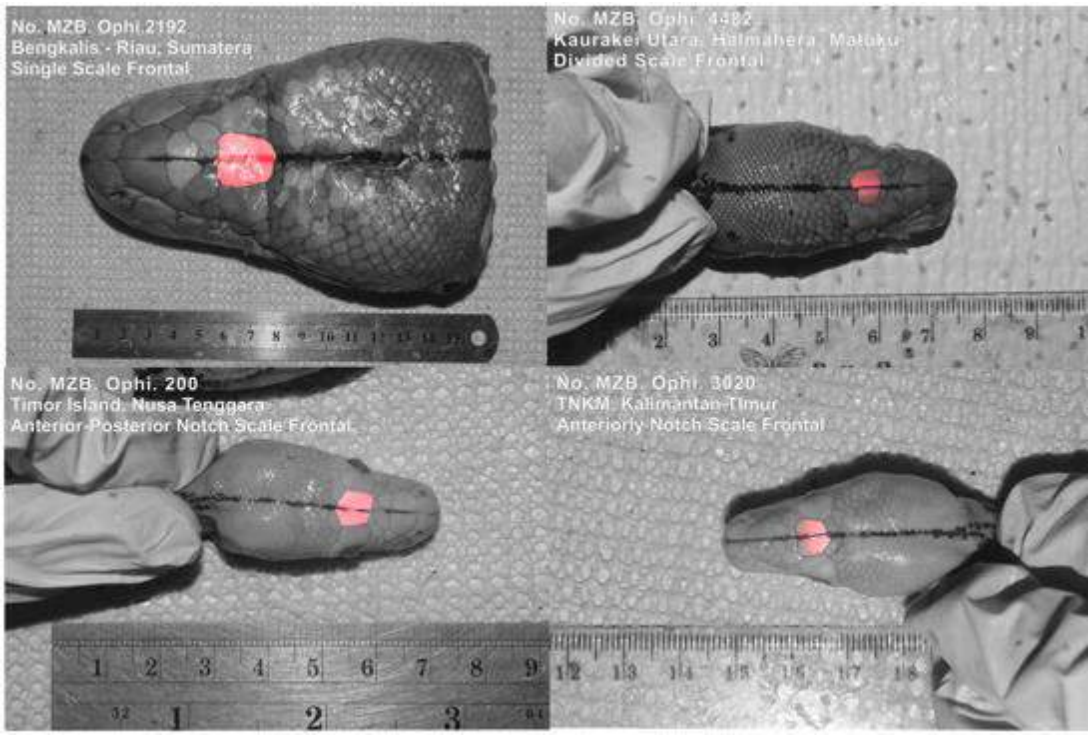

Figure 2. Comparisons of the Frontal Scales of several specimens from various localities, Single (top-left), Divided (top-right), Anterior-Posteriorly Notch (bottom-left), and Anteriorly Notch Frontal Scales (bottom-right) (blue lines indicate the notch).

muscle system that connected to the ribs and vertebrae, so the number of ventral scales reflects the number of vertebrae of the specimens. Individuals with a large number of vertebrae have a possibility to grew longer than individuals who have fewer vertebrae, affecting the number of existing scales.

Differences in the shape and number of frontal scales were also found with the presence of a single, divided, anterior-posteriorly notch, and anteriorly notch frontal scales (Figure 2). It was stated that this variation is due to geographical variations expressed in the form of divided or single scales, different from one region to another [8, 9]. Kluge [10] states that there are several morphological characters that are different from some of the specimens studied in Kalimantan (Borneo) with a variation of almost dividing from posterior, anterior, or both, as well as singles and divided scales. Underwood and Stimson, also Mark Auliya *et al.* [11, 4] state that the formation of the frontal scales is a type of intraspecific variation. These findings strongly support the existence of intraspecific variations in frontal scales in the population studied, and cannot be categorized as geographic variations based on frontal scales of reticulated python.

The diagnostic characters of M. reticulatus sbp. problems

Prefrontal scales show inconsistencies in a variation of *M. reticulatus* specimens in each population (Table 3). Mark *et al.* [4], states that there were specific variations in the row of prefrontal scales in each *M. reticulatus* sbp. The species of *M. reticulatus reticulatus* has 2 rows of posterior prefrontal scales with slightly short anterior prefrontal scales, the species of *M. reticulatus jampeanus* has only 1 row of prefrontal posterior scales, with elongated anterior prefrontal scales. Whereas *M. reticulatus saputrai* has 2 rows of posterior prefrontal scales, and slightly enlarged anterior prefrontal scales. Direct observations showed specimens from Sulawesi has 1-row of fragmented posterior prefrontal scales and anterior prefrontal scales on varying size (ID. Number: MZB.Ophi. 1762, MZB.Ophi. 2297, MZB.Ophi. 1558, MZB.Ophi. 3221) resembles *M. reticulatus jampeanus*. Specimens from Maluku also showed the presence of 1 row posterior prefrontal scales with elongated anterior prefrontal scales (ID. Number: MZB.Ophi. 1951, MZB.Ophi.4481, MZB.Ophi. 4482). However, the specimen observed from Tanahjampea, Kalaotoa, Karompa,

Table 3. Comparison of dorsal, ventral, prefrontal scales to few literature of *M. reticulatus*

Population	Mid- Dorsal Scale	Ventral Scales	Prefrontal Scales	Resemblance	Source
(Sunda land) *M. r. reticulatus*	68-78	304-325	2 rows ppf, apf small	-	[4]
(Selayar) *M r. jampeanus*	64-68	290-301	1 row of ppf, apf slightly longer than Sunda retic	-	[4]
(TanahJampea) *M. r. saputrai*	77-81	330-334	2 rows of ppf, apf very long	-	[4]
M. reticulatus	69-79	297-330	Variated	Sulawesi Population	[13]
M. reticulatus	71-75	300-322	-	Java Population	[1]
Sumatera (n=6)	65-76	310-319	Variated	to *M. r. reticulatus*	This study
Kalimantan (n=6)	63-74	312-320	2 rows of ppf	to *M. r. reticulatus*	This study
Jawa (n=4)	61-77	301-320	2 rows of ppf	to *M. r. reticulatus*	This study
Sulawesi (n=13)	66-90	294-343	Variated	-	This study
Maluku (n=6)	67-78	284-333	Variated	to Sulawesi Population	This study
NTB (n=1)	69	314	2 rows of ppf	to *M. r. reticulatus*	This study

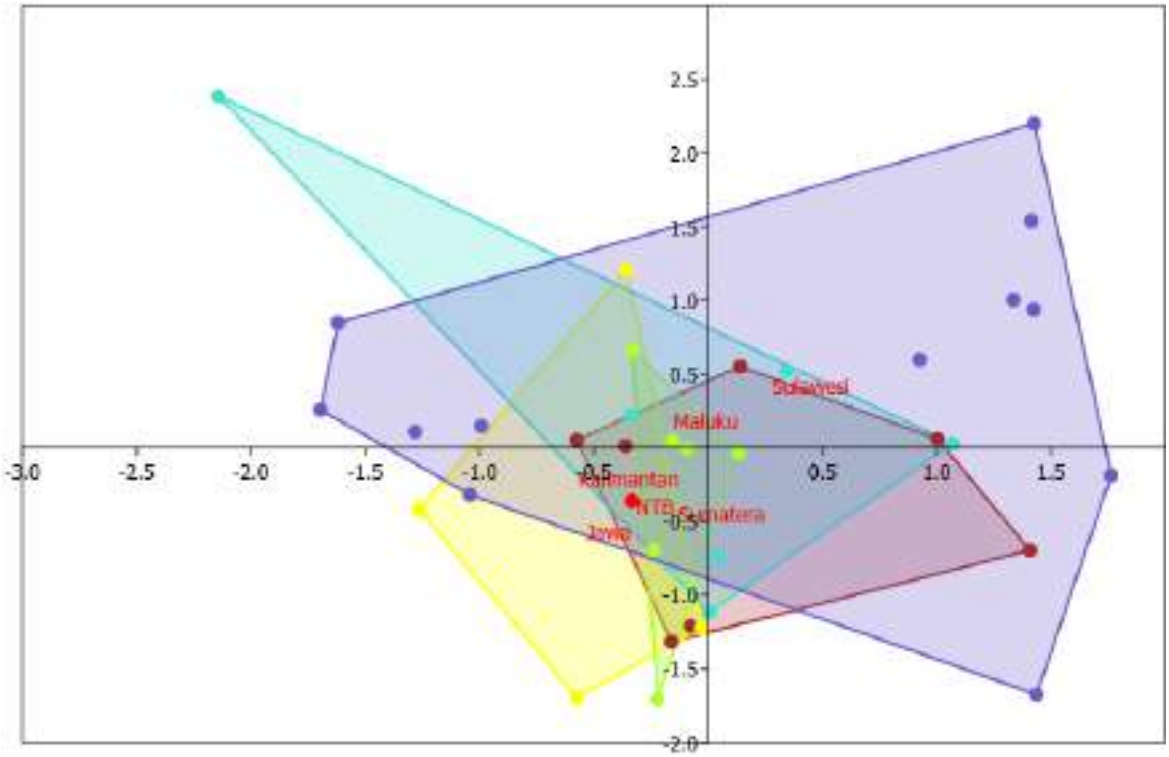

Figure 3. Two-dimensional Scatter plot of 38 *M. reticulatus* specimens from several population (Sumatra: Brown, Java: Yellow, Kalimantan: Green, NTB: Red, Sulawesi: Blue, and Maluku: Turqoise)

and Madu Island (ID. Number: MZB. Ophi. 3223, MZB. Ophi. 3437, S.Voucher.020, S.Voucher.021, S.Voucher.022, S.Voucher.023) shows the tendency of 1 row posterior prefrontal scales with elongated anterior prefrontal scales, resembling the diagnostic character of the *M. reticulatus jampeanus*. In accordance Hanifa *et al.* [12], which suggest that the Karompa, Kalaotoa, and Madu islands were acting as stepping stones on the dispersal patterns of this species, though

share similarities to the *M. reticulatus jampeanus* based on morphological and molecular data.

However, these variations are still difficult to distinguish morphologically based on their locality (reticulatus: Greater Sunda-land; saputrai: Selayar; jampeanus: Tanahjampea), given the high morphological variations in these specimens, although phylogenetically have proven to be distinct subspecies [4]. This underlines that the diagnostic character of subspecies based on morphological differences in the prefrontal scales of *M. reticulatus* is still ambiguous and needs deep observation in other characters such as anatomical and morphological features. Specifically, a measurement of prefrontal scales (Anterior-Posterior) are suggested in the future analysis to distinguish this species.

Population grouping of M. reticulatus from Indonesia

Scatter plots show an overlap in each observed population. The population of Sulawesi has a wide plot width, due to the strong number of Ventral and Dorsal mid characters, where the number of Ventral Scales in the Sulawesi Population and some specimens from Sumatra and Kalimantan have a higher range than other populations.

Based on the analysis, there is no significant differences were found between populations from data on morphometric variations and prominent signs of character variation among the islands. Characters that are owned by a population are still owned by other populations. Geographic isolation has not made any morphological variations that can be used as distinguishing characters. This possible in regards to the varied landscape, habitats, and ecosystems in Indonesia, making it difficult to select a new adaptive character.

Conclusion

The analysis showed the highly variation on the scale range of anterior prefrontal, posterior prefrontal, frontal, parietal, preocular, postocular, loreal, temporal, upper labial, lower labial, and dorsal scales. Ventral and subcaudal scales in male and female specimens showed highly variation in the scale count, but ratio comparison of tl:SVL length indicated the sexual dimorphism. Anterior-posterior prefrontal and frontal scales show high variation and are difficult to distinguish between each locality at the subspecies level and suggest it to be intra-specific variation. There is no significant grouping were found between populations from data on morphological variations.

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