BAB IV. RESULT AND DISCUSSION

4.1 Morphology Characters

Morphology characters that has been obtained shows on Attachment 1. In the table morphology characters divided into two parts, that's morphometric characters and meristic characters. The morphometrics part contain measured characters (length and width), meristic characters known by calculated the characters.

4.1.1 Morphometric Characters

Morphometric characters has presented on Table 1., in mean value that has been compared with *I. sumatranus.*

Table 1. Morphometric comparison between *I.* cf. *sumatranus* and *I. sumatranus* in mean value and *p* value based on Mann-Whitney. Where n is amount of species, * is significant different, ns is not significant different, and all the characters measured in Millimeter (mm)

Species	*Ichthyophis* cf. *sumatranus*		*I.sumatranus Taylor, 1960*	
Locality type characters	South Solok regency (n=11)	Solok regency (n=2)	Kapahiang. Bengkulu (n=2)	*P* value
TL	211.73	242.50	234.75	0.462^{ns}
HL	9.30	9.50	10.275	0.004^{*}
TAL	2.35	2.15	4.175	0.031^{*}
HW	5.85	6.50	7.7	0.003^{*}
BWM	7.62	8.80	9.3	1.000^{ns}
WIL	28.17	28.05	28.2	1.000^{ns}

Table 1., shown the data from morphometrics measurement and comparison with *I. sumatranus* from Kepahiang, Bengkulu Province that available on Taylor (1960). For *I.* cf. *sumatranus* the range for HL is 7,66-11,7; TaL is 1,93-3,11; TrL is 143-299; TL is 115-315. Whereas in *I. sumatranus* have range for HL is 9-11,5; TaL is 3,2-5; no TrL; and TL is 176-285. In head characters of *I.* cf. *sumatranus*, the range for IOD is 3,95-5,56; ITD is 3,38-5,88; IND is 1,32-3,28; END is 2,47-4,39;

ETD is 0,88-1,91; TND is 0,92-5,32; and EJD is 0,97-5,32. In *I. sumatranus* there is no head characters available excuses HL.

From the table, available the *p* value from Mann-Whitney U test. The variable that has been analyzed on Mann Whitney U Test is six characters as shown in Table 1., that is HL (head length), TL (total length), TaL (tail length), HW (head width), BWM (body width in max), and WIL (width in length), it adapts to characters that available on *I. sumatranus* literature data that can be used to analyze. The character that indicates differentiation between the species is the number that showed in the bold value, the component has a significant difference because the *p* value is under the alpha which is 0,05. The component especially from the head that is HW and HL, and from the tail that is TaL. The characters that show no differentiation is the body's characters which are TL, BWM, and WIL, so can conclude that there is no differentiation in the size of the body overall, but the difference showed in the head and tail characters.

Whereas for ratio comparison has grouped into two, that is body character and head character. Table 2., showed the ratio of body character morphometrics measurements that HL (head length), TaL (tail length), and TrL (trunk length) that have been compared with TL (total length) to show the comparative ratio of each character to TL. The ratio of the body characters also completed with Mann-Whitney U test. The ratio of head character morphometrics measurements (IOD, ITD, IND, END, ETD, TND, and EJD) divided by HL. The comparisons of ratio used different character between the body and the head to make it easier to describe the comparison

of each character. The data consist of the mean, standard deviation, minimum, and maximum values of characters.

Table 2. Comparison of the average ratio of body and head character measurements, standard deviation, characters value ranges, and *p* value. * for significant different value, and ns for not significant different value

No.	Characters	Population		Mann Whitney U Test significance level p≤0.05
		I. cf. *sumatranus* (n=13)	*I. sumatranus* (n=4)	
1.	TL	216.0 ± 55.00 155.0 – 315.0	234.0 ± 53.00 176.0 – 285.0	P = 0,462ns
2.	HL/TL	0.043 ± 0.024 0.035 – 0.054	0.044 ± 0.020 0.040 – 0.051	P = 0,016*
3.	TaL/TL	0.011 ± 0.006 0.009 – 0.011	0.018 ± 0.018 0.018 – 0.0 18	P = 0,004*

The standard deviation is low as shown on the Table 2. in body characters part, this indicates that the data distribution cluster is around the average value. The value of the data obtained is not much different from the required average value. But in total length the standard deviation is literally high, that is because the data distribution is high.

Table 3. Ratio of character from *I.* cf. *sumatranus*.

No.	Characters	*I.* cf. *sumatranus* (n=13)
1.	TrL/TL	0.95 ± 0.90 0.67 - 1.39
2.	IOD/HL	0.50 ± 0.42 0.43 – 0.60
3.	ITD/HL	0.50 ± 0.42 0.45 – 0.64
4.	IND/HL	0.30 ± 0.18 0.23 – 0.31
5.	END/HL	0.30 ± 0.25 0.27 – 0.39
6.	ETD/HL	0.10 ± 0.08 0.10 – 0.14
7.	TND/HL	0.20 ± 0.17 0.21 – 0.29
8.	EJD/HL	0.20 ± 0.18 0.16 – 0.24

In body characters, the value of the standard deviation is quite low for some characters while it is higher for other characters. This indicated that in some of the characters the variation of the data obtained is low and in others the variation of the data is quite high, so for clusters the distribution of data is the same because a low standard deviation indicates the data distribution is closely clustered around the mean value and a high standard deviation indicates the data distribution is far from the mean cluster.

4.1.2 Meristic Characters

Meristic character counted and presented in the Table 4., with the range of all the data and comparison with *I. sumatranus.*

Table 4. Meristic comparison between *I.* cf. *sumatranus* and *I. sumatranus*

	Range	
characters	*I.*cf. *sumatranus* (n=13)	*I. sumatranus* (n=4)
TA	269-292	315-329
VPA	2-5	7-7
PMM	19-36	41-44
VP	20-37	38-47
MDB	21-31	37-45
SPL	8-19	20-26

The data consist of the dentition, total annulus, and tail anulus. *I.* cf. *sumatranus* has a slightly different character from *I. sumatranus* Taylor, 1960. *I.* cf. *sumatranus* has a transverse fold that has crossed on the ventral side from the first transverse fold to the end of the transverse fold, while in *I. sumatranus* the first 4-5 transverse folds do not cross and are not clearly visible on the ventral side. 3., shows the distribution of meristic data for each species From *I. sumatranus* and *I.* cf. *sumatranus.* There are 13 samples from *I.* cf. *sumatranus* dan four sample from *I. sumatranus.* The meristic

characters found some quite striking differences between *I. sumatranus* and *I.* cf. *sumatranus*, the difference can be seen in the character of TA wherein *I. sumatranus* there is a higher number of annulus than in *I.* cf. *sumatranus*, in *I. sumatranus* the TA range is 315-329 while in *I.* cf. *sumatranus* TA range is 275-298 (dorsal part, counted as a whole). In addition, in the number of the annulus in the tail (PVA) there are also differences, with seven annulus in *I. sumatranus* and 2-5 annulus in *I.* cf. *sumatranus*, so the number of annulus *I. sumatranus* was higher than *I.* cf.

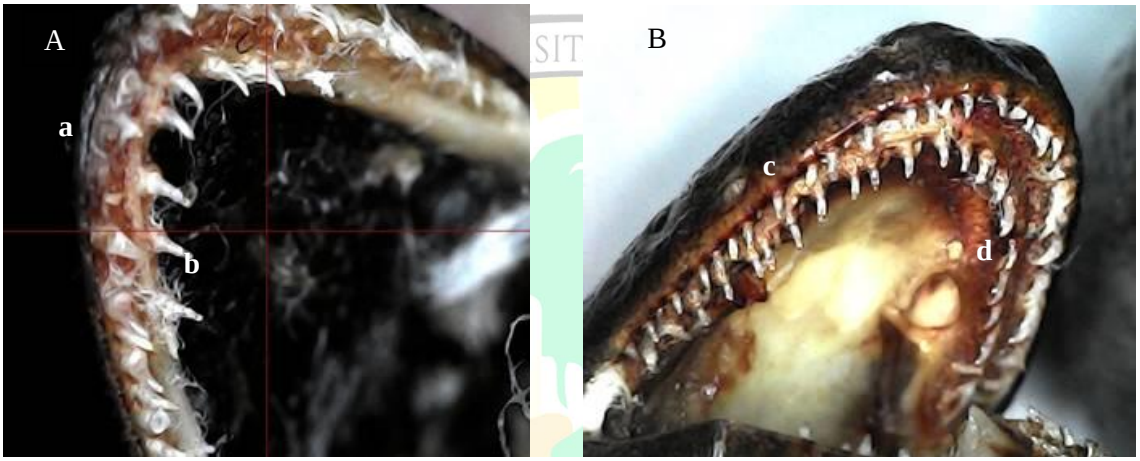

Figure 1. Dentition of *I. cf sumatranus*. A. lower jaw, B. upper jaw, a. mandibular teeth; b. splenial teeth, c. maxilary=premaxillary teeth, d. mandibullar teeth

sumatranus.

Another difference that is found in the meristic character is in the teeth. Figure 2., shows the teeth formation in *I.* cf. *sumatranus.* The PMM teeth found in *I. sumatranus* were 41-44, whereas in *I.* cf. *sumatranus* there are 19-36. In *I. sumatranus* there were 38-47 VP teeth, while in *I.* cf. *sumatranus* there are 20-37. Furthermore, there are 37-45 MDB teeth on *I. sumatranus* and on *I.* cf. *sumatranus* there are only 21-31. Furthermore, in SPL teeth there are differences, in *I. sumatranus* there are 20-26 while in *I.* cf. *sumatranus* there are 8-20. According to Nishikawa (2012), splenial teeth are one of the characters that can be used as a

comparison character to determine the species in the caecilian, although this has not been confirmed to be accurate.

Teeth are a characteristic that can be used to identify a caecilian species. According to Maciel and Hoogmoed (2011), a species can be identified by diastema and vomerpalatine teeth (VP). In some species of caecilians, there are diastema between prevomerine and palatine teeth, but when there are no diastema, they use prevomerine-palatine teeth, or in this research, known as vomer palatine teeth.

In other species of caecilian like I. elongatus that are also found in West Sumatra, they have some different characteristics like the number of PMM teeth was 62–66; the number of SPL teeth was 28–32; and the number of transverse folds ranged from 287–319 (Harapan et al., 2020). So, if compared with *I. elongatus*, *I. sumatranus* has smaller character values. Whereas for unstripped *Ichthyophis*, the example is *I. lakimi* teeth on PMM 32–38, VP 34–41, MDB 37–39, SPL 11–14, Nisikhawa et al. (2012), which also have some different characters in the count or range The differentiation between some characters is compared between *I. cf. sumatranus* and *I. sumatranus*, indicating that they are different species. The most clear difference is shown by the tail characters. The tail of *I. cf. sumatranus* is completely different. Table 3 shows three annuli for VPA or tail annulus, mostly on *I. cf. sumatranus*, because of 13 samples, 10 of which had three annuli.

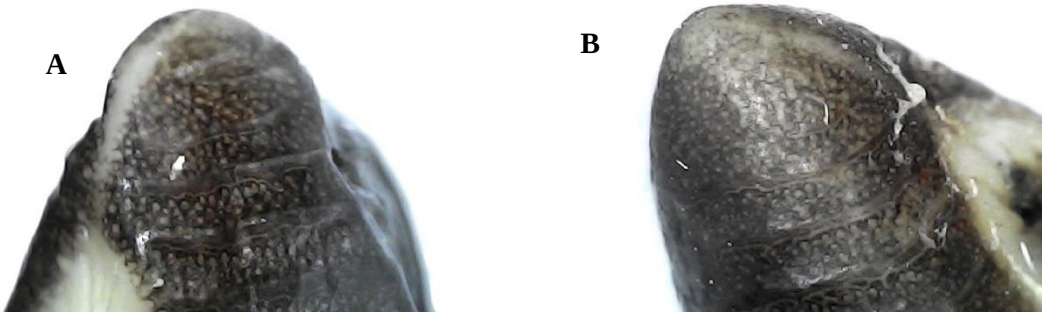

Figure 2. Tail anulus on *I.* cf. *sumatranus*. a. spesiment 1, b. specimen 4

Another difference is shown by the splenial teeth. They can be seen in the lower jaw as shown in Figure 3. (a), but the variation of the number of splenial teeth in *I.* cf. *sumatranus* is high, with a range of 8-19, but this is still lower than in *I. sumatranus* that has more than 20 SPL teeth. According to Nishikawa (2012), splenial teeth can be used as characters for identification of the *Ichthyophis*, because some species have no splenial teeth anymore (reduced) and others still have their splenial teeth, so some experts use able or absent splenial teeth for species identification.

4.2 Comparison and Cluster

4.2.1 Comparison

The data that was obtained has been compared with another species from the *Ichthyophis* genus. The comparison aims to see how the data is distributed. The comparison presented in Table 3., between *I.* cf. *sumatranus, I. sumatranus, I. elongatus, I. lakimi,* and *I. monochrous.* Compared with I. elongatus, because they can be found in the same place at the same time. In contrast to *I. lakimi* and *I. monochrous,* which have some characters that lack a lateral line on the side of the body. The comparison has been done with other species from Southeast Asia region.

Table 5. shows the morphometric characters of some Ichthyophis species; data shows that I. cf. sumatranus has fewer characters in each character than other species.The body's character also has a similar number between *I.* cf. *sumatranus* and I. elongatus. As shown by Harapan *et al.* (2020), the TL for *I. elongatus* is 154-299 mm, whereas on *I.* cf. *sumatranus* it is 155-315 mm.

Table 5. Comparison between *I.* cf. *sumatranus*, *I. sumatranus*, *I. elongatus*, *I. lakimi*, *I. monochrous*, n is amount of sample. NA is not available, for the data that not exist on the literature.

Average/range of some species in Ichthyophis							
Species	*I.* cf. *sumatranus*	*I. sumatranus*	*I. elongatus*		*I. lakimi*	*I. manochrous*	
Source			Taylor, 1965	Harapan *et al*., 2020	Nishikawa *et al*., 2012		
Locality	South solok, Indonesia	Kepahiang, Bengkulu	Padang, Indonesia		Sabah, Malaysia	Kalimantan Indonesia	Sarawak, Malaysia
TL	216.46	234.75	300	234.25	292.5	226	233
HL	9.29	10.28	12	NA	12.6	9	10.75
TRL	202.69	NA	NA	NA	275.8	213.2	220.2
TAL	2.33	4.18	3.4	2.24	4.1	3.8	2.05
VL	2.70	NA	NA	NA	2	NA	1.5
SL	6.10	NA	NA	NA	7.8	NA	7.05
LJL	5.20	NA	NA	NA	6.8	NA	6.5
S2CL	11.23	NA	14.9	NA	13.3	NA	12.55
S3CL	14.68	NA	19	NA	17.5	NA	16
1CL	2.69	NA	NA	NA	2.7	NA	3.3
2CL	3.44	7.70	NA	NA	3.2	NA	4.15
HW	5.93	NA	NA	NA	7.6	NA	8.15
MXHW	6.47	9.30	7.6	NA	9.2	7	9.75
BWM	7.74	NA	NA	8.15	9.7	10	10.75
TAW	2.50	NA	NA	NA	4.4	NA	3.65
IOD	4.83	NA	NA	NA	5.4	6	5.9
ITD	5.07	NA	NA	NA	6.1	NA	6.5
IND	2.42	NA	6	NA	2.9	NA	2.75
END	3.44	NA	4.5	NA	3.7	NA	4.2
ETD	1.35	NA	1.65	NA	1.3	1	1.8
TND	2.37	NA	3.45	NA	2.5	2.5	3.1
WIL	28.05	28.20	30	NA	NA	NA	0
EJD	2.25	NA	0.3	NA	3	NA	2.5
TA	269-292	325-329	274-290	154-299	121.6-292.5	247	294-311
VA	4-6	NA	NA	NA	5-6	NA	6
PVA	2-5	7	3	NA	4-7	NA	3.5
PMM	19-36	41-44	59-64	57-66	32-48	50	48-49
VP	20-37	38-47	54	NA	34-45	42	34-40
MDB	21-31	37-45	58	NA	37-41	38	33-37
SPL	8-19	20-26	28-32	28-32	11-14	8	4-5

In BWM or WB (width of body) in Harapan *et al*., 2020, *I. elongatus* had 4,68–10,65 mm, and *I.* cf. *sumatranus* had 4,63–10,5 mm. The body's character is one of the characteristics that can be affected by the environment and nutrition, so a similar body size in a genus with different species might be possible.

4.2.2 Cluster

The morphometric data obtained were then tested for normality to determine the shape of the distribution of the data. After the normality test, body correction was carried out to reduce the effect of the allometry effect on the results of the measurements that had been carried out. The results of the measurements have been balanced and carried out by body correction. Then, data analysis was carried out using Mann Whitney and principle component analysis (PCA) to see the pattern of morphometric differentiation between the populations of each observed sample. The Mann–Whitney test was chosen because the data distribution is not normal in some characteristics and the sample size is small, so non-parametric analysis is more worthwhile to be carried out.

The measurement results for the samples obtained as shown in Table 1. , that is 11 samples from South Solok and two samples from Solok district as *I.* cf. *sumatranus,* and four samples from Kepahiang that are known as *I. sumatranus*, were used as comparison data. While the characters compared are six characters out of a total of 29 characters that are measured and observed, this is because it adjusts to the data contained in the literature.

Principal Component Analysis (PCA) was applied to the total data, and scores of the first factor were stored. The effect of size variation in the sample is reduced by

the way that each character is regressed to a factor value of 1 PCA, and then the residue from each regression is used as a character in the Discriminant Function analysis (Strauss, 1985; Reis *et al.*, 1990; Maciel and Hoogmoed, 2011).

Of the six characters, three of them have significantly different *p* values based on the *p* value and characters that do not have different values. The box that has the furthest distance is the HW box plot (D), the next is the TaL box plot (B), and the last is the HL box plot (F). This corresponds to the *p* value. The result of the distribution of the data analysis using PCA is shown in Figure 4., which shows that there is clear distance between *I.* cf. *sumatranus* and *I. sumatranus* group.

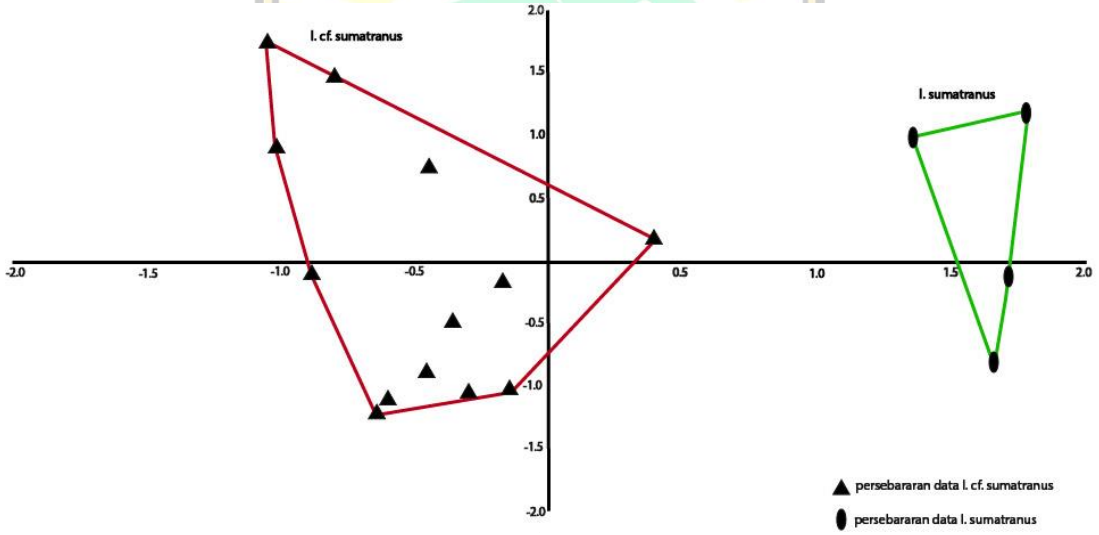

Figure 3. Results of a principal component analysis based on taxonomically relevant morphometric, and meristic characters. Scores on the first two principal components have been plotted to check how the distribution of each sample. The result showed that there are differences in the plot.

In the plots obtained from PCA, it can be seen that there is a clear plot or distance between *I.* cf. *sumatranus* and *I. sumatranus* from Kapahiang, which has a separate group which indicates that the character possessed by the sample shows a fairly clear difference and has the possibility of being two different species.

From the morphometric analysis in which the six characters are being compared, three of them have very significant differences. The PCA results show that the data group from *I. sumatranus* is separated from the data group from *I.* cf. *sumatranus.* In addition, the comparison of meristic characteristics also shows a clear difference between *I. sumatranus* and *I.* cf. *sumatranus,* and cluster test for the sample shows that the group between *I.* cf. *sumatranus* and *I. sumatranus* has separated with a clear distance, so it can be assumed that *I. sumatranus* and *I.* cf. *sumatranus* are most likely different species.

In taxonomic studies such cases can occur, for example in the morphometric study of Dendrelaphis snakes conducted by Vogel and Rooijen (2007) who discovered a new species of Dendrelaphis by comparing three species of Dendrelaphis. This study shows that in some characters, animals that are still in the same genus are possible to have several morphometric characteristics that are similar or not significantly different.


UNIVERSITAS ANDALAS
UNTUK
KEDJAJAAN
BANGSA