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# Phenetic Analysis of Swamp Buffalo (*Bubalus bubalis*) in Central Lombok Based on Morphological Parameters

Akhmad Sukri<sup>1,b</sup>), Siti Rabiatul Fajri<sup>1,c</sup>), Husnul Jannah<sup>1,d</sup>), Ieke Wulan Ayu<sup>2,e</sup>),  
Marheny Lukitasari<sup>3,a</sup>)

<sup>1</sup>Department of Biology Education, Universitas Pendidikan Mandalika, Mataram, NTB, Indonesia

<sup>2</sup>Department of Agrotechnology, Universitas Samawa, Sumbawa Besar, NTB, Indonesia

<sup>3</sup>Department of Biology Education, Universitas PGRI Madiun, Madiun, East Java, Indonesia

<sup>a</sup>)corresponding author: lukitasari@unipma.ac.id

<sup>b</sup>)akhmadsukri@undikma.ac.id

<sup>c</sup>)sitirabiaturfajri@undikma.ac.id

<sup>d</sup>)husnuljannah@undikma.ac.id

<sup>e</sup>)iekewulanayu002@gmail.com

**Abstract.** This study describes the morphological parameters and investigates a phenetic analysis on domestic swamp buffalo (*Bubalus bubalis*) in Central Lombok. The morphological parameters measured head length, neck length, tail length, leg length, and chest circumference. Morphological parameters were measured using a measuring tape; then, the data were analyzed quantitatively to determine the Euclidian similarity index. Furthermore, Principal Component Analysis (PCA) is carried out to determine the grouping of buffalo individuals based on morphological parameters. Then it is followed by reconstructing the dendrogram using the UPGMA method. The result of this observation on buffalo's morphological parameters shows that there are variations in morphological sizes, including head length, neck length, tail length, leg length, and chest circumference, with low similarity in the two observation areas (0.217). The results of the similarity percentage analysis show that the chest circumference variable has the highest contribution in forming morphological variations (43.58%). Furthermore, the PCA results prove that buffalo distribution spread in the two observed populations; it is also strengthened by phenetic analysis, which shows morphological mixing between buffalo individuals in the two observed populations in Central Lombok Regency.

## INTRODUCTION

Swamp buffalo (*Bubalus bubalis*) is a livestock commodity that can produce meat for human consumption [1]. Buffaloes have high adaptability to be raised in areas that have inadequate environmental conditions [2]. Buffaloes have variations in body and coat color [3]. The results of qualitative measurement of buffalo in Bali by Yulianti [4] showed that most of the buffaloes have dark gray and albino coat colors. Sukri et al.[5] reported a similar result, who found most of the buffalo in Central Lombok Regency have gray coats with black skin and short, fat bodies with relatively wide chest circumferences.

In addition, besides natural characteristics, buffaloes also have variations in morphological sizes. Sukri et al.[5] reported differences in the length of buffalo's head, neck, and legs caused by age differentiation. Furthermore, Sunarko et al.[6] revealed differences in body growth rate between male and female individual swamp buffalo in Central Lombok Regency. Another study conducted by Anggraeni [7] showed that the morphometric body size of female buffalo from North Sumatra is larger than female buffalo from Banten, South Kalimantan, Nanggroe Aceh Darussalam, and South Sulawesi. On the other hand, the morphometric size of male buffalo from South Sulawesi is larger than male buffalo from Central Java, Banten, and NAD.

Research to reveal the morphological characteristics of buffalo needs to be done, especially in Central Lombok Regency. It is beneficial for the improvement and preservation of buffalo germplasm. In addition, this research is

essential to be conducted to develop a better quality of livestock breeds. A study about buffalo morphology in Central Lombok Regency has been conducted by Sukri et al.[5]. This research still has its shortcomings, so it needs to be improved with phenetic analysis to reveal the morphological characteristics, phenetic, and morphometric grouping of buffalo in Central Lombok Regency in more depth. Therefore, this research can also be used to reference the breeding of buffaloes, especially in the Central Lombok Regency.

## RESEARCH METHOD

### Morphological Parameter Measurement

Morphological characteristics in this study were limited to five aspects of the phenotype, namely head length, neck length, tail length, leg length, and chest circumference. The measurement of morphological parameters adopted the method of Purnomoadi [8] carried out with the technique shown in Figure 1. The measurements were carried out using a measuring tape with 2 meters in length and 1 cm accuracy.

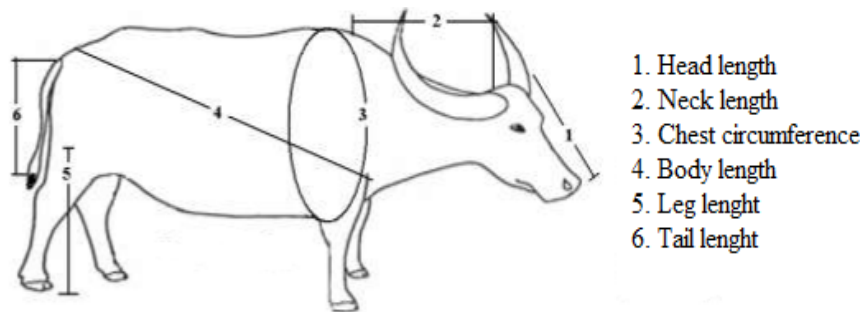


FIGURE 1. Technique for measuring buffalo's morphological parameter

### Research Sample

The subjects of this study were swamp buffalo (*Bubalus bubalis*), with a total sample of 21 buffaloes mixed between males and females. This sample was taken purposively from two buffalo populations in Central Lombok Regency, West Nusa Tenggara, Makam Village, and Kekere Village. Sampling was taken from these two locations because they were considered representative of the buffalo population with a reasonably high population compared to other areas in Central Lombok Regency.

### Data Analysis

The buffalo morphological parameter data were analyzed using a quantitative approach through descriptive statistical analysis to find the average and percentage of each morphological parameter. In addition, to determine the individual similarity of buffalo from the two observed populations, a similarity analysis [9] was conducted using Euclidean distance because the data is numeric [10]. After similarity analysis, similarity percentage analysis was conducted to determine which morphological parameters had the highest contribution in determining diversity. The Principal Component Analysis was carried out to determine the distribution of buffalo based on morphological parameters [11], which was complemented by phenetic analysis using the UPGMA method [12]. The analysis was assisted using PAST computer software version 4.03 [13].

## RESULTS AND DISCUSSION

### Morphological parameter

The result of the measurement of morphological parameters that include (1) head length, (2) neck length, (3) tail length, (4) leg length, and (5) chest circumference is shown below in Table 1.

**TABLE 1.** Result of Morphological Parameters Measurement on Local Buffalo (*Bubalus bubalis*)

Sample	Head Length (cm)	Neck Length (cm)	Tail Length (cm)	Leg length (cm)	Chest circumference (cm)
M	29	28	54	80	149
M	29	28	57	59	135
M	45	39	68	107	170
M	43	47	74	116	205
M	38	29	54	107	149
M	49	64	72	135	200
M	34	29	57	95	142
M	29	24	48	87	150
M	37	24	64	150	160
M	33	25	55	150	150
K	39	39	53	111	148
K	17	50	56	98	175
K	40	36	28	99	140
K	45	48	68	115	170
K	44	42	68	106	140
K	47	37	69	112	200
K	46	46	64	110	190
K	46	14	17	111	198
K	40	41	54	105	170
K	38	32	62	100	215
K	33	20	64	101	160

The buffalo morphological parameters measurement result in two observation areas, namely Makam Village (M) and Kekere Village (K), Central Lombok Regency, shows the mixed result. The largest chest circumference is found in the Kekere area with an average length of 173 cm, while leg length is found in the Makam area with 150 cm. Likewise, the parameters of neck length, tail length, and head length have different mean values in the two observation areas (Table 2). A similarity percentage analysis is carried out based on Euclidian distance to strengthen this result. The results of the similarity analysis resulted in a score of 0.217; this indicates that the individual buffaloes at the two observation locations have relatively small morphometric size similarities even though they are from the same species. The low similarity value is thought to be due to the diversity of morphometric measurements caused by the gender and age of the buffalo in the study, which the researcher did not control. Based on the results of previous studies, it is known that these two variables are believed to affect the morphology of buffaloes [7][14].

**TABLE 2.** Similarity percentage analysis on morphological parameters of buffalo (*Bubalus bubalis*)

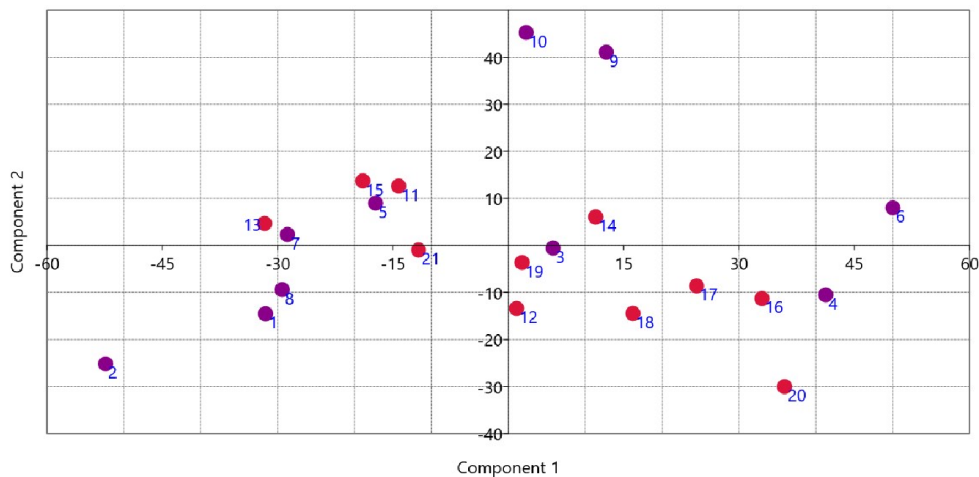
Analysis of similarity		Similarity Percentage					
Index	P (same)	Variable	Av. Dissim	Contrib. %	Cumm. %	Mean M	Mean K
Euclidean	0.217	Chest circumference	1243	43.58	43.58	161	173
		Leg length	849.8	29.79	73.37	109	106
		Neck length	273.8	9.6	95.71	33.70	36.80
		Tail length	363.6	12.75	86.11	60.30	54.80
		Head length	122.2	4.285	100	36.6	39.50

The similarity percentage analysis in Table 2 reveals that the chest circumference variable is the most significant cumulative percentage in individual buffalo's morphological parameters diversity, followed by leg length, neck length, tail length, and head length parameters. This result indicates that there are variations in the quantitative characteristics of buffalo. It confirms previous research by Sukri et al.[5], which found variations in the morphological characteristics of buffalo in the Central Lombok Regency. In addition, study by Erdiansyah and Anggraeni [14] revealed a diversity

of phenotypes of buffalo in the Dompu area, West Nusa Tenggara, and has almost similar characteristics as the results obtained. It is also evidence that similar species buffalo have diverse morphological characteristics [3][15][5]. The variety of morphological parameters measured in this study is also caused by the different ages of individual buffalo [5][16].

## PCA Analysis Result

PCA analysis is carried out to determine the distribution of individual buffalo based on morphological parameters. The result of the PCA analysis of individual buffalo groupings is shown in Figure 2.

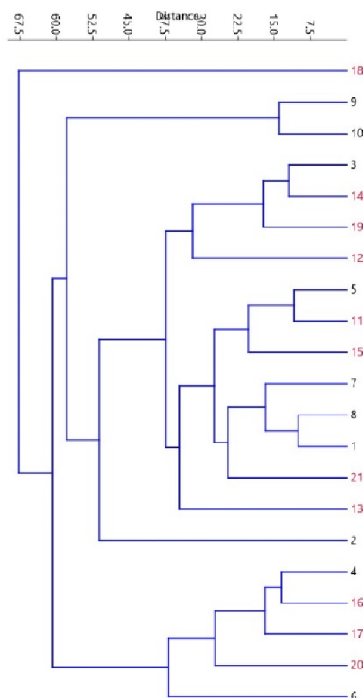


**FIGURE 2.** Result of PCA analysis on buffalo (*Bubalus bubalis*) of Central Lombok

Figure 2 shows no specific buffalo morphology classification in the two observation areas, the Makam area (purple color) and the Kekere area (red color). It is indicated by the combination of buffalo in all quadrants. Quadrant I consists of buffalo from the Makam and Kekere, namely individuals 6, 9, 10, and 14. Likewise, quadrants II, III, and IV consist of buffalo combinations from the two observation areas. This result indicates that buffalo in Central Lombok Regency have morphological similarities. It confirms the previous research conducted by Sukri et al. [17], which found genetic mixing among buffalo populations in Central Lombok Regency. It has occurred because the population distribution was still widely spread [18]. So, there was the possibility of breeding between both populations. Figure 2 also shows that there is no specific variation of buffalo morphology in the two populations; this can be observed through the uniform distribution of buffalo individuals on the x and y axes, meaning that there is no one component that has the most influence on buffalo morphometrics in the two observed populations.

## Buffalo phenetic analysis

The buffalo phenetic analysis in Central Lombok is shown in Figure 3. The buffalo phenetic analysis based on morphological parameters using the UPGMA method shows that the buffalo individuals were scattered into clusters on the phylogenetic tree. These results also reveal no specific cluster of buffalo based on the observation area. It proves the existence of morphological mixing between buffalo individuals in the two observation areas. This result is supported by Sukri et al. [17], revealing genetic mixing among buffalo populations in Central Lombok Regency. Geographically, the two buffalo populations from the two observation areas are far apart and do not allow for natural breeding. Genetic mixing has occurred due to human factors through trade routes that resulted in the movement of buffalo in and out of and into different populations in Central Lombok Regency [17][18].



**FIGURE 3.** Phenetic analysis result of Buffalo (*Bubalus bubalis*) in Central Lombok

## CONCLUSION

Observation of buffalo morphological parameters showed variations in morphological sizes, including head length, neck length, tail length, leg length, and chest circumference. Results of similarity percentage analysis show the chest circumference variable has the highest contribution in shaping the morphological variation. Furthermore, the PCA result proves that the distribution of buffalo individuals spread in the two observed populations, which is also strengthened by phenetic analysis that suspects morphological mixing between buffalo individuals in the two observed populations in Central Lombok Regency.

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