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MORPHOMETRIC DIVERSITY OF SWAMP BUFFALOES IN INDONESIA: A META-ANALYSIS

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ABSTRACT

The frame size of a buffalo is influenced by several morphometric variables. Large frame sizes are expected to have more meat than small frames. There are many morphological studies of swamp buffalo in Indonesia, but meta-analysis has never been carried out to see the genetic potential based on morphometrics. Data obtained from various publications are stored in Microsoft Excel. Body length, wither height, and chest girth was analyzed using Orange 3.27.1 software to generate principal component analysis and hierarchical clustering. Indonesian swamp buffalo has a medium frame size compared to the crossbred Murrah buffalo and Azikheli except the Maluku buffalo which has a small frame size. Based on hierarchical clustering, there are four clusters for Indonesian swamp buffalo based on three morphometric variables. To produce Indonesian swamp buffalo with a larger frame size, it is advisable to mate male buffalo Aceh with female Southeast Sulawesi buffalo.

Keywords: *Bubalus bubalis*, buffaloes, meta-analysis, swamp buffalo, morphometric, diversity

INTRODUCTION

The descent of both river and swamp types from the wild Asian water buffalo (*Bubalus arnee*) supported by anatomical and archaeological evidence (Cockrill, 1984). The two forms are morphologically distinct, with the river buffalo having a black body and normally curved horns, while the swamp buffalo is typically dark grey with white chevrons (one or two white stripes on the throat), socks and tail tips, and horns that are relatively straight, often long, pale colored (Zhang *et al*., 2020). Swamp buffaloes are a livestock that are often kept in rice fields with the function of plowing the fields. In Toraja culture in Indonesia, the buffalo is a marker of social status for the Toraja people. In some large islands in Indonesia, there must be buffalo populations. In Indonesia, the largest buffalo population in 2020 is in Sumatra Island. In data from the Domestic Animal Diversity Information System (DAD-IS), FAO. Indonesia has 14 breeds of buffalo, namely Anoa, Gayo, Java, Kalang Kalsel, Kalang Kaltim, Kuntu, Moa, Murrah, Pampangan, Simeulue, Sumatra-Barat, Sumatra-Utara, Sumbawa and Toraja. Mechanization of agriculture causes the swamp

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buffalo population to decrease because swamp buffalo is rarely used to help plow fields. In addition, breeders have very few males which causes a high depreciation of inbreeding. Morphometric is an important indicator of the diversity of swamp buffalo in Indonesia. Besides that, using the Mahalanobis distance approach can see genetic diversity based on morphometrics. The objective of this research was to study three morphometric traits (body length, wither height, and chest girth) in published journal and to determine genetics relationship among them.

MATERIALS AND METHODS

All publications are searched using google scholar (Table 1). Data is stored in Microsoft Excel. Mahalanobis distance, hierarchical clustering, and principal component analysis from body length, wither height, and chest girth were performed using Orange 3.27.1 software (Demsar *et al*., 2013).

RESULTS AND DISCUSSIONS

Chest girth has the largest principal component value, which means that chest girth describes the variations in principal component analysis (Table 2). Body length and chest girth have a regression value of 0.58. Maluku buffalo has a shorter body length and chest girth compared to other buffalo in Indonesia (Figure 1). On the other hand, the Murrah and Azikheli buffaloes, which are river buffalo, have a longer body length and chest girth. Body length and withers height have a regression value of 0.78. The withers height of river buffalo is higher than swamp buffalo (Figure 2). Breeding programs for Indonesian swamp buffalo can be carried out based on body length and withers height. Heritability of body length in cattle is around 0.34-0.51 and chest girth is around 0.27 to 0.47 (Kamprasert *et al*., 2019). Heritability at the withers height of Bali cattle is 0.6 (Warmadewi *et al*., 2017). Heritability for the withers height is greater than the other two variables. It is hoped that the selection based on body length and withers height Indonesian swamp buffalo has a better carcass percentage. According to de Souza Júnior *et al* (2013), large frame sizes showed better carcass conformation. Priyanto *et al.* (2019) stated Buffalo has a lower dressing percentage than local Indonesian cattle and a higher non-carcass percentage. Because of this, in Indonesia more cattle are developed for fattening than buffalo (Nuraini *et al*., 2018). Therefore, the breeding program for Buffalo in Indonesia must prioritize frame size and carcass percentage. Based on the PCA, the Maluku buffalo is separated from other buffaloes base on morphometric, the Maluku buffalo is smaller (Figure 3). Southeast Sulawesi buffalo have a close relationship with North Sumatra buffalo based on three variables observed in this study. Hierarchical clustering with Mahalanobis distance can separate river buffalo from swamp buffalo even though it only uses three variables (Figure 4). Based on hierarchical clustering, four swamp buffalo clusters were found. The diversity of body length, withers height and chest girth were very diverse in Indonesian swamp buffalo. Genetic diversity based on functional genes such as GH, GHR, GHRH and Pit-1 in Indonesian swamp buffalo is very low (Sumantri *et al*., 2010). Furthermore, based on three microsatellite loci and COI gene, Indonesian swamp buffalo has low genetic diversity (Saputra *et al*., 2013; Saputra *et al*., 2020). However, the diversity in the cytochrome b gene is more diverse in Indonesian swamp buffalo (Rusdin *et al*., 2020).

Table 1. Studies in meta-analysis of morphometric diversity of swamp buffaloes in Indonesia.

No	Reference	Breed	Location	Sex	Age (year)
1	Anggraeni *et al*., 2013	Swamp buffalo	Banten, Center Java, South Sulawesi, Aceh, West Nusa Tenggara, South Sulawesi, North Sumatra (Indonesia)	Male, Female	2-8
2	de Melo *et al*., 2018	Murrah crossbred	São Luís do Quitunde (Brazil)	Female	Unknown
3	Husni *et al*., 2017	Swamp buffalo	Tambora Dompu (West Nusa Tenggara)	Female	2-3
4	Khan *et al*., 2013	Azikheli buffalo	Pakistan	Male, Female	2-3
5	Murni *et al*., 2020	Swamp buffalo	Banten (Indonesia)	Unknown	Unknown
6	Rusdin *et al*., 2018	Swamp buffalo	Southeast Sulawesi (Indonesia)	Male, Female	3-4
7	Salamena *et al*., 2010	Swamp buffalo	Moa Island (Maluku, Indonesia)	Male, Female	2-4

Table 2. Principal component value from three variable.

Principal component	Withers height	Body length	Chest girth
PC1	-0.59	-0.61	-0.53
PC2	-0.44	-0.31	0.85
PC3	0.67	-0.73	0.08

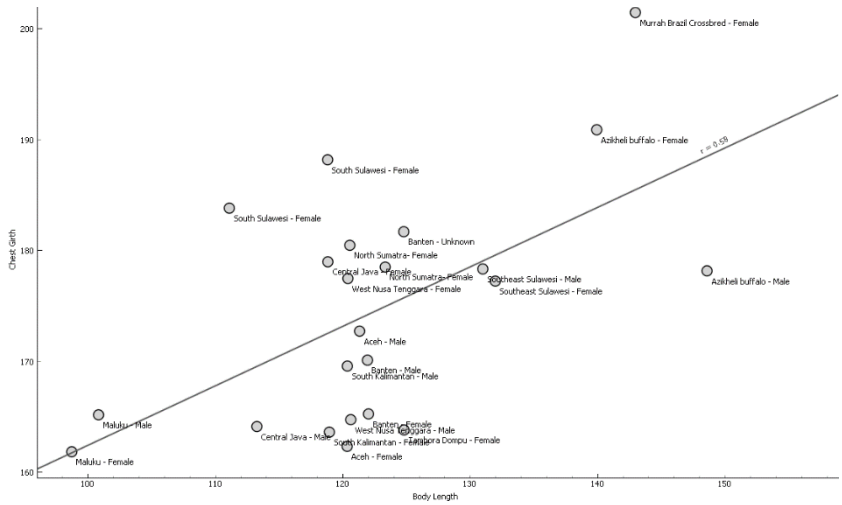

Figure 1. Regression plot between body length and chest girth.

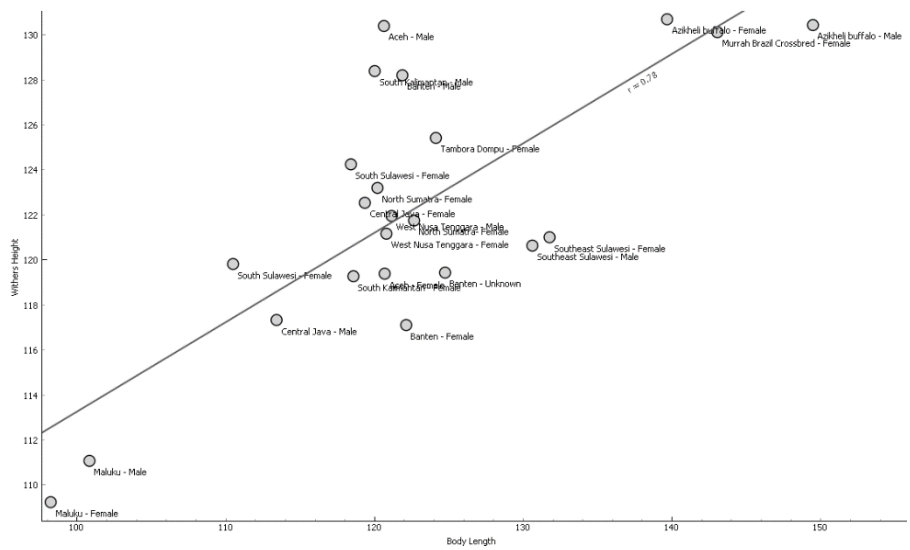

Figure 2. Regression plot between body length and withers height.

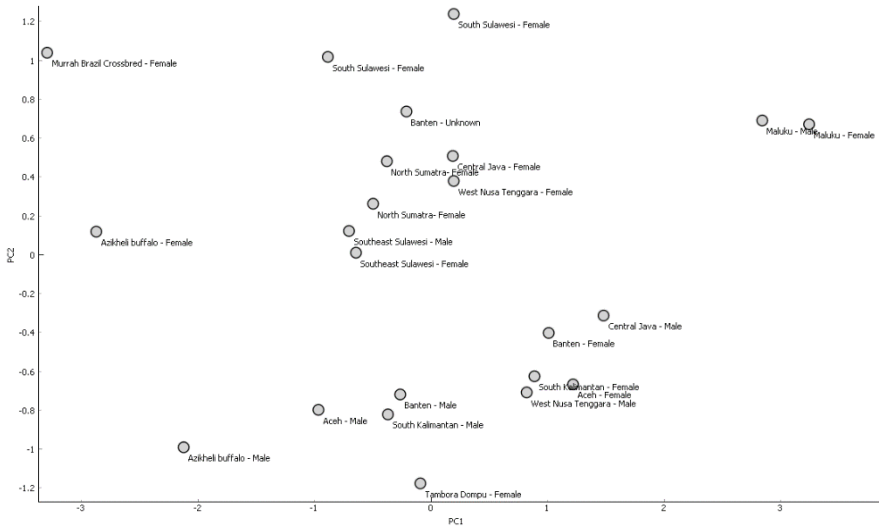

Figure 3. Principle component analysis of swamp buffaloes in Indonesia.

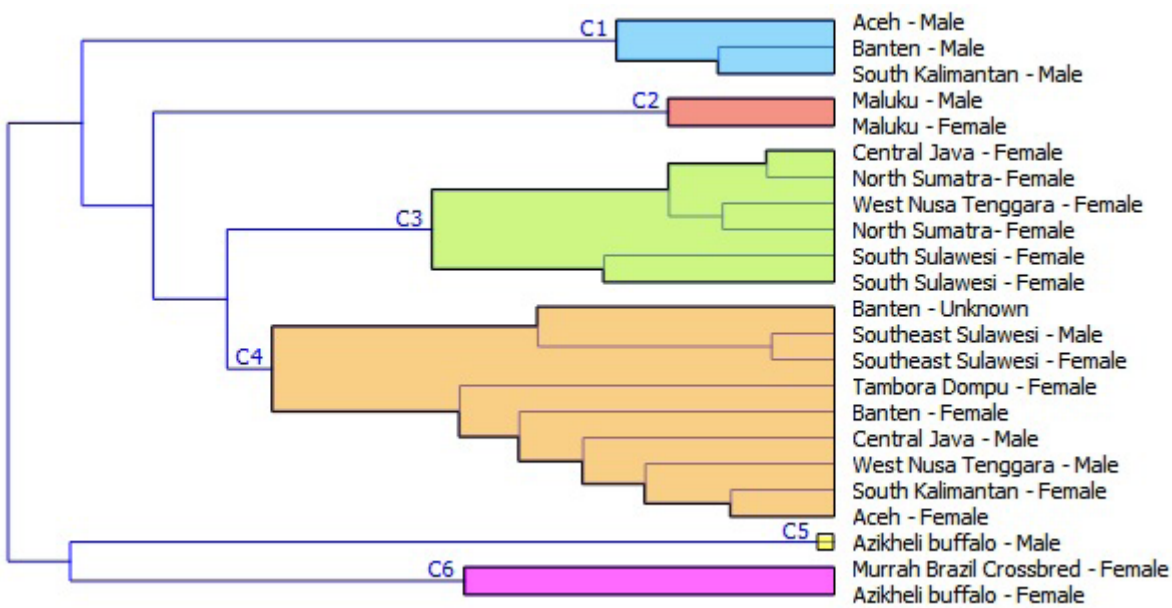

Figure 4. Hierarchical clustering using mahalanobis distance of swamp buffaloes in Indonesia.

This is because the diversity of cytochrome b genes is higher than COI in mammals (Tobe *et al*., 2010). Southeast Sulawesi buffalo has a longer body length than other swamp buffalo.

Furthermore, the male Aceh buffalo had a higher withers height. Therefore, it is possible to mate between male Aceh buffalo with female buffalo from Southeast Sulawesi.

REFERENCES

Anggraeni, A., C. Sumantri, L. Praharani, Dudi and E. Andreas. 2011. Genetic distance estimation of local swamp buffaloes through morphology analysis approach. *Indonesian Journal of Animal and Veterinary Sciences*, **16**(3): 199-210. DOI: 10.14334/jitv.v16i3.614

Cockrill, W.R. 1984. Water buffalo, p 52-63. *In* Mason, I.L. (edn.) *Evolution of Domesticated Animals*. Longman, London, England.

De Melo, B.A., I. de Melo Nascimento, L.T.A. dos Santos, L.G. de Lima, F.C.T. de Araújo, R.R.S. Rios, A. de Gusmão Couto and A.B. Fraga. 2018. Body morphometric measurements in Murrah crossbred buffaloes (*Bubalus bubalis*). *J. Appl. Anim. Res*., **46**(1): 1307-1312. DOI: 10.1080/09712119.2018.1502669.

De Souza Júnior, E.L., W.H. de Sousa, E.C.P. Filho, S.G. Neto, F.Q. Cartaxo, M.F. Cezar, M. das G.G. Cunha and J.M.P. Filho. 2013. Effect of frame size on performance and carcass traits of Santa Inês lambs finished in a feedlot. *Rev. Bras. Zootecn*., **42**(4): 284-290. DOI: 10.1590/S1516-35982013000400008 .

Demsar, J., T. Curk, A. Erjavec, C. Gorup, T. Hocevar, M. Milutinovic, M. Mozina, M. Polajnar, M. Toplak, A. Staric, M. Stajdohar, L. Umek, L. Zagar, J. Zbontar, M. Zitnik and B. Zupan. 2013. Orange: Data mining toolbox in python. *J. Mach. Learn. Res*., **14**: 2349-2353. Available on: https://jmlr.org/papers/volume14/demsar13a/demsar13a.pdf

Husni, C. Arman and Maskur. 2017. Phenotypic characteristics of doro ncanga swamp buffalo reared extensively on the native Savannah of Tambora Dompu regency. p. 677-680. *In The 7th International Seminar on Tropical Animal Production, Contribution on Livestock on Food Sovereignity in Tropical Countries*, Yogyakarta, Indonesia. Available on: https://jurnal.ugm.ac.id/istapproceeding/article/viewFile/29898/18015

Kamprasert, N., N. Duijvesteijn and J.H.J. Van der Werf. 2019. Estimation of genetic parameters for BW and body measurements in Brahman cattle. *Animal*, **13**(8): 1576-15827. DOI: 10.1017/S1751731118003348

Khan, M., I. Rahim, H. Rueff, S. Jalali, M. Saleem, D. Maselli, S. Muhammad and U. Wiesmann. 2013 Morphological characterization of the Azikheli buffalo in Pakistan. *Animal Genetic Resources Information*, **52**: 65-70. DOI: 10.1017/S2078633613000027

Murni, D., U. Lestari, S.E. Indriwati, A. Efendi, N. Maryani and M. Amin. 2020. Morphometric diversity and phenotypic relationship among indigenous buffaloes of Banten, Indonesia. *Biodiversitas Journal of Biological Diversity*, **21**(3): 933-940. DOI: 10.13057/biodiv/d210311

Nuraini, H., E.L. Aditia and B. Brahmantiyo. 2018. Meat quality of indonesian local cattle and buffalo. *In* Sadashiv, S.O. and J. Sharangouda (eds.) *Bovine Science - A Key to Sustainable Development*. Patil, IntechOpen, DOI:

10.5772/intechopen.79904.

Priyanto, R., H. Nuraini, Muladno, M. Ismail and H. Wijayanto. 2019. Slaughter, carcass and non-carcass characteristics of local cattle and buffalo in Indonesia. *Pakistan Journal of Nutrition*, **18**(2): 117-124. DOI: 10.3923/pjn.2019.117.124

Rusdin, M., D.D. Solihin, A. Gunawan, C. Talib and C. Sumantri. 2018. Sifat-sifat kuantitatif dan jarak genetik kerbau lokal Sulawesi Tenggara Berdasarkan pendekatan morfologi. *Jurnal Ilmu Pertanian Indonesia*, **23**(3): 203-210. DOI: 10.18343/jipi.23.3.203

Rusdin, M., D.D. Solihin, A. Gunawan, C. Talib and C. Sumantri. 2020. Genetic variation of eight Indonesian Swamp-buffalo populations based on cytochrome b gene marker. *Tropical Animal Science Journal*, **43**(1): 1-10. DOI: 10.5398/tasj.2020.43.1.1.

Salamena, J. and J. Papilaja. 2010. Characterization and genetic relationships analysis of buffalo population in Moa island of South-east west Maluku regency of Maluku province. *Journal of the Indonesian Tropical Animal Agriculture*, **35**(2): 75-82. DOI: 10.14710/jitaa.35.2.75-82

Saputra, F., Jakaria and C. Sumantri. 2013. Genetic variation of mtDNA cytochrome oxidase subunit I (COI) in local Swamp buffaloes in Indonesia. *Media Peternakan*, **36**(3): 165-170. DOI: 10.5398/medpet.2013.36.3.165

Saputra, F., Jakaria, A. Anggraeni and C. Sumantri. 2020. Genetic diversity of Indonesian Swamp buffalo based on microsatellite markers. *Tropical Animal Science Journal*, **43**(3): 191-196. DOI: 10.5398/tasj.2020.43.3.191

Sumantri, C., R. Diyono, A. Farajallah, A. Anggraeni and E. Andreas. 2010. Pemanfaatan famili gen hormon Pertumbuhan (GH, GHR, GHRH dan PIT-1) untuk mendeteksi keragaman genetik kerbau di Kabupaten Pandeglang dan Lebak Provinsi Banten. *Jurnal Ilmu Ternak Dan Veteriner*, **15**(4): 286-296.

Tobe, S.S., A.C. Kitchener and A.M.T. Linacre. 2010. Reconstructing mammalian phylogenies: A detailed comparison of the cytochrome *b* and cytochrome oxidase subunit I mitochondrial genes. *PLoS ONE*, **5**(11): e14156. DOI: 10.1371/journal.pone.0014156

Warmadewi, D.A., I.G.N. Gde Bidura and I.N. Budiana. 2017. Comparison of estimated genetic improvement of Bali cattle based on the selection of body dimensions. *Journal of Veterinary and Animal Sciences*, **1**(2): 59-61. DOI: 10.24843/JVAS.2017.v01.i02.p59

Zhang, Y., L. Colli and J.S.F. Barker. 2020. Asian water buffalo: Domestication, history and genetics. *Anim. Genet*., **51**(2): 177-191. DOI: 10.1111/age.12911