Biplot Simulation to Determine the Growth Rate of Body Dimension in Local Bali Ducks

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Abstract

Biplot simulation using factor analysis rotation promax kapa 90 was conducted to determine the growth rate of body dimension in female Bali duck of 0-16 week-old. The result of the biplot simulation showed that the body dimension of female Bali ducks that belongs to slow growth rate was in quadran II including the length of radius ulna, femur, tarsal and humerus. The body dimensions of female Bali ducks with the moderate growth rates were in quadrant I such as the length of carpal, chest circumference, body weight, the length necks, the length of digital 1 and the length of head. The body dimension with fast growth rate such as head circumference, neck circumference, abdominal circumference, and the length of digital 2, 3 and 4, and the length of tibia-fibula. Based on the ages, the coordinates distances in two dimension Eigen vector space were as follows. At the most distance position was at the age of 0-2 weeks, followed by the age of 2-4 weeks, and finally with closest distance was at the age of maturity.

Keywords: Biplot; Ducks bali; Body dimensions; Growth rates

Introduction

In animals, the growth of body dimension during their growth phase usually follows exponential function with different growth rates among many different parts of the body. The differences in the growth rate among many different body dimension can be due to the fisiological and functional differences as well as their tissue components.. The body dimensions which are required to be functional early tend to grow faster than those required to be functional latter. The body dimension consisting of bones as the main functional components are required to develop earlier than those consisting of muscle and fat [1].

Sampurna [2] reported that the development of body dimensions in Bali duck can be determined by allometric equation. Based on the allometic equation, the development of such body dimension in Bali Duck started from head and neck, and proceeded by the development in the back area. The development of body dimension also occurs in other parts of the body starting from legs, lower and upper thighs, chest and finally at the wings. Sampurna dan Suatha [3] reported that the growth of the body dimension in male Bali cattle is started from the neck, head, back parts of the body, and finally in the front parts of the body. Meanwhile, the body dimensions that develop and grow early are chest circumference, preceded by abdominal circumference, front and back neck circumference. Sampurna [4] showed that the fastest growth in livestock occurs when they reach inflexion point.

In many studies, however, researchers are often faced with too many body dimensions, and presentation using allometric equation and allometical graph are often less interesting as it cannot be presented in Figure 1. Bispot presentation using rotation promax kapa 90 for exponential function is able to demonstrate the differences in the growth dimension into 3 quadrants in a double dimesion local space consisting of quadrant II for those with slow growth rate, quadrant I for those with medium growth rate and quadrant IV for those with fast growth rates. Based on those result, the dimension of Bali calf in quadrant II has slow growth rate , those in quadrant I has medium growth rate and those in quadrant IV has fast growth rate [5]. Factor analysis using rotation promax kapa 90 on the body dimensions illustrated in cross axes of local space is also able to demonstrate the closeness of the relationship among body dimension base on their growth rate. If the body dimensions are in similar growth rate, the

coordinate distance among the body dimension will be close to zero, whereas the body dimension the longer coordinate distances have a wider range of the growth rates [6].

Cluster analysis is multivariate analysis aimed to group the data obtained from studies based on their characteristic similarities. Characteristic similarities are usually measured by the inter-object closeness of simmilaritis and un similarities. Furthermore, in data grouping based on the objects, another multivariate analysis that can be used is biplot analysis. The purpose of the analysis is to demonstrate both the raw (objects) and column (variables) on matrix data simultaneously in low dimension graph (two or three dimensions). The demonstration includes the variance and correlation among variables, and the closeness of the relation among objects which in turn will be able to identify the object grouping [7].

Biplot demonstration using factor analyisis to figure the raw (object) and the column (variables) of the available matrix data simultaneously in a low dimension graph is usually done by using rotation varimax. Mattjik and Sumertajaya [8] stated that the variables will be pictured as dried line. Two variables that has positive correlation will be pictured as two lines with the same direction or forming a acute angle. Meanwhile, two variables which have a negative correlation is pictured as two line with the opposite direction or forming a obtuse angle. Two variables which have no correlation will be pictured as two lines forming 90° angle (right angle). Variable with a small variance will be pictured as short vector, whereas those with big variance will be pictured as long vector. For the closeness among objects, two objects with the same characteristics will be pictured as two spots at close positions. Objects

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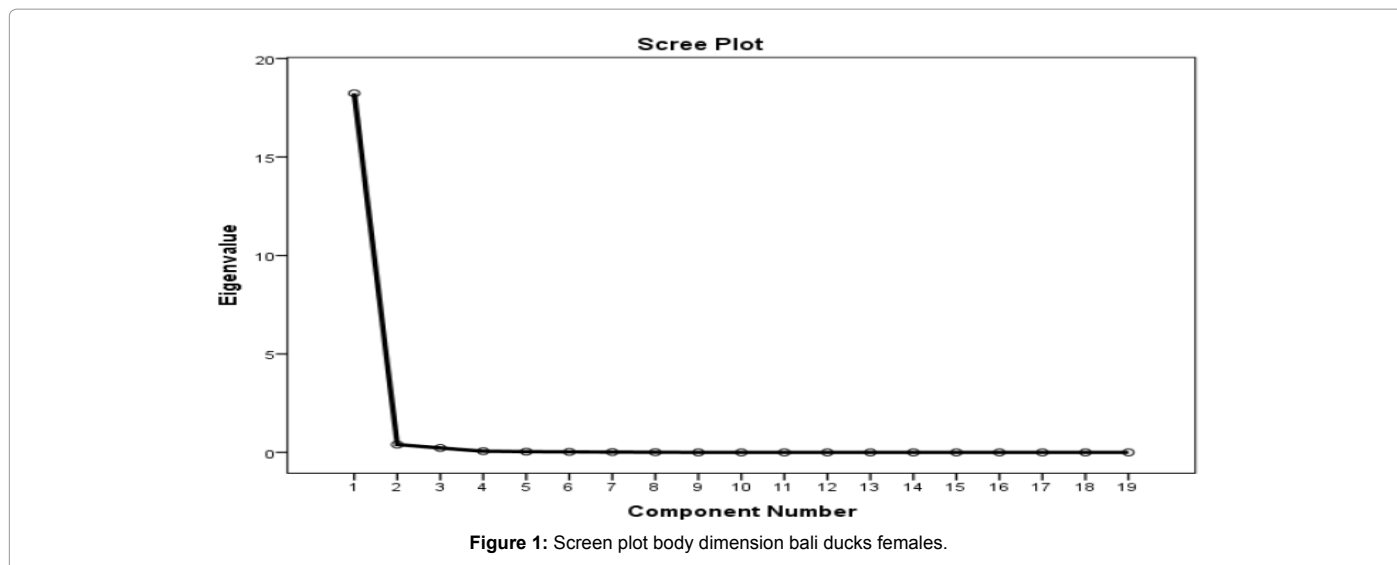
Figure 1: Screen plot body dimension bali ducks females.

with a position in the same directions with a variable will have the value of above average. In contrary, other objects with the position in the opposite direction of the variable will have value of below the average. Meanwhile, the object with the position almost at the middle will value almost the sama as the average value. Sampurna [9] reported that biplot demonstration using rotation promax kapa 90 can show the closeness of the relationship among variables. The shorter the distance among variables, the closer the correlation among them and their correlation will be close to 1, whereas th angle among variable, and the standard or vector length of variables cannot describe the value of correlate and the variance among variables.

Biplot is an explorative data analysis method of multiple variables which can demonstrate in graph on the closeness among objects, the variance of variables, correlation among variables and the association among variables and objects. In addition, biplot analysis is used to describe the correlation among variables and objects in space with two dimensions. From biplot it was obtained three approach matrixes related to data, variables and objects [10]. In principle, biplot analysis is an effort to demonstrate a graph of matrix data X in a plot by redundant display of vectors in space with low dimension, usually space with two dimension representing vectors of row X (objects) and vector representing column X (variables). From this graph display it is expected to obtain the description of objects, such as the closeness of the relationship among objects, and description of variables, both on variance and the correlation, as well as the association among objects and variables [11].

In order to make assessment of relevant factors, the first selection steps is followed by rotation of factor which function to give a more understandable result. Rotation can be orthogonal or slope (enabling the factor to correlate). Promax rotation is an alternative non-orthogonal rotation of computation method which is faster than direct obliging method and is therefore sometimes used for a large number of data set. In practice of rotation in factor analysis, it is highly recommended to try several sizes of subspaces of factors retained for assessment of rotation stability [12].

This study was aimed to find out to the close relation among body dimensions of female Bali ducks based on their growth rate in bispot graph simulation in order to find out which body dimension and at which age of those with slow, medium and fast growth rates.

Material and Methods

Biplot analysis was used to determine the body dimension of female Bali duck starting at the age of 0 to 16 weeks. The data were collected every two weeks in which 5 ducks were randomly selected starting at week 0, 2, 4, 6. 8. 10. 12, 14 and 16. The total ducks used in this study were 9x5=45 ducks. The body dimensions measured was: Head circumference, which includes the supra orbital margin of frontal. Neck circuference, which includes the vertebrae cervicalis. Chest circumference was measured in the area surrounding the sternum and the coracoid. Abdominal circumference was measured across the the os.ischium and theischiadicum. Humeral length was measured from proximal to distal regions of the humerus.

The length of radius ulna was measured from proximal to the distal regions of the radius ulna. The length of carpometacarpal was measured from proximal to distal regions of carpometacarpus. The length of femur was measured from the proximal to the distal regions of the femur. The length of fibula was measured from proximal to the distal portions of the tibia fibula. Panjang tars metatarsus, yang diukur dari proximal sampai ke bagian distal thetarsometatarsus. The lengths of digital 1, 2, 3 and 4 were measured from proximal to dital portions of thedigiti 1, 2, 3 and 4. The length of beak was measured at thepremaxillare from proc. Frontalis to i proc. maxillaries

The length of head was measured at thefrontal fromi proc. premxillare to prominentia cerebellaris. The length of neck was measured from the Atlas to the vertebrae cervicalis 14. The body overall length was measured from thethoracic vertebrae to thevertebrae caudal,The body weigh was measured by weighing the life duck using a balance weigher. The data obtained from this study was analysed by factor analysis based on the correlation among variables to obtain their correlation matrix and their significance. Eigen vector was determined by their correlation Rxo= λ xo, to obtain f(x)=R- λ I=0. Thus f(λ)=0 was disignated as own matrix equation R, the root of this equation was reffered to as matrix eigen root R and the vector which in accord with their eigen root was called eigenvector.

The data collected were their average values in order to obtain a value of 1 with differences only in their standard deviations. Biplot graph was obtained from 2 eigenvector with the highest eigen root which equal to the highest eigen root as X axis and the second highest eigen root as Y axis using Rotation Promax Kapa 90.

Coordinate position for each body dimension on X and Y axis in own space represent the the degree of correlation among many different body dimensions. The body dimensions with close position indicate close relation, whereas those with distant position indicate differences in growth rate. The uses of Rotation Promax Kapa 90 are intended to divide the position of the body dimension into 3 different quadrants. The body dimension in quadran II was used for those with slow growth rates, quadran I for those with medium growth rates and quadrant IV for those with fast growth rates. The object coordinate position or duck aged 0-16 weeks was based on Factor Scores Method Regression analysis factor 1 as absis and factor 2 as coordinate. The analysis was conducted using SPSS 22 program (Statistical Product and Service Solutions version 22).

Results and Discussion

The result showed that 98.05% of the 19 body dimensions in female Bali ducks with many differences in the growth rates can be demonstrated as biplot of Eigen space with 2 dimensions. The use of the two main components is, therefore, considered to be able to derscibe the data variation in body dimension with various differences in their growth rates (Table 1).

Scree plot of female bali ducks body dimensions in Figure 1 showed that Eigen root values decreased sharply from component 1 to component 2, but no significant decrease was observed after component 2 to component 19 indicated by flat line which shows that the 19 body dimension of female Bali ducks can be demonstrated in two dimension eigen space with component 1 as abs is and component 2 as coordinate (Figure 1).

Based on the coodinate of component 1 as abs is and component 2 as coordinate. Table 2 was shown that the body dimensions in quadrant II were the body dimension with slow growth rate at the ages of 0 – 16 weeks i.e. respectively from the slowest growth rate of radius ulna, followed by the length of femur, the length of tarsal and finally the length of humerus. The length of carpal, chest circumference, body weight, the length of neck, the length of digital 1 and finally the length of head were in quadrant I which were the body dimensions medium growth rate at the age of 0 – 16 weeks. The other body dimension were in quadrant IV consisting of those with fast growth rate such as the length of tibiae and fibulae, followed by abdominal circumference and finally the head circumference.

The result showed that the body dimension of female Bali duck aged 0-16 weeks have different growth rates. Such differences in the growth rate appear to be due the differences in the function and functional requirement of each body dimension [13-17]. Biplot demonstration showed that the wing component of female Bali duck such as radius ulna, tarsal and humerus have slower growth rates as compared to the leg components which are required to be functional earlier such as digital 2, 3 and 4. The result is in accord with the previous study by Sampurna [2] that the wings of Bali duck have slower growth rate as compared to the leg components as water fowl such as duck require leg to be functional earlier than wings (Table 2). Based on the coordinate score, it was shown that the body dimension of female Bali duck aged 0-4 weeks was in quadrant III, whereas at the age of 6 – 16 weeks was in quadrant I indicating that the growth rate rates of duck body dimension were affected by the age (Table 3).

Biplot graph simulation in Figure 2 showed that the body dimension of female Bali duck respectively from quadrant I to quadrant IV were as follows. Quadrant II were for those with the slowest groth rates such as the length of radius ulna, followed by the length of femur, the length

of tarsal and finally the length of humerus. Quadrant I were for those with the medium growth rate such as the length of head and finally. Quadrant IV wa s for those with fastest growth rates such as head circumference and the length of tibia fibulae. The distance among body dimensions in Figure 2 showed that the body dimension with close positions were those with close relationship and with a high correlation, even for those in diffferent quadrant such as the length of humerus

Initial Eigenvalues			Extraction Sums of Squared Loading			Rotation Sums of Squared Loading
Total	%of Variance	Cumulative %	Total	%of Variance	Cumulative %	Total
18.234	95.967	95.967	18.2	95.967	95.967	18.127
0.396	2.083	98.05	34	2.083	98.05	17.955
0.223	1.171	99.222	0.396			
0.062	0.325	99.547				
0.036	0.19	99.737				
0.025	0.134	99.871				
0.017	0.088	99.959				
0.008	0.041	100				

Table 1: Total variance explained body dimension bali ducks females.

Quadrant	Body Dimensions	Component	
		1(Abscissa)	2(Ordinate)
II	Lengths of Radius Ulna	-0.752	1.724
	Lengths of Femur	-0.712	1.678
	11 Lengths of Tarsal	-0.478	1.457
	Lengths of Humerus	-0.174	1.153
I	Lengths of Carpal	0.077	0.918
	C'i.rcu1uference of Chest	0.186	0.788
	Body Weight	0.257	0.717
	Lengths of Neck	0.392	0.607
	Length of Digiti 1	0.767	0.232
	Length of Head	0.849	0.148
IV	Circumference of Head	1.017	-0.022
	Length of Digiti 2	1.036	-0.054
	Length of Beak	1.150	-0.159
	Lengths of Body	1.178	-0.185
	Length of Digiti 4	1.188	-0.212
	Circumference of N eek	1.251	-0.261
	Length of Digiti 3	1.306	-0.319
	Circumference ofAbdominal	1.438	-0.465
	Lengths of Tibia Fibula	1.481	-0.502

Table 2: The coordinates of the pattern matrix body dimension bali ducks females.

Quadrant	Age (week)	Factor	
		1(Abscissa)	2(Ordinate)
III	0	-2.34993	-2.06605
	2	-0.77463	-1.16573
	4	-0.02716	-0.27005
I	6	0.22285	0.19992
	8	0.43324	0.51532
	10	0.47476	0.58994
	12	0.48799	0.5856
	14	0.74136	0.75366
	16	0.79152	0.85739

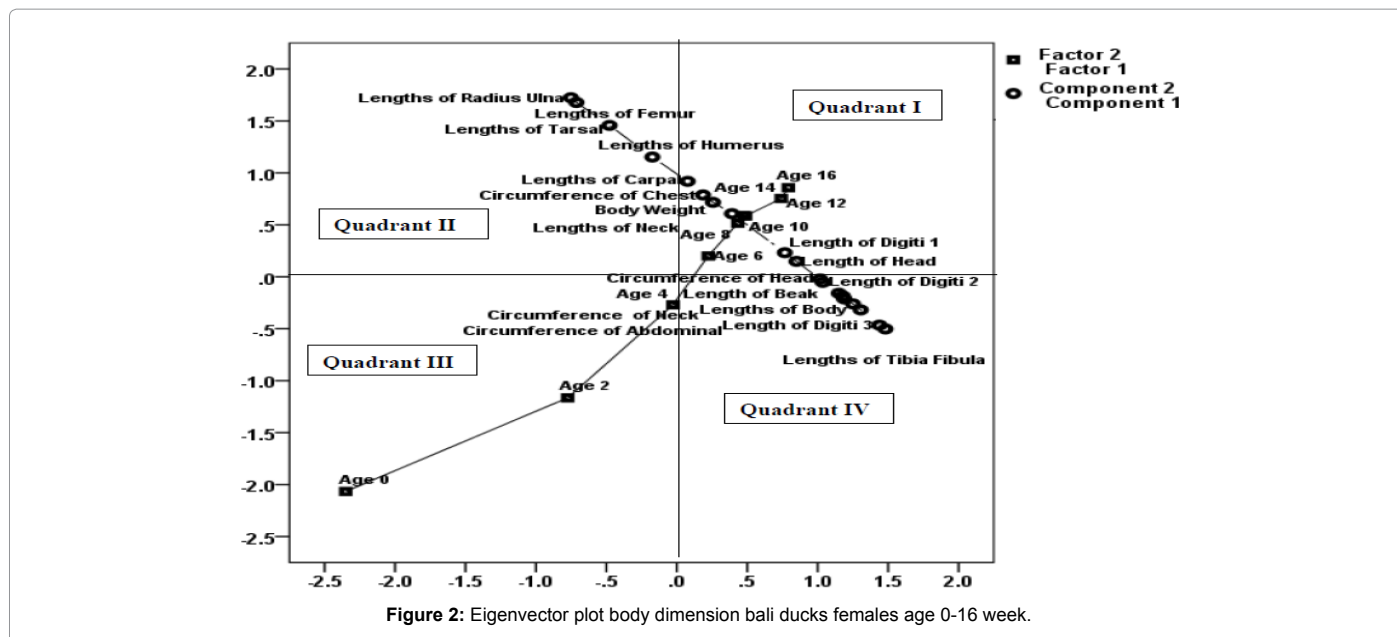**Table 3:** The coordinates of the age factor body dimension bali ducks females.

Figure 2: Eigenvector plot body dimension bali ducks females age 0-16 week.

and carpal which has a closer relation as compared with those of the length of humerus and radius ulna. The length humerus and carpal were at the different quadrants, whereas the length of humerus and the length of radius ulna were in the same quadrant. The body weight of female Bali ducks belonged to medium body dimension which is the resultant of all body dimensions. Based on their coordinate of the body dimension, the body weight has the closest position with chest circumference indicating that the body weight has a closest relation with chest circumference (Figure 2).

Coorinate position based on the age of female Bali duck in Figure 2 showed that the h the most distance position was observed at the ages between 0 week and 2 weeks, followed by the age between 2 weeks and 6 weeks. The older the age of duck, the closer the coordinate position in the graph and some of which have a distance close to 0. This Figure 2 showed that the differences in the distance of coordinate positions and the closeness among ages are in turn able to identify the grouping among ages or among objects [6]. The result also showed that the growth rates of the body dimension of female Bali ducks were the fastest at the age of 0 to 2 weeks, and they were slowing down as the ducks getting older. The fastest growth rates were observed from the time of hatching to the age 4 weeks which reaches an average inflation point at 2 week old. After the inflexion point the growth rates of the body dimension were getting slower until they reaches adult as shown in biplot simulation that at the age of 14 and 16 weeks their coordinate positions were at disatnce of close to zero as they reaches their maturity. This is in accord with previous study by Sampurna [4] that the fastest growth rates of animal body dimensions occurs before they reaches their inflexion points. Suparyanto [18] reported that the fastest growth occurs in cross-breed ducks between Pekin and Mojosari ducks from hatching to 30 day-old.

Conclusion

Biplot simulation using rotation promax kapa 90 is able to demonstrate the differences in the body dimension growth rates of female Bali ducks aged 0–16 weeks and can therefore be used to demonstrate which body dimensions have the slow, medium and fast growth rates. Based on their ages, biplot rotation promax kapa 90 is able to demonstrate at which age the average body dimension of female

bali ducks with the fastest growth rates or reaches their inflexion point and at which age they have a slow growth rate or reaches their mature.

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