Short Communication

Growth Model of Body Weight and Body Size Traits of Alashan Bactrian Camel (*Camelus bactrianus*)

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A B S T R A C T

In this study, SPSS software was used to fit five growth models (Logarithmic, Quadratic, Cubic, S, and logistic) of body weight and body size traits of Alashan Bactrian camel. The results showed that the S growth model of body height, body length, chest circumference and tube circumference had the best fitting effect, and the fitting degree was 0.937, 0.982, 0.972 and 0.914, respectively. The S growth models of body height, body length, chest circumference and tube circumference were $Y=e^{(5.219-0.520/X)}$, $Y=e^{(5.140-0.601/X)}$, $Y=e^{(5.473-0.615/X)}$, $Y=e^{(3.006-0.674/X)}$, respectively. The cubic model and S model of the body weight of Alashan Bactrian camel had the best fitting effect (R^2 = 0.979, 0.974), the cubic growth model of the body weight of Alashan Bactrian camel was $Y=103.083+128.340X-11.138X^2+0.325X^3$, and the S growth model was $Y=e^{(6.491-1.228/X)}$.

Camels, known as the "boat of the desert", are mainly divided into single humped and double humped camels. However, the single humped camels are mainly distributed in Sudan, Somalia, India and other countries. On the other hands, approximately half of the double humped camels are distributed in Australia. In China, these camels are mainly distributed in Xinjiang, Gansu and Inner Mongolia. Bactrian camels are important source for livestock products such as meat, milk and fur. Furthermore, they have played a significant role in the human development and desert conquering. In recent years, a great deal of investigations has beem made to assess genetic diversity (Bai *et al.*, 2020) and organization structure (Ye *et al.*, 2014a, b; Wang *et al.*, 2016) of Bactrian camels. Addtionally, epidemiological prevalence of mastitis and the serological detection of neosporia have been confirmed in camel (Aljumaah *et al.*, 2018). Alashan Bactrian camel is an ancient camel species with a long-standing history and are in largest number in China, mainly distributed in Alashan Left Banner and Alashan Right Banner in Inner Mongolia. Since the growth cycle of camel is prolong, and sexual and body maturity are relatively late, the study of weight and body size traits of Alashan Bactrian camel will be helpful to further understand their growth characteristics.

Materials and methods

The data on the male Bacterian camels was mainly acquired from the animal husbandry research of Alxa League from Alxa Left Banner in Inner Mongolia Autonomous Region. The measurement of traits invovles (i) body weight: The live weight taken with the weighbridge before the camel drunk water; (ii) body height was measured from the base of the front to the rear edge of camel peak to the ground; (iii) body length was attributed to the distance from shoulder to hip (measured with a measuring stick); (iv) chest circumference include a circle around the center of the horny pad at the bottom of the chest from the base of the posterior edge of the front peak (measured with a tape measure) and (v) tube circumference accounted for the upper third part of the tube of the left forelimb, which was formed in a circle (measured with a tape measure). The SPSS software was used to analyze the curve regression of body weight and body size characters to age of Alashan Bactrian camel. The best regression model was selected according to the fitting degree.

Table I. Growth curve fitting results of weight and body size characters of Alashan Bactrian Camel.

Traits	Model	Equation	b_0	b_1	b_2	b_3	R^2	P	F
Body height	Logarithmic	$Y=b_0+b_1 (InX) o+b1\times(lnX)$	19.796	128.998			0.692	0.000	29.229
	Quadratic	$Y=b_0+b_1X+ b_2X^2$	114.564	13.471	-0.684		0.768	0.000	19.904
	Cubic	$Y=b_0+b_1X+ b_2X^2+ b_3X^3$	88.753	30.193	-3.214	0.105	0.900	0.000	32.912
	S	$Y=e^{(b0+b1/X)}$	5.219	-0.520			0.937	0.000	194.159
	Logistic	$Y=1/(1/u+b0(b_1{}^X))$	0.007	0.983			0.352	0.020	7.075
Body length	Logarithmic	$Y=b_0+b_1 (InX) o+b1\times(lnX)$	108.739	22.642			0.856	0.000	77.240
	Quadratic	$Y=b_0+b_1X+ b_2X^2$	95.929	13.537	-0.646		0.897	0.000	52.219
	Cubic	$Y=b_0+b_1X+ b_2X^2+ b_3X^3$	80.396	23.601	-2.169	0.063	0.942	0.000	59.468
	S	$Y=e^{(b0+b1/X)}$	5.140	-0.601			0.982	0.000	706.711
	Logistic	$Y=1/(1/u+b0(b_1{}^X))$	0.008	0.976			0.511	0.003	13.600
Chest circumference	Logarithmic	$Y=b_0+b_1 (InX) o+b1\times(l nX)$	146.675	33.982			0.912	0.000	134.323
	Quadratic	$Y=b_0+b_1X+ b_2X^2$	134.192	17.509	-0.779		0.889	0.000	47.904
	Cubic	$Y=b_0+b_1X+ b_2X^2+ b_3X^3$	104.462	36.771	-3.694	0.121	0.967	0.000	106.176
	S	$Y=e^{(b0+b1/X)}$	5.473	-0.615			0.972	0.000	492.503
	Logistic	$Y=1/(1/u+b0(b_1{}^X))$	0.006	0.974			0.603	0.001	19.776
Body weight	Logarithmic	$Y=b_0+b_1 (InX) o+b1\times(l nX)$	237.515	152.304			0.951	0.000	251.465
	Quadratic	$Y=b_0+b_1X+ b_2X^2$	26.204	7.536	0.458		0.950	0.000	114.660
	Cubic	$Y=b_0+b_1X+ b_2X^2+ b_3X^3$	103.083	128.340	-11.138	0.325	0.979	0.000	172.543
	S	$Y=e^{(b0+b1/X)}$	6.491	-1.228			0.974	0.000	483.325
	Logistic	$Y=1/(1/u+b0(b_1{}^X))$	0.003	0.947			0.682	0.000	21.993
Tube circumference	Logarithmic	$Y=b_0+b_1 (InX) o+b1\times(l nX)$	12.691	2.650			0.685	0.000	28.211
	Quadratic	$Y=b_0+b_1X+ b_2X^2$	11.027	1.691	-0.084		0.718	0.001	15.281
	Cubic	$Y=b_0+b_1X+ b_2X^2+ b_3X^3$	7.624	3.896	-0.418	0.014	0.844	0.000	19.856
	S	$Y=e^{(b0+b1/X)}$	3.006	-0.674			0.914	0.000	138.536
	Logistic	$Y=1/(1/u+b0(b_1{}^X))$	0.069	0.977			0.367	0.170	7.538

Results and discussion

Figure 1 show the fitting results of weight and body size characters of Alashan Bactrian camel under five growth models (Logarithmic, Quadratic, Cubic, S, and logistic). As it is depicted in the Figure 1, the fitting results of body weight, body length, body height, chest circumference and tube circumference were the worst under logistic model.

As outlined in the Table I, the fitting effect of the S growth model of Alashan Bactrian camel body height was the best ($R^2 = 0.937$), and the S growth model was $Y=e^{(5.219-0.520/X)}$, followed by the cubic model with better fitting effect ($R^2 = 0.900$). However, the fitting effect of other models was unsuitable and thus was not considered. The fit effect of S growth model of Alashan Bactrian camel body length was the best ($R^2 = 0.982$), the S growth model was $Y=e^{(5.140-0.601/X)}$, followed by the cubic model with better fitting effect ($R^2 = 0.942$). The fitting effect of additional two models was not ideal.

The fitting effect of S growth model of Alashan Bactrian camel's chest circumference was the best ($R^2 = 0.972$), the S growth model was $Y=e^{(5.473-0.615/X)}$. The fitting effect of cubic model ($R^2 = 0.967$), and logarithmic model was considerable ($R^2 = 0.912$) whereas the fitting effect of other models is not ideal. In contrast, the fitting effect of S model for the growth of Alashan Bactrian camel tube circumference was the best ($R^2=0.914$), and S model was $Y=e^{(3.006-0.674/X)}$. The fitting effect of additional models was not ideal.

The cubic model and S model of the body weight of Alashan Bactrian camel had the best fitting effect ($R^2 = 0.979, 0.974$). The cubic growth model of the body weight of Alashan Bactrian camel was $Y=103.083+128.340X-11.138X^2+0.325X^3$, and the S growth model was $Y=e^{(6.491-1.228/X)}$. The fitting effect of quadratic model and logarithmic model appeared better ($R^2 = 0.950, 0.951$) among all, and logistic model showed the worst corelation ($R^2 = 0.682$).
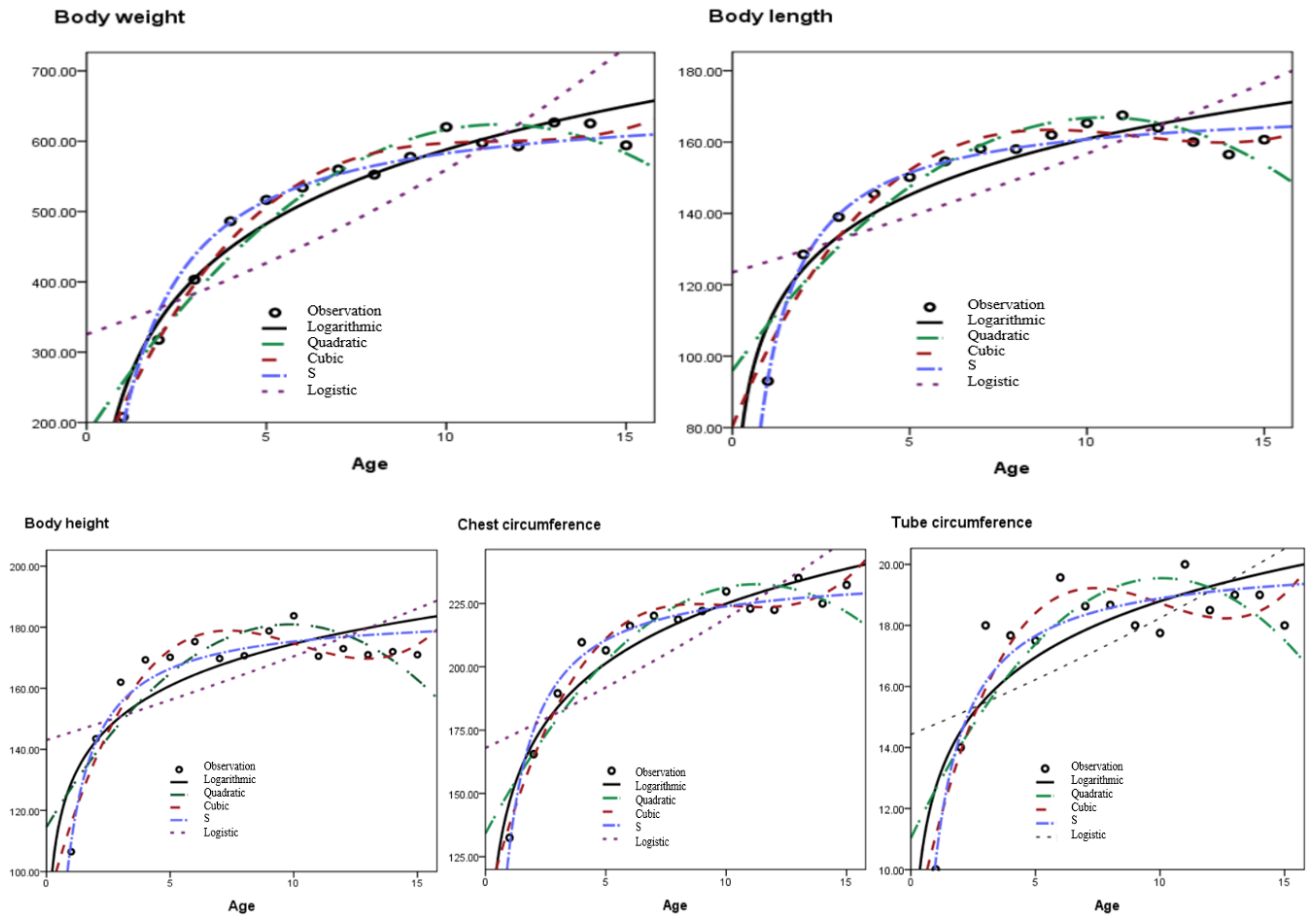
Fig. 1. Growth curve fitting of Alashan Bactrian Camel.

The results of the current study showed that the S growth model of the body weight of Alashan Bactrian camel was similar to that of Feng *et al*. (2008) who have shown that the S growth model of the body weight of Bactrian camel was $Y=e^{(6.321-2.754/X)}$. However, they have only studied the body weight growth model of Bactrian camel. In our study, not only the body weight growth model of Alashan Bactrian camel was studied, but the growth models of body height, body length, chest circumference and tube circumference of Alashan Bactrian camel were also invstigated. Therefore, finding of the current study provide a comprehensive data to further fuide the breeding of Alashan Bactrian camel in the country.

Statement of conflict of interest
The authors have declared no conflict of interest.

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