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Resting Metabolic Rate in Three Age-groups of *Alligator sinensis*

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Abstract.-The resting metabolic rate in three age-groups of *Alligator sinensis* is influenced the temperature, season, body weight and other factors. Among these factors, the effect of body weight, temperature, season, which are greater than that of others. The relationship between the body weight and the resting metabolism is not consistent with the "third-quarter" surface area law. In the equation $M=aW^b$, the value of "a" ranges from 0.009 to 0.028, and the value of "b" ranges from 0.522 to 0.591, so that b is approximately equal to 2/3 in empirical equation.

Key Words: Reptilia, Crocodilia, Alligatoridae, *Alligator sinensis,* China, metabolism.

Introduction

Alligator sinensis is a kind of special and precious reptile. It is classed as a first grade protected form of wildlife in China. Much research on the adaptability of *Alligator sinensis* have been done in the fields of morphology, distribution, reproduction and so on (Chen, 1985; Chen and Wang, 1984). Zhang (1986; 1989) reported information about infant *Alligator sinensis* whose weights ranged from 35 to 50 grams. Because energy metabolism is a very important criterion for the adaptability of *Alligator sinensis*, the purpose of our work was to explore the regularity of daily gain in total energy from diet, with relation to digestibility and energy allocation and to explore the resting metabolic rate of *Alligator sinensis.* This paper deals with the resting metabolic rate of three age groups in *Alligator sinensis.*

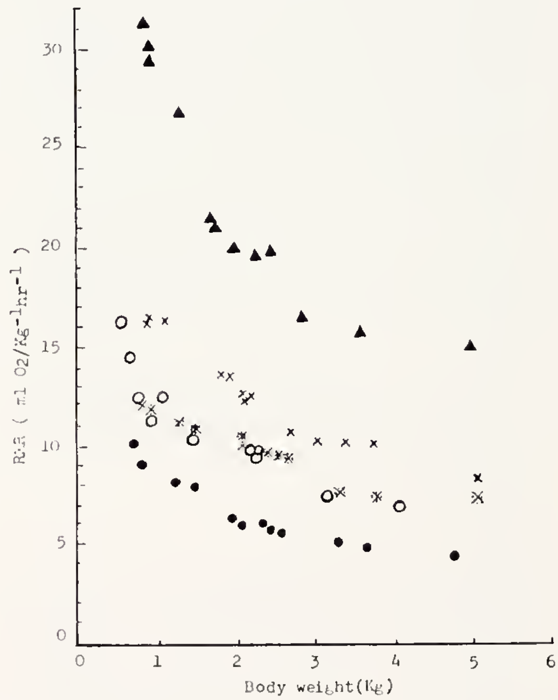

FIG. 1. Relationship between RMR and body weight in *Alligator sinensis.* Open circle- May (20°C); solid triangle- July (28°C); x- September (24°C); *- October (20°C); solid circle- January (12°C).

Materials and Methods

The *Alligator sinensis* that we used were provided by the Shanghai Zoo. The total number of tested animals was 13. Five of them were born in 1980, and their average body weight was 2.84 ± 0.053 (M±SD) kg at the beginning of the experiment in 1986 and 3.126±0.053 kg at the end of 1987. Four of them were born in 1981, and their average body weight was 1.54±0.59 kg at the beginning of the experiment in 1986 and 2.139±0.857 kg at the end of the experiment in 1987. Four of them were born 1982, and their average body weight was 0.900±0.284 kg at the beginning of the experiment and 1.231±0.536 kg at the end of the experiment in 1987.

The experiment began in May 1986 and ended in January 1987. These animals were reared in the three ponds according their age differences. These ponds were simple artificial environments and the size of each pond was 3x4 square meters.

Table 1. The linear regression equations and the approximate surface area equations of *Alligator sinensis*.

Months	Ta=C	Linear regression equations	Approximate surface area equations
May	20°	logY=log-1.911+0.568 logX	$M=0.012W^{0.568}$
May	25°	logY=log-1.789+0.549 logX	$M=0.016W^{0.549}$
July	25°	logY=log-1.584+0.579 logX	$M=0.026W^{0.579}$
July	28°	logY=log-1.549+0.571 logX	$M=0.028W^{0.571}$
Sep.	24°	logY=log-1.750+0.542 logX	$M=0.018W^{0.542}$
Sep.	25°	logY=log-1.730+0.550 logX	$M=0.019W^{0.550}$
Oct.	20°	logY=log-1.882+0.591 logX	$M=0.013W^{0.591}$
Oct.	25°	logY=log-1.774+0.525 logX	$M=0.017W^{0.525}$
Jan.	12°	logY=log-2.050+0.544 logX	$M=0.009W^{0.544}$

TABLE 2. T-test of regressional coefficient.

Months	May		July		September		October		January
T=C	20°	25°	25°	28°	24°	25°	20°	25°	12°
t-value	1201	1203	1072	637	302	1819	1043	1272	4599

Note: all t values are over $t_{0.001}df_6=5.96$ and $t_{0.001}df_5=6.86$.

In this paper the measure of the resting metabolic rate is in ml $O_2/kg^{-1}hr^{-1}$ or ml $O_2/W^{0.56}hr^{-1}$. The closed-system respirator meter of Wang et al. (1980) was used to measure the oxygen consumption of *Alligator sinensis* under two different temperatures. The first, 25°C, is the contrast temperature that comes from the adaptive temperature of *Alligator mississippiensis* reported by Coulson and Coulson (1986). The other is the seasonal temperature that is derived from the average temperature of each month in the last five years in Shanghai (Table 1). The ingestive food behavior in the animals was fasted to avoid its effect on metabolism during the measuring of oxygen consumption.

Results and Discussions

The relationship between the body weight and the resting metabolic rate (RMR)

The relationship between the body weight and the resting metabolic rate of *Alligator sinensis* is summarized in Fig. 1. The resting metabolic rate to unit weight declines with the raise of individual weight in each month or under each temperature. That is, there is a negative correlation between the body weight and the weight-specific resting metabolic rate of *Alligator sinensis* that corresponds with the surface area law. The further analysis of the correlation between the weight and the

TABLE 3. A comparison of RMR in three age groups of *Alligator sinensis* from 1986-1987.

Age groups	RMR	May 1986		July 1986		Sept. 1986		Oct. 1986		Jan. 1987
		20°C	25°C	25°C	28°C	24°C	25°C	20°C	25°C	12°C
	ml 0^2/kg^{-1}h^{-1}									
	Mean	8.52	10.28	16.19	17.54	10.51	11.10	8.80	10.31	5.44
	S. E.	0.77	1.07	1.15	1.24	0.71	0.79	0.62	0.75	0.36
A group	%	100	100	100	100	100	100	100	100	100
Born 1980	ml 0^2/W$^{0.56}$h^{-1}									
	Mean	13.26	16.39	27.98	28.87	17.44	18.40	14.12	16.84	8.76
	S. E.	0.39	0.46	1.85	0.66	0.32	0.37	0.34	0.91	0.09
	%	100	100	100	100	100	100	100	100	100
	ml 0^2/kg^{-1}h^{-1}									
	Mean	10.98	13.89	21.08	21.85	13.09	13.84	9.87	12.19	6.49
	S. E.	0.64	0.72	2.35	2.76	1.33	1.45	0.79	1.51	0.66
B group	%	128.9	135.1	130.2	124.6	124.5	124.7	100.8	118.2	119.3
Born 1981	ml 0^2/W$^{0.56}$h^{-1}									
	Mean	12.61	16.55	26.41	27.23	17.73	18.72	13.53	16.55	8.63
	S. E.	0.53	0.35	0.42	0.52	0.13	0.23	0.22	0.62	0.67
	%	95.1	101.0	94.5	94.3	101.7	101.7	95.8	98.3	98.5
	ml 0^2/kg^{-1}h^{-1}									
	Mean	13.87	18.62	25.08	27.42	15.18	16.52	11.61	14.52	8.47
	S. E.	1.16	1.42	1.84	2.33	0.76	1.46	0.73	1.14	0.79
C group	%	162.8	181.1	154.9	156.3	144.4	148.8	131.9	140.8	155.7
Born 1982	ml 0^2/W$^{0.56}$h^{-1}									
	Mean	12.28	15.96	26.79	29.19	17.00	18.31	12.87	15.88	8.87
	S. E.	0.50	0.49	1.44	0.80	0.61	0.04	0.76	0.14	0.20
	%	92.6	97.4	95.8	101.1	97.5	99.5	91.2	94.3	101.3

resting metabolic rate of *Alligator sinensis* begin by converting or "transforming" observed values to their logarithms and the linear regression equation and the approximate surface area equation (Table 1) which are formed on the base of their logarithms according to the methods of Avery (1979). In equation $M=aW^b$ from Table 1, the value "a" ranges from 0.009 to 0.028, the value "b" ranges from 0.522 to 0.591.

The significance of coefficients on the linear regression equations in Table 1 are also examined through the T-test (T=b/sb) and the results are shown in the Table 2. All values of "t" are larger than $t_{0.001df5}$=6.86 and $t_{0.001df5}$=5.96 (Table 2), so the values of p are less than 0.001. We may be to deduce that the body weight has a great effect on the metabolic rate, and has a similar effect in other crocodilians (Coulson and Hernandez, 1983).

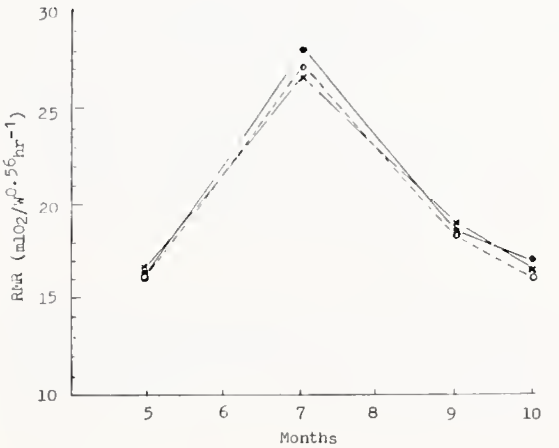

FIG. 2. Seasonal influence on the RMR of *Alligator sinensis* maintained at 25°C. Solid circle- 1980 age group; x- 1981 age group; open circle- 1982 age group.

Effects of temperature and season

Table 3 shows that the resting metabolic rate of *Alligator sinensis* affected by the temperature and season. In the cool season or under the low temperature, the resting metabolic rate is at a lower level, and vice versa. This is similar to that of the other reptiles (Coulson and Coulson, 1986; Huggins et al., 1971; Wang and Lu, 1986; Wang and Xu, 1987; Wang et al., 1983, 1988). This metabolic character is due to the result of acclimatization of seasonal temperature rhythm in evolution of animals.

We further analyze the relationship between RMR (resting metabolic rate) and temperature as well as season. We used 0.56 power of body weight to adjust all values of observing, so that the effect of body weight in RMR is eliminated. The results are summarized in Table 3. The values of ml $O_2/W^{0.56}hr^{-1}$ from Table 3 show the temperature and season effect on RMR. The levels of RMR are higher under high temperatures than low, and it is a similar state that there is a higher level of RMR during hot seasons than during cool seasons.

From Fig. 2, is is further shown that the RMR changes with seasons under the same temperature of 25°C. In July, the RMR is the highest level; in September, the RMR becomes lower and it is continues to fall in October. This suggests that the energy consumption is relevant to the seasonal change which also corresponds with the rules of the energy consumption and requirements of *Alligator sinensis*. Among the growth months of *Alligator sinensis* as in July, there is a high water temperature, and there is intensive metabolism and rapid growth in *Alligator sinensis*. The data below support this statement. The group born in 1980 ingested daily 172.02±77.65 (M±SD) g fresh fish in June, 221.35±35.58 g fresh fish in July, 54.73±41.14 g fresh fish in September. The daily body weight growth of the group was also rapid, such as 10.3 g in June, 44.6 g in July and 15.8 g in September. In May, *Alligator sinensis* had just awaked from hibernation, when the RMR was lower. In October, *Alligator sinensis* will stop the feeding when the RMR declined to a low level, and there were some changes in their physiological attributes for the coming hibernation stage. It is indicated that *Alligator sinensis* has a series of adaptive strategies for the seasonal changes.

The relationship between age and RMR

The relationships between age and RMR in three age groups are shown in Table 3. There are two kinds of data on the RMR. The first RMR in Table 3 is influenced by body weight, and does not eliminate the effect of body weight. It is expressed in ml $O_2/kg^{-1}hr^{-1}$. The second RMR eliminates the effect of body weight by expressing RMR in ml $O_2/W^{0.56}hr^{-1}$. A comparison on the level of both kinds of RMR in three age groups is based on 100 in RMR of age groups in 1980. The results of comparison suggest that the first kind of RMR falls as the age of groups increases. The second kind of RMR slightly falls in younger groups, except in a few months.

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