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WEIGHTS AND LINEAR MEASUREMENTS OF THE BODY AND SOME ORGANS OF THE ADULT MALE AND FEMALE AFRICAN WHITE BELLIED TREE PANGOLINS (*Manis tricuspis*)

[1]OZEGBE*, P. C., [2]OGUNSANMI, A. O. AND [2]OGUNJOBI, E. O.

Departments of [1]Veterinary Anatomy and [2]Wildlife and Fisheries Management
University of Ibadan, Ibadan, Nigeria

*E-mail: Library@kdl.ui.edu.ng
uivetmed@steineng.net

SUMMARY

The absolute weights of the body, heart, kidneys, spleen, pancreas, liver, gonads, digestive tract and adrenal glands, as well as the absolute linear measurements of the body, digestive tract and oviduct were determined in adult female and male African white-bellied tree pangolins. The relative weights, relative lengths and weight per unit length were derived from the relevant data. Statistical analyses of sex effect showed that all the organs, except the length of the oesophagus relative to the nose-tail length ($P<0.05$), were not significantly different. The data provided could be helpful in future laboratory investigations where the body-and organ-weights and linear measurements of the captive and wild pangolins would be of practical value

KEYWORDS: Body, Organ, weight, length, relative, pangolin, *Manis tricuspis*

INTRODUCTION

The African white-bellied tree pangolin *(Manis tricuspis)* is a nocturnal arboreal animal found in the tropical rainforests, along forest edges and savannahs of Africa (Rahm and Thenius, 1975). It is consumed by the rural population in Nigeria. The literature contains very scanty information on the anatomy of this ant-eating mammal.

The organ to body weight ratio is a practical tool in both nutritional and toxicological investigations (Kaunitz *et al.*, 1956; Krumholz, 1956). Such ratios had been established for some laboratory animals (Webster *et al.*, 1947; Webster and Liljegren, 1949, 1955; Latimer and Sawin, 1955; 1957; Latimer *et al.*, 1961) but have not been documented in the pangolin. This study was initiated, therefore, to establish these ratios and determine, if any, the influence of sex on them.

MATERIALS AND METHODS

Ten healthy adult African white-bellied tree pangolins (5 males and 5females) were used for this work. The animals were captured in Ikire, Nigeria. The captured animals were transported to the laboratory,

weighed and exsanguinated by cardiac puncture following ether anaesthesia. The total body length (from the tip of the snout to the tail end) was measured with a meter tape rule prior to autopsy. Linear measurements of the digestive tract, from the tip of the oesophagus to the anus, and its parts were made with a metric tape rule after removing the contents. The spleen, kidneys, adrenals, liver, heart, lungs, trachea, parts of the digestive tract, gonads, oviduct and pancreas were carefully removed, cleaned of all fat and connective tissue, blotted dry and weighed. The entire anaesthesised pangolin as well as its major parts were weighed to the nearest gram on a laboratory balance sensitive to 0.1gm. The smaller organs were weighed on an analytical balance.

Differences in the mean absolute and relative weights and lengths of organs between the sexes were statistically evaluated by t-test procedure of a statistical analysis system software (SAS, 1988). The weight (mg) per unit length (mm) for the entire digestive tract and its parts were calculated. The body build index (Latimer and Sawin, 1957) was found for both sexes.

RESULTS

Weight and linear measurement

The mean weights and linear measurements, together with their standard errors of mean (s.e.m), coefficients of variation (c.v) and coefficients of correlation (r) to the body weight and/or length are as shown in Tables IA, IIA and IIIA. There were eight parts or organs that were significantly heavier ($P<0.05$) in the female compared to three in the male. The hearts in both sexes had equal absolute weight. Parameters in the male were more variable than those in the female.

The weights of the heart, digestive tract, oesophagus and stomach showed significant positive correlation to the body weight ($P<0.05$) in both sexes while the linear measurements of the oesophagus was the only linear parameter with significant positive correlation to the nose-tail length in both sexes.

Relative body weight and length

Tables IB, IIB and IIIB show the mean weight and length of organs (and/or parts of organs) relative to the gross body weight and nose-tail length, respectively. The s.e.m, c.v. and r are also indicated.

Generally, the female had higher relative weights for the digestive tract. oesophagus, stomach, small intestine, spleen, and kidneys while the liver, heart, lungs, adrenal glands, gonads and large intestine of the male were higher, albeit, non-significantly ($P>0.05$). Although the relative lengths of the oesophagus, stomach, small intestine and digestive tract were greater in the male than in the female, only the relative length of the oesophagus was significantly affected by sex ($P<0.05$). The relative lengths of oesophagus and large intestine were significantly correlated ($P<0.05$) to the body length in the male. The relative length of the large intestines of both sexes were the most variable parameters. The value of the relative length of the

oesophagus is second to that of the small intestine in the male unlike the female where the large intestine is the second longest segment.

The adrenal gland was the most variable male organ while the gonad was the most variable in the female.

Relative to digestive tract weight and length

The relationship between the digestive tract and its various parts are as shown in Tables IIC and IIIC. The relative lengths of the intestines (large and small) were longer in the female. However, the female had shorter oesophagus and stomach. The relative length of the oesophagus was quite variable in both sexes, but the intestines were equally variable in the male only.

Generally, the relative weight of the small intestine was higher than the relative weight of the stomach while the relative weight of the oesophagus had the least value. The relative length of the small intestine was the longest segment in both sexes. Although the relative length of the oesophagus was longer than the relative length of the large intestine in the male, but the large intestine of the female had a relatively longer relative length than the oesophagus.

The average of the c.v. of the digestive tract and its parts were almost similar in both sexes; viz 30.8% in the male and 29.6% in the female. However, some individual parts showed more marked sex differences in variability.

Body build index and weight per unit length

The male, with a body build index of 0.24 ± 0.01, was more slender than the female (0.25 ± 0.01). However, the female was more variable than the male; *c.v.* being 9.964% and 5.268%, respectively.The female had heavier weight per unit length of the digestive tract, oesophagus, stomach and small intestine but the large intestine of the male was heavier (Table IV).

DISCUSSION

Weight and linear measurement

The observation that the female pangolin has more organs heavier than those of the male agrees with the earlier reports by Latimer and Sawin (1955, 1957) in the rabbit. The sex effect on five out of the eleven parameters common to the work of Latimer and Sawin (1957) and this report are similar.

A comparison of the *c.v.* of the various parameters, excluding the highly variable gonads and oviduct, shows the male pangolin, like the male rabbit of Latimer and Sawin (1955, 1957), to be more variable than the female.

Relative Body weight and length

Changing the absolute weight to relative gross-body weight alters the sex differences in relative proportion. Thus, there are six parts or organs heavier in the male and another six heavier in the female pangolin, albeit, non-significantly ($P>0.05$). The relative heart weight becomes greater in the male than in the female pangolin in agreement with the finding of Latimer and Sawin (1957) that

larger animals have relatively smaller heart.

The observed 0.224% mean relative weight of the testes of pangolin is smaller than the 0.269% of chimpanzee (Short, 1978) and 0.88% of African giant rat (Oke, 1988). However, it is remarkably bigger than the 0.079% of man, 0.018% of gorilla (Short, 1978) and 0.13% of the guinea fowl (Aire *et al.*, 1980).

The positive correlation observed between body weight and testes weight in the pangolin is in line with the observations for the giant rat (Oke, 1988), rat, mouse and hamster (Leathem, 1977).

The mean relative weights of the kidney and liver are smallest in the pangolin but the pangolin has the largest adrenal glands and the second largest heart when compared to the Mongolian gerbil, rat and rabbit (Freudenberger, 1932; Latimer and Sawin, 1957; Kramer; 1964). This could be due in part to the differences in nutrition, metabolism, domestication and the need for "fright, fight and flight" syndrome in the wild.

The male pangolin with more variable viscera than the female is unlike the rabbit where the female is more variable (Latimer and Sawin, 1957, 1961). The sex difference in c.v. in the pangolin has been narrowed from 11.2% to 5.9% by converting the organ measurements from absolute to relative values. A similar trend is discernible from the data of Latimer and Sawin (1957) on the rabbit.

The relatively heavier but shorter digestive tract, heavier but longer oesophagus, stomach and small intestine as well as lighter and shorter large intestine in the pangolin when compared to the rabbit might be an adaptation for digestion of insects in the pangolin. The rabbit requires its longer and heavier large intestine as well as longer digestive tract for fermentation and the subsequent coprophagy.

Relative to digestive tract weight and length

The observed sex differences in the relative weights of the oesophagus, stomach, small intestine and large intestine of the pangolin are contrary to the reported findings in the rabbits (Latimer and Sawin, 1957; 1961).

The distribution gradients of the relative lengths of the various parts of the digestive tract, as well as the relative weights of the small intestine and the oesophagus are similar in the pangolins and the Race III rabbit of Latimer and Sawin (1961). The relative weight of the large intestine is slightly heavier than the stomach in the Race III rabbit probably because of the adaptation for coprophagy. The greater relative weight of the stomach when compared to the large intestine in the pangolin is probably because of the increase in thickness of the stomach musculature as a compensatory mechanism for the lack of teeth to masticate food in the pangolin.

Body build index and weight per unit length

The pangolin with body build indices of 0.24 ± 0.01 and 0.25 ± 0.01 (males and

females, respectively) is more slender than the rabbit (1.61, 1.49, 1.65, 1.6, 1.67, 1.60, for males and females of Race III, Normal and Dwarf rabbits of Race X, respectively) as reported by Latimer and Sawin (1957). The male pangolin is slightly more slender than its female counterpart unlike in the rabbit where the male is bulkier (Latimer and Sawin, 1957).

The female pangolin with heavier weight per unit length of the digestive tract and its parts, except the large intestine, is similar to the Normal X rabbit but contrary to those of adult cat (Latimer and Sawin, 1961).

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TABLE I: Summary of the absolute and relative weights of the body and its viscera

Panel A – Weight (g)						
	Male			Female		
Parameter	Mean ± SEM	CV	R	Mean ± SEM	CV	R
Gross body weight	1136±205	36.1	-	1206.8±128.9	23.9	-
Liver	28.±4.3	30.9	0.9109	29.7±4.80	36.3	0.9719*
Spleen	2.0±0.40	42.2	0.9599**	2.10±0.20	25.5	0.7617
Heart	4.9±0.90	36.7	0.9839**	4.90±0.50	23.9	0.9055*
Lungs	6.50±0.50	17.1	0.9272	6.80±0.70	23.1	0.9312*
Adrenal glands	0.80±0.1	35.3	-0.4462	0.50±0.10	37.0	-0.5352
Kidneys	6.30±1.1	35.9	0.1056	7.10±0.80	25.9	0.9861*
Gonads	2.775±0.9776	70.45	0.999**	1.75±0.5551	73.25	0.7509
Oviducts			-	3.88±1.5173	87.447	0.6352
Panel B-% gross body weight						
Liver	2.515±0.193	15.35	-0.4198	2.411±0.142	13.17	0.7782
Spleen	0.1725±0.012	13.89	0.1621	0.1776±0.014	17.62	-0.3188
Heart	0.433±0.016	07.38	0.0152	0.4039±0.02	11.07	-0.1391
Lungs	0.5947±0.054	18.16	-0.9181	0.5621±0.025	9.945	-0.181
Adrenal glands	0.073±0.016	43.80	-0.7995	0.0469±0.012	57.2	-0.752
Kidneys	0.5639±0.052	18.44	-0.2533	0.5831±0.014	5.369	0.3262
Gonads	0.2244±0.032	29.36	0.9646	0.1695±0.0568	67.02	0.454
Oviducts	-	-	-	0.2984±0.1176	88.15	0.458

*P<0.05 **P<0.01 ***P<0.001

TABLE II: Summary of absolute and relative weights of the digestive tract and its parts

	Male			Female		
Parameter	Mean ± SEM	CV	r	Mean ± SEM	CV	r
Panel A - Weight (g)						
Digestive tract	69.5±16	45.9	0.9499*	77.3±13.2	38.1	0.9712**
Oesophagus	02.5±0.5	37.1	0.9955**	02.8±0.30	25.5	0.9316
Stomach	24.9±4.70	37.6	0.9857**	26.6±3.00	25.3	0.9602**
Small intestine	27.3±7.80	56.9	0.9326	35.7±8.40	52.6	0.9662**
Large intestine	13.5±3.90	57.9	0.904	12.2±1.60	28.6	0.9594**
Panel B-% gross body weight						
Digestive tract	6.0±0.5	16.9	0.2769	6.3±0.5	16.3	0.7825
Oesophagus	0.224±0.005	4.3	0.2574	0.235±0.022	9.3	0.1287
Stomach	2.191±0.08	7.6	-0.0321	2.203±0.0723	7.3	0.14102
Small intestine	2.31±0.329	28.5	0.5355	2.812±0.388	30.9	0.8636*
Large intestine	1.158±0.175	30.2	0.3211	1.007±0.043	9.5	0.2285
Panel C-% digestive tract weight						
Oesophagus	3.793±0.352	18.56		3.814±0.248	14.54	
Stomach	36.845±2.38	12.89		35.73±1.914	11.98	
Small intestine	38.052±3.827	20.11		44.099±3.02	15.31	
Large intestine	18.921±1.667	17.62		16.354±1.136	15.53	

*P<0.05 **P<0.01

TABLE III: Summary of absolute and relative length of the digestive tract and its parts

	Male			Female		
Parameter	Mean ± SEM	CV	r	Mean ± SEM	CV	r
Panel A-length (cm)						
ose-tail length	77.7±4.80	12.4		78.4±3.50	9.9	-
Digestive tract	181.3±34.7	38.3	0.5302	169.8±9.10	12.0	0.1749
Oesophagus	11.0±0.40	7.4	0.9741*	10.0±0.70	15.8	0.8959*
Stomach	4.90±0.10	5.1	0.0518	4.70±0.2	11.1	0.8694
Small intestine	150.3±31.2	41.5	0.5585	144.2±8.8	13.7	0.1187
Large intestine	11.3±3.3	58.4	0.9629**	11.0±0.50	11.1	-0.552
Panel B-% nose-tail length						
Digestive tract	232.1±39.64	34.17	0.14	218.02±14.9	15.24	-0.546
Oesophagus	14.211±0.35	05.0	-0.9613*	12.71±0.47	08.3	0.5169
Stomach	6.34±0.418	13.2	-0.8943	5.94±0.144	05.4	-0.0019
Small intestine	191.93±35.01	36.5	0.2028	185.22±14.127	17.1	-0.5167
Large intestine	13.923±3.08	44.2	0.9548*	14.22±1.27	20.0	-0.8447
Panel C-% digestive tract length						
Oesophagus	6.7791±1.306	38.53		5.983±0.577	21.52	
Stomach	3.004±0.58	38.62		2.767±0.154	12.45	
Small intestine	82.1±1.53	03.73		84.77±0.801	02.11	
Large intestine	6.244±1.037	33.22		6.526±0.344	11.79	

*P<0.05 **P<0.01