قسم : التشريح.
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دراسات قياسيه للعظم اللا اسم له في بعض الثدييات

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إجريت هذه الدراسة على العظم اللا اسم له في اربع ثدييات هي: الانسان وخفاش الفاكهة والقط والأرنب -

أجريت عشرة قياسات على أثنين وثلاثين عظم لااسم له قسمت بالتساوى بين الحيوانات الاربع (ثمانية عظام لكل نوع).

ومن نتائج هذه الدراسة أن :-

ذوات الرجلين كالانسان يتميزون بزيادة طول وعرض الحرقفه ككل وزيادة طول وعرض الجزء الذيلي للحرقفه وزيادة طول تجويف الحق الحرقفي ، وهذه المميزات تقاوم تأثير وزن الجسم واحتياجات الوقوف والحركه على الرجلين.

ولكن ذوات الأربع كالارنب والقط بتميزون بزيادة طول عظمة الورك وطول واتساع الحدبه الوركية وذلك لمقاومة تأثير قوى دفع الجسم للامام أثناء الحركة والمشي على أربع واثناء الحفر والقفز، وذوات اللاربع ايضا يتميزون بزيادة طول الارتقفاق العاني والوركي الذى يمثل فيهم الجزء الاساسي لارتكاز أحشاء الحوض بينما خفاش الفاكهة مميز فقط بزيادة طول عظمة العانه ، ولكن وجد أن هذا ليس له دور في تطور الوضع بالمقارنه بذوات الاربع وذوى الرجلين.

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PARAMETERIC STUDIES ON THE HIP BONE OF SOME MAMMALS

(With One Table and 4 Figures)

By
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SUMMARY

Ten measurements were taken to give a satisfactory description of the shape of the hip bone in thirty-two hip bones representing both sexes of rabbit, cat, fruit bad and man. Bipedes as man, has a specific long and wide ilium as a whole, long and wide caudal part of ilium and longest acetabulum. These characteristic measurements are attributed to withstand the effect of compression of the body weight and the demands of the erect posture. Quadrupedes as rabbit and cat, have a specific long ischium and long and wide ischial tuberosity to withstand the effect of propulsive forces of the body forward during quadrupedal locomotion and in digging and leaping habits respectively. Also, quadrupedes have specific long pelvic symphysis ischio-pubic symphysis, which is the main factor in supporting the pelvic viscera. Fruit bat has a specific long pubis, but it seemest to have no role in development of posture.

A great deal of behavioral variations in rabbit, cat fruit bat and man are possible with little differences in the measurements of the hip bone.

INTRODUCTION

The length and diminsions of the bony component parts of the hip bone showed discrepancies in diferent mammals. STRAUS (1929) noticed that the iliac $\left(\frac{\text{width X 100}}{\text{length}}\right)$ and interiliac $\left(\frac{\text{cranial iliac height X 100}}{\text{caudal iliac height}}\right)$ indices are higher in man than in other primtes. WATERMAN (1929) found that the ilio-innonminate $\left(\frac{\text{iliac length X 100}}{\text{length of hip bone}}\right)$ and ischioinnominat $\left(\frac{\text{ischial length X 100}}{\text{length of hip bone}}\right)$ indices are higher in aroreal quadrupedal primates then in non-arboreal quadrupedes. ELFTMAN (1932) and CLARK (1955) noticed that man has a short broad ilium and a short ischium in comparison with those of primates. LEUTENEGER (1974), MORBECK (1977) & FLEAGLE (1978) recorded short caudal iliac length in leaping primates. ROSE (1978) found that the ischial length is short in leaping animals but RODMAN (1979) found that it is long in climbing arboreal quadrupedes. MANASTER (1979) and STEUDAL (1981) reported that the length of ischium is the most significant measurement in discrimination between groups of primates of different habits. The ischium is short in leaping animals and long in

climbing arboreal ones. The caudal iliac length is the next important measurement. It is short in leaping primates and it had a tendency to decrease more in length in heavy animals.

MATERIAL and METHODS

Ten measurements were taken to give a full description of the shape of the hip bone in the studied mammals. Thirty two hip bones representing both sexes of rabbit, cat, fruit bat and man (eight for each animal) were taken .

The technique is the same as that used by STEUDAL (1981). the total 320 measurements were carried out by using divider and a ruler. The readings were represented in cintemeter. These measurements includes (Figs. 1, 2, 3, 4).

1) **Iliac length :**

It was taken from the most cranial point on the iliac crest to at point a the center of acetaulum.

2) **Ischial length :**

It was taken from the center of the acetabulum to the most medial point on the ischial body.

3) **Pubic length :**

It was measured from the center of the acetabulum to the most medial point on the body of pubis.

4) **Cranial iliac breadth :**

It was measured from the ventro-cranial iliac spine to the dorso-cranial iliac spine. In fruit bat, as there is no distinct spines, the cranial iliac breadth was measured from the most ventral and dorsal projecting points of ilium.

5) **Caudal iliac breadth :**

It represents the maximum breadth across the ilium from its ventral to dorsal border.

6) **Caudal iliac height :**

It was measured from the center of acetabulum to the most dorsal extension of the articular surface of ilium.

7) **Pelvic symphysis length :**

It was measured from the most cranial point to the most caudal one comprising the bony symphysis. Female fruit bats were excluded as they have no pelvic symphysis.

8) **Length of ischial tuberosity :**

It was taken from the most cranial extent of the ischial tuberosity to its most medial extent in a straight line.

Man is characterized by longest and widest ilium, longest and widest caudal part of ilium and longest acetabulum.

Fruit bat is characterized by longest pubis, shortest and narrowest ilium, shortest and norrowest caudal part of ilium and short acetabulum.

Cat is characterized by longest pelvic symphysis while the remaining measurements are moderated.

Rabbit is characterized by longest and widest ischial tuberosity, while the remaning measurements are moderated.

DISCUSSION

1- The iliac length :

The present results show that man has the longest ilium followed by rabbit, cat and fruit bat. These results are similar to those obtained by WATERMAN (1929) and STRAUS (1929). HOWELL (1932) and SMITH and SAVAGE (1956) and added that jumping animals have a short ilium but galloping animals have an elongated one.

As the ilium represents the lever power arm of the hip bone from the fulcrum at the acetabulum. So, when its length is increased the power of this lever is increased (WATERMAN, 1929). Also, the increased length of the human ilium is suggested to increase the length of its surface of articulation with the sacrum and consequently increase the strength of the sacro-iliac joint (SNYDER, 1954).

2- The cranial iliac breadth :

The present data show that man has the widest ilium followed by rabbit, cat and bat. These data are confirmed by WETERMAN (1929), ELFTMAN (1929), STRAUS (1929), REYNOLDS (1931), CLARK (1955) and STEUDAL (1981).

The cranial iliac breadth is essential for muscular attachments (WATERMAN, 1929). The increased human iliac breadth is give a large area for the attachments of the glutei and the erector spinae muscles and this give improvement levarges to these muscles and increse their power during erect posture.

3- The caudal iliac height and bredth :

The present work reveals that man has the longest and widest caudal part of ilium, followed by cat, rabbit and fruit bat. STRAUS (1929), MORBECK (1977), FLEAGLE (1978) recorded similar data in primates.

The caudal part of the ilium represents the area lying between the sacro-iliac joint and the acetabulum. In man, this area is under the effect of the force of body weight during bipedal posture. Therefore the increased length and width of this area is to withstand the effect of these forces. In rabbit and cat, the force of body weight upon this area is diminshed as the main part of the body weight is transmitted via the fore legs (YOUNG, 1957). In fruit bat the marked decreased length and breadth of the caudal part of the ilium is due to marked reduction of the forces lying upon this part as the body weight is supported mainly by the wings during flying of the animal (BOURLIERE, 1955).

4- The ischial length :

The present results show that fruit bat has the longest ischium, followed by rabbit, cat and lastly man. ELFTMAN (1929), WATERMAN (1929), CLARK (1955) and RODMAN (1979) confirmed these data.

The length of ischium represents the lever power arm of the hamistring muscles from the fulcrum at the acetabulum. The power of this lever arm is increased as the length of ischium is increased (WATERMAN, 1929). the ischial length of rabbit and cat is more longer than that of man, this is needed to increase the power of the hamistring muscles which act to abduct and extend the hip joint during jumping habits of these mammals.

5- The ischial tuberosity length and width :

The present study reveals that rabbit and cat have ischial tuberosity longer and wider than that of man.

The increased length and width of ischial tuberosity in rabbit and cat give a wide area for attachments of the extensors and abductors of the hip joint which are important in leaping and digging habits of these animals (YOUNG, 1962; JENKINS, 1977).

6- The pelvic symphysis length :

It is seen that cat and rabbit have the longest pelvic symphysis, fruit bat has the next longer one, while man has the shortest symphysis. F-test shows that these differences are statistically significant between both cat and rabbit, and man only.

CHAPMAN (1919), in rodents and burrowing animals, recorded long symphysis in some species as Pipodomys deserti and allacta longior, and short symphysis in other species as quette vole. ELFTMAN (1932), in man and primates, recorded longer symphysis in man than in other primates.

The magnitudes of the ranks of mean squar and F-test show that among all the pelvic measurements the length of the pelvic symphysis is the most significant one in discrimination between the studied animals, which is highly correlated with changes in posture between them.

The long pelvic, ischio-pubic, symphysis in cat and rabbit may be attributed to the fact that this symphysis, with the adjacent bones, forms the main pelvic floor in these quadrupedes. But, the short symphysis in man and the fruit but may be attributed to the development of strong pelvic floor muscles.

7- The acetabular length :

According to our results man has the longest acetabular length followed by the cat and fruit bat, but rabbit has the shortest one. F-test, shows that these differences are statistically significant between man and each of rabbit and the fruit bat.

The long acetabular length in man may be attributed to its role in transmission of the body weight. But, in cat, inspite of being quadrupedes, the recorded long acetabular length may be attributed to its special leaping habit which needs large acetabulum to facilitate wide rotation and abduction beyond the normal ranges present in other quadrupedes (JENKIN, 1977).

9) Breadth of ischial tuberosity :

It was the maximum breadth across the ischial tuberosity.

10) Acetabular length :

It was the distance between two longitudinal lines. These lines pass on the cranial and caudal margins of acetabulum.

Measurments number 8 and 9 were carried out only in rabbit, cat and man, but not in bat which has no ischial tuberosity.

Because the mammals included in this study differed considerably in size it was necessary to make some adjustment so that differences due to size would not obscure adaptations due to different locomotor habits among them.

To remove size-correlated variation, the data were transformed to natural logarithms and regression of each variable was performed against a measure of over all pelvic size, overall individuals by means of analysis of covariance (STEEL and TORRIE, 1980).

The size measurement was the natural logarithms of the amount of water in cubic cintemeter of the full immersed hip bone, that seemed best to reflect size of it. Each measurement of each animal was then adjusted in accordance with the slope of its respective regression line by the formula :

$$Yij = Yig - ajXi$$

Where Yij is the natural logarithm of the measurement for variable j on the ith individual animal, aj is the slope of regression of the variable j on size, and xi is the size measure on individual animal.

The adjusted measurement was then converted to give a new value which is free from the effect of size.

RESULTS

The analysis of covariance is concerned with two or more measured variables where any measurable independent variable is not at predetermind levels as in a factorial experiment. It makes use of the concepts of both analysis of covariance and of regression (STEAL and TORRIE, 1980). When observed variation in Y (such as length of ilium, length of ischium, length of pubis ... etc) is partly attributed to variation in X (size), variation in Y should be adjusted to make them the best estimates of what they would have been if all X had been the same.

Table (1) shows that :

A) The mean of F-ratio "adjusted" is significant in all measurement except that of the length of the pubis.

B) The significant differences among the adjusted means of these measurement revealed that :

1- The iliac length of man was the longest but that of fruit bat was the shortest. The differences are statistically significant between fruit bat and each of man, cat and rabbit.

2- The ischial length of fruit bat was the longest but that of man was the shortest. The differences are statistically significant between fruit bat and the other studied mammals, and between man and rabbit.

3- The pubic length of fruit bat was the longest but that of man was the shrotest, but the differences are not statistically significant.

4- The cranial iliac breadth of man was the widest but that of fruit bat was the narrowest one. The differences are statistically significant between man and each of rabbit, cat and fruit bat.

5- The caudal iliac breadth of man was the widest but that of fruit bat was the narrowest one. The differences are statistically significant between each one of the four mammals and the others.

6- The caudal iliac hight of man was the longest but that of fruit bat was the shortest. The differences are statistically significant between each order and the other mammals except man and cat.

7- The length of the pelvic symphysis of cat was the longest but that of man was the shortest. The differences are statistically significant between man and both cat and rabbit.

8- The length of ischial tuberosity of rabbit was the longest but that of man was the shortest. The differences are statistically significant between rabbit and both man and cat.

9- The width of the ischial tubesosity of rabbit was the widest but that of man was the narrowest one. The difference are statisticaly significant between each order and the other mammals.

10- The length of the acetabulum of man was the longest but that of rabbit was the shortest. The differences are statisticlly significant between man and each of rabbit and fruit bat.

C) On the other hand, it could be noticed from table (1) that the original means of the all measurements, not adjusted to size, were largest in man and smallest in fruit bat. But cat and rabbit had nearly similar measurements which were smaller than man but larger than fruit bat.

D) Determination of the important mesurements by taking into consideration the rank of the magnitudes of F-ratio and the adjusted mean squars. These measurements were classified into three groups according to their importance in relation to the habits of the studied mammals :

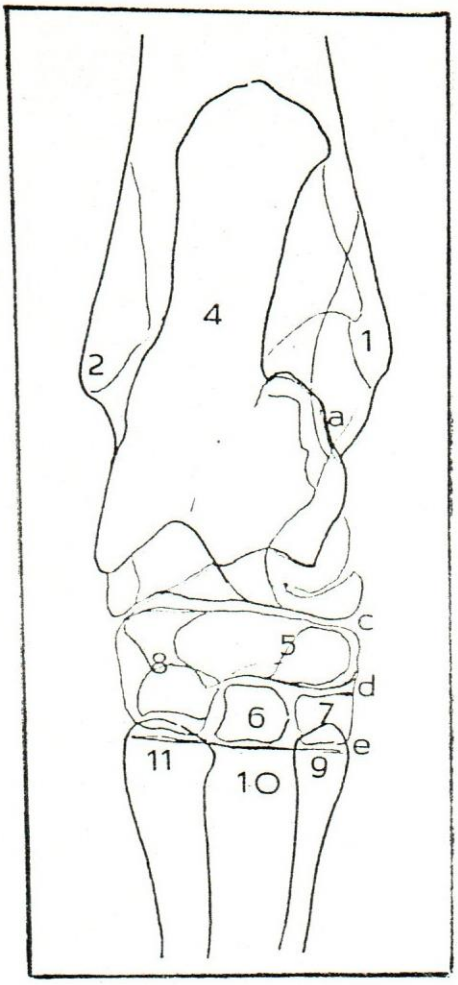
1- The most important measurements are the width of ischial tuberosity, the length of the pelvic symphysis and the caudal iliac breadth.

2- The next important measurements are the length of ischial tuberosity, the length of the ischium, the caudal iliac height and the length of ilium.

3- The least important measurerments are the length of acetabulum, the cranial iliac breadth and the length of the pubis.

E) The characteristic measurements in each one of the studied mammals in relation to the others.

Fig. 1



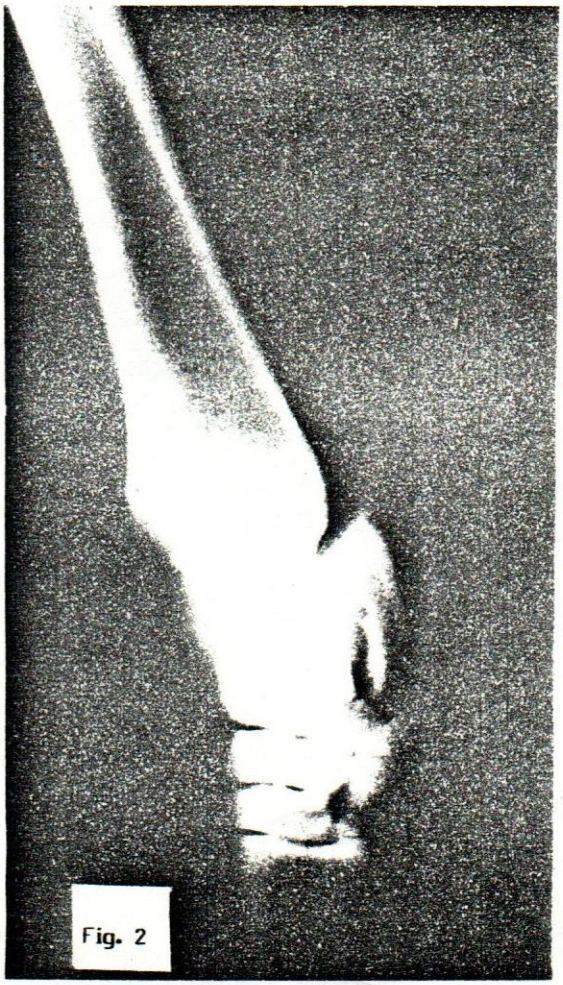
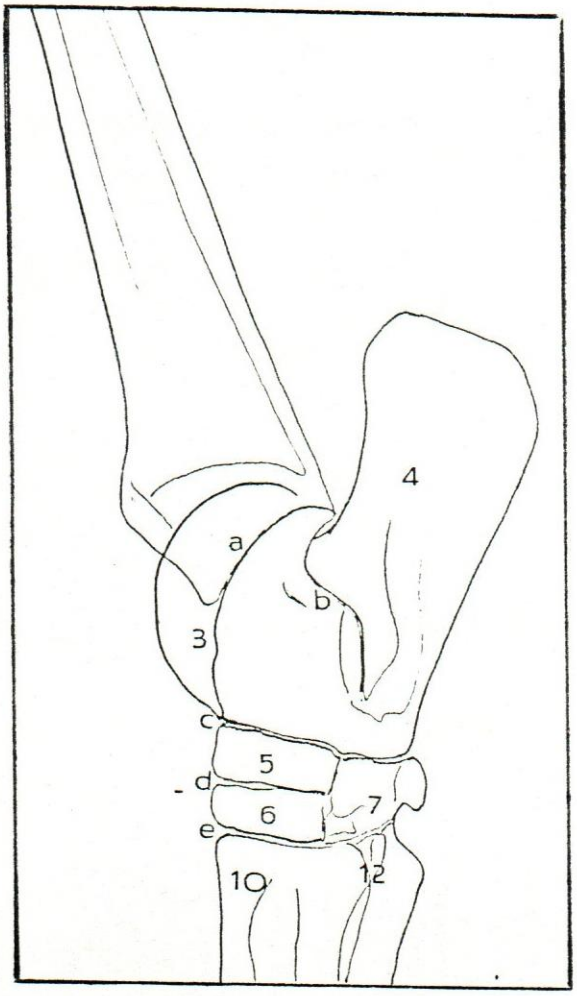


Fig. 2



CONCLUSION

It can be concluded that a great deal of behavioral variations in rabbit, cat, fruit bat and man is possible with little differnces in their pelvic measurements. It is worth to mention that, among these pelvic measurements, the length of the pelvic symphysis, the width of the ischial tuberosity and the width of caudal part of ilium are the three important triats. They are proposed to play a major role in the shape of the hip bone that correlates with different posture, habits and locomotion between these mammals. Moreover, each mammal has its own characteristic measurements which are of particular biomechanical significance in making discrimination between it and the others.

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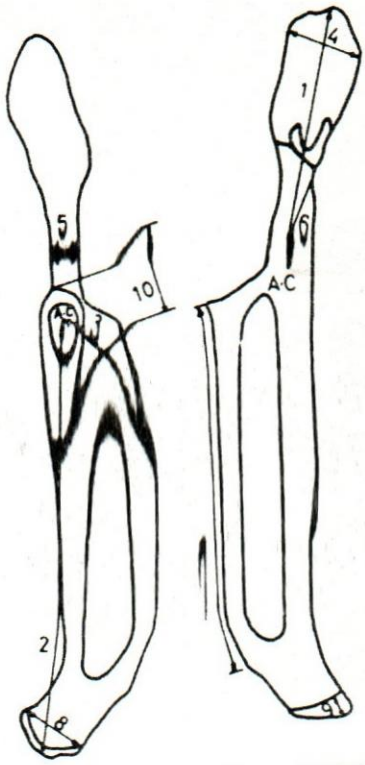
STUDIES ON THE HIP BONE

Table (1)

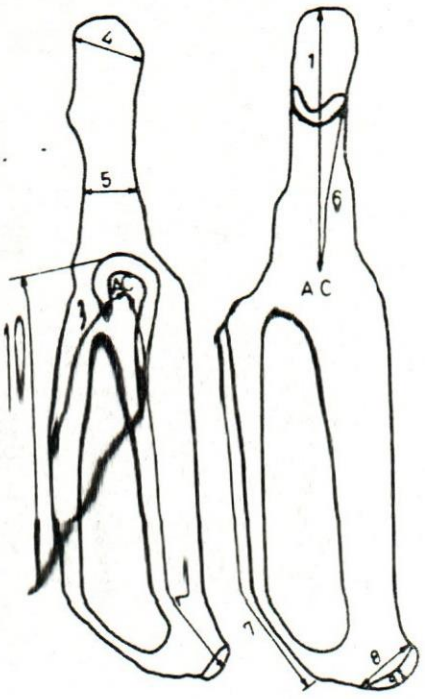
Means, adjusted F-ratios and adjusted mean squares of the pelvic measurements

No.	Mammals / Masurements		RABBIT	CAT	Fruit Bat	MAN	F-ratio		Meansquars		Magnitudes of ranks of F-ratio and mean squars
							Adjusted	Rank	Adjusted	Rank	
1	Iliac Length	Original	4,1000 cm.	4,3000 cm.	1,4000 cm.	12,7500 cm					
		adjusted	1,5041 a	1,4895 a	1,0100 b	1,7426 a	32,2200**	4	0,0607	7	Seventh
		converted	4,5000	4,4350	2,7750	5,7122					
2	Iliac Length	Original	3,3000	2,9000	0,9000	6,7000					
		adjusted	1,3529 c	1,0029 a	1,6538 b	- 0,1445 a	8,5245**	7	0,3035	3	Fifth
		converted	3,8687	2,7263	5,2268	0,8655					
3	Pubic Length	Original	1,5000	1,6000	0,9000	7,9000					
		adjusted	0,5086 a	0,5767 a	0,6029 a	0,3717 a	2,8000	10	0,0084	10	Tenth
		converted	1,6600	1,7800	1,8300	1,4500					
4	Cranial iliac breadth	Original	1,6000	1,3000	0,4000	14,7500					
		adjusted	0,6099 b	0,3390 b	0.3116 b	1,2600 a	3,2000**	9	0,0241	9	Ninth
		converted	1,8400	1,4030	1,3700	3,5300					
5	Caudal iliac breadth	Original	1,6000	2,0000	0,5000	5,5000					
		adjusted	- 0,3300 c	- 0,0147 d	- 1,2400 b	0,7655 a	68,9000**	3	0,1772	5	Third
		converted	0,7200	0,9850	0,2890	2,1500					
6	Caudal iliac height	Original	0,6000	0,9000	0,1000	7,2000					
		adjusted	0,5490 c	0,7400 a	0,056 b	0,9700 a	19,900**	5	0,1079	6	Sixth
		converted	1,7000	2,1000	1,0600	2,6400					
7	Pelvicsymphysis Length	Original	1,7000	2,2000	1,7000	3,9000					
		adjusted	0,7568 c	0,8990 bc	0,3219 abc	1,0560 a	122*	2	2,4223	1	Second
		converted	2,1315	2,4600	1,3000	0,3500					
8	Length of ischial tuberosity	Original	1,2000	1,0000	--	7,0000					
		adjusted	0,6900 b	0,3196 ac	-	- 0,2566 a	11,4000**	6	0,1934	4	Fourth
		converted	1,9900	1,3800	-	0,7736					
9	Width of ischial tuberosity	Original	0,5000	0,5000	-	2,8000					
		adjusted	0,1800 c	0,0200 b	-	- 3,2000 a	219**	1	0,4009	2	First
		converted	1,2000	0,9700	-	0,0400					
10	Acetabular Length	Original	0,9000	1,2000	0,3000	5,4000					
		adjusted	- 0,0120 b	- 0,1820 a	0,0550 b	0,2500 a	7.7800**	8	0,0437	8	Eight
		0,9900	1,200	1,0560	1,2800						

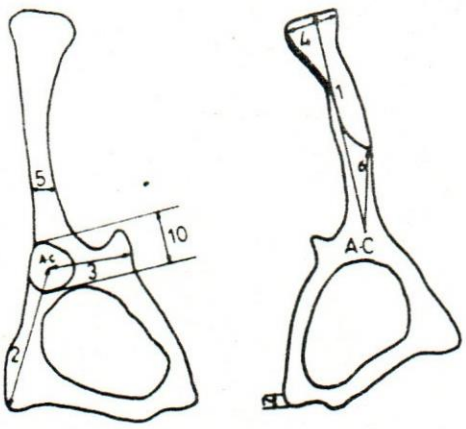
The means followed by the same alphabetical letter are not statistically significant. ** Significant F-ratio.



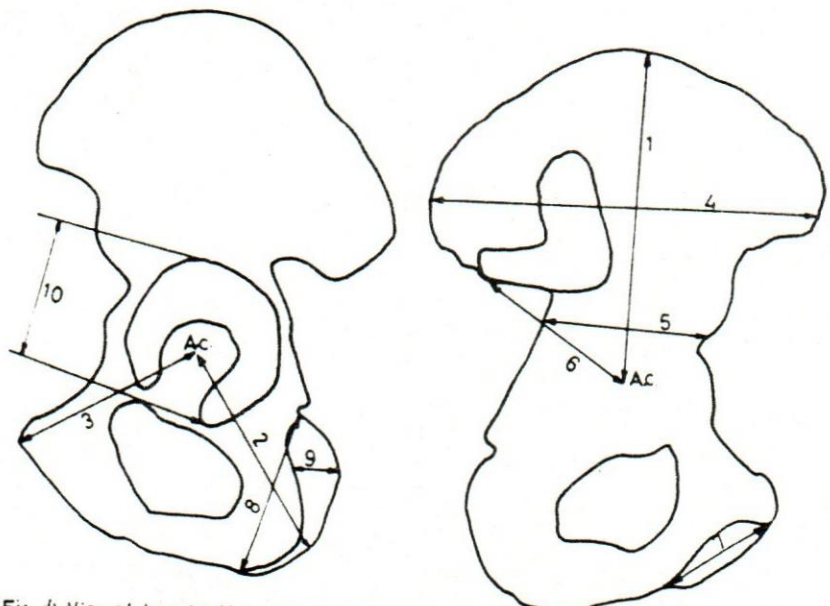
(Fig 1 Visual key to the measurements taken in the hip bone of rabbit.



(Fic 2 Visual kev to the measurements taken in the hip bone of cat



(Fig 3 Visual key to the measurements taken in the nip bone of friut bat.



(Fig 4 Visual key to the measurements taken in the hip bone of man.