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The morphological study of the pelvic guirdle and hind limbs of Jardina Roof rat (*Rattus rattus*)

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الملخص

مجموعة من جرذان الاسقف (Rattus rattus) المتواجدة بجردينة تم تجميعها. تمت الدراسة الشكلية الهيكلية للحزام الحوضي لهذه الجرذان. اتضح من الدراسة أن العظام المكونة للحوض هي: الحرقفة، الوركي والعاني. هناك أيضاً العناصر المكملة للحوض والمساعدة في التمفصل مع الأطراف الخلفية كتجويف الحق، الثقب المسدود وبعض البروزات الأمامية والخلفية للحوض.

كذلك تمت الدراسة التشريحية الشكلية لعظام الأطراف الخلفية: القريب الفردي وهو الفخذ والبعيد المزدوج وهو القصبة زايد الشظية. تم التعرف على رؤوس وبروزات الأطراف العلوية والسفلية لهذه الأطراف. تبين إن بروز رأس عظم الفخذ هو المتمحور داخل تجويف الحق للحزام الحوضي وهو المفصل الرئيس المساعد في حركة عظام الأطراف الخلفية.

العظيمات الرسغية والمشطية للقدم هي الأخرى تم النظر إليها والتعرف عليها. لوحظ إنها مرتبة في صفوف متداخلة وصنفت إلى أماكن قريبة وبعيدة، فاتضح أن الرسغيات هي المكونة للكاحل أما الأمشاط هي المكونة للأخمص الذي يرتكز عليه الجرذ. ما بعد الرسغيات والأمشاط لوحظ وجود القطع السلامية والمكونة لأصابع القدم المنتهية بمخالب. تبين أن هناك خمس أصابع خلفية كلا منها به ثلاثة سلاميات ما عدا الإبهام به سلاميتين. عظام الحوض والأطراف صورت واخذت لها مناظر داخلية وخارجية ليتم توضيح تقعراتها وتحدباتها.

الكلمات المفتاحية: جرذان الاسقف بجردينة، حزام الحوض، عظم الفخذ والساق الشظية.

Abstract

The morphology of pelvic girdle and the hind limbs skeleton of Jardina roof rat were studied. The girdle has one pair of os-coxae, each os-coxae consisted of anterior-dorsal illium, posterior dorsal ischium and ventral posterior pubis. The construction of the bones is generally similar to other rodents. There were differences between the acetabulum, obturator, ischium and pubis of the jardina roof rat and African giant rat. The hind limbs are comprised of the single proximal bone, the femur and the distal paired bone, the tibia-fibula. The three trochanters of the femur were the same as other rats. The fibula was shorter than the tibia and separated proximally with a large interosseous space and fused with its distal third length to the tibia. The tarsals are the proximal bones that formed the ankle and the metatarsals are the distal bones that form the sole of the foot. The five metatarsals ended with three phalanges except the first one which has two phalanges. The fifth digit is characterized by an s-shaped phalanx.

Keywords: Jardina roof rat, Pelvic girdle, Femur and Tibia-fibula.

1. INTRODUCTION

Rat is a genus that belongs to rodents which includes about 50 species, the most common of which are the brown rat (*Rattus norvegicus*) and the grey roof rat (*Rattus rattus*). The Jardina roof rat is categorized under the order Rodentia, family Muridae and subfamily Cricetidae [1]. It is a wild rat wildly distributed around Jardina. It is a nocturnal animal that inhabits a variety of habitats and thus prefers a burrow to rest during the day [2]. Their hind feet are used to push the excavated soil away and can support their bodies by standing on their hind limbs and raising the forelimb from the ground [3]. Kind of the African giant pouched rat (*Cricetomys gambianus)* is currently being domesticated in Nigeria [4]. In their preliminary work on the appendicular skeleton of the African giant pouched rat (*Cricetomys gambianus)*, Olude et al., [5] were able to identify its specific bones.

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The pelvic girdles and limbs of the African giant pouched rat (*Cricetomys gambianus*) have been observed by Sulaiman et al., [6] to have a total of 106 bones that form the the skeleton of this species of rat. They found that the weights of the rats positively affect the size of each bone in the skeleton. According to ABC Encyclopedia Britannica [7] Rudolf had observed that the equal length of fibula and tibia is one of the characteristic features of rodents but that there was an exception in beavers where they are close to each other distally. Romer [8] reported that generally there is no fourth trochanter in the femur of mammalia. This study will give more information about the bones that form the pelvic girdle and the hind limb of the Jardina roof rat (*Rattus rattus*).

2. MATERIALS AND METHODS:

A total of three adult Jardina roof rats (Fig. 1) were used for this study. Some of the external characteristic features of these rats were as mentioned in the results. These rats were captured alive in the wild around Jardina village in Benghazi city-Libya, by using metal cage traps. The rats were euthanized using gaseous

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chloroform in a confined container. The specimens were buried for about two months. The samples were then cleaned with different dissecting tools to remove skin, decayed viscera and muscles; they were teased carefully to leave the skeleton without any debris or tissue attachments. The pelvic and hind limb bones were then rinsed in running water, air dried, bleached with a hydrogen peroxide solution and photographed individually in the laboratory of Zoology department. The total number of bones were selected and labeled. To prevent their destruction from bacteria, the bones were stored in vital small bottles with naphthalene.

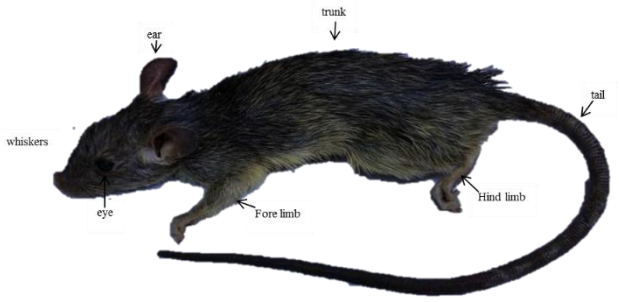

Figure 1. Lateral view of Jardina Roof rat (Rattus rattus)

3. RESULTS:

Some of the external characteristic features of the Jardina rat were noted, their color was dorsally grey and ventrally white; their eyes and ears were large in sizes and the length of the tail was longer than the length that includes the head and the trunk. Their weights were less than the Norway's brown rat (*Rattus norvegicus*) which has been mentioned above. The measurements of the lengths taken were as follows: trunk = 17 cm, tail = 23.5 cm, and hind limbs = 6 cm. The pelvic limb bones of the Jardina rat were found to be generally similar to other members of the rat family with some differences in the morphology and number of some bones.

1. Pelvic girdle

The pelvic girdle (ossacoxarum) (Figs. 2, 3) of the Jardina rat is comprised of os-coxae on both sides. Each os-coxae consisted of anterior-dorsal illium, posterior dorsal ischium and ventral posterior pubis.

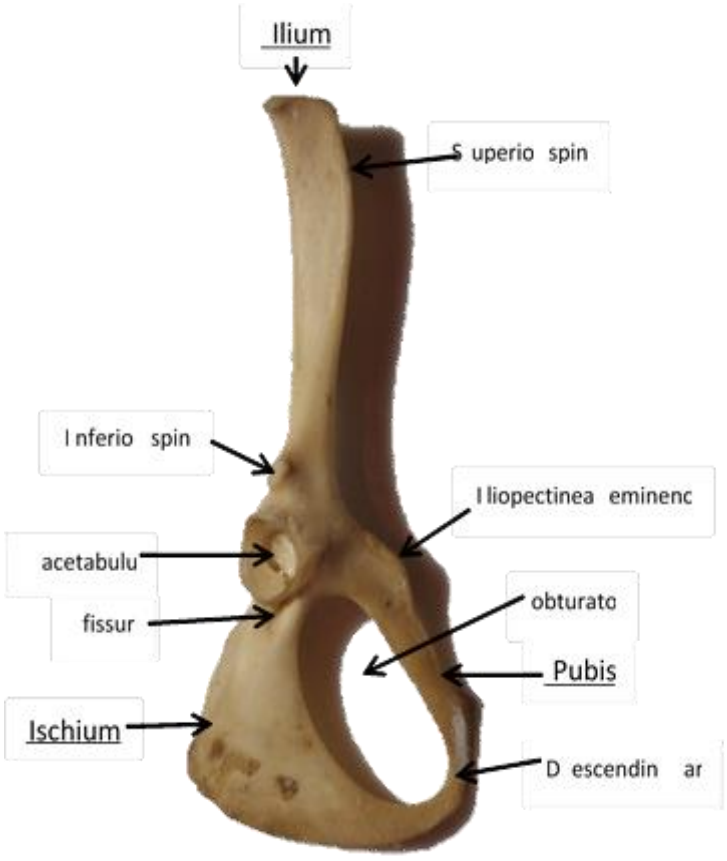

Figure. 2. Right os-coxae –lateral view

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A. The ilium

The ilium (Fig. 2, 3) has a thin shaft (wing) and it is longer than the ischium. Its half proximal portion is wide and flat than the rest of its distal portion. Its proximal, lateral face has a long groove that extended between the superior and nearly the inferior lateral spines. The aforementioned groove is limited with dorsal and ventral ridges. The proximal, medial portion of the ilium has a wide, long concave area that ends anteriorly with a pointed lateral crest. The concave area is the place that articulates with the sacrum and is surrounded by thin dorsal and thick ventral edges. The posterior end of the ilium fuses the dorsal and the ventral aspects of ischium and pubis respectively, to form the acetabulum that articulates the head of femur. The acetabulum is deep and supported anteriorly with a prominent inferior spine and posteriorly with a small fissure in the edge.

B. The ischium

The ischium bone (Figs. 2, 3) has a large surface triangular-shape with a head beside the acetabulum and a curved base posteriorly. Its dorsal side has a sharing extending edge between the ilium and the caudodorsally eminence of the ischium. The lateral face of the ischium is convex but the medial one is concave. The ventral edge of the ischium that forms the dorsal side of the obturator foramen meets the posterior curved edge to form a pointed area. The later narrowed area of the ischium is fused to the posterior end of the descending arm of the pubis.

C. The pubis

On the ventral side of the acetabulum, the distal ventral edge of the ilium has an iliopectineal eminence which is the fusion area between the ilium and pubis ventrally. The pubis (Figs. 2, 3) consists of an ascending and descending arm, in-between them there is the angle of the pubis. The ascending ramus is straight and wider than the thin, curved descending one

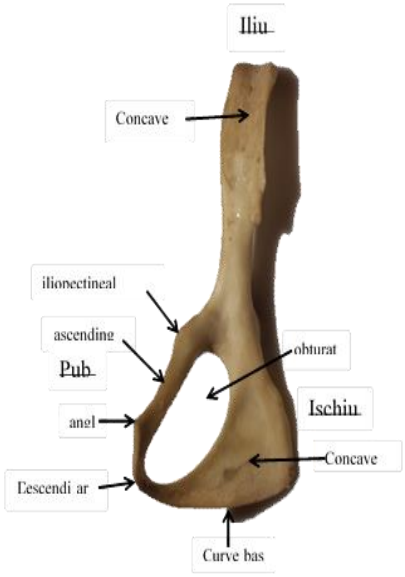

Figure3. Right os- Medial View

The bean-shape foramen of the obturator is limited ventraly and caudaly with the upper edges of ascending and descending arms of pubis respectively. The dorsal and the anterior curved edges of the obturator foramen are limited by the ischium and the distal end of the ilium. The distance which is between the distal end of the ilium and the angle of the pubis appeared as a V-shaped space in front the pubis symphysis ventrally.

In the ossa coxarum (Fig. 4), the space between the two medial faces of the iliums embraces the sacral vertebrae of sacrum. In the posterior of the pelvic girdle bones, the opposite of the left and right descending arms of pubis leads to forming the pubis symphysis. The distance of the later symphysis is short when it is compared to the lengths of other bones.

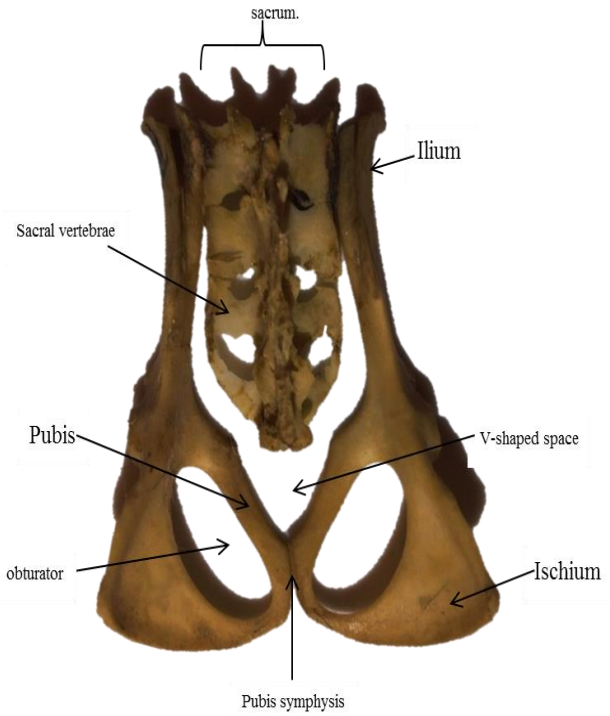

Figure 4. Dorsal view of ossacoxarum

2. The hind limbs

The hind limbs (Figs. 5, 6, 7, 8) are comprised of the single proximal bone, the femur and the distal paired bone, the tibia-fibula. The limbs are ended with the tarsas that form the ankle and the metatarsas that present the sole; the digital foot appendages consist of different sizes of phalanges.

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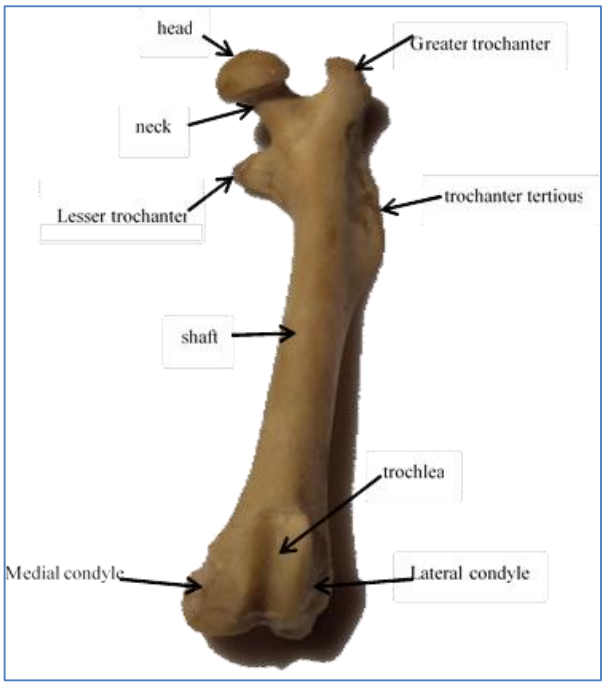

Figure 5. Cranial view of left femur

A. The femur: It is the first hind bone that articulates with the extrinsic skeleton (pelvic girdle). It consists of several prominences, three trochanters and the head. The caudal view of the femur (Figs. 5, 6) directs the position of its head towards the medial side and the head is branched medially from the proximal end of the femur with a neck that bears a round bead-shaped head with a top middle pit to articulate with the acetabulum. The proximal side of the neck is shorter than the distal one. The lateral greater trochanter is separated from the head with a narrowed deep space. The medial side of the greater trochanter has a small intertrochanteric fossa, which is in between the three prominences. The lesser trochanter is located medially at the base of the neck and is connected to the greater trochanter caudally with a clear L-shaped ridge. Laterally the greater trochanter bears an aspera line that leads to an obvious convex ridge called trochanter tertious that makes the upper proximal portion of the femur wider than the rest of the shaft. The thin surface of the latter ridge is compressed on both sides and has a small pit on the proximo- caudal side. The line of the latter ridge extends posteriorly on the length of the two third cylindrical shaft of the bone to reach the distal lateral condyle. Caudally, the distal end of the femur has two condyles; the medial condyle is larger than the lateral one. There is a deep intercondyloid fossa between the two condyles, the fossa leads cranially to the trochlea. The shallowly grooved trochlea is limited with two small curved ridges and it is the articulation place with the patella. The dorsal aspect of each condyle contains a rough area that supports the articulation between the femur and tibia-fibula bones.

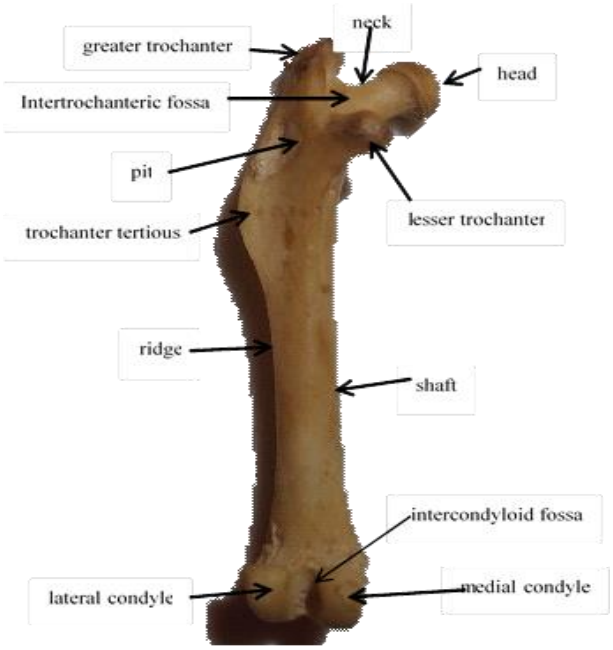

Figure: 6. caudal view of left femur

B. The tibio-fibula: It consists of paired bone, the tibia and fibula (Figs. 7, 8). This distal bone is longer than the proximal femur, on the other hand the tibia is thicker than the fibula, and both of them form a shape that looks like a safety pin.

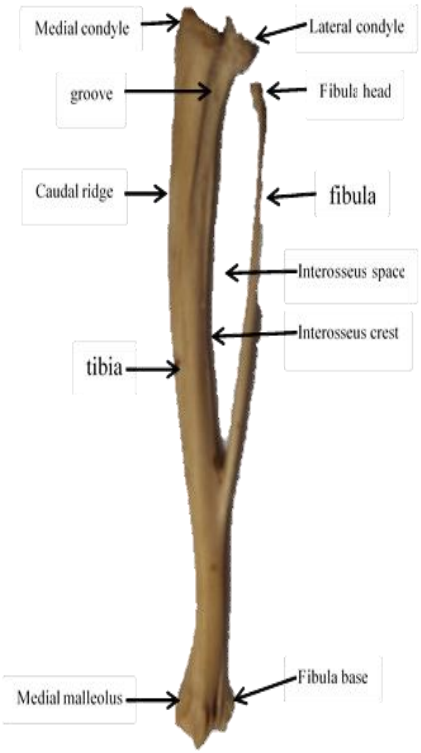

Figure: 7. Medial view of left tibio- fibula

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the patella. The two condyles meet caudally at a pointed angle (tuberosity) that is connected to the shaft ridge line which separates the medial aspect from the lateral one. The two-thirds lateral face is covered with a shallow concave surface while the medial face is smooth and nearly convex at the upper portion. The curved proximal shaft of the tibia is thicker than the short straight distal end that contains a different kind of prominent called malleolus. The medial malleolus which has two small heads is bigger than the lateral malleolus that is fused with the distal base of the fibula.

II-The fibula: The fibula is the delicate thinner hind bone, it has two triangle-shaped bones that present the proximal head and the distal base. The distal third length of fibula is fused beside the last straight portion of the tibia and its base articulates near the lateral malleolus. The distal two-thirds length of the fibula-shaft is separated clearly with a wide long V-shaped space (interosseus space) opposite to the cranial ridge line (interosseus crest) of the tibia. The cranial surface of the fibula head is concaved and its top end meets the lateral condyle with a narrowed space between them. There is a small narrowed notch between the base of the fibula and other condyles of the tibia that leads to the articulation of the tarsals bones.

C. Tarsals and metatarsal bones: They are distributed in two proximal and distal groups (Fig. 9). The tarsals are the proximal bones that formed the ankle and the metatarsals are the distal bones that form the sole (instep) of the foot. Each of the two groups contains four small pieces of bones. There are different numbers of small seasemoid bones that are located between the articulations of digital segments.

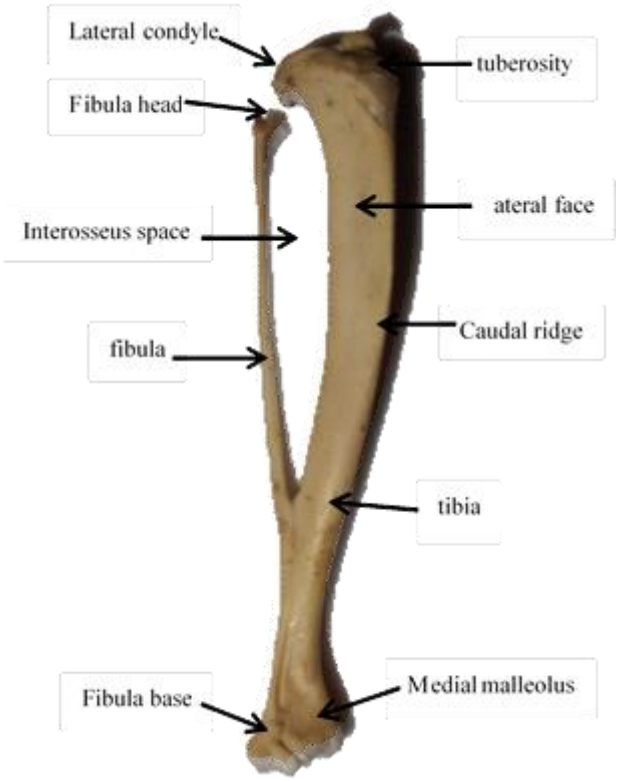

Figure8. Lateral view of left tibio – fibula

A. The tarsals:-

I-The proximal tarsals are various pieces of different sizes of bones that form the ankle. Their locations are in irregular sites and the large piece of them is the calcaneus which is under the lateral malleolus and beside it medially is the talus (astragalus). The other two pieces of the proximal row, the navicular (centralia) and the tibiale are mixed above the bones of the distal row.

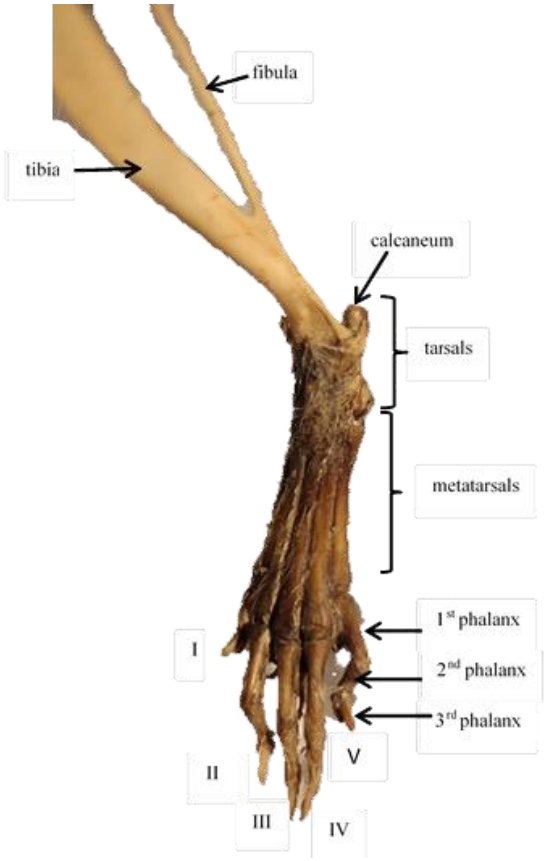

Figure 9. Tarsals – Metatarsals and Phalanges of left hind limb

II-The distal tarsals: Some of the distal tarsal bones as in the first, second and third cuneiforms are basically arranged regularly from the medial to the lateral side respectively. The navicular which is a compound of the fourth and fifth cuneiform is medially under the distal end of the calcaneus.

B. The metatarsals and the phalanges: They are long, thin cylindrical shaft of bones that form the skeletal region (instep) which is between the tarsals and the phalanges. It is the longest region in the foot and is comprised of five bones that are arranged from internal to external as follows: first, second, third, fourth and fifth metatarsals. They have different lengths and number of phalanges. The short metatarsal is the first one and after that comes the fifth. The second is longer than the first and the fifth. On the other hand the third and the fourth are the longest metatarsals. Not all the digits have the same number and length of phalanges; the first has two and other four each has three phalanges. Consistently, the proximal phalanx is the first, the distal one is the third and in-between them the second. Usually, in the

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Jardina roof rat usually the distal phalanx is presented as a small pointed claw. There are small seasemoids between the articulation of the metatarsals and the phalanges.

The length of first phalanx is always the same for all digits. The second phalanx of the second and the fifth digits are the same length. The second phalanx of the third and fourth digits are nearly equal in length. The phalanges of the fifth toe take an S-shape appearance which is always far away from the fourth digit and with a space that makes a characteristic mark for this rat. From the number of toes and their phalanges in rat, the phalangeal formula of hind limb is as follow:

I II III IV V

2 3 3 3 3

4. DISCUSSION:

The morphological study of ossa coxarum and hind limb skeleton of the Jardina rat shows many similarities to and differences from other rodents used in researches by Greene [9], Yilmaz et al. [10] and Ozkhan [11]. There are many differences that has been found between the Jardina roof rat and the African giant rat used by Sulaiman et al. [6] namely: The acetabulum of the African rat was with a posterior notch; however in the Jardina roof rat it is with a fissure outside its diameter. The obturator shape of the African giant rat had a curved back beside the ischium whereas in the Jardina roof rat it was flat and like a bean-shape. In the African giant rat the posterior region of ischium was with angles, whereas it was round and thin in the Jardina roof rat. In the Jardina roof rat the ascending and descending ramus of pubis are thick and thin respectively while those in African giant rat pubis were of the same thickness. The posterior edge of symphysis in the African giant rat was like the shape of desert tent, on the other hand in the Jardina roof rat it seems to be V-shape. The other structures of the pelvic bones are nearly the same in both rats but with large size in the African giant one. Saunders and Manton [12] observed in Erinaceus and Centetes the presence of three trochanters around the head of femur and this was similar to what had been found in the Jardina roof rat. Sulaiman et al.,[6] noted that the proximal end of the fibula has an attachment to that of the tibia. It agreed with what was found by Yilmaz et al.,[10] in porcupines (Hystrix cristata). These observations were contrary to the case of Olude et al.,[5] and to the present study where the two bones have a space between them. Saunders and Manton [12] reported that the tibia and fibula in Erinaceus were fused distally. This later case is similar to the result of the Jardina roof rat where the third distal end of fibula is fused with the distal extremity of the tibia. As noted in ABC Encyclopedia Britanicca [7], Rudolf revealed that the fibula has the same length and the tibia in rodents which contradicts with this paper, where the fibula is thin and shorter than the tibia.

The position of the tarsal bones in the Jardina roof rat ankle are similar to what was found in the Wistar rat by Hebel and Stromberg [13] and in the African rat by Sulaiman et al., [6]. This case differed from the result of Hedgehog study by Ozkan [14], where the medial tibial tarsal was absent. The arrangement of seasemoid bones in this paper is applied to all rats and resembles the African giant rat by Sulaiman et al., [6]. The complete five digits of the Jardina rat agreed with different authors like: Hebel and Stromber [13] in studying the Wistar rat; Rudolf and Stromberg [15] in laboratory rat; Ozkan et al., [16] in Rabbit; Dursum and Tipidamaz [17] in Mink (Mustelavison); Dinc [18] in Badger (Melesmeles) and (Ozkan [11] in Mole rat (Spalaxleucodon Nordmann). However, Kuru [19] observed that the pedis of the family Ernaceidae were comprised of four digits. Olude et al., [5] revealed that the shape of the distal phalanx was attributable to the rat's burrowing habit. The latter case is similar to what has been found in the Jardina roof rat where the third distal phalanx is presented with a pointed claw.

5. CONCLUSION:

The pelvic girdle and hind limbs of the Jardina roof rat (*Rattus rattus*) were studied; it has been found that the ossacoxarum is comprised of both left and right os coxae. The hind limbs are comprise of a single proximal- and a paired distal- bones, each ended with the tarsas which forms the ankle and the metatarsas that presents the sole. It has been observed that the digital foot appendages consist of different sizes of phalanges ending with claws.

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