

## ARTICLE / INVESTIGACIÓN

## Comparative anatomical study to skeleton for same species of Turtles in Iraq

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**Abstract:** Bones were recorded in the skeleton of some species of Iraqi turtle *Mauremys rivulata*; the objectives of this study came in light of current conditions, environmental developments, talents and techniques of biological studies taking place in the country, need for an anatomy guide in river turtles of Iraqi species, to identify all kinds of similarities and differences with their preaching, this work or study has become written in response to those modern needs. It is designed to be one of the resources for those interested in biological studies, beginners or professionals, and veterinarians, distinguishing them from marine and global species. Turtles were dissected in the laboratories of the Research Center and Museum of Natural History / the University of Baghdad. The specimen was dissected by removing the abdominal cortex, muscles, and internal viscera and imaging the bone starting from the skull to the hind leg bones. This first study was in Iraq.

**Key words:** Turtles (*Mauremys rivulata*), anatomy, skeleton, bone, Iraq.

### Introduction

The history of turtles (*Mauremys rivulata*) goes back to the Jurassic period when they were found about 210 million years ago. They are considered the oldest primitive armored animal with some standard features with the others to this day, and the most prominent thing in common is a bony shell that consists of a group of ribs that fuse to form that apparent solid plate<sup>1</sup>. Turtles are classified into two main types: 1- pleurodires that bend to one side for each head and neck. 2- Cryptodires that pull the head back in a vertical and straight line between their shoulders is known as the movement of the letter S<sup>2</sup>. These river turtles produced many sea turtles that trace their origins to the Cretaceous period, about 65 million years ago. Based on fossils found in different regions of the world<sup>3</sup>.

*Mauremys rivulata* is a turtle that descends from the coasts of Croatia, Albania, and Macedonia with Greece and part of southwestern Turkey, through the Middle East, Iraq, Jordan, and Syria, Palestine, and Lebanon<sup>4</sup>. Its presence in these places is due to the weather and the moderate environment that suits it<sup>5</sup>. *M. rivulata* in static and slow waters such as lakes, irrigation streams, swamps, estuaries, ponds, and even dams are the habitats you prefer to be in rather than fast-flowing water<sup>6,7</sup>.

The turtle's body outline is classically represented as a result of morphology and development, as it has a dorsal shield and also there is ossified abdominal support with four legs, two front and two hinds; the nature and shapes of the turtle shields are still under the interest of scientists, the shield is a part of the axial cartilaginous skeleton of the thoracic vertebrae and the ribs with a group. The dermis that overlaps with it, and there are many dermis forms, magnifies its component in this great mosaic<sup>8,9</sup>.

The ossification of the skeleton in the skull is typical of

vertebrates. However, it is rare after the cranium that the ribs change according to the limbs and the girdles between them, the abdominal or thoracic brace interferes with the thoracic or pelvic girdles in the front and backside of the ribs due to its close association with the dermis. To maintain the position Dorsal, tetrapods are related to the axis of the dorsal girdle ventral deep; in this study, the bony parts will be clarified<sup>10</sup>.

Some studies author study the evolutionary inclusion of the turtle's body and how it evolved from the primitive tetrapods to the more typical shape as a result of a developmental conflict between similarity to the structural elements in turtles<sup>11,12</sup>.

The skeleton of sea turtles is characterized by heavyweights that reach about a (1ton) and a length of about 2 meters<sup>13</sup>. Also consists of the dorsal and abdominal supports, axial skeleton, and four legs. The number of bones was found up to (280) bones of different shapes and sizes<sup>14-16</sup>.

Turtles have been exploited over the years as they are considered a nutritional value for some coastal areas; the turtle shell has been used in various cultures<sup>17-19</sup>. In comparison, the bones do not attract scientists much attention to their relatively large number with the diversity of their shapes and sizes for the prominent types of turtles with the recording of numbers of bones In some records of archaeological areas<sup>18,19</sup>. The movement of the spine is an essential requirement for every animal. The reason for movement is not to obtain food but because it needs movement to escape predators<sup>20</sup>. The turtle shell is an excellent shield for it because it contributes to protecting the head and neck and the internal viscera, and the head retracts vertically or horizontally laterally inside the shell<sup>21</sup>. A turtle's neck consists

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of eight cervical vertebrae articulated with the skull with a group of complex joints that facilitate movement<sup>22</sup>.

### Cost Components

- Kingdom: Animalia
- Phylum: Chordata
- Class: Reptilia
- Order: Testudines
- Suborder: Cryptodira
- Superfamily: Testudinoidea
- Family: Geoemydidae
- Genus: *Mauremys*
- Species: *M. rivulata*
- Binomial name<sup>23,24</sup>.

## Materials and methods

Samples were taken from irrigation creek water from Babel and Diyala provinces during the summer season (June- July 2021 ). Four species of adult turtles *Mauremys rivulata* (2 ♂, 2 ♀), male weight  $660 \pm 3.30$  g and length of  $25 \pm 1.39$  cm and female weight  $560 \pm 2.30$ g and length of  $23 \pm 1.24$  cm, The animal was anesthetized, and then the abdominal shell was removed with anatomical tools. The internal viscera was removed, all parts of the shell and bones were cleaned from the remains of muscles, the bones were extracted for the front and back legs with the head and tail and studied in terms of shape and location and compared to each other<sup>25</sup>.

## Results

### The shell

At the beginning of the study, the female had shells darker in color than the males. The dorsal shells have 40 in number and the ventral ones have 12 in number, while the dorsal shells of the males have 37 and the ventral ones have 11, according to (Fig.1) ., and from here, it was found that the females are more comprehensive to they carry eggs inside them.

The shells were fused to the turtle's spine with a trace of the ribs that may have been fused with the shells for additional protection and support for the animal from dangers as a defense mechanism (Fig.2).

### The skull and vertebrae

Is unpretentious in composition, consisting of the temporal bone fused with the orbit of the eye socket and the nasal bone opening. Additionally, the two ear holes and jaw bone discriminate between the upper and lower mandible containing the teeth (Fig.3). The 6 cervical vertebrae are fused with the skull; the straightforward form is fused. The last vertebra is fused with the sternum, collarbone, and dorsal

shell. (Fig.4). thoracic vertebrae 8 in number is, fused with the shells. The remains of the ribs and shells are shown in (Fig.5).

The lumbar vertebrae are 4 in a number smaller than the thoracic vertebrae. They also fuse with the dorsal shell. Furthermore, the sacral or coccygeal vertebrae show 3 vertebrae fused to form one bone fused with the dorsal shell (Fig.6).

The caudal vertebrae in females were smaller in size than in males. They contain the shape of the vertebrae in the advanced vertebral organism. Their number ranges from 20-22 vertebrae that are not fused with the shells. (Fig.7).

### Appendicular skeleton

Forelimbs, the scapula is a flat bone showed that does not contain the protrusion of the scapula and articulation with the humerus bone, which was more prominent in males than females, and the presence of the radius and ulna; these two bones were relative in shape to each other, but the radius bone was thicker than the ulna (Figs 6,8, and 9).

It articulates with the carpal bone, which is 10 tiny bones in each of the anterior vertebrae, fused and articulating with the phalanges (Fig.9).

The fingers in both sexes were 5 in the front limbs and 4 in the hind limbs, which were longer than the front fingers and contained claws, hind limbs, The femur bone, which articulates with the pelvic bone on the proximal side, and articulates with the tibia and fibula on the distal side, the tibia, and fibula, in two sexes tibia thicker than fibula but male thicker than female and those two bones. Articulation with 5 small metacarpal bones fused together and connected with phalanges and fingers (Fig.10 and 11).

The pelvic bone in females is more comprehensive than in males due to the presence of the ovary and the female reproductive organs. It contains three fused bones that make up the pelvis: ischium, ilium, and pubis. (Fig. 7).

## Discussion

Author used almost all sea turtles - including marine ones belonging to the family Cheloniidae –to have a shell consisting of a dorsal and ventral shield, and the material that does not consist of it is carnelian brown in color<sup>26</sup>. Like river turtles with different colors, they tend to the dorsal shell to dark brown color in males and females, while the shell The abdomen is dark green. The name of the tortoiseshell in the literature came (ar chae o log i cal and eth no Graph ic). It is an unclear term referring to the shell in the dorsal and ventral parts, considered a carotenoid shell or bony horn. In many cases, this is clear from context<sup>27</sup>. The osteology section of this atlas is The bones of the skull (prefrontal, frontal, parietal, postorbital, supraoccipital, squamosal, quadratojugal, jugal, and maxilla) and mandible (dentary, angular, surangular, prearticular, splenial, and articular bones) while.

The results observed that the skull had undifferentiated fused bones consisting of the temporal bone fused with the orbit of the eye socket and the nasal bone opening, the two ear holes, and the discrimination of the upper and lower mandible containing the teeth<sup>28</sup>. The observed author explained that the neck is long for evasion and capture of prey, consisting of cervical vertebrae that help it to move freely, crouching inside the body when sleeping and feeling fear, comparable to what was explained<sup>29,30</sup>. The neck is long in all species, whether aquatic or semi-aquatic. Con-



a

b

**Figure 1.** Show dorsal and ventral (a) male and (b) female shall.



a



b

**Figure 2.** Show ribs fused with shall in (a) male and (b) female shall.

Control of the neck is crucial for turtles as it is multi-joint with a complex structure consisting of developed vertebrae to the neck, body, and head of the vertebrae are articulated to make them more accurately and efficiently and control their freedom during movement during rapid movements in proportion to its nature, and this is indicated by (22) where this development of the cervical vertebrae is proportional to the accompanying muscles that allow them to move vertically or horizontally river turtles in Iraq are little studied. However, cervical vertebrae were found in all types of turtles that supply eight rectangular vertebrae (C1 to C8) and nine joints. observed<sup>31</sup>.

Observed appendicular skeleton in their study, there were some similarities in the skeleton of the thoracic and pelvic girdle and the fore and hind limbs in the reptiles studied; *P. guttatus* and *A. boskianus*<sup>32</sup>. With the presence of incommensurable differences in the length of the angled ends

of the bones in the thoracic and pelvic, which is similar at the same time to river turtles with fewer bones in size and thickness, a similarity was found in terms of the presence of double wishbones on the non-double-bone river turtles are more developed than them<sup>33</sup>. The skeleton of the forelimbs of the same studied, which consists of the humerus, radius, ulna, and metacarpal bones, was observed, and it is similar to the river turtles studied in this research, and it is connected with the thoracic girdle, and in general, it is identical to mammals and birds. The bone radius was a long bone articulated with the carpal uncle and ulna as in turtles, while the ulna was more prominent and thicker in sources, unlike river turtles, it was a slight difference in thickness. Studies of reptiles assured *P. guttatus* and *A. boskianus* having a pelvic girdle consisting of the pubic, iliac, and ischium; It fused and met the acetabulum, and they left a wide foramen (fenestra ischio-pubic fenestra). There was a clear difference in the

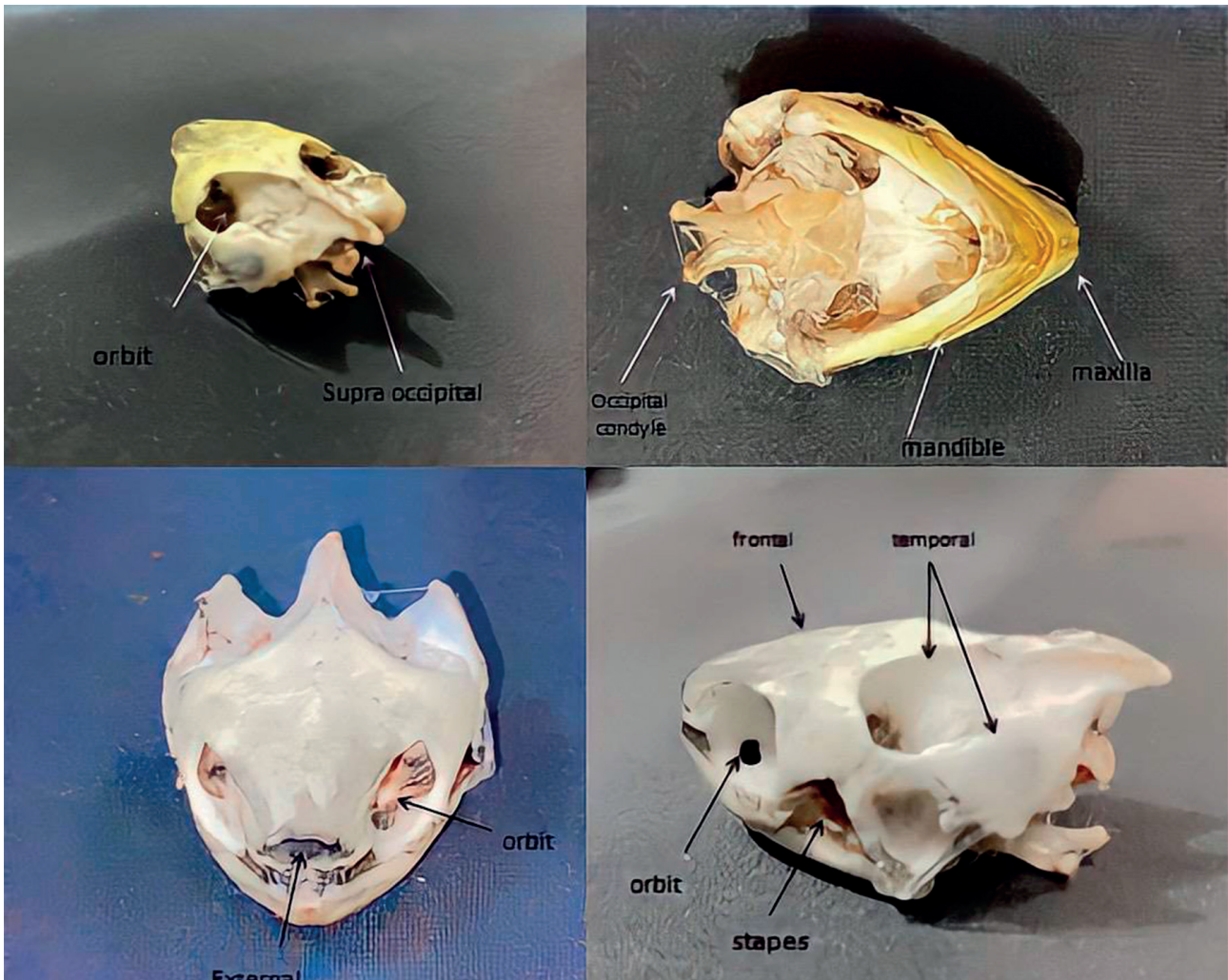
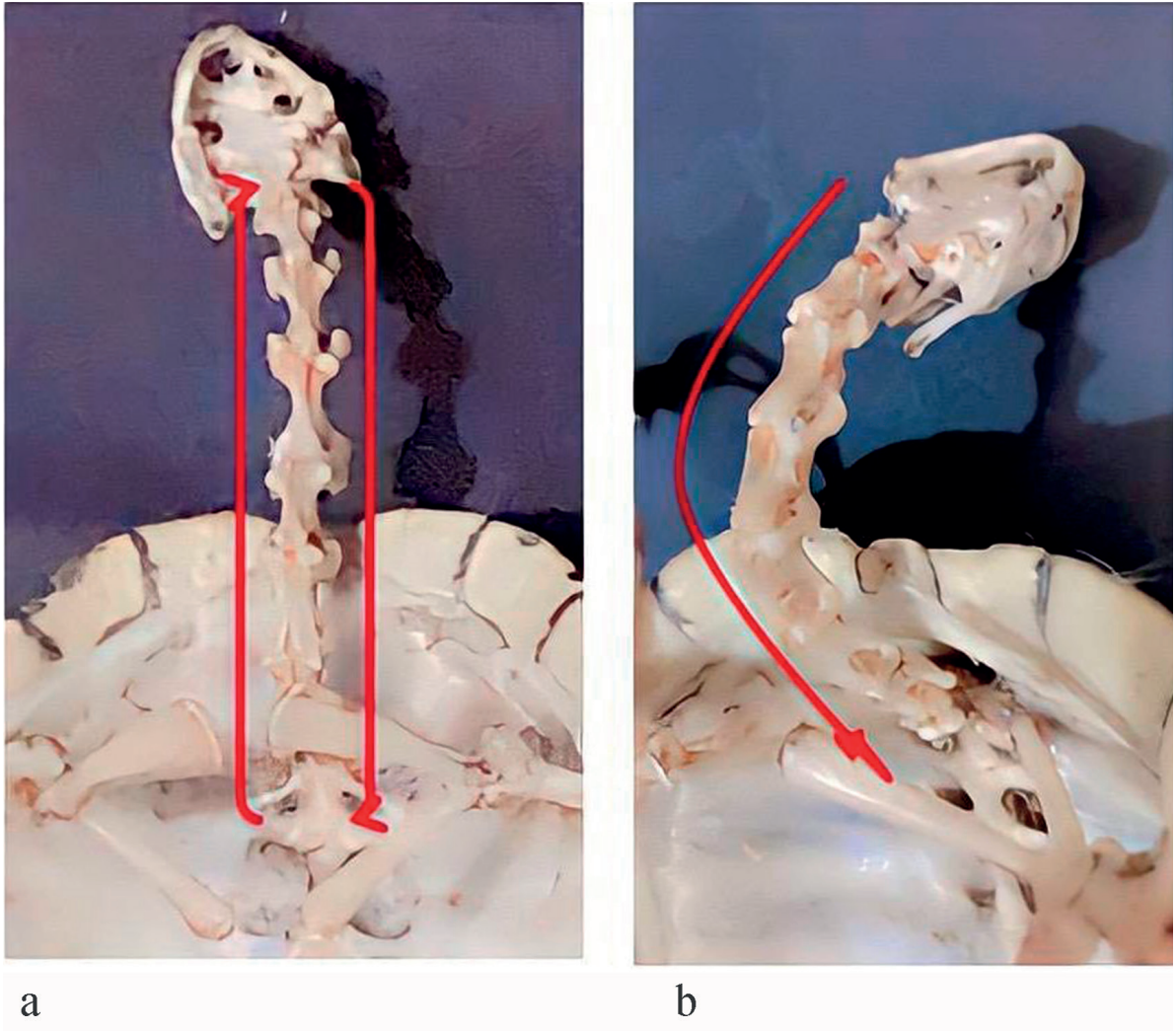


Figure 3. Show skull in the two species the same.



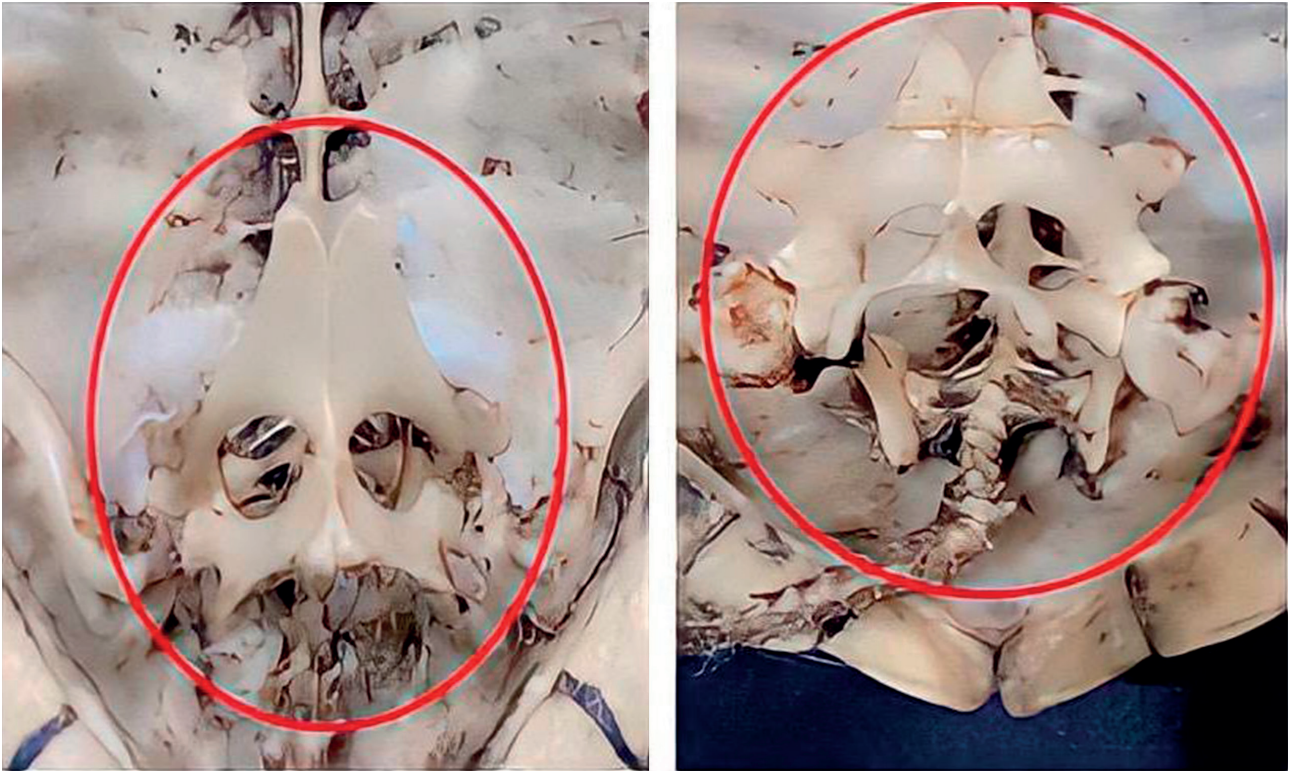
Figure 4. Show the occipital condyle articulation with 1<sup>st</sup> cervical vertebrae



**Figure 5.** Show cervical vertebrae (a) male (b) female.



**Figure 6.** The black arch show thoracic vertebrae fused with ribs and shall ,red circle the pelvic bone (ileum +ischium ,pubis) , red arrow its scapula ,black arrow the clavicle bone blue arrow the coracoids bone.



a

b

**Figure 7.** Show caudal vertebrae And pelvic bone (ischium, ilium, and pubis) (a) male (b) female.



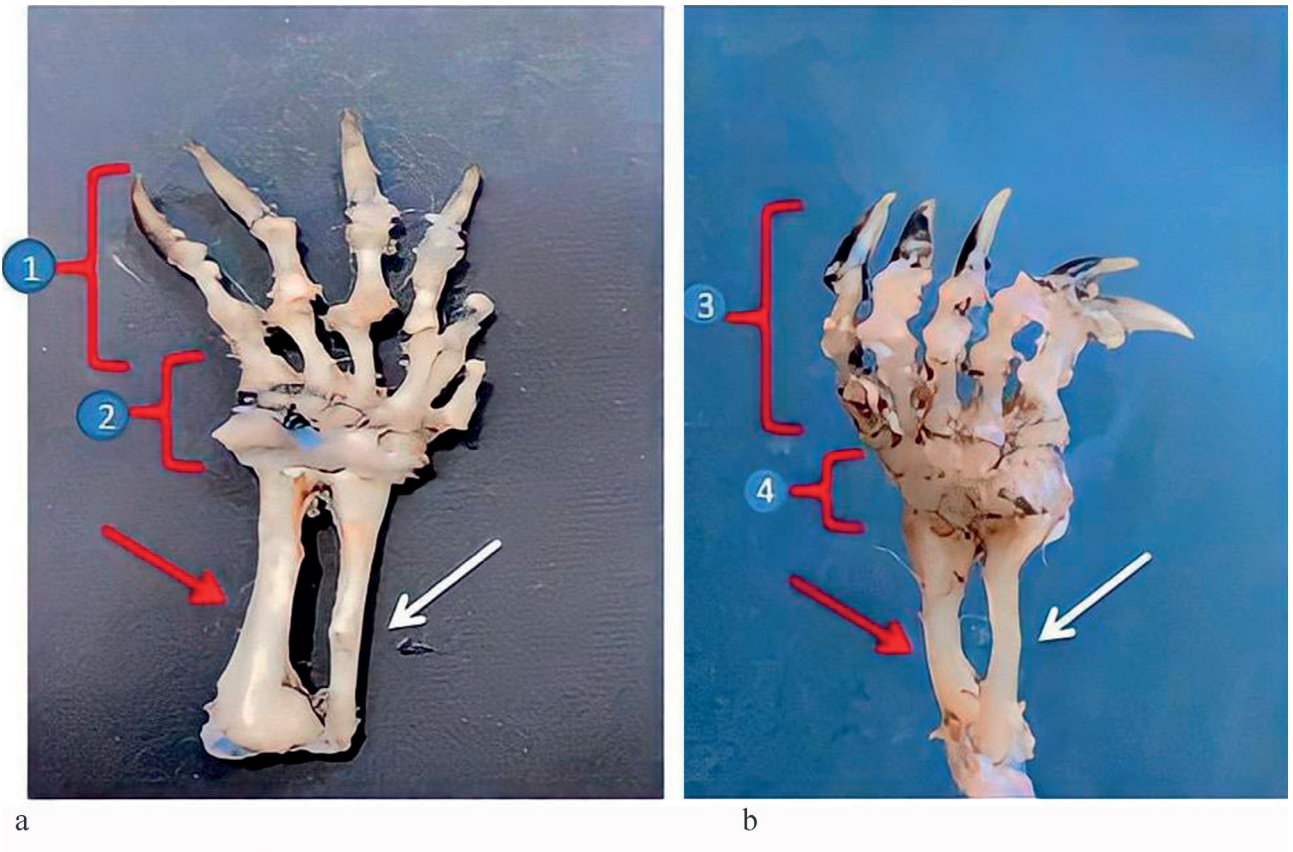
**Figure 8.** Show forelimb red arrow humerus bone ,black head arrow head of humerus ,brown arrow scapula and blue arrow the clavicle bone.

shape of the pubis, ischium, and iliac of the two species studied with river turtles in terms of size and thickness with pelvic bones<sup>32,34</sup>.

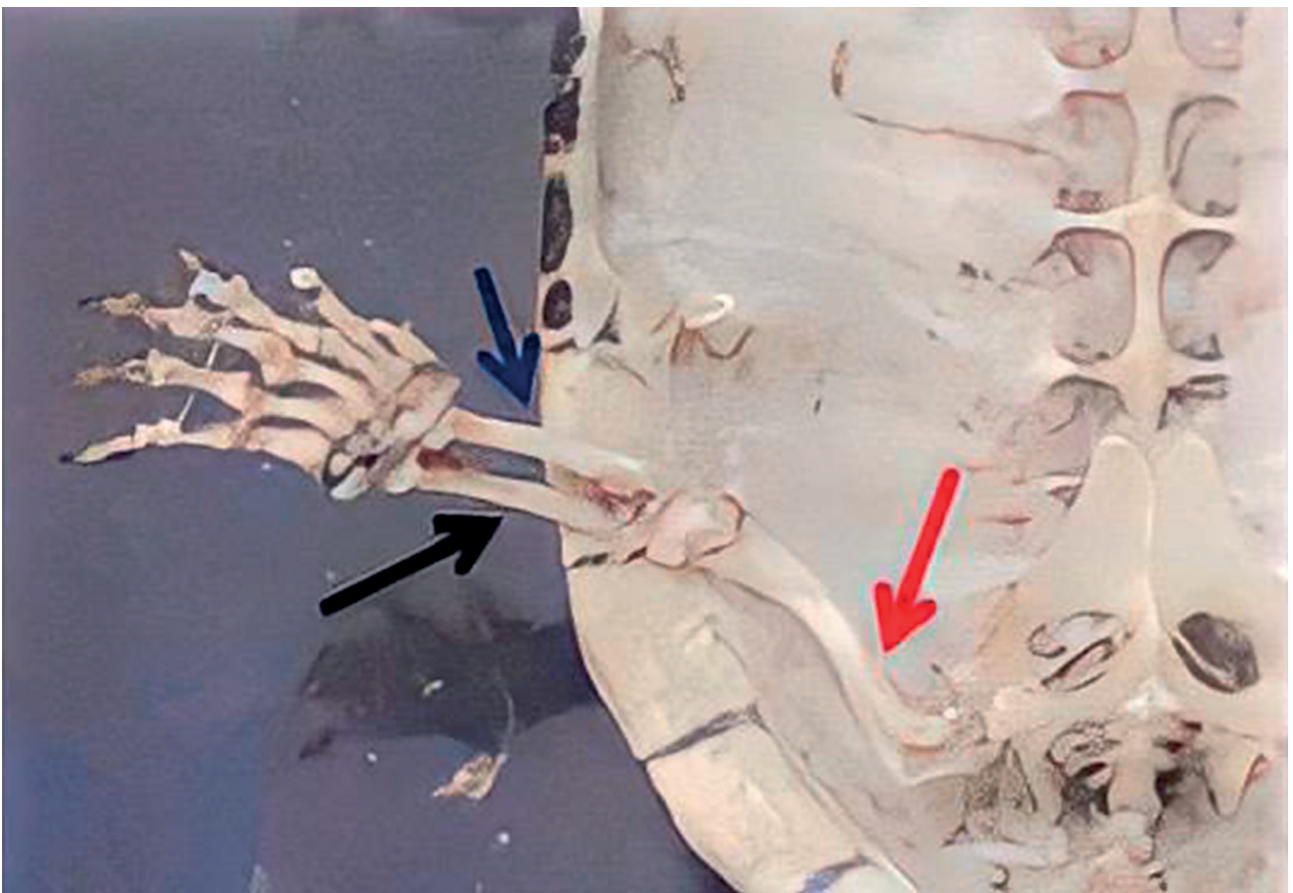
The study contained the tibia and fibula of approximately equal length but shorter and thinner than the femur and also noted that the tibia is more straight than the fibula and articulated with the femur by the tibial condyle of the femur. The distal part is articulated with the heel bone and is ana-

logous to the study of a developed vertebrate<sup>35</sup>.

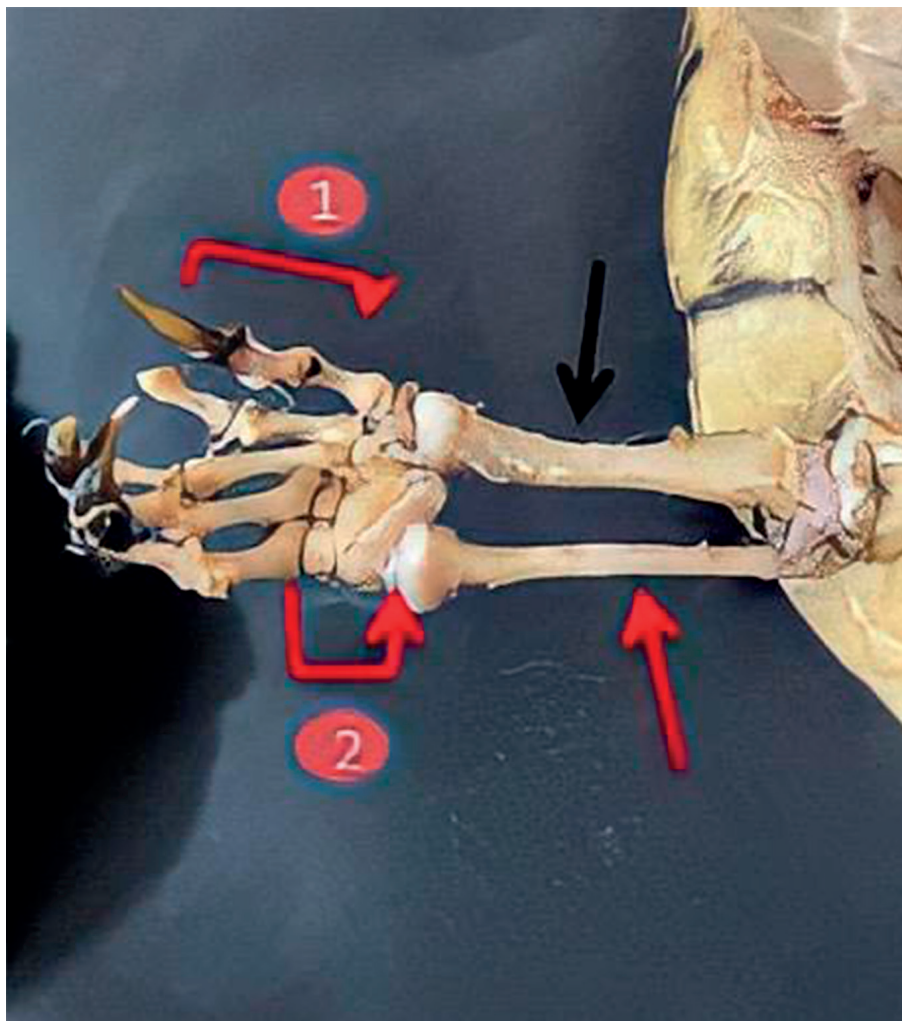
The phalanges and their total number in the anterior and posterior extremities, respectively (manus: 2-3-3-3-2, pes: 2-3-3-3-1). It is similar to river turtles except that the back end contains five digits, only in *C. flavomarginata*, it is also found with a missing phalanx in the 5 digit of manus and pes; They also appear in species in the pes of *C. mouhotii*. In *C. flavomarginata*, the fifth digit of pes is also missing.



**Figure 9.** Shows forelimb red arrow ulna bone , white arrow radius bone, 1&3– phalanges 2&4- carpal bone.



**Figure 10.** Show hind limb red arrow femur bone, black arrow tibia bone, blue arrow fibula bone.



**Figure 10.** Red arrow tibia bone, black arrow fibula bone.

1- Phalanges  
2- Metacarpal (tarsal) bone

Due to changes in some other terrestrial and semi-terrestrial geological materials (*Cuora mccordi*, *Heosemys spinosa*, part *C. mouhotii* and *Leucocephalon yuwonoi*) they also took a similar pattern which led to the disappearance of the fifth finger of pes. It is also found in turtles (Testudinidae), and in another group of terrestrial Chelonians, and land turtles of the genus *Terrapene* (Emydidae); missing phalanges or whole digits are known to be found in the species *Malayemys subtrijuga*, *Morenia petersi*, *Pangshura smithii*, and *Siebenrocki* that have been studied where The finger found the fifth digit of the manus(2-3-3-3-3); on one side of the body there are phalanges of P. 3-3 These are aquatic turtles came similar to the study of river turtles<sup>36</sup>.

Since there are few studies of river turtles, the writer discussed the jaw with reptiles, and as it is known, their lower jaw consists of several bones. Cuvier gave them a descriptive name in line with the jaws of crocodiles, turtles, lizards, and snakes in the order named with slight differences in turtles

In (37) the wishbone was not distinct or was small in the thoracic girdle, while in river turtles, the wishbone is found clearly and distinctly. It has thick and convex borders.

## Conclusions

This study observed the skeleton of Iraqi river turtles in general and is considered the first study in Iraq. The simplicity of the composition concerning the skull is obvious, with

the development of the limbs and their differentiation and difference from sea turtles in the presence of claws, and it required a separate study for each part of the skeleton.

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