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ROLE OF THE BONES OF THE WING AND PELVIC LIMB OF QUAILS IN ITS MODE OF LOCOMOTION

(With 2 Tables & 9 Figs.)

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دور عظام الجناح والطرف الحوضي في السمان في كيفية حركتها

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أجريت هذه الدراسة على اثني عشر طائر من السمان تم إحضارها من مدينـــة العريش حيث يتم تربيتها ولكن لوحظ أن الأجيال الناتجة غير قادرة على الطيران رغـم أن اباء هذه الطيور في الأصل طيورا مهاجرة قدمت إلى مصر من أوربا ، لذا تهـــدف هذه الدراسة إلى إلقاء الضوء على الدور الذي تلعبه عظام الأطراف في كيفية حركـــة هذه الطيور . ولقد أبرزت النتائج أن عظمة القصبة الصنعية هي أطول وأثقل عظام الأطراف على الإطلاق تليها عظمة الفخذ وهما عظمتان يتبعان الطرف الحوضي كما وجد أن الطـرف الحوضي أطول وأثقل من الجناح وأن نسبتهما المئوية بالنسبة للوزن الكلي للهيكل ٧ر٢٨٪ ، ٩ر١٨٪ على الترتيب ومن هذا نستدل على أن الطرف الحوضي في هذه السلالة من طيـــور السمان التي تم دراستها يكون أقوى من الجناح مما يلائم أكثر وظيفة المشي وليـــس الطيران .

SUMMARY

The bones of the wing and pelvic limb of twenty quails brought from Elarish city at the north coast of Egypt on the Mediterranean sea was submited to this study.

The main morphological features as well as the length and weight of each bones and its percentages were recorded.

The results showed that the tibiotarsus and femur which belong to the pelvic limb were the longest and heaviest of all studied bones. Also it was found that each bone of the pelvic limb was longer and heavier than the corresponding one of the wing. Moreover, the percentage of the weight of the pelvic limb to the total weight of the skelton was 28.7% while that of the wing is 18.9%.

Comparing the obtained data with that of the other birds in the available literature revealed that it mostly agreed with the walking birds, although the parents of the studied species of quail are migratory ones.

INTRODUCTION

Several interbreeding subspecies of quails are recognized, the more important being the Europian, Coturnix coturnix and the Asiatic or Japanese, Coturnix coturnix Japonica. Europian quails migrating south across the Mediterranean sea where, in their exhusted condition, easly caught or trapped (WALLACE and MAHANE, 1975). The author added that his available Egyptian and Biblical records do not indicated that these birds were ever bred in captivity. Recently the quails are bred in Egypt. It is observed, however, that their breed are unable to fly.

The aim of the present work is to study the bones of the wing and pelvic limb of such species of quails and its role in locomotion and the reflection of circumstances (captivity) on their morphology. This study was enlightened by preceeding ones carried out on different species of birds and classified them according to mode of locomotion into walking, swimming and flying birds.

MATERIAL and METHODS

Twenty quails were submitted to this study. The specimens were brought from certain farms in Elarish city at the north coast of Egypt on the Mediterranean sea. The muscles were dissected from the wings and pelvic limbs. The bones then boild in water until it became cleaned from any attached soft tissue. Finally the bones were washed by 1% solution of hydrogen peroxide to be clean, white and bright. The main characterstic features were described. The length and weight of each bone were measured and percentage of these parameters were analysed and interpretted (The digits were neglected because of its different lengths) statistical analysis of the obtained data was carried by using SAS (1988).

RESULTS

I - **Morphological features:**

Bones of the wing: (Fig. 1)

1) Humerus: (Fig. 2)

The pneumotricipital fossa of the humerus (2/1) is double formed in quails. It extends into the head (2/2) and the ventral tubercle (2/3). Consequently there is no pneumatic foramen. The ventral tubercle is separated from the head by the Incisura capitis (2/6) and the dorsal tubercle (2/4) continued with the pectoral crest (2/5). The Margo caudalis is obliquely directed (2/7). In the distal extrimity the dorsal condyle is larger than the ventral one.

2) Ulna & Radius: (Fig. 3)

The ulna (Fig. 3) is larger than the radius (3/2). Its shaft is curved and that of the radius is straight, therefore, the interossous space in quails is wide (3/3).

The nutrient foramen is found at the proximal third of the interosseous border of both bones but it can not be seen without the aid of a lens.

The papillae remigiales which are found on the shaft of the ulna for the attachment of secondry flight feathers are not distinct.

3) Carpometacarpus: (Fig. 4)

The carpometacarpus (Fig. 4) is formed by the fusion of the carpal bones except the radial and the ulnar with metacarpal ones. The metacarpal bones are Os metacarpale majos (4/1), Os metacarpale minus (4/2) and Os metacarpale alulare (4/3). The large and small metacarpal bones are separated by the Spatium intermetacarpale (4/4). In quails this space is wide and the intermetacarpal process (4/5) is very prominent but the alular process is very small. The facies articulares digitales major and minor are at the same level (4/6, 7).

Bones of the pelvic limb: (Fig. 5)

1) Femur: (Fig. 6)

The shaft of the femur is twisted (Fig. 6). The Trochanteric femoris (6/2) is higher than the head (6/1), an antitrochanteric facet is found between them. This facet articulates with a corresponding one on the antitrochanteric process of the pelvic bone. This may restrict the movment of the hip joint in abduction and adduction. The medial condyle (6/3) is larger than the lateral one (6/4). It extends more proximally and ends abruptly into the cranial surface of the shaft. In the distal extremity, the Crista supracondyloid medialis (6/5) and Crista tibiofibularis as well as the Trochlea fibularis are easly distinguished.

2) Tibiotarsus: (Fig. 7)

The tibiotarsus (Fig. 7) is formed by fusion of the proximal row of the tarsal bones with the distal end of the tibia. The cranial cnemial crest (7/1) is larger than the lateral one (7/2) and curved outward. In between the Sulucus intercristalis (7/3) is narrow and deep in quails. The bones supratendineus (supratendineal bridge) is oblique and directed laterally and distally (7/5). Deep to this bridge is found the canalis extensorius for the passage of extentor tendon. The fibula is attached to the Crista fibularis (7/4) and proximal and distal to it is present the proximal and distal interosseous foramen.

3) Tarsometatarsus: (Fig. 8)

The tarsometatarsus (Fig. 8) consists of the distal row of the tarsal bones with the metatarsal bones II, III, IV. The shaft is flattened dorsoplanterlly. Dorsally it has the Sulcus extensorius (8/1) and planterally it has two ridges separated by the Sulcus flexorius (8/2). An intermediate ridge is present in quails but it appears only in the proximal and distal ends of the shaft (8/3). The Cotyla medialis (8/4) is higher than the Cotyla lateralis (8/5). The Hypotarsus (Calcaneus) (8/6) is well formed consisting of one canalis hypotarsi and two Sulci hypotarsi for the passage of the flexor tendons of the digits. In the distal extremity the Trochlea metatarsi III (8/8) is the largest one and extends further distally. The Trochlea metatarsi II (8/7) is the smallest and shortest one and extends planterly.

II- Quantitative study:

The humerus is the largest and heaviest bone of the wing (Table 1) and the tibiotarsus is the longest and heavist bone of the pelvic limb (table 2).

Each bone of the pelvic limb is longer and heavier than the corresponding one of the wing and consequently the total length and weight of the pelvic limb are more than those of the wing (table 1 & 2). Moreover, it is found that the percentage of the pelvic limb to the total weight of the skelton is 28.7% while that of the wing is 18.9% (i.e the pelvic limb form one third of the skelton).

The present study also showed that the bones of the wing and pelvic limb could be arranged according to both the length and weight as follow: Tibiotarsus, Femur, humerus, forearm, tarsometatarsus and carpometacarpus (Fig. 9).

The analysis of variance as well as Duncan's multiple range test showed a highly significant difference between the lenght and weight of the wings and limbs also between their individual bones ($P \leq 0.01$).

Correlation corfficiants between the weight and lenght of the wings and pelvic limbs were highly significants ($r = 0.99$ and 0.64).

Also a high significant correlation coefficiant was recorded between the weights and lenghts of the bones of the arm as well as femur, however, the correlation coefficiants of the weights and lengths of humerus and tibia were only significant ($r = 0.96$ and 0.98).

DISCUSSION

The pneumotricipital fossa in quails is dual type. This complies that recorded by BAUMEL, et al. (1979) in penguins, loons, gerbes, cormorants anhingas, diving ducks, rails and some passerines. KOCH (1973) added that this fossa replaces the foramen pneumaticum in nonfliers where the humerus in these birds are nonpnumatized.

MOAWD (1988) mentioned that in walking birds the dorsal tubercle of humerus is continous with the pectoral crest and the ventral tubercle is separated from the head by a groove. Similar finding were reported in the present work.

LATIMER and ROSENBAUM (1926), mentioned that the humerus is strong in fowl and turkey. This agrees with the present findings in quails.

The length of the humerus form 42% of the weight of the wing and is two times that of the carpometacarpus in quails. This corresponds to that mentined by HIFNY, et al. (1988) in walking birds.

The weight of the humerus form 50% of the total weight of the wing and equal both the forearm and carpometacarpus. This corresponds the walking birds described by MOAWD (1988) in which the percentage was 45-50%.

HIFNY, et al. (1988) mentioned that the percentage of the weight of the forearm to weight of the wing is directly proportional to the power of flying where it reaches about (36%) in walking and swimming birds. In the present study this percentage is 35% which proved that quails agree with the walking birds.

FEDUCCIA (1975) stated that the bony projections of the ulna for the secondary feathers are greatly pronounced in strong fliers and reduced in Galliformes. In quails, like Galliformes, it is less distinct.

MOAWD (1988) mentioned that the nutrient foramen is found in the middle of the shaft of radius and ulna in flying birds and at the proximal third in walking ones. In quails the present study revealed that the nutrient foramen lies in a position similar to that found in the walking birds.

The intermetacarpal space is wide and the intermetcarpal process is distinct only in crow and in walking birds. These findings in quails simulate that of walking birds. The Facies articularis major and minor of the carpometacarpus are at the same level in quails which resembles that of the flying birds. However, in walking birds the minor articular process project more distally than the major one.

YOUNG (1981) mentioned that the femur articulates with the acetabulum in such a way that the movement is restricted to anterioposterior direction and there are no movement of abduction and adduction. Simillar finding was given in the present work.

The tibiotarsus is the longest and heaviest bone of the pelvic limb. The percentage of its length is (40%) and weight (45%). This correspond that of the walking birds as reported by MOAWD (1988). Like the domestic birds (NICKEL, et al. 1977) the intercrestal groove in quails is deep.

HIFNY, et al. (1988) stated that the percentage of weight of the tarsometatarsus to that the pelvic limb is 20% in all studied birds. The same percentage is found in quails.

In quails like fowl, pigeon, duck and goose as mentioned by NICKEL, et al. (1977) the Hypotarsus posses one canal and two sulci.

According to WALLACE and MAHAN (1975) and KING and MCLELLAND (1984), birds who fly must have a marviously designed wings and the walking and running birds tend to have relatively long legs. The present work showed that quails, from this point of view, resemble the walking birds. Also the arrangment of the six bones of the wing and pelvic limb in quails according to their length and weight revealed that they simulate the walking birds studied by HIFNY, et al. (1988). Moreover it is found from this arrangment, that the first two bones in quails were the tibiotarsus and femur i.e pelvic limb bones. This in accordance with that described by HIFNY, et al. (1988) who added that in flying birds the first two bones are the forearm and humerus i.e. wing bones.

HIFNY, et al. (1988) stated that the total weight of the wing forms about one fold and half that of the pelvic limb in flying birds. In walking ones the total weight of the bones of the pelvic limb is two folds that of the wing, which is similar to that recorded in quails.

The present study also showed that the total length of the pelvic limb is larger than that of the wing. This agree the statment of BERGER (1952) who mentioned that the crusorial habit of a bird is reflected on the elongation of the hind limb.

All the previously mentioned discussion revealed that the bones of the wing and pelvic limb of the domesticated quails are consistent with that of the walking birds.

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LEGENDS

Fig. 1: Bones of the left wing.
1, Humerus; 2, Ulna; 3, Radius; 4, Carpometacarpus; 5, Digits.

Fig. 2: Right humerus.
Caudal aspect, left & Cranial aspect, right.
1, peumotricipital fossa; 2, head; 3, ventral tubercle; 4, dorsal tubercle; 5, Incisura capitis; 6, pectoral crest; 7, Margo caudalis; 8, Corpus humeri; 9, Condylus dorsalis; 10, Condylus ventralis.

Fig. 3: Right ulna & radius.
Cranial aspect, left & Caudal aspect, right.
1, Ulna; 2, Radius; 3, interossous space; 4, Olecranon.

Fig. 4: Right carpometacarpus.
Dorsal aspect, left & Ventral aspect, right.

1, Os metacarpale majus; 2, Os metacarpale minus; 3, Os metacarpale alulare; 4, Spatium intermetacarpale; 5, Intermetacarpal process; 6, Facies articularis digitalis major; 7, Facies articularis digitalis minor.

Fig. 5: Bones of right pelvic limb.
1, femur; 2, tibiotarsus; 3, Tarsometatarsus; 4, digits.

Fig. 6: Right femur.
Cranial aspect, left & Caudal aspect, right.
1, head; 2, Tochanteric femoris; 3, medial condyle; 4, lateral condyle; 5, Corpus femoris (Facies caudalis), 6, Corpus femoris (Facies cranialis).

Fig. 7: Right tibiotarsus & fibula.
Cranial aspect, left & Caudal aspect, right.
The arrow refers to the canal for the passage of the extenor tendon 1, cranial cnemial crest; 2, lateral cnemial crest; 3, Sulcus intercristalis; 4, Crista fibularis; 5, Pons supratendineus; 6, Corpus fibulae.

Fig. 8: Right tasometatarsus.
Cranial aspect, left & Caudal aspect, right.
1, Sulcus extensorius; 2, Sulcus flexorius bonded by two ridges; 3, an intermediate ridge; 4, Cotyla medialis; 5, Cotyla lateralis; 6, Hypotarsus; 7,8 & 9, Trochleae metatarsi II, III & IV.; 10, Fossa metatarsi.

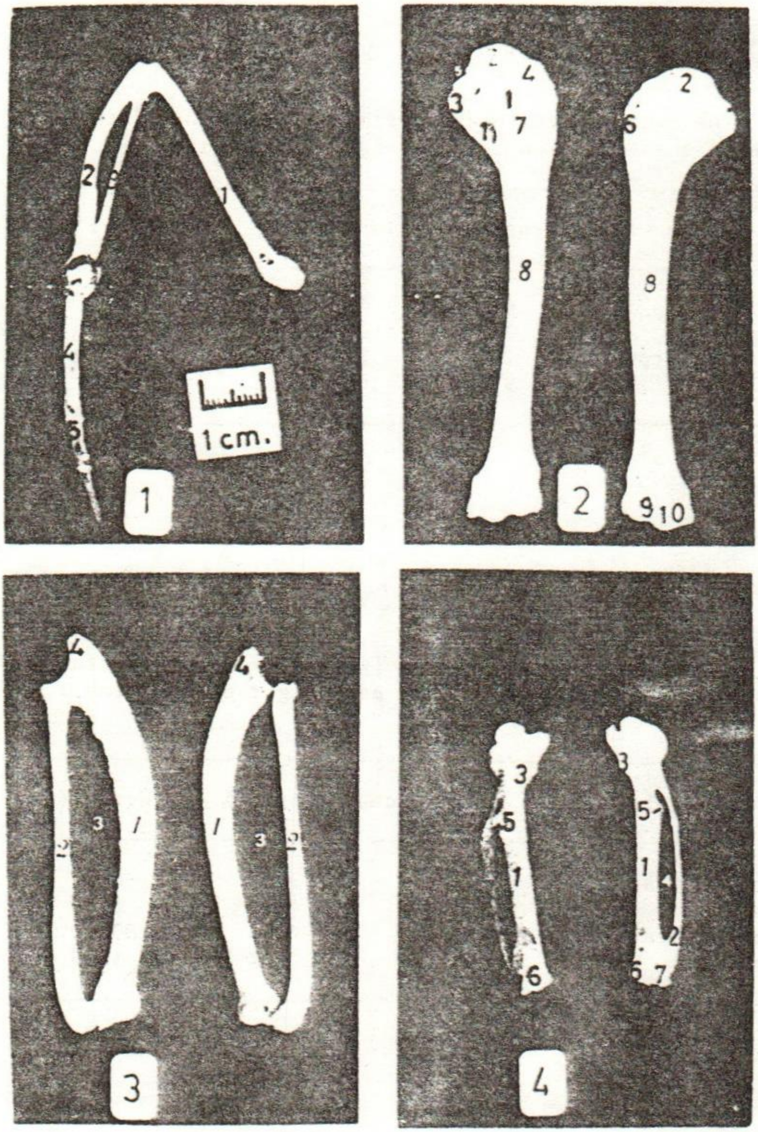
Fig. 9: The bones of the wing and pelvic limb (right side) arranged according to their lengthes.
1, tibiotarsus; 2, femur; 3, humerus; 4, ulna & radius; 5, tarsometatarsus; 6, carpometacarpus.

Table 1 : The average length and weight of each bone of the wing and their percentage to the total length and weight of the wing.

Bones of the wing	length(cm)	length %	Weight(gm)	Weight %
1) Humerus	4.1	42 %	0.33	50 %
2) Forearm	3.4	35 %	0.23	35 %
3) Carpometacarpus	2.2	23 %	0.10	15 %
Total	9.7	100 %	0.66	100 %

Table 2 : The average length and weight of each bone of the pelvic limb and its percentage to the total length and weight of the limb .

Bones of the plvic limb	length(cm)	length %	Weight(gm)	Weight %
1) Tibiotarsus	5.1	33 %	0.37	36 %
2) Femur	4.2	40 %	0.46	45 %
3) Tarsometatarsus	3.4	27 %	0.20	19 %
Total	12.7	100 %	1.03	100 %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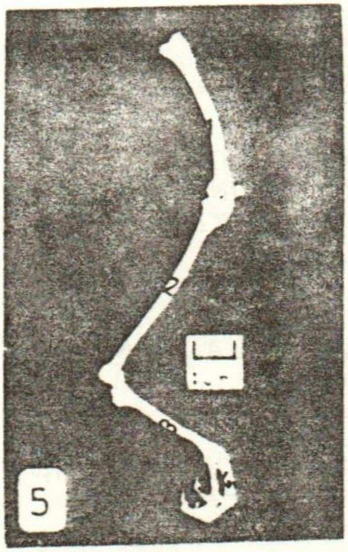
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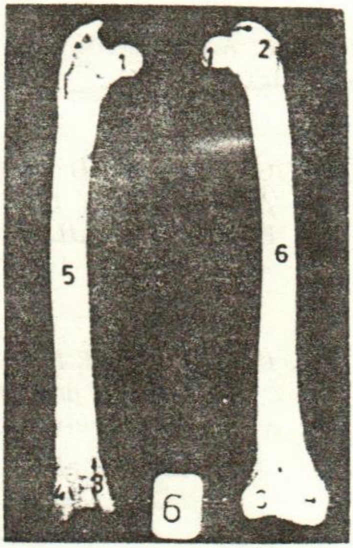
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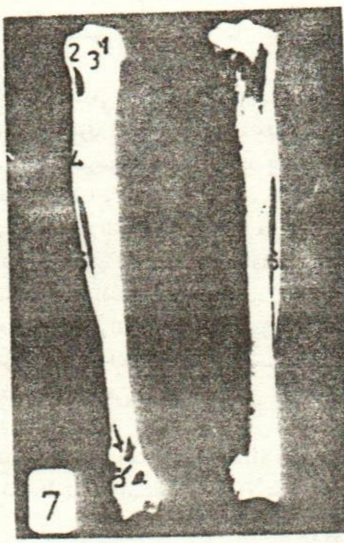
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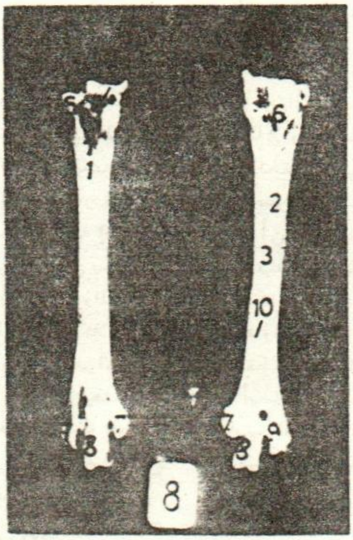
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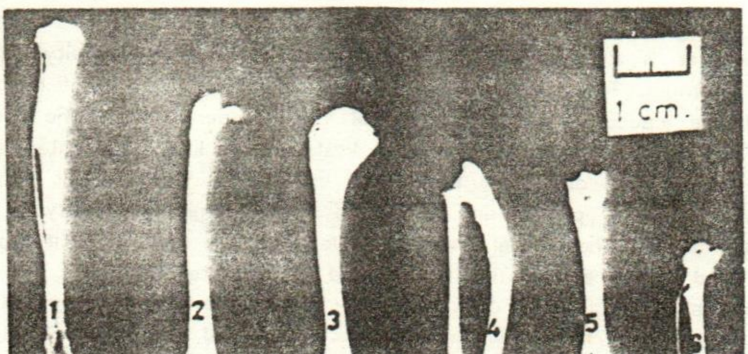
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