# REPAIRED BONE INJURIES IN BIRDS

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*Plates 13, 14*

THE extent and severity of bone injury which a wild animal may sustain and survive is a matter of considerable speculative interest. This is especially true of birds because disability often forces them into an unnatural habitat where they must contrive not only to escape their enemies, but to secure sufficient food as well.

The period of comparatively helpless convalescence is often long—indeed, it is remarkable that so many cripples survive. Roggemann ('Untersuchungen über die Heilung von Knochenbrucken bei Vögeln', Zeitschr. f. Wiss. Zool., 137: 627–686, 1930), working with pigeons and canaries, found that specimens injured in the laboratory, by having a wing or a leg broken, were still partly incapacitated after a convalescence of three weeks. Roggemann observed that though injured domestic pigeons attempted to use their wings after a period of a week, a lapse of three weeks was generally required for the fracture to knit and heal sufficiently to permit ordinary flight.

The length of the convalescent period depends considerably upon the temperament of the bird. Roggemann (l. c.) says that if the animal remains relatively inactive the period is much shorter. For example, he writes that an excitable individual accomplished no more mending of a fractured tarso-metatarsus in twenty-three days than a less active one (undergoing the same laboratory treatment) in sixteen days. He also states that the mending of a fracture of the ulna and radius requires as much time as that of the humerus.

Roggemann further observed that the appetite and food requirements of the birds did not diminish noticeably during the mending of the fracture. Whether this would be true of wild animals in a convalescent state is a matter of conjecture. While it is certain that they would have to obtain some food, it is possible that their requirements would be less if they remained relatively inactive for a long period. We must bear in mind that Roggemann's birds were in a controlled environment. The matter of survival of wild birds must be much more variable. For instance, how can a Ferruginous Rough-leg, whose diet consists largely of rabbits and ground squirrels, secure its food while it is disabled by a fractured femur? Yet this has occurred. This individual, entirely dependent upon the large femora for the force necessary to seize and hold its prey, nevertheless managed

to support its weight on the uninjured member, and to use the same member in grasping prey, with the help of its great wings, until the fractured 'thigh bone' had become sound again. I have observed among the birds of prey, twenty-nine hawks and owls that have sustained major fracture of either leg or wing, and must have been incapacitated for three to four weeks at least. In spite of this handicap, and the retarding effect of motion on the process of healing, these birds somehow managed to elude their enemies and to secure sufficient food to tide them over that long period of hazards.

It is the purpose of this paper to present a survey of the repaired bone injuries of birds, with tabulations as to the location, the specific bones involved, the injuries which appear to be peculiar to certain groups, and to ascertain the probable cause of injuries, and, if possible, to suggest correlation of the injury with the habits of the bird.

The scientific designations that have been used are those of the A. O. U. 'Check-list,' 4th edition.

I wish to thank Mr. C. D. Bunker, Assistant Curator in Charge of the Museum of Birds and Mammals, who made available to me the fine skeletal collection in his care and has given me the opportunity to complete this work. To Dr. H. H. Lane, Head of the Department of Zoology, University of Kansas, under whose direction the problem was taken, I am indebted for helpful suggestions and criticisms.

A total of 6,212 specimens in the collections of the University of Kansas Museum of Birds and Mammals has been carefully examined and the data checked. Of this number 4.50 per cent or 280 specimens show unmistakable evidence of repaired bone injury. This is a rather high percentage considering the fact that many of these injuries are of such a serious nature as to reduce the victims' chances of survival almost to the vanishing point. Yet they managed to overcome these odds and lived to be collected for museum specimens.

Of the great numbers of birds which sustain fatal injuries throughout any given period of time, none would normally ever reach the museum, the exception being birds collected by a museum party. This fact makes the data even more significant as the number which naturally succumb must be very much higher.

Skeletal examinations were made of 3,111 male birds, 2,371 females, and 730 birds of undetermined sex. Of the 3,111 male bird skeletons examined, 150 or 4.82 per cent showed repaired bone injuries; of the 2,371 females, 112 or 4.71 per cent; and of the 730 specimens of undetermined sex, 18 or 2.46 per cent showed repaired bone. The slightly higher average in males over the females may be attributed to the fact that the males are, generally speaking, more conspicuously

colored than the females and would be the first to attract the attention of man and receive injuries in that manner. This would seem to be particularly true in the birds injured by shot as illustrated by the family Anatidae in which five of the seven specimens that were shot were males. The much lower percentage of injuries in the birds of undetermined sex can be explained by the fact that the majority of these birds were young or immature specimens. We may safely assume that injured immature birds would be much less likely to survive, hence such individuals would have succumbed before falling prey to collectors.

There is a great variation in the severity of the injuries that the birds suffered. The specific bone injuries range from a broken toe to a fractured skull. Even the pubic bone has come in for its share. In fact nearly every bone except some of the single elements of the skull has been injured and repaired.

There have not been as many types of injuries as might be supposed. Most of the injuries may definitely be termed fractures. Some of the injuries have been caused by shot and in that event have not been termed fractures unless there was definite separation of the two ends of the injured part. Pathological conditions other than injuries were very few. In specimen K. U. 20490, *Struthio camelus,* which was a zoological-garden specimen, some of the vertebrae appear to have been osteomyelitic, though this is not definitely established. None of the remaining cases could positively be termed other than the direct result of the bone injury.

The injuries were tabulated according to the sex of the bird to ascertain any significant difference in injuries in the two sexes. The survey shows that there is not a great difference between the two and that the one has suffered as many and as severe injuries as the other. By counting the injuries it is noticed that the males received 203 injuries and the females 157. Comparing these with the number of specimens of each sex, 3,111 males and 2,371 females, it is seen that the percentage is 0.09 per cent greater in females.

Many people have doubtless wondered why a bird turns to the right or left when it appears that the opposite direction would be the better move. The injuries appear as severe and as numerous on the left side of birds as on the right. By tabulating those on one side and comparing them with those on the other it will be seen that they are identical, 163 on each side (injuries in the median line have not been entered in this tabulation). This seems to indicate that a bird does not favor one side over the other and so can definitely not be either 'right-' or 'left-handed'.

The bones that have been injured the greatest number of times are the clavicles. (The terms right and left clavicles instead of the term furcula, which includes the two bones, have been used to insure specificity.) The right clavicle has been injured and repaired 66 times while the left has received 63 injuries. This makes a total of 129 injuries to the two. In 21 instances both the right and the left had been injured. There are several interesting facts brought out by the study of clavicular injuries. Perhaps the most interesting fact is that 99 of the 129 occurred in the passeriform birds. Clavicle injuries, along with those of the scapula and sternum, include nearly all the injuries present in that group of birds. Most of the skeletons in the collection except those of the Corvidae—crows and jays—are those of rather small birds. Of the 3,809 passeriform skeletons 130 or 3.41 per cent show mended injuries. This is 1.09 per cent less than the average for the entire collection and would indicate that the smaller birds receive less injuries or succumb more often to their injuries than the larger ones and that the chances are nearly 3 to 1 that the injury will be of one of the clavicles.

There are several reasons why the smaller birds injure the clavicles. If one watches a small bird which has flown into a building and is attempting to find an exit, he will notice that it flies against a window pane with almost enough force to break the glass, and that the force of the impact is usually borne by the bird's thoracic region. That impact or one received in a similar manner might easily cause a fracture of the clavicles. We know when birds are migrating during a fog, or when they are attracted to a light at night, that they often fly into objects. A great number probably injure themselves in this way. In the pursuit of ordinary activities a bird might also sustain an injury to the clavicles. I have seen Meadowlarks fly into a fence. If one is observing in the woods at night, he may, by frightening a number of birds in a tree, see them flying into branches and other obstacles in the rush to get into the open.

The scapulae rank next to the clavicles in the frequency of injuries. The right scapula was injured and repaired 17 times and the left 16, making a total of 33. All the injuries were fractures and a large number had been incurred probably as a result of attack. The scapulae are situated in a rather vulnerable position in birds and have very little protection. A blow on a bird's back would almost certainly injure a scapula.

The sternal keel was injured in 31 specimens. In a number of instances the injury can definitely be attributed to the effect of shot. In fig. 5 (Plate 13) a circular hole 13 by 11 mm. can be noted in the

keel. The same shot also made a rectangular opening 17 mm. long in the body of the sternum. In several instances, especially in the smaller birds, the keel has been injured at its anterior end, as a result, probably, of the bird flying into some object.

The body of the sternum showed evidence of repair in 19 instances, and most of these, like that of the keel, were the result of gunshot. It is remarkable, indeed, that a bird like specimen K. U. 19931, *Corvus cryptoleucus,* White-necked Raven (Plate 13, fig. 5) could live after it had been injured so severely. Yet, the injury was not a recent one, as the process of repair had been well advanced. It may sound ironical but it is nevertheless true that the very same bird having received this injury and overcome it, was then collected by the U. S. Bureau of Biological Survey as a specimen in their food-habits research, and is now a permanent record in the University Museum.

The three main bones of the wing, the ulna, radius, and humerus, have been injured and repaired in 51 instances, the humerus 11, ulna 16, and radius 24. Of the 51 injuries, 15 were in the family Anatidae. The majority of these injuries were of such a serious nature that the bird was certainly unable to use that wing for a period of two or three weeks. It is difficult to conceive any particular reason why these bones should be injured. In a few instances the wounds were probably caused by gunshot.

The procedure followed in designating a certain fracture or injury as caused by gunshot was first to examine the bone carefully for shot. In a number of instances shot were present. When a likely circular cavity in a bone was observed, and when the shot itself could not be found, an attempt was made to determine whether the opening might have had a pathological origin. If no pathological evidence was discovered in the bone structure it was designated as having been caused by shot.

In a number of instances where a bird is seriously wounded, the injury has not been severe enough to cause immediate death. The injured bird then hides away for several weeks nursing its wounds. If it is successful in evading its enemies and in securing food it will again be able to take to the air, and in a short time to lead a fairly normal life.

Dr. Frank M. Chapman (Bird-lore, 60: 268–269, 1907) gives an account of a merganser that had been injured during the hunting season. The injury was a fracture of the humerus. This bird was unable to join its comrades in the spring migration. It had escaped by crawling under a log where it would hide during the winter. The mending of the fracture had left the bone greatly distorted and useless in flight.

Dr. Chapman asks the question, why, if (as had been asserted) birds set their leg bones, do they not apply that alleged surgical ability to their wings?

The femur, tibia, fibula and tarso-metatarsus have sustained 63 injuries. (The terms tibia and fibula instead of tibio-tarsus have been used because it was thought that the two terms would be more definite.) Considered separately the femur sustained 14 injuries, the tibia 19, the fibula 11, and the tarso-metatarsus 19. In most instances a leg injury would not be as serious as a wing injury since it would be easier for a large bird, such as a hawk or a duck, to obtain its food if it had a fractured femur than it would be if the humerus were fractured.

In specimen K. U. 22197 *Buteo swainsoni* and K. U. 22198 of the same species, the head of the femur had been severed from its shaft. In K. U. 22197 the head of the femur had become fused inside the acetabulum by the growth of callus. Such a fracture would leave the bone without any support except that of the muscles.

Injuries to the bones of the leg could occur in a number of ways. In several instances it had been caused by shot. The birds that are inhabitants of bodies of water might be bitten on the legs by turtles. In those birds like the hawks and owls, a bone of the leg could be fractured when the bird has its prey in its grasp. For instance, if a Rough-legged Hawk in pursuit of a large jack rabbit, weighing as much as or more than the hawk, succeeded in grasping it, and the rabbit ran under something, the chances are that the bird would receive a fracture of a leg before it could succeed in releasing its grasp.

With the above discussion of the leg bones most of the injuries have been considered. There remain the smaller bones of the wing and leg and such injuries as were thought to be of no particular interest to consider in detail.

It may be of interest to discuss the Ostrich skeleton K. U. 20490 in which there were numerous injuries. Only the fractures of the right and left pubis have been mentioned in the account. The other fractures in this specimen have not been considered in the tabulations. This specimen, a female, was in the Kansas City Zoological Garden along with a number of others in the same pen. Of 32 fractures that had mended, the majority were of the ribs. Large bones such as the pubis and sternum were also fractured. Some of the vertebrae show a condition that may have been osteomyelitis, a disease that has not been considered in this paper. The only plausible explanation for so many injuries is that the animal probably received the fractures when it was kicked by other Ostriches.

CASES OF BONE INJURY EXAMINED

| *Family* | *Number Examined* | *Number Injured* | *Per cent* |
|---|---|---|---|
| Struthionidae | 2 | 2 | 100.00 |
| Gaviidae | 2 | | |
| Colymbidae | 14 | | |
| Hydrobatidae | 2 | | |
| Pelecanidae | 15 | 2 | 13.33 |
| Phalacrocoracidae | 8 | | |
| Fregatidae | 2 | | |
| Ardeidae | 84 | 6 | 7.14 |
| Phoenicopteridae | 1 | | |
| Anatidae | 256 | 33 | 12.89 |
| Cathartidae | 32 | 27 | 21.84 |
| Accipitridae | 290 | 25 | 8.62 |
| Falconidae | 49 | 2 | 4.08 |
| Tetraonidae | 25 | 2 | 8.00 |
| Perdicidae | 45 | 1 | 2.22 |
| Phasianidae | 10 | 1 | 10.00 |
| Meleagridae | 8 | | |
| Gruidae | 5 | | |
| Rallidae | 39 | 2 | 5.12 |
| Haematopodidae | 2 | | |
| Charadriidae | 59 | 5 | 8.49 |
| Scolopacidae | 311 | 10 | 3.21 |
| Recurvirostridae | 8 | 1 | 12.50 |
| Phalaropidae | 5 | 1 | 20.00 |
| Laridae | 60 | 6 | 10.00 |
| Rynchopidae | 1 | | |
| Columbidae | 82 | 5 | 6.09 |
| Psittacidae | 19 | | |
| Cuculidae | 885 | 4 | 4.06 |
| Tytonidae | 13 | 1 | 7.69 |
| Strigidae | 187 | 16 | 8.55 |
| Caprimulgidae | 83 | 7 | 8.43 |
| Micropodidae | 55 | 1 | 1.81 |
| Trochilidae | 15 | | |
| Alcedinidae | 11 | 1 | 9.09 |
| Picidae | 326 | 9 | 2.76 |
| Tyrannidae | 280 | 12 | 4.27 |
| Alaudidae | 88 | 9 | 11.36 |
| Hirundinidae | 143 | 4 | 2.79 |
| Corvidae | 358 | 11 | 3.07 |
| Paridae | 161 | 7 | 4.34 |
| Sittidae | 29 | | |
| Certhiidae | 27 | | |
| Cinclidae | 1 | | |
| Troglodytidae | 140 | 2 | 1.42 |
| Mimidae | 105 | 1 | .95 |
| Turdidae | 199 | 15 | 7.53 |


REPAIRED BONE INJURIES


REPAIRED BONE INJURIES

CASES OF BONE INJURY EXAMINED—*Continued*

| *Family* | *Number Examined* | *Number Injured* | *Per cent* |
|---|---|---|---|
| Sylviidae | 89 | | |
| Motacillidae | 23 | 1 | 4.34 |
| Bombycillidae | 24 | | |
| Ptilogonatidae | 2 | | |
| Laniidae | 71 | 1 | 1.40 |
| Sturnidae | 52 | 1 | 1.92 |
| Vireonidae | 122 | 3 | 2.45 |
| Compsothlypidae | 286 | 5 | 1.75 |
| Ploceidae | 21 | 1 | 4.76 |
| Icteridae | 443 | 32 | 7.22 |
| Thraupidae | 35 | 1 | 2.85 |
| Fringillidae | 1202 | 24 | 1.99 |
| Total | 6212 | 280 | 4.50 |

The highest percentage of injuries, considering the families in which there were enough specimens to insure accurate data, occurs in the family Anatidae (ducks and geese). There were 33 injuries in the 256 specimens or 12.89 per cent. The family Alaudidae (larks) is second with 9 of the 88 specimens or 11.36 per cent having evidence of injury. The family Accipitridae (hawks and eagles) is third with 8.62 per cent of the 290 specimens displaying injuries.

Only 1 or 0.95 per cent of the 105 specimens in the family Mimidae (mockingbirds and thrashers) shows evidence of an injury. This is the lowest percentage of any of the families considered. The family Fringillidae (grosbeaks, sparrows and finches) with 1,202 specimens, had only 24 birds with mended injuries or 1.99 per cent.

In 33 of the 280 birds with mended injuries there is sufficient evidence to say that their injuries were caused by shot. Thus 11.78 per cent of all the injuries is the result of the deliberate activity of man. Six of the 33 were in the family Anatidae which are termed 'game-birds' and are hunted. This, however, leaves 27 to account for and the only reason that these birds were shot is the killing instinct in man.

In 64 birds there were two or more bones injured and mended. This fact may not prove anything in particular but it does show the vitality of the birds.

Twenty-two bones had been injured more than once. In the majority of instances the injuries had been simultaneous, but in others they were on different occasions.

The amount and texture of the callus that was formed around the injury is quite variable. In certain instances the callus is abundant and bulbous, and the texture is very porous. In others the callus is

small and very compact. Much of the variation is due to the fact that the process of mending was in a different stage when it was arrested by the death of the specimen. Where the process was well under way there would be much callus present. Secondary infection would also alter the texture and amount that surrounded the bone.

In some of the specimens the setting of the fracture has been very accurate. The amount of callus is small and the texture is nearly that of the bone itself. It is, indeed, astonishing that this should occur at all, considering the odds against these birds.

## CONCLUSIONS

In conclusion it may be of interest to reiterate several of the points that have been brought out in the foregoing pages.

1. Of the 6,212 skeletons examined, 4.50 per cent were injured and mended.

2. The skeletons of male birds were injured 0.11 per cent oftener than those of females but the injury in the females concerned 0.09 per cent more bones than in the males.

3. Very few of the skeletons were pathologic other than as the result of injury.

4. Injuries occurred as often on the left side of the birds as on the right.

5. Passeriform birds have the highest percentage of clavicular injuries. The chances are 3 to 1 that an injured bone will be a clavicle.

6. Hawks, owls, and ducks have a high percentage of injuries to the wings and legs.

7. Of the total injuries, 11.78 per cent have been the result of gunshot wounds.

8. The highest percentage of injuries was in the family Anatidae (ducks and geese).

9. The lowest percentage was in the family Mimidae (mockingbirds and thrashers) with 0.95 per cent.

## EXPLANATION OF PLATES

### PLATE 13

Fig. 1.—Rocky Mountain Grosbeak (*Hedymeles melanocephalus papago*). K. U. 19214. Dorsal view of skull. Injury of the right parietal of the skull.

Fig. 2.—Green-winged Teal (*Nettion carolinense*). K. U. 17771. Ventral view of lower jaw. Shot fractured right and left dentaries.

Fig. 3.—Carolina Wren (*Thryothorus ludovicianus*). K. U. 12765. Lateral view of right femur. Right femur 21 per cent shorter than left. The callus is quite porous but the mending has been firm.

Fig. 4.—Western Meadowlark (*Sturnella neglecta*). K. U. 17292. Anterior view of furcula. Both clavicles had been fractured and mended. Notice the great amount of callus.

Fig. 5.—White-necked Raven (*Corvus cryptoleucus*). K. U. 19931. Lateral view of right side of sternum. Note the large hole 13 by 11 millimeters in the sternal keel and the fracture of the right clavicle.

### PLATE 14

Fig. 6.—Lesser Prairie Chicken (*Tympanuchus pallidicinctus*). K. U. 20903. Lateral view of left femur. The callus is very firm and of nearly the same texture as the bone itself.

Fig. 7.—Black Vulture (*Coragyps atrata*). K. U. 22162. Lateral view of left femur. The distal portion of the femur has become fused anterior to and upon the proximal end. Left femur 2.1 centimeters or 24 per cent shorter than the right.

Fig. 8.—Ferruginous Rough-leg (*Buteo regalis*). K. U. 22147. Lateral view of left femur. The bone was distorted so that it was 2.5 centimeters or 27 per cent shorter than the right.

Fig. 9.—Ferruginous Rough-leg. K. U. 22159. Posterior view of left tarso-metatarsus. Notice the shot at A.

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