NOTES UPON THE OSTEOLOGY OF *CINCLUS MEXICANUS.*

BY R. W. SHUFELDT.

It has never been my good fortune to enjoy the opportunity of studying the habits and manners of our American Dipper in its native haunts, but this seems to have been due more to my ill-luck, than to any neglect on my part to seize upon every chance to visit the localities where this bird, one that I have so often longed to see alive, certainly should have occurred; I refer to the rocky, mountain streams that course down the gorges of the Big Horn Mountains and the Laramie Hills. Many a time I have scrambled alone up through the rocky cañon that marked the bed of one of these noisy, bounding torrents with the vain hope of finding *Cinclus*, but, like many a naturalist before me, I was obliged to leave the country where these birds undoubtedly occur without ever having seen one of them. So that of my own personal experience I have nothing to add, so far as its life history is concerned, to the many beautiful descriptions of this bird given in our standard ornithologies, familiar to all lovers of the science, and to those read in its literature.

Of skins of *Cinclus* I have examined many a score, as has every one who from time to time has gone through large collections, but the very nearest, the most intimate acquaintance that I can boast of ever having made with this little bird, was with a pair and three young that had been stowed away by themselves in alcohol for several years in the large collection at the Smithsonian Institution. Of this material I was kindly allowed to avail myself, or of so much of it at least as was necessary to develop the facts that I now have the pleasure of presenting to my reader in this paper.

I did very little with the viscera, and this part of its anatomy has been laid aside for some future study, my attention having been directed more particularly to the skeleton, and to the extremely interesting points that it presented for consideration. These I shall endeavor to describe, as minutely and elaborately as the limits of this article will permit, at the same time sup-

pressing as many of the technicalities in terms, as is compatible with exactness, and in accord with the tastes of those who have not devoted themselves especially to anatomical reading and work.

In studying the skeletons of birds, or of anything else for that matter, the student must keep the fact ever present in his mind, that the great value of such studies and the descriptions that may follow them, rests almost entirely upon the comparisons that he makes; the more carefully and minutely he compares the form he may have under consideration with nearly related forms, the greater will be the value of his results; to this end tend all the studies of biologists of the present day.

With respect to the skull of *Cinclus*, our space will not permit us to enter upon the engaging part of the subject as to the mode of formation of this part of the skeleton in the adult from the many segments found in the cranium of the chick, it being enough for us to say that the usual bones ossify, unite, and leave the ordinary ones free, as the pterygoids, the ossa quadrata, and the lower jaw. The superior mandible is drawn out into a sharp point, and the bony nostril on either side occupies considerable space, being long and elliptical in outline; as in all nearly related genera these apertures are not separated by a bony partition or septum, but below we detect a delicate vomer in the median plane.

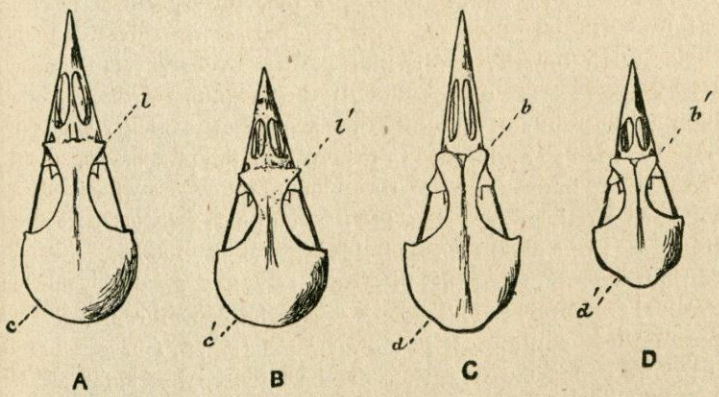
The eye-cavities or orbits are well shut off from the nasal chambers beyond them by broad bony walls composed of the usual elements, and here each is of a quadrate figure, as seen in so many genera of birds. The upper and outer angles of these osseous partitions are rounded. The almost complete separation existing between the two cavities just referred to by no means exists between the orbits themselves, for here we find an extremely deficient septum, and a large aperture leading into the brain-case at the usual site of the exit of the nasal nerves, the openings for the optic nerves being circular and entire.

On the inferior aspect of the skull we find maxillo-palatines, of a more or less spongy composition, existing between maxillaries and the delicate palatines, which latter are slightly bent downwards from the horizontal plane. The pterygoids are very slender, and articulate in the usual manner with the quadrates and the palatines.

The external form of the brain-case is more or less globular, the supra-occipital prominence being well developed behind. Above in the median line a shallow furrow is carried forward as far as the fronto-maxillary suture.

There is but little of interest to note in the lower mandible, to illustrate the points we have in view.

From this slight sketch of this part of the skeleton we are prepared to look a little into how *Cinclus* compares with other forms of near kin. The writer, to illustrate his remarks, offers the student the four accompanying cuts of the superior aspects of the skulls of birds chosen with the view of showing the comparable points.



A is of *Oreoscoptes montanus*, B of *Sialia mexicana*, C of *Cinclus* itself, and D of *Siurus nævius*.

In the figures, the angle formed at *l*, *l'*, *b*, and *b'* is due to the lachrymal bone on that side; viewed from above in such forms as *Sialia*, *Turdus grayi*, *Oreoscoptes*, *Hylocichla unalascæ*, and no doubt *Merula* and *Mimus*, less so in *Harporhynchus*, this projection is markedly angular; while in *Siurus*, the Wrens, and rather less so in *Anthus*, it is *rounded*, as shown in *Siurus* and also in *Cinclus* itself.

Of the forms we have examined, *Siurus* appears to be closer to the Dipper in this respect than any other genus, the Wrens (*Salpinctes*) next, and *Anthus* next. This also applies to the manner in which the median furrow at the summit of the cranium approaches the fronto-maxillary suture, also shown in C

and D in the cuts, this feature in the opposed forms mentioned above occupying a position between the superior orbital margins.

There is still another very marked distinction among the birds we have thus far compared, and that is in the general external form of the brain-case proper. A and B show the form assumed by the genera we mentioned above in connection with them; smooth, large, and globular, all indicating the possession of a brain of no mean size as compared with the owner. In *Cinclus*, *Siurus*, and the *Troglodytinæ* the prominence of the supra-occipital eminence causes depressions to exist at *d* and *d'* that are not present in A and B at *c* and *c'*.

With regard to this last characteristic the outline assumed by *Siurus* seems to claim the nearer place, over the other forms mentioned.

So much for the skull, and the writer must reluctantly and with as good grace as possible allow the student to observe other interesting points of difference for himself, though he would be only too glad to assist him in this part of the skeleton.

There are fourteen cervical vertebræ in *Cinclus*, the last two bearing each a pair of free ribs, the ultimate pair possessing uncinate processes; this arrangement holds good in *Siurus* and *Salpinctes*, but we remember that in *Eremophila** we found only thirteen cervical vertebræ; the number of ribs varied however. *Cinclus* also possesses, in common with the form mentioned, four dorsal ribs; these are connected with the sternum by sternal ribs, the first sacral vertebra possessing an additional pair, but its sternal ribs only articulate along the hind border, on either side of the true sternal and last pair. This condition obtains, we know, in very many birds.

If we do not include the pygostyle or last coccygeal vertebræ, we observe that *Cinclus* has *seven* caudal vertebræ, *Siurus* and *Salpinctes* each only *five*, *Oreoscoptes* having *six*, so that the number of these segments may vary more or less among the genera we have quoted above.

The general pattern of the pelvis of the Dipper, the Wrens, the Thrushes, and *Sialia* is pretty much the same for all, that is it would be very hard to point out decided differences among them upon casual examinations; of course they are proportionate

* See Bull. U. S. Geol. Surv., Vol. V, Art. 5.

in size to that of their respective owners, and we might, in extensive series of each, by exceedingly careful measurements, detect relative differences. These remarks cannot be applied to the genus *Harporhynchus*, as the pelvis there has a very striking form, best expressed by saying that it is more angular than the others cited, the processes are more pronounced and sharper. In *Cinclus*, as in other forms noted, the bone is broad across, with the distal extremities of the pubic bones and ischia flaring well outwards; the ilio-neural canals open; the sacral vertebræ very broad, with numerous foramina or openings existing among them.

What we have just said in regard to the pelvis applies with equal force to the shoulder girdle and sternum; indeed, this latter bone is singularly alike among the various genera that I have referred to; the shape it assumes is that described by Professor Owen in his Anatomy of Vertebrates, as the "Cantorial sternum," it being the pattern allotted to the vast majority of the class *Aves*. In front we find the manubrium bifurcated, and supported upon a stout and produced base, directed upwards and outwards. The body behind is 1-notched, the lateral xiphoidal processes thus formed having dilated ends. The keel is deep, convex below, sharp and concave in front, forming an acute carinal angle at the point of meeting. The costal processes are very lofty, broad and directed forwards, having the facets for the sternal ribs placed along their posterior borders, which meet on either side the xiphoidal borders at a very obtuse angle. The "merry-thought" of *Cinclus* is delicately formed, having expanded upper extremities and a median plate below.

Our subject has, in addition to the usual number of bones in the pectoral limb, quite a sizable sesamoid, to be found at the back of the elbow; this bonelet is likewise found in *Oreoscoptes* and may be a common character of other birds we have mentioned. The arm seems to be completely non-pneumatic, indeed I have failed to find the apertures for the entrance of air in any of the bones composing it. Several months ago my attention was directed to a note, I think in the Proceedings of the Zoölogical Society of London, in which some English observer says the same of the European Dipper. This non-pneumatic condition of the long bones, not only of the upper but also of the lower extremities, seems to hold good among all the other forms and genera we have thus far referred to in this article.

The proximal extremity of the *humerus* is very much expanded, and rather abruptly bent in the direction of the bird's body, the member being considered in a position of rest. The "crest" we know curls over the usual site of the pneumatic fossa, which depression is divided by a bony partition from a lesser cavity above. This characteristic is also more or less strongly marked in the Rock Wren, *Siurus*, and others, and is feebly shown in *Harporhynchus*.

The articular cavity of the shoulder joint is increased in the Dipper by a good sized *os humero-scapalare*, a sesamoid that we are aware is to be found among other orders.

We will present the reader here with a table showing the relative lengths, etc., of some of the bones we have thus far examined, in order that a study of their comparative development may be made. (The measurements are given in centimeters.)

Species.	Sternum.		Humerus.	Radius and ulna.	Hand.	Long axis of skull.
	Length from bifurcation of manubrium to end of body.	Depth of keel.				
Cinclus mexicanus.	2.7	0.8	2.2	2.6	2.6	4.4
Siurus nævius.	1.9	0.6	1.7	2.1	1.7	3.1
Salpinctes obsoletus.	1.6	0.5	1.7	2.0	1.7	3.6
Oreoscoptes montanus.	2.3	0.7	2.2	2.7	2.4	4.2
Sialia mexicana.	2.3	0.8	2.0	2.8	2.3	3.5
Anthus ludovicianus	2.1	0.7	1.8	2.5	2.1	2.9
Merula migratoria.	3.4	1.1	2.9	3.4	—	—
Hesperocichla nævia.	3.0	1.6	2.5	3.1	3.1	4.6

A great many points of extreme interest and of the highest importance reward the ornithotomist's study of the pelvic limb of *Cinclus;* some of these the writer has already remarked upon in papers now in press, but he offers them here again, confident of the fact that they will be of interest to ornithologists generally,

particularly to those whose aim it is to pursue the study more than "skin deep."

In the adult Dipper the pelvic limb, as far as its skeleton is concerned, is made up of the most usual number of bones; the thigh having the *femur*, the leg the *tibia* and *fibula*, a *patella*, the tarsus the bone *tarso-metatarsus*, and finally a foot arranged upon the plan of four toes, with first, second, third, and fourth digit composed of 2, 3, 4, and 5 joints respectively.

I have already said that these bones are non-pneumatic, they are also of lengths proportionate to the size of the bird, the claws being curved about as much as they are in a typical Thrush. Anatomists have described certain general points for examination on these long bones composing the leg; many of these are present, but we shall only call the student's attention to a few of them, so as to make clear what we have to point out hereafter. Nothing of striking variance marks the femur, as distinguishing it from the common form of the bone among birds of this class. The same might be said of the tibia, but we must note the two large flaring processes at the anterior and upper end of this, the larger bone of the leg; in this bone, too, the condyles are well developed below. The *tarso-metatarsus*, or the bone of the tarsus, we observe in the old bird, has rather a slender shaft, presenting for examination at its upper end the usual dilatation, crowned by a smooth, undulating surface to articulate with the tibia; behind this, at the same end, we find a tuberous process that has given comparative anatomists no little trouble to name; but we will speak of this further on. The lower end of the tarso-metatarsus has the little lateral facet for the diminutive first tarsal bone, and the three trochleæ for the other toes.

Let us now, after this brief survey of the bones in the adult take up the young of this species. We find first that the femur has grown in the usual manner, its lower end bearing the two large condyles has been formed by one epiphysis which included both of these articulate surfaces. Nothing of particular interest is to be observed in the development of the fibula or the small "splint bone" of the leg. The superior end of the tibia has been formed by the epiphysis including the two large processes that I spoke of above. These plates are called the procnemial and the ectocnemial processes, the inner and outer one respectively. They are turned slightly outwards, springing abruptly

from the shaft in the adult, very much as I figured them in *Lanius*.

Such of my readers as have read my account of the development of *Centrocercus* in the Osteology of the *Tetraonidæ*, will remember what we had to say in regard to the lower end of the tibia and its growth, and also all that Professor Morse has done for us in that direction. The specimen we have of the young of *Cinclus* does not admit of the demonstration of the *intermedium;* the *fibulare* and the *tibiale* seem to ossify separately, however. We must admit, then, that in this instance we are no nearer solving the problem of the homologies of the avian tarsal segments than we were before, but a little light at least is thrown on the subject when we come to examine the next bone, the tarso-metatarsus.

In nearly all birds this bone has at the back part of its upper end a tuberous process, amalgamated with the shaft in the adult, that assumes various forms in different members of the class. This bony process has long been regarded with suspicion, as to whether it was one of the ankle or rather tarsal bones or not. Let us hear what a few of the authorities have to say in this matter. Professor Owen tells us in Vol. II of his Anatomy of the Vertebrates, when speaking in general terms of this process, that: "One or more longitudinal ridges at the back of the upper end of the metatarsal are called 'calcaneal'; they intercept or bound tendinal grooves which, in some instances, are bridged over by bone and converted into canals; the ridges may be expanded and flattened." This would lead one to think that the Professor *might* regard this process as the homologue of the os calcis, a tarsal bone.

Professor Huxley, in his Anatomy of Vertebrated Animals, page 254, tells us, in speaking of this process, that: "Again in most birds, the posterior face of the proximal end of the middle metatarsal, and the adjacent surface of the tarsal bone, grow out a process, which is commonly, but improperly, termed "calcaneal." The inferior surface of this *hypo-tarsus* is sometimes simply flattened, sometimes traversed by grooves or canals, for the flexor tendons of the digits."

Mivart says, when referring to birds: "Thus no projection corresponding with the tuberosity of the os calcis exists in this compound bone." (Elementary Anatomy, p. 206.)

Coues, in his Osteology of *Colymbus torquatus*, leaves no doubt in our mind how he regards this projection of the tarso-metatarsus; this author says:—"The process of bone representing the *os calcis*, rises at the superior end of the bone, on its posterior aspect, as a very conspicuous crest."

Professor Morse, in his Tarsus and Carpus of Birds (Ann. Lyc. Nat. Hist., N. Y., Vol. X, 1872), speaks of the centrale, but not in connection with this process.

In the chick of *Centrocercus* I found that the *centrale did not include this process*, consequently in my Osteology of the *Tetraonidæ* (Bull. U. S. Geol. Surv., Vol. VI) I declared that this process had nothing whatever to do with the os calcis, and in the osteology of *Lanius*, termed it the *tendinous* process, from the fact that the flexor tendons in so many birds either pass over or through it. Now our young of *Cinclus mexicanus*, just before it leaves the nest, has its metatarsal bones still ununited, and crowned by a *separate* segment that has apparently ossified from one single centre, a segment that not only includes the *centrale*, but the entire process of which we have been speaking. So between *Cinclus* and *Centrocercus* we must still look for other forms to throw light upon this problem. The subject is an extremely engaging one for the ornithologist to look into and investigate.

The shaft of the tarso-metatarsus of this bird develops after the usual rule set forth in works upon the subject, and the same may be said of the phalanges.

The writer only hopes that his sketch, necessarily brief, and far from being exhaustive, will have at least the tendency to induce other ornithologists to record their observations upon this subject whenever the opportunity offers.

Our studies, as far as we have carried them, seem to point pretty conclusively to the fact that our American Dipper is quite closely related to the genus *Siurus*, and not far removed from some of the Wrens.

LIST OF BIRDS OBSERVED AT HOUSTON, HARRIS CO., TEXAS, AND IN THE COUNTIES MONTGOMERY, GALVESTON AND FORD BEND.

BY H. NEHRLING.

(*Concluded from p. 175.*)

152. **Ægialites vociferus** *Bonap.* KILLDEER PLOVER.* — Common resident throughout the year, but most abundant during the spring and fall migrations.

153. **Ægialites semipalmatus** *Bonap.* SEMIPALMATED OR RING PLOVER. — Rare and only observed during migrations.

154. **Ægialites wilsonius** *Ord.* WILSON'S PLOVER. — Common during the breeding season, but I did not succeed in finding a nest.

155. **Strepsilas interpres** *Illig.* TURNSTONE. — Seen on Galveston Bay and on the Gulf Coast.

156. **Recurvirostra americana** *Gmel.* AVOCET. — Winters, but not noticed in summer.

157. **Gallinago wilsoni** *Bonap.* WILSON'S SNIPE. — Common during migrations; arriving from the north usually in the middle of October, sometimes earlier, sometimes later. I think none remain here to breed, and all go farther south to winter. The time of arrival from their winter quarters is unknown to me.

158. **Tringa maculata** *Vieill.* JACK SNIPE; GRASS SNIPE.—Common in September and again in April. None remain to winter or to breed.

159. **Tringa minutilla** *Vieill.* LEAST SANDPIPER. — Not uncommon in winter.

160. **Actiturus bartramius** *Bonap.* BARTRAMIAN SANDPIPER; UPLAND PLOVER. — Abundant on the prairies during March and April and again in October. None remain to breed or to winter.

161. **Limosa fœda** *Ord.* MARBLED GODWIT. — Rare; seen only in March and October.

162. **Totanus semipalmatus** *Temm.* WILLET; TATTLER. — This well-known bird is also common in this region in all suitable localities. Resident throughout the year; breeds.

163. **Numenius longirostris** *Wils.* LONG-BILLED CURLEW. — Common during migrations; occasionally seen during the breeding season.

164. **Tantalus loculator** *Linn.* WOOD IBIS. — This bird is common in all marshy localities near the Gulf Coast. I have seen it frequently in the marshes and ponds near Spring Creek and the Brazos, in company with Herons and other water fowl.

165. **Platalea ajaja** *Linn.* ROSEATE SPOONBILL. — Common in the breeding season. Never seen in companies, but always singly, associated

* Of *Grallatores, Lamellirostres*, etc., I can give only a very incomplete list, as I have never had favorable opportunity to observe these birds.