

## THE CAUDAL MOLT OF CERTAIN CORACIIFORM, COLIIFORM, AND PICIFORM BIRDS.

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In the great majority of birds, the molts of which have been studied, the order in which the rectrices are shed and replaced is centrifugal, that is, the middle pair are the first to be dropped and renewed, and the molt proceeds outward, the successive feathers being affected in turn, the outermost pair being the last to be molted. In fact, so widespread is this type of molt that it has come to be regarded as the usual condition in birds. Thus, Stone (1) found that in cases,

\* \* \* where there is an appreciable difference in the time of shedding the different pairs of tail feathers, it is the general rule that the outermost pair is the last to be shed, and birds are not infrequently found with the new central pair of tail feathers half grown, while the old outermost pair is still retained. \* \* \*

In *Quiscalus* and some other birds the central pair is the last to be molted, all the others having nearly completed their growth before the old middle feathers are shed.

In the Woodpeckers the molt begins with the pair next to the middle and extends outward while the central pair is the last to be shed. \* \* \*

In this family the tail has a particular function, i. e., in climbing; hence the slow molt, as the birds would be at a great disadvantage if the whole tail was lost at once. The central pair of feathers are of particular importance, and the old ones are, therefore, retained until the new quills of the next pair have become sufficiently developed to temporarily take their place during their own renewal.

It may be gathered from the above quotation that there are some exceptions to the usual centrifugal sequence of rectricial ecdysis, and it is the object of the present paper to record further exceptions, and to suggest that with continued study more such cases will probably be discovered. Years ago Heinroth (12) recorded two types of tail molt—"centrifugal" and "alternating," and while some of his observations are inaccurate, still his paper is a valuable one and little deserves the neglect it has received.

Beebe (2) seems to have been the first to record a centripetal type of tail molt (that is, one starting with the outermost pair of rectrices and proceeding inward and ending with the middle pair, in other words, just the opposite of the centrifugal type), and, indeed, it is in his work that the two terms centripetal and centrifugal were first applied to the present subject. Beebe found that some pheasants started the caudal molt with the middle pair of rectrices, while others began with the outermost pair. Later, in another paper (3) he made a hasty survey of immediately available material and found that a woodpecker (*Celeus* species) also had a centripetal tail molt. All the true pheasants (subfamily Phasianinae containing, according to Beebe, the genera *Lophophorus*, *Chalcophasis*, *Acomus*, *Lophura*, *Diardigallus*, *Lobiophasis*, *Crossoptilon*, *Gennaues*, *Catreus*, *Pucrasia*, *Syrmaticus*, *Calophasis*, *Phasianus*, *Chrysolophus*, and *Gallus*) have a centripetal tail molt, while the *Perdicinae* (genera *Perdix*, *Coturnix*, *Caccabis*, *Francolinus*, *Pternistes*, etc.) have a centrifugal type. In the peafowl (*Pavo*) the molt begins with the second from the outermost pair and

\* \* \* there follows a regular progression inward, the outer pair being molted just before the inner ones. This sequence is invariable, both in the 10 pairs of rectrices of the cock and the 9 pairs of the peahen.

In the argus pheasants and their allies (subfamily Argusianinae containing the genera *Polyplectron*, *Chalcurus*, *Argusianus*, and *Rheinardius*) Beebe finds the molt to begin with the third from the central pair and to proceed outward and inward, the second and first pairs (inner) falling, respectively, between the fourth and the fifth and the fifth and the sixth pairs.

In his life history studies of the Panamanian toucan, *Rhamphastos brevicarinatus*, Van Tyne (4) writes that—

\* \* \* in their method of tail molt toucans are nearly unique among birds. Instead of molting the rectrices in regular order, beginning with the central pair and progressing outward, they exactly reverse this and molt the tail from the outer toward the central feathers. Beebe \* \* \* first described this and called it the "centripetal type" of tail molt. He also recorded this type \* \* \* in a tropical woodpecker (*Celeus*) and in certain pheasants.

I am not aware of its occurrence outside of these groups.

The fact that a centripetal type of tail molt had been found in a woodpecker and in a toucan suggested the thought that it might be fairly widely distributed among coraciine and picarian birds. Consequently, while studying the extensive series of species of these two and related orders collected in Africa by the late Edgar A. Mearns, I made a point of examining their molts in detail. Later I made a rather hasty survey of Neotropical and Asiatic groups not found in Africa to get a somewhat broader picture of the distribution of the centripetal tail molt.

I find that most woodpeckers molt their rectrices centrifugally, but a few, such as *Campethera nubica nubica*, *Dinopium javanensis intermedia*, and *Picus viridis viridis* appear to have a centripetal caudal molt. However, it should be noted that my observations are made wholly on skins in the museum, not on living birds, and that the cases of apparently centripetal ecdysis may well be all of the type described above by Stone and also by Heinroth (12). However, *Dendropicos fuscescens hemprichii* and *Thripias namaquus* have a regularly centrifugal molt. Stone's explanation, quoted above, has a teleological flavor that need not concern us in this connection, as this paper is meant merely to record certain facts and not to advance or criticize any hypotheses concerning them.

Van Tyne (4) does not mention whether *Rhamphastos brevicarinatus* is the only toucan examined by him, or if he studied other species as well and found them all to molt the tail feathers centripetally. I have gone over the toucans in the collection of the United States National Museum and found molting specimens of eight forms other than the one studied by Van Tyne. The tail molt is centripetal in *Rhamphastos tocard*, *Pteroglossus sanguineus*, *Pteroglossus in-scriptus*, *Selenidera spectabilis*, and *Aulacorhynchus prasinus*; it appears to be irregular in *Rhamphastos ambiguus*, and centrifugal in *Rhamphastos erythrorhynchus*. Heinroth (12) says that the molt in the Rhamphastidae is centrifugal, but does not list the species examined.

The barbets, being among the closest relatives of the toucans, were studied with unusual interest, and the following facts were ascertained: A number of species have centrifugal tail molts, but an equal number shed their rectrices centripetally, while some appear to be irregular in their sequence. The order of rectrix renewal has no systematic significance here (or in the toucans) as it has among the pheasants, for it does not remain constant even within generic limits. The following species molt their tail feathers centrifugally: *Lybius guifsobalito guifsobalito*, *Tricholaema diadematum diadematum*, and *Tricholaema lacrymosum lacrymosum*. Those with a centripetal molt are *Tricholaema melanocephalum stigmatothorax*, *Trachyphonus darnaudii böhmii*, and *Trachyphonus darnaudii usambiro*. Two species, *Trachyphonus erythrocephalus jacksoni* and *Trachyphonus margaritatus somalicus* are irregular in this respect. It may well be that more abundant material will show these to be definite in their molting sequence and that they are comparable to such cases as Pavo and the Argusianinae in the pheasants.

The colies, being one of the best marked, systematically most isolated groups of birds, present yet another character to help set them off from all other avian families in the fact that apparently all the species of the group molt their rectrices centripetally. The



material available of *Colius indicus* and *Colius castanotus* has been very slight, but of *Colius striatus* (subspecies *striatus*, *kikuyuensis*, *erlangeri*, *hilgerti*, and *jebelensis*), of *Colius macrourus* (races *macrourus* and *pulcher*), and of *Colius leucocephalus turneri*, the material has been abundantly ample to demonstrate beyond question the centripetal sequence of their tail molt.

Among the buccos and puff birds, the only species that I have found in proper condition for this study are *Bucco dysoni* and *Bucco ruficollis ruficollis*. The former appears to be irregular, the latter centrifugal in the sequence of rectrix renewal.

Only two forms of jacamars with molting tails have been examined: *Galbula chalcothorax* and *Galbalecyrhynchus purusianus*, both of which have centrifugal molts.

I have found no evidence of a centripetal type of tail molt in either the kingfishers or the parrots, but the molting material has not been extensive. Heinroth (12) reports only a centrifugal molt in the Alcedinidae, and an irregular molt in the Psittacidae.

The kakelaars (Phoeniculidae), of which three forms have been studied (*Phoeniculus purpureus niloticus*, *Phoeniculus somalicus neglectus*, and *Scoptelus aterrimus notatus*), suggest the condition reported by Stone in the woodpeckers. Their tail molt is centrifugal beginning with the next to the middle pair and proceeding outward, the middle pair being shed after the fourth pair (counting from the middle). *Scoptelus* appears to be somewhat less definite in this matter than *Phoeniculus*.

Only one bee eater (*Melittophagus revoilii*) has been available in sufficient quantity of molting specimens. Its tail molt is irregular as far as I can make it out; that is, the condition shown in one specimen contradicts that shown in another, while a third is different from either of the first two.

The hornbills are of great interest because of a sexual difference in the tail molt. The females lose all their rectrices simultaneously, while in the males the molt is a long drawn-out process. This appears to be correlated with their peculiar nesting habits. The female is imprisoned in a hole in a tree, the entrance to which is largely plastered over preventing the passage of the bird to and from the nest. While confined in this small space all the old rectrices (and the remiges too) are dropped and new ones are grown. In the males, the tail molt is usually centrifugal, definitely and very regularly so in *Lophoceros nasutus nasutus* and in *Lophoceros erythrorhynchus erythrorhynchus*; less definite, somewhat irregular, but on the whole, centrifugal in *Lophoceros deckeni*, *Lophoceros jacksoni* *Bycanistes cristatus cristatus* and *Bucorvus abyssinicus*, where it starts with the middle pair of rectrices and then becomes somewhat

irregular in its progression toward the outermost pair; while in *Lophoceros melanoleucus geloensis* the molt begins simultaneously with the middle and the outermost pair.

Wetmore (5) has noted the peculiar condition found in the tail of the Malayan giant hornbill, *Rhinoplax vigil*, in which but one feather of the central pair is developed at one time.

\* \* \* and this spike, much longer than the other rectrices, on reaching maturity, remains in position for more than a year, probably for two. Its companion, beginning its growth after the other has gained its extreme length, then equals it in size. The first feather is then molted and is gradually replaced by another, so that in the renewal of this central pair there is a continual alternation instead of the usual method by which these feathers are renewed synchronously on the right and left sides.

The facts presented in this paper form only a beginning of what might quite easily be discovered by a careful examination of the countless specimens of birds preserved in the museums of the world. Molt is an important subject in the biology of birds and it is to be hoped that more investigators will pay attention to it, either directly, or in the course of other studies. Dwight's work (6) on the molts of passerine birds, and (7) of gulls should be extended to cover all the various groups of birds of the world. Of fairly recent authors only a few have taken much pains with the subject, but those few writers, such as Stressemann (8) on *Eos*, *Merops*, *Aplornis*, *Graucalus*, and other birds of Ceram, and of Bali (11), and of Laubmann (9, 10) on kingfishers, have found enough points of interest to stimulate further researches.

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