ON THE NUMBER OF PRIMARIES IN BIRDS.

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Little attention has been paid to the number of primaries in the different species of birds save in the *Oscines*, where the number has been supposed to vary from nine to ten. In 1840 Nitzsch, in his great work on the feather tracts of birds, showed that nearly all birds, except the nine-primaried species, had ten primaries. However, he showed that the Storks, Flamingoes, some species of *Colymbus*, *Alca torda*, and some species of *Uria* had eleven primaries. Later Sundevall* showed that the wing feathers are, like those of the rest of the body, in quincunx order. In treating of the primaries, he says that they vary from nine to eleven, the only cases of the last number being found in *Podiceps*, *Phœnicopterus*, *Anastomus*, *Tantalus*, *Ciconia*, *Musophaga*, and *Corythaix*. The first primary, when present, is inserted on the third phalanx of the II finger, at least in *Podiceps*, the second primary on the second phalanx, the third and fourth on the first phalanx, and the rest on the metacarpal. Sundevall also states that there are as many coverts as primaries.

Until the publication of Baird's "Review of American Birds," it was supposed that Passerine birds varied in the number of their primaries, some families, as the Thrushes, having ten primaries, others, as the Tanagers, and Finches, having nine, and in one group, the Vireos, some species were thought to have nine, others ten primaries. In the work above referred to Professor Baird showed that in nine-primaried *Oscines* there were two "little feathers" placed at the end of the wing, which he considers, judging from position and color, to be the first primary and covert. In ten-primaried birds there is but one little feather, which Professor Baird called a covert.

In 1876, Dr. Coues† repeated the observations of Professor Baird in all the North American families of *Oscines*. He found that, with the possible exception of *Collurio* and *Ampelis*,‡ all

* Kong. Vetenskaps Academien Handlingar, 1843, übersetzt im Cabanis's Journ. für Orn., III. Jahr. (1855), pp. 118–168.

† Bull. Nutt. Ornith. Club, I, No. 3, Sept., 1876, pp. 60–63.

‡ *Ampelis* has two little feathers.

the ten-primaried families have but one "little feather" while the nine-primaried birds have two. Dr. Coues comes to the conclusion that the second little feather is the homologue of the first primary in ten-primaried birds. Next he passes on to the first "little feather" and considers the pros and cons of this being a primary also, but does not commit himself. He states that size and shape point to its being a primary; that color, principally relied on by Prof. Baird, points both ways; and "that if the feathers be not a covert, then the first fully developed primary has none, while the rest have one apiece."

In 1878, Mr. Batchelder* showed that the second "little feather" is sometimes developed into a spurious quill, thus confirming the supposition of Professor Baird. About the same time Dr. Coues† again returned to the subject, only this time he implies that both the "little feathers" are primaries. He states that size, shape, and position are in favor of the first "little feather" being a primary, while "coloration is against such hypothesis," though it sometimes points the other way, as in *Sitta carolinensis*. He entirely omits his argument about the first primary having no covert, though he refers the readers to his paper in the Bulletin.

Before going farther it is necessary to study the feathers on the wing in regard to position, structure, color, and shape. The feathers of the wing are naturally divided into four or more sets. These are (1) the remiges with their coverts above and below; (2) the contour feathers of the upper surface; (3) the contour feathers of the lower surface; (4) the contour feathers of the anterior edge, and the feathers of the false wing. The remiges are developed along the posterior, or radial, edge of the fore-arm and hand. Each remex has two coverts, one above and one below — the upper covert more distal in position than the remex it belongs to — which serve to a greater or less degree in flight. The coverts are arranged in quincunx order in relation to the remiges, and morphologically are only the contour feathers next to the remiges. However, they show such constant relations to the remiges that they are naturally classed with them. The remaining feathers of the upper and lower surfaces are contour

* Bull. Nutt. Ornith Club, III, No. 2, Apr., 1878, pp. 97–98.

† Birds of the Colorado Valley, Pt. I, pp. 486–487, foot note.

feathers more or less modified. Here it is only necessary to note that since all feathers are in quincunx order, they bear definite relations to each other.

The feathers of the anterior edge run in two or more rows along the fore-arm and hand, certain ones being modified to form the spurious wing. Since these are continued to the very tip of the index finger they often fall into rank with the primaries and coverts of the opposite aspect, and hence can not be distinguished by their geometrical relations from the primaries and coverts. They can be distinguished from primaries, however small, by their relations to the finger bones. The primaries are always on the so-called flexor face, the feathers of the anterior surface are on the opposite face. As a rule these two surfaces are separated by the tip of the index finger, which, generally, projects, and in young Ducks bears a claw.

There is no positive distinction between any of the feathers as regards structure and shape. The feathers of the upper and lower surfaces gradually shade into the primaries. Professor Baird has endeavored to distinguish the primaries from the coverts by their colors. But Dr. Coues has shown that the difference in color, when present, does not always separate the coverts from the primaries, and that in many species there is no difference in color. So we are forced to the conclusion that the only reliable means of determining a primary or other feather is by its position. Allowing that position is the true key to the homology of the wing feathers, it is evident that in all attempts to determine the number of primaries in birds we should begin with the most simple condition of the feather; in short, we should study the embryo and fledgeling. The study of these also has the advantage that they are much less specialized than the adult.

I shall now take up several of the groups of birds represented in North America in relation to the number of their primaries, considering the young whenever they have been procurable.

Oscines. In a young nine-primaried bird, as *Melospiza melodia*, nine nearly equal conical papillæ will be seen on the posterior edge of the hand, and besides these a much smaller one on the extreme tip of the wing. These are the papillæ of the nine developed and the rudimentary primary. Immediately above these on the dorsal surface are nine small points projecting from the skin between the bases of the primaries; these are the papillæ of

the primary coverts, and above these yet another row. Besides these there is a double row of feathers running down the anterior edge of the wing to the tip, distinguished from the rest by their smaller size and position on the opposite side of the finger bones. The thumb also has a special set of papillæ, which develop into the spurious wing feathers. Passing to the fore-arm we first come to the secondaries, in this case nine in number. Above these we find another row of papillæ, the secondary coverts, placed between the bases of the secondaries. These papillæ are not nine in number, but eleven, the first one being placed above the tenth primary and the eleventh behind, or proximal to the last secondary. This first secondary covert later grows into close relations with the last primary and has been mistaken for a primary covert. From this arise the statements that there are as many primary coverts as primaries. That this feather is really not a primary covert is apparent in very young birds. Above the secondary coverts there is yet a third row of eight. Besides these, if we look carefully, we find two or more little papillæ placed between the tenth primary and first secondary and the first and second secondaries. When the wing feathers have broken out of their sheaths many more little feathers are developed along the edge of the fore-arm. These little feathers can, for the most, be referred to two rows, one between and alternating with the secondaries and the other between the secondaries and their coverts. Besides these, other little feathers appear at the carpal region, between the primaries and secondaries; these I cannot correllate, though they are quite constant both in position and number.

If we now take a young Sparrow in its first plumage and count forwards and backwards from the carpal joint we find exactly the same number of feathers as papillæ in the nestling. Only the second "little feather" must be counted as the first primary and the first little feather as the covert, not of the first primary but of the second. The first has no covert. In the wing of a young Song Sparrow (*Melospiza melodia*) now before me the "second little feather" is clearly in line with the other primaries and the first little feather, larger than the second is placed above and between the second little feather and first primary of systematic writers: that is to say, between the first and second primaries. In the adult Song Sparrow we find exactly the same conditions save that the two

little feathers lie one over the other and, owing to their small size, apparently on the shaft of the first developed primary. The same condition is found in the young of *Goniaphea ludoviciana*, and *Sialia sialis*. *Passer domestica* differs in that the first primary is in due proportion to the first covert.

This proves that the "first little feather" is nothing but the covert to the first developed primary and that the "second little feather" is an undeveloped primary.

There is no room for doubt about the homologies of the papillæ, and the feathers are nothing but parts of the papillæ. The second and subsequent sets of feathers are developed from buds of the original papillæ, much after the manner of teeth, and hence are equally determinate with the original papillæ from which they spring.

If we examine a ten-primaried Oscinine bird we find the same condition of things as in the nine-primaried, except that the first primary papilla is of good size. Of this condition of things the fledglings of *Troglodytes aëdon* and *Mimus carolinensis* are good examples. So the formula for a nine-primaried and a ten-primaried Oscinine bird is the same. The number of feathers can be represented as follows, "ab." standing for aborted, and a minus sign indicating a feather belonging to a series of the fore-arm beyond the carpus:

Melospiza melodia: Pr., 1 ab., 2—10; pr. c., 2—10, 3rd row, 7. Sec., 9, sec. c., — 1, 2 — 11, 3rd row, 8.

Mimus carolinensis: Pr. 1 — 10, pr. c., 2 — 10, 3rd row, 7. Sec., 9, sec. c., — 1, 2 — 11, 3rd row, 1 — 6. 7 — 8 small.

To this rule *Corvus americanus* forms an exception, since it seems to have ten primary coverts.

Passing to the *Clamatores*, the King Bird (*Tyrannus carolinensis*), will be taken as an example. Here the fore-arm remains nearly the same, even in respect to the auxilliary feathers, but in the hand we find a first covert beyond the first primary and another corresponding feather added to the third row. So the formula for *Tyrannus carolinensis* is: Pr., 10, pr. c., 10, 3rd row, 8; sec., 9, sec. c., 10 — 1, 3rd row, 9.

In the fledgling of *Chætura pelasgica* we find the following formula: Pr., 10, pr., c. 10, 3rd row, 8, sec., 9. sec. c., 10 — 1, 3rd row 7. Besides these there are several more rows.

In the adult *Trochilus colubris* there are ten primaries and

ten coverts. The same number is found in the young, though the first covert is very small.

Anisodactylæ. I have not been able to examine any young of this group, which it is especially desirable to do, since in the Kingfishers the adult has ten primaries, ten coverts, and a "little feather," which may be another primary. This at least is the case in *Ceryle alcyon* and in species of *Dacelo*.

Pici. In *Picoides arcticus* the young gives the following formula: Pr., 10, pr. c., 9, 3rd row, 6. In the nestlings of this species and of *Colaptes auratus*, the only young Woodpeckers I have seen, the last three or four primaries are very small and seem not to become fully grown till after the moult. This may be an adaptation to the home of the young bird, since it enables the wing to fold up close with less pressure on the growing feathers than would be the case if they were all fully developed.

Accipitres. Among the Hawks, I have examined the young of *Buteo pennsylvanicus* and found, to my surprise, eleven primaries, ten coverts, and a terminal claw. That it was a true claw there can be no doubt, its resemblance to the undoubted claw of the I finger or thumb being complete. The presence of the claw is here of interest, as it points to the existence of a third phalanx, a thing not accredited to the Hawks and not ossified in my skeleton of the Sharp-shinned Hawk (*Accipiter fuscus*). I limit my remarks to this specimen, since, judging from the almost universal absence of the ungual phalanx of the thumb, no reliance can be placed on museum specimens. In adult *Buteones* there is a small feather in the proper position for the first primary, but structurally it is only a contour feather. This may be developed from the first primary papilla or the papilla may abort; it is difficult to say which.

Of the remaining groups of birds my observations have been even more sparse than in the foregoing. For convenience I will next consider the Ducks, taking a domestic Duck in illustration. In this case, as is true of all the lower birds, down tufts are developed from the papillæ of the primaries, thus making a strong contrast to the young birds previously described, where the papillæ assume the structure of pin-feathers before they burst. So instead of simply counting the papillæ we must separate out the little tufts and count their number. If this is done in the case of a young Duck eleven primary tufts and ten smaller covert

tufts can be seen. But this is not all; at the extreme tip of the finger can be seen a well developed claw. Passing now to the adult wild Dusky Duck (*Anas obscura*) we find ten developed primaries, nine well developed coverts and two "little feathers," which, by the way, are good sized. These two little feathers are in precisely the same relative positions as in *Melospiza* and represent the aborted first primary and first covert. A year ago I made an examination of the last phalanx of the second finger for a claw but only found a slight trace of it in one case out of about twenty, so that we may fairly class the claw as an organ now functionless and accordingly disappearing. The same condition of the wing holds good for all the Ducks examined by me. They were the following: *Œdemia perspicillata*, *Anas obscura*, *Aix sponsa*, *Querquedula carolinensis*, *Bucephala islandica*.

Among the *Limicolæ* I have examined the young of *Vanellus cristatus* and of the Woodcock (*Philohela minor*). In the young of the Spur-wing there are distinctly eleven primaries and ten coverts. In the young, however, I have been unable to find more than ten among adult birds of this group. I have examined the following and found all but the last to have "little feathers": *Charadrius fulvus*, *Strepsilas interpres*, *Ægialites semipalmatus*, *Ereunetes semipalmatus*, *Totanus melanoleucus*, *Totanus flavipes*, *Tringoides macularius* (young), *Philohela minor*.

Of Sea-fowl I have been able, through the kindness of Mr. J. A. Allen, to examine the young of a Gull, an Auk and a Petrel. In the first case I found eleven primaries and ten coverts; in the second, the same numbers and a terminal claw; in the third case, only ten primaries and ten coverts.

Mr. Allen also gave me for examination two young of the South African Ostrich. Here the primaries and secondaries run in a straight line from the elbow to the tip of the II finger and have no connection with the little III finger. Hence it is difficult to say how many spring from the hand and how many from the arm, certainly seventeen and perhaps eighteen, there being about thirty-two in all. Whether we call these primaries depends on our ideas of phylogenetic relations of the *Struthiones*. If these are degredational forms from flying birds then we must call them the representatives of primaries; if, on the other hand, the Ostriches never flew they ought, I suppose, to be considered as simple contour feathers.

If we summarize the above facts we find that the number of primaries of which signs can be found varies from ten to eleven in Carinate birds, while many more exist in the Ratitate birds, while the functional primaries vary from nine to eleven in number. In regard to the primary coverts, there are for the most part one less than the number of primaries, varying from nine to ten in number. All the above conditions can be classed in four groups, the first group containing the nine primaried birds, all of which belong to the *Oscines*. In this group the first primary and the first covert are rudimentary. The second group, containing all birds with ten developed primaries and nine coverts, includes the rest of the *Oscines*, and *Pici*, and I presume most of the other Passerine groups.

The third group, all those with ten primaries and ten coverts, includes the *Cypseli*, *Trochili*, *Ardeidæ*, *Turbinares*, and probably others, the young of which I have not been able to examine.

The last group, containing those birds with eleven primaries, includes the *Alcedinidæ*, *Falconidæ*, *Plotidæ*, *Ciconiidæ*, *Phœnicopteridæ*, *Anatidæ*, *Charadriidæ*, *Scolopacidæ*, *Paridæ*, *Colymbidæ*, *Aicidæ*, and probably most of the other lower birds.

Thus we see that the number of primaries does not hold constant for the larger groups of birds, but that the higher birds of the various groups show a tendency towards a reduction in the number of primaries. So the reduced number of primaries and coverts would seem to point to high development, but not to be of use in dividing the major groups.

The rule according to which the primaries and coverts abort is interesting and of importance, since it makes it possible to decide whether a "little feather" be a primary or a covert. The law is simply that the most distal one aborts first, hence a covert before its primary. Hence when one "little feather" is found we can tell if it be a covert, as in the *Tyrannidæ*, or a primary, as in the Kingfishers, by seeing what the next developed feather is,—in the first case a primary, in the last a covert. When there are two little feathers one is a primary and the other a covert, the covert being uppermost.

The definiteness in the wing formula of birds closely related is very great, the formula for one answering perfectly for the rest. So the plan ought to be a help in determining the position of doubtful birds.