

THE SEQUENCE OF PLUMAGES OF THE ROOK.

WITH SPECIAL REFERENCE TO THE  
MOULT OF THE "FACE."

BY

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(PLATES 4-11.)

INTRODUCTORY.

It has always been a disputed point as to whether the Rook (*Corvus f. frugitegus*) gets its bare "face" by means of abrasion of the feathers or by a moult. Most ornithologists have favoured the moult theory or have regarded it as a "natural peculiarity." This conclusion has been reached, however, by inference rather than by actual experiment. A few somewhat trivial experiments have been made with captive birds, but no proper investigation of the subject has hitherto been undertaken so far as I am aware.

Waterton (*Essays on Natural History*, First Series, 1838) appears to have thought that he had solved the problem when the feathers on the face of a young Rook, kept in a cage by a keeper, began to fall out in the middle of August. Unfortunately the bird met with a fatal accident at the end of August, so that although Waterton had good reason for saying "that the feathers fall off from the root of the Rook's bill, by the order of nature," he did not realize that had the bird lived a little longer new feathers would have grown "by the order of nature," and that the bird would have had a fully-feathered face as part of its first winter-plumage.

Knox (*Zoologist*, 1844, pp. 628-33) made a closer investigation, but for want of sufficient care he also came to wrong conclusions. He kept young Rooks in captivity and found that they moulted normally and attained feathered faces in their first winter-plumage. In the spring one of them began to lose its nostril-bridles, but Knox concluded that this was on account of friction

from the bars of the cage, and the bird soon after died. The only one which survived lost none of the feathers on the face, and even after its second winter-moult the face was fully feathered! It is well known that birds in captivity often moult most irregularly, and this is a good instance of the danger of drawing conclusions regarding moult and sequences of plumage from captive birds. Knox, however, continued his investigations by observing wild birds, and found that a small portion of the nostril-bristles was lost in the winter or early spring, but that the plumage of the throat was still nearly perfect. He goes on to say that the rest of the feathers do not disappear until the bird has paired and "the calls of a hungry family urge it to dig from morning till night . . . and induce it to convert the dilatable skin of the throat into a convenient hunting-pouch, the naked scabrous appearance of which can be no mystery to any one who has narrowly observed the habits of the bird at this season of the year." Although he was quite correct in concluding that the "face" becomes bare (though the chin is the first and the nostrils are the last) when the bird is about a year old, the reason he gives for this is mere supposition and he produces no evidence to prove the point.

Blackwall (*Researches in Zoology*, 1873) also kept young Rooks in captivity, but his bird (for only one survived) evidently moulted quite abnormally and did not get a bare face until its second autumn-moult.

Other writers, so far as I have read, have either quoted the above-mentioned experiments, or have theorized on the question, or have ignored it altogether.

With a view to settling the point, I have during the last two years or more made a close investigation of the subject, which has proved full of interest. The material which I have worked upon has consisted entirely of wild birds, and these have been obtained in every month and in nearly every week of the year. For this material I am chiefly indebted to Her Grace the Duchess of

Bedford, who has allowed her keeper, Mr. John Clark, to send me specimens from Bedfordshire; and to Mr. Hugh S. Gladstone, who has similarly permitted his keeper, Mr. Charles Hyslop, to send me Rooks from Dumfriesshire. These two keepers have very kindly supplied specimens of all ages with great regularity, and without such a complete and large series it would have been quite impossible to have solved this somewhat intricate problem. I am also indebted to Mr. Abel Chapman for some specimens sent from time to time. My grateful thanks are also due to Miss A. C. Jackson, who has not only provided me with a number of useful skins and notes, but has most kindly mounted many feathers for microscopical examination.

I have examined eighty-three specimens in the flesh and have kept very careful notes of the condition of the plumage and sexual organs, and have either preserved the whole skin or the head and wing.

#### PART I.—THE MOULT OF THE “FACE.”

The full sequence of the plumages of the Rook will be given below (see part II.), but I will first describe the process by which the “face” becomes bare.

As is well known, the Rook in its juvenile-plumage has the “face” normally feathered like that of a Carrion-Crow (*Corvus corone*)—that is to say, the nostril-region extending to the base of the skull is covered with bristle-like feathers; similar, but smaller bristles, as well as small contour feathers, grow on the sides of the lower mandibles at their bases, and on the lores, while small feathers are found on the region under the eyes, and feathers clothe the chin and upper-throat—all of which parts become bare in the adult. A closer examination reveals the fact that a number of minute filoplumes or hair-like feathers grow amongst the nostril-bristles, and that larger filoplumes as well as many plumules, or down-like feathers, are concealed amongst the contour feathers of the chin and throat.

In the moult from juvenile- to first winter-plumage, which takes place in July and August, the head moults last, and all the feathers in the regions which afterwards become bare are renewed in a normal manner. The old feathers are cast very rapidly, so that almost all the new feathers in these regions are in sheath together (Plate 4, Fig. 2) and are afforded practically no protection by the old feathers. If damage were done at any time to the feathers by the bird digging in the ground with its bill, as has often been suggested, surely it would be at this stage, when the feathers are just breaking from the sheath, that they would be most prone to injury. Yet when full grown the new feathers are perfect and show no sign whatever of abrasion.

I have examined microscopically feathers taken from the chin twenty-two millimetres from the angle of the lower mandibles\* of Rooks in juvenile- and first winter-plumage and can find no essential difference in their structure, though the juvenile-feathers are of a looser texture, their rami and radii being further apart than in the first winter-feathers (Plate 6). But the feathers of this region of the chin and throat which afterwards becomes bare, are even in the first winter of a somewhat degenerate character: the rhachis projects beyond the rest of the feather and is almost bare at its distal end; the distal rami are the same: the rami are far apart, and the radii are also far apart and comparatively long and straggly, not interlocked. The peculiar structure of these feathers, which is markedly different from that of feathers lower down on the throat (Plate 7), may have some significance in relation to the bare patch, but it must be remarked that all other members of the Corvidæ which I have examined have feathers of similar structure in this region, even in adult-plumage. Another circumstance which may be significant is that some of the feathers on the chin, generally those nearest the angle of the lower mandibles,

\* This being the centre of the region which afterwards becomes bare.

are very frequently white, especially in juvenile but also in first-winter birds.

The Rook remains with its "face" fully feathered until January, and in some individuals until a month or two later. A very gradual moult then commences on the chin, the feathers dropping out generally first in the centre of the part which afterwards becomes bare (Plate 4, Figs. 4-7). The feather papillæ become active and produce "pins," most of which, after growing a millimetre or two (occasionally as much as four or five and exceptionally more) above the skin, then stop growing and remain as "pins" with their tips slightly curled over and shaped like a rounded cone, and without any trace of feather-growth coming from them.\* From some of the pins, however, very short degenerate feathers grow. These are in structure almost exactly like plumules, except that they are rather larger. To the naked eye they are down-like: under the microscope they are seen to have a very thin, fine rachis and long, straggling, fine rami and radii, and are quite unlike the feathers they replace (Plates 8-9). They are dark grey in colour, only some four or five millimetres long, and sometimes show a very slight gloss. Occasionally one finds growing among these "pins" and degenerate feathers, a new feather of normal structure which has somehow escaped the degeneracy of the others.

It is a remarkable fact that most of the filoplumes and plumules remain and are not shed with the other feathers. A plumule arises from a papilla situated alongside that of a contour (or true) feather, but the two are quite independent, for I have frequently found among the body-feathers during the moult a newly-

\* These "pins" when examined under a microscope appear to consist of a series of semi-transparent inverted cups fitting one over the other, and I can detect no trace of feather-growth within them. In Plate 10, Fig. 26, one of these "pins" is figured but unfortunately the preparation was not sufficiently transparent to show the inverted cups.

growing contour feather with the plumule alongside it, old and unshed; yet the two are so close as to seem joined together, like the two barrels of a gun.

The skin of the chin is at first pink and soft, but soon gets hard and whitish after most of the contour feathers have moulted. The newly-grown, soft, degenerate contour feathers and the old plumules and filoplumes gradually wear down, but worn remnants of them are always to be seen with a glass until the autumn-moult.

By the time the chin is half-moulted, the small feathers and bristles on the bases of the lower mandibles begin to fall out (Plate 5, Fig. 14), and the moult creeps up to the region under the eyes and the lores, and lastly the bristles on the fore-head and at the base of the nostrils are lost (Plate 5, Fig. 15). In all these regions the proximal feathers fall first, and the last to be left are the bristles nearest to the nostrils and in the distal portion of the lores, and occasionally a few bristles remain here until the following moult. Some of the papillæ of these regions remain dormant and a distinct cavity is left where a feather has fallen out, but most produce "pins," which however grow only a millimetre or two above the skin and, unlike those on the chin, never appear to produce feathers, but remain as small rounded knobs.

The time at which this moult takes place no doubt varies individually, but it seems a lengthy process, and even at the beginning of June it is not complete in some birds, although by this time some primaries have dropped and the second autumn-moult has then commenced.

NOTE.—I have carefully examined the generative organs of all the specimens in first summer-plumage (i.e. one year or a little more old) and have not found any in a breeding condition. In the females the ova were always massed and scarcely visible separately, and the oviducts were invariably thin and straight throughout. The testes of the males were larger than in winter, those of first-winter birds measuring four or five millimetres and the largest of the first-summer birds (March and April) ten millimetres in length; but the testes of adults in April measured from seventeen to twenty-one millimetres. One female had a small incubating-patch, although the condition

of its oviduct proved that it had never laid eggs. In Volume IV., p. 370, Mr. E. Dunlop mentioned that he had once seen a Rook that was undoubtedly breeding which had the face only partially bare of feathers, and there is other evidence that such birds are sometimes present in Rookeries in the breeding-season. It seems just possible that such birds may act as "nurses," and I think the point would be well worthy of investigation, but it would be necessary after watching such birds at the nest, to secure them and examine their sexual organs.

At the moult into second winter-plumage, and at every subsequent autumn-moult when the bird is adult, the bare space on the chin and upper-throat becomes thickly covered with dark blackish-grey down (Plate 4, Fig. 9). This consists of the new plumules and filoplumes, which moult annually, and a varying number of degenerate plumule-like feathers growing from the true contour-feather papillæ, but many (probably the majority) of the first-summer "pins" remain and are not moulted. The degenerate feathers are exactly similar in structure (Plate 9) to those which grow here and there at the first summer-moult, but they are rather larger (about six to eight millimetres in length) and more numerous. Their rami and radii, being loose and comparatively long, spread in all directions and hide the "pins," so that the whole chin appears to be well covered.

Only a few minute degenerate bristles grow here and there on the nostril-region, fore-head, and on the sides of the lower mandibles, and these are scarcely noticeable without a glass. The papillæ of these regions appear to remain almost inactive at the moult, most of them showing no sign whatever of feather-growth. The "pins" which grew in the moult to first summer remain, and have become rounded and compacted. A varying number of filoplumes, however, grow in these regions, some specimens having many and others scarcely any.

Unlike the birds in their first year, there is now no further moult until the following autumn. The down on the chin and throat does not fall out, but becomes gradually worn down by abrasion (Plate 4, Figs.

10-13). An examination with a glass of the chins of a series of birds from August to January, shows the gradual effect of this wearing process very clearly. By January (and in some individuals in December) the chin and upper-throat look quite bare at a little distance, but a close examination shows that there are many remains of degenerate feathers and plumules and longish filoplumes, and these remains, getting smaller and smaller as the summer goes on, are still to be seen with a glass up to the autumn-moult. An examination under a microscope of a series of these feathers, taken from birds shot at intervals, shows that they are worn down gradually all round rather than broken off short (Plate 10, Fig. 25). They are of such a delicate nature that I am inclined to think this shows that they cannot often be subjected to violent friction, and that when the Rook digs it does not usually allow its chin and throat to touch the ground. Indeed, it would be hardly possible for it to thrust its head so far into the ground as to touch the lower part of the bare patch on the throat, while the portion of the chin which lies within the angle of the mandibles would be protected to a certain extent by the projecting ridges of the mandibles. When we consider the abrasion which goes on in a normal contour feather, the action of wind and weather alone, it seems to me, is quite sufficient to account for the wearing away of this delicate "down." A line of "down" just alongside and parallel to each lower mandible (Plate 4, Fig. 12), remains unworn longest, but this is not because the projection of the mandible protects it from friction by "digging," but because this part of the skin folds inwards when the "pouch" is empty, and the "down" along this "crease" is thus not exposed.

I much regret that owing to a want of knowledge of the process of feather-development, I have been unable to investigate the cause of the debility of the feather-papillæ. I hope that someone who has studied

feather-development will take up this question and I shall be most happy to lend what material I have to help in its elucidation.

A comparison between our Rook (*Corvus frugilegus frugilegus*) and the Eastern Rook (*Corvus frugilegus pastinator*) is interesting, because it shows, I think, that our Rook has proceeded further in its evolution than the Eastern form. This bird, which inhabits Eastern Siberia, China, and Japan, is very similar to ours in first winter-plumage, but the adult has only the nostril-region and a very small patch on the sides of the lower mandibles bare, the chin, throat, and lores being feathered (Plate 5, Fig. 16). In two specimens, however, I found a very narrow line of bare skin down the centre of the chin from the angle of the mandibles, and in this bare skin were "pins" like those on the chin of our Rook. Two other specimens had some "pins" on the chin which were concealed by the feathers. These facts, taken in conjunction with the fact that there is a considerable growth of degenerate feathers at every moult on the chin of our Rook and scarcely any on the nostril-region, show, I think, that the bare chin is of comparatively recent development. It should also be noted that in *Corvus f. pastinator* the feathers on the chin and upper-throat in first winter-plumage have the rhachis much elongated, as is the case in our bird. In the adult, however, though the feathers on the upper-throat are exactly like those in first winter-plumage, the feathers of the chin within the angle of the lower mandibles have the rhachis much less elongated and sometimes not at all. Moreover, these feathers in the adult, instead of sloping in a normal manner away from the point of the bill, stand up at right angles to the skin, and thus give the chin a "furry" appearance (Plate 5, Fig. 16).

## PART II.—THE SEQUENCE OF PLUMAGES.

*Male and Female.*

*Down-plumage.*—Dusky grey; skin of body black.  
*Distribution*—Humeral, spinal, ulnar and femoral (*vide* A. G. Leigh, Vol. IV., p. 73).

*Juvenile-plumage.*—Acquired while in the nest, the down-plumage being completely moulted.

*Nasal bristles* black, slightly glossy; *fore-head, crown* and *nape* black with a slight greenish gloss; *hind-neck* dull sooty-black; *mantle* and *scapulars* sooty-black with a slight purple gloss; *back, rump,* and *upper tail-coverts* sooty-black with a slight greenish gloss; *ear-coverts* and *cheeks* black, with a slight greenish gloss; whole of the *under-parts* sooty-black with a very slight greenish gloss; *tail* black underneath, greenish-purple above; *under wing-coverts* and *axillaries* brownish-black with a purplish gloss; *primaries* underneath brownish-black, above black with a purplish-green gloss especially on the outer webs and on the tips; *secondaries* underneath brownish-black, above outer webs purple, inner webs brownish-black with a faint purplish-green gloss, which is most marked on the two innermost feathers; *bastard-wing* and *primary-coverts* like the primaries but with more gloss on the outer webs; *greater coverts* like the secondaries; *median* and *lesser coverts* purple.

N.B.—All the body-feathers including those on the chin and the nasal bristles are of a much looser texture than in first winter. The feathers of the chin and upper-throat down to about fifty millimetres from the angle of the lower mandible have their shafts elongated and thickened at the tip, this portion being without rami, and the rami near the distal ends of the feathers are similar in structure and bear no radii at their tips. These feathers are also looser in general structure than those lower down on the throat, the radii being wide apart and not closely held together. The feathers of the chin, and especially those nearest the angle of the bill, are frequently white. The bases of the body-feathers and the underdown are brown-grey.

*First Winter-plumage.*—Acquired by a complete moult, with the exception of the remiges, bastard-wing, primary-coverts, majority of greater coverts (the two innermost only are moulted), and rectrices. The moult commences on the back and flanks, and the whole body and wing-coverts are soon involved, the head being the last to moult.

*Nasal bristles* glossy black; *fore-head, crown,* and *nape* glossy purplish-green; *hind-neck, mantle, scapulars, back, rump,* and *upper tail-coverts* glossy purple; *ear-coverts, cheeks, chin,* and *upper-throat* glossy purplish-green (the chin and especially its upper-part has very little gloss); *lower-throat, sides of neck, breast, belly, flanks* and *under*

*tail-coverts* glossy purple; *vent* sooty-black; *tibial-feathers* glossy purplish-green; *tail* as in the juvenile but of a more brownish-black underneath and with some of the gloss above lost by abrasion; *under wing-coverts* and *axillaries* sooty-black with some purplish gloss; *primaries* and *secondaries* as in the juvenile, but of a more brownish-black underneath and with some of the gloss above lost by abrasion; *bastard-wing*, *primary-coverts*, and *greater coverts* as in the juvenile, but with some of the gloss lost by abrasion, except in the two innermost *greater coverts* which are new; *median* and *lesser wing-coverts* glossy purple.

N.B.—The bases of the body-feathers and the under-down are of a paler brownish-grey than in the juvenile, i.e. not so brown, more grey. The structure of all the body-feathers is closer and more compact.

*First Summer-plumage.*—Acquired by abrasion and fading, except for the nasal and gape bristles and the feathers at the bases of the lower mandibles and on the lores, chin and upper-throat, which are moulted as described in Part I.

Even by January the *greater wing-coverts*, *secondaries*, and tips of the *primaries* are becoming brown and losing their gloss, while by April and May they are very brown with little or no gloss, and the *under-wing* is also brown. The tail also loses its gloss but does not get so brown as the wings.

The Rook does not breed in its first summer.

*Second Winter-plumage.*—Acquired by a complete moult, which commences early in May and is not complete until the middle of September. The order of the moult is as follows: *Primaries*, beginning at the tenth and proceeding very gradually to the first, each *primary-covert* being moulted with its *primary*.\* It is not until the middle of June that the moult extends beyond the *primaries* and *primary-coverts*, and by this time only half the *primaries* have moulted; the *greater wing-coverts* then moult, and unlike the *primary-coverts* these all drop together (Plate 11); about the same time the upper *tail-coverts* begin, the *secondaries* and *tail* follow, and

\* The same *primary* in each wing is moulted at the same time, and the new feather has always started growing before the next *primary* falls.

then the rump, back, flanks, breast and neck, and lastly the head, by which time the first primary, which is the last to moult, is growing and the bastard-wing is moulting. The moult of the primaries thus extends over some four or five months. The tail-feathers moult from the centre outwards on each side, while the order of the moult in the secondaries, though not invariably regular, is almost always in three groups, the first moulting first and being followed by the second, third, fourth, and fifth; the seventh is moulted before the sixth; and the eighth, ninth, and tenth are moulted in the order named at the same time as the first group is being moulted.

Like that of the first winter, but with the *nasal region, fore-head, lores, under the eyes and sides of the lower mandible* at its base practically bare of feathers, the skin being whitish and covered with short rounded "pins" or "knobs"; *chin* and *upper-throat* covered with mouse-brown "down"; *tail* like that of first winter but more glossed with greenish-purple; *primaries* and *secondaries* underneath deep black not brownish-black as in first winter: above, the *primaries* with a purplish-green gloss on the outer webs and a considerable amount on the inner webs, *secondaries* with a rich purple gloss on the outer webs and a greenish gloss on the inner webs; *primary-coverts* glossed with purplish-green; *greater-coverts* glossed with purple on the outer webs and purplish green on the inner; rest of the plumage like that of first winter.

*Second Summer-plumage.*—Acquired by abrasion only, there being no moult at all. The down on the chin is gradually worn away during the winter until by January (and in some individuals before) this region is practically bare except for the aborted "pins" and small pieces of "down" here and there and remains of filoplumes. From May until the following moult, the "down" and filoplumes are so worn down that their remains can scarcely be seen without the aid of a glass. The filoplumes and a few degenerate bristles in the nostril region also become gradually worn down.

The rest of the plumage becomes duller and browner, some of the gloss being lost by abrasion, especially on the wings and tail, but these never become so brown as in first summer.

*Adult Winter- and Summer-plumages.*—Acquired in exactly the same way and at the same times as the second-winter and second-summer plumages, and are indistinguishable from them.

N.B.—I can detect no difference in the plumage of males and females, but all the measurements of the males are larger, including the bare patches of the face. Thus—

	ADULT MALES.			ADULT FEMALES.		
	No.	Min. & Max.	Average.	No.	Min. & Max.	Average.
Wing ... ..	12	305-330	315.4	10	290-311	301.9
Bill, from nostril to tip ...	12	35-40	37.4	10	31-38	34.7
*From nostril to end of bare skin on fore-head	24	14-22	17.25	25	12-20	15.4
*From nostril to end of bare skin on sides of face, i.e. under or just behind the eye.	22	29-37	32.3	23	28-34	30.0
*From angle of lower mandible to end of bare skin on throat	21	37-66	50.9	21	35-55	45.1

\* These measurements were taken in the flesh.

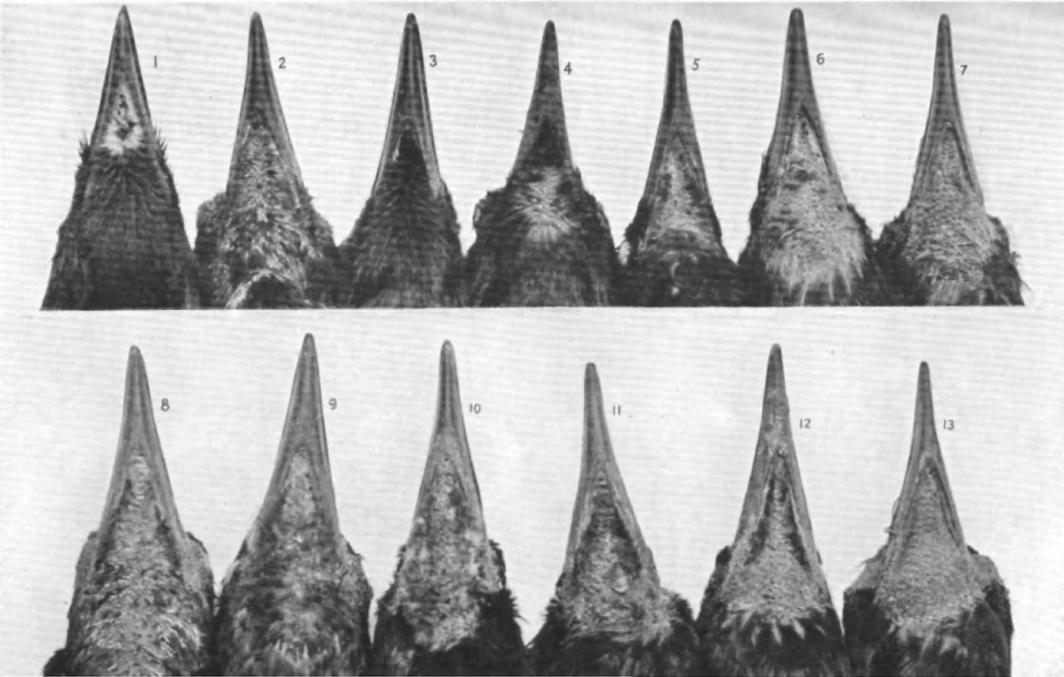
#### EXPLANATION OF PLATES.

PLATE 4.—Rooks' heads.—*Fig. 1*, Juvenile (♂ June 6th, 1912). *Fig. 2*, Moulting from Juvenile to First winter (♀ Aug. 23th, 1912). *Fig. 3*, First winter (♂ Sept. 9th, 1912). *Figs. 4-7*, A progressive series of First-summer birds to show the moult of the chin. Degenerate feathers and "aborted pins" are growing on 4-6, while in 7 the moult is nearly complete, but a considerable amount of "down" remains. (*Fig. 4*, ♀ March 17th, 1913; *Fig. 5*, ♂ Jan. 30th, 1913; *Fig. 6*, ♂ March 17th, 1913; *Fig. 7*, ♂ April 24th, 1913.) *Figs. 8-13*, A progressive series of adults from the Autumn-moult to late summer. *Fig. 8*, In full moult in autumn (♀ Sept. 9th, 1912.) *Fig. 9*, The moult nearly complete, showing growth of degenerate feathers and plumules (♂ Sept. 14th, 1912.) *Figs. 10-13* show the gradual wearing off of these. (*Fig. 10*, ♂ Dec. 31st, 1912; *Fig. 11*, ♀ Jan. 30th, 1913; *Fig. 12*, ♀ Dec. 18th, 1912; *Fig. 13*, ♀ June 5th, 1912.)

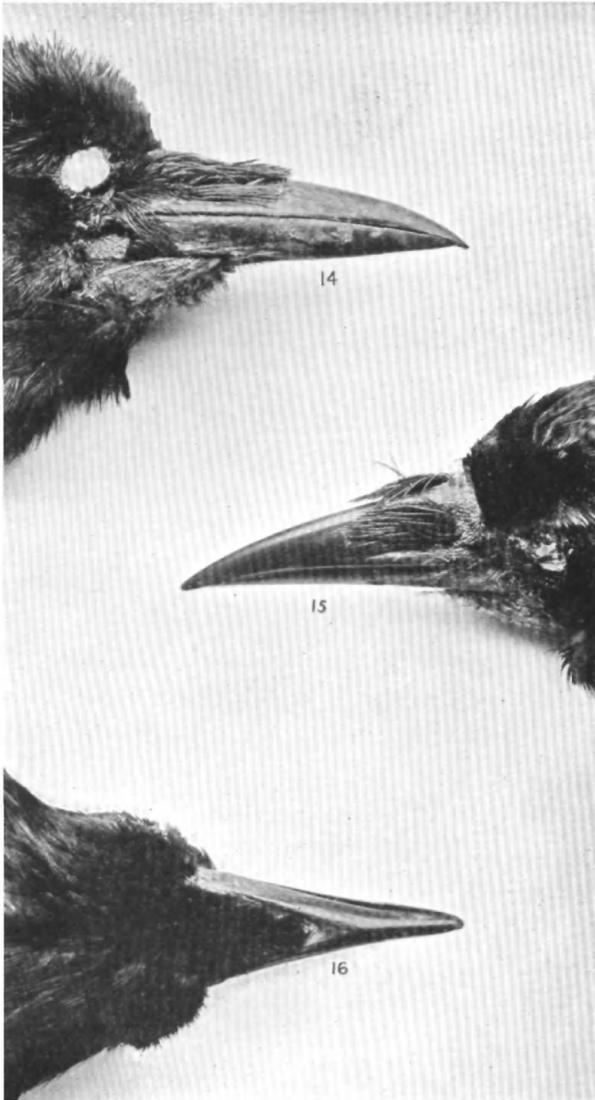
PLATE 5.—*Fig. 14*, First-summer Rook—the same bird as in Plate 4, *Fig. 5*—to show moult on side of lower mandible. *Fig. 15*, First-summer Rook—the same bird as in Plate 4, *Fig. 7*—to show moult of nasal and forehead bristles. *Fig. 16*, Adult Eastern Rook (*C. f. pastinator*) (♀ Feb. 27th, 1912, Hankow, China), to show feathered chin.

PLATE 6.—*Fig. 17*, Photo-micrograph of feather from chin (22 mm. from angle of mandibles) of Juvenile Rook (♂ July 16th, 1912), magnified 7 diam. *Fig. 18*, Feather of First-winter Rook (♂ Sept. 9th, 1912) from the same region, magnified the same.

- PLATE 7.—*Fig. 19*, Portion of *Fig. 17*, magnified 18 diam. *Fig. 20*, Portion of feather from throat (80 mm. from angle of mandibles) of First-winter Rook (♂ Sept. 27th, 1912), magnified 18 diam..
- PLATE 8.—*Fig. 21*, Plumule from amongst feathers of chin (22 mm. from angle of mandibles) of First-winter Rook (♂ Sept. 27th, 1912), magnified 7 diam. *Fig. 22*, Portion of same magnified 18 diam.
- PLATE 9.—*Fig. 23*, Degenerate feather (newly grown) from chin of Adult Rook (♀ Sept. 14th, 1912), magnified 7 diam. *Fig. 24*, Portion of same magnified 18 diam.
- PLATE 10.—*Fig. 25*, Much worn degenerate feather and a filoplume from chin of Adult Rook (♀ March 10th, 1913) magnified 7 diam. *Fig. 26*, Piece of skin from chin of Adult Rook (♂ October 18th, 1912) showing an "aborted pin," magnified 18 diam.
- PLATE 11.—Wing of Rook (♂ May 27th, 1912) showing *Primaries* 1 to 5 old (6 is dropped and 7 and 8 are growing but are not far enough up to show); 9 and 10 new and nearly full grown. *Secondaries* all old. *Greater Coverts* all moulted and growing together before any of the secondaries are lost.



ROOKS' HEADS. Fig. 1, Juvenile. Fig. 2, Juvenile Moulting. Fig. 3, First Winter. Figs. 4-7, Molt of First Summer. Figs. 8-13, Adults. Fig. 8, Autumn moult. Fig. 9, Molt just complete. Figs. 10-13, To show gradual wear of "down." For explanation see p. 138.



Figs. 14 and 15, Moults of First-summer Rook.

Fig. 16, Adult Eastern Rook.

For explanation see p. 138.

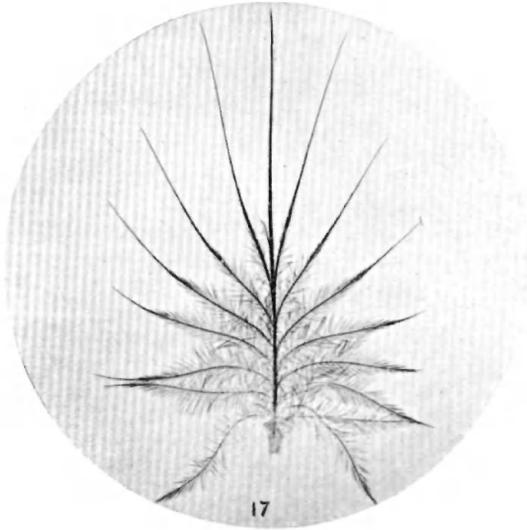


Fig. 17, Feather from Chin of Juvenile Rook.  
Fig. 18, Feather from Chin of First-winter Rook. Both  $\times 7$  diam.  
For explanation see p. 138.

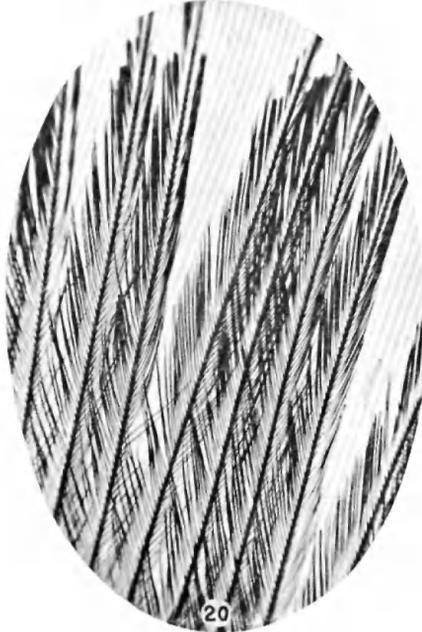


Fig. 19, Portion of Fig. 17 magnified 18 diam.  
Fig. 20, Portion of Feather from Throat of First-winter Rook  $\times$  18 diam.  
For explanation see p. 139.

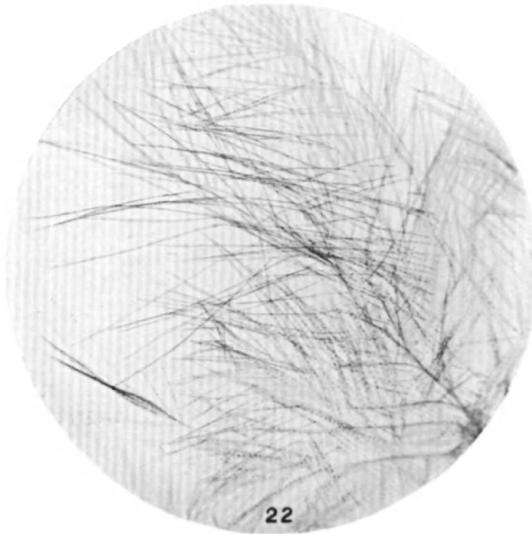


Fig. 21, Plumule from Chin of First-winter Rook  $\times 7$  diam.

Fig. 22, Portion of same magnified 18 diam.

For explanation see p. 139.



Fig. 23, Degenerate Feather from Chin of Adult Rook  $\times 7$  diam.

Fig. 24, Portion of same magnified 18 diam.

For explanation see p. 139.

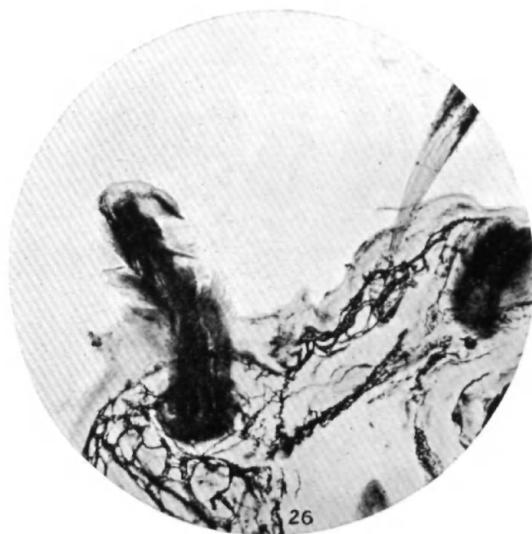
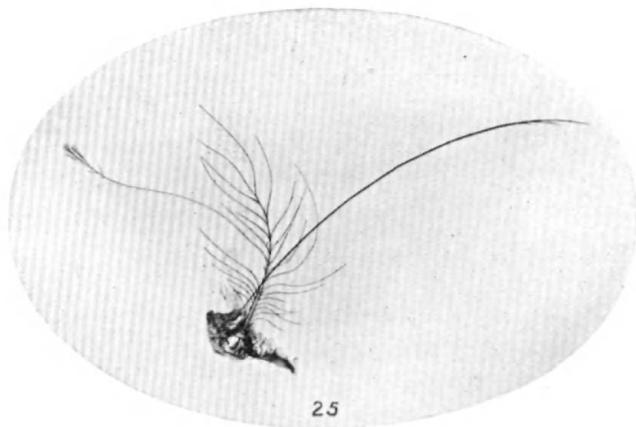
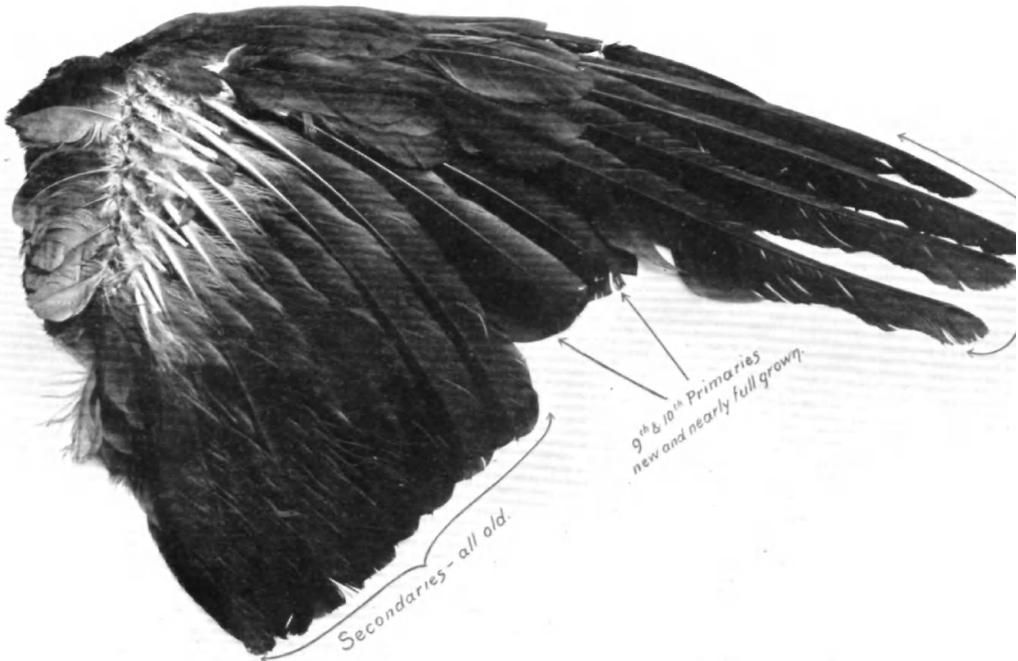


Fig 25, Much worn Degenerate Feather and a Filoplume from Chin of Adult Rook  $\times 7$  diam.

Fig. 26, An " Aborted Pin " from Chin of Adult Rook  $\times 18$  diam.

For explanation see p. 139.



WING OF ROOK IN MOULT. For explanation see p. 139