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COMMITTEE OF PUBLICATION.

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**Article I.—THE CHANGES OF PLUMAGE IN THE
DUNLIN AND SANDERLING.**

By FRANK M. CHAPMAN.

One of the most interesting chapters in Gätke's notable work 'The Birds of Heligoland' is entitled 'Changes in the Colour of the Plumage of Birds without Moulting.' Herein Herr Gätke tells us that for over forty years he has given "the most unremitting attention" to this subject. As a result he presents us with three explanations of the manner in which a bird may pass from winter dress into full breeding plumage without molting. Briefly, they are the following: First, by "shedding the edges of the feathers...." Second, by "a peeling off of the separate barbs of the feathers, whereby these are stripped of a thin inconspicuously coloured envelope, so that the purer and finer colour previously concealed beneath the latter becomes exposed.....Further, the feathers, which by the end of winter were worn irregularly, and blunted at the tips, after this change of color, again have their margins completed, and their tips beautifully and evenly rounded off, so that they are in all respects like perfectly new feathers, such as would be produced by moulting." The third process is the "most wonderful," and

[*March, 1896.*]

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"consists in an actual, complete, and very striking change in the colour of the feathers, without such alteration being brought about, or even assisted, by any changes in their texture." The examples cited as illustrating this change are the Little Gull, Guillemots, and Razor-billed Auk, in which the head and neck change from white or whitish to slaty black or blackish brown; the Dunlin, in which the upper belly changes from white to black, and other species.

The first explanation given by Herr Gätke is well known to occur in many species, and calls for no special remark in this connection. The second and third are, in part, original with him, and the evidence which he presents in their support is derived entirely from his own observations.

Probably owing to our comparative ignorance of the molt of birds and its attendant phenomena, these statements of Herr Gätke's have not only passed unchallenged, but have actually been endorsed as correct. Already we find that they have become part of the literature of general ornithology, and we read of the renewal of the worn tips of feathers and repigmentation as though they were established facts.

Herr Gätke describes in some detail the manner in which the changes of color previously mentioned occur. He does not, however, tell us just how his conclusions were reached, whether by the examination at one time of large series of specimens, or at intervals upon occasional specimens during the forty years which he has devoted to the subject. This, of course, is a matter of some importance, as every one who has studied the molt knows, and it seems to me that before accepting Herr Gätke's views they should be thoroughly tested by a study of series of specimens representing the species he mentions. As a contribution to this end I offer the following notes on the changes in plumage of the Dunlin (*Tringa alpina*) and Sanderling (*Calidris arenaria*), two species from which Herr Gätke obtained "surprising results."

The Dunlin may, I think, be quickly disposed of. It will be remembered that in winter plumage this bird is almost uniform brownish gray above, the breast is washed with the same color and indistinctly streaked with blackish, the throat and belly are

pure white. In summer plumage the feathers of the back are black broadly margined with bright rufous, somewhat lighter terminally, while the scapulars have more or less irregular sub-terminal black or rufous bars.

The change from winter to summer plumage is explained by Herr Gätke as follows: "In the ash-grey feathers of the back the shaft first becomes black; this color spreads rapidly over the feather, finally leaving only broad grey margins. The latter at first change to a dull rusty grey, which, however, subsequently passes into a beautiful ferruginous color. At the same time the dull ash-grey tips of the feathers pass into a whitish grey, their margins being simultaneously rounded off to their former entirety. This shows that these feathers also, which in winter are worn in such a way as to assume a lanceolate shape, undergo a renovation of structure, and that their tips do not acquire their whitish colour simply by fading. In the Dunlin this change does not extend to the long posterior flight-feathers and the smaller outer plumage of the wings, in which the colour only becomes somewhat blacker, and the margins somewhat more even, but which do not acquire the appearance of newly developed feathers, like those of the upper parts of these birds." The change in the color of the lower belly from white to black is accomplished by the third process described by Herr Gätke, mentioned above, that is by "complete and very striking change in the colour of the feathers, without such alteration being brought about or even assisted by any changes in their texture."

Whether the gray feathers become black and rufous by a chemical change in their pigment or by repigmentation is not said, but since white feathers are said by Gadow to be pigmentless, we infer that according to Herr Gätke the Dunlin's white belly becomes black by an actual influx of pigment.

Now let us see how far his claims are borne out by the series of Dunlins before me. This consists of fifty-seven specimens, of which eleven are *Tringa alpina*, while forty-six are *Tringa alpina pacifica*. Of the whole number, twenty-seven are in fall or winter plumage, and thirty are in spring or summer plumage. It is the latter series which interests us. Of these thirty birds eighteen have apparently acquired their breeding plumage. There is of course

considerable variation in their colors ; some are much blacker below and more rufous above than others, in fact the differences are of just the nature we expect to find in a series of birds in breeding plumage, and are presumably dependent upon the age and physiological condition of the individual.

The remaining twelve have not completed their breeding plumage, and are in various stages of the molt. This statement so obviously affects Herr Gätke's conclusions in regard to the change in plumage in the Dunlin that it will be well to describe some of these molting specimens in detail. The dates of capture range from April 2 to May 22 ; the localities represented are the Atlantic, Pacific and Gulf Coasts of the United States. Am. Mus. No. 29888 (So. Car., April 13, 1883, Hoxie) is just beginning to acquire the summer plumage. It has numerous pin-feathers upon the foreneck, breast and belly, the head, hindneck, back, and scapulars. Many of these new black, or rufous and black feathers are half grown, while a few are fully grown and their unworn edges are in strong contrast to the ragged borders of the gray winter plumage. Am. Mus. No. 64970 (Long Island, April 3, 1882, Dutcher) resembles the bird just mentioned, and also has numerous pin-feathers in various stages of growth upon the foreneck, breast, belly, hindneck, back, and scapulars. Am. Mus. No. 55008 (Texas, April 25, 1891, Chapman) is more advanced, being evidently at the height of the molt, and one cannot raise the plumage of any part of the body without discovering numbers of growing new feathers wrapped in their dermal sheaths. The remaining nine molting birds simply confirm what those described show, that is, that in passing from winter to summer plumage the Dunlin undergoes a complete molt of the body feathers and scapulars, but retains its rectrices and remiges.

Turning now to the Sanderling, Herr Gätke remarks that in this species "we meet with an actual threefold change of colour in the feathers of the upper parts of the winter plumage, each one of which undergoes a transition from a uniform light grey to a deep black, and from a beautiful ferruginous colour to a pure white. The black, which forms the ground colour of the feathers of the summer plumage, at first appears above their subsequently white terminal markings, and advances with increasing intensity

towards the radical portions of the feathers. Soon dull rust-coloured lateral borders are developed, side by side, with this ground colour, and a blurred spot of similar colour is formed on each web of the feathers; these spots increase in size, become purer in colour, and partially pass into transverse bands; simultaneously with these changes the dull light-grey tips of the feathers become transformed to a pure white; not, however, by mere fading, but in this case also by a restoration of the worn and blunted barbs to their previous entirety. When the change of colour is complete, the feathers are of a deep glossy black, with broad, pure white borders, and beautiful sharply defined ferruginous spots at the sides, or transverse bands of the same colour: their tips, too, which had been worn down to a lanceolate shape, have now reassumed their formal [*lege* former?] beautiful rounded form and entirety of margins. In this species the change of colour, and simultaneous restoration of the edges of the feathers, extends to the long posterior flight-feathers and outer wing-coverts."

The barred and rufous breast of the breeding bird is not described, and the breast is said to become even whiter than in winter, a statement I do not understand, but that is of no importance in this connection. I have here quoted Herr Gätke at length, because his explanation of the manner in which the Sanderling acquires its summer plumage is quite as wonderful as any statement in his chapter on 'Colour Changes.' With every desire to thoroughly and fairly test Herr Gätke's claims, I have, through Mr. Ridgway's kindness, been permitted to borrow the Sanderlings in the National Museum, and these, in connection with the specimens in the American Museum, give me a series of ninety-seven examples, representing every month in the year except July. I will therefore describe the plumage changes of this bird in some detail.

Beginning with the adult bird in full breeding plumage, the necessity for large series in studying the molt and the erroneous conclusions which may be drawn from negative evidence, is at once apparent. There is no reason to doubt that the Sanderling, like other birds, undergoes a complete molt after the breeding season, nevertheless not one of my twenty August specimens

shows any signs of molt in progress in the wings or tail. In the larger number, however, the remiges and rectrices are in an apparently fresh and unworn condition, and I assume that in most cases these important feathers are acquired before the migration is begun. This would be in July, a month which, as I have said, is not represented in my series.

Growing feathers can, however, be found in numbers upon the body as the new gray plumage slowly replaces the worn one of rufous and black, and the winter plumage is completed late in September or in October.

The young bird in the down I have not seen, but the nestling plumage is followed by the well-known plumage of the immature bird in which the back is black, each feather being terminally bordered with whitish or with two terminal whitish spots. Late in the autumn these young birds molt their body feathers and acquire a gray and white plumage closely resembling the adult. This change is shown by specimens from Yucatan, Paraguay, Aldabra Island, and other localities. In winter plumage the upper parts, including the scapulars, are ashy gray, the entire under parts pure white. A specimen collected by Herr Gätke at Heligoland, January, 1879, shows that in some instances, at least, the birds of the year can be distinguished from adults as late as midwinter by the narrow black tips of the wing-coverts.

This brings us to the change from winter to breeding plumage, which Herr Gätke, as already described, asserts is accomplished without molt.

My series of twenty specimens illustrating this change show that it begins late in March or during the first half of April and is completed in May. They show, furthermore, that it is accomplished by a molt. In proof of this statement I will describe several of these molting birds. No. 3685 (Coll. Geo. B. Sennett, Corpus Christi, Texas, March 28, 1886) is to all outward appearances in the winter plumage of the adult, but examination shows that the molt is in active progress over the entire body, in the scapulars, tertials, all but the greater series of wing-coverts, the upper and under tail-coverts. One of the median pair of rectrices is about one-third grown, while its fellow is missing. Am. Mus. No. 45485 (California, April 13, Xantus) closely resem-

bles the preceding in appearance, and like it is undergoing an active molt throughout the body and scapulars. The wing-coverts and median rectrices, however, as yet show no indications of the molt. No. 6042 (Coll. Geo. B. Sennett, Corpus Christi, Texas, April 20, 1889, Singley) is slightly more advanced than either of the birds just described. New feathers are appearing not only over the whole body, tertials, lesser and median wing-coverts, but the molt extends to the outer pair of tail-feathers, which with the median pair are about half grown. Only seven of the twelve old tail-feathers remain, and it seems probable that all the rectrices are renewed.

Am. Mus. No. 60007 (Micco, Florida, April 30, 1891; C. S. Allen) has nearly completed the molt, though new feathers are still appearing all over the body. The rectrices, tertials and lesser and median wing-coverts have apparently been renewed. Nearly all the newly-grown or growing feathers of the upper parts are broadly tipped with ashy gray, which, as numerous specimens show, is later worn off, leaving the black and rufous of the full breeding plumage.

It is evidently unnecessary to describe other specimens in this series which show the molt in every stage, and prove beyond question the manner in which the change from winter to summer plumage is accomplished.

Would that Herr Gätke's explanation of this change could be explained as easily, for in view of the large number of molting birds contained in my series of Dunlins and Sanderlings, his failure to find a single molting spring specimen is certainly a remarkable coincidence.

As further supporting my belief in the incorrectness of Herr Gätke's observations, I may add that I have examined specimens of several other species which he would have us believe acquire their breeding plumage through the same mysterious and wholly inexplicable cause to which he ascribes the changes above described in the plumages of the Dunlin and Sanderling. As a result, whenever my series has contained individuals taken at the proper season, it has clearly demonstrated that the change was accomplished by molt. Thus the Golden Plover, Knot, and other members of the order Limicolæ are shown to have a spring molt,

and while I have seen no molting specimens of *Larus minutus* the Museum possesses spring examples of *Larus atricilla* in the height of the molt.

There is evidently, therefore, urgent need for a thorough revision of this remarkable chapter on 'Colour Changes without Moulting,' and so strongly do I dissent from Herr Gätke's views, I venture to assert that his claims for changes in the color and disposition of pigment, and new growth in old feathers, will be found to be entirely baseless.