Proceedings of the Iowa Academy of Science

Volume 85 | Number Article 6

1978

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Proc. Iowa Acad. Sci. 85(2):66-69. 1978

Effects of Silky and Color Mutations on Structure and Color of Down Feathers in Ring Neck Doves[1]

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The ring neck dove, *Streptopelia risoria* (Goodwin, 1970), has six color mutations — blond, white, rosy, ivory, pied, and albino — and the structural mutation silky plumage. Down from squabs with these mutant phenotypes was compared with down of wild-type squabs. Down pigmentation, texture, length, and diameter were examined microscopically. This paper describes the effects of the mutations on the down, and how they relate to the effects of the mutations on the adult plumage. A complete description of wild-type down as determined microscopically is also included.

INDEX DESCRIPTORS: *Streptopelia risoria,* ring neck doves, down feathers, silky plumage, blond, white, rosy, ivory, pied, albino.

This study was designed to find what correlation, if any, exists between the structure and color of down feathers and the structure and color of the adult feathers in ring neck doves, *Streptopelia risoria* (Goodwin, 1970). Down feathers, or plumulae, as described by Levi (1957), are soft, hairy infant feathers found on newly hatched squabs. Down of dove squabs is simple filamentous rather than branched. According to Moment (1967), down feathers lack a shaft and consist of a tuft of many short fluffy barbs devoid of interlocking apparatus. Down feathers drop off as the squabs grow older. Some may remain attached for a time to the distal end of the first regular plumage feathers.

The color mutations included in this study were the genetic recessives, blond (d^B), white (d^W), rosy (ry), ivory (iv), pied (pi), and albino (al). Blond is a dilution of the wild-type, dark (D+ at this locus). White is a recessive allele to blond and produces an extreme dilution of the wild-type pigment. Both are sex-linked (Cole, 1930). Rosy and ivory are nonallelic and autosomal colors. They produce reddish and reduced colors, respectively. Pied, also autosomal, produces a pattern in which portions of the squab feathers are pigmented and other portions are lacking pigment; the adult feathers are individually pigmented or not pigmented (pers. comm., W. J. Miller, Dept. of Genetics, Iowa State University). Albino gives a complete lack of melanin pigment (Tange, 1949), thereby blocking the expression of any other color mutations inherited by the dove (epistasis).

In this study, down texture, pigmentation, length, and diameter were examined to determine how they were affected by the color mutations. A similar study was done by Somes *et al* (1966) using chicks. They concluded that a substantial amount of the genetic makeup responsible for the intensity of phaeomelanin of the down of the chicken also is responsible for the phaeomelanic intensity of the post juvenile plumage of the chicken. Down structure was not considered in that study.

An autosomal recessive gene has been described (Hunt, 1951) in which all down in chicks that would otherwise be cream, greenish-white, or yellow is a snow-white color; this gene has no visible effect on later plumage. Color mutations in ring neck doves might show some effect on the amount of pigmentation in the down, as shown for chicks. The enzyme system controlling the xanthophyll of the down feathers, however, may be entirely unrelated to that for the adult feathers, as with the snow-white gene in the chicks.

The structural mutation under consideration was silky, originally termed lacy (L). This autosomal mutation is a partial dominant to wild type. Expression in the heterozygote (L/+) is moderate, with feathers plumose. Expression is extreme in the homozygote (L/L), with the feathers appearing tattered, twisted, and curved.

The silky gene causes a reduction in strength and elasticity of the barbules of the feathers and a tendency of the barbs to twist (Miller, 1956). The barbules do not lack hooks; rather, the hooks are abnormal in form, thickened, and somewhat crowded compared with normal. It seemed possible that the silky gene might also have some similar effect on the structure of the down.

A general examination of normal down was also included in the study. The basic structure of the filaments, number of filaments in each bundle, and any variation in these factors in down from different areas of the squab's body were examined.

METHODS

Subjects

69 doves successfully hatched in individual mating pens at the dove colony of the genetics laboratory at Iowa State University between 7 June and 9 August, 1976 were included in this study. Also included were 6 doves successfully hatched in several individual mating pens set up specifically for possible production of homozygous silky squabs between 1 September, 1976 and 20 February, 1977. These were ring neck doves or hybrids of dwarf turtle doves, *Streptopelia humilis* (Goodwin, 1970), backcrossed with ring necks. The doves were approximately 3 days old when examined; the sex of most was unknown. Another 92 doves had previously had their down lengths measured and color recorded although the down was not examined microscopically.

Procedure

The length of the back down of each dove was measured within 3 days of hatching. These measurements were made with a ruler to the nearest 0.5 mm. It was assumed that growth of the down was complete at the time of hatching. The down lengths were compiled according to the doves' presumed adult colors and, later, according to their silky phenotypes. The down was then examined on the doves' body at a magnification of 20X. The general appearance of the down and the number of filaments per bundle were noted. Comparisons were made between bundles from the back, wing, and head regions. Some filaments then were removed from each of these three regions and placed on a slide. These were examined under a binocular microscope at 35 and 100 magnifications. Variations in texture and pigmentations were noted. The diameters of the tip, base, and midway along the length of the filaments were measured. These measurements were made to the nearest 5 μm.

RESULTS

A description of the down for the wild-type and each of the mutant phenotypes follows.

Dark — Because this was the wild-type, the down from the dark squabs was considered "normal" and was used for comparison with the down from squabs of other colors. At a magnification of 20X, the down had a straw-like appearance. The down on the back was quite straight, and the filaments were in bundles of six to eight (Fig. 1). The wing down was fairly curly and often very dense. Again, there were usually six to

[1]Journal Paper No. J-8847 of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa. Project No. 1940.

eight filaments per bundle (Fig. 2).

In the head region, the down generally was shorter than in the other areas. The down was sparse on the top of the head, growing more dense around the eyes and toward the sides of the head. There were four to six filaments per bundle. The bundles in the center top of the head often had all the filaments fused for their entire length, forming one larger filament. From other areas of the head, the ends of the filaments of a bundle frequently were fused, but the major portions of the filaments were separate (Fig. 3). In the superciliary and ocular regions the filaments were in bundles of six, with no fusion.

Under 35 and 100 magnifications, the down had a solid, dark appearance. The diameter of each filament was quite constant for the entire length of the filament, occasionally tapering slightly to the tips. All the tips were rounded, including those fused together. The tips sometimes were slightly enlarged. Occasionally, an enlarged translucent spot was seen on one or more of the filaments of a bundle. The diameters of these spots were about 1.5X the diameters of the rest of the filaments. The filaments frequently were broken at these spots (Fig. 4). Otherwise, all filaments had smooth edges with no irregularities.

Blond — The down from the blond squabs showed no differences from the wild-type. The filaments had the same general appearances under all magnifications. The measurements of length and diameter also were closely similar to those of the wild-type (Tables 1, 2, 3).

White and Albino — The down from squabs of these two colors appeared identical. It was extremely sparse over the entire body, and had a crinkled appearance as though it had been repeatedly bent. The down had a waxy look, rather than the straw-like appearance of the normal down. The filaments were often fused at the proximal end by a dark yellow substance. The down was considerably shorter and had a smaller diameter than normal (Tables 1, 2). There seldom were more than six strands in a bundle, and there were as few as one or two per bundle. The down on the wings was slightly curly, but still had the waxy and crinkled appearance. The head region was completely or nearly bald. Any filaments present were fused for their entire length. Under greater magnification, the filaments looked translucent. Often, the tips were pointed or broken rather than rounded as normal. The edges were rough and gave the strands a tattered appearance (Fig. 5).

Table 1. *Variation in down length according to color in ring neck doves*

No. Examined	Squab's Color	Range of Back Down Lengths (mm)	Mean of Back Down Lengths (mm)
26	Dark (Wild type)	4-6	5.23
44	Blond	4-6	5.21
24	Pied	3-6	5.10
21	Rosy	2-4	2.97
10	Ivory	2-4	2.95
8	White	1.5-3	2.24
11	Albino	1.5-3	2.25

Table 2. *Variation in range of diameters of down filaments according to color in ring neck doves*

Squab's Color	Range of Diameters of Down Filaments (μm)		
	Back	Wing	Head
Dark (Wild-Type)	25-45	20-45	20-45
Blond	25-45	20-45	20-45
Pied	25-45	20-45	20-45
Rosy	10-30	10-25	10-25
Ivory	10-30	15-30	15-25
White	5-20	10-25	10-20
Albino	5-20	10-20	10-20

Table 3. *Variation in means of diameters of down filaments according to color in ring neck doves*

Squab's Color	Mean of Diameters of Down Filaments (μm)		
	Back	Wing	Head
Dark (Wild-Type)	36.1	33.0	32.8
Blond	35.9	33.1	33.0
Pied	36.1	32.8	33.0
Rosy	20.5	18.1	18.3
Ivory	19.9	21.9	19.9
White	12.2	16.8	14.7
Albino	12.1	15.9	15.0

Rosy and Ivory — (included D + ry/ry, d^B ry/ry, D + iv/iv, and d^B iv/iv) The down from squabs of these colors appeared the same. The down was shorter and had a smaller diameter than wild type (Tables 1, 2, 3) and was sparse. The back down was straight, and the wing down was curly. There seldom were more than six filaments per bundle. The head region was nearly bald, and most of the filaments that were present were fused. The down from all areas had a slightly waxy appearance and showed the crinkled appearance described previously for the white and albino.

The filaments were slightly translucent under 35 and 100 magnifications, although not as much so as the albino and white. Some of the tips were pointed rather than rounded. Several bundles showed filaments with enlarged spots, which were more translucent than the rest of the filament. At some of these spots, the filaments were broken. The edges generally were smooth, and the down did not have the tattered appearance observed with the white and albino.

Pied — (included D+ pi/pi and d^B pi/pi) The down from pied squabs showed no differences from normal. The down had the same appearance under all magnifications. It had the usual six to eight filaments per bundle with straight down on the back, somewhat curlier down on the wings, and sparser down on the head. The back down was very slightly shorter than normal (Table 1).

Moderate (heterozygous) Silky — There were no distinguishing characteristics observed in down from heterozygous silky squabs. All the previously described variations were observed in both normal (for silky) and moderately silky squabs, including waxy and crinkled down, pointed tips, tattered edges, and translucent enlarged spots. Down lengths ranged from 1.5 to 7.0 mm, correlating with the squabs' colors.

Extreme (homozygous) Silky — Very few homozygous silky squabs were observed during this study. There were no dark or pied homozygous silkies. The down from the blond homozygous silky squabs

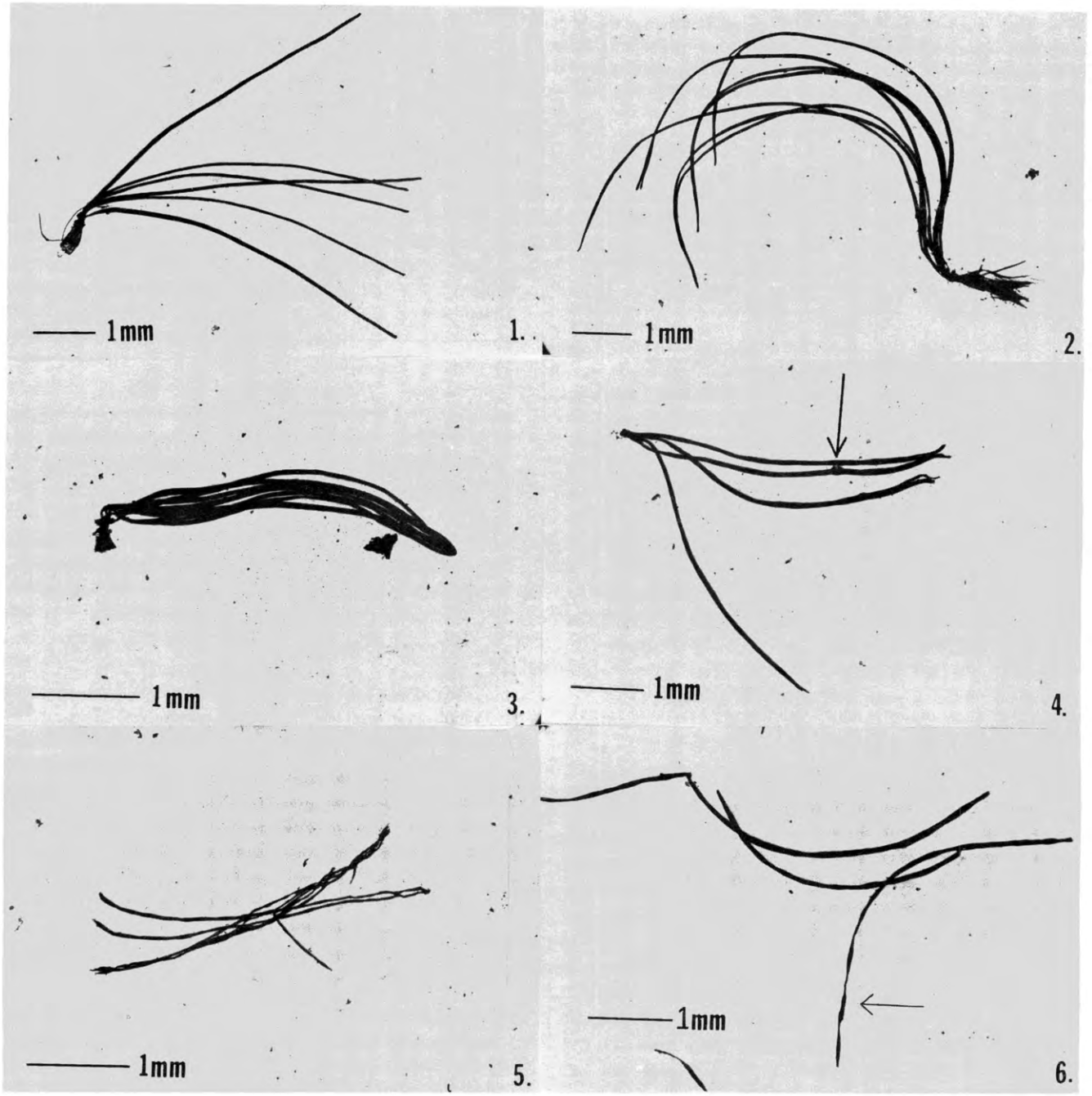

Figure 1. *Down from the back of a* d^B *+/iv +/pi ++ squab showing a normal bundle of 6 filaments.* Figure 2. *Down from the wing of a* D^+ *+/iv ++ squab showing curliness and interfusion of filaments.* Figure 3. *Down from the head of a* d^B *+/iv +/pi ++ squab showing fusion of tips.* Figure 4. *Down from a* d^B *+/iv L/+ squab showing enlarged translucent spot with slight breakage (arrow).* Figure 5. *Down from an al/al squab showing much interfusion, tattered appearance, and translucence.* Figure 6. *Down from a* D^+ *ry/ry/ L/L squab showing the extreme diameter variation found with homozygous silkies (arrow).*

showed no variation from down of moderately silky or normal blonds. There was one outstanding characteristic common to the homozygous silky squabs of the other four color mutations (d^w, al, ry, iv). The down from these squabs showed extreme variation in diameter along the length of the filaments, giving them a very wavy appearance (Fig. 6). The diameters measured from 3 to 20 μm.

DISCUSSION

The effects of the color mutations on the squab down fall into quite distinct patterns. The blond and pied mutations have no discernible effect on the structure and color of the down. The white and albino genes do affect the down, evidently blocking any pigment formation. This gives the down the translucent, waxy appearance. The white and albino genes pleiotrophically also cause structural changes, that is, shortened and thin filaments with a crinkled or tattered appearance.

The rosy and ivory mutations seem to cause a slight blockage of pigment formation, giving the down a somewhat translucent appearance. The filaments also are slightly shorter and thinner than normal. The rosy and ivory genes reduce the pigmentation of the down, but not quite as extensively as the white and albino genes. Such reduction of pigmentation can also be seen in the adult plumage.

The cause of the occasional enlarged translucent spots found on down of every color, including wild type, was not determined.

There was no distinguishing difference between down of squabs with normal and heterozygous silky phenotypes. A possible structural effect of the extreme silky phenotype was an extreme variation in diameter along the length of the filaments. More homozygous silky squabs should be examined for this to be confirmed. It was not possible to predict normal or moderately silky conditions from simple examination of the down (see also Miller, 1956); extreme silky was predicted correctly for several of the squabs on the basis of the extreme diameter variability in the down seen microscopically.

ACKNOWLEDGMENTS

The author wishes to thank Mary Hadaway and Dr. Wilmer Miller for their help with the research and Dr. Harry T. Horner for taking the photographs.

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