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THE EFFECTS OF AGE AND WEAR ON COLOR BANDS

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Bird studies using color code systems of leg bands (Marion and Shamis, 1977) require color-fast material often proving to be of limited duration in the field. Time may be lost in ascertaining which materials or techniques are best. The problems increase with long-term studies, so it is important that they be resolved at the outset.

A study of individually color-banded Fulmars (*Fulmarus g. glacialis*), began in 1950, on the island of Eynhallow, Orkney (Dunnet and Ollason, 1978), has continued to the present. Examination of color bands from some of these Fulmars has revealed the advantage and limitations of certain materials and colors.

MATERIALS AND METHODS

Initially, breeding Fulmars were banded with two-color combinations of celluloid flat-bands 9 mm diameter, 7.5 mm wide and 0.6 mm thick from a range of 10 colors: black, white, red, yellow, pink, dark green, light green, dark blue, light blue, and orange. The choice of either the right or the left leg for positioning of the serially numbered metal band allowed the same color combination to be used on two different individuals (Carrick and Dunnet, 1954; Ollason, 1978). The practice of sealing celluloid rings with acetone was begun in 1957. Because the more distinguishable color combinations were used up, a few birds were banded with different combinations on each leg, but this created identification problems in the field (both legs of all birds had to be examined) and was, therefore, quickly discontinued in favor of triple colors on each leg. Three celluloid and one metal bands almost cover a Fulmar tarsus but do not inconvenience the bird.

In 1958, a new type of aluminum color band of half-hard aluminum alloy (99% aluminum, 0.4% iron, 0.2% magnesium, 0.2% silicon) 1.3 mm thick was introduced and used for five years. On to this we bonded a 0.01 mm coating of Scotchlite reflective material to the outer face, available in six colors; black, white, red, yellow, blue, and green. One hundred sixty-eight nestlings banded from 1961 to 1964 were given (in addition to the serially numbered band) a plain monel band with a strip of fluorescent orange Scotchcal sheeting wrapped around it on each leg.

Semi-rigid P.V.C. Darvic bands, 7 mm wide and 1.0 mm thick, were introduced to the study in 1963 but their extensive use did not begin

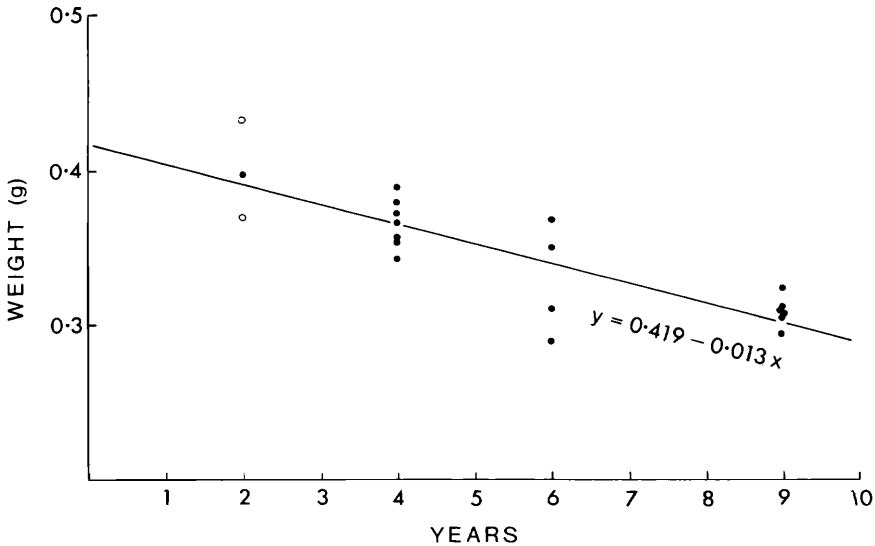

FIGURE 1. Weight loss in 20 green celluloid bands. Open circles represent a pair of bands (see text).

until 1972. They are made (Coulson, 1963) in a wide variety of colors but only seven (black, white, red, yellow, blue, green, and brown) are used on Fulmars. These bands may be sealed with "Tensol" cement.

In the study area birds are normally identified with the naked eye up to 2 m away, with 9 × 35 binoculars up to 50 m and with 20 × telescope up to 120 m.

The accessibility of most nest sites allowed rebanding, especially of adults brooding chicks in July when nest contents were least likely to be lost due to disturbance.

RESULTS

Wear and Annual Weight Loss

Weight loss was determined for celluloid bands only because too few Darvic and Scotchlite/aluminum bands were available for analysis. All 115 worn, but unbroken, celluloid bands were weighed to 0.001 g. Average weight loss each year was about 3% (Table 1). Most of the wear was evident at the single thickness of material separating the outer and inner ends of the band; here it was noticeably thin after five years (0.34 mm) and extremely so in the ninth year (0.28 mm). By then 28% of the original weight would have been lost (Fig. 1) and the band considerably weakened. Ten celluloid bands >9 years old have been recovered; one lasted 16 years but was so worn that it soon would have fallen from the leg.

The original weights of the worn bands examined likely varied be-

TABLE 1.
Annual weight loss of celluloid color bands removed from Fulmars.

Color	n	Mean annual wt. loss (g)	% Mean annual wt. loss	Correlation (*r*)	*P*
Red	15	0.008	2.06	0.749	<.02
Black	16	0.008	2.16	0.515	<.05
White	17	0.009	2.39	0.742	<.001
Yellow	16	0.012	2.93	0.729	<.01
Green	20	0.013	3.10	0.839	<.001
Pink	10	0.016	3.51	0.454	NS
Dk. blue	21	0.016	3.80	0.883	<.001

tween batches; recently manufactured bands were found to be slightly lighter in weight than older ones. The average weight of 30 new green bands was 0.349 g (SD = 0.005), and they were lighter than some earlier models with 4 years' wear (Fig. 1). Similar results were obtained with eight other colors of new bands which showed little difference in average weight within, or between batches (n = 270, $\bar{x}$ = 0.369 g, range 0.325 to 0.409).

Thirty-seven Scotchlite/aluminum bands were examined and found to be prone to abrasion of the thin color coat. If bands were circular in shape when closed, and thus able to revolve on the tarsus, the color coating was lost in two years. Most bands were closed to an oval shape on the flat tarsus so that abrasion was restricted to vertical strips, about 2 mm wide after two years, at the front and to the rear of the band. The resulting patches of color on either side were quite effective but grew progressively smaller at variable rates. Some patches were 3 mm^2 in area after three years and some took 12 years to reach that condition. Such concentrated wear on the band itself had an important weakening effect. The hammering action of adjacent metal bands intensified the weakening process, wearing or flanging the edges of contact, as soon as one month after banding. The flanged edges were never found to harm the bird, as the flange on the inner edge of the band was worn away against the horny scutes of the tarsus. No Scotchlite/aluminum band older than 12 years has been recovered.

Of the 168 Fulmar chicks banded with Scotchcal/monel, only seven were recovered, from 6 to 12 years old. Four had lost a monel color band. The Scotchcal color strips were completely eroded after nine years but traces of identifiable color remained on one 11-year-old band.

Only 27 Darvic rings of known age, an insufficient number for weight analysis, were available. They show remarkably little wear or damage, even after 14 years. A disadvantage with Darvic is a tendency to brittleness after exposure to the elements; in a few bands as early as one year after banding, the outer overlap broke off when the band was being removed.

TABLE 2.

Loss of color, related to age, in 321 celluloid bands.

Years	Black	White	Red	Yel-low	Pink	Dk. green	Lt. gr.	Dk. blue	Lt. bl.	Orange
1	A* (1)**	B (2)	A (3)	A (2)	C (2)	C (1)		A–B (3)	C (3)	
2	A (9)	A (7)	A (5)	A (5)	A (2)	C (3)	B (1)	B (8)	C (9)	
3	A (4)	A–B (2)	A–B (3)	A (3)	C (2)		A (1)	B (1)	C (6)	C (2)
4	A–C (6)	A–B (5)	C (3)	A (3)	C (2)	C (8)		A–C (4)	C (1)	A (2)
5	A (6)	A–C (6)	C (4)	A (7)	C (5)			A (8)	A–C (12)	A (2)
6	A (3)	A–B (3)		A (2)	A–C (9)		A (4)	A–C (8)	A–C (9)	
7		C (1)		A–B (5)	B–C (2)			A–B (3)	C (2)	
8	A (2)	A–B (5)	A–C (4)		C (1)			B (1)	A (1)	A (3)
9	A (7)	A–B (6)	A–B (4)	A–C (6)	C (1)		A (6)	A (4)		A–B (4)
10	A (5)	B (1)	B (4)	A–C (4)	C (1)			A (1)		A (2)
11	A (1)		A (2)				A (1)	A (4)	A (1)	A (1)
12	A (2)	B (2)	B (2)	A (3)			A (1)	A (4)		
13										
14	A (1)									
15										
16				A (1)						

* Assessment of color-loss scored: A—not faded, B—faded but recognizable, C—confusable with another color in field.
** ( ) = number of bands examined.

Color Retention

Although celluloid bands can be retained on the tarsus for many years, certain colors are more prone to fading or discoloration than others. White may become yellowed with age whereas some yellows tend to become white, leading to misidentification of birds. Other common color changes are from red to pink, pink to white, light green to yellow and from dark blue to light blue.

An attempt has been made (Table 2) to classify the color retention of 324 used celluloid bands of different ages. The assessments are unavoidably subjective; I ranked the bands in three orders according to the likelihood of their being correctly identified by me in the field. Black is the only consistently good color and dark blue possibly second best, despite its graying tendency from one year onwards. At least six colors (represented by fewer than 16 bands) were still of an acceptable standard in the 10th year and a yellow one after 16 years' wear. Pink, dark green, and light blue are least color-fast.

All six colors of Scotchlite sheet on aluminum and of orange Scotchcal on monel showed remarkably good color retention up to the last traces of color material remaining, even after 12 years' wear. The color intensity seems unaffected by abrasion, sunlight, or seawater.

Of the 27 Darvic bands removed from Fulmars, the oldest are: two brown (11 years), one black and one white (14 years), and they retain near-perfect color. The remaining 23 bands are aged 1 to 4 years and are of similar color quality. Field observations of all seven colors of Darvic bands confirms the long-term color retention of this material.

DISCUSSION

Few celluloid bands > 10 years old have been recovered from Fulmars; at that age they have lost about one third of their original weight and are clearly near to the maximum age for that type of band. Weight analysis has been much used in studies of wear of metal numbered bands (e.g., Anderson, unpubl. data) but is less meaningful when applied to celluloid color bands. Not only is there greater variability in manufacture, giving different initial weights for different batches of color bands, but there may also be differential wear according to the position of a band on a bird's tarsus. For example, a band "sandwiched" between a metal band below it and another color band above it is likely to lose more weight than the uppermost band of the combination. Such a pair of color bands is seen in Figure 1, and smaller differences in weight were found in three other pairs of bands subjected to similar wear. Loss of color in celluloid is generally more important than loss of weight, some bands having to be replaced within one year (Table 2) to prevent misidentification of individual birds. Birds that live in shady habitats may retain band color longer. C. M. Perrins (pers. comm.) tested celluloid bands for small passerines and found that colors faded faster in bright conditions, but this was due to temperature effects, not light.

The use of a sealant such as acetone may be decided against on the grounds of additional disturbance of the bird or possible damage to the band. Excessive amounts of acetone do cause immediate surface removal of the celluloid, but when carefully applied it has no harmful effects on the band or its color. Sealing not only ensures band retention, it also eliminates the reversing of positions of color bands on the leg which give rise to misidentification.

In spite of the disadvantages of poor color retention and wearing qualities, celluloid bands (when carefully selected) should continue to be useful in short-term studies because they are inexpensive, readily available, and simple to use.

Scotchlite sheeting bonded to metal bands, although less successful on Fulmars, may be of some advantage on other species where band abrasion is less likely to occur, or where the band can be applied safely above the tarsal joint such as in certain wading birds.

The Darvic band is regarded as the most durable and color-fast of those examined. It is, however, not available commercially and because of its toughness is less easy to put on. The further disadvantage of increased brittleness with age (whether caused by the environment or the heating/molding process in band manufacture is not known) leading to fracture, may be compensated for, to some extent, by cementing the band once it is on the tarsus.

SUMMARY

Since 1950, three different kinds of color bands were used on breeding Fulmars in Orkney; celluloid, Darvic, and "Scotchlite" sheet bonded to aluminum. Strips of "Scotchcal" fluorescent sheet on blank monel bands served as age-class marks on nestling Fulmars from 1961 to 1964. Recovered bands were examined for wear and color-loss.

Celluloid bands lost, on the average, about 3% of their weight each year and were extremely thin by the ninth year. Celluloid colors are variable in quality and have the poorest color retention. Some fade within one year, but one yellow band was good after 16 years. Thin Scotchlite and Scotchal coatings abrade rapidly but can retain color quality for 12 years. Darvic bands are color-fast and wear-resistant, lasting up to 14 years. It is recommended that celluloid and Darvic bands be sealed.

ACKNOWLEDGMENTS

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REQUEST FOR INFORMATION

C.W.S. SHOREBIRD COLOR-MARKING

In 1980, the Canadian Wildlife Service will be continuing a large-scale shorebird banding and color-marking project in James Bay. Since 1974, over 45,700 shorebirds of 27 species have been captured, and much information on migration and dispersal routes is being obtained. Observers are asked to look for and report any color-dyed *or* color-banded shorebirds that they may see. Reports should include details of species, age (if possible), place, date, time, color-marks and a note of the number of that species present. For color-dyed birds please record the color and area of the bird that was dyed. For color-bands and standard metal leg bands, please record which leg the bands were on, whether they were above or below the "knee," the colors involved, and the relative position of the bands if more than one was on a leg (e.g., lower right leg, blue over metal, etc.). All reports will be acknowledged and should be sent to DR. R. I. G. MORRISON, *Canadian Wildlife Service, 1725 Woodward Drive, Ottawa, Ontario, Canada K1G 3Z7.*

REQUEST FOR INFORMATION

INTERNATIONAL SHOREBIRD SURVEYS, 1980–1981

The International Shorebird Survey scheme is organized by the Canadian Wildlife Service and Manomet Bird Observatory to obtain information on shorebird migration and distribution for conservational and research purposes. The scheme was started in 1974 and is providing a continental picture of shorebird distribution through surveys carried out by volunteers in eastern Canada and the U.S.A., the Caribbean Islands, and Central and South America. In 1980, we plan to continue and extend the scheme in as many areas as possible. Any observer who may be able to participate in regular survey counts of shorebirds during spring, autumn and winter periods is asked to contact one of the undersigned. Occasional counts from observers visiting shorebird areas on an irregular basis would also be most welcome.

For areas in Canada: DR. R. I. G. MORRISON, *Canadian Wildlife Service, 1725 Woodward Drive, Ottawa, Ontario, Canada K1G 3Z7.*

For areas in the U.S.A., Caribbean Islands, Central and South America: BRIAN A. HARRINGTON, *Manomet Bird Observatory, Manomet, MA 02345.*