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Use of shed feathers in population studies of *Accipiter* hawks (Aves, Accipitriformes, Accipitridae)

PAUL OPDAM & GERARD MÜSKENS

ABSTRACT

A method is described by which it is made possible to recognize the individuals of populations of *Accipiter* hawks. A set of morphological characteristics of moulted primaries (length, shape, pattern of pigmentation, colour and diameter of rhachis) have been found to show considerable variation among individuals. On the other hand, these features are closely similar in feathers from consecutive moults of any given bird. Differences in feather morphology between yearlings and adults are described. The feasibility of the method in population studies is discussed.

INTRODUCTION

In the study of a bird population it is often essential to recognize its constituent individuals. For this purpose the application of aluminium or coloured rings may be useful, but this requires, of course, frequent capturing. Wing tags and other conspicuous marks may be applied to medium-sized and large, conspicuous species, but fail in species like *Accipiter* hawks, which live secretively in wooded habitats and rarely permit free observation. In this paper we present a method, by which it is made possible to recognize the individuals of *Accipiter gentilis* (Linnaeus, 1758), the Goshawk, and *Accipiter nisus* (Linnaeus, 1758), the Sparrowhawk, by means of shed feathers. We successfully used this technique in a study of Dutch-German populations. Thus far it has not been described in the literature, though it has been briefly mentioned by Brüll (1964).

MOULT IN *Accipiter*

At the time of egg-laying the females of *Accipiter* start moulting their flight feathers. Within a few weeks the males follow (cf. Brüll, 1952, 1964). As the females account for incubation and care of the young, they stay in the nesting

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area almost throughout the reproductive period. So most of their feathers shed during this time can be found in a restricted area. The males, on the contrary, which have to procure food for the whole family, leave their feathers scattered all over the hunting range, so that only occasionally one of their flight feathers is found. After the young have left the eyrie, the parents visit the nesting area with decreasing frequency. In late summer, however, there is some revival of display activities, and especially Goshawk pairs can be observed in the nesting range once again. Moulting is finished in October (Brüll 1964).

Feathers may be found under the nest, but particularly under the roosting trees, which are marked on the ground by the birds' droppings and by the remains of their prey. Regular scanning of the nesting area permits estimation of the date of moult.

The moulting of the primaries starts with the proximal one (1st = p1) and descends distally. In the Goshawk the innermost four to six pairs of primaries have been shed when the female resumes hunting activity, whereas female Sparrowhawks usually have already shed p7 or p8 when the young fledge. These primaries, shed in the nesting area, constitute the framework of our study. A varying number of rectrices and secondaries furnish additional information.

This study has been based on a large collection of Goshawk and Sparrowhawk feathers, assembled during an extensive ecological investigation in the Reichswald forest near Kleve (Federal German Republic) and in the adjacent Dutch region during 1969-1975.

Comparison of shed feathers

To make recognition of individual birds by their feathers possible two conditions have to be fulfilled. Firstly, the variability in feather morphology among individuals should be fairly large, whereas, secondly, for any particular specimen homologous feathers from subsequent moults should resemble each other closely. The feasibility of our technique will be evaluated with the help of a set of characteristics, including length, shape, pattern of pigmentation and colour of the feather, diameter of the rhachis and date of the moult.

Length

Feather length is defined here as the length of the rhachis measured along a straight line. Homologous primaries of different individuals show considerable differences in length (figs. 1 & 3), whereas a comparison of homologous feathers from subsequent moults in a single bird reveals only very slight variation, if any at all (figs. 2 & 4). Juvenile primaries are on the average shorter than those of later moults (table I).

TABLE I. Some measurements of primaries of immature and adult *Accipiter* hawks. Values in mm.

		immature		adult		p = [2]
Sparrowhawk		$\bar{x}$ [1]	s	$\bar{x}$ [1]	s	
p3	length	150.2	3.4	151.9	2.3	n.s.
	rhachis	3.17	0.10	3.37	0.11	<0.001
p4	length	158.9	3.6	162.3	2.8	<0.01
	rhachis	3.32	0.08	3.54	0.13	<0.001
p5	length	185.9	3.6	188.4	4.0	0.01
	rhachis	3.52	0.07	3.66	0.15	0.003
Goshawk		$\bar{x}$ [3]	s	$\bar{x}$ [3]	s	
p3	length	227.9	2.4	231.8	4.5	0.025
	rhachis	4.76	0.08	5.05	0.10	<0.001
p4	length	242.3	3.3	249.4	4.7	<0.01
	rhachis	4.89	0.07	5.16	0.06	<0.001
p5	length	272.8	6.0	279.9	6.2	0.01
	rhachis	5.10	0.11	5.54	0.20	<0.001

[1]) n = 20 [2]) Mann Whitney U-test (Siegel 1956) [3]) n = 10

Shape

Primaries may show differences in width of the vanes, pointedness of the tips as well as in emargination of the vanes. These characteristics are, however, difficult to quantify, so they are best studied by direct comparison. Figs. 1 & 3 show individual variability in primary shape, whereas figs. 2 & 4 illustrate close similarity between the feathers of the same bird in different years. First year primaries stand out by their more pointed tips and narrower vanes.

Pattern of pigmentation

Due to unequally distributed pigment, flight feathers of *Accipiter* hawks often show a pattern of dark coloured cross-bars and paler fields between them. This pattern, which as a rule is only marked on the inner vane, occurs in numerous designs, ranging from distinctly barred types with large whitish fields in between to types in which these fields have been largely filled up with pigment (figs. 1 & 3). Complete absence of barring occurs in the Goshawk only. First year birds of both species are recognizable by the more clear-cut bars (often rather narrow as compared with adults), the spotless buff to yellowish pale areas, and the light patches on the outer vane (figs. 1 & 3, left). From the second year onwards the bird keeps its specific pigmentation pattern throughout its life, so that it is possible to identify the members of a population as long as they stay in the research area (figs. 2 & 4).

We were not able to confirm Kleinschmidt's assertion (Kleinschmidt, 1943) that the older the Goshawk the more the barring would be replaced by a more uniform "marbled" pattern. This statement is contradicted by fig. 2,

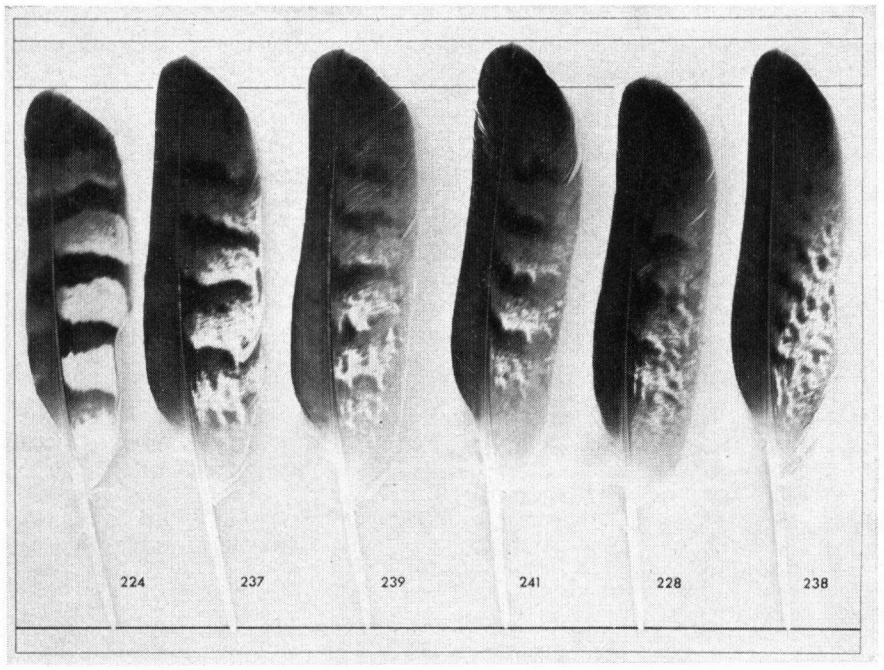

FIG. 1. Primaries (p2) of Goshawk females, showing individual variability in morphology. Values indicate length of feather. Note the immature feather left.

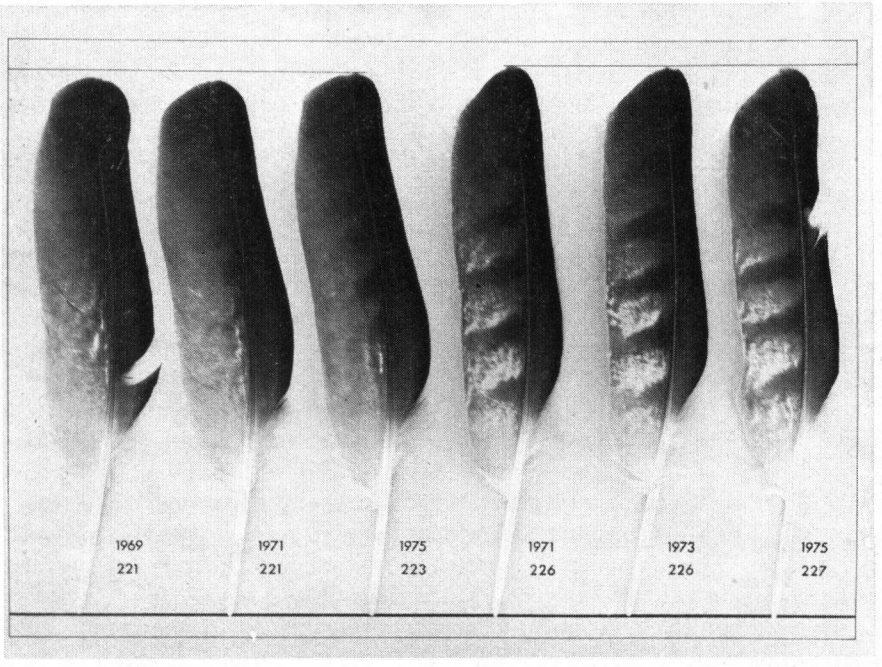

FIG. 2. Two sets of primaries (p1, p2) from different moults of two Goshawk females, showing similarity in morphology over a period of years. Values indicate year of moult and length of feather.

showing feathers of two female Goshawks over periods of 5 and 7 years. Still another female showed the marbled pattern already in its second plumage (not depicted). Our observations concur with those of Brüll (1964).

Thus, although hard to quantify, the pattern of pigmentation is a very useful feature because of its great variability.

Colour

Although not suited for quantification either, colour may also be taken into consideration. There is some variability in the tinge of the deeply stained parts, varying from dark-brown to gray-brown. The pale fields can be tinted white, ivory or buff. On the other hand the colour of subsequent plumages of a particular bird is sufficiently akin to be properly used in our study.

Diameter of the rhachis

Measurement of the thickness of the rhachis provides evidence of the bird's age. For each species the shafts of 3 primaries (p3, p4 & p5) have been measured just below the lowest point of implantation of the barbs, employing a vernier calliper correct to 0.01 mm. In the Goshawk 10 immature and 10 adult primaries of each group (representing 20 different individuals) have been measured, in the Sparrowhawk these samples could be enlarged to 20.

Differences between first year and adult feathers were significant in all groups (table I). The values referring to immature and adult Goshawks did not overlap, those referring to Sparrowhawks did, so that in this species it was not possible to determine whether a particular primary had belonged to an immature or an adult by considering the thickness of the rhachis only.

Because of considerable intra-individual variability this measure could not be applied to discriminate between individual hawks.

Moulting scheme

Thus far only morphological characters have been considered. There remains another parameter of physiological nature, which is defined here as moulting scheme. Brüll (1952, 1964) and Schiemenz (1958) observed that the moulting of the primaries starts with p1 and subsequently descends distally. However, they failed to remark upon the individual variability of the periods between the shed of two consecutive feathers. According to our observations female Goshawks may moult p1-p4 within two weeks, as did the female studied by Brüll (1964), or may need the complete reproductive period (2½ month) for this. Similarly, some female Sparrowhawks have already shed p8 when the young fledge, whereas at that time others are only as far as p5. Between these extremes any other possible scheme occurs. Despite these differences, any single bird traced over a period of years by means of the morphology of its feathers moulted each year according to the same schedule.

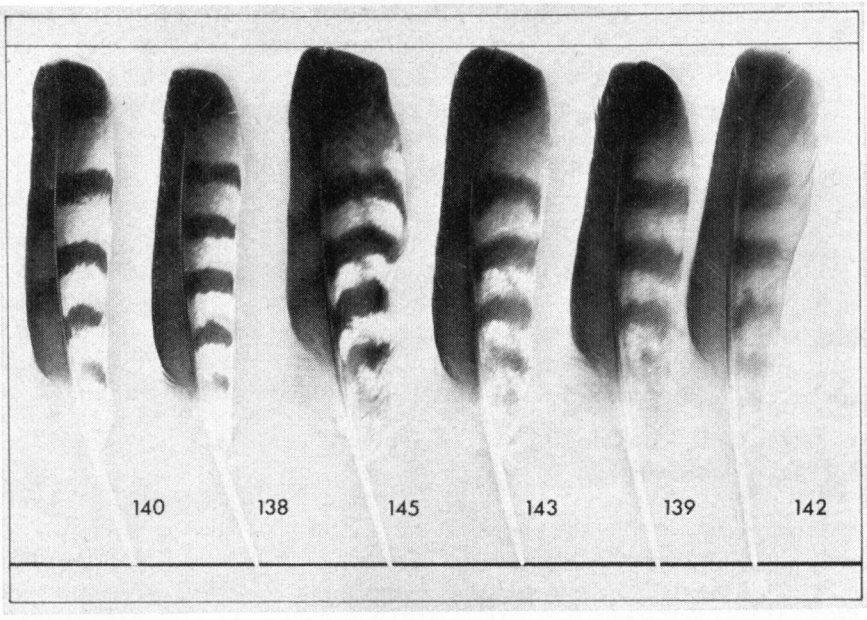

FIG. 3. Primaries (p1) of Sparrowhawk females, showing individual variability in morphology. Values indicate length of feather. Note the two immature feathers left.

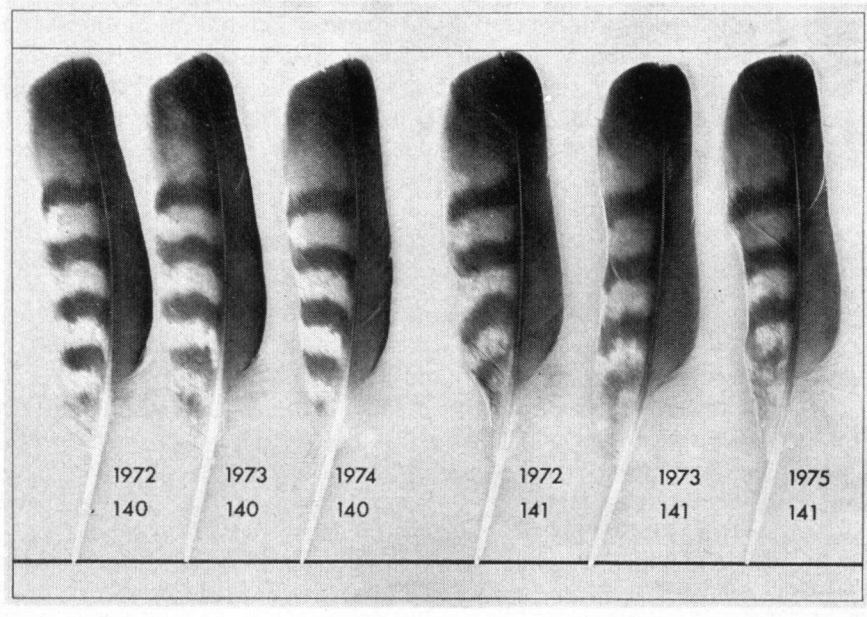

Fig. 4. Two sets of primaries (p1) from different moults of two Sparrowhawk females, showing similarity in morphology over a period of years. Values indicate year of moult and length of feather.

Hence, it was possible to use the moulting scheme to establish a hawk's identity. However, yearlings shed their primaries always with comparatively short intervals. Hence, the moulting scheme is characteristic for the individual hawk not until the second moult.

Conclusion

In the preceding sections it was shown that individuals from *Accipiter* populations can be recognized by the feathers shed during the nesting season. Due to the great variability of various features of feather morphology they can be distinguished from each other, whereas constancy of these features for the consecutive adult plumages of any given bird makes it possible to establish its presence over the years. Comparison of the various morphological characteristics should not be carried out with rigidity. Small differences in feathers of subsequent moults may occur; they have to be weighed against similarity in other features.

Unfortunately the transition from immature to adult plumage interferes with a universal application of this method. In such cases two ways-out are possible. Firstly, the behaviour of the bird at the breeding place is often characteristic. Secondly, secondaries and rectrices which have not been shed in the first moult are shed during the nesting season of the second year. When compared with the feathers of the first moult, they may provide information on the bird's identity.

Although the method has been applied to one genus only, we suggest that it is applicable to other raptors as well, and probably also to other solitary birds which moult in a restricted area (near the nest) and show in their feather morphology a good deal of individual variability. Tentative examination of a number of flight feathers of Buzzard *Buteo buteo* and Honey Buzzard *Pernis apivorus* has substantiated our impression. Admittedly the technique has its restrictions, as any method has, but it may be worth testing its validity in other species.

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P. OPDAM
Zoological Laboratory
Dept. of Animal Ecology
Toernooiveld — Nijmegen
the Netherlands

G. MÜSKENS
Cranenburgse straat 47
Groesbeek
the Netherlands