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IDENTIFICATION GUIDE TO THE FEATHERS OF EUROPEAN BIRDS IN PREPARATION

Gabriel Hartmann
Station 24, 6063 NP Vlodrop, The Netherlands
Email: HartmannGa@AOL.com

Abstract

The identification of bird strike remains has two approaches: microscopic and macroscopic. The microscopic approach is necessary if only small feather fragments or blood traces are found, but it is rather expensive because it requires special equipment and training.
In contrast, the macroscopic approach has the advantage that it can rely on direct visual comparison and does not need expensive instruments. This method is useful if bigger feather remains (or other body parts) are found. Whereas there are already some identification keys to microscopic feather analysis of European birds, a complete guide to macroscopic feather identification is still missing. Such a guide to the feathers of European birds is in preparation and its concept is presented by the main author. The main part of the book will be formed by more than 600 large colour photos, which will show a full set of primaries, secondaries and tail feathers as well as a selection of coverts and body feathers of each bird species. The feathers of most passerines will be illustrated in natural size for easy comparison. Detailed species accounts will describe colouration, structure, measurements and distinguishing features of similar species. The objective is to enable airlines and airports to identify macroscopic feather remains from bird strikes as much as possible on their own instead of having to send them to experts.

Key Words: Feather identification, Bibliographic.

1. Introduction

Feather identification is of crucial importance to the investigation of aircraft accidents (e. g. BENTZ 1982, BENTZ & BROM 1990, BROM & BENTZ 1991). In order to evaluate and prevent the severe hazards birds can cause to aviation it is important to know what bird species are involved. After a bird strike often the only part that remains of the bird are a few feathers or feather fragments. The identification of such remains has two approaches: microscopic and macroscopic. The microscopic approach involves the analysis of downy feather structures under the microscope and in some cases biochemical examination or even DNA extraction. This method is necessary if only small feather fragments or blood traces are found, but it is rather expensive because it requires special equipment and training.
In contrast, the macroscopic approach has the advantage that it can rely on direct visual comparison and does not need expensive instruments. This method is useful if bigger feather remains (or other body parts) are found.

Whereas there are already some elaborate identification keys to microscopic feather analysis of European birds (BROM 1991, PRAST & SHAMOUN 1997), literature on macroscopic feather identification is scarce and a complete illustrated guide is still missing, especially one with colour photos. The guide to pellets and pluckings by MÄRZ (1969, revised edition reprinted 1987) contains hardly any images and its very short texts do not provide sufficient details for identification. The series by HANSEN et al (1973-1998) is limited to the tail feathers of central European species and contains only black and white drawings. The popular guide by BROWN et al (1987) covers less than half of the European species and only illustrates 3 or 4 feathers per species on drawings. The promising work of BUSCHING (1997), which was planned in 10 volumes over 20 years, was unfortunately stopped by the publisher.

Faced with this lack of a practical guide, one and a half years ago I decided to develop a feather identification book based on colour photos. The project is already well advanced. Several publishers have expressed interest to print the book, but additional finances have to be found because of the high production cost.

2. Material and methods

The basis for this work is a large feather collection, which I have assembled over 15 years with the help of many institutions, and which is stored at the Zoological Museum of the University of Hamburg. From there the needed material is borrowed. Missing species are loaned from other collections. The plan is to illustrate and describe the feathers of nearly all European bird

species (more than 500) on about 800 pages of the format 24 x 34 cm. Only a few species may have to be left out due to the lack of material.

The main part of the book will be formed by more than 600 large **colour photos**, which will show a full set of primaries, secondaries and tail feathers as well as a selection of coverts and body feathers of each bird species. The feathers of most passerine species will be illustrated in natural size for easy comparison. Larger species will be depicted in reduced size, but it is tried to show similar or related species in the same scale. The feather types on different illustrations will be always arranged in the same way. Since a bird has two symmetrical halfs, only the feathers of the right body half are shown so that the illustrations are easier to compare with each other. If the sexes and / or age groups show considerable differences, two or even three full illustrations may be dedicated to one species. Minor variations of sex and age that are restricted to only a few feathers will be illustrated in smaller illustrations within the text section.
A lot of effort has gone into finding out the best colour reproduction procedure. The feathers are glued with their calamus on grey cardboard and scanned directly with a high resolution scanner that is especially calibrated for this task. This method proved to yield better and more repeatable results than taking photographs with a camera, although it is much more time consuming. The feather sheets of large species measure up to 105 x 150 cm and have to be scanned in up to 32 separate pieces to be pasted together in an image manipulation programme afterwards. There are some problems that can occur during scanning and especially during printing, such as moiré patterns and Newton rings caused by interferences of the feather structure with the scanner resolution and screening resolution, but these problems were solved with the help of experts.

The **species accounts** will be facing the corresponding illustrations for easy references. They are written in a compact style without unnecessary verbs and articles to keep them as short as possible. The text is subdivided into 4 paragraphs. The first paragraph describes the colouration of the feathers, taking into account the differences between the sexes and age groups if relevant. The colour names will be illustrated by colour swatches in the introduction of the book and will be as simple as possible.
The second paragraph treats structural aspects. It states the number of primaries, secondaries and tail feathers, the position of the longest ones, the length differences to the shortest inner and outer ones (expressed in percent of the longest ones), and their shapes (emarginations, tip shapes, exceptionally wide or narrow feathers etc.).
The third paragraph gives the measurements of the longest primary and longest tail feather. In addition to the measurements taken directly on isolated feathers, a method has been developed to convert the wing and tail measurements from other sources into feather measurements. This is done

by measuring the wing and tail of a bird and then measuring the longest primary and longest tail feather of the same bird after plucking it. Thereby the ratio between wing length and primary length and the ratio between tail length and the length of the longest tail feather can be determined for each species where sufficient material is available. The ratio is then used for the conversions.
The fourth paragraph lists similar species and their distinguishing characters. In difficult cases, the problematic species may be compared in a table, such as figure 2.

The species accounts will be preceded by **family accounts**, which summarize the common and typical features of each family, including a brief summary of the moult schedule. When a feather or plucking is found, a rough identification key by size should help to determine to which families the feather may belong by limiting the number of families in question. This key is only for flight and tail feathers. In order to use the key, it is necessary to know the approximate position of the feather in the wing (which is easy with a little practice) and measure it. By comparing the measurement with the diagram in figure 1, one arrives at a certain size range, for example “Thrush-size”. A list will specify all the families and species that fall into that size category and the user can then check out the respective family accounts and species accounts to fine tune the identification. As a last verification, the similar species listed in the last paragraph of each species account can be referred to in order to see if any confusion with them is possible.

3. Results

Example of a species account

322 *Anthus trivialis* Tree Pipit

Colouration. **Adult**. Flight-feathers medium to dark brown-grey, inner webs grading to light brown-grey on edge. On outer primaries this brightened area of inner web quite well defined by borderline running from emargination notch to base of shaft. P9 with sharp off-white or cream-white outer fringe, following primaries with sharp and narrow yellowish-cream outer fringes, turning light grey-brown and more poorly defined on inner primaries and secondaries but broadening towards tertials. Tertials (S7-S9) black-brown, basal half of inner web grading to medium brown-grey; broad but poorly defined light brown to light olive-brown fringes along outer web, broadest towards tip where they extend a little to distal part of inner web. Fringes of tertials and outer primaries bleach to cream or off-white when worn. Shafts of all flight-feathers coloured similar to adjacent webs or slightly darker. Greater and medium secondary coverts dark brown with broad cream to off-white distal fringes.

Figure 1. Rough identification key to size categories, based on the measurements of the flight and tail feathers.]

T1 dark grey-brown to black-brown with broad but very poorly defined light olive-brown to light greyish-brown fringe along outer web and narrower one along inner web and tip. T2-T5 black-brown, base of inner web slightly brightened to medium brown-grey; sharp and narrow outer fringes coloured light grey-brown, paler towards T5. T4 sometimes with small white spot on tip. T5 with larger white spot or small white wedge on tip of inner web, often extending to outer web on tip and tinged very faintly brown-grey when fresh. This spot or wedge 2-14 mm long, exceptionally 20-30 mm (ROSELAAR in CRAMP 1988), variation independent of sex or age. T6 divided diagonally into outer white and inner black-brown part with very narrow off-white inner fringe; dividing line starts at base of outer web, crosses shaft below middle and ends at distal quarter or third on or near inner web's edge. Distal part of outer web washed light or pale brown-grey, white portion of inner web tinged faintly brown-grey when fresh. Shafts of T1-T5 coloured similar to adjacent webs,

slightly lighter towards base. In some individuals dark shaft of T5 continues to tip, creating a spear-like extension into white spot. T6 with dark shaft almost to tip, contrasting with white webs. Under tail-coverts cream.
Juvenile. Very similar to adult, but under tail-coverts with dark brown shaft streak.
Structure. **Wing**: 10 primaries. P7 longest, P8 exceptionally equally long or slightly longer. P1 20.5-24.8% shorter (n=14), P9 1.2-5.5% shorter (n=38), P10 about 88% shorter. 9 secondaries. S1-S6 with little length differences. Tertials (S7-S9) elongated, S7 reaches 84.2-96% of longest primary (n=32) and lies in length between P5 and P6. **Tail**: 6 pairs of feathers. One or several of (T3-) T4-T5 (-T6) longest, most frequently T5 (GRÖSSLER 1981). T1 4.5-10% shorter (n=10). Longest tail feather about 89-93% of longest primary (n=2), length lies in middle between P5 and P6. **Feather shapes:** Emarginations on outer webs of P6-P8 (P6 indistinct) and faintly on inner webs of P7-P9. Tips rounded on outer primaries, slightly notched on inner primaries and on S1-S6, rounded to bluntly pointed on tertials. Tail feathers rather narrow, tips pointed (especially in juveniles), more rounded on T1. Lateral curvature of outer tail feathers very slightly S-shaped.

Measurements. **Longest primary:** 69-78.5 mm (n>112). Converted wing measurements from ROSELAAR in CRAMP (1988): male c. 70-81 mm, female c. 68.5-77 mm (conversion ratio 84.1-85%, n=3). **Longest tail feather:** 59.5-74.5 mm (n>206). Converted tail measurements from ROSELAAR in CRAMP (1988): male c. 60-70 mm, female c. 60-66.5 mm (conversion ratio 110.5-111.2%, n=2).
Similar species. Very similar to ***Anthus pratensis*** and ***Anthus cervinus*** (see fig. 3 for distinguishing characters). ***Anthus spinoletta*** in average bigger, fringes on all feathers greyer, white field on T6 smaller with dark shaft penetrating less into white field. ***Anthus petrosus*** with greyer fringes, light fields on T5 and T6 sullied darker grey-brown and smaller***. Anthus novaeseelandiae*** and ***Anthus campestris*** in average larger, fringes "warmer" brown or cream without olive-brown tinge, T5 and T6 with more white. ***Emberiza citrinella, E. cirlus, E. hortulana, E. cia, E. schoeniclus*** and ***Calcarius lapponicus*** in average larger (especially tail feathers), tertials not or very little elongated, white on inner edge of flight-feathers, fringes more red-brown, tail feathers blacker with different distribution of white on T5 and T6. **Flight-feathers of *Lullula arborea*** generally smaller***. Calandrella brachydactyla*** and ***C. rufescens*** with reddish-brown tinge on all feathers and more brightened inner webs of flight-feathers.

Example of an illustration: See Figure 3.

Figure 2. Example of a table comparing 3 species that are difficult to distinguish (Meadow Pipit Anthus pratensis, Tree Pipit A. trivialis, and Red-throated Pipit A. cervinus). Based on a manuscript by Axel Müller.]

Figure 3. Example of an illustration in the planned book (Tree Pipit Anthus trivialis, adult). The abbreviations below the feathers will be explained in the introduction of the book.]

4. Discussion

The objective is to enable airlines and airports to identify macroscopic feather remains from bird strikes as much as possible on their own instead of having to send them to experts. However, this is not the only area of application. Historically, the identification of isolated feathers became relevant in the context of the research on the diet of birds of prey by UTTENDÖRFER (1930, 1939, 1952), MÄRZ (1953, 1956, 1969) and later authors. Feather identification has also been applied in proving species records for particular localities (e. g. BUSCHING 1990a & 1990b), in population studies of birds of prey (e. g. OPDAM & MÜSKENS 1976, ZIESEMER 1983), in recording bird migration (RISTOW et al 1986), in moult studies based on shed feathers found in the wild (OPDAM & MÜSKENS 1976, SNOW & SNOW 1976, DEN BLANKEN et al 1981, WALTERS 1978 & 1979), in archaeological work (HARGRAVE 1965, MESSINGER 1965, BENNIKE & DYCK 1986), and even in forensic science connected to wildlife law enforcement (DAVIES 1970,

ROBERTSON et al 1984), food contaminations (OLSEN 1981), and criminology (DEEDRICK & MULLERY 1981, LIPSKE 1982).

The book should cover as many of these areas of application as possible. It should address not only the aeronautic industry, but anyone who ever found a feather and wondered from what bird it came, be it a forest ranger, a hobby ornithologist, a customs officer or anyone else. It should also help bird ringers and museum workers who work on live birds and skins to discover fine details of identification that are not found in other guides. Therefore, it will treat ALL European species, not just those which are likely to cause strikes to aircraft. Evidently, many of the species will be hardly ever involved in strikes.

All the applications listed above have different starting-points. For most purposes, it would be sufficient to illustrate only the primaries, secondaries and tail feathers because they are the largest feathers and most commonly found. This would justify to simplify the colour plates by omitting the coverts and body feathers. However, it is exactly these small feathers that are often found in bird strikes. Therefore, the body feathers and coverts have been included on the illustrations. Thereby the illustrations become very full and it may be confusing when looking at them for the first time. One way of making the images less full would be to divide them into several smaller images that illustrate only one type of feathers at a time, but this would result in a very large number of small pictures that would be even more confusing. The advantage of concentrating all feathers of one species on a single illustration is that they can be seen at one glance. Since the position of the different feather types will be the same on each image, it should not take long to locate the feathers of a particular body part on the image.

In most cases, the colour and size of the feathers are the most important features for identification. However, the length relationships within the feathers and their shapes can also provide important information, especially in species of very similar colour and size, such as the 3 pipit species listed in figure 3. The length difference between the longest primary and the innermost one (P1), expressed in percent of the longest one, is similar to the primary index introduced by KIPP (1959). The primary index measures the length difference between the wing tip and the tip of the first secondary (S1) on the closed wing, expressed in percent of the wing length. This index is correlated to the migratory habits of each species and subspecies. Long-distance migrants have higher indexes than short-distance migrants and residents. For applying a similar index to lose feathers, the length difference from the longest primary to P1 was taken instead of the difference to S1, because S1 can be difficult to distinguish from the neighbouring secondaries. Expressing this index in percent rather than in millimetres has the advantage that it is proportionate to the size of the bird and thus varies much less between individuals than absolute measurements in millimetres do. In the example of the 3 very similar

pipit species in figure 3, it is obvious that ***Anthus cervinus*** and ***Anthus trivialis***, which migrate further than ***Anthus pratensis***, have a longer index than ***Anthus pratensis***, which migrates least of the three species. Another characteristic is the length difference between the longest primaries and the outermost ones, again expressed in percent of the longest one. This measurement indicates the amount of roundedness of the wing and is often correlated to age. In juvenile birds, the outer primaries are often relatively longer than in adult ones. In the Lapwing Vanellus vanellus, there are even differences between the sexes. The reduced outermost primary (P10) of many passerines and the remicle of non-passerines are often so much shorter than the preceding primary that they are considered separately. In the case of the tail feathers, the length difference between the longest and shortest one, expressed in percent of the longest one, indicates the amount of roundedness of the tail or the depth of the tail fork.

It may be desirable to include a description of the moult schedule of each species in the species accounts, but the limited space does not allow this and it is not absolutely necessary for the identification of feathers. A summary on the general moult patterns of each family is given in the family accounts, and further details for different species can be found in CRAMP et al (1977-1994) if needed. Distribution maps of each species cannot be included, either, due to the lack of space, but information on the distribution and habitat of each species can be found in most ornithological field guides, and at least one of these guides will be on the book shelf of anyone working with birds.

The identification key presented in figure 1 is only intended as a rough classification. A detailed identification key with many numbers and branches was felt to be too complicated and would not be used by most people, anyway. Instead, the colour photos themselves provide the best identification key.

Even though this work is limited to European species, the family accounts will summarize many common features that also apply to related non-European species, which may allow airlines flying outside of Europe to identify feathers at least down to the family level.
Nevertheless, it is clear that this work has its limitations for the identification of bird strike remains. The majority of bird strike remains consist of microscopic feather parts, for which the macroscopic approach presented here has little to offer. The microscopic approach has generally been favoured for bird strike identification (BROM 1991). The reason is that the microscopic approach can be also used for identifying macroscopic remains, whereas the macroscopic method cannot be used for microscopic remains. However, there are several advantages of macroscopic identification.
1) The macroscopic approach is cheaper because it does not need special equipment like microscopes, and it does not require technical training.

2) In cases where macroscopic remains are found, the method of direct visual comparison with the images in the book will often lead to the identification more quickly than the microscopic method.
3) The microscopic characters are in many cases not distinct enough between species to allow identification to the species level because they can only concern structural differences (colours are more or less irrelevant under the microscope). Although this can be also true for macroscopic characters, the differences between closely related species tend to be clearer on the macroscopic level because in addition to structural differences the differences in colour can be used.
4) According to BROM (1991), the macroscopic approach also has the advantage that the age of the bird can be often determined by the colour pattern of the feather, whereas microscopic investigations generally do not show any difference between the feathers of adult and juvenile birds.
For the best results, however, both approaches should be combined.

Any suggestions by people involved in bird strike identification on how to improve the concept are welcome.

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