

## A COMPUTER BASED BIRD REMAINS IDENTIFICATION SYSTEM

W Prast<sup>#</sup>, C S Roselaar<sup>\*</sup>, P H Schalk<sup>#</sup> & J Watter<sup>\*</sup>

<sup>#</sup>Expert Center for Taxonomic Identification  
Mauritskade 61, 1092 AD Amsterdam, The Netherlands

<sup>\*</sup>Institute for Systematics and Population Biology/Zoological Museum  
PO Box 94766, 1091 AT Amsterdam, The Netherlands

### ABSTRACT

The demand for expertise on identifying bird remains is growing but requires experts knowledge. As the number of experts is limited, a user friendly computer information and identification system for bird remains is being developed based on ETI's Linnaeus II software. The system consists of a multimedia database which stores detailed textual and pictorial information on feather structures and specific DNA sequences of birds. A computer guided identification system assists the user to recognise and use the identification characters and to identify the taxa. In addition general information about bird species: descriptions, colour pictures on the bird and its eggs, distribution maps, specific calls and sonograms is being stored. The first version of the bird remains identification system will concern 75 European species and will be released on CD-ROM. An international network of ornithologists, working together to create a database of all bird species is proposed.

# A Computer Based Bird Remains Identification System

W. Prast<sup>#</sup>, C.S. Roselaar<sup>\*</sup>, P.H. Schalk<sup>#</sup>, & J. Wattel<sup>\*</sup>

<sup>#</sup> Expert center for Taxonomic Identification  
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**Abstract.** The demand for expertise on identifying bird remains is growing but requires experts knowledge. As the number of experts is limited, a user friendly computer information and identification system for bird remains is being developed based on ETI's Linnaeus II software. The system consists of a multimedia database which stores detailed textual and pictorial information on feather structures and specific DNA sequences of birds. A computer guided identification system assists the user to recognize and use the identification characters and to identify the taxa. In addition general information about bird species: descriptions, color pictures on the bird and its eggs, distribution maps, specific calls and sonograms is being stored. The first version of the bird remains identification system will concern 75 European species and will be released on CD-ROM. An international network of ornithologists, working together to create a database of all bird species is proposed.

## Introduction

The identification of bird remains is of great importance to aviation. Birds collide frequently (tab.1) and those that end up in the engines or against screens of airplanes cause a damage of millions of dollars worldwide. In addition, birds colliding with planes form a hazard for both passengers and those living on the ground. Also in other fields like archeology, criminology or studies on food consumption of carnivores, and for example in enforcement of nature protection laws, identification of bird remains is an important tool.

In all these cases remains of birds, sometimes very tiny, have to be identified. Such remains may consist of pieces of feather, skin and blood and it requires special expertise to identify these. Once the species is known, information on migration routes, cruising height, flocking, foodweb relation etc. can be accessed in literature.

The number of specialists on identifying bird remains is limited and are scattered over the world. With increasing airplane densities, and a growing concern for nature conservation, the demand for this type of knowledge is growing. There is a clear need to concentrate what is presently known on bird remains identification characters and make it worldwide available in an easy accessible and applicable way. In many ways publications on paper don't suffice as a medium. The number of pictures that can be published is limited due to costs, while good useful keys demand an interactive medium, allowing the user to start with characters known (or remaining), instead of a rigid dichotomous key.

Modern day computer technology offers an innovative tool to document the knowledge on bird remains and expert systems can assist the user in the identification process. ETI and the the Department of Ornithology of the Zoological Museum in Amsterdam have started a project to apply interactive multimedia computer tools for the identification of bird remains. We here present a preliminary report of our efforts based on the use of the Linnaeus II interactive taxonomic software. First results are presented here and we actively solicit comments, suggestions and input from ornithologists and others who are working on the identification of bird remains.

| Bird taxa                  | Total number of bird strikes identified microscopically | Number identifiable to species by large feather remains | percentage of total |
|----------------------------|---|---|---------------------|
| Pelecanidae                | 1   | 0   | 0                   |
| Ardeidae/Ciconiidae        | 5   | 5   | 100                 |
| Anatini                    | 21  | 10  | 48                  |
| Anserini                   | 5   | 4   | 80                  |
| Accipitridae               | 22  | 34  | 87                  |
| Falconidae                 | 15  | 13  | 72                  |
| Galliformes                | 4   | 4   | 100                 |
| Rallidae                   | 1   | 1   | 100                 |
| Haematopodidae             | 5   | 5   | 100                 |
| Charadriidae/ Scolopacidae | 53  | 17  | 32                  |
| Laridae/Sternidae          | 160   | 54  | 34                  |
| Columbidae                 | 57  | 36  | 63                  |
| Apodidae                   | 210   | 205   | 98                  |
| Cuculiformes               | 1   | 1   | 100                 |
| Psittaciformes             | 480   | 150   | 31                  |
| Strif. Aves spec.          | 53  | 0   | 0                   |
| Total No.                  | 1170  | 623   | 53                  |

Table 1. Taxa recognizable on microscopic structure of feather barbules in the bird strike records of the Royal Netherlands Air Force for the period January 1985 - July 1994.

**Linnaeus II software**

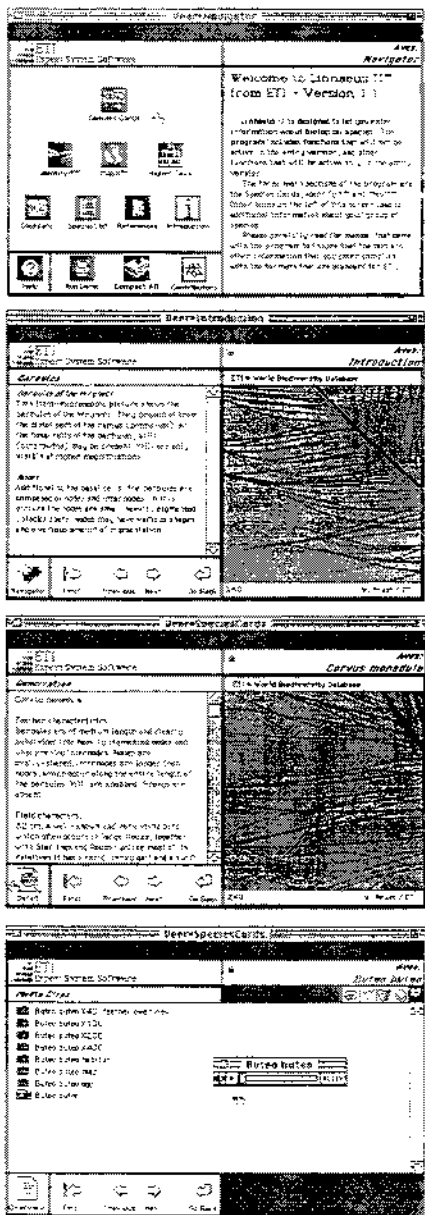
ETI has developed an interactive multimedia software package for biodiversity documentation, named Linnaeus II. It allows specialists to store various types of information on species in text, pictures, videos and sounds. Linnaeus II runs on both Macintosh and Windows computers and offers a standardized format for biological data (Schalk, 1992; Estep et al., 1993). In addition to a multimedia species database the specialist can construct novel "multiple entry" identification systems. This system will allow users, contrary to traditional dichotomous keys, to start with any known character to begin the identification. The computer assists in the identification process by suggesting other characters to be used to decide between species and by giving "hit" percentages for the targeted species. The Linnaeus II system has various on-line help functions, describing the character/states in text and pictures as well as instructions how to use them. Hyperlinked texts provide means to look up specific terms and their definitions or special methods in an interactive glossary. Therefore data entered in this information and identification system will open up taxonomic keys also to relative laymen or students and these programs may therefore also be used as a modern teaching tool (Schalk & Los, 1994).

**A Bird Remains Identification System**

To identify bird remains, the skill and experience of the scientist plays an important role in determining the success of the identification process. A major problem is that this type of information is not readily available in the literature. This is mainly caused by the fact that the used characters on feather features have to be recognized visually but are extremely difficult to describe in text. Publishing a thousand microscope photographs on various feather parts and structures in a traditional way is too expensive, but textual descriptions lead to confusion and to keys which are difficult to apply.

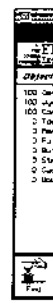
However, in digital form the number of plates used and stored do not raise the costs of reproduction and therefore multimedia software offers great opportunities to taxonomists depending on graphical information to describe their organisms or identification characters. As no completely illustrated key based on feather characteristics has ever been published, the project on a Bird Remains Identification System described here, sets out to do so.

With the help of a light microscope and the Bird Remains Identification System, also non-experts like airbase personnel will be able to identify what species of birds are involved in bird strikes. However, iden-

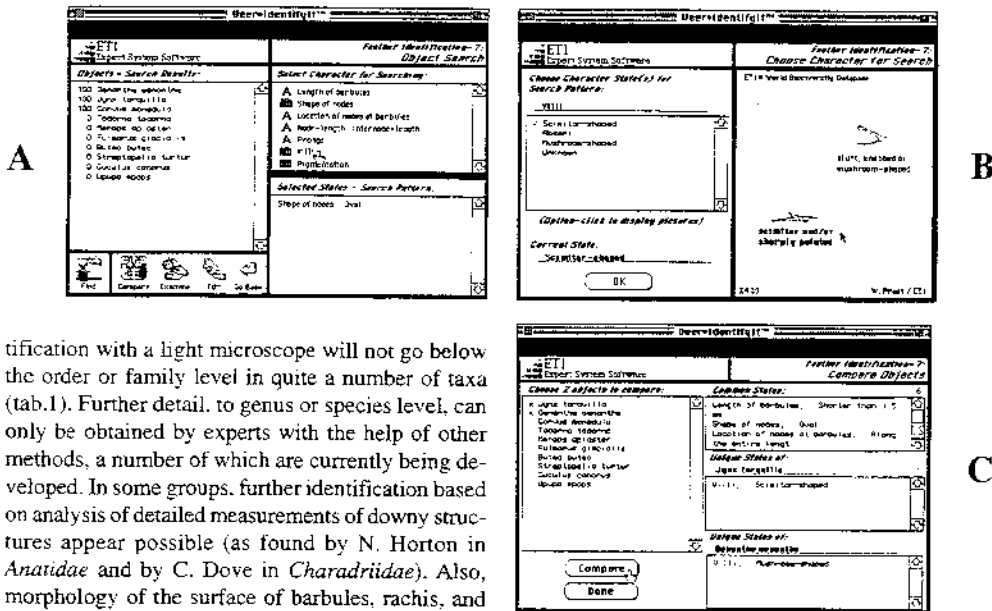


A  
B  
C  
D

Fig. 1 A. The "navigator" screen is the central place from which the various sections of the Bird Remains Identification System (BRIS) can be reached. E.g.: B. The "Introduction" section informs on how to use the program and provides the user with general information on birds and bird remains identification characters and methods in particular. C. The "Species" screen contains a short description and an overview picture for quick reference. The "detail" button on the lower left leads to extensive data. D. The "Detail" screen gives access to the various database fields: description, taxonomy, synonyms, literature, and multimedia. The latter contains a list of all picture, sound and movie files, which can be accessed by a simple click.



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tification with a light microscope will not go below the order or family level in quite a number of taxa (tab.1). Further detail, to genus or species level, can only be obtained by experts with the help of other methods, a number of which are currently being developed. In some groups, further identification based on analysis of detailed measurements of downy structures appear possible (as found by N. Horton in *Anatidae* and by C. Dove in *Charadriidae*). Also, morphology of the surface of barbules, rachis, and rami (worked out by K. Perremans) and transverse sections of these (worked out by J. Dyck) may offer possibilities, though perhaps not for all taxa. High reliability to the species level can be expected from keratin protein electrophoresis (developed by H. Ouellet and co-workers), provided that at least 10 mg of feather remains is available. Perhaps the best method for identification to species level are the "finger prints" obtained from base-sequences of amplified parts of the mtDNA, for which even tiny smears of blood or tissue are sufficient for diagnosis. This method, which requires relatively simple molecular biological techniques, is now in use by J. Hermans for identification of tiny remains of bird strikes supplied by the Royal Netherlands' Airforce. Though the databank of the European Molecular Biological Laboratories (EMBL) presently contains base-sequence data of less than 100 bird species, this number is rapidly expanding through the efforts of Hermans to obtain sequence data for those birds most commonly involved in bird-strikes (tab.2). The data from biochemical research, plates showing detailed structures of feathers and down, and base-sequence data can be stored in the Linnaeus II software.

ETT's Bird Remains Identification System aims, in its first development phase, at storing information on about 75 European birds most commonly involved in bird-strikes (tab.2). At present we concentrate on documenting knowledge on those feather structures that can be seen through a light microscope and on specific parts of mtDNA from bird tissue, as well as on building identification systems. Some examples of the on screen information are given (fig1, 2, and

Fig.2. The IdentifyIt module in de Linnaeus II software offers an easy to use tool for identifying bird remains. E.g. A: The first screen shows the species names on the left and the identification characters on the top right. After selection of a particular character, the computer offers a screen (B) with character states which can be chosen. For easy identification all states can be linked to illustrations (drawings, photographs) but also to sounds and videos, which pop up on the right. More states can be selected if one is not sure. The result of the identification is visible on screen A as "hit" percentages of character/state matches which will appear in front of the species names. C: The "compare" mode of the program allows the user to compare two species on the "hit list". The program will then show common and unique character/states for these species, thereby guiding the choice of the user.

| NON-PASSERIFORMES                        |        | PASSERIFORMES                       |        |
|--|--------|-------------------------------------|--------|
| 1 Swif Apus apus                         | 206    | 1 Skylinek Alcedo arvensis          | 29     |
| 2 Lapwing Vanellus vanellus              | 48     | 2 Barn Swallow Hirundo rustica      | 24     |
| 3 Black-headed Gull Larus ridibundus     | 21     | 3 Chaffinch Fringilla coelebs       | 24     |
| 4 Common Buzzard Buteo buteo             | 27     | 4 Swallow/Martin Hirundo/Delichon   | 22     |
| 5 Rock/Racing Pigeon Columba lina        | 23     | 4 Starling Sturnus vulgaris         | 17     |
| 6 Kestrel Falco tinnunculus              | 10     | 5 Fieldfare Turdus palustris        | 9      |
| 7 Herring Gull Larus argentatus          | 11     | 6 House Martin Delichon urbica      | 7      |
| 8 Wood Pigeon Columba palumbus           | 11     | 7 Redwing Turdus iliacus            | 7      |
| 9 Mallard Anas platyrhynchos             | 9      | 8 Song Thrush Turdus philomelos     | 6      |
| 10 Common Gull Larus canus               | 8      | 8 Thrush Turdus socot.              | 6      |
| 11 Gyrfalcon Falco gyrfalco              | 5      | 9 Meadow Pipit Anthus pratensis     | 5      |
| 12 Grey Heron Ardea cinerea              | 5      | 10 White Wagtail Motacilla alba     | 3      |
| 13 Grey Partridge Perdix perdix          | 4      | 11 Jackdaw Corvus monedula          | 3      |
| 14 Golden Plover Pluvialis aprinaria     | 4      | 12 Crow Corvus corone               | 3      |
| 15 Common Sandpiper Gallinago gallinago  | 4      | 13 Brambling Fringilla monticola    | 2      |
| 16 Black Kite Nisus niger                | 3      | 14 Linnet Carduelis cannabina       | 2      |
| 17 Black-tailed Godwit Limosa limosa     | 3      | 15 Rook Corvus frugilegus           | 2      |
| 18 Red-throat Tringa totanus             | 3      | 16-24 9 various species             | each 1 |
| 19 Lesser Black-backed Gull Larus fuscus | 3      |                                     |        |
| 20 Goshawk Accipiter gentilis            | 2      |                                     |        |
| 21 Sparrowhawk Accipiter nisus           | 2      |                                     |        |
| 22 Bar-tailed Godwit Limosa lapponica    | 2      |                                     |        |
| 23-34 12 various species                 | each 1 |                                     |        |
| In total, 34 species in 442 strikes      |        | In total, 24 species to 180 strikes |        |

Table 2: Bird-strike records of the Royal Netherlands' Air Force. Birds macroscopically identified to species January 1985 - July 1994.

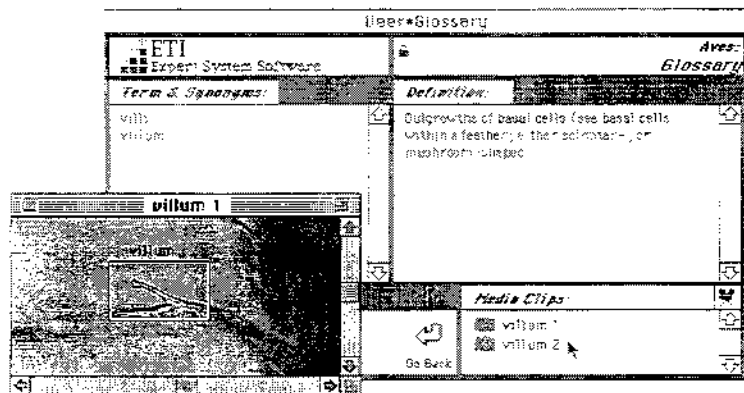


Fig.3. Linnaeus II is fully interactive. This means that it is very easy to move from any section in the program to any other and return. For instance all text is hyperlinked. Clicking on an unknown word in the text sections of the program will lead of to a glossary of terms, where a definition and when necessary an illustration or movie is provided.

3). The Bird Remains Identification System thus being constructed can easily be expanded with other types of information that will make the system even more broadly applicable. As all the information is digitally available in a standardized format, it is easy to link the feather and DNA data to ETI's "Birds of Europe" database. This database was published on CD-ROM in 1992 and contains general information on (419) European bird species, including descriptions, pictures of each birds and their eggs, a distribution map and their call and sonograms. This system will be of use to scientists as well as to a great number of other users depending on getting access to this type of information.

**International Network of Ornithologists**

ETI's mission is concerned with concentrating, preserving and worldwide distribution of taxonomic and biodiversity knowledge. With international support, ETI started to build the World Biodiversity Database, that will contain multimedia information and identification data on all presently described (±1.4 million) species. To build such a huge biodiversity database, ETI works together with UNESCO to organize, coordinate and support both regional and international networks of specialists who use the Linnaeus II software shell for local database building. Datasets are being sent back to ETI. Working with these networks of specialists ensures standardization and quality control of the data. Completed sets (on a particular taxonomic group or geographic area) are disseminated by ETI on CD-ROMs. The so formed

"digital monographs" can be easily and cheaply, and therefore regularly, updated. The CD-ROMs are free for the authors who composed the programs, while others only pay the costs of production.

We hope that this project to construct a computerized Bird Remains Identification System will stimulate specialists in this field to join forces and make these data available in digital form. This will certainly facilitate and enhance an easy exchange and combination of data. We actively solicit comments from specialists in this field. An international network of specialists on bird remains and ornithologists would form a good start for expanding the here presented system to a system with worldwide coverage.

**Acknowledgements**

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**Literature**

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