

New developments in vertebrate cytotoxicology*

VIII. A current list of references on avian karyology

L. E. M. De Boer

Biological Research Department, Royal Rotterdam Zoological and Botanical Gardens, P.O. Box 532, 3000 AM Rotterdam, The Netherlands

Abstract

A list of 256 references dealing with avian karyology is presented. This list is updated to April 1983 and covers 587 bird species, 385 non-passerines and 202 passerines. It includes 37 non-passerines and 29 passerines that were only studied in the period from 1902 onwards to the early 1950s using less sophisticated techniques (mostly on sectioned material of gonadal tissues). The remaining 348 non-passerines and 173 passerines were studied with more advanced techniques using colchicine-treated material of feather-pulp, embryonic tissue, bone-marrow, leucocyte or tissue culture. The species studied to date belong to 25 of the 26 avian orders and to 96 of the 160 avian families.

Introduction

The last comprehensive review of avian karyology was that published by Ray-Chaudhuri in 1973. It included data and references on cytogenetic studies of 83 species. A few years earlier Bloom (1969) published a list of chromosome numbers of 91 species of birds, while in 1974 Srb presented references on 160 species. The reason for the lower number of species reported by Ray-Chaudhuri was that she did not include references from the older literature in her review. In fact the first reference on avian chromosome studies dates from 1902 (Guyer, on two Columbiformes). From then until the early 1950s some 55 papers were published describing the chromosomes of no less than some 107 species. Nearly all these early studies used material obtained from sectioned gonadal tissues. The results of these

studies are rather inferior to those obtained by the modern techniques introduced in the late 1950s which involve the use of feather-pulp, bone-marrow, embryonic tissue, leucocyte or tissue-culture material, treated with colcemid or colchicine to obtain condensed sharply demarcated chromosomes, and with hypotonic solutions to render well-spread metaphase plates. For this reason, comparison between the results of early and recent studies is difficult, and this led Ray-Chaudhuri to exclude all early studies from her 1973 review. Although Bloom (1969) and Srb (1974) did include the older literature in their lists, many species which had been studied are absent from their tables, while in many other cases they did not refer directly to the original papers presenting karyotypic descriptions but rather to early review papers covering part of the old literature such as Makino's 'Atlas of chromosome numbers in animals' (1951). Thus, the early literature on avian chromosomes is currently inaccessible due to the absence of an adequate list of references.

Since Ray-Chaudhuri's 1973 review no attempt has been made to extensively review the karyolo-

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gical literature on birds. Nevertheless, several brief reports have been published reviewing certain aspects of avian karyology. Shoffner (1974) reported on the general characteristics of bird karyotypes and on the methodology of bird cytogenetics. Shields (1980), Sasaki and Takagi (1981), Tegelström and Rytman (1981) and Shields (1982) concentrated on comparison of numerical chromosome data from 214, 227, 234 and 300 bird species respectively. None of them, however, has presented a complete list of references. Bulatova (1981), finally, published an extensive review exclusively dealing with the karyology of the Passeriformes, including data on 100 species.

Since 1975 the present author and his co-workers have been involved in avian karyology and have studied over 140 species in this period (see Belterman & De Boer, 1984, for a complete list). In connection with these activities extensive records have been kept of the world literature on bird chromosomes. As of April 1983 these records covered data on 587 species, 385 non-passerines and 202 passerines. On realizing that this number is considerably higher than those given in previous reviews or lists and that our records include more detailed references to the early as well as to the recent literature, it was decided to produce a new exhaustive list of references on avian karyology.

The 587 bird species listed here include 64 species (37 non-passerines and 29 passerines) that were only studied with the old techniques of sectioning gonadal material; only part of the species studied up to the early 1950s have been reinvestigated using more advanced techniques. Nevertheless, the remaining 521 species (348 non-passerines and 173 passerines) investigated with modern methods is almost six times as high as the number reviewed a decade ago by Ray-Chaudhuri (1973). This indicates that avian karyology has been rapidly advancing in recent years. Keeping in mind, however, that there are over 9 000 extant species of birds, it must be admitted that the class Aves is still one of the least studied groups of vertebrates. Although karyotypes are known for representatives of 25 of the 26 bird orders, 64 of the 160 families still remain completely unstudied.

Literature cited in the list

The list of avian species which have been studied cytogenetically gives as complete as possible a

survey of all original papers describing bird karyotypes since 1924. Whenever possible reference is made to papers including original illustrations and descriptions. Reference to lists summarizing the species studied by one author or a group of co-authors is avoided as much as possible. Such lists are only referred to with regard to species that were not included in other publications of the same author(s) (e.g. some species of the list of Srivastava & Misra, 1973), or if such species were only described in publications that are more or less inaccessible (e.g. theses).

Similarly, no reference is made to earlier reviews and reference lists that did not include new data at the time of publication (e.g. Makino, 1951; Bloom, 1969; Matthey, 1939, 1950; Herman & Holinsky, 1970; Ray-Chaudhuri, 1973; Srb, 1974). Of the review-like papers that also presented new data (e.g. Shoffner, 1974; Bulatova, 1981; Shields, 1982) only this original information is referred to.

The karyotypes published in the 'Chromosome atlas: fish, amphibians, reptiles and birds' (Vols. I, II and III, 1971, 1973 and 1975 respectively) are included in the list. This work is referred to as 'Chromosome Atlas' rather than as Hsu and Benirschke (co-ordinating editors) or Beçak *et al.* (editors) since the original sources of the karyotypes included are not always clear.

References to abstracts are kept to a minimum. They are only included when they report studies of new species or on the application of new (banding) techniques and only then if no other publications by the same author(s) exist on these topics.

Unpublished work is not referred to. The sole exception to this is a number of species mentioned in Shields (1982) indicated as unpublished work of Shields, Troy and Shields, and Biederman. They are included in the present list because Shields (1982) presents at least some information on karyotypic structure of the species involved.

For those species that have been studied very frequently only a selected series of references is given, covering a chronological overview and representing studies involving the application of various techniques. These species are: *Gallus domesticus*, *Columba livia*, *Anas platyrhynchos*, *Coturnix coturnix*, *Meleagris gallopavo* and *Streptopelia decaocto* ('risoria').

As noted in the introduction, this list is updated to April 1983. However, it is admitted that a number of references may still prove to have been

overlooked, especially more recent ones. Nevertheless, it is hoped that the list will be useful to anyone directly or indirectly involved in avian karyology.

Treatment of data

Karyotypic structure

It is difficult to summarize the karyotypic structure of bird species in the form of numerical formulae including diploid chromosome number, and the numbers of chromosome arms, metacentrics, acrocentrics, macrochromosomes and microchromosomes. The diploid number counted is highly dependent on the quality of the available metaphase plates or the illustrations presented. Often there is no sharply demarcated boundary between macro- and microchromosomes, so it depends on the personal choice of the author(s) involved how many elements are recognized in each category. The numbers of metacentrics, submetacentrics and acrocentrics are dependent on which elements are counted as macrochromosomes and on the quality of the available material; in many cases banded chromosomes appeared to exist among the smaller elements when better metaphase plates became available. Thus, numerical data on bird karyotypes can not be relied on, unless the original illustrations are checked and even then differences in quality hamper sound comparisons.

For these reasons it was decided not to include numerical data in the list presented here. For details of karyotypic structure the reader is referred to the original publications.

Nomenclature

The list follows the nomenclature used by the American Museum of Natural History given in their 'Reference list of the birds of the world' (Morony *et al.*, 1975), which in the cases of the species listed here deviates only slightly from 'Peters' checklist of the birds of the world' (Peters *et al.*, 1934-1979).

Order of presentation

The data are presented according to order and to family. All orders and families are listed, regardless

of whether or not karyological data are available. Two of the larger families of Passeriformes are divided into subfamilies (viz. Muscicapidae and Emberizidae); only those subfamilies of which data are available are listed. Orders and families are arranged according to the traditional sequence as followed in Morony *et al.* (1975). In order to facilitate the use of the list it is preceded by an alphabetical index of orders and families referring to the appropriate page numbers.

Within each family, genera and species are listed strictly alphabetically.

In order to give an impression of the extent of current knowledge on the karyology of the various families, immediately after each family name a code is added giving the number of extant genera and species recognized in the family plus the number of genera and species studied cytogenetically to date and thus included in the list. For example, in the family Accipitridae the code '65/217-26/46' indicates that 65 genera with 217 species are recognized in this family of which to date 26 genera with 46 species have been studied cytogenetically.

Synonyms

Whenever authors have used synonymous names in their original publications these are included in the list, reference is then made to the nomenclature of Morony *et al.* (1975) adopted here (e.g. *Puffinus leucomelas*: see *Calonectris leucomelas*). In these cases the synonym used in the original publication is added in brackets to the reference [e.g. *Calonectris leucomelas*: Yamashina & Udagawa, 1954b (*Puffinus leucomelas*)].

Minor differences in spelling or printing errors in original publications are neglected.

Subspecies

Subspecies are not included in the list. If authors mentioned subspecific names in their original publications (whether as part of the synonymous names or not) these are added in brackets to the reference [e.g. *Penelope jacquacu*: Sasaki *et al.*, 1982 (*P. j. granti*); or *Bonasia bonasia*: Yamashina, 1952b (*Tetrastes bonasia vicinitas*)].

Hybrids

Studies on hybrids are listed under both parental

species. In all cases the second parental species is indicated in brackets after the reference [e.g. *Meleagris gallopavo*: Ohno *et al.*, 1964 (*M. meleagris* × *Phasianus colchicus*) and *Phasianus colchicus*: Ohno *et al.*, 1964 (*P. colchicus* × *Meleagris gallopavo*)]. If hybrids were published using synonymous names of parental species the synonyms of the original publication are given in brackets.

Additional information

Whenever authors have reported studies other than those involving routine chromosome staining techniques (Giemsa, orcein stain) this is added in brackets following the reference (e.g. meiosis, G-, C-, R-, Q-banding, NOR, autoradiography).

Older references, based on studies of sectioned gonadal material are indicated with the addition 'gonads'.

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References

(This section only includes those references given in the above text that do not appear in the references to the list of avian species studied cytogenetically. The complete set of references to the list are given at its end.)

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