KARYOTYPE ANALYSIS IN ORNITHOLOGICAL STUDIES: II THE CHROMOSOMES OF FOUR SPECIES OF AFRICAN BIRDS (NECTARINIDAE, PLOCEIDAE AND STURNIDAE)

Ernesto CAPANNA and Cristina GERALICO

ABSTRACT - The karyotype of four species of East African birds were investigated, i.e. *Chalcomitra amethystina*, *Plocepasser mahali*, *Ploceus intermedius* and *Buphagus erythrorhychus*. The Nectarinid *Chalcomitra* shows an unusual karyotype made up of a large number of minute chromosomes; a comparison between the two Ploceids reveals important karyological differences; the oxpecker shows the basic karyotype of the Sturnidae.

KEY WORDS: chromosomes/Passeriformes/cytotaxonomy

As stressed in a previous paper on bird karyology published in this journal (Calafati & Capanna 1981), in spite of the well known phenomenon of "chromosomal homogeneity" found in birds (Ohno *et al.* 1964), a few interesting results may unexpectedly come to light in a cytotaxonomic approach to problems of bird systematics and phylogenesis. This is particularly true if this karyotype comparison is carried out within lower taxa, i.e. genera and/or families.

Moreover, despite recent important studies (Hammer 1966, 1970; Ray-Chaudhuri 1973; Takagi & Sasaki 1974) our karyological knowledge of the Carinatae still refers to less than 3% of the species. Therefore we deemed it of interest to take advantage of the opportunity of a short stay in East Africa to collect and karyotype a number of resident birds peculiar to this zoogeographic region. The result was a cytogenetical documentation of exotic and rare species which has previous been found to be of interest and utility in a cytotaxonomic approach (Capanna & Merani 1980; Capanna *et al.* 1982).

MATERIAL AND METHODS

All the material came from the region of Afgoje, on the middle reaches of the Scebeli river (Somali Democratic Republic), a sparsely farmed area mainly characterized by degraded un-

Istituto di Anatomia Comparata
University of Rome
Via Borelli, 50
00161 ROME

derbrush. The birds examined herein are all Passeriformes belonging to the following families.

Nectarinidae: two females of the Amethyst Sunbird *Chalcomitra amethystina* (Shaw 1811-12) were examined. As these females were immature, the assignment could be incorrect, as they could be confused with the related species *C. hunteri* (Shelley 1899).

Ploceidae: one male and one female White-browed Sparrow-weaver *Plocepasser mahali* (Smith 1836) and two males of the Masked Weaver *Ploceus intermedius* (Ruppel 1845), were examined.

Sturnidae: one male and one female Red-billed Oxpecker *Buphagus erythrorhynchus* (Stanley 1814) were studied.

The material was preserved in alcohol and deposited at the museum of the Istituto di Anatomia Comparata of the University of Rome.

The chromosomal preparation technique used was that suggested by Calafati and Capanna (1981). It consists of an air-drying technique using bone marrow from birds pretreated in vivo with an antimitotic. Vinblastine sulphate (Velban) was used as an antiblastic drug, while 0.035 M KCl was used as a hypotonic solution. Slides were stained with Giemsa 4% in phosphate buffer pH 7.

Biometric analyses are the result of at least 20 measurements of each karyotype element ; mean relative lenght ($\overline{lr}$) was calculated with reference to the haploid set of the first 10 macrochromosomes, including the Z heterochromosome. An Olivetti P 6060 computer was used for statistical analyses.

RESULTS AND COMMENTS

The karyotypes of the four Passeriformes are reproduced in Fig. 1, their metaphases from bone marrow preparations in Fig. 2 and 3, and the morphometry of the chromosomes is given in Tab. I.

Nectarinidae

The unusually high diploid number (2n=96-100) of the Amethyst Sunbird immediately characterizes the karyotype of this species. Among birds, such high diploid numbers have been found for a Scolopacid (*Gallinago gallinago*, 2n=98, sed. Hammer 1970), a Picid (*Picus viridis*, 2n=94, sec. Hammer 1970) and for a Tytonid (*Tyto alba*, 2n=92, sec. Renzoni and Vegni-Talluri 1966), although even in such systematic contexts they represent exceptional conditions. The high diploid number of the Amethyst Sunbird is exceptional even considering that the diploid number of the Passeriformes, ranges from the 2n=68 of *Strunopastor contra* and *Turdoides striatus* (Ray-Chaudhuri *et al.* 1969) to the 2n=86 of *Saxicola torquata* (Piccini and Stella 1970), as ascertained in numerous species from more than 12 different families.

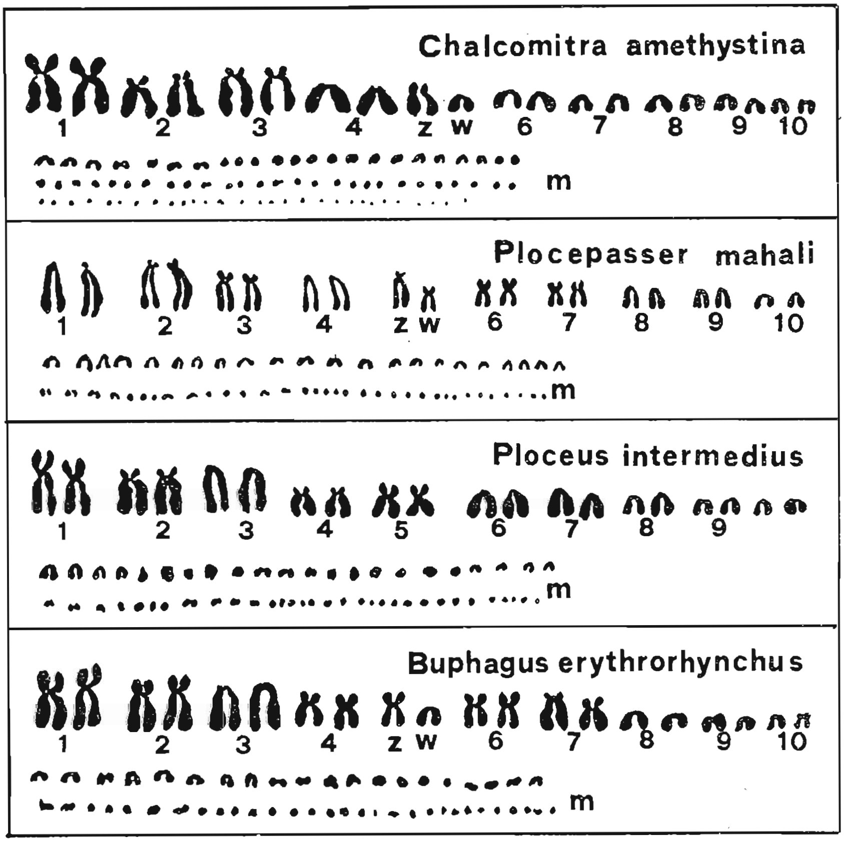

FIGURE 1 - Karyotypes of the four African Passeriformes herein described.

The macrochromosome morphology of *Chalcomitra amethystina* also appears rather unusual, as the biarmed chromosomes are vastly outnumbered by the acrocentrics. Only the first pair is clearly metacentric, while pairs 2 and 3 are subtelocentric, as is the Z heterochromosome. All the other chromosomes are acrocentric. A further unusual characteristic of the Amethyst sunbird karyotype is the small size of the acrocentric macrochromosomes (smaller than the Z heterochromosome). The average length of chromosome 6 is only 1.2 µm, i.e. only slightly larger than the value of 1 µm conventionally accepted as the limit between micro- and macro-chromosomes. The karyotype of *Chalcomitra amethystina* would thus appear to be the result of the genome splitting up into a myriad of

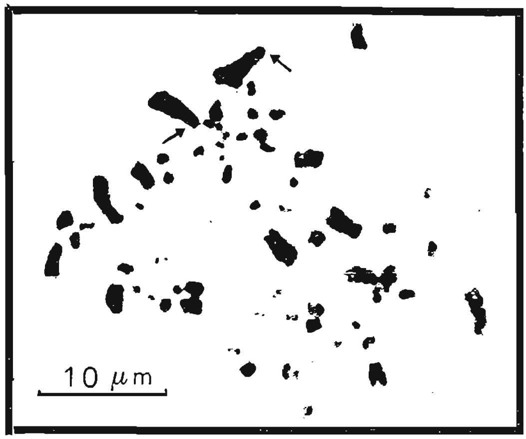

FIGURE 3 - Metaphasic plate of *Plocepasser mahali*; arrows indicate the chromosomes of the 1st pair showing a subtelocentric morphology.

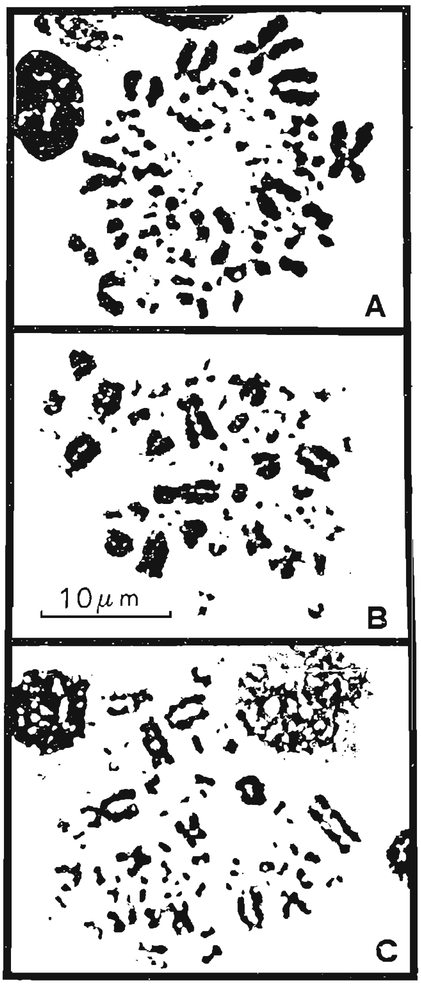

FIGURE 2 - Metaphasic plates from bone marrow preparations;
a - *Chalcomitra amethystina*
b - *Ploceus intermedius*
c - *Buphagus erythrirhynchus*

tiny chromosomes. It is extremely unusual to find a karyotype like this in birds, particularly in the Passeriformes.

TABLE I - Mean lenghts ($\bar{x}$), relative lenghts ($\bar{l}r$) and centromeric indices (ic) of the 10 largest chromosomes of the karyotypes of the four African birds herein investigated. (Mean values from 20 measures; SD = standard deviation).

Chalcomitra amethystina				*Plocepasser mahali*			
no.	$\bar{x}$ ± SD	$\bar{l}r$	ic ± SD	no.	$\bar{x}$ ± SD	$\bar{l}r$	ic ± SD
1	4.45 ± 0.31	21.6	0.36 ± 0.02	1	4.18 ± 0.19	16.2	0.12 ± 0.06
2	3.41 ± 0.29	16.6	0.18 ± 0.06	2	4.06 ± 0.19	15.7	0.21 ± 0.02
3	3.27 ± 0.36	15.8	0.20 ± 0.01	3	3.21 ± 0.02	12.4	0.31 ± 0.02
4	2.40 ± 0.45	11.7	-	4	2.40 ± 0.22	9.3	-
Z	1.58 ± 0.34	7.6	0.26 ± 0.03	Z	2.20 ± 0.21	8.5	0.24 ± 0.06
6	1.20 ± 0.07	5.8	-	6	2.64 ± 0.68	10.2	0.41 ± 0.07
7	1.17 ± 0.10	5.6	-	7	2.44 ± 0.28	9.5	0.45 ± 0.05
8	1.14 ± 0.16	5.5	-	8	1.98 ± 0.08	7.7	-
9	1.10 ± 0.12	5.2	-	9	1.34 ± 0.03	5.2	-
10	0.98 ± 0.10	4.7	-	10	1.34 ± 0.03	5.2	-
W	1.16 ± 0.12	5.6	-	W	1.84 ± 0.34	7.6	0.32 ± 0.03
Ploceus intermedius				*Buphagus erythrorhynchus*			
1	4.96 ± 0.68	18.3	0.33 ± 0.03	1	5.62 ± 1.41	18.6	0.32 ± 0.02
2	3.61 ± 0.02	13.3	0.18 ± 0.08	2	4.58 ± 0.91	15.1	0.31 ± 0.05
3	3.87 ± 0.10	14.4	-	3	3.68 ± 0.76	13.8	-
4	2.27 ± 0.21	10.2	0.23 ± 0.07	4	2.73 ± 0.20	9.0	0.31 ± 0.05
5	2.99 ± 0.02	11.0	0.41 ± 0.02	Z	3.67 ± 0.53	12.1	0.35 ± 0.03
6	3.33 ± 0.12	8.6	-	6	2.69 ± 0.38	8.8	0.38 ± 0.05
7	2.16 ± 0.06	8.0	-	7	2.88 ± 0.49	9.5	0.18 ± 0.04
8	1.84 ± 0.09	6.8	-	8	1.38 ± 0.18	4.6	-
9	1.36 ± 0.03	4.8	-	9	1.33 ± 0.22	4.4	-
10	1.28 ± 0.04	4.7	-	10	1.21 ± 0.19	4.0	-
				W	1.34 ± 0.24	4.4	-

On the other hand, the Nectarinidae are taxonomically distant from the other Oscines whose karyotype is known, and it is quite conceivable that, as our karyo-systematic knowledge of the huge passeriformes order increases, karyological situations will be found on which to base a rational explanation of this unusual karyotype.

Ploceidae

The karyotype of the white-browned Sparrow Weaver and that of the Masked Weaver differ considerably. Although having the same diploid number (2n=74-78) which lies within in the range of variation of the Oscines, their chromosome morphology is radically different. Restricting the comparison to the first 4 pairs of macrochromosomes for the time being, it is apparent (Fig. 1) that the former lacks the pair of large submetacentrics present not only in the latter but also in the other Ploceidae of the genus *Passer* (Castroviejo *et al.* 1969) and in a number of Turdidae, Fringuillidae and Sturnidae (Calafati and Capanna 1981). It must also be borne in mind that, on the basis of G-banding observa - tions, Takagi and Sasaki (1974) clain that this metacentric is shared by the karyotype of numerous orders of both Ratitae and Carinatae. Although there may be some hesitation in accepting such a widespread presence, even restricting our attention to the order Passeriformes, the absence of this marker in the White-browed Sparrow Weaver is an event signifying a sudden interruption in an extensive karyotypic uniformity.

As for the chromosomal mutation mechanisms that may be used to explain this transformation, the deletion of most of the short arm may legitimately be propo sed. In fact, the mean relative length of this metacentric element ranges from 18 to 20 in all those Oscines that, in addition to being karyotyped, have also been subjected to suitable biometric analysis for each pair of macrochromosomes (Ray-Chaudhuri 1973; Calafati and Capanna 1981). Consequently, a mean relative length value of 16.2 for *Plocepasser mahali* is a clear indication of the loss of a large chromosomal portion of metacentric no. 1.

If pairs no. 2, 3 and 4 of the karyotypes of the two Ploceidae investiga - ted here are compared, it is observed that chromosomes no. 2 are identical in the two species. There is also a possible homology between no. 4 of *Plocepasser mahali* and no. 3 of *Ploceus intermedius*. If this were true, no. 4 of *Ploceus in termedius* would be interpreted as deriving from no. 3 of *Plocepasser mahali* by deletion of the terminal section of the long arm.

Also for pairs 6 and 7, differences may be observed when the karyotypes of the Masked Weaver and the Sparrow Weaver are compared; in the latter, they are submetacentrics and in the former acrocentrics. It is worth pointing out, in or der to stress the contradictory nature of some of the cytotaxonomic evidence , that the morphology of pairs 6-10 in *Plocepasser* is the same as that observed in 2 other Ploceidae, i.e. *Passer domesticus* and *P. montanus*, while the arrange ment found in *Ploceus intermedius* closely resembles the karyotype, of some Pari dae e.g. *Parus maior* and *P. palustris* (Castroviejo *et al.* 1969).

Sturnidae

The karyotype of the Red-billed Oxpecker is the same as other species of Sturnidae previously karyotyped, i.e. *Sturnopastor contra* (Ray-Chaudhuri *et al.*

1969), *Sturnus vulgaris* (Calafati and Capanna 1981) and *Sturnus v. poltaratsky* (Bulatova *et al.* 1970). As mentioned previously, the Sturnidae so far apparently display a high degree of karyotypic conservativeness, which is all the more interesting in that it involves both the Sturninae and the Buphaginae.

CONCLUSIONS

There is no doubt that the total available data on bird karyology is still insufficient for a full cytotaxonomic picture to be obtained even for the individual orders. However, as we point out elsewhere (Capanna *et al.* 1982), karyotypic variability can be expected under certain circumstances in the phyletic pattern of birds, i.e. when ecological and ethological factors favour the establishment and spread of a karyotypic transformation in the population. Because of the great vagility of birds and their large population size, this does not happen very often. However, in investigations of resident and territorial species in which the population is split into demes of actual minimal present size, it will be possible to identify cases of chromosomal differentiation also in birds.

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RIASSUNTO

ANALISI DEL CARIOTIPO NEGLI STUDI ORNITOLOGICI: II° I CROMOSOMI DI QUATTRO SPECIE DI UCCELLI DELL'AFRICA ORIENTALE (NECTARINIDAE, PLOCEIDAE E STURNIDAE)

E' stato studiato, su metafasi somatiche del midollo osseo, il cariotipo di 4 specie di Passeriformi dell'Africa Orientale, vale a dire un Nectarinidae, *Chalcomitra amethystina*, due Ploceidi, *Plocepasser mahali* e *Ploceus intermedius*, ed uno Sturnidae, *Buphagus erythrorhynchus*. Il cariotipo del Nectarinidae si è mostrato inconsueto sia per l'elevato numero diploide (2n=96-100) sia per le piccole dimensioni dei macrocromosomi. Dal confronto tra i cariotipi dei due Ploceidi emergono interessanti differenze; infatti il grande metacentrico della I^ coppia, presente in *Ploceus intermedius* e nella totalità degli altri Passeriformi fin ora studiati, si mostra in *Plocepasser mahali* subtelocentrico avendo perduto per delezione gran parte del braccio corto. Al contrario, il cariotipo della Bufaga a becco rosso si mostra eguale a quella degli altri Sturnidi fin ora

studiati cariologicamente.

RESUME

L'ANALYSE DU CARYOTYPE DANS LES ETUDES ORNITHOLOGIQUES: II° LES CHROMOSOMES DE QUATRE ESPECES D'OISEAUX D'AFRIQUE ORIENTALE (NECTARINIDAE, PLOCEIDAE ET STURNIDAE).

Les Auteurs ont entrepris une récherche caryosystématique chez 4 espèces de Passeriformes d'Afrique, c'est à dire 1 Nectarinidae, *Chalcomitra amethystima*, 2 Ploceidae, *Plocepasser mahali* et *Ploceus intermedius*, et 1 Sturnidae, *Buphagus erythrorhynchus*. La Souîmanga améthyste montre un caryotype inhabituel soit pour son numbre diploïde elévé (2n=96-100) soit pour les dimensions menues des macro-chromosomes. La comparaison entre le caryotype des 2 Ploceidés a montré l'absence chez *Plocepasser mahali* du grand métacentrique n.1 présent chez *Ploceus intermedius* et aussi chez tous le Passeriformes jusqu'à ce moment etudiés du point de vue chromosomique; une délétion de la plupart du bras court de ce chromosome a été supposé responsable de la transformation caryotypique. Le caryotype du Pique-boeufs à bec rouge correspond parfaitement à ce qu'on à observé chez tous les autres Sturnidés etudiés.

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