KARYOTYPE ANALYSIS IN ORNITHOLOGICAL STUDIES: THE CHROMOSOMES OF SIX SPECIES OF OSCINES (PASSERIFORMES)

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ABSTRACT - Karyotype morphology of six species of Passeriformes (*Turdus philomelos, T. pilaris, T. merula, Monticola solitarius, Coccothraustes coccothraustes, Sturnus vulgaris*) is studied. Cytotaxonomical interrelationships within Turdidae, Fringillidae and Sturnidae are discussed and the relevance of karyosystematics in ornithological studies is pointed out.

KEY WORDS: Passeriformes / Chromosomes / Cytotaxonomy

In spite of the size and extension of the class Aves, only scanty information is available on bird karyology. As has been shown by recent reviews (Capanna 1973, Ray-Chaudhuri 1973) karyological data are available for only 150 bird species, i.e. little more thah 2% of the 8700 species comprised in the class. Even fewer data are available for the Passeriformes, the karyotype of only 50 species being known, i.e. about 1% (Hammar 1970, Ray-Chaudhuri 1973, Takagi & Sasaki 1974).

The lack of information on this important taxon has two main causes. On one hand, cytologists consider it a difficult task to interpret the typical morphology of bird karyotype, i.e. very large numbers of small chromosomes. Moreover, some workers (Ohno et al. 1964) claim that the karyotype homogeneity found in a number of orders and families is indicative of the inadequacy of such material for the purpose of pinpointing speciation mechanisms linked to karyotype transformation phoenomena, or for seking taxonomic affinity through karyological similarity. On the other hand, uncommon birds frequently represent interesting systematic problems which an appropriate karyological analysis could solve (Capanna & Merani 1980), but ornithologists, who could cooperate with cytogeneticists, have respect for rare birds and are becoming increasingly unwil

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ling to sacrifice the life of even few of them for the purpose of karyological analysis. In fact, the blood and feather pulp culture techniques (Sasaki *et al.* 1968) do not entail animal sacrifice, but these techniques can be applied only to birds of certain size, from Galliformes upwards. In most cases bone marrow from birds pretreated with antimitotic *in vivo* must be used, which of course means sacrificing the animal.

However, we feel that despite these real methodological limitations which apply also to other animal groups (discussed at length by one of us, Capanna 1973, 1975), karyotype analysis can be used also for birds to provide evidence of biological importance in defining certain problems of evolutionary and taxonomic nature. This is particularly true if the analysis and comparison are carried out in taxonomically homogeneous groups, i.e. within the same genus or family.

For this reason, and for promoting a fruitful cooperation between ornithologists and cytogeneticists, we have undertaken the analysis of karyotype in species of birds.

MATERIALS AND METHODS

Six species of Passeriformes belonging to 3 separate families were examined, namely:

Turdidae - the Song Thrush *Turdus philomelos* Brehm,
the Black-bird *Turdus merula* L.,
the Fieldfare *Turdus pilaris* L.,
the Blue Rock-thrush *Monticola solitarius* (L.)

Fringillidae - the Hawfinch *Coccothraustes coccothraustes* (L.)

Sturnidae - the Starling *Sturnus vulgaris* L.

Only one female specimen of Hawfinch and Blue Rock-thrush was studied, while for the other species both sexes were studied. In Blackbird and Starling we examined two individuals of each sex.

The technique used was a modified version of the usual air-drying bone marrow technique (Hsu & Patton 1969) used for mammals. The variations we introduced regarded the dose and administration time of the antimototic and the type of hypotonic solution. The antiblastic consisted in an intraumuscular injection of Vimblastine sulphate (Velban, Lilly) in the dose of 1 μg/g.d.w. The drug was allowed to act for about 30' and then the bone marrow was resuspended in Sodium citrate 0.5%.

Slides were stained with Giemsa 4% in phosphate buffer 0.01 M pH 7. A minimum number of 20 good quality metaphase plates were studied for each species.

RESULTS AND DISCUSSION

The diploid number of the three species of *Turdus* genus was found to be

2n = 80, while for *Monticola solitarius*, *Coccothraustes coccothraustes* and *Sturnus vulgaris* it was 2n = 82. In the Song-thrush the first 8 pairs of chromosomes are clearly macrochromosomes, while from pair 9 on the chromosomes consist of small acrocentrics and may be classified as microchromosomes. In the other species of Turdidae family and in the Fringillidae *Coccothraustes coccothraustes* there are 7 macrochromosome pairs. In *Sturnus vulgaris* pair 6 already consists of acrocentrics that can no longer be classified as macrochromosomes. It must, in fact, be emphasized that a clear-cut distinction between macro- and microchromosomes cannot always be made, and there is gradual transition from one type of chromosome to the other (see Fig. 1).

The macrochromosome pairs include the heterochromosomes. The heterogametic sex is the female one, the Z chromosome is larger than the W and it is always biarmed while the W-chromosome is usually telocentric.

In order to detect similarities and differences between karyotypes for the purpose of ascertaining cytotaxonomic affinities, it is better to examine macrochromosome morphology as it appears from the biometric analysis of the first 10 chromosome pairs, i.e. 9 autosomal pairs and the heterochromosomes, rather than limit oneself to the diploid number alone. The survey was done on a minimum of 20 highly dispersed metaphases for each species, taking two parameters into account: average relalive lenght ($\bar{l}$.r.) with respect to the first 10 chromosome pairs, and the centromeric index (c.i.) that is the lenght of the major chromosome arm divided by the lenght of whole chromosome (Levan *et al.* 1964) (see Fig. 2).

The first impression one gets on examining this table is the existence of the chromosomal uniformity claimed by Ohno et al (1964) to be typical of birds. After closer examination, however, several interesting considerations my be made. If the genus *Turdus* is taken, it can be seen that while *Turdus pilaris* and *T. merula* have roughly the same karyotype morphology, which also resembles that of different *Turdus* species studied by other workers (*T. musicus* by Bulatova *et al.* 1970 and *T. sibiricus* by Itoh *et al.* 1969), it differs considerably from that of *T. philomelos*. The latter karyotype is characterised by having a large number of metacentrics and resembles the one Jovanovic *et al.* (1969) described for *T. migratorius*. The other Turdidae whose karyotype is known, i.e. *Monticola* (present paper), *Oenanthe* (Hammar 1970, Bulatova *et al.* 1970) and *Saxicola* (Piccini & Stella 1970), have karyotypes that are morphologically very close to the *Turdus* of the *merula-pilaris* group.

Two cytotaxonomic groupings may thus be formed within the Turdidae studied, the first comprising a larger number of species, and the second with only *T. philomelos* and *T. migratorius* for the time being, having a karyotype atipically characterised by a large number of metacentrics. In view of the paucity of karyological data available on the family it is still too early to drawn any final

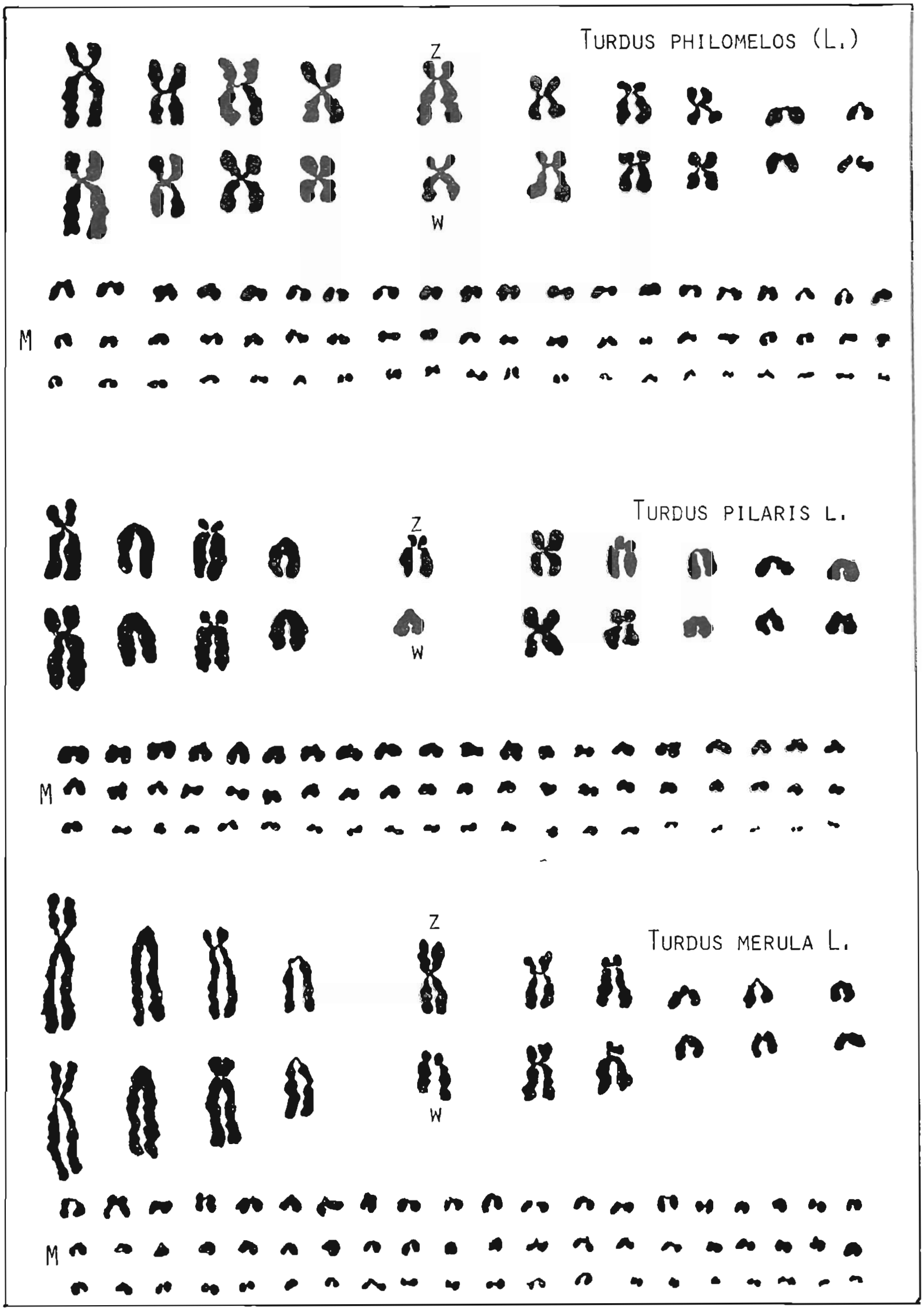
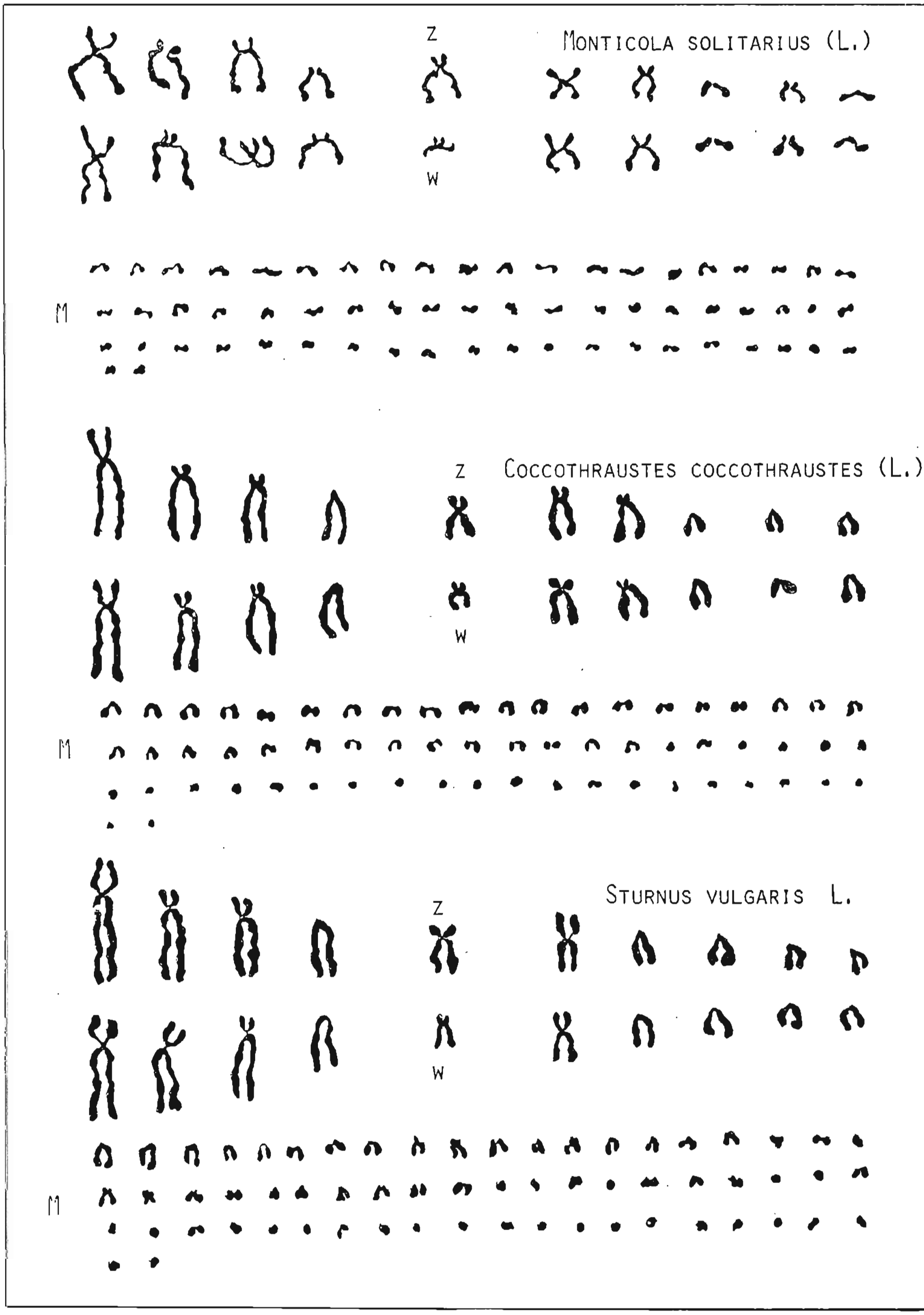


FIGURA 1 - Karyotype of six species of Passeriformes from somatic metaphase plates from bone marrow.


MONTICOLA SOLITARIUS (L.)
Z
W
M
COCCOTHRAUSTES COCCOTHRAUSTES (L.)
Z
W
M
STURNUS VULGARIS L.
Z
W
M

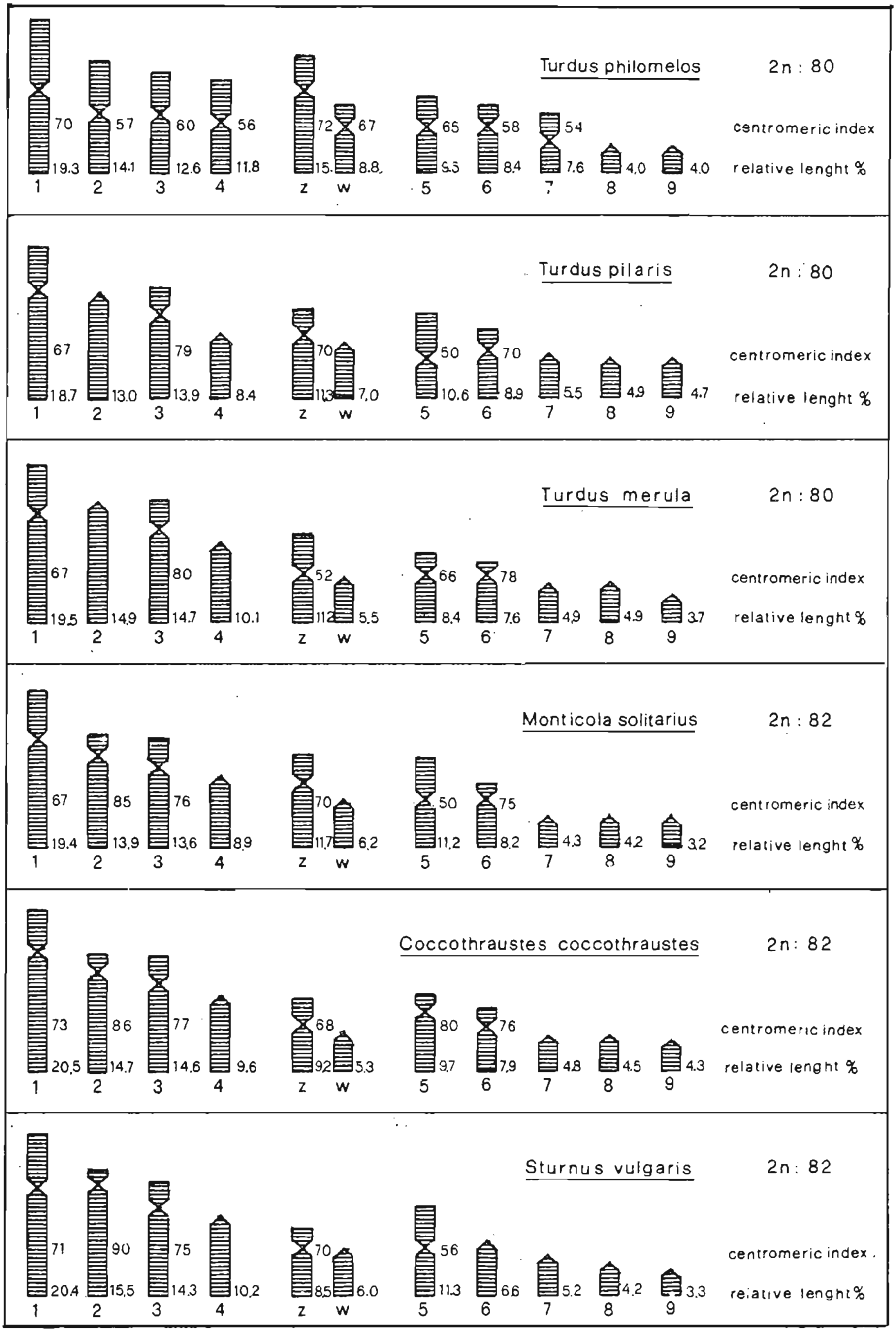


FIGURA 2 - Comparaison of karyograms of the six bird species studied. Macrochromosome morphology as appears from the biometric analysis of the first 9 pairs of chromosomes.

conclusion. It is extremely interesting however, to note that, at least in the case of the Turdidae, the forecast karyotype uniformity was not found. Indeed, there would seem to be much scope for a throrough cytotaxonomic study to be carried out on numerous representatives of this large family.

The karyotype morphology of the other two Passeriformes studied is somewhat similar to that of the thrushes of the *merula-pilaris* group. In this case also, however, a careful comparison of karyotype morphology reveals interesting correlations. In the case of the Hawfinch the karyotype found by us is identical to that of *Serinus canarius* (Ohno *et al.* 1964) while it differs, although only slightly, from the one described for other Fringillidae of the *Fringilla* genus (Piccini & Stella 1970) and of the *Carpodacus* genus (Bulatova *et al.* 1970).

The karyotype found for the Starling *(Sturnus vulgaris)* is the same as that described for other Sturnidae, e.g. *Sturnopastor contra* (Ray-Chaudhuri 1969) and *Sturnus vulgaris poltaratsky* (Bulatova et al. 1970).

It would thus appear that when the material prepared is of good quality and a sufficiently large number of species is examined, and when the field of investigation is narroved down to fairly small taxonomic groups, i.e. genera and families, the cytotaxonomic procedure can be extremely useful in systematic and evolutionary studies.

RIASSUNTO

ANALISI DEI CARIOTIPI NEGLI STUDI ORNITOLOGICI: I CROMOSOMI DI SEI SPECIE DI OSCINAE (PASSERIFORMI)

E' stata effettuata l'analisi cariologica di quattro specie di Turdidae *(Turdus philomelos, T. pilaris, T. merula* e *Monticola solitarius)*, una specie di Fringillide *(Coccothraustes coccothraustes)* e una di Sturnidae *(Sturnus vulgaris)*. I dati relativi alla cariologia del Passero solitario *(M. solitarius)* e del Frosone *(C. coccothraustes)* sono nuovi, mentre per le altre specie si tratta di una conferma di dati di precedenti osservazioni e di una aggiunta di precisione nella caratterizzazione della morfologia del cariotipo. Proprio grazie ad una precisa caratterizzazione morfologica del cariogramma è stato possibile un preciso confronto con cariotipi noti per altri Turdidae così da stabilire due gruppi citotassonomici, il primo comprendente il maggior numero di specie appartenenti ai generi *Turdus, Monticola, Oenanthe* e *Saxicola*, mentre il secondo con solo *Turdus philomelos* e *T. migratorius*, caratterizzato da un peculiare cariotipo con un alto numero di cromosomi metacentrici. Le presenti osservazioni ribadiscono l'interesse della caratterizzazione cariologica anche per gli Uccelli ove una presunta "omogeneità cariotipica" ne poneva dei severi limiti.

RESUME

L'ANALYSE DU CARYOTIPE DANS LES ETUDES ORNITHOLOGIQUES: LES CHROMOSOMES DE SIX ESPECES DE OSCINES (PASSERIFORMES)

Les Auteurs ont entrepris une investigation caryosystématique chez 6 espèces de Passeriformes, c'est à dire 4 Turdidés *(Turdus philomelos, T. pilaris, T. merula* et *Monticola solitarius)* un Fringillidé *(Coccothraustes coccothraustes)* et un Sturnidé *(Sturnus vulgaris)*.

Les données sur la caryologie du Merle Bleu et du Gros-bec representent neauvoté, tandis que pour les Grives et pour l' Etourneau on a ajouté des précisions d'ordre morphologique. Une soigneuse analyse et comparaison entre caryotypes a permis d'établir des groupes cytotaxonomiques à l'intérieur des familles, ainsi qu'on peut ramener à des justes proportions l'idée de la "homogéneité caryotypique" consideré, jusqu'ici, limitative de l'inérêt des études portant sur la caryologie des Oiseaux.

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