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A preliminary note on the chromosome complement of the House Swift, *Apus affinis*

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Abstract The karyotype of *Apus affinis* presented by Bhunya and Mohanty (1987 showed a remarkable difference of chromosome number (78) compared to the other three swift species studied so far 62, 64 and 62 respectively). Re-examining its chromosome number revealed a discordant result, with only 68 chromosomes. A comparison of the karyotype of *A. affinis* with that of *A. apus* shows a great difference in the number of macro- and microchromosomes, despite a morphological resemblance of macrochromosomes 1 to 6. The possible mechanism which can account for the addition of chromosome number of *A. affinis* is discussed.

Introduction

The use of morphological characters alone in a homogenous group of birds is often not sufficient to clarify taxonomic relationships between species. Given the utility of karyotypic data in determining relationships amongst species of mammals (Searle *et al.* 1989, Fredga *et al.* 1980), very little attention has been given to this technique as a taxanomic tool in bird systematics. Up to 1990, only 800 species of birds have been karyotyped and even fewer have been analyzed with differential banding techniques (Christidis 1990).

The lack of complete descriptions of more avian karyotypes is largely due to the difficulties in obtaining good chromosome preparations (Belterman and De Boer 1984; Christidis 1985; Shields 1987). Moreover, the organization of avian karyotypes makes detailed analysis difficult. Most birds have high diploid chromosome numbers ranging from 60 to 126 and the majority of these chromosomes are minute and obscure (Hammar 1970, De Boer and Sinoo 1984).

The diverse opinion on karyotypic similarity combined with the small size of the chromosomes has inevitably further discouraged works on avian cytotaxonomy. Swifts (Apodidae) are one of the least studied families in avian cytogenetics. Of about 84 species belonging to this family (Howard and Moore 1980), only 4 species have been karyotyped. Those species are reported to have different diploid numbers of chromosomes: *A. affinis* with 2n=78 (Bhunya and Mohanty 1987), *A. pacificus* and *Hirundapus caudacutus* have 2n=62 and 2n=64 respectively (Bian *et al.* 1980), while *A. apus* has 2n=62 (Andayani 1990). Therefore, avian karyotypes are not as conservative as previously reported and it is already evident that species of the Apodidae show substantial karyotypic variation.

The karyotype of *A. affinis* reported by Bhunya and Mohanty (1987) differs remarkably from the other swift species. This report suggested the species has 78 chromosomes, which can be easily divided into 7 pairs of macro- and 32 pairs of microchromosomes. On the contrary, the other three swift species are reported to have only 62-64 chromosomes with 6 pairs of macrochromosomes. Such a great difference in chromosome number in congeneric species has not been reported previously in birds. Therefore, the question arises whether several fissions have actually occured in *A. affinis* or if another explanation should be put forward to account for this unusual karyotypic variation.

This study was carried out to re-examine the chromosome number of *A. affinis* and to determine possible mechanisms underlying the additional number of homologues.

Methods

Swifts were collected from nests found in Senayan, Jakarta. Birds used in this study were both young and adult individuals. Somatic metaphase chromosomes were prepared using an *in vitro* bone marrow procedure described by Fredga (1987). Bone marrow cells from both femur and tibia were incubated in

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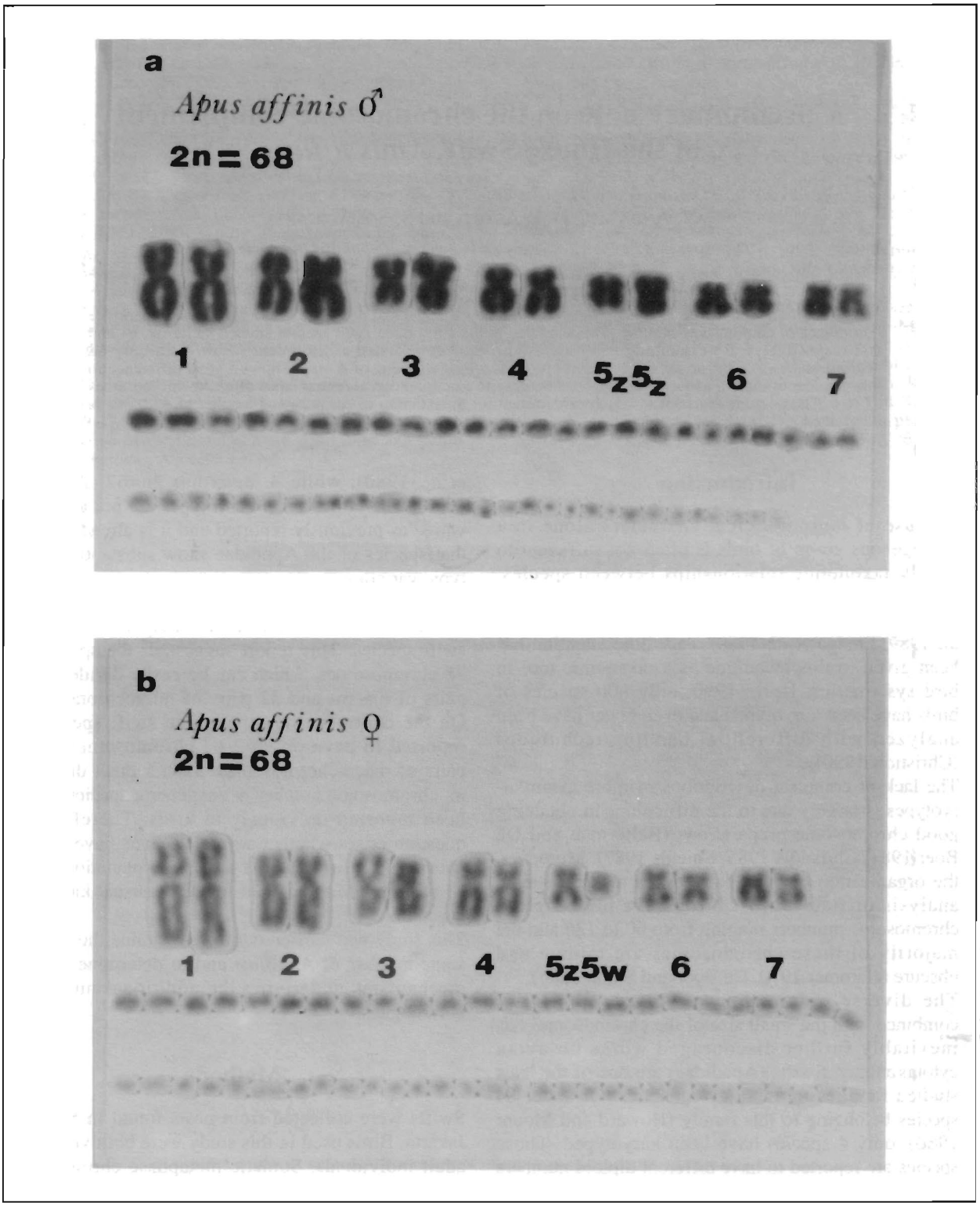

Figura 1. Karyotype of *A. affinis*, a: male; b: female

RPMI 1640 medium (Flow laboratories) supplemented with 15% Fetal Bovine Serum (FBS). To each 5 ml of media-cell suspension, 0.1 ml colchicine (0.01%) was added. This was then incubated at 37° for 30-40 min. The cells were treated in hypotonic solution (0.4% Kcl) for 15-30 min, then fixed in three changes of 3:1 methanol-glacial acetic acid. Splash preparations were made by dropping two separate drops of the cell suspension onto a clean and dry slide from a height of 10-30 cm. The slides then were air dried and stained for 8 min in 5% of Giemsa solution.

Favourable cells were photographed with a NIKON HFX camera mounted on a NIKON LABOPHOT microscope at a magnification of 500x. Kodak Technical Pan 135 film was used and developed in KODAK PRO B/W for 7 min.

An idiogram of *A. affinis* was constructed based on measurements of 10 selected pictures. Only 7 chromosome pairs (6 pairs of autosomes and the ZW chromosome) were measured individually. To simplify the measurements of the rest of the chromosome complement, which were minute and indistinct, measurements were done on the first several chromosomes which could be seen quite clearly and a few last ones. The chromosome length of microchromosome components was then determined by averaging those values.

The chromosome designation followed the nomenclature proposed by Levan *et al.* (1964) and arranged according to decreasing length.

Results

The diploid chromosome number is 68. The karyotype is shown in Figure 1 and the idiogram in Figure 2. The results of the chromosome measurements are presented in Table 1. With respect to the position of the centromere (centromeric index), each chromosome is included in one of classes m, sm, st, and t. (Levan *et al.* 1964). The range of relative length is 6.63 to 20.33.

The karyotype consists of 7 pairs of macrochromosomes, including the Z, and 27 pairs of microchromosomes. The first three autosome pairs are comprised of m chromosomes, while pairs 4, 6, and 7 are sm. All microchromosomes are made up of t elements. As expected, females have ZW sex chromosomes, males ZZ. The Z chromosome is an m

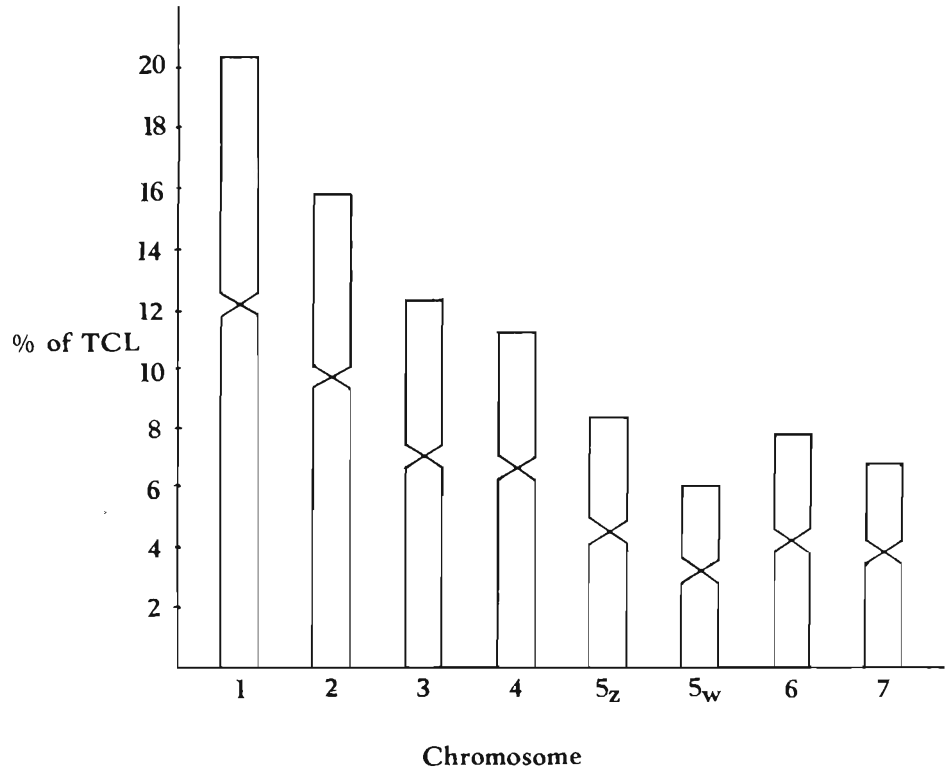

Figura 2. Idiogram of *A. affinis*; unit of ordinate per cent of total haploid male chromosome length.

Table 1. Chromosome measurement of *A. affinis*. Mean of 5 female and 5 male cells.

Chromosome	Chromosome designation[1]	Relative length % of male haploid set				Centromeric index[2]	
		p mean	q mean	p+q mean	se	mean	se
1	m	8.09	12.24	20.33	1.52	39.42	3.98
2	m	6.14	9.71	15.85	1.18	39.58	4.39
3	m	5.32	7.01	12.33	0.84	43.28	4.22
4	sm	4.61	6.61	11.22	0.58	31.19	5.65
5_z	m	3.88	4.5	8.38	0.96	46.71	3.07
5_w	m	2.80	3.24	6.04	2.84	47.43	2.56
6	sm	3.49	4.24	7.73	1.22	34.75	4.16
7	sm	2.80	3.83	6.63	1.34	32.16	3.84

[1]:The nomenclature symbols recommended by Levan *et al.* (1964)

[2]:The centromeric index, i = p/(p+q)·100; p= short arm of chromosome, q= long arm of chromosome (Fredga, 1972)

type and fifth in size, the W is also identified as an m with the size of a microchromosome. All macrochromosomes are relatively easy to identify on the basis of length and centromeric index, while the remaining microchromosomes comprise elements of gradually decreasing size which are impossible to distinguish individually.

Discussion

The karyotype of *A. affinis* studied previously by Bhunya and Mohanty (1987) showed a remarkable difference when compared to other swift species. The diploid number is 78 with 7 pairs of macrochromosomes which can be easily distinguished from the microchromosomes by their size.

Karyotypic description of *A. affinis* in this study revealed a discordant result from that of Bhunya and Mohanty (1987). In this study the diploid number of *A. affinis* is 68 with 7 pairs of macrochromosomes and 27 pairs of microchromosome. Despite the great difference in the diploid chromosome number, the macrochromosome complements show a morphological resemblance to the karyotypic description reported later by Mohanty (1987).

The discrepancies of chromosome number of *A. affinis* from the two studies might be due to errors in determining microchromosome numbers in the former study. Microchromosome are difficult to count in a light microscope and can easily escape from one metaphase plate and join an other during preparation, resulting in higher chromosome counts. Moreover small spots of dye can be misjudged as microchromosomes.

The karyotype of *A. affinis* is nearly identical to that of *A. apus* (Andayani 1990), except that the later species has a diploid chromosome number of 62 and lacks the sm pair of macrochromosome 7. Nevertheless, the difference in chromosome number cannot be easily explained by proposing simple Robertsonian translocations.

Tegelstrom and Ryttman (1981) have shown that there is a negative correlation between the number of macro and microchromosome in birds. If the number of macrochromosome increases, then the number of microchromosome will decrease. However, this rule is not applicable to *A. affinis* in which both macro- and microchromosomes number is increased.

The possible explanation to account for such karyotypic variation in the two species is that the 7th macrochromosome pair of *A. affinis* was derived from fusion of the two largest microchromosomes of *A. apus*. This was then followed by fissions of various microchromosomes. This suggestion is supported by the difference in the size of macro- and microchromosomes between the two species. The size of macro- and microchromosomes of *A. affinis* is clearly different, whereas *A. apus* shows a gradual decrease of chromosome size. However, it is difficult to prove that fission of microchromosomes has really taken place, since the small size of microchromosomes makes detailed analysis difficult. Nevertheless, it is obvious that more species should be studied before a

comprehensive picture of chromosomal diversity of the Apodidae can be established.

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Riassunto - Il cariotipo di *Apus affinis* studiato da Bhunya and Mohanty (1987) mostra un numero cromosomico (78) molto più alto rispetto ad altre tre specie di rondoni studiati (62, 64 e 62 rispettivamente). Questo studio invece mostra soltanto 68 cromosomi. La maggior differenza rispetto ad *A. apus* risulta essere il numero di macro e microcromosomi, nonostante la notevole somiglianza dei macro cromosomi da 1 a 6. Si discutono i meccanismi che hanno portato *A. affinis* ad avere cromosomi addizionali.

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