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KARYOLOGICAL STUDIES ON SOME BREEDS OF DUCK

Abdeltawab, M. Ata(*), Ahmed. E. Abu salha., Hasan. Z. Allam and Walid. A. Fandy

Dept. Genetics, Fac. Agriculture, Minia University
(*)Corresponding author: abdeltawab_ata@mu.edu.eg

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ABSTRACT

In order to clarify and characterize the chromosome variation between five duck breeds, three of *Anas* breeds (Dumyati, Khample and Pekin) and two breeds belonging to *Cairina moschata* (Muscovy and Sudani), comparative analysis of conventional karyotypes were made. Cytological investigations revealed that there were 80 chromosomes in the somatic cells of *Anas* and *Cairina* studied breeds. Ten largest chromosomes including ZW sex chromosomes were identified as macrochromosomes in which some of their karyological features such as chromosome length, q and p arm lengths, arm ratio, and centromeric position were obtained. Karyotype of the three *Anas platyrhynchos* breeds showed that chromosome pairs nos. 1 and 2 were large sized submetacentrics and, chromosomes nos. 3 to 9 were medium and small sized acrocentrics. The Z chromosome was medium sized acrocentric. Karyotype of *Cairina moschata* breeds showed that chromosome pairs nos. 1 and 2 were large sized submetacentrics, chromosome pair no. 3 was medium sized subacrocentric and, chromosomes nos. 4 to 9 were medium and small sized acrocentrics. The Z chromosome was medium sized subacrocentric. The W chromosome was small sized subacrocrocentric in *Anas* breeds while it was acrocentric in *Cairina* breeds. The remaining 30 pairs which appear as dots

under light microscope were classified as microchromosomes. In addition, the variation in relative lengths of the ten chromosomes was insignificant within *Anas* breeds (Dumyati, Khample and Pekin) as well as within *Cairina* Duck breeds (Muscovy and Sudani). On the other hand, significant differences were found in the relative lengths of chromosome nos (1, 2, 3, 6, 7 and 8) across the two studied duck species (*Anas platyrhynchos* and *Cairina moschata*) whereas; lengths of chromosome nos 4, 5, 9, Z and W) were relatively the same in the two species. The karyotype similarities and dissimilarities and their role in duck evolution are seemly discussed.

Key words: Chromosome – Karyotype – Duck – *Anas platyrhynchos - Cairina moschata*

INTRODUCTION

Duck is one of the most important domestic avian species in the world. Following on from the turkey, the Pekin duck (*Anas platyrhynchos*) is the next obvious target among domestic birds for detailed genomic studies due to its agricultural importance, with worldwide duck consumption being between 4 and 5% of the total poultry market (FAO, 2014). Avian genome is characterized by a small amount of genetic material, having the smallest genomes of all amniotes, with an average haploid genome size of only 1.45 pg of DNA or roughly 1.45 billion bases (Gregory, 2005), constitutes about 33% of human genome size (Burt, 2002a). This relatively small genome is packed into a large number of chromosomes about 40 pair of chromosomes in most avian species except some notable extremes with the macrochromosomes being relatively gene poor compared to the gene- rich microchromosomes (Burt, 2002b). Seven or eight pairs of them are the largest chromosomes 'the macrochromosomes' which are 3µm ~ 6µm in length; the remaining are 0.5µm ~2.5µm in length and named as microchromosomes (Gregory, 2002; Rodionov, 1996, Ata *et al*, 2017). Karyological observation showed morphological differences in chromosome 1 and the Z chromosome between *Anas platyrhynchos* and *Cairina moschata*: the short arm of chromosome 1 was longer in *Anas platyrhynchos* than *Cairina moschata*; and the Z chromosome was subtelocentric in *Anas platyrhynchos* and acrocentric in *Cairina moschata* (Islam *et al*., 2013 and Ata *et al*, 2017). In fact, Griffin *et al*. (2007) have argued that the ancestral avian karyotype was similar to that of chicken, with macrochromosomes 1, 2, 3, 4q, 5, 6, 7, 8, 9, 4 p and Z representing the ancestral state for chromosomes 1–10 plus Z (Ata *et al*,

2005 and 2007). Chromosome 4 was regarded as the most ancient linkage group within this karyotype (Shahin *et al*, 2014 and Ata *et al*, 2012). The Mallard duck *(Anas platyrhynchos)* shows the ancestral form (with chicken chromosome 4 paint hybridizing to two chromosomes (Schmid *et al*., 2005). However, it has long been demonstrated by cytogenetic procedures, extensively applied to animals from different regions, that chromosomal polymorphism exists in most species (Benirschke *et al*., 1980).Various cases of chromosomal polymorphism in birds were reported suggesting that karyotypic monitoring should be considered in conservation actions (Schmid *et al*., 2005). There are several similarities and dissimilarities between the karyotypes of *Anas platyrhynchos* and *Cairina moschata*. The most cytogenetic research works were extensive only on the macrochromosomes of birds. Therefore, this work presents karyological studies of five duck breeds (two for meat, Pekin and Muscovy), (one table egg breed, Khample), and (two Egyptian indigenous breeds Sudani and Dumyati).

MATERIAL AND METHODS

The Ducks were obtained from El-Serw Research Station, Water Fowl Branch, Water Fowl Research Department, Animal Production Research Institute, Agricultural Research Center, Ministry of Agricultural, Egypt. Samples were taken from 25 birds, 5 (3 males and 2 females) from each breed. The mitotic chromosome preparations were carried out according to technique of Ford and Hamerton, (1956) and modifications of Ata and Shahin, (2006): Ducklings were injected with 0.1 ml of 0.05% colchicine intraperitoneally. Bone marrow cells were incubated in 0.56% KCl at 37 ^{o}C for 15 min, and fixed and washed three times in fixative solution (3 Methanol: 1 Acetic Acid). Small drops of cell suspension were put onto the dried slide and left to dry at room temperature.

Air dried slides were stained with 4% Geimsa dye solution for 3 min at room temperature, then washed with tape water. For conventional karyotype analysis, 50 good metaphase spreads from each bird (male and female) were scored and photographed using Olympus BX51 microscope with a C-4040 zoom digital camera. Ten macrochromosomes (including sex chromosomes) were counted and measured under microscope using Soft Imaging System (SIS) analysis program (version 3.0) to estimate chromosome length; long (q) and short (p) arm lengths. The arm ratio (q / p) and centromeric index [p / (p + q) x 100] for each macrochromosome were calculated and nomenclature classification of centromere positions was done according to the method of (Levan *et al*., 1964). Karyotype ideogram was designed using the available data of chromosome

morphology and application of Microsoft Excel 2010 Program.

RESULTS

In order to clarify and characterize the karyological variation between five duck breeds, comparative analysis of conventional karyotypes was made. The ten largest chromosomes including ZW sex chromosomes were identified as macrochromosomes in which some of their karyological features such as chromosome length, q and p arm lengths, arm ratio, and centromeric position were obtained. The remaining 30 pairs which appear as dots under light microscope were classified as microchromosomes.

1- Karyotypes of three breeds belonging for *Anas platyrhynchos:*

Cytological investigations revealed that there were 80 chromosomes in the somatic cells of *Anas* breeds (Dumyati, Khample and Pekin). The size of individual chromosomes varied according to stage of chromosomal condensation.

1.a. Dumyati ducks (*Anas platyrhynchos*) karyotype*:*

Regular metaphase spreads and their corresponding ideogram of both males and females of Dumyati duck breed were depicted in Figs. (1a, b and c). Karyological features of the nine large macrochromosomes and ZW sex chromosomes are shown in Table (1). The average length of the first (largest) chromosome pair was 5.54±0.24 µm with arm ratio of 1.89 and centromeric index of 34.66%. The first chromosome was classified as submetacentric chromosome. The second chromosome pair was submetacentric with 4.07±0.16 µm average length, 1.38 arm ratio and 42.01 % centromeric index. Chromosome pairs no. 3-9 were acrocentric chromosomes with average lengths of 3.25±0.14 µm, to 0.88±0.04 µm. Average length of the sex chromosome Z, arm ratio and centromeric index were 2.40±0.11 µm, 3.90 and 20.42 %, respectively. So it was classified as subacrocentric chromosome and the fourth in length. The subacrocentric W-sex chromosome has an average length of 0.87±0.07 µm, and its arm ratio was 5.69, while the centromeric index was 14.94. W chromosome is the tenth in length.

1.b. Khample ducks (*Anas platyrhynchos*) karyotype*:*

Metaphase spreads and their corresponding ideogram of both males and females of Khample duck breed are shown in Figs. (2a, b and c). The measurements and nomenclature of nine macrochromosomes and ZW chromosomes are shown in Table (2). The average length of the first chromosome pair was 5.55±0.2 µm with arm ratio of 1.86 and 34.95 % centromeric index. it was classified as submetacentric. The second chromosome pair was submetacentric with 4.09±0.13 µm average length, 1.43 arm ratio and 41.08 % centromeric index. Chromosome pairs

nos. 3-9 were acrocentrics with average lengths of 3.21±0.08 µm, to 0.87±0.04µm. Average length of the sex chromosome Z, arm ratio and centromeric index were 2.42±0.07 µm, 4.38 and 18.59 %, respectively. So it was classified as subacrocentric chromosome and the fourth in length. The subacrocentric W-sex chromosome has an average length of 0.85±0.03 µm and its arm ratio was 5.54, while the centromeric index was 15.29 %. W chromosome is the tenth in length.

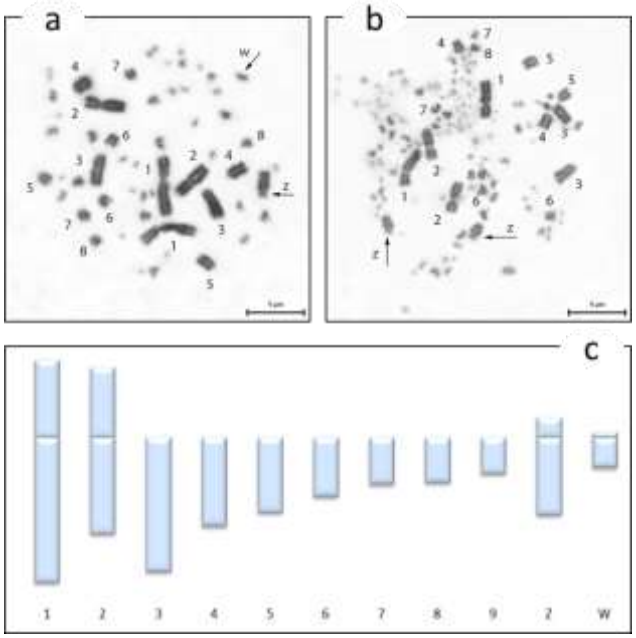

Figure (1): Metaphase spreads of both Females (a) and Males (b) and their corresponding ideogram (c) of Dumyati duck breed.

Table (1): The measurements and nomenclature of nine macrochromosomes and ZW chromosomes in males and females of *Anas platyrhynchos* (Dumyati duck breed).

Chr. No.	Long arm (q)		Short arm (p)		Total length (t)		Arm ratio q / p	Centromeric index P / t *100	Chromosome Type
	M±SE	Std. Dev	M±SE	Std. Dev	M±SE	Std. Dev			
1	3.62±0.16	0.67	1.92±0.09	0.39	5.54±0.24	1.03	1.89	34.66	SM
2	2.36±0.10	0.44	1.71±0.08	0.33	4.07±0.16	0.68	1.38	42.01	SM
3	3.25±0.14	0.61	-	-	3.25±0.14	0.61	-	0.00	A
4	2.13±0.12	0.51	-	-	2.13±0.12	0.51	-	0.00	A
5	1.81±0.13	0.56	-	-	1.81±0.13	0.56	-	0.00	A
6	1.42±0.08	0.33	-	-	1.42±0.08	0.33	-	0.00	A
7	1.12±0.07	0.31	-	-	1.12±0.07	0.31	-	0.00	A
8	1.01±0.07	0.3	-	-	1.01±0.07	0.3	-	0.00	A
9	0.88±0.04	0.17	-	-	0.88±0.04	0.17	-	0.00	A
Z	1.91±0.10	0.41	0.49±0.02	0.1	2.40±0.11	0.46	3.90	20.42	SA
W	0.74±0.05	0.14	0.13±0.03	0.13	0.87±0.07	0.3	5.69	14.94	SA

SM = SubMetacentric, A= Acrocentric, SA= subAcrocentric

Table (2): The measurements and nomenclature of nine macrochromosomes and ZW chromosomes in males and females of *Anas platyrhynchos* (Khample duck breed).

	Long arm (q)		Short arm (p)		Total length (t)		Arm ratio q / p	Centromeric index P / t *100	Chromosome Type
	M±SE	Std. Dev	M±SE	Std. Dev	M±SE	Std. Dev			
1	3.61±0.13	0.5	1.94±0.08	0.29	5.55±0.20	0.74	1.86	34.95	SM
2	2.41±0.09	0.33	1.68±0.08	0.31	4.09±0.13	0.47	1.43	41.08	SM
3	3.21±0.08	0.3	-	-	3.21±0.08	0.3	-	-	A
4	2.11±0.07	0.25	-	-	2.11±0.07	0.25	-	-	A
5	1.81±0.06	Chr. No.	-	-	1.81±0.06	0.24	-	-	A
6	1.39±0.03	0.12	-	-	1.39±0.03	0.12	-	-	A
7	1.12±0.03	0.12	-	-	1.12±0.03	0.12	-	-	A
8	1.02±0.04	0.14	-	-	1.02±0.04	0.14	-	-	A
9	0.87±0.04	0.15	-	-	0.87±0.04	0.15	-	-	A
Z	1.97±0.05	0.2	0.45±0.03	0.1	2.42±0.07	0.25	4.38	18.59	SA
W	0.72±0.03	0.11	0.13±0.02	0.08	0.85±0.03	0.11	5.54	15.29	SA

SM = SubMetacentric, A= Acrocentric, SA= subAcrocentric

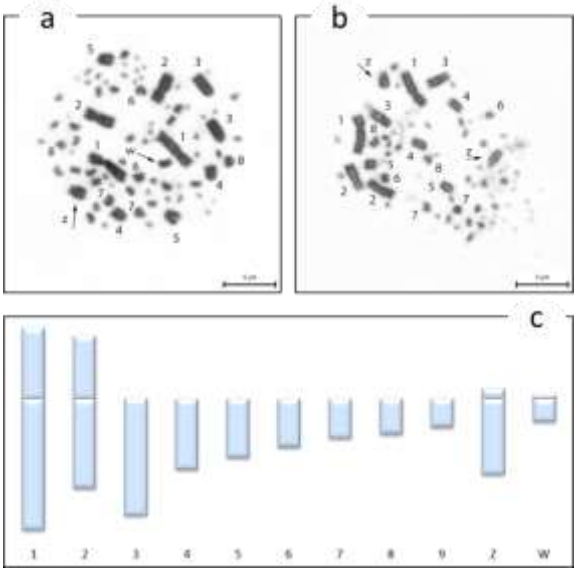

Figure (2) Metaphase spreads of both Females (a) and Males (b) and their corresponding ideogram (c) of Khample duck breed.

1.c. Pekin ducks (*Anas platyrhynchos*) karyotype*:*

Metaphase spreads and their corresponding ideogram of both males and females of Pekin duck breed are shown in Fig.3 (a, b and c). The measurements and chromosome nomenclature of nine macrochromosomes and ZW are shown in Table (3). The average length of the first chromosome pair was 6.02±0.25 µm with arm ratio of 1.85 and centromeric index of 35.05 %. So it was classified as submetacentric. The second chromosome pair was submetacentric with 4.46±0.15 µm average length, 1.48 arm ratio and 40.30 % centromeric index. Chromosome pairs nos. 3-9 were acrocentric chromosomes with average lengths of 3.53±0.13 µm, to 0.95±0.04µm. Average length of the sex chromosome Z, arm ratio and centromeric index were 2.62±0.13 µm, 4.69 and 17.56 % respectively. So it was classified as subacrocentric chromosome and equals the 4th in length. The subacrocentric W-sex chromosome has an average length of 0.92±0.07 µm, and its arm ratio was 5.13, while the centromeric index was 16.30 for this chromosome. W chromosome is the 10th in length.

Table (3): The measurements and nomenclature of nine macrochromosomes and ZW chromosomes in males and females of *Anas platyrhynchos* (Pekin duck breed).

Chr. No.	Long arm (q)		Short arm (p)		Total length (t)		Arm ratio q / p	Centromeric index P / t *100	Chromosome Type
	M±SE	Std. Dev	M±SE	Std. Dev	M±SE	Std. Dev			
1	3.91±0.16	0.72	2.11±0.11	0.49	6.02±0.25	1.14	1.85	35.05	SM
2	2.66±0.09	0.38	1.80±0.08	0.36	4.46±0.15	0.68	1.48	40.30	SM
3	3.53±0.13	0.57	-	-	3.53±0.13	0.57	-	-	A
4	2.32±0.10	0.47	-	-	2.32±0.10	0.47	-	-	A
5	2.00±0.09	0.42	-	-	2.00±0.09	0.42	-	-	A
6	1.52±0.07	0.3	-	-	1.52±0.07	0.3	-	-	A
7	1.21±0.06	0.27	-	-	1.21±0.06	0.27	-	-	A
8	1.10±0.05	0.24	-	-	1.10±0.05	0.24	-	-	A
9	0.95±0.04	0.19	-	-	0.95±0.04	0.19	-	-	A
Z	2.16±0.10	0.43	0.46±0.04	0.18	2.62±0.13	0.58	4.69	17.56	SA
W	0.77±0.05	0.23	0.15±0.02	0.11	0.92±0.07	0.31	5.13	16.30	SA

SM = SubMetacentric, A= Acrocentric, SA= subAcrocentric

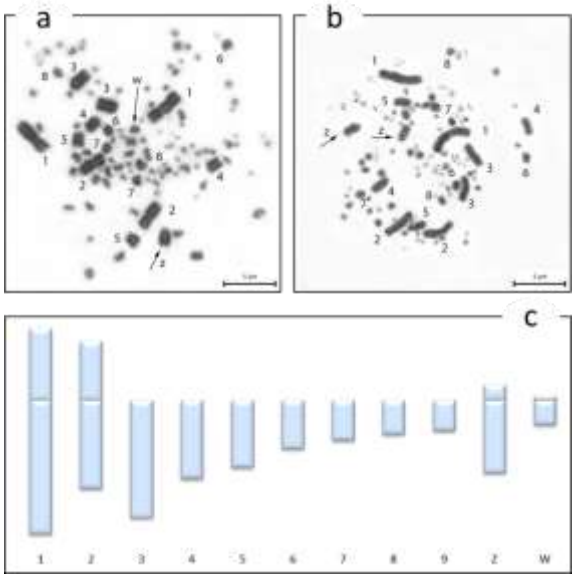

Fig. (3) Metaphase spreads of both Females (a) and Males (b) and their corresponding ideogram (c) of Pekin duck breed.

2. Karyotypes of two breeds belonging for *Cairina moschata:*

Somatic cells of birds of Muscovy and Sudani breeds showed 80 chromosomes. As in other birds this chromosome complement is divided into two categories 20 macrochromosomes and 60 microchromosomes or dot chromosomes.

2.a. Muscovy ducks (*Cairina moschata*) karyotype*:*

Metaphase chromosomes and their corresponding ideogram of both males and females of Muscovy duck breed were depicted in Fig.4 (a, b and c). Chromosome nomenclatures of the largest nine macrochromosomes and ZW sex chromosomes were shown in Table (4). The largest chromosome was 5.93±0.25 in length and had 1.92 arm ratio and 34.23 % centromeric index. This chromosome was classified as submetacentric chromosome. The second chromosome pair was submetacentric with 4.43±0.17 µm average length, 1.53 arm ratio and 39.50 % centromeric index. The arms ratio of the subacrocentric third chromosome was 5.62 and its centromeric index 15.10 % while the average length was 3.51±0.12 µm. Chromosome pairs no. 4-9 were acrocentric chromosomes with average lengths of 2.34±0.08 µm to 1.04±0.06 µm. The sex chromosome Z was classified as acrocentric with an average length 2.60±0.09 µm, so its size likes the 4th

one. The subacrocentric W-sex chromosome had an average length of 1.01 and its arm ratio was 4.94 while the centromeric index was 16.83 % for this chromosome.

2.b. Sudani ducks (*Cairina moschata*) karyotype*:*

Metaphase chromosomes and their corresponding ideogram of both males and females of Sudani duck breed are shown in Fig. 6 (a, b and c). Karyological measurements of the nine macrochromosomes and ZW are shown in Table (5). The largest chromosome was 5.63±0.18 in length and had 1.90 arm ratio and 34.45 % centromeric index. This chromosome was classified as submetacentric chromosome. The second chromosome pair was submetacentric with 4.14±0.13 µm average length, 1.55 arm ratio and 39.13 % centromeric index. The arms ratio of the subacrocentric third chromosome was 5.57 and its centromeric index 15.22 % while the average length was 3.35±0.11 µm. Chromosome pairs nos. 4-9 were acrocentric chromosomes with average lengths of 2.20±0.05 µm to 0.97±0.03 µm. The sex chromosome Z was classified as acrocentric with an average length 2.49±0.05 µm, so its size likes the 4th one. The subacrocentric W-sex chromosome had an average length of 0.92±0.03 and its arm ratio was 6.08 while the centromeric index was 14.13% for this chromosome.

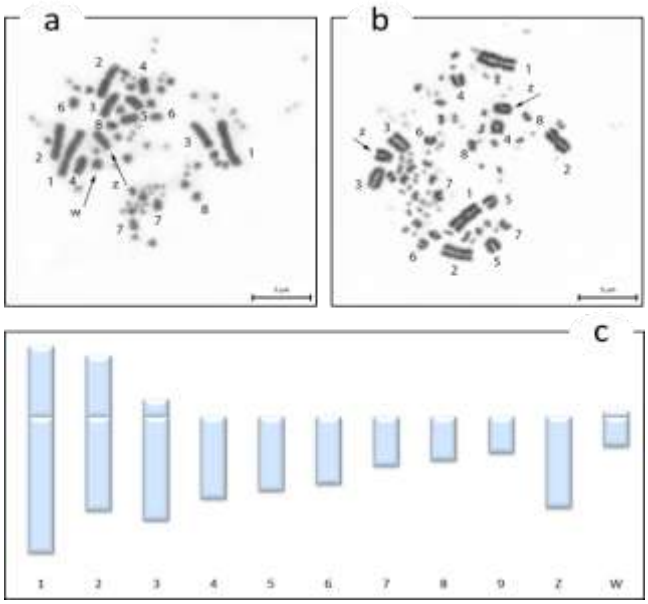

Fig. (4) Metaphase spreads of both Females (a) and Males (b) and their corresponding ideogram (c) of Muscovy duck breed.

Table (4): The measurements and nomenclature of nine macrochromosomes and ZW chromosomes in males and females of *Cairina moschata* (Muscovy duck breed)

Chr. No.	Long arm (q)		Short arm (p)		Total length (t)		Arm ratio q / p	Centromeric index P / t *100	Chromosome Type
	M±SE	Std. Dev	M±SE	Std. Dev	M±SE	Std. Dev			
1	3.90±0.15	0.69	2.03±0.11	0.47	5.93±0.25	1.12	1.92	34.23	SM
2	2.68±0.09	0.42	1.75±0.10	0.44	4.43±0.17	0.77	1.53	39.50	SM
3	2.98±0.12	0.54	0.53±0.03	0.15	3.51±0.12	0.55	5.62	15.10	SA
4	2.34±0.08	0.38	-	-	2.34±0.08	0.38	-	-	A
5	2.11±0.07	0.33	-	-	2.11±0.07	0.33	-	-	A
6	1.92±0.09	0.39	-	-	1.92±0.09	0.39	-	-	A
7	1.40±0.06	0.26	-	-	1.40±0.06	0.26	-	-	A
8	1.25±0.06	0.27	-	-	1.25±0.06	0.27	-	-	A
9	1.04±0.06	0.26	-	-	1.04±0.06	0.26	-	-	A
Z	2.60±0.09	0.4	-	-	2.60±0.09	0.4	-	-	A
W	0.84±0.05	0.24	0.17±0.02	0.1	1.01±0.07	0.3	4.94	16.83	SA

Table (5): The measurements and nomenclature of nine macrochromosomes and ZW chromosomes in males and females of *Cairina moschata* (Sudani duck breed).

Chr. No.	Long arm (q)		Short arm (p)		Total length (t)		Arm ratio q / p	Centromeric index P / t *100	Chromosome Type
	M±SE	Std. Dev	M±SE	Std. Dev	M±SE	Std. Dev			
1	3.69±0.11	0.49	1.94±0.09	0.39	5.63±0.18	0.79	1.90	34.45	SM
2	2.52±0.08	0.35	1.62±0.07	0.31	4.14±0.13	0.58	1.55	39.13	SM
3	2.84±0.10	0.45	0.51±0.03	0.13	3.35±0.11	0.51	5.57	15.22	SA
4	2.20±0.05	0.24	-	-	2.20±0.05	0.24	-	-	A
5	1.94±0.06	0.26	-	-	1.94±0.06	0.26	-	-	A
6	1.77±0.05	0.23	-	-	1.77±0.05	0.23	-	-	A
7	1.34±0.03	0.11	-	-	1.34±0.03	0.11	-	-	A
8	1.19±0.02	0.11	-	-	1.19±0.02	0.11	-	-	A
9	0.97±0.03	0.13	-	-	0.97±0.03	0.13	-	-	A
Z	2.49±0.05	0.25	-	-	2.49±0.05	0.25	-	-	A
W	0.79±0.02	0.14	0.13±0.01	0.06	0.92±0.03	0.12	6.08	14.13	SA

SM = SubMetacentric, A= Acrocentric, SA= subAcrocentric

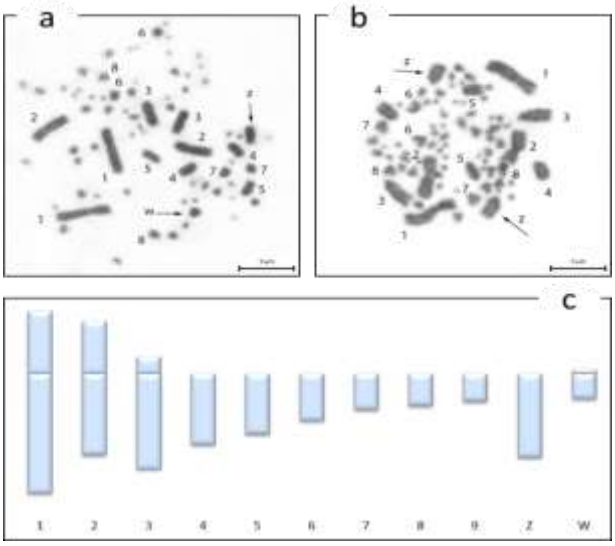

Figure (5) Metaphase spreads of both Females (a) and Males (b). Their corresponding ideogram (c) of Sudani duck breed.

3. Estimation of the relative chromosome lengths in the studied duck breeds. To avoid the differences in chromatin condensation the accurate lengths of chromosomes estimated as relative lengths which equals the ratio between chromosome length and whole length of macrochromosomes in the studied five duck breeds are shown in Table (6).

Table (6) Relative length of ten macrochromosomes including Z- and W-Sex chromosomes in the five duck breeds

Chr. No.	*Anas platyrhynchos*		*Cairina moschata*			Mean± SE	LSD
	Dumyati	Khample	Pekin	Muscovy	Sudani		
1	22.61	22.70	22.59	21.55	21.70	22.25±0.26	0.23
2	16.62	16.74	16.64	16.09	15.95	16.44±0.18	0.34
3	13.26	13.14	13.25	12.74	12.92	13.08±0.11	0.19
4	8.68	8.61	8.71	8.50	8.48	8.61± 0.05	---
5	7.40	7.42	7.50	7.65	7.49	7.50±0.07	---
6	5.79	5.69	5.71	6.97	6.83	6.20±0.28	0.15
7	4.59	4.58	4.52	5.10	5.15	4.80±0.13	0.06
8	4.12	4.16	4.12	4.53	4.60	4.31±0.11	0.08
9	3.60	3.57	3.65	3.76	3.73	3.61±0.06	---
Z	9.78	9.90	9.84	9.45	9.59	9.72±0.09	---
W	3.55	3.48	3.46	3.66	3.56	3.48±0.07	---

DISCUSSION

Early attempts to determine the diploid chromosome number of duck species (*Anas platyrhynchos* and *Cairina moschata*) and their hybrids suggested 34 to 62 chromosomes (Sokolowskaja, 1935). Crew and Koller (1936) considered that it ranged from 54 to 70 chromosomes. The reports of (Yamashina, 1941; Yamashina, 1942) determined 80 in males and 79 in females and explained that the 2N difference between the two sexes might be due to Z chromosome loss. The present study confirmed that the diploid number in both sexes of all studied breeds, three of *Anas platyrhynchos* (Dumyati, Khample and Pekin) and two of *Cairina moschata* (Muscovy and Sudani) is $2n=80$. Their Karyotype consists of ten large and medium-sized macrochromosome pairs (including ZW) and 60 indistinguishable microchromosomes. In fact, it has now been generally accepted that the diploid chromosome numbers in birds range from 40 to 126, and the mode of the chromosome number in birds is $2n=80$ (Seo *et al.*, 2016). Statistical analysis of karyological features and macrochromosome nomenclature revealed no significant differences among the present three breeds belonging to *Anas platyrhynchos.* Similarly, no karyotypic differences were seen between two duck breeds belonging to *Cairina moschata*. Thus, these finding conclusively suggest that the karyotypes have highly been conserved between the two duck genera and support the occurrence of chromosome rearrangements with only less frequency among bird species after they diverged. However, significant differences were found in size of pair no. 1 and in centromere position of pair no. 3 and Z chromosome between breeds of *Anas* and those of *Cairina*. Indeed, it is well known however that deviation in chromosome size could be due to differences in chromatin condensation during late prophase and metaphase stages which this wouldn't allow accurate comparison among karyotypes of different breeds. For avoiding this problem in the present study, the relative lengths of the ten macrochromosomes including ZW sex chromosomes were estimated and their statistical analysis (LSD and SE of MSTAT program) were used. Even though, variations in relative lengths of the ten chromosomes were found between *Anas* and *Cairina* breeds. For instance, significant differences were found in the relative lengths of chromosomes no. 1, 2, 3, 6, 7 and 8 across the two studied duck species (*Anas platyrhynchos* and *Cairina moschata*). Data presented herein are in agreement with those reported before (Islam *et al.*, 2013 and Wojcik and Smalec, 2007). This may reflect the high karyotype conservation as common in avian genomes (Griffin *et al.*, 2007). Hence, duck species conservation is currently a matter of serious concern due to the uncontrolled breeding, interbreeding,

and hybridization of domesticated and natural populations of closely related species all over the world (Seo *et al.*, 2016). Differences in chromosome morphology could be due to chromosomal aberrations such as centromeric reposition, translocations, inversions, deletions and/or duplications. Comparison of the relative length of the ten macrochromosomes between the five studied duck breeds supported the probability of new-centromere formation or precentric inversion rather than other types of chromosome aberrations during duck genome evolution (Skinner *et al.*, 2009).

Differences in size and centromere position of Z chromosome between *Anas* and *Cairina* breeds were fully explained by Islam *et al.* (2014) and Shahin *et al.*, (2014). Two possibilities for the process of chromosome rearrangements in the Z chromosomes were suggested, centromere repositioning that occurred in the ancestral acrocentric Z chromosome of Galloanserae or, a pericentric inversion that occurred in the ancestral acrocentric Z chromosome, followed by at least one large paracentric inversion. Systems include ZW (female heterogamety) in which the sex-specific element W is a more or less degraded version of the Z and is shorter because of deletion or longer because of insertion and amplification have been suggested (Ezaz *et al.*, 2017). The avian Z chromosome is highly conserved in size and morphology across all bird families. Comparative chromosome painting and sequence analysis showed high sequence homology across the most distantly related birds, and physical mapping revealed high levels of linkage homology (Nishida-Umehara *et al.*, 2007; Shetty *et al.*, 1999; Shibusawa *et al.*, 2004 and Zhou, 2004). There is no sex-specific *SRY* in birds and reptiles, but the *DMRT1* gene, which is present on the Z but absent from the W, is considered a good candidate sex determining gene (Marshall Graves and Shetty, 2001). Karyological investigations confirmed that, the five duck breed karyotypes were of the same to the general organization of avian genomes which characterized by numerous microchromosomes and relatively few macrochromosomes (Christidis, 1990), and corresponding very closely to the putative ancestral avian karyotype as suggested by Griffin *et al.*, (2007). These findings may share in improving our understanding of the karyotype evolution process of bird lineages.

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الملخص العربى

دراسات على الطرز الكروموسومية لبعض سلالات البط

عبد التواب محمد عطا، أحمد عزت أبوصالحة، حسن محمد زكي علام ، وليد عبدالحميد فندي

قسم الوراثة، كلية الزراعة، جامعة المنيا ، جمهورية مصر العربية

تم تحليل و مقارنة الطرز الكروموسومية لثلاث سلالات من البط التابع لجنس *Anas platyrhynchos* وهى (الدمياطى والكامبل والبكينى) وسلالتين من البط التابع لجنس *Cairina moschata* وهى (المسكوفى والسودانى) وذلك لتوضيح وتوصيف الاختلافات الكروموسومية بينها. وقد اظهرت النتائج أن العدد الثنائى كان 80 كروموسوم فى الخلايا الجسدية لسلالات البط تحت الدراسة من ال *Anas* و *Cairina*. وأظهرت النتائج أن العشر كروموسومات الكبرى والتى تشمل كروموسومى الجنس ZW وصفت على انها macrochromosomes والتى اخذت عليها بعض القياسات السيتولوجية مثل طول الكروموسوم طول الزراع الطويل والقصير ، نسبة الأذرع ، موضع السنترومير. ولقد أظهر الطراز الكروموسومى لسلالات ال *Anas* أن زوجى الكروموسومين رقم 1 و 2 كبيرى الحجم وتحت وسطية السنترومير وازواج الكروموسومات من 3–9 متوسطة الى صغيرة الحجم وطرفية السنترومير. وكروموسوم Z متوسط الحجم وطرفي السنترومير. والطراز الكروموسومى لسلالات ال *Cairina* اظهر ان زوجى الكروموسومين رقم 1و 2 كبيرى الحجم وتحت وسطية السنترومير وزوج الكروموسومات رقم 3 وسطى الحجم وتحت طرفى السنترومير وازواج الكروموسومات من4–9 متوسطة الى صغيرة الحجم وطرفية السنترومير. كروموسوم Z متوسط الحجم وتحت طرفي السنترومير. وكروموسوم W صغير الحجم وتحت طرفى السنترومير فى سلالات ال *Anas* بينما صغير الحجم وطرفى السنترومير فى سلالات ال *Cairina*. وتظهر ازواج الكروموسومات الثلاثين المتبقية كنقاط تحت الميكروسكوب الضوئى. وبدراسة التباين فى الطول النسبى لازواج الكروموسومات العشرة كان غير معنوى بين سلالات ال *Anas* (البط الدمياطى والكامبل والبكينى) وكذالك بالمثل بين سلالتى ال *Cairina* (البط السودانى والمسكوفى). ومن ناحية اخرى وجدت اختلافات معنوية فى الطول النسبى لازواج الكروموسومات ارقام (1، 2 ،3، 6، 7، 8) فيما بين سلالات الجنسين المدروسين من البط (*Anas platyrhynchos* and *Cairina moschata*) كما تمت عمل مناقشة متعمقة للتشابه وعدم التشابه بين الطرز الكروموسومية فى البط وما يحدثة ذلك فى تطور أنواع البط.