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Research Article

Chromosomes of *Oedipoda schochi schochi* and *Acrotylus insbricus* (Orthoptera, Acrididae, Oedipodinae). Karyotypes and C- and G-Band Patterns

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Abstract: Chromosomes, with detalied karyotype information (number, shape, total length, relative length, arm ratio and centromeric index) and C- and G-band patterns of two species of grasshoppers belonging to the subfamily Oedipodinae in Turkey are described. The karyotype of *Oedipoda schochi schochi* with 2n ♂ = 25 (X0) comprises eight pairs of metacentric, two pairs of submetacentric, one pair of acrocentric and one pair of subacrocentric autosomes, which come from 2n ♂ = 23 through centric fission and the metacentric X chromosome, while *Acrotylus insbricus* with 2n ♂ = 23 (X0) possesses metacentric autosomes, and the metacentric X chromosome.

Key Words: Oedipodinae, chromosome, C- and G-band patterns

Oedipoda schochi schochi ve *Acrotylus insbricus*'un (Orthoptera, Acrididae, Oedipodinae) Kromozomları. Karyotipleri, C- ve G-band Örnekleri

Özet: Oedipodinae alt familyasına ait Türkiye çekirgelerinden iki türün kromozomları, detaylı karyotip bilgileri (sayı, şekil, total uzunluk, relatif uzunluk, kol oranı, sentromerik indeks) ve C- ve G-band örnekleri tanımlanmıştır. *Oedipoda schochi schochi* sekiz çift metasentrik, iki çift submetasentrik, bir çift akrosentrik, bir çift subakrosentrik ve metasentrik X kromozomu içeren, sentrik fisyon sonucu 2n ♂ = 23 den oluşan 2n ♂ = 25 (X0) kromozomlu bir karyotipe sahiptir, buna karşılık *Acrotylus insbricus* metasentrik otozom ve metasentrik X kromozomu içeren 2n ♂ = 23 (X0) kromozomlu bir karyotipe sahiptir.

Anahtar Sözcükler: Oedipodinae, kromozom, C- ve G-band örnekleri

Introduction

The family Acrididae of grasshoppers is characterized by a great uniformity in both chromosome number and chromosome morphology, since about 90% of the known species have a karyotype consisting of 2n ♂ = 22 + X0 acrocentric chromosomes (1). Within the Acrididae the subfamily Oedipodinae shows a remarkable uniformity with respect to chromosome number because only a centric fusion in some Trimerotropini reduces the standard 23 complement to 21. However, chromosome morphology seems to be more variable in this subfamily since many pericentric inversions have been reported in many species of the American genera *Trimerotropis* and *Circotettix* (1,2) and also in Spanish populations of *Ailopus strepens* (3) and *Sphingonotus coerulans* (4).

Oedipoda schochi schochi and *Acrotylus insbricus* have a wide geographical range in Turkey (5). The present study contains detailed cytological information on *O. schochi* and *A. insbricus*. The karyotype analysis includes the number, morphology and relative length of chromosomes, and C- and G-banding patterns. The results obtained, concerning the number of chromosomes, their structure and C- and G-banding patterns, and the type of sex determination, may be used for establishing or verifying the taxonomic attachment of some species. Furthermore, the data given may provide a basis for further population investigations.

Materials and Methods

Five male and six female adults of *O. schochi schochi* (1884) were collected in Gaziantep (Turkey) (September, 1999). Six male and four female adults of *A. insbricus* (1788) were collected in İzmir (Turkey) (August, 1999).

The karyological preparations were made according to the method described by Warchalowska-Sliwa (6). The slides were examined under a light microscope, and 20 well-spread metaphase figures were chosen for observation. Some of these figures were photographed and ordered in the karyotype according to length. For each chromosome, the short arm, long arm and total length were measured and recorded using these karyotypes. The relative lengths, arm ratios and centromeric index were determined from these findings. Chromosomes were classified according to Levan et al. (7).

The C-banding examination was carried out according to Sumner (8) with a slight modification. G-banding was obtained with the method described by Zhan et al. (9).

Results

Oedipoda schochi schochi, 1884

All individuals analysed showed the chromosome number 2n ♂ = 25 (24 A + X0) (FN = 48). At the mitotic metaphase of these species eight pairs of metacentric, two pairs of submetacentric, one pair of acrocentric and one pair of subacrocentric autosomes were visible. The metacentric X chromosome was the eighth element in the karyotype (Figures 1-3, Table 1).

The C-banding pattern in the mitotic metaphase of these species was characterized by the presence of paracentromeric C-bands in all autosomes. Additionally, distal C-bands were present in pairs 5, 7 and 8. In pairs 7 and 8, interstitial thin C-bands were found. It was detected that the short arm of pair 9 was a positive C-band. The X chromosome was megameric (Figures 4, 5).

The G-banding technique, which was used to analyze the chromosomes of *O. schochi schochi*, did not produce true G-bands in the sense used for mammalian chromosomes, since a sequence of dark bands and light interbands was not observed (Figure 6).

Acrotylus insbricus, 1788

All individuals analyzed showed a chromosome number with 2n ♂ = 23 (22 A+ X0) (FN = 46). All autosomes and the X chromosome were metacentric. The X chromosome was the fifth element in size (Figures 7-9, Table 2).

The C-banding pattern was characterized by the presence of a paracentromeric block in all autosomes and in the X chromosome. Interstitial C-bands were present in pairs 3, 4, 6, 7, 8 and 9 (Figures 10 and 11).

The G-banding pattern of *A. insbricus* is given in Figures 12 and 13. The centromeric areas of all chromosomes were G-negative. In pair 5, a G-band was not detected. In the distal portions of the chromosome arms of pairs 2, 6, 9 and 11 dark G-bands were present. The X chromosome was completely G-positive.

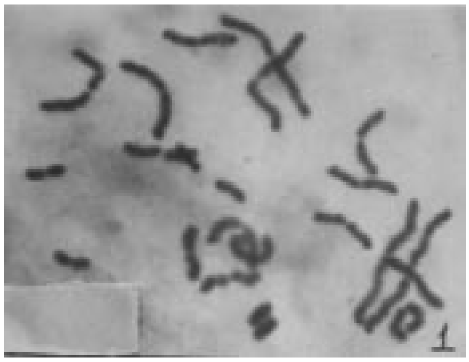

Fig. 1. Mitotic metaphase of *Oedipoda schochi schochi*.

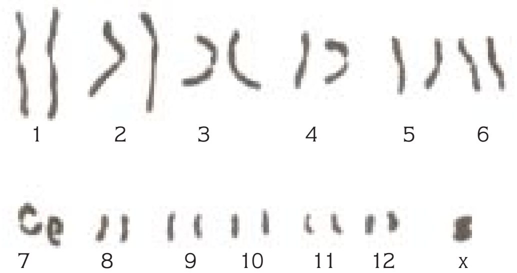

Fig. 2. Karyotype of *Oedipoda schochi schochi*.

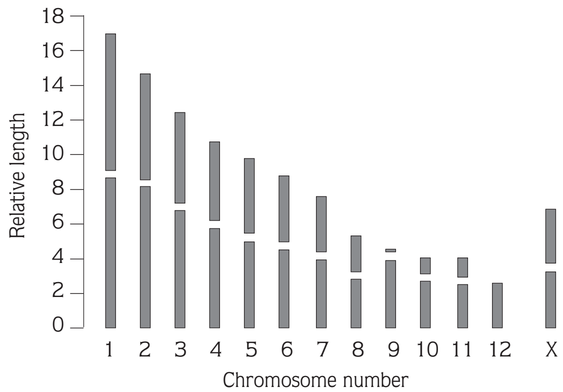

Fig. 3. Idiogram of *Oedipoda schochi schochi*.

Table 1. Morphometric characteristics of the chromosomes of *O. schochi schochi*.

Number of chromosome pair	Total length (µm) Mean ± S. E.	Relative length (% of 2n set)	Centromeric index Mean ± S. E.	Arm ratio (long:short) Mean ± S. E.	Chromosome morphology
1	29.73 ± 0.74	16.09 ± 0.71	48.63 ± 0.68	1.05 ± 0.02	m
2	25.75 ± 0.50	13.94 ± 0.59	45.85 ± 0.98	1.18 ± 0.04	m
3	21.56 ± 0.62	11.67 ± 0.53	46.13 ± 2.60	1.17 ± 0.12	m
4	18.54 ± 0.32	10.03 ± 0.29	46.19 ± 2.34	1.20 ± 0.13	m
5	16.64 ± 0.89	9.01 ± 0.39	47.90 ± 1.32	1.09 ± 0.05	m
6	14.90 ± 0.62	8.06 ± 0.31	47.00 ± 2.14	1.13 ± 0.10	m
7	12.82 ± 0.44	6.94 ± 0.33	47.43 ± 1.28	1.16 ± 0.05	m
8	8.60 ± 0.55	4.65 ± 0.41	46.10 ± 2.08	1.17 ± 0.09	m
9	7.20 ± 0.45	3.89 ± 0.37	24.52 ± 2.48	3.16 ± 0.44	st
10	6.37 ± 0.25	3.44 ± 0.37	34.44 ± 8.67	2.33 ± 0.88	sm
11	6.35 ± 0.61	3.43 ± 0.18	36.11 ± 7.34	2.00 ± 0.57	sm
12	4.58 ± 0.44	2.48 ± 0.28	-	∞	a
X	11.63 ± 0.37	6.29 ± 0.24	49.12 ± 0.88	1.03 ± 0.03	m
Total	184.67				

m: metacentric, sm: submetacentric, a: acrocentric, st: subacrocentric

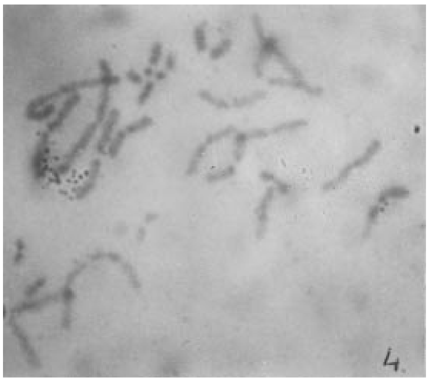

Fig. 4. Mitotic metaphase with C-band of *Oedipoda schochi schochi*.

Fig. 6. Mitotic metaphase with G-band of *Oedipoda schochi schochi*.

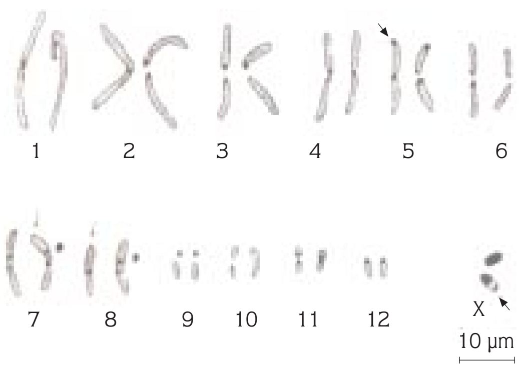

Fig. 5. Mitotic metaphase with C-band of *Oedipoda schochi schochi*; (→) indicates distal C-bands; (•) indicates interstitial C-bands.

Fig. 7. Mitotic metaphase of *A. insbricus*.

Table 2. Morphometric characteristics of the chromosomes of *A. insbricus*.

Number of chromosome pair	Total length (μm) Mean ± S. E.	Relative length (% of 2n set)	Centromeric index Mean ± S. E.	Arm ratio (long:short) Mean ± S. E.	Chromosome morphology
1	37.66 ± 0.85	19.59 ± 0.23	49.45 ± 0.54	1.02 ± 0.02	m
2	27.24 ± 0.94	14.17 ± 0.53	48.57 ± 1.05	1.05 ± 0.04	m
3	24.72 ± 0.52	12.86 ± 0.43	48.57 ± 1.05	1.06 ± 0.04	m
4	19.98 ± 0.65	10.39 ± 0.40	48.12 ± 1.02	1.07 ± 0.04	m
5	13. 65 ± 0.44	7.10 ± 0.25	48.72 ± 0.64	1.05 ± 0.02	m
6	12.72 ± 0.49	6.61 ± 0.31	44.65 ± 3.68	1.27 ± 0.19	m
7	10.77 ± 0.23	5.60 ± 0.11	44.64 ± 2.18	1.25 ± 0.10	m
8	10.00 ± 0.20	5.20 ± 0.13	44.28 ± 4.99	1.32 ± 0.29	m
9	6.98 ± 0.60	3.63 ± 0.37	47.89 ± 2.10	1.09 ± 0.09	m
10	6.38 ± 0.36	3.32 ± 0.16	50.00 ± 0.00	1.00 ± 0.00	M
11	5.41 ± 0.25	2.81 ± 0.17	50.00 ± 0.00	1.00 ± 0.00	M
X	16.65 ± 0.25	8.66 ± 1.10	50.00 ± 0.00	1.00 ± 0.00	M
Total	192.16				

m-M: metacentric

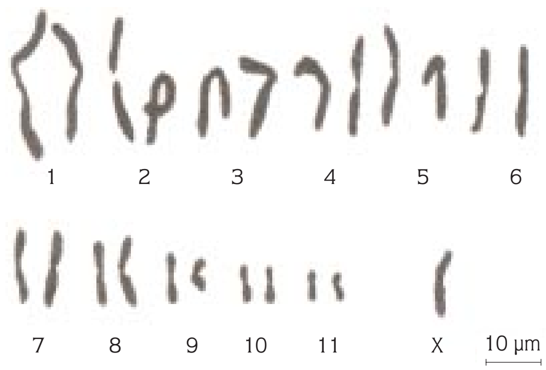

Fig. 8. Karyotype of *A. insbricus*.

Fig. 10. Mitotic metaphase with C-band.

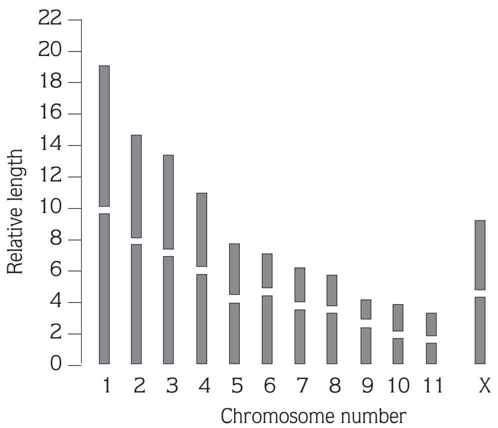

Fig. 9. Idiogram of *A. insbricus* chromosomes.

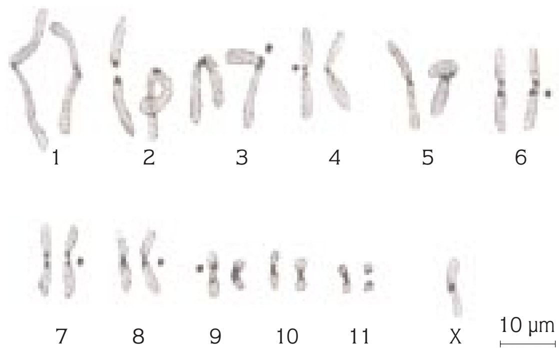

Fig. 11. Mitotic metaphase with C-band; (•) indicates interstitial C-bands.

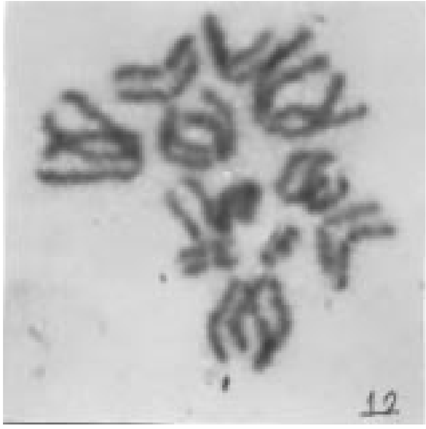

Fig. 12. Mitotic metaphase with G-band.

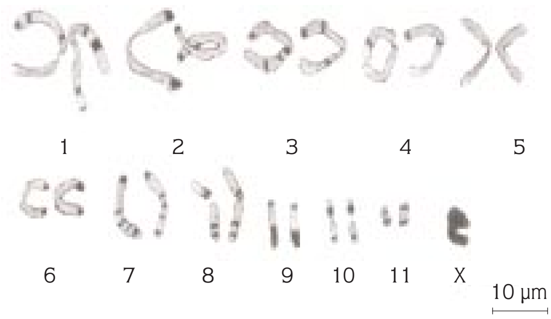

Fig. 13. Mitotic metaphase with G-band.

Discussion

A great karyotypic conservationism seems to characterize the Acrididae complement in chromosome number and chromosome morphology. However, karyotypic differences have recently been observed in some species of Acrididae. Karyotypic differences in this group have involved some chromosomal rearrangements causing small alterations in the number and morphology of chromosomes (1-4).

In the present work, we found that *O. schochi schochi* has 2n ♂ = 25 (X0) chromosomes, while *A. insbricus* has 2n ♂ = 23 (X0) chromosomes. In the literature, information concerning the karyotype of *O. schochi schochi* is absent.

Additionally, the known species of the family Acrididae of grasshoppers have a karyotype consisting of acrocentric chromosomes (1). However, we observed that *O. schochi schochi* and *A. insbricus* have a different chromosome morphology. The origin of this morphology of chromosomes is connected with pericentric inversion. This kind of rearrangement has generally been found in grasshoppers (1,16-18), but until it now was not observed in Oedipodinae.

Detailed data (especially chromosome numbers, chromosome morphology, and G-banded karyotypes) have been used to indicate chromosomal rearrangements in many groups of mammals (19-22). Individual chromosomes can be indentified on the basis of morphological characters (relative size), centromere position, and secondary constrictions. In most species, however, chromosome identification depends on an analysis of individual banding patterns. In general, banding can be used in different ways: (1) to identify differences in chromosomes between related species; (2) to deduce phylogenetic relationship; (3) to analyse the origin of the bands themselves (23).

However, G-banding, which produces the most informative banding pattern in mammalian chromosomes, cannot be successfully applied to insect chromosomes (in this study, G-banding pattern of *O. schochi schochi*), because the banding pattern does not show enough specificity (24). Therefore in insects C-banded metaphase chromosomes are most often used for analysis.

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