KSÜ Tarım ve Doğa Derg 25 (Ek Sayı 1): 65-71, 2022
KSU J. Agric Nat 25 (Ek Sayı 1): 65-71, 2022
https://doi.org/10.18016/ksutarimdoga.vi.981285

Cytogenetic Characteristics of *Gerbillus dasyurus* and *Meriones tristrami* (Rodentia: Gerbillinae) from Kilis, Turkey: Conventional and C Banded Karyotypes

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ABSTRACT
In this study, diploid chromosome number and constitutive heterochromatin distributions of chromosomes were determined in *Gerbillus dasyurus* and *Meriones tristrami* species. The diploid chromosome numbers (2n) and autosomal chromosome arms (NFa) of *G. dasyurus* and *M. tristrami* were determined as 2n=60, NFa= 68, and 2n=72, NFa= 73, respectively. It was found that there were differences in autosomal chromosomal arms (NFa) of two different gerbil species, the karyotypes of which were obtained in this study, compared to previously conducted studies in Türkiye. Heteromorphic chromosome pair (submetacentric/acrocentric) was found in the autosomal set of *M. tristrami.* There was an enlarged heterochromatin block on the short arm of submetacentric chromosome in heteromorphic chromosome pair.

Biology

Araştırma Makalesi

Article History
Received : 10.08.2021
Accepted : 24.12.2021

Keywords
Constitutive Heterochromatin
Chromosome
Tristram's jird
Wagner's gerbil

Gerbillus dasyurus ve *Meriones tristrami* (Rodentia: Gerbillinae) Türlerinin Sitogenetik Özellikleri: Standart ve C Bantlı Karyotipler

ÖZET
Bu çalışmada, *Gerbillus dasyurus ve Meriones tristrami* türlerinin diploid kromozom sayısı ve kromozomların konstitütif heterokromatin dağılımları belirlenmiştir. *G. dasyurus* ve *M. tristrami* diploid kromozom sayısı ve otozomal kromozom kol sayıları sırasıyla 2n=60, NFa= 68 ve 2n=72, NFa= 73 şeklindedir. Karyotipleri elde edilen iki farklı gerbil türünün otozomal kromozom kol sayılarında (NFa) Türkiye'den daha önce gerçekleştirilen çalışmalara kıyasla farklılık olduğu belirlenmiştir. *M. tristrami*'nin otozomal kromozom setinde heteromorfik kromozom çiftinin (submetasentrik/akrosentrik) olduğu belirlenmiştir. Heteromorfik kromozom çiftinde submetasentrik kromozomun kısa kolunda genişlemiş heterokromatin blok bulunmaktadır.

Biyoloji

Araştırma Makalesi

Makale Tarihçesi
Geliş Tarihi : 10.08.2021
Kabul Tarihi : 24.12.2021

Anahtar Kelimeler
Konstitütif heterokromatin
Kromozom
Tristrami çöl sıçanı
Wagner gerbili

Atıf Şekli: Coşar Z, Akan E, Kefelioğlu H, Selçuk A.Y. 2022. *Gerbillus dasyurus* ve *Meriones tristrami* (Rodentia: Gerbillinae) türlerinin sitogenetik özellikleri: Standart ve C bantlı karyotipler. KSÜ Tarım ve Doğa Derg 25 (Ek Sayı 1): 65-71. https://doi.org/10.18016/ksutarimdoga.vi.981285

To Cite : Coşar Z, Akan E, Kefelioğlu H, Selçuk A.Y. 2022. Cytogenetic characteristics of *Gerbillus dasyurus* and *Meriones tristrami* (Rodentia: Gerbillinae) from Kilis, Türkiye: Conventional and C banded karyptypes. KSÜ Tarım ve Doğa Derg 25 (Suppl 1): 65-71. https://doi.org/10.18016/ksutarimdoga.vi.981285

INTRODUCTION
The *Meriones* and *Gerbillus*, which are classified within Gerbillinae subfamily, are two rodent genera and their representatives are distributed in steppe and semi-arid habitats (Kryštufek and Vohralik, 2009). The genus *Gerbillus* is represented with one species (*Gerbillus dasyurus*) in Türkiye, while the genus *Meriones* is represented with six species (*Meriones persicus*, *M. vinogradovi*, *M. dahli*, *M. crassus*, *M. libycus* and *M. tristrami*) (Kryštufek and Vohralík, 2009).

Meriones and *Gerbillus* species may show a large number of chromosome variations. These species draw attention with their variation fundamental number arms (NFa) or constitutive heterochromatin distributions (Lay et al., 1975; Lay, 1983; Qumsiyeh

et al., 1986; Volobouev et al., 1995; Aniskin et al., 2006; Abiadh et al., 2010; Kaya and Çoşkun, 2012; Mahmoudi et al., 2020). There are limited numbers of chromosome studies conducted on *G. dasyurus* in Türkiye (Yiğit et al., 1997). The first record of *G. dasyurus* from Türkiye, the northernmost distribution border of the species, was reported by Yiğit et al. (1997). In this study, the standard karyotype characteristics and morphological characteristics of this species were reported. In the studies carried out within the distribution borders of *G. dasyurus* species, different researchers have reported variations in the number of chromosomal arm (NFa) of the samples (Qumsiyeh et al., 1986). A similar situation is also true for *M. tristrami* species, which is largely distributed in Anatolia, Transcaucasia and Middle East (Korobitsyna, 1975; Korobitsyna and Korablev, 1980). In the studies conducted to find out the karyological characteristics of *M. tristrami*, this species has been found to have different number of chromosomal arms in Anatolia population (Kefelioğlu, 1997; Yiğit and Çolak, 1998; Kaya and Çoşkun, 2012; Mahmoudi et al., 2020).

The aim of this study is to perform a chromosome banding analysis of the karyotype of *G. dasyurus* and *M. tristrami* from Türkiye with the use of C-banding and to compare the results with previous studies regarding the species.

MATERIAL and METHODS

One specimen (female) of *G. dasyurus* species and one specimen (male) of *M. tristrami* species were collected using live animal catch traps from the province of Kilis (N 36° 43' 00" E 37° 16' 00", Southeast Anatolia, Turkish-Syrian border) between November 1 and 10, 2020. Chromosome preparations were obtained from the femoral bone marrow cells of colchicine treated animals (Ford and Hamerton, 1956). The diploid chromosome number (2n), fundamental number of autosomal arms (NFa) and sex chromosomes of the specimens used in the study were identified. The constitutive heterochromatin distribution was determined using techniques from Summer (1972). From each specimen, 10 to 20 slides were prepared and at least 10 well-spread metaphase plates were analysed. Tissue samples the skins prepared as standard museums materials and karyotype preparations of two species were stored in Ondokuz Mayıs University Cytogenetic laboratory for further studies (Museum sample no: *G. dasyurus* : 41-AYS; *M. tristrami* : 42-AYS). This study was carried out with the permission of Ondokuz Mayıs University local ethics committee for animal experiments (permission number: E-68489742-604.01.03.-12821).

RESULTS

The diploid chromosome number of *G. dasyurus* was 2n=60, NFa= 68 and NF=72. While five pairs of chromosomes (chromosomes no: 1-5) were biarmed chromosomes in autosomal chromosomes, 24 pairs of chromosomes are acrocentric of different sizes (chromosome no:6-29). X chromosome was a large biarmed chromosome (metacentric or submetacentric) (Figure 1).

Figure 1. Conventional karyotype of *G. dasyurus* (female) from Kilis (Southeast Anatolia), arrow: biarmed chromosomes in metaphase plates

Şekil 1. G. dasyurus' un (dişi) standart karyotipi, ok: çift kollu kromozomlar

The diploid chromosome number of *M. tristrami* was 2n=72, NFa= 73 and NF=77. Autosomal chromosomes had a pair of biarmed chromosomes (chromosomes no: 1), a pair of heteromorphic (chromosome no:2, submetacentric/acrocentric) and 33 pairs of different sizes of acrocentric (chromosome no:3-35) chromosomes. Of the sex chromosomes, the X and Y chromosomes were biarmed chromosome (metacentric or submetacentric) (Figure 2).

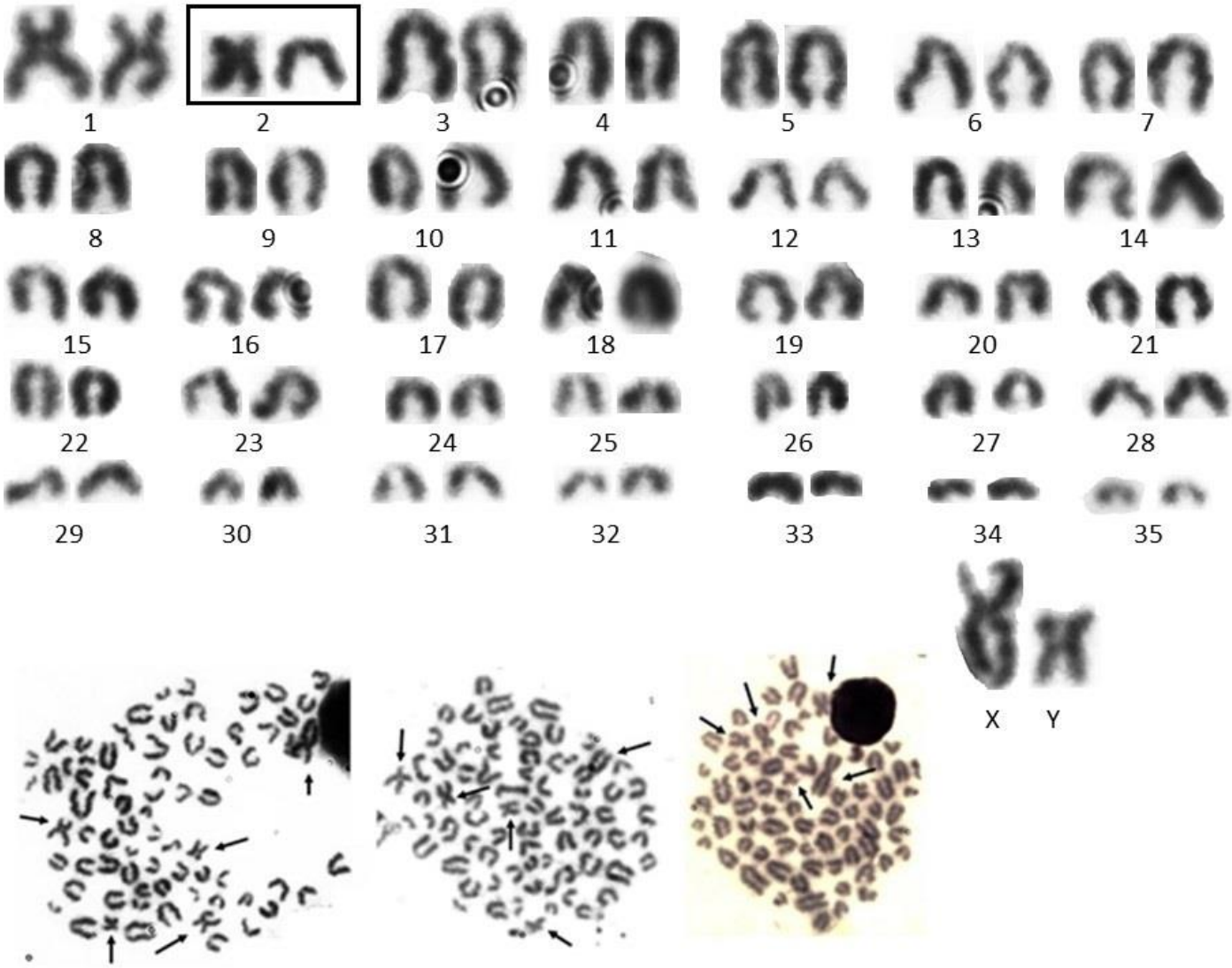

Figure 2. Conventional karyotype of *M. tristrami* (male) from Kilis (Southeast Anatolia) and heteromorphic chromosome no:2, arrow: biarmed chromosomes in metaphase plates

Şekil 2. M. tristrami' nin (erkek) standart karyotipi ve heteromorfik 2. kromozom çifti, ok: çift kollu kromozomlar

In the C-banded karyotype of *G. dasyurus*, the constitutive heterochromatins were in the centromere region, and they were notably distinct. The X chromosome was distinctively C-band positive (Figure 3).

In the C-banded karyotype of *M. tristrami*, positive constitutive heterochromatins were in the centromere region. Contrary to this, some acrocentric autosomes had not heterochromatin block. The X chromosome was C-band positive. In addition, there was an enlarged heterochromatic region on the short arm of submetacentric chromosome in heteromorphic chromosome pair (chromosome no:2) (Figure 4).

DISCUSSION

In studies conducted to find out the karyotype characteristics of *G. dasyurus* distributed in the Middle East, Arabic peninsula, Egypt and Türkiye's southeast region (Palestine, Wahrman and Zahavi, 1955; Israel, Wahrman et al., 1988; Egypt, Wassif et al., 1969; Lay et al., 1975; Jordan, Qumsiyeh et al., 1986, Abu Baker et al., 2009; Türkiye, Yiğit et al., 1997; current study), it was found that this species had stable diploid chromosome number (2n=60),

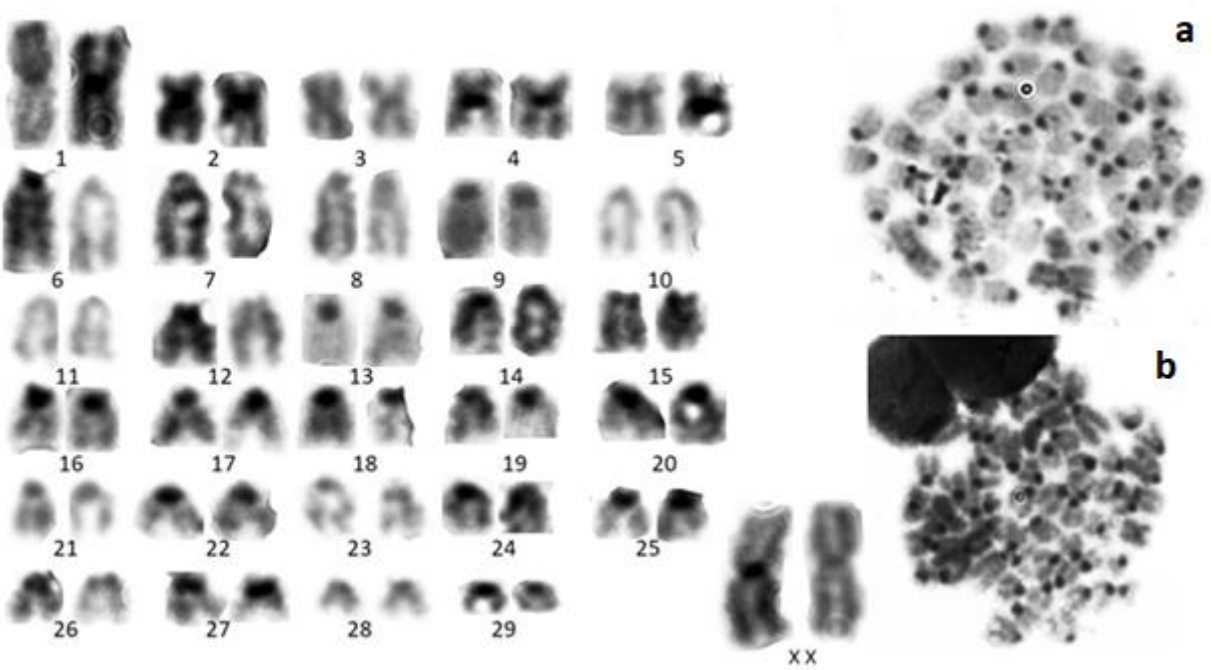

Figure 3. C-banded karyotype of *G. dasyurus* (female) and metaphase plates (a,b)
Şekil 3. G. dasyurus' un (dişi) C bant karyotipi ve metafaz plakları (a,b)

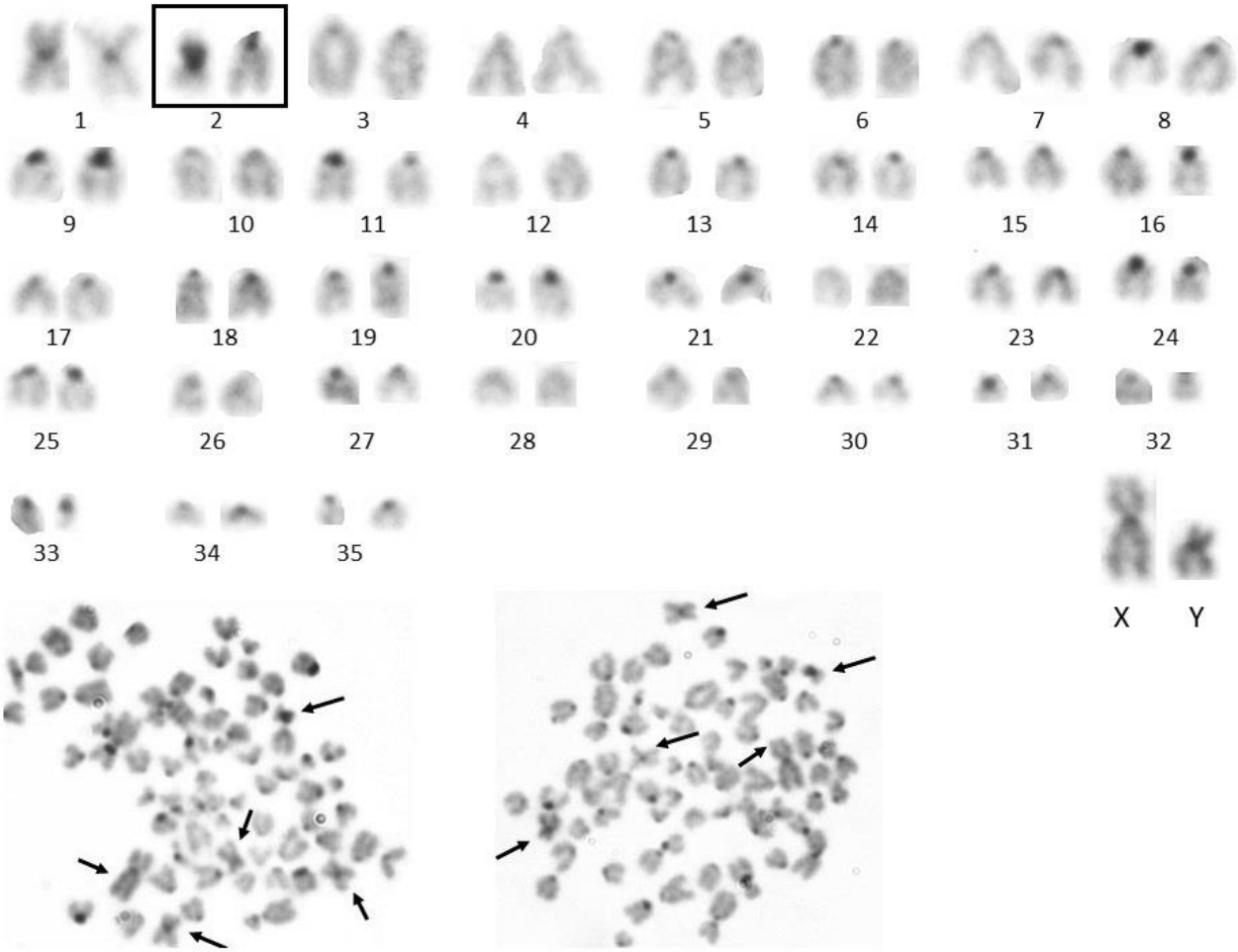

Figure 4. C-banded karyotype of *M. tristrami* (male) and heteromorphic chromosome no:2, arrow: biarmed chromosomes in metaphase plates
Şekil 4. M. tristrami' nin (erkek) C bant karyotipi ve heteromorfik 2. kromozom çifti, Ok. Çift kollu kromozomlar

while variation (NFa= 66, 68, 70) was found in the number of autosomal chromosome arm resulting from the variation in the number of biarmed chromosome (Qumsiyeh et al., 1986). Yiğit et al. (1997) reported that the karyotype of *G. dasyurus* was NFa=66. However, the number of autosomal chromosome arms found was NFa=68 in this study (Table 1). While constitutive heterochromatin distribution may constitute nearly half of the total length of chromosomes in karyotypes of *Gerbillus* species (*G. nigeriae* and *G. aureus*, Pequignot-Viegas et al., 1984; Volobouev et al., 1995), it may also show low rates of heterochromatin density (Aniskin et al., 2006). According to the results obtained this study (Figure 3a), heterochromatin regions in *G. dasyurus* were in centromere regions.

Table 1. Karyological characteristics of *G. dasyurus* and *M. tristrami* species from Türkiye, Southeast Anatolia (Batman, Diyarbakır, Gaziantep and Kilis), Central Anatolia (Ankara, Konya, Kırıkkale, Karaman), West Anatolia (İzmir), East Anatolia (Ağrı), North Anatolia (Kastamonu). Metacentric (M), Submetacentric (SM), Acrocentric (A) chromosome

Çizelge 1. G. dasyurus ve *M. tristrami türlerinin Türkiye' den belirlenen karyolojik özellikleri,* Güneydoğu Anadolu (Batman, Diyarbakır, Gaziantep ve Kilis), Merkez Anadolu (Ankara, Konya, Kırıkkale, Karaman), Batı Anadolu (İzmir), Doğu Anadolu (Ağrı), Kuzey Anadolu (Kastamonu). Metasentrik (M), Submetasentrik (SM), Akrosentrik (A) kromozom

Species *Türler*	**Method** *Yöntem*	**Locality** *Lokasyon*	**2N** *2N*	**NFa** *NFa*	**X** *X*	**Y** *Y*	**References** *Kaynakça*
G.dasyurus	Conventional	Kilis	60	66	SM	A	Yiğit et al., 1997
G.dasyurus	**Conventional, C-banding**	**Kilis**	**60**	**68**	**biarmed**	**-**	**In this study**
M.tristrami	Conventional	İzmir	72	72	M	M	Yiğit et al., 1998
M.tristrami	**Conventional, C-banding**	**Kilis**	**72**	**73**	**biarmed**	**biarmed**	**In this study**
M.tristrami	Conventional	Kilis	72	74	SM	SM	Yiğit and Çolak, 1998
M.tristrami	Conventional	Gaziantep	72	74	SM	-	Kaya, 2010
M.tristrami	Conventional	Various locality	72	76	SM	SM	Kefelioğlu, 1997
M.tristrami	Conventional	Karaman, Kastamonu	72	78	SM	SM	Yiğit et al., 1998
M.tristrami	Conventional	Various locality	72	80	SM	SM	Kefelioğlu, 1997
M.tristrami	Conventional	Kırıkkale	72	80	M	M	Demirbaş and Pamukoğlu, 2008
M.tristrami	Conventional	Unknown	72	80	SM	SM	Arslan and Zima, 2014
M.tristrami	Conventional, Ag-NOR banding	Ankara, Kırıkkale	72	80	M	-	Aşan et al., 2010
M.tristrami	Conventional, C-banding, Ag-NOR banding	Konya	72	80	SM	M	Mahmoudi et al., 2020
M.tristrami	Conventional	Diyarbakır	72	82	M	SM	Kaya and Coşkun, 2012
M.tristrami	Conventional	Ağrı	72	82	A	A	Yiğit et al., 2006
M.tristrami	Conventional, Ag-NOR banding	Batman	72	86	M	M	Ulutürk, 2022

In the studies conducted to find out the karyotype characteristics of *M. tristrami* species distributed in Transcaucasia, a part of Middle East and Anatolia (Armenia and Azerbaijan, Korobitsyna and Korablev, 1980; Palestine, Hermann, 1973; Jordan, Qumsiyeh et al., 1986, Sözen et al., 2008; Iran, Mahmoudi et al., 2020; Anatolia, Table 1), this species was found to have a stable diploid chromosome number (2n=72) and X chromosome was biarmed (except Yiğit et al., 2006). However, the number of biarmed chromosomes

of *M. tristrami* was reported in extensive variation (Matthey, 1957; Korobitsyna, 1975; Korobitsyna and Korablev, 1980; Zima and Král, 1984; Mahmoudi et al., 2020; current study, Table 1). The intraspecific variation of fundamental number of autosomal arms (NFa= 70-86) in *M. tristrami* resulted from the presence/absence of heterochromatic arms (Zima and Král, 1984; Korobitsyna and Korablev 1980; Qumsiyeh et al., 1986). In addition to this, previously conducted studies have reported that heteromorphic chromosome pairs in the autosomal chromosome set of *M. tristrami* species (speciemens from Jordan, Sözen et al., 2008; Azerbaijan and Armenia, Korobitsyna and Korablev, 1980; Türkiye, current study).

Constitutive heterochromatin distribution in *M. tristrami* bi-armed autosomes was C-positive as in previous studies (Korobitsyna and Korablev, 1980; Mahmoudi et al., 2020). In the karyotype of *M. tristrami*, C-heterochromatin distribution of small biarmed chromosomes can be in pericentromeric region, while it may also be in the form of complete C-heterochromatic arm (Mahmoudi et al., 2020). In the results of a previous study performed on the specimens from Transcaucasia (Korobitsyna and Korablev, 1980) and the present study (Figure 4), there was an enlarged heterochromatin block on the short arm of chromosome in heteromorphic chromosome pair.

As a conclusion, it was found that there were differences in the autosomal chromosome arm rates (NFa) of two different gerbil species (*G. dasyurus* and *M. tristrami*), the karyotypes of which were obtained in the present study, when compared with previously conducted studies in Türkiye. Furthermore, autosomal chromosome arm polymorphisms need to be better characterized cytogenetically in similar localities, particularly for *Meriones tristrami.*

Author Contributions

The contribution of the authors is equal

Conflict of Interest

The authors declare that they do not have any competition and any conflicts of interest.

REFERENCES

Abiadh A, Chetoui M, Cheniti-Lamine T, Capanna E, Colangelo P 2010. Molecular phylogenetics of the genus *Gerbillus* (Rodentia, Gerbillinae): Implications for systematics, taxonomy and chromosomal evolution. Molecular Phylogenetics and Evolution 56 (2010) 513–518

Abu Baker MM, Khalil A, Alsheyab F, Amr ZS 2009. A karyotypic study of the genus *Gerbillus* (Mammalia: Rodentia: Muridae) from Jordan. Vertebrate Zoology, 59:115-120.

Aniskin VM, Benazzou T, Biltueva L, Dobigny G, Grankon L, Volobouev V. 2006. Unusually extensive karyotype reorganization in four congeneric *Gerbillus* species (Muridae: Gerbillinae). Cytogenetic and Genome Research 112:131–140

Arslan A, Zima J 2014. Karyotypes of the mammals of Turkey and neighbouring regions: a review. Folia Zoologica 63(1): 1–63.

Aşan N, Albayrak I, Demirbaş Y, Yorulmaz T, Toyran K, Gözütok S 2010. Nucleolar organizer regions (NORs) in *Cricetulus migratorius* (Pallas, 1773) and *Meriones tristrami* Thomas, 1892 (Mammalia: Rodentia) from Central Anatolia. Turkish Journal of Zoology 34(2): 231–236.

Demirbaş Y, Pamukoğlu N 2008. The Bioecology of *Meriones tristrami* Thomas, 1892 in Kırıkkale Province (Mammalia: Rodentia). International Journal of Natural and Engineering Sciences 2: 39-44.

Ford C, Hamerton J 1956. A colchicine, hypotonic citrate, squash sequence for mammalian chromosomes. Stain Technology 31(6): 247–251.

Hermann B 1973. Donnes nouvelles sur l'assortiment chromosomique de *Meriones tristrami* Thomas (Rodentia, Gerbillinae). Genetica 44: 579-587.

Kaya A 2010. The karyological and morphological peculiarities of subfamily Gerbillinae (Mammalia: Rodentia) in Southeast Anatolia region. Dicle University, Phd thesis. p:115 (in Turkish).

Kaya A, Coşkun Y 2012. A new chromosomal form of *Meriones tristrami* Thomas, 1892 (Rodentia: Gerbillinae) in Southeast Anatolia. Zoology in the Middle East 55(1): 127–129.

Kefelioğlu H 1997. Türkiye *Meriones tristrami* Thomas, 1892 (Mammalia: Rodentia)'lerinin Taksonomik Durumu ve Karyolojik Özellikleri [Taxonomic Status and Karyological Characters *Meriones tristrami* Thomas, 1892 (Mammalia: Rodentia) in Turkey]. Turkish Journal of Zoolog: 21:57-62 (in Turkish).

Korobitsyna KV 1975. Intrapopulation chromosomes polymorphism of *Meriones tristrami* (Gerbillinae, Rodentia). 'Systematics and cytogenetics of mammals'. Abstracts of All-Union Symposium. Publishing house 'Nauka', Moscow, 22-24 (in Russian).

Korobitsyna KV, Korablev VP 1980. The intraspecific autosome polymorphism of *Meriones tristrami* (Gerbillinae, Cricetidae, Rodentia). Genetica, 52/53: 209-221.

Kryštufek B, Vohralik V 2009. Mammals of Turkey and Cyprus. Rodentia I.- Koper. 3-: pp.374

Lay DM, Agerson K, Nadler CF 1975. Chromosomes of some species of *Gerbillus* (Mammalia: Rodentia). Zeitschrift Säugetierkunde 40:141–150.

Lay DM 1983. Taxonomy of the genus *Gerbillus* (Rodentia: Gerbillinae) with comments on the applications of generic and subgeneric names and an annotated list of species. Zeitschrift Säugetierkunde 48:329–354.

Mahmoudi A, Arslan A, Zima J, Eybpoosh S, Mohammadi A, Hanifi H, Mostafavi E 2020. Cytogenetic Characteristics of Four *Meriones* spp. (Rodentia: Gerbillinae) from Turkey and Iran. Acta Zoologica Bulgarica 72 (2): 193-198

Matthey R 1957. Cytologie et taxonomie du genre *Meriones*, Illiger. Saugetierk. Mitt. 5:145-150

Pequignot-Viegas E, Benazzou T, Homme'Prod M, Dutrillaux B 1984. Characterisation of a very complex constitutive heterochromatin in two *Gerbillus* species (Rodentia). Chromosoma (Berl), 89:42-47

Qumsiyeh MB, Schlitter DA Disi AM 1986. New records and karyotypes of small mammals from Jordan. Zeitschreift für Säugetierkunde, 51: 139-146.

Sözen M, Karataş A, Fawzi A, Shehab A, Amr Z 2008. Karyotypes of seven rodents from Jordan (Mammalia: Rodentia). Zoology in the Middle East 44: 3–10

Sumner A 1972. A simple technique for demonstrating centromeric heterochromatin. Experimental Cell Research 75: 304–306.

Ulutürk S 2022. A New Cytotype of *Meriones tristrami* Thomas, 1892 (Rodentia: Gerbillinae) and its Nucleolar Organizer Regions (NORs) from Batman, South-eastern Turkey. Acta zoologica Bulgarica 74 (1): 3-8.

Volobouev V, Vogt N, Viegas-Pequignot E, Malfoy B, Dutrillaux B 1995. Characterization and chromosomal location of two repeated DNAs in three *Gerbillus* species. Chromosoma, 104: 252-259

Wahrman J, Zahavi A 1955. Cytological contributions to the phylogeny and classification of the Rodent genus *Gerbillus*. Nature 175, 600-602.

Wahrman J, Richler C, Ritte U 1988. Chromosomal considerations in the evolution of the Gerbillinae of Israel and Sinai. Monographiae Biologicae 62: 439–486.

Wassif K, Luffy RG, Wassif S 1969. Morphological, cytological and taxonomical studies of the rodent genera *Gerbillus* and *Dipodillus* from Egypt. Proceedings of the Egyptian Academy of Sciences (Egypt) 22:77-93.

Yiğit N, Çolak E, Kıvanç E, Sözen M 1997. Gerbil record from Turkey: *Gerbillus (Hendecapleura) dasyurus* (Wagner, 1842) (Rodentıa: Gerbillinae). Israel journal of zoologv, 43, pp. 13-18

Yiğit N, Çolak E 1998. A new subspecies of *Meriones tristrami* Thomas, 1892 (Rodentia: Grebillinae) from Kilis (Southeastern Turkey): *Meriones tristrami kilisensis* subsp. n. Turkish Journal of Zoology 22: 99-103.

Yiğit N, Kıvanç E, Çolak E 1998. On the taxonomic status of *Meriones tristrami* Thomas, 1892 (Rodentia: Gerbillinae) in Turkey. Zoology in the Middle East 16, 1998: 19-30.

Yiğit N, Gharkheloo MM, Çolak E, Özkurt Ş, Bulut Ş, Kankılıç T, Çolak R 2006. The Karyotypes of Some Rodent Species (Mammalia: Rodentia) from Eastern Turkey and Northern Iran with a New Record, *Microtus schidlovskii* Argyropulo, 1933, from Eastern Turkey. Turkish Journal of Zoology. 30:459-464.

Zima J, Král B 1984. Karyotypes of European mammals II. Acta Scientiarum Naturalium Academiae Scientiarum Bohemoslovacae-Brno 18 (8): 1–62.