between 40 and 50% smaller than the normal one (Figure A and B). The symmetrical position of these 2 different nucleoli in sister-nuclei seemed to point to the probability that each was organized by a different, specific chromosome.

With a view to analysis of the chromosomes, a number of specimens were prepared in accordance with the technique of TJIO and LEVAN[5]. All the metaphases showed the 16 chromosomes typical of the onion, but in the pair normally possessing satellites[6-8], only one of the chromosomes possessed one (Figure C and D), a form of heterozygosis similar to that already observed by GIMÉNEZ-MARTÍN[9], in the satellite pair of *Allium cepa*. Bulbs with nucleoli of the same size were found to have the normal SAT-chromosomes (Figure E). The presence of different-sized nucleoli is therefore correlated with the absence of a satellite or the corresponding secondary constriction in one of the chromosomes of *Allium cepa*.

This absence of the secondary constriction might be due simply to a physiological condition[10], since there is evidence that the morphology of the secondary constrictions is controlled by genes within the chromosome itself[11]. But many studies have demonstrated the connection between the amount of chromosome material responsible for organizing the nucleolus and the volume of the nucleolus[2,3,12,13] or the number of ribosomal cistrons present[14,15]. The possibility of deletion of the secondary nucleolar constriction[16] in the anucleolate mutant in *Xenopus laevis*[17] is demonstrated by the fact that in this mutant the ribosomal cistrons are not merely inactivated but absent[15]. We might interpret the case we are presenting as a partial deletion of 1 nucleolar organizer, of which the cytological expression would be the difference in size between the 2 nucleoli, due to the heterozygosis.

Resumen. Se describe el hallazgo de un bulbo de *Allium cepa* en el cual los dos nucleolos de cada núcleo muestran una clara diferencia de tamaño. El nucleolo menor posee aproximadamente la mitad del diámetro del nucleolo normal. Esta alteración de la morfología nucleolar se correlaciona con la ausencia de satélite en uno de los dos cromosomas normalmente satelizados.

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Chromosomes of Three Asian Mammals: *Meriones meridianus* (Rodentia: Gerbillinae), *Spermophilopsis leptodactylus* (Rodentia: Sciuridae), *Ochotona rufescens* (Lagomorpha: Ochotonidae)

Chromosomal analysis of many mammalian species during the last decade has demonstrated the potential usefulness of cytological characters in taxonomic investigation. Acquisition of 3 Asian mammals now provides additional information concerning chromosomal relationships within the rodent genus *Meriones*, between the 2 families of Lagomorpha, and between Asian and North American ground squirrels.

Materials and methods. The following specimens were studied: (1) *Meriones meridianus* Pallas, Iran: 21 km west of Sarakhs, one male; (2) *Ochotona rufescens* Gray, West Pakistan: 24 km S. Quetta (Chiltan Mtn.) 4 females and 3 males; (3) *Spermophilopsis leptodactylus* Lichtenstein, Iran: 24 km south of Sarakhs, 1 female and 2 males.

Chromosomes were analyzed from cell suspensions of femoral bone marrow[1]. Karyotypes were arranged in pairs according to size and centromere position (metacentric, submetacentric, acrocentric). Because morphological differentiation was difficult in *O. rufescens*, acrocentrics (telocentrics) and subtelocentrics were grouped together and similarly the biarmed chromosomes (metacentrics and submetacentrics) were grouped together. The fundamental number of chromosome arms (FN) is computed by counting biarmed autosomes as 2 arms and acrocentric autosomes as 1 arm; in *Meriones* the sex chromosome arms are included to facilitate comparison with prior publications.

Results. The diploid chromosome number ($2n$) of *Meriones meridianus* is 50 and the karyotype contains 12 metacentric, 14 submetacentric, and 22 acrocentric autosomes (Figure 1). A large submetacentric and a medium-sized submetacentric comprise the sex chromosomes and they are designated X and Y respectively because sex chromosomes of identical morphology have been found in 4 other species of *Meriones*[1,2]. The FN is 78.

Ochotona rufescens has a $2n$ of 60 and a karyotype containing 24 biarmed and 34 acrocentric and subtelocentric autosomes, a medium-sized submetacentric X and a minute, dot-like Y chromosome (Figure 2). The FN is 82.

Spermophilopsis leptodactylus has a $2n$ of 38. The autosomes are composed of 14 metacentrics, 20 submetacentrics, and 2 acrocentrics with prominent satellites (Figure 3). A medium-sized submetacentric X and a very small biarmed Y constitute the sex chromosomes (Figure 3). The FN is 70.

Discussion. 9 previously studied species of *Meriones* displayed $2n$'s of 40–72 and FN's of 72–78[1-6]. The chro-

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mosomes of *M. meridianus*, $2n = 50$, constitute a new pattern for the genus that falls between *M. sacramenti*, $2n = 46$, and *M. crassus*, $2n = 60$[1]. Karyotypic interrelationships between *M. meridianus* and other species of the genus seem to be due primarily to centric fusions; pericentric inversions must also be postulated in order to account for the variation in FN from 72–78[1]. Because FN's of 78 characterize *M. shawi* ($2n = 44$), *M. vinogradovi* ($2n = 44$), and *M. unguiculatus* ($2n = 44$), *M. meridianus* might be considered more closely related to these species than to *M. hurrianae* ($2n = 40$, FN = 76), *M. persicus* ($2n = 42$, FN = 72), *M. crassus* ($2n = 60$, FN = 72), *M. libycus* ($2n = 44$, FN = 74), or *M. tristrami* ($2n = 72$, FN = 74)[1]. Morphological data do not corroborate this suggestion[7]. Thus, before the diverse karyotypes that occur in *Meriones* may be interpreted in an evolutionary sense more lines of taxonomic evidence must be investigated.

Within the order Lagomorpha only a few species of the family Leporidae have been examined cytologically. The $2n$'s of 6 species of *Lepus* from Eurasia and North America are 48[8–10] whereas *Oryctolagus cuniculus* has a $2n = 44$[9], and species of *Sylvilagus* display $2n$'s = 42 or 52[10–11]; FN's vary from 66–80. *Ochotona rufescens* constitutes the first description of a species from the family Ochotonidae and it displays a higher $2n$ and FN than most of the Leporidae. If these attributes are found in additional species of *Ochotona*, chromosomes may serve as another means for differentiating the families of Lagomorpha. Future comparisons of Eurasian and North American *Ochotona* will also be of interest.

Fifteen species of North American ground squirrels of the genus *Spermophilus* exhibit $2n$'s of 30–46 and FN's of 60–78[12]. 2 species, *S. beecheyi* and *S. variegatus* ($2n = 38$; FN = 72) show a close chromosomal resemblance to *Spermophilopsis leptodactylus*, the latter differing by its FN of 70 and pair of chromosomes with satellites. This degree of karyotypic similarity between Asian and North American ground squirrels may indicate a common ancestry or perhaps a basic conservatism in the karyotype of the ground squirrels studied to date throughout their intercontinental distribution. The satellited acrocentric autosomes in *Spermophilopsis* are the first reported in the Sciuridae and they may provide a means for investigating relationships with African species of the tribe Xerini, a group considered closely related to *Spermophilopsis*[13,14].

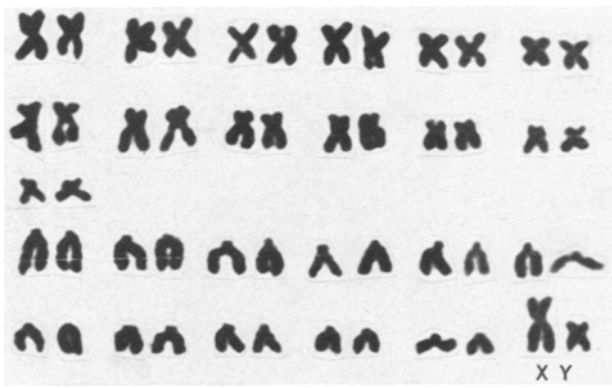

Fig. 1. Karyotype of a male *Meriones meridianus* ($2n = 50$). × 2700.

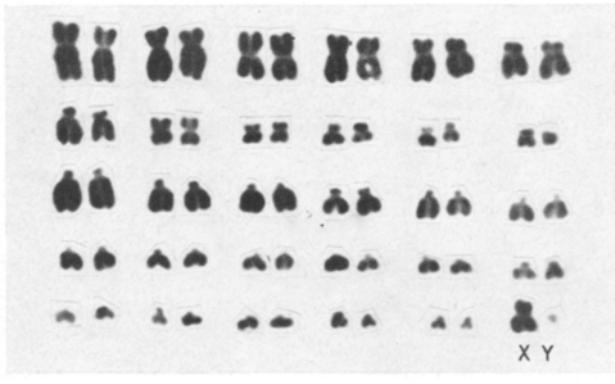

Fig. 2. Karyotype of a male *Ochotona rufescens* ($2n = 60$). × 2700.

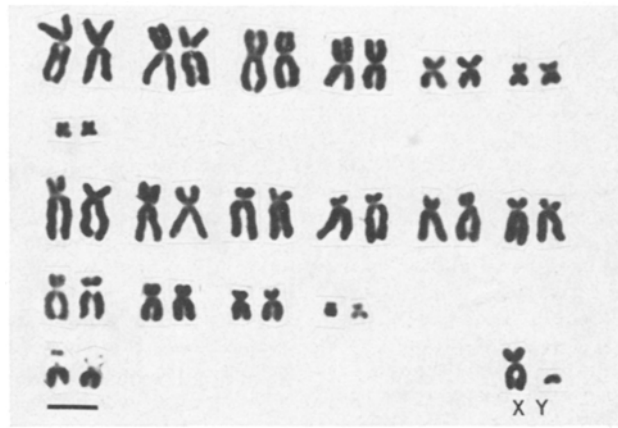

Fig. 3. Karyotype of a male *Spermophilopsis leptodactylus* ($2n = 38$). The acrocentric autosomes with satellites are underlined. × 2700.

Zusammenfassung. Chromosomenanalyse von 3 asiatischen Säugetieren: *Meriones meridianus* ($2n = 50$), *Ochotona rufescens* ($2n = 60$) und *Spermiophilopsis leptodactylus* ($2n = 38$). Deren $2n$'s und Karyotypen wurden mit verwandten Formen ninsichtlich der Geschlechter und Gattungen verglichen und zur Klassifizierung diskutiert.

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