the same result was obtained with valine as the infiltrated amino acid, the phenomenon is apparently not unique to the glutamic acid family of amino acids. The effect of hypogravity seems to be greater in the case of glutamic acid than the other amino acids tested both in magnitude and in the linear output immediately after treatment. It was not necessary to subject the plants to hypogravity for any length of time in order to produce the effect. If normal plants were infiltrated with labelled glutamate and placed on horizontal clinostats, a decrease in $^{14}CO_2$ evolution was noticed at the first period of measurement 10 min later. The total time required for the injection and mounting on the clinostat to the first measurement required 30 min. Under our conditions this appears to be ample time for the substrate to permeate the symplast. Considering the short time involved and the anticipated dilution of the infiltrated amino acid by the endogenous pool, the amount and rapidity of breakdown is considerable.

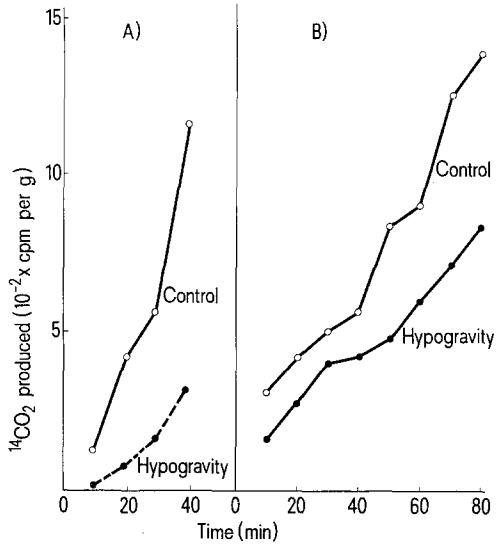

Fig. 2. Comparison of $^{14}CO_2$ produced from control and hypogravity plants after infiltrating (A) 5 µCi L-proline-U-^{14}U (specific activity 198 mCi per mmole) and (B) 4 µCi L-valine-U-^{14}C (specific activity 218 mCi per mmole). The results are expressed on a fresh weight basis.

These results indicate that decarboxylating systems are sensitive to hypogravity effects and might offer a good index for future studies on the effects of hypogravity on cellular metabolism. The results could be due to effects on the enzymes themselves or the physical processes involved in the transfer and release of the gas. The production of ethylene, also a gas, in tomato plants was markedly enhanced by hypogravity[5], in contrast to our results with $^{14}CO_2$. This suggests the possibility that the enzymes involved in the metabolism of glutamic acid or their regulation under hypogravity conditions may be modified from that in the normal plant. Based on certain theoretical considerations, AUDUS[6] has calculated that if only a slight displacement of particles is required for gravity perception, then mitochondria can move through a distance of their own diameter in 6 min. Such movement or lack of movement could transform the internal cellular environment rapidly enough to obtain the results presented in this report.

Zusammenfassung. L-Glutamat-U-^{14}C, L-Prolin-U-^{14}C und L-Valin-U-^{14}C wurden in Ringelblumen (*Tagetes patula*) injiziert, die sich in einer Gasaustauschkammer befanden, und auf senkrechte und waagrechte Klinostaten montiert. Menge und Bildungsgeschwindigkeit des entstehenden $^{14}CO_2$ waren stets geringer in den schwerkraftkompensierten als in den unter normalen Bedingungen gehaltenen Pflanzen.

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[8] To whom requests for reprints should be sent.

Chromosomes of the African Ground Squirrel, *Xerus rutilus* (Rodentia: Sciuridae)

African ground squirrels of the genera or subgenera *Atlantoxerus*, *Euxerus*, *Geosciurus*, and *Xerus* are generally agreed to constitute a distinct group, of at least tribal rank, within the subfamily Sciurinae[1–4]. However, their relationships to other ground squirrels (*Spermophilus*) of the tribe Marmotini, and to the long-toed ground squirrel (*Spermophilopsis leptodactylus*) of Middle Asia, are not clearly understood. The present report describes the Giemsa-band patterns of the chromosomes of *Xerus rutilus*, compares them with the chromosomes of *Spermophilopsis* and *Spermophilus*, and evaluates the relationships between these genera.

Materials and methods. Seven specimens of *Xerus rutilus* (Cretzschmar) (2♂♂, 5♀♀) were collected at Lake Baringo, north of Nakuru, Kenya, Africa. Chromosomes were analyzed from cell suspensions of femoral bone marrow[5]. Skin biopsies grown in tissue culture by Dr. T. C. HSU, M. D. Anderson Hospital, Houston, Texas, were utilized for analysis of Giemsa banding patterns by the method of SEABRIGHT[6].

Results. *Xerus rutilus* had a $2n = 38$ and karyotype composed of 14 metacentrics, 20 submetacentrics, 2 acrocentrics with prominent satellites, a medium-sized submetacentric X and a minute biarmed Y chromosome (Figure 1). The karyotype of *X. rutilus* is indistinguishable from that reported for *Spermophilopsis leptodactylus*[7,8]. A schematic representation of G-bands from *X. rutilus* is depicted in Figure 2. Comparison of these G-bands with

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those of *Spermophilus columbianus* and *S. undulatus*[9] (2 n = 32) and *S.* (*Otospermophilus*) *beecheyi* with 2 n = 38 (unpublished), a species considered to retain primitive characteristics[10], suggests that only 3 chromosome pairs could possibly be homologous. Moreover, satellited chromosomes are restricted to *X. rutilus* and *S. leptodactylus* and are not found among the karyotypes of other Eurasian and North American ground squirrels.

Discussion. The great similarity between the chromosomes of *Xerus rutilus* and *Spermophilopsis leptodactylus* confirms the placement of the latter in the tribe Xerini[2,4,11] rather than its assignment to a distinct subfamily[12]. Moreover, the considerable differences between the karyotypes of these xerine ground squirrels and primitive marmotine ground squirrels with 2 n = 38 suggest that the two tribes are not closely related.

These data are in agreement with the fossil record reviewed by BLACK[13]. The earliest xerines (*Heteroxerus*) are found in the late Oligocene of western Europe, while the earliest marmotines (*Miospermophilus*) are from the late Oligocene of Wyoming. No fossil xerines are known outside of western Europe and Africa, while fossil marmotines (*Spermophilinus*) do not appear in Europe until the late Miocene, although the position of the early Miocene (and possibly Oligocene) *Palaeosciurus* remains problematical.

The present distribution of the tribe Xerini is fragmented; *Geosciurus* occurs in south and southwestern Africa, *Euxerus* in tropical Africa, *Xerus* in northeastern Africa, *Atlantoxerus* in Morocco and Algeria, and *Spermophilopsis* in Russian Turkestan and adjacent Afghanistan and Iran. Most of the genera (or subgenera) are disjunct from one another, and MOORE[4] believes that xerines are 'in the contracting phase of their evolution...', in contrast to marmotines. While MOORE[4] suggests in one place (p. 195) that xerines may have given rise to marmotines, he also says it is more likely that marmotines arose independently from tree squirrels (p. 197); our results support the latter interpretation.

Comparison of the chromosomes from *X. rutilus* with other Eurasian Sciuridae revealed a striking similarity with the tree squirrel *Dremomys rufigenis* (Blanford) from Viet Nam (2 n = 38)[14]. The karyotype of *Dremomys* exhibited 2 more pairs of nearly metacentric autosomes than *X. rutilus* and the smallest pair of autosomes in the former was acrocentric or subtelocentric rather than sub-

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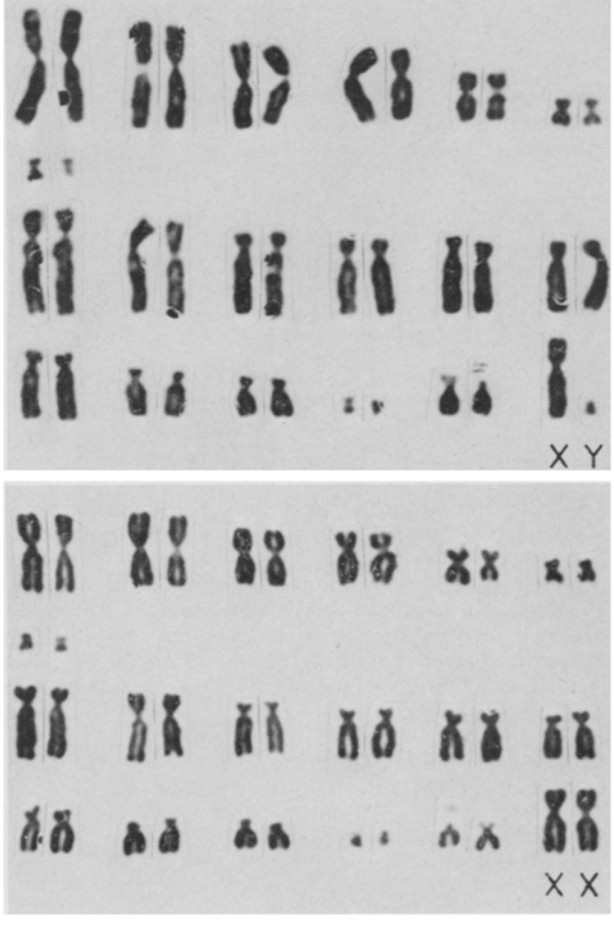

Fig. 1. Karyotypes of male (above) and female (below) *Xerus rutilus* (2 n = 38) from Kenya. Note acrocentric autosomes with satellites at lower left.

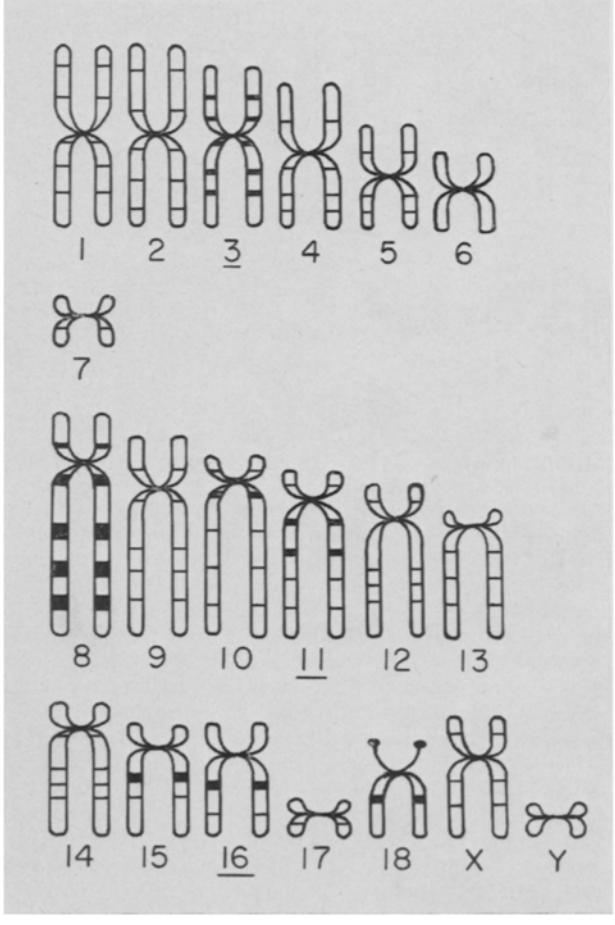

Fig. 2. Schematic representation of G-band patterns in the chromosomes of *Xerus rutilus*. Chromosome pairs possibly homologous with those of *Spermophilus* are underlined.

metacentric; the sex chromosomes were similar and both taxa had an indistinguishable pair of acrocentrics with prominent satellites. These data, particularly the common occurrence of satellited chromosomes, suggest that xerine ground squirrels and certain Asian tree squirrels may have evolved from common ancestral stock, a hypothesis amenable to further testing by means of G-band comparisons.

Finally, the discovery of $2n = 38$ in xerine ground squirrels, an old group that diverged from other squirrels early in its history, lends support to our earlier postulate that the ancestral chromosome complement of the subfamily Sciurinae was in the range of $2n = 38$–40[14].

ВЫВОДЫ. Хромосомы африканских земляной белки, *Xerus rutilus*, не отличаются от тонкопалого суслика, *Spermophilopsis leptodactylus*, из Средной Азии. Кариотип содержит 6 метацентрических, 20 субметацентрических, и 2 акроцентрических аутосом с хорошо выраженными спутниками. *X*-хромосома – метацентрик; *Y*-хромосома – очень маленькая. Хромосомный сходство оказывает поддержку для включения *Spermophilopsis* в трибу Xerini.

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5 March 1974.

[15] Supported by National Science Foundation Grants No. GB 32114X, 29131X, and the Sprague Foundation. We thank Dr. T. C. HSU, M. D. Anderson Hospital, Houston, Texas, for Giemsa-band chromosome preparations from skin biopsies. JOSEPHINE THOMPSON, Nairobi, Kenya, obtained live *Xerus rutilus* for us, and LJERSTETKA DEUTSCH provided technical assistance.

Gamma-Radiation Induced Variation in some Morphological and Nutritional Components of *Cicer arietinum* L. cv. Chhola

All the prevalent commercial cultivars of *Cicer arietinum* L. in Pakistan possess an adequate nutritive value[1] but are low-yielding and susceptible to the gram pod-borer; *Heliothis armigera* Hb. This study with *C. arietinum* L. cv. Chhola has assessed the acute gamma radiation effects on the morphological and nutritional parameters.

Materials and methods. Seven 50 g seed lots of one year old *Cicer arietinum* L. cv. Chhola at 9.4% moisture content were given single γ radiation exposures of 1.0, 2.0, 3.0, 4.0, 5.0, 7.5 and 10.0 Kiloroentgens (kR) from a ^{60}Co 4500 Ci source. An extra lot served as the control.

Nutritional evaluation. 25 g seed samples with the respective treatments were ground on a micro sample mill to pass through a 40 mesh sieve size and stored at 4 °C in air-tight containers. Standard procedures for moisture and KJELDAHL protein[2], sample hydrolysis[3] and amino acid analysis[4] were adopted. Cystine and methionine were not analyzed by oxidation to cysteic acid and methionine sulfone.

Morphological evaluation. From the respective 50 g irradiated seed samples, lots of 80 seeds for each treatment were separated and immediately planted in flats containing a steam sterilized 2:1:1 mixture of soil, sand and peat. The flats were kept in the greenhouse at temperatures of 29.4 °C (day) and 18.3 °C (night). A randomized complete block design was used with 4 replicates and 20 seeds were planted for each treatment and replication. Germination and seedling height were recorded 15 days after 50% germination was observed in the control. From this data the seedling performance was derived according to the technique of OSBORNE and LUNDEN[5].

Results and discussion. The morphological data for germination, seedling height and seedling performance (Table 1) has manifested growth stimulation of varied degrees as a consequence of seed irradiation. The germination in all treatments was earlier and higher than the control while seedlings were taller in 1.0, 2.0 and 3.0 kR and shortened from 5.0 kR. The seedling performance interpolations[5] depicted an increase from 1.0 to 4.0 kR with a progressive decrease subsequently. All comparisons were significant ($p \geqslant 0.01$). Early germination in treated seeds has been a phenomenon reported and reviewed earlier by MUJEEB and GREIG[6]. In Chhola this stimulation continued up to 10.0 kR and is manifested by this trait's

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Table I. Mean values of some morphological growth characteristics of *Cicer arietinum* L. cv. Chhola as influenced by γ-radiation exposures with characteristic/dosage correlations

Characteristics[a]	Dosage (kR)								*r* for
	0	1	2	3	4	5	7.5	10	characteristic/dosage
Germination	71	74	75	74	75	75	75	75	0.702
Seedling height (cm)	6.8	7.2	7.2	7.1	6.8	6.1	5.8	5.7	−0.88[b]
Seedling performance	1.00	1.10	1.11	1.09	1.06	0.95	0.90	0.88	−0.84[b]

[a] LSD 0.01 for germination = 2; seedling height = 0.2; seedling performance = 0.04. [b] Significant at $p \geqslant 0.01$.