of the evidence presented favors the recognition of a new class of thyroid carcinoma producing CT, though the possibility of the formation of amyloid by eventual metastases cannot be actually rejected[2,17].

In summary, the investigation of CT-production should be extended to trabecular tumours of the thyroid and not restricted to medullary cancer with amyloid[18].

Résumé. Un cancer trabéculaire de la thyroïde, riche en mucopolysaccharides et dépourvu de stroma amyloïde, produit 1000 fois plus de calcitonine que le tissu thyroïdien normal. Il semble s'agir d'une entité anatomopathologique nouvelle, correspondant à une tumeur différenciée sécrétant de la calcitonine.

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Chromosomes of Some Asian and South American Squirrels (Rodentia: Sciuridae)

North American squirrels are characterized by differing degrees of chromosomal variation; cytological mechanisms postulated to account for karyotype evolution vary in different taxa. Striking diversity, due mainly to Robertsonian changes, occurs in terrestrial squirrels, Marmotini, of the genera *Spermophilus* $(2n = 30$–$46)$[1–4] and *Marmota* $(2n = 36$–$42)$[5,6]; species of *Cynomys* $(2n = 40;\ 2n = 50)$ are differentiated by both Robertsonian mechanisms and pericentric inversions[7]. *Ammospermophilus* $(2n = 32)$[8] constitutes a monomorphic genus. Taxa within the genus *Tamias* $(2n = 38)$[9–12] share similar diploid numbers but differ due to pericentric inversions. In another ground squirrel tribe, Xerini, *Spermophilopsis* has a $2n = 38$[12,13].

In contrast, tree squirrels, Sciurini, exhibit remarkable chromosomal homogeneity examplified by $2n = 40$ and similar karyotypes in 4 species of *Sciurus*[14]. Two species of *Tamiasciurus*[15], Tamiasciurini, have $2n = 46$. Comparison of karyotypes from the above taxa usually provides a clear appraisal of the number and kinds of chromosomal rearrangements associated with their evolution, but direction of evolution is difficult to evaluate, because of inability to distinguish centric fusions from fissions. This difficulty is compounded by lack of knowledge concerning the probable basic or 'ancestral' $2n$ of Sciuridae.

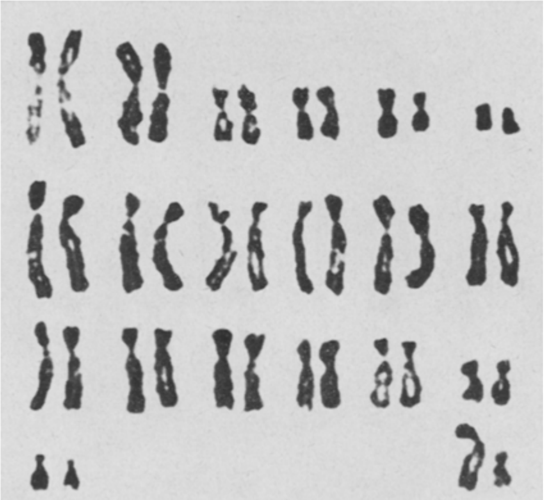

Fig. 1. Karyotype of a male *Sciurus anomalus* ($2n = 40$) × 3000. The sex chromosomes are at the right of the bottom row.

The present investigation describes the chromosomes of several species of South American and Asian squirrels of the tribes Sciurini and Callosciurini. Chromosomal data from these and previously reported species provide a broadened perspective that allows a preliminary appraisal of trends in karyotype evolution in the subfamily Sciurinae.

Materials and methods. Chromosomes from the following specimens were studied: *Sciurus anomalus* Güldenstaedt, Iran, Zagros Mountains, 1 male; *Menetes berdmorei* (Blyth), South Vietnam, Calu, 1 male; *Dremomys rufigenis* (Blanford), South Vietnam, Mt. Sontra, 1 male; *Callosciurus flavimanus* (I. Geoffroy), South Vietnam, Vanderift Combat Base, Quan Tri, 1 male; *Sciurus granatensis* Humbolt, South America, unknown locality, 1 male; and Venezuela, Los Venados, Monte Avila, D.F., 1 female. The number of autosome arms were counted to determine the fundamental number (FN)[16].

Results. The $2n$ of *Sciurus anomalus* is 40 (FN 76) and the karyotype contains 18 pairs of metacentric and submetacentric autosomes and 1 pair of subtelocentric autosomes; an unpaired medium sized submetacentric and a second small submetacentric probably represent the X and Y respectively (Figure 1).

Sciurus (or *Guerlinguetus*) *granatensis* has a $2n = 42$ (FN 78) and a karyotype comprised of 19 pairs of metacentric and submetacentric autosomes and 1 pair of acrocentric autosomes, a large submetacentric X and a medium sized submetacentric Y chromosome (Figure 2).

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Callosciurus flavimanus, $2n = 40$ (FN 74), displays 17 pairs of metacentric and submetacentric autosomes, 2 pairs of acrocentric autosomes, and a pair of unequal sized submetacentric sex chromosomes (Figure 3).

The $2n$ of *Dremomys rufigenis* is 38 (FN 62); the karyotype exhibits 16 pairs of metacentric and submetacentric autosomes, 1 pair of minute acrocentric autosomes, and another pair of larger acrocentrics with prominent satellites. The X and Y chromosomes are probably large and small submetacentrics respectively (Figure 4).

A $2n$ of 62 (FN 76) characterizes *Menetes berdmorei*. The karyotype contains 8 pairs of metacentric and submetacentric and 22 pairs of acrocentric autosomes; a large and a small submetacentric constitute sex chromosomes (Figure 5).

Discussion. Examination of chromosome number and morphology from all taxa of Sciuridae presently available is a prerequisite for postulating relationships among squirrel species (Table). A $2n = 38–40$ predominates in the tribes Xerini and Sciurini, and the subtribes Tamiina and Marmotina of tribe Marmotini. Within the subtribe Spermophilina where $2ns$ range from 30–50 the numbers most commonly found are $2n = 36–42$; certain of the more unspecialized species such as *Spermophilus* (*Otospermophilus*) sp. have a $2n = 38$. Similarly, in the genus *Cynomys* the less specialized species (*C. gunnisoni*) is characterized by $2n = 40$ whereas the more specialized forms have $2n = 50$. In the Callosciurini, the tree squirrels *Dremomys* and *Callosciurus* also conform ($2n = 38–40$), while the ground squirrel *Menetes* is divergent ($2n = 62$). Exceptions to the predominating pattern of $2n = 38–40$ occur in the tribe Tamiasciurini ($2n = 46$) and Funambulini ($2n = 46, 54, 56$)[17,18].

We postulate that: 1. In the subfamily Sciurinae the basic $2n$ of 38–40 represents an approximation to the ancestral $2n$ of the subfamily because it occurs in many ecologically and morphologically divergent forms; 2. Taxa with a $2n$ lower than 38–40 probably underwent predominantly centric fusions during their karyotype evolution; and 3. Taxa with $2ns$ higher than 38–40 attained their karyotypes by a fissioning process. The existence of chromosomal fissioning or dissociation in karyotype evo-

Fig. 3. Karyotype of a male *Callosciurus flavimanus* ($2n = 40$) × 3000. The sex chromosomes are at the extreme right in the bottom row.

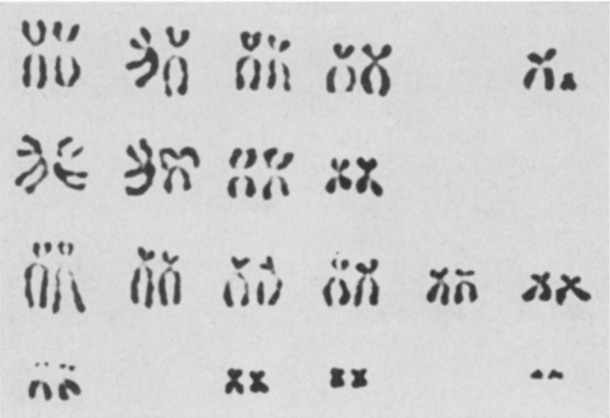

Fig. 4. Karyotype of a male *Dremomys rufigenis* ($2n = 38$) × 3000. The sex chromosomes are placed at the right in the top row and the pair of acrocentric autosomes with satellites are at the left of the bottom row.

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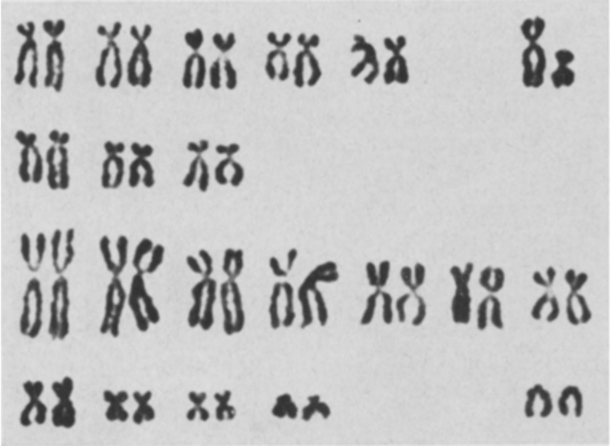

Fig. 2. Karyotype of a male *Sciurus granatensis* ($2n = 42$) × 3000. The sex chromosomes are placed at the extreme right of the top row.

Fig. 5. Karyotype of a male *Menetes berdmorei* ($2n = 62$) × 3000. The sex chromosomes are placed at the extreme right in the top row.

Chromosomes of representatives of various suprageneric groups of the subfamily Sciurinae (after Moore[25], Simpson[26] and others)

Suprageneric group	Genus, subgenus, species	2*n*	FN	Reference
Tribe Marmotini				
Subtribe Tamiina	*Tamias striatus*	38	58	[9]
	Tamias (*Eutamias*) sp.	38	58–60	[9–12]
Subtribe Spermophilina	*Spermophilus* (*Spermophilus*) sp.	30–46	56–68	[1–4,22]
	S. (*Urocitellus*) sp.	32–34	60–64	[22,31]
	S. (*Ictidomys*) sp.	32–34	60–64	[1]
	S. (*Poliocitellus*) *franklinii*	42	66	[2]
	S. (*Otospermophilus*) sp.	38	72	[2]
	S. (*Callospermophilus*) sp.	42	78	[2]
	S. (*Xerospermophilus*) sp.	36	68	[2]
	Ammospermophilus sp.	32	60	[8]
	Cynomys (*Cynomys*) *ludovicianus*	50	96	[7]
	C. (*Leucocrossuromys*) sp.	40–50	72–96	[7]
Subtribe Marmotina	*Marmota* sp.	36–42	62–66	[5,6,30]
Tribe Xerini	*Spermophilopsis leptodactylus*	38	70	[12,13]
Tribe Tamiasciurini	*Tamiasciurus* sp.	46	80–88 ?	[15]
Tribe Sciurini	*Sciurus* sp.	40	74–76	[12,14,23]
	Sciurus anomalus	40	76	Present paper
	Sciurus (*Guerlinguetus*) *granatensis*	42	78	Present paper
Tribe Callosciurini	*Callosciurus flavimanus*	40	74	Present paper
	Dremomys rufigenis	38	62	Present paper
	Menetes berdmorei	62	76	Present paper
Tribe Funambulini	*Funambulus palmarum*	46	?	[18]
	Funambulus pennanti	54–56	?	[17,18]

lution of Sciurinae, a controversial issue at present[19], is also supported by cytotaxonomic data from *Marmota*[5], *Cynomys*[7], *Spalax*[20] and marsupials[21].

Karyotype evolution within Marmotini has been discussed elsewhere[22], and conforms to the principles enumerated above. Chromosomal repatterning in certain taxa must have involved both fusion and fission from a basic $2n = 38$–40[5,7].

Relationships between Asian and American species of *Sciurus* may be evaluated similarly. *S. anomalus* from Iran ($2n = 40$; FN 76) and from Armenia[12] are chromosomally similar to four species of North American *Sciurus* although they differ from the latter species by differences in the morphology of certain autosomes and by the submetacentric *Y* chromosome. *S. vulgaris* from Siberia[12] and Japan[23] also has a $2n = 40$ and acrocentric *Y* chromosome like North American *Sciurus* but unlike the other species has a FN of 74 due to the presence of two pairs of acrocentric autosomes. Thus, the chromosomal similarities of these species supports their inclusion within a single genus *Sciurus*. Karyotypic differences between these species may be explained by pericentric inversions or reciprocal translocations involving both autosomes and the *Y* chromosomes.

The South American *S. granatensis* ($2n = 42$, FN 78) is chromosomally divergent from other *Sciurus* and we postulate that chromosomal fissioning produced its higher 2*n*. The generally accepted opinion that South American sciurids evolved from ancestral North American stock[24] strongly supports this concept.

The 3 species of Callosciurini we examined are quite different karyologically and morphologically. *Callosciurus* ($2n = 40$, FN 74) may be more nearly like the ancestral forms of this subtribe than the other two species; it is chromosomally quite similar to *Sciurus*. *Menetes berdmorei* ($2n = 62$, FN 76) and *Dremomys rufigenis* ($2n = 38$, FN 62) are morphologically and ecologically more specialized than *Callosciurus flavimanus*[25–27] and they probably evolved from an ancestral form with chromosome pattern of $2n = 40$ by fission and fusion respectively.

Within the tribe Funambulini there are no species with chromosome numbers approximating $2n = 38$–40. Their evolutionary history is thus unclear but it is again likely that the observed 2*n*s of 46, 54, and 56 evolved by fissioning from a $2n = 38$–40 ancestral pattern.

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The 2 species of *Tamiasciurus* ($2n = 46$; FN 80–88) display a considerable degree of cytological divergence from the $2n = 38$–40 and FN 74–78 found in the majority of tree squirrels, which supports the tribal status of the Tamiasciurini[28,29,32].

Zusammenfassung. Chromosomensätze verschiedener Sciurinae sind: *Sciurus anomalus* ($2n = 40$), *S. granatensis* ($2n = 42$), *Callosciurus flavimanus* ($2n = 40$), *Dremomys rufigenis* ($2n = 38$) und *Menetes berdmorei* ($2n = 62$). Ein Vergleich mit früher beschriebenen Sciurinae-Karyotypen ergibt als ursprünglich diploide Sätze 38–40, Spaltung, sowie Fusion zu grösseren und kleineren $2n$'s führend.

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Radioprotective Effect of Reticuloendothelial System Blockade in Mice

Reticuloendothelial system (RES) acts as a primary host defence mechanism against effete self substances, as well as against intruded foreign materials. There is good evidence that a large number of aged erythrocytes are trapped by RES in spleen and liver[1,2]. Our in vitro and in vivo observation, that erythrocytes treated with phenylhydrazine, saponin, or mercuric chloride were prone to adhere to peritoneal exudate cells, may be relevant to the scavenger activity of RES[3,4]. This scavenger activity of RES may have an important role also in the death of sublethally irradiated animals. As generally known, RES is radioresistant[5–7], and some authors have reported even the enhancement of phagocytosis after irradiation[8,9]. It was also reported that, after the exposure of animals to radiation, a lot of cell débris occurred in the blood stream and were sequestered by RES[10]. Of course the hematopoietic depletion is mainly responsible for the radiation-induced lethality, since radiation does not inflict great damages on the mature blood cells but suppresses the recruitment of blood cells. In this case, slightly injured cells, which still maintain a large part of their biological activity, may be assumed to function until cell recruitment is restored. In the sublethally irradiated animals, however, even these slightly injured but still potential cells would be cleared by RES, resulting in the remarkable leukopenia, and death of animals would be accelerated. If it actually proceeds in animal bodies, the 'blockade' of RES by 'overloading' with particulate material will provide the animal with a greater degree of tolerance of radiation by interfering the phagocytosis of slightly injured but still functional blood cells.

Material and method. 30-day-old male mice of ICR-JCL strain, weighing about 23 g, were used. They were divided into 4 groups of 25 mice respectively. Mice in groups 2 and 4 were injected i.v. with 10 mg of carbon particles (Pelikan ink, Günther-Wagner, Germany) suspended in 0.2 ml of physiological saline. 24 h later, mice in groups 3 and 4 were exposed to 600 R of X-ray, with a filter of 0.3 mm Cu and 0.5 mm Al, at the dose rate of 50.0 R per min, 200 KV, 20 mA. Mice in group 1 were left untreated. After the irradiation each mouse was weighed every other day for 30 days.

Results and discussion. Survival of the X-irradiated mice were shown in the Figure 1. Whole body irradiation with 600 R X-ray caused 17 in 25 mice to die in the following 14 days. On the contrary, all of the mice which had been injected with 10 mg of carbon particles prior to the irradiation escaped from death. Figure 2 shows the changes in the mean body weights of the surviving mice. In the 8 mice which escaped from death, 4 mice appeared to be completely resistant to radiation and continued to gain their body weights (S-2 in Figure 2). Other 4 mice started losing their weights 10 days after irradiation until day 16 and then tended rapidly to recover their weights (S-1 in Figure 2).

Both lethal and wasting effects of radiation were almost completely prevented by the administration of carbon particles 24 h prior to irradiation. Mice injected with carbon particles behaved similarly to the control mice, and not a single mouse was observed to lose its weight at any time after exposure. Such a strong protective effect of carbon particles was also confirmed in another experiment in which 5 mg and 15 mg carbon particles were administered.

Although the mechanism of the protection by carbon particles from radiation-induced injury is still obscure, the present results seem to support our before-mentioned hypothesis. Concerning the divergent results on the phagocytotic response after the irradiation[11,12], Cottier[10] suggested the possibility that increase in the amount of cell particles and damaged cells occurring in the irradiated animals might affect the activity of the phagocytotic cells. As RES usually shows no morphological damage[5] and little change in phagocytotic capacity when tested in vitro[6,7], one can suppose that the changes in the phagocytotic activity is not due to the direct effect of radiation but attributable to the enhanced capacity to remove damaged cells and their particles. Then the differences reported by many authors might well be explained as the results of the different level of requirement to clear denatured substances according to the degree of the injury of other tissues. In the case of animals exposed to the sublethal dose of X-ray, the 'partial blockade' with carbon particles might

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