Chromosomes of some Species of *Meriones* (Mammalia: Rodentia)[1]

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The fourteen species of jirds currently recognized to comprise the rodent genus *Meriones* (Gerbillinae) occupy the Great Palearctic Desert from Mongolia to North Africa. Numerous investigators have dealt with the taxonomic relationships among the species of this interesting and widespread genus. Heptner (1940) reported on the species of *Meriones* inhabiting Iran. Ellerman (1941) recognized three subgenera: *Parameriones*, containing three species, *Meriones*, with 14 species, and *Cheliones*, with one species. The classification proposed by Chaworth-Musters and Ellerman (1947) though somewhat modified by more recent work provides the basis for current classification of the genus. These authors recognized five subgenera and 13 species as follows:

Subgenus *Sekeetamys*
Meriones calurus
Subgenus *Parameriones*
M. persicus
M. rex
Subgenus *Cheliones*
M. hurrianae
Subgenus *Meriones*
M. tamariscinus
M. blackleri
Subgenus *Pallasiomys*
M. unguiculatus
M. meridianus
M. shawi
M. libycus
M. arimalius
M. crassus

Meriones vinogradovi, though recognized specifically, was not placed in any subgenus. Ellerman and Morrison-Scott (1951) using the system proposed by Chaworth-Musters and Ellerman (op. cit.) placed *M. vinogradovi* in the subgenus *Meriones*. Zahavi and Wahrman (1957) in a study of the gerbils and jirds of Israel showed that *Meriones sacramenti* constitutes a species distinct from *M. crassus* with which Chaworth-Musters and Ellerman (op. cit.) had synonymized it. Matthey (1957) and Baltazard et. al. (1960) have presented evidence that *M. blackleri* should be recognized as a junior synonym of *M. tristrami* and that *tristrami* must be given specific rank and not that of a subspecies of *shawi* as proposed by Chaworth-Musters and Ellerman (op. cit.). Setzer (1961:88) in his review of the jirds of Egypt suggests that it is "doubtful that *shawii* exists as a species." All the *Meriones* species occurring in the fauna of the USSR have been treated by Bobrinsky et al. (1944, 2nd ed. 1965) and by Gromov et al. (1963). These works are identical in recognizing eight species. Both use the name *blackleri* for the species *tristrami* and the latter work in contrast to the former employs *erythrourus* for the species *libycus*. Both recognize *M. zarudnyi* as a distinct species whereas Chaworth-Musters and Ellerman (op. cit.) synonymized this form with *M. crassus*. Gromov et al. (op. cit.) employ two subgenera for the species treated, but provide no rationale for this use. Their categories are:

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Subgenus *Meriones*
M. persicus
M. vinogradovi
M. tamariscinus
M. zarudnyi
M. blackleri
M. unguiculatus
Subgenus *Pallasiomys*
M. erythrourus
M. meridianus

Petter (1956) has distinguished *Sekeetamys* as a genus. In summarizing the above taxonomic views the following classification incorporates findings since 1947 into Chaworth-Musters and Ellerman's (op. cit.) revision of the genus.

Genus *Meriones*
Subgenus Parameriones
M. persicus
M. rex
Subgenus *Cheliones*
M. hurrianae
Subgenus *Meriones*
M. tamariscinus
M. tristrami
M. zarudnyi
M. vinogradovi
Subgenus *Pallasiomys*
M. unguiculatus
M. meridianus
M. shawi
M. libycus
M. arimalius
M. crassus
M. sacramenti

Chromosomes have been analyzed from the following species: *Meriones persicus, M. vinogradovi, M. tristrami, M. shawi, M. libycus, M. crassus* (Matthey 1953, 1954, 1957), *M. sacramenti* (Zahavi and Wahrman 1957), *M. unguiculatus* (Awa et al. 1959). According to these reports diploid chromosome numbers ranged from 42 to 72 and all species possessed 74 chromosome arms, designated the fundamental number (FN), except *tristrami* which showed 76. This suggested that a series of Robertsonian centric fusions may have been responsible for evolution of the seemingly diverse karyotypes (Matthey 1957). Because *M. sacramenti* (2n = 46) and *M. crassus* (2n = 60) possess distinctive chromosome complements, the conclusion of Ellerman and Morrison-Scott (1951) that both of these forms represent *M. crassus* has been rejected (Zahavi and Wahrman 1957; Matthey 1957). While Ellerman and Morrison-Scott (1951) make *M. tristrami* (2n = 72) a subspecies of *M. shawi* (2n = 44), Matthey's (1953, 1957) chromosome studies present cogent evidence for specific recognition of *M. tristrami*. The studies of several independent investigators have all yielded similar chromosomal data among the species studied except in the case of *M. crassus* where Matthey (1957) reported a FN of 74 and Zahavi and Wahrman (1957) described a lesser but unspecified number of chromosome arms.

Our purpose is to describe for the first time the chromosomes of the species *Meriones hurrianae* representing the monotypic subgenus *Cheliones*. Chromosomes were also analyzed from *Meriones crassus* obtained from Egypt and Iran in order to clarify the problem concerning the karyotype and FN of this species. Specimens of *M. shawi, M. unguiculatus* and *M. vinogradovi* were studied to obtain more detailed karyotypic data than available in the literature by employing newer cytogenetic methodology than was available to earlier investigators.

Materials and Methods

The following specimens were studied: (1) *Meriones hurrianae* Jerdon, 1867, West Pakistan: Gizri (2 mi. E Karachi), 2 males and 1 female; (2) *Meriones shawi* Duvernoy, 1842, Egypt: Matruh Governate; Bahig, Burg el Arab, one female born

March 11, 1966, in Chicago of parents caught wild at the above locality (age 8 months); (3) *M. unguiculatus* Milne-Edwards, 1867, Laboratory stock of unknown history, one male and one female; (4) *M. vinogradovi* Heptner, 1931, Iran: unspecified locality, one female; (5) *M. crassus* Sundevall, 1842, Iran: Isfahan Province; Mahallat, one male born April 22, 1966, in Chicago of parental stock obtained wild from the above locality (age 3 months); Egypt: exact locality unkown, 2 males.

Specimens used in this study were identified using cranial and pelage characters (Ellerman 1948, Petter 1961) and by comparison with specimens in the collections of the Field Museum of Natural History, Chicago. These specimens are preserved in the collection of the junior author at the Department of Anatomy of the University of Chicago. This study analyzes chromosomes obtained from femoral bone marrow cells. Animals were injected intraperitoneally with one cc of a 0.05% colcemide solution and sacrificed after a lapse of two hours. Marrow clumps washed from the femur with 1% sodium citrate and subsequently aspirated gently through a 21 gauge needle provided a suspension of cells. After exposure in this hypotonic solution at room temperature for 15 minutes followed by centrifugation the supernatent was removed and the cells fixed in acetic-alcohol (1:3) for 30 minutes. The fixative was changed twice by centrifugation, 15 minutes per change and each time the cells were resuspended in 1 cc of fresh fixative. A drop of the final suspension was dried on a microscope slide by gentle blowing and the chromosomes were stained 12 hours later with acetic orcein. Chromosome counts were obtained from well spread metaphase cells. Karyotypes were constructed from photomicrographs and the chromosomes were arranged in seemingly homologous pairs according to size and centromere position (acrocentric, submetacentric or metacentric). Definite assignment of certain chromosome pairs to either metacentric or submetacentric groups is difficult without obtaining arm length ratios from a large number of specimens. Therefore, in this paper classification of some of these pairs is arbitrary. For the purpose of comparing different taxa (Table 1) we have included metacentric and submetacentric autosomes in the same

Table 1

Chromosome characteristics of some species of *Meriones*

Species	Subgenus	2 n	Autosomes			Sex Chromosom.		Reference
			FN	M & S	A	X	Y	
M. hurrianae	*Cheliones*	40	76	36	2	S	S	Present paper
M. persicus	*Parameriones*	42	74	32	10	*		Matthey, 1957
M. unguiculatus	*Pallasiomys*	44				S	A	Awa et al., 1959
M. unguiculatus	*Pallasiomys*	44	78	32	10	S	S	Present paper
M. shawi	*Pallasiomys*	44	74	30	14	*		Matthey, 1953, 1957
M. shawi	*Pallasiomys*	44	78	34	10	*		Present paper
M. libycus	*Pallasiomys*	44	74	30	14	*		Matthey, 1953, 1957
M. sacramenti	*Pallasiomys*	46						Zahavi and Wahrman, 1957
M. crassus	*Pallasiomys*	60	74	14	46	*		Matthey, 1957
M. crassus	*Pallasiomys*	60	72	10	48	S	S	Present paper
M. tristrami	*Meriones*	72	74	2	70	*		Matthey, 1957
M. vinogradovi	*Meriones*	44	74	30	14	*		Matthey, 1954
M. vinogradovi	*Meriones*	44	78	34	10	*		Present paper

FN = total number of chromosome arms including the sex chromosomes, M = metacentric, S = submetacentric, A = acrocentric chromosomes.

* Sex chromosomes unidentified and included with autosomes.

morphologic category and have not utilized differences in these chromosomes in formulating conclusions. Acrocentrics, however, are readily distinguished in these species of *Meriones* and can be utilized as taxonomic characters with much greater confidence. The fundamental number (FN) is usually computed by counting the number of autosome arms in the karyotype. Each metacentric and submetacentric possesses two arms and each acrocentric possesses one. However, in this report the FN is computed in a different manner in order to facilitate comparison with previously published material; all chromosome arms including the sex chromosomes are totaled to arrive at the FN.

Results

The diploid chromosome number (2n) of *Meriones hurrianae* is 40. The karyotype contains 26 metacentric, 10 submetacentric, and 2 acrocentric autosomes. Cells from the males show a large submetacentric X and a smaller submetacentric Y chromosome, whereas cells from the female possess two submetacentric X chromosomes (Fig. 1). The FN is 76.

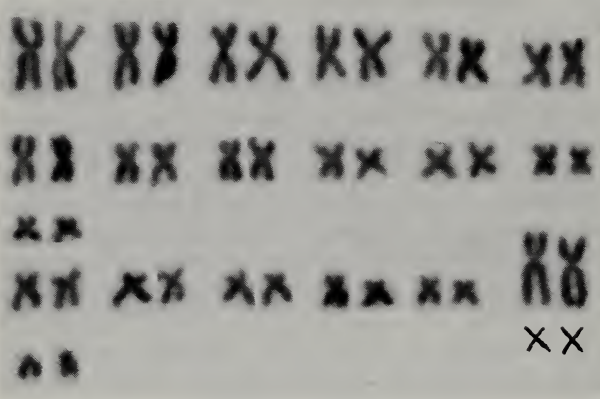

Fig. 1. Chromosomes of *Meriones hurrianae*

M. unguiculatus posseses a 2n of 44 and a karyotype constaining 22 metacentric, 10 submetacentric and 10 acrocentric autosomes, a large submetacentric X and a smaller submetacentric Y chromosome. The FN is 78 (Fig. 2).

M. shawi has a 2n of 44. The karyotype displays 22 metacentric, 12 submetacentric and 10 acrocentric autosomes. Two large metacentric chromosomes observed in the single female examined may likely represent the X chromosomes because the X chromosomes of all species of *Meriones* reported in the literature are of this morphological type. (Note, however, inclusion of this large pair with the metacentric group above). The FN is 78 (Fig. 3).

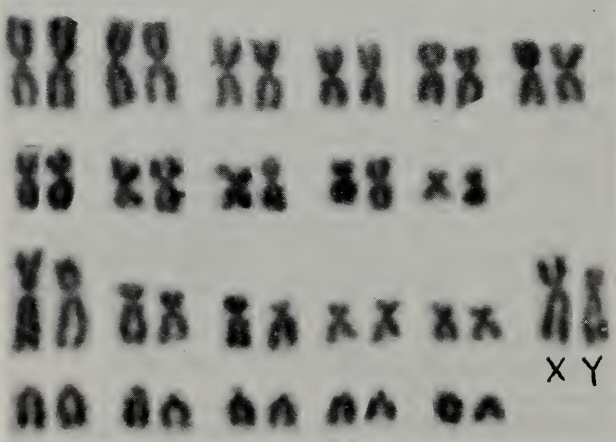

Fig. 2. Chromosomes of *Meriones unguiculatus*

M. vinogradovi has a 2n of 44 and karyotype that cannot be differentiated from *M. shawi.* Because only females were analyzed the sex

chromosomes cannot be identified with certainty. The FN is 78 (Fig. 4).

Specimens of *M. crassus* from Egypt and Iran have a 2n of 60 and the karyotypes of the representatives of two widely separated populations are indistinguishable. The male karyotype shows two metacentric, eight submetacentric including a minute pair, and 48 acrocentric autosomes. The X chromosome is a submetacentric larger than any of the autosomes. — The Y is a submetacentric equal in size to the third largest pair of submetacentric autosomes but possesses a more terminal centromere. The FN is 72 (Fig. 5).

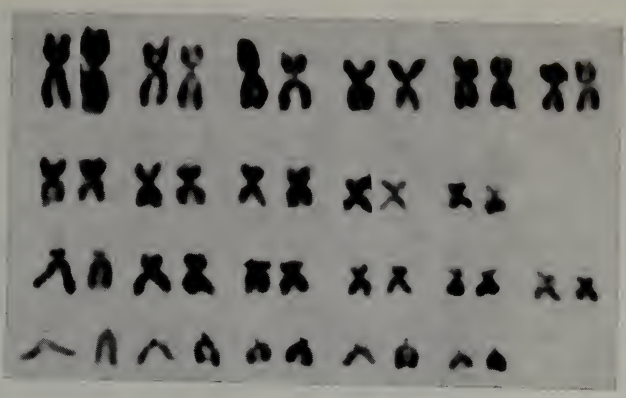

Fig. 3. Chromosomes of *Meriones shawi*

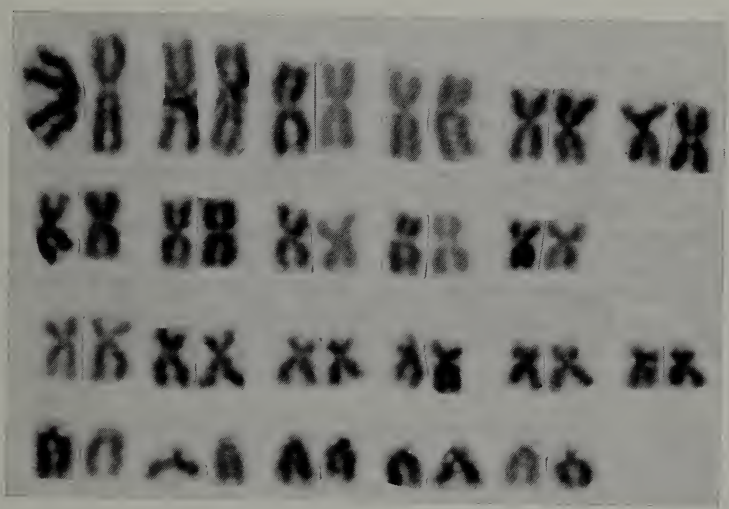

Fig. 4. Chromosomes of *Meriones vinogradovi*

Discussion

Comparison of the chromosomal characters of nine species of *Meriones* in Table 1 shows a number of differences between our data and that reported earlier by other investigators. Matthey (1953, 1954, 1957) reports data derived from testicular preparations prior to the advent of the newer cytological methods that employ hypotonic solutions and colchicine to enhance chromosome spreading and hence study of chromosome morphology. Because of the less accurate older methodology for determination of chromosome morphology it seems likely that the discrepancies are due to these differences in technique. Zahavi and Wahrman (1957) did not describe their method of chromosomal analysis but because they do not report karyotypic information other than the statement that *M. crassus* possesses a lower FN than other

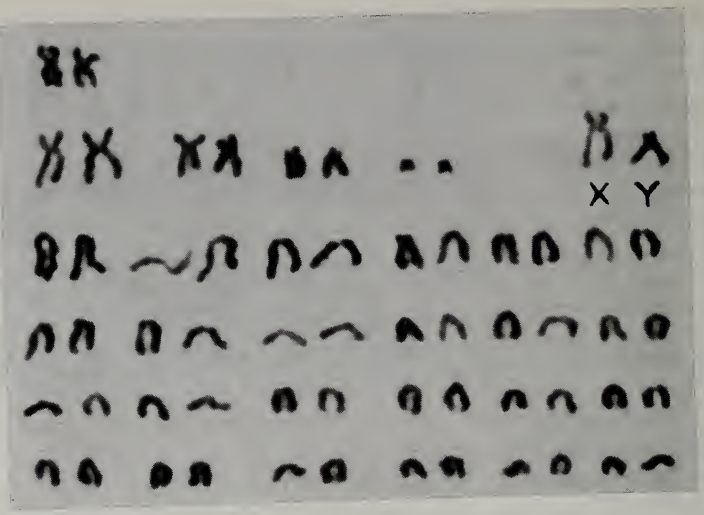

Fig. 5. Chromosomes of *Meriones crassus*

species of *Meriones* this neglect seems inconsequential. Finally, Awa et al. (1959) using tissue culture and hypotonic saline report 44 chromosomes for *M. unguiculatus* but fail to specifically enumerate the number of chromosomes in each morphologic type and the FN. That no disagreement exists in the diploid number reported for any of the species and only slight disagreement in features of chromosome morphology between our results and those of previous studies certainly reflects credit to the virtuosity of these earlier investigators.

The earlier observations of a similar FN (74–76) in the studied species of *Meriones* suggested a continuous sequence of karyotype evolution from high to low diploid number by a series of Robertsonian centric fusions (Matthey 1957). Our observation of several different FNs within the genus suggests karyotype evolution due to rearrangements in addition to centric fusion, such as pericentric inversions. It seems important to correlate chromosomal data with present views concerning the taxonomy of *Meriones*.

The sequence of the diploid chromosome numbers of species of the genus *Meriones* spans 40 to 72 (cf. Table 1). Excluding the monotypic subgenus *Cheliones* and the subgenus *Parameriones* for which karyotype analysis has been made for only one of the two constituent species, neither of the other two recognized subgenera, *Meriones* or *Pallasiomys*, represents a distinctive group on the basis of chromosome complement. The species of these subgenera differ, 44 and 72 in the former and 44, 46, and 60 in the latter for those component species studied karyotypically to date. Evidence of chromosome numbers for species of the subgenera *Meriones* and *Pallasiomys* thus suggests that these may not represent natural groupings. The data of diploid chromosome numbers known for *Meriones* imply that at least six groups corresponding to the diploid numbers 40, 42, 44, 46, 60 and 72 (cf. Table 1) may be recognized in the genus. Karyotypes with higher diploid number, many acrocentrics and few metacentrics have been considered more primitive than those with a lower diploid number, few acrocentrics and many metacentrics (Bender and Chu 1963). In this respect *M. tristrami* and *M. crassus* with diploid numbers of 72 and 60 respectively may be regarded as chromosomally more primitive than any of the seven remaining species studied to date, which range in diploid number from 40–46 (cf. Table 1).

The problem of whether mammalian karyotypes may evolve from low to high

diploid numbers by dissociation of metacentric chromosomes remains unresolved. When other lines of evolutionary evidence are analyzed, *Meriones* may offer a promising model for assailing this important question.

Summary

All previous chromosomal data concerning the genus *Meriones* is reviewed. The previously unpublished karyotype, diploid and fundamental numbers of *Meriones hurrianae* are presented for the first time. The fundamental number of *M. unguiculatus* is published for the initial time. Evidence is presented to show that the fundamental number of *M. shawi* and *M. vinogradovi* is 78 and not 74 as previously indicated by Matthey (1953, 1954, 1957). The fundamental number of *M. crassus* is shown to be 72 and not 74 as stated by Matthey (1957). Karyotypes are presented for *M. unguiculatus, M. shawi, M. crassus* and *M. vinogradovi*. It is suggested on the evidence of chromosome numbers that the subgenera *Meriones* and *Pallasiomys* sensu Chaworth-Musters and Ellerman (1957) represent unnatural groupings and that at least six groups may be recognized in the genus.

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