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New species of vole of "*guentheri* " group (Rodentia, Arvicolinae, *Microtus*) from Iran

Fedor N. Golenishchev, Vladimir G. Malikov, Ferdoun Nazari, Amir Sh. Vaziri, Olga V. Sablina & Andrei V. Polyakov

ABSTRACT. According to data on comparative cytogenetics, morphology and hybridization a new species *Microtus* (*Sumeriomys*) *qazvinensis* Golenishchev **sp. nov.** from Bu'in-Zahra (Qazvin Province, Northern Iran) is described.

KEY WORDS: *Microtus guentheri*, *Microtus qazvinensis* **sp. nov.**, taxonomy, morphology, hybridization, karyology, distribution.

Fedor N. Golenishchev [microtus@zin.ru], Zoological Institute, Russian Academy of Sciences, Universitetskaya nab. 1., Saint Petersburg 199034, Russia; Vladimir G. Malikov [vova@VM8572.spb.edu], Zoological Institute, Russian Academy of Sciences, Universitetskaya nab. 1., Saint Petersburg 199034, Russia; Ferdoun Nazari [morowati@peyam.net], Plant Pests and Diseases Research Institute, Ministry of Agriculture, P.O. box 19359-1459, Tehran, Iran; Amir Sh. Vaziri [morowati@peyam.net], Plant Pests and Diseases Research Institute, Ministry of Agriculture, P.O. box 19359-1459, Tehran, Iran; Olga V. Sablina [sablina@bionet.nsc.ru], Institute of Cytology and Genetics, Siberian Branch of the Russian Academy of Sciences, pr. Lavrent'eva 10, Novosibirsk 630090, Russia; Andrei V. Polyakov [polyakov@bionet.nsc.ru], Institute of Cytology and Genetics, Siberian Branch of Russian Academy of Sciences, pr. Lavrent'eva 10, Novosibirsk 630090, Russia.

Новый вид полевки группы "*guentheri* " (Rodentia, Arvicolinae, *Microtus*) из Ирана

Ф.Н. Голенищев, В.Г. Маликов, Ф. Назари, А.Ш. Вазири, О.В. Саблина, А.В. Поляков

РЕЗЮМЕ. Описан новый вид полевки из группы "*guentheri*" *Microtus* (*Sumeriomys*) *qazvinensis* Golenishchev **sp. nov.** из северного Ирана (окрестности города Казвин в провинции Казвин). Приведены сравнительное описание черепа, зубной системы, бакулюма, кариотипа и результаты гибридологического анализа.

KEY WORDS: *Microtus guentheri*, *Microtus qazvinensis* **sp. nov.**, таксономия, морфология, гибридизация, кариология, распространение.

Introduction

For last few years a number of papers on morphology, taxonomy, and distribution of voles of the subgenus *Sumeriomys* Argyropulo, 1933 from the former Soviet Union, Turkey, Iran, and Syria have been published (Kefelioğlu, 1995; Çolak *et al*., 1997; Yiğit & Çolak, 1998, 2002; Kefelioğlu & Kryštufek, 1999; Sözen *et al*., 1999; Golenishchev *et al*., 1999, 2002; Kryštufek & Kefelioğlu, 2001a, b). Nevertheless, the detailed geographical ranges of the species and systematic position of some forms belonging to the subgenus is still in question.

Ellerman (1941) subdivided the subgenus into two groups of species: the "*socialis*" and the "*guentheri*" groups. Such a decision has been the most acceptable by now. The "*socialis*" group includes *Microtus* (*Sumeriomys*) *socialis* Pallas, 1773 (diploid number 2n=62) and *M. schidlovskii* Argyropulo, 1933 (2n=60). In spite of some distinct morphological differences between *M. socialis* and each of the nominal forms initially called *M. irani* Thomas, 1921 and *M. paradoxus* Ognev et Heptner, 1928, they occurred to be of the same karyotype (Zykov & Zagorodnyuk, 1988; Golenishchev *et al*., 1999, 2002). Now, taking into account the complete fertility of hybrids between each of those two forms and *M.* (*S.*) *socialis*, we consider them to be subspecies of the latter.

The "*guentheri*" group has been known to include the only one 54-chromosomal species *M. guentheri* Danford et Alston, 1880. The taxonomic status of *M.* (*S.*) *dogramacii* Kefelioğlu et Kryštufek, 1999 (2n=48) that also seems to belong to the "*guentheri*" group is still uncertain.

In the Autumn, 1996 in Northern Iran in the region of Bu'in-Zahra (Qazvin Province) that is to the south from Qazvin City in the lucerne crop field we found a population of social voles which, possessing a "*guentheri*"-like diploid number of chromosomes (2n=54), differ in

TABLE 1. BODY AND SKULL MEASUREMENTS IN VOLES OF THE "*GUENTHERI*" GROUP.

Measurements	Taxon										
	*M. guentheri**		*M. qazvinensis* sp. nov.		*M. g. strandjensis*		*M. g. philistinus*		*M. g. hartingi***	*M. g. philistinus***	*M. lydius***
	n	Mean±SD	n	Mean±SD	n	Mean±SD	n	Mean±SD	n=1, >	n=1, >	n=1, >
Head and body length	–	–	17	109.6±7.7	20	124.8±5.3	20	129.6±5.5	107	125	115
Tail length	22	25.5±2.4	17	26.2±2.8	20	28.4±2.9	19	26.0±2.2	26	26	26
Hind foot length	23	19.8±1.0	17	17.9±0.9	20	18.7±0.7	20	17.9±0.6	18	18	18
Ear length	23	13.0±0.6	17	9.8±0.7	20	11.7±0.8	20	12.1±0.5		11	11
Condylobasal length	10	26.7±1.3	18	26.9±1.1	20	29.9±1.0	20	28.9±0.6	29.5	28.5	26.6
Skull height	11	10.0±0.4	17	10.1±0.3	20	10.5±0.3	20	10.7±0.4	10.1	10.2	9.2
Zygomatic breadth	13	15.7±0.8	17	16.4±1.0	20	17.2±0.5	20	16.8±0.6	17.1	16.3	15.2
Interorbital constriction	13	3.9±0.2	18	4.0±0.1	20	3.5±0.1	20	3.8±0.2	3.6	3.8	3.9
Upper diastema	13	8.0±0.6	18	8.6±0.5	20	9.4±0.4	20	9.0±0.3	9	8.8	8.7
Maxillary tooth row	14	6.3±0.2	18	6.0±0.2	20	6.9±0.4	20	6.4±0.2	6.7	6.9	6.4
Mandible length	14	16.5±0.7	18	16.4±0.7	20	18.0±0.6	20	16.8±0.4	17.9	17	18.7
Mandibular tooth row	14	6.2±0.3	18	6.1±0.3	20	6.8±0.2	20	6.3±0.2	7	6.5	6.3

* Data on *Microtus guentheri* from the type locality are according to Yiğit & Çolak (2002).
** Measurements of the holotype from the Natural History Museum (London) are from the original description.

some morphological traits from all the other specimens that had been collected in Iran before (Fig. 1). As a result of further investigation that form was considered to be a distinct species new for science. The description of this species is presented below.

Materials and methods

Two males and three females from Qazvin Province were founders of the live laboratory stock. The total number of specimens of the form dealt with was 26. In addition 35 specimens of *M. guentheri strandjensis* Markov, 1960 (Bulgaria, Burgas Province, vicinity of Sozopol), 17 live individuals and 23 specimens of *M. g. philistinus* Thomas, 1917 (Israel, Qiryat Shemona and Yvne), paratypes of *M. g. martinoi* Petrov, 1939 (collection of the Zoological Institute, Russian Academy of Sciences, St.-Petersburg [ZIN]), and types of *M. g. hartingi* Barret-Hamilton, 1903, *M. g. lydius* Blackler, 1916, and *M. g. philistinus* (collection of the Natural History Museum, London) (Tab. 1) have been investigated. The Complex Taxonomic Analysis of the materials has been carried out according to M.N. Meyer (Meyer *et al*., 1996).

Metaphase chromosomes and meiotic chromosomes cover-glass preparations were made from the bone marrow cells using the generally adopted methods (Ford & Hamerton, 1956; Williams *et al*., 1971). G- and C-banding were performed according to Seabright (1971) and Sumner (1972) respectively.

For three years (1997–1999) the voles of the new species were being intercrossed in laboratory with *M. socialis* and *M. g. philistinus*. The backcrossing of F1 hybrid females was being carried out as well. The total number of inter- and backcrossings is 26. In the experiments on hybridization the parental non-conspecific individuals were being kept in monogamous couples for no less than five months. When, during that period of time, no offspring were brought to birth, the sexual partners were changed.

Taxonomy

Microtus (*Sumeriomys*) *qazvinensis* Golenishchev **sp. nov.**

Holotype — ZIN 86088, adult female (skull). Bu'in-Zahra (35°39'E, 49°58'N), 65 km to the south from Qazvin City, Qazvin Province, northern Iran. Collector V.G. Malikov, IX. 1996.

Paratypes — ZIN 82672, subadult male (in alcohol). Locality and collector as for the holotype, 17/XII 1996; ZIN 82884, male (skin and skull), laboratory generation. Locality as for the holotype, 10/XI 1997; ZIN 82883, female (skin and skull), laboratory generation. Locality as for the holotype, 10/XI 1997; ZIN 84935-6, 8, 9, 10, 11, 12, 13, 18, 19*, 21, 23, 24*, 25, 26, 27*, 29*, 30, 32*, 33*, 40, 41, 43 (altogether 22 specimens), skulls and bacula (marked by *).

DIAGNOSIS. Back more reddish than in all the other nominal forms of "*guentheri*" group; underparts almost white with a grayish tint (base of the guard hair gray and the tips

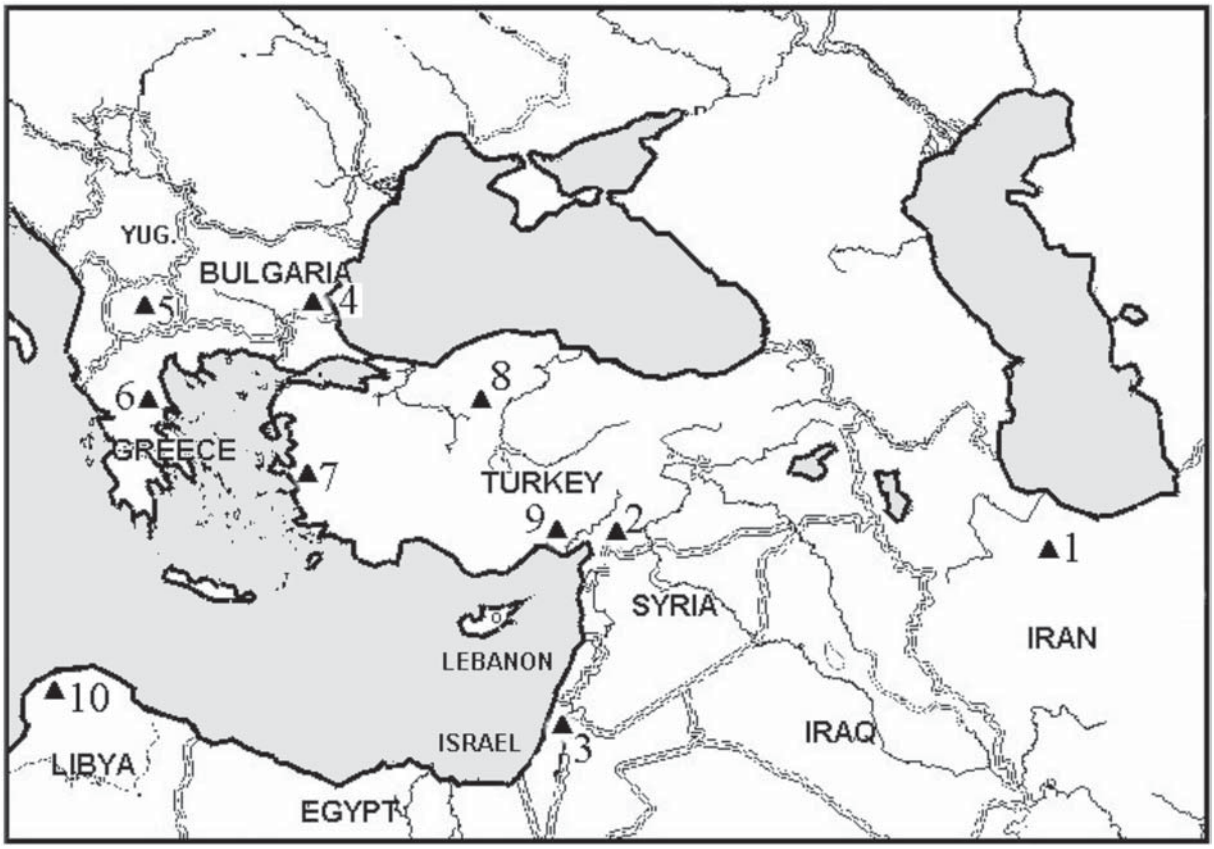

Figure 1. Type localities of the nominal forms of "*guentheri*" group voles.
1 — *Microtus qazvinensis* **sp. nov.**; 2 — *M. guentheri guentheri*; 3 — *M. g. philistinus*; 4 — *M. g. strandjensis*; 5 — *M. g martinoi*; 6 — *M. g. hartingi*; 7 — *M. g. lydius*; 8 — *M. g. ankaraensis*; 9 — *M. g. shevketi*; 10 — *M. g. mustersi*.

white); tail monochromatic in contrast to slightly bichromatic tail of *M. guentheri*. Head and body up to 123 mm, tail 22–33 mm, foot 17–20 mm. Comparatively wide skull with large auditory bullae, braincase broadened, condylobasal length up to 28.8 mm. In contrast to nominal forms of *M. guentheri* M2 always possess an additional lingual loop, quite often additional loop of that kind present also in M1. More often in M3 there are four prismatic folds from the labial side and four (morphotype 4/4 = "duplicata") or five folds (morphotype 5/4 = "complex") from the lingual side, while in *M. guentheri* the prevailing morphotype of M3 — 4/3 = "typica". Total baculum small, trident's medial ossicle comparatively large, the shoulders of the shaft's base are turned up. Diploid chromosome number 2n=54. All autosomes acrocentric. X-chromosome large subtelocentric, Y-chromosome small metacentric.

DISTRIBUTION. Type locality.

ETYMOLOGY. The new species is named after Qazvin City.

Description

Exterior. Being compared with upper surface and underparts in the nominal forms of *M. guentheri*, in the new species pelage is lighter, with distinct yellow-reddish tinge of the upper surface. We did not observe the pelage of such a kind in *M. g. philistinus* or *M. g. strandjensis*. The pelage of upper surface in *M. guentheri* from the type locality was mentioned in the original description as "yellowish mouse-grey" (Danford & Alston, 1880: 63), and quite recently as "uniformly dark brownish" for the specimens from Kahramanmaraº, Turkey (Yiğit & Çolak, 2002). So, neither of those kinds of color seems to be similar to that of the *M. qazvinensis* **sp. nov.** As in all the other species of the subgenus the number of footcorns is 5/5. The voles of the new species are somewhat smaller than *M. g. philistinus* and *M. g. strandjensis*, being closer in size to *M. g. guentheri* (Tab. 1).

Skull and dentition. The skull is smaller than in *M. g. philistinus* and *M. g. strandjensis*, being quite similar in size with that in *M. g. guentheri*, but more broadened (Tab. 1) and with a less angle between braincase and facial part of skull (Fig. 2). In contrast to all the other nominal forms of the "*guentheri*" group the new species has more complicated pattern of molar occlusal surface (Fig. 3). Their M2 and M1 possess an additional enamel loop that is less distinct in the latter. The "duplicata" (4/4) morphotype of M3 was registered in 85% of the specimens, the "complex" (5/4) morphotype is in 10% and the "typica" (4/3) morphotype is in 5% (Fig. 3). At the same time, in *M. guentheri guentheri* the "duplicata" morphotype of M3 is present in only 15% of specimens while those of the "typica" morphotype were 85% (Yiğit & Çolak, 2002). A few voles of other subspecies of *M. guentheri* possess even simpler morphotype of M3, that is the "simplex" (3/3). The complicated molars of *M. qazvinensis* **sp. nov.** are quite similar to those of *M. socialis paradoxus* (Golenishchev *et al*., 2002). More often, in the Qazvin vole the paraconid of m1 is more complicated in contrast to that of all the known nominal forms of *M. guentheri* (Fig. 3).

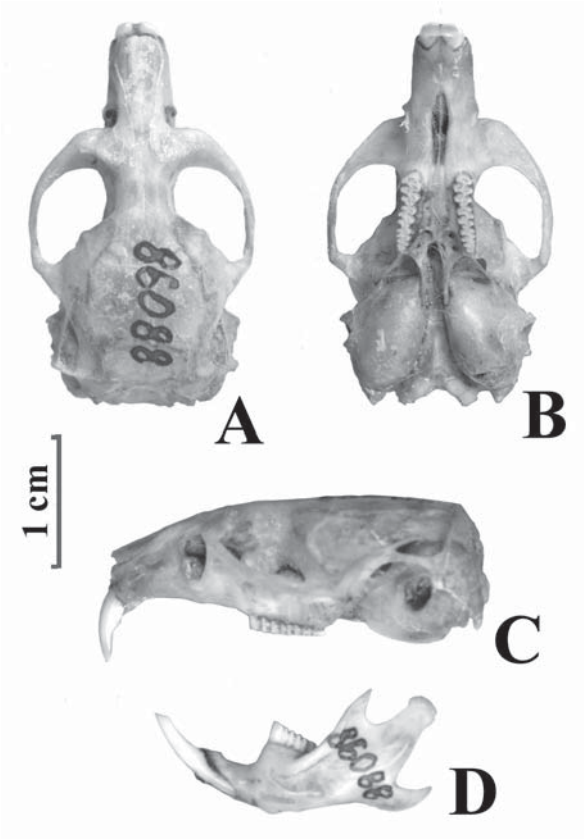

Figure 2. ZIN 86088, skull (adult ♀), holotype of *Microtus qazvinensis* **sp. nov.**
A — dorsal view; B — ventral view; C — lateral view; D — mandible in lateral view.

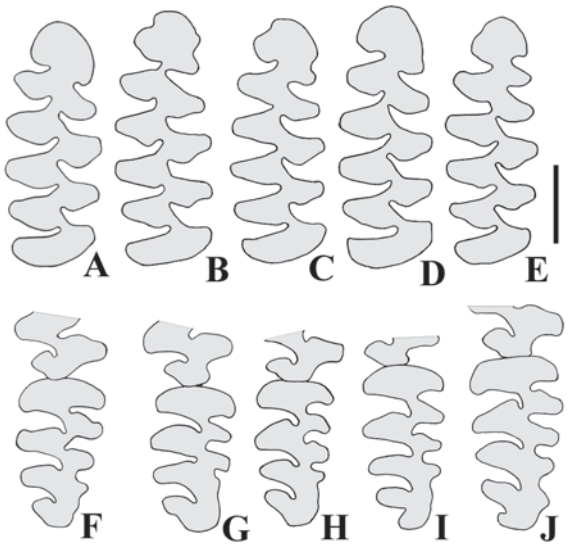

Figure 3. Molars of *Microtus qazvinensis* sp. nov. in occlusal view: m1 (A-E) and M3 with posterior portion of M2 (F-J).
A, F — ZIN 86088, holotype. B — ZIN 84935-11; C — ZIN 84935-13; D — ZIN 84935-25; E, I — ZIN 84935-26; G — ZIN 84935-9; H — ZIN 84935-29; J — ZIN 84935-12. Scale bar 1 mm.

Baculum. The total baculum is not large (Tab. 2), medial trident's ossicle is comparatively long, the shoulders of the shaft's base are turned up (Fig. 4). The baculum of such a kind differs from all those known for *M. guentheri*, being quite similar to *os penis* of *M. schidlovskii* (Golenishchev *et al*., 2002). In baculum of *M. qazvinensis* **sp. nov.** the length of the medial trident's ossicle is always more than the width of the shaft's base, while in *M. g. lydius* (Turkey, Ankara Province) (Sözen *et al*., 1999), *M. g. philistinus*, and *M. g. strandjensis* the medial trident's ossicle is comparatively small, being either equal or even less than the width of the shaft's base. The

Table 2. Baculum measurements in voles of the "*guentheri*" group (in mm). Average (first line) and limits of variation (second line).

Taxon and locality	n	Measurements				
		Total length	Shaft's length	Width of the shaft's base	Length of the trident's medial ossicle (=process)	Length of the trident's lateral ossicle (=process)
M. qazvinensis sp. nov.	6	4.23 3.98–4.40	2.48 2.33–2.60	1.43 1.33–1.55	1.67 1.55–1.80	1.22 1.13–1.38
M. guenther * Turkey, Kahramanmaras	4		2.5	1.5		
M. g. lydius * Turkey, Izmir, Aydin	7		2.3	1.0		
M. g. lydius * Turkey, Ankara	14		2.9	1.5		
M. g. philistinus	3	4.20 4.15–4.25	2.93 2.80–3.08	1.88 1.80–2.00	1.19 1.15–1.23	1.00 0.93–1.08
M. g. strandjensis	5	4.43 4.15–4.75	3.15 2.95–3.50	1.92 1.55–2.30	1.24 1.15–1.35	1.08 1.05–1.15

* Data after Yiğit & Çolak (2002). These authors consider *M. g. lydius* from Turkey, Izmir, Aydin to be a separate species, while *M. g. lydius* from Turkey, Ankara is referred to a new subspecies *M. lydius ankaraensis*.

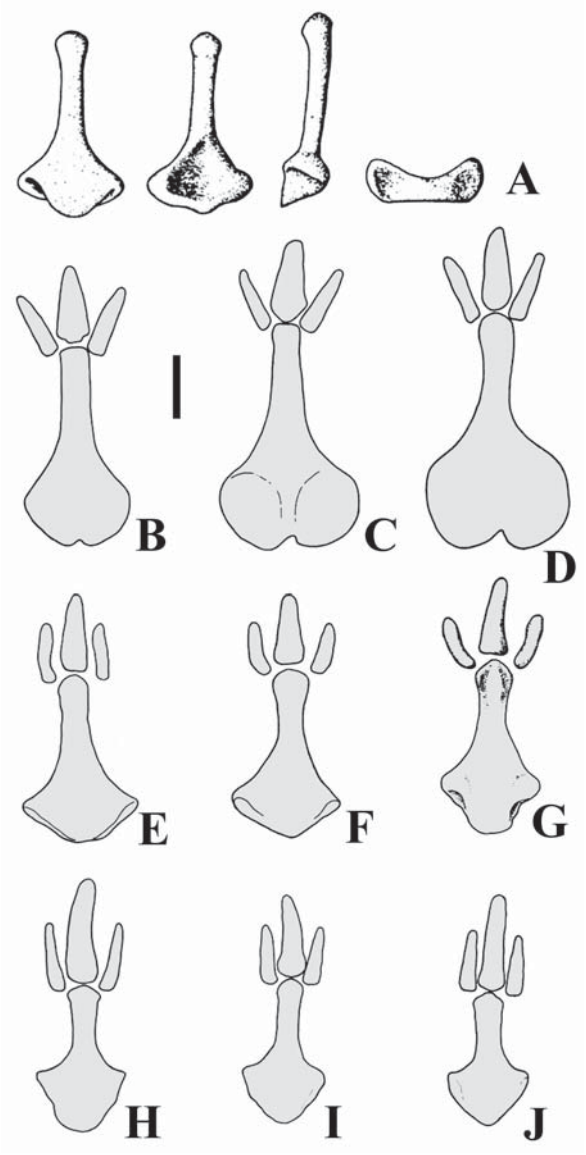

Figure 4. Baculum in the voles of the "*guentheri*" group. A — *M. guentheri guentheri*, in dorsal, ventral, lateral and basal views (after Çolak *et al*., 1997: fig.3); B–D — *M. g. strandjensis* (B — ZIN 84905-458; C — ZIN 80128; D — ZIN 84912-434); E–G — *M. g. philistinus* (E — ZIN 84937-56; F — ZIN 84937-48; G — ZIN 84013); H–J — *M. qazvinensis* **sp. nov.** (H — ZIN 84935-24; I — ZIN 84935-29; J — ZIN 84935-33). Scale bar 1 mm.

baculum of the new species also differs from that in nominative form of *M. guentheri* (Çolak *et al*., 1997).

Karyotype. Within the "*guentheri*" group, C- and G-banding of chromosomes have been known only in *M. g. strandjensis* (Belcheva *et al*., 1980; Golenishchev *et al*., 2002), while the totally stained chromosomes of the other nominal forms were presented in a number of papers (Matthey, 1953; Živković & Petrov, 1975; Kefelioğlu, 1995; Kefelioğlu & Kryštufek, 1999; Yiğit & Çolak, 2002).

In *M. g. strandjensis* all the autosomes are acrocentric of a gradually decreasing size. The first pair of autosomes is distinctly larger than the others (Fig. 5). X–chromosome is subtelocentric, Y–chromosome is completely heterochromatic acrocentric element, in all the other chromosomes heterochromatine is in a form of centromeric blocks.

In *M. g. philistinus* all the chromosomes are acrocentric, the first pair of them being distinctly larger than the others. Y-chromosome is completely heterochromatic, in all the other ones there are heterochromatine precentromeric blocks.

In *M. qazvinensis* **sp. nov.** all the autosomes are acrocentric. The first four pairs of them are considerably larger than the others which are of a gradually decreasing size. In contrast to the nominal forms listed above, *M. qazvinensis* **sp. nov.** possess metacentric Y-chromosome. The latter is comparatively small. X-chromosome, being comparatively large, is subteloceentric. Heterochromatine is presented by the whole Y-chromosome, large blocks in the first four pairs of autosomes and X-chromosome which are about one third of the consequent element in length, and centromeric blocks of a usual size in other autosomes.

Those three nominal forms are of a close but not similar G-banding of their chromosomes. Largest chromosome of each karyotype consists of three elements which are homologous to three autosomes of 62-chromosomal vole *M. socialis*. Two of those three elements are homologous in *M. g. philistinus*, *M. g. strandjensis*, and *M. qazvinensis* **sp. nov**., while the third ones are not homologous to each other, being similar to different chromosomes of *M. socialis*. So, the karyotype of the voles belonging to the "*guentheri*" group could be derived from that of *M. socialis* or some chromosomal form that was very close to the latter.

Hybridization

M. qazvinensis* sp. nov. x *M. socialis and ***M. socialis* x *M. qazvinensis* sp. nov.** In experiments on hybridization we used *M. socialis* which were offsprings of the founders from Georgia (type locality of *M. s. binominatus*) and Iran (a form from Hamadan Province that is very close in morphology to *M. s. binominatus* and *M. s. irani* from its type locality that is near to Shiraz, Fars Province). Among their F1 hybrid offsprings which were born as a result of ♀*M. qazvinensis* **sp. nov.** x ♂*M. socialis* and ♀*M. socialis* x ♂*M. qazvinensis* sp. nov. intercrossings only males occurred to be sterile. They showed abnormally small testicles and a lack of spermatozoa. The F1 hybrid females were fertile. Then backcrossing offsprings originated from F1 hybrid females and males of *M. socialis* were obtained.

M. qazvinensis* sp. nov. x *M. g .philistinus. One of two females of *M. g. philistinus* which were paired with males of *M. qazvinensis* **sp. nov.** has brought to birth F1 hybrids. The F1 hybrid males were sterile (with a lack of even initial stages of meiosis). The F1 hybrid females, being paired with males of *M. qazvinensis* **sp. nov.** and *M. g. philistinus* occurred to be fertile.

One should take into consideration that, according to our previous data, *M. g. strandjensis*, in contrast to *M. qazvinensis* **sp. nov**., being intercrossed with *M. socialis*, brought to birth sterile hybrids of both sexes (Zorenko *et al*., 1997). So, being much more similar in karyotype to species of the "*guentheri*" group than to *M. socialis*, *M. qazvinensis* **sp. nov.** could be closer in genotype to *M. socialis* in contrast to *M. g. strandjensis*. The possible reasons of such a phenomenon is being discussed elsewhere (Golenishchev *et al*., 2002; Golenishchev & Malikov, 2002).

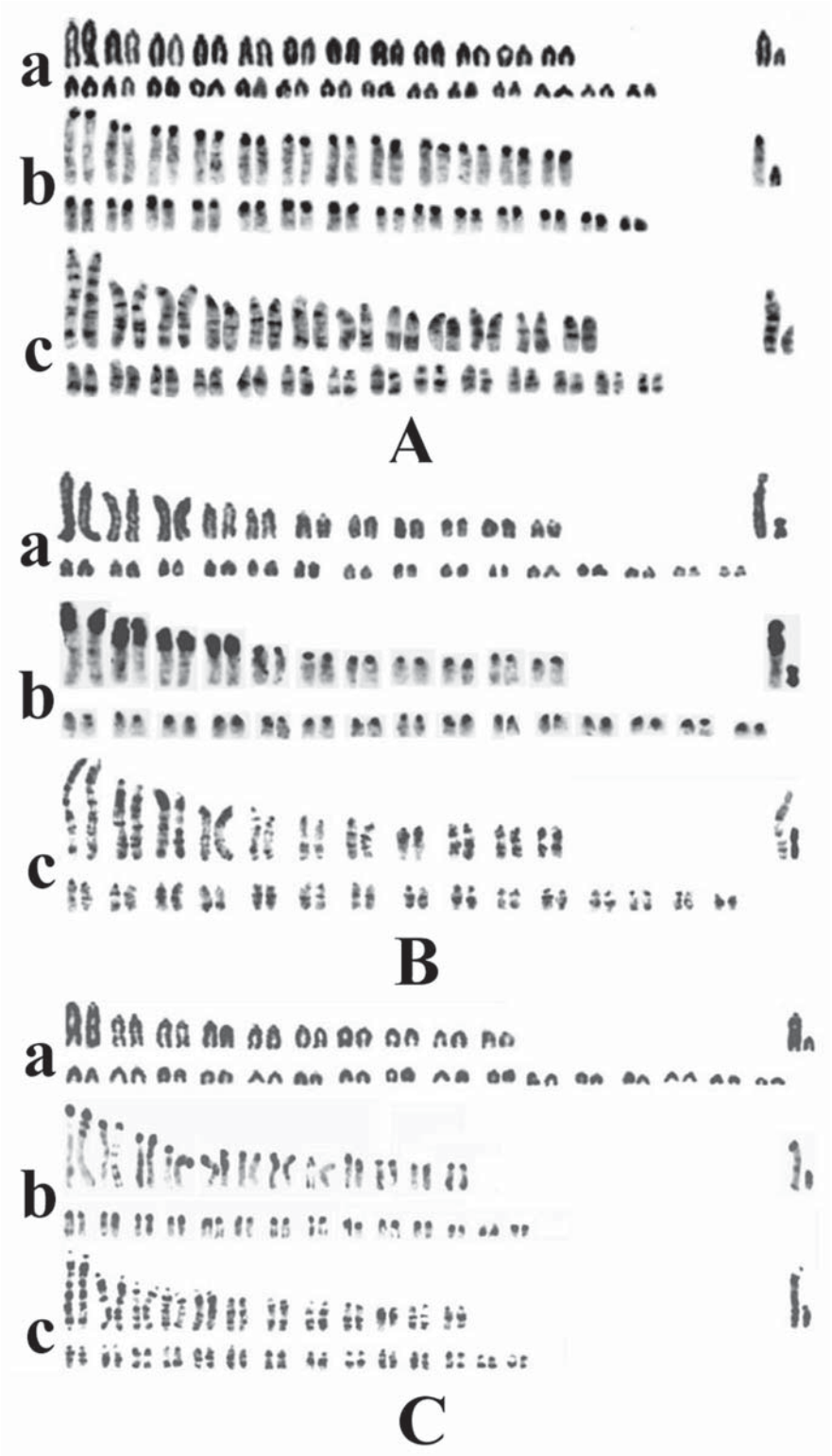

Figure 5. Karyotype in the voles of the "*guentheri*" group (a — total staining; b — C-banded chromosomes; c — G-banded chromosomes).
A — *M. g. strandjensis*; B — *M. qazvinensis* **sp. nov.**; C — *M. g. philistinus*.

We have not got any live individuals of *M. guentheri* from the type locality needed for experiments on hybridization. Nevertheless, partial post-mating reproductive isolation between the new form and both *M. socialis* and *M. g. philistinus* as well as its considerable morphological distinctness proves this social vole to be a really distinct species of the "*guentheri*" group.

Discussion

M. qazvinensis **sp. nov.** seems to be the most eastern representative of the "*guentheri*" group. When working in Iran we did not manage to find this vole outside of the type locality. All the other seven localities from where our specimens of the subgenus originated were occupied by different forms of *M. socialis*. One of them, in the vicinities of Karaj, was only about 70 km to the North-East from the type locality of *M. qazvinensis* **sp. nov.**

Due to global degradation of the "*guentheri*" group's geographical range, especially in the East, nowadays there might be only one relict population of the Qazvin vole left. In addition to *M. guentheri* and *M. qazvinensis* **sp. nov.** the "*guentheri*" group seems likely to include some more distinctspecies, judging not only by high diversity of dentition and baculum, but by some karyotypic traits as well. For example, we suppose the large southern European nominal form of *M. guentheri* to be a separate species *M. martinoi* Petrov, 1939 that includes also *M. g. strandjensis*. *M. g. hartingi* may be closer to *M. g. guentheri* than it was thought before. Comparatively large *M. g. philistinus*, which differs distinctly in morphology from both *M. g. strandjensis* and *M. g. guentheri*, could be close to large forms from Turkey, in particular to *M. g. lydius* from the vicinities of Ankara.

The systematic relationships between *M.* (*S.*) *mustersi* Hinton, 1926 from Libya and the species of the "*guentheri*" group is still in question in spite of the accurate morphological description (Ranck, 1968). The fragmentary published data on the group and low level of divergence emphasize the necessity of complex taxonomic approach to the systematics of the "*guentheri*" group that first of all should include differential staining of chromosomes and experiments on hybridization.

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