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Note on the systematic status of shrews of the *Sorex araneus* group in NW Anatolia

Miloš MACHOLÁN*, Maria G. FILIPPUCCI, Lenka SLIVKOVÁ and Shimon SIMSON

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Although it was assumed that the northern parts of Asia Minor were occupied by the Caucasian shrew, *Sorex satunini*, some recent findings have cast doubts on the specific status of shrew populations in NW Anatolia. Here, a single shrew from Uludag was studied using enzyme electrophoresis. It was compared to *S. araneus* from Europe and *S. satunini* from NE Turkey as well. The results unequivocally classify the animal under study with *S. satunini* and it is suggested that the common shrew, *S. araneus*, does not occur either in NW Anatolia or in Asia Minor in general.

Institute of Animal Physiology and Genetics, Academy of Sciences of the Czech Republic, Veveří 97, CZ-602 00 Brno, Czech Republic (MM, LS); Department of Biology, Rome University II "Tor Vergata", Via O. Raimondo, I-00173 Rome, Italy (MGF, SS)

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Introduction

Shrews of the *Sorex araneus* group living in Asian Turkey apparently do not seem to create any systematic difficulties at least as concerns the area along the southern coast of the Black Sea. According to most authors (Osborn 1965 in Sokolov and Tembotov 1989, Spitzenberger 1968, Corbet 1978, Şimşek 1986, Pavlinov and Rossolimo 1987, Dogramaci 1989, Hutterer 1993) that area is occupied by the Caucasian shrew, *Sorex satunini* Ognev, 1922. This species was formerly referred to as *Sorex caucasicus* Satunin, 1913, but recently its type series has been found to contain (including the holotype) also specimens of *S. raddei*, the name *caucasicus* thereby being invalidated (Pavlinov and Rossolimo 1987).

However, the distribution of the Caucasian shrew in Turkey appears to be rather scattered (Fig. 1) and the level of genetic and morphological differentiation among species within the *S. araneus* group in general (eg Hausser *et al.* 1991,

*Address of the corresponding author: Laboratory of Genetics and Embryology, Institute of Animal Physiology and Genetics, Academy of Sciences of the Czech Republic, Veveří 97, CZ-602 00 Brno, Czech Republic, e-mail: macholan@ipm.cz

Ruedi 1998) and between *S. araneus* and *S. satunini* in particular (Macholán 1996, L. Fumagalli, pers. comm.) is rather low. That is why the specific identification based on morphological criteria (as in the papers cited in the introducing paragraph) could be highly problematic. Obviously, there is a need for careful study of putative *S. satunini* from as many of its Turkish localities as possible.

Recently, two findings have cast particular doubts on the specific status of shrew populations in NW Anatolia. First, it was shown that the population from the vicinity of Demirköy (Kirklareli Distr., Istranca Mts., Thrace), ie the type locality of a subspecies of the Caucasian shrew described by Şimşek (1986) as *S. caucasicus* sultanae, belonged in fact to the common shrew (Zima *et al.* 1994). This population was later described as the "Istranca" chromosome race by Zima *et al.* (1997). Their results consequently blurred also Şimşek's systematic classification of Anatolian shrew populations with the Thracian subspecies of *S. satunini*. Second, the only individual from Anatolia hitherto studied electrophoretically was found to be genetically very close to *S. araneus* populations from the Balkan Peninsula (M. G. Filippucci and S. Simson in Macholán 1996). Unfortunately, no karyotypic data have been presented in either of the reports on shrews from Anatolia published up to date (Fig. 1).

A recent chromosomal and allozyme survey of *Sorex satunini* from NE parts of Asia Minor (Macholán 1996) focused on the level and partitioning of genetic

Fig. 1. Map of Turkey with sites indicated from which data on *Sorex araneus* and *S. satunini* were reported: 1. Demirköy (Kirklareli); 2. Uludag (Bursa); 3. Abant (Bolu); 4. Tosya (Kastamonu); 5. Güzyurdu (Gümüşhane); 6. Handere (Kars); 7. Sirbaşan (Kars); 8. Bagdaşan (Kars); 9. Yalnizçam Geçidi (Artvin). Closed circles: morphological data on shrews described as *S. caucasicus sultanae* (Şimşek 1986); dots: morphological data by Spitzenberger (1968) on *S. satunini*; asterisk: type locality of the "Istranca" chromosome race of *S. araneus* (Zima *et al.* 1997); open triangle: the individual investigated in this study; closed triangles: electrophoretic data on *S. satunini* (Macholán 1996). Note: Güzyurdu was erroneously ascribed to the District of Bayburt by Macholán (1996).

variation both within and among *S. satunini* populations, and between the Caucasian and common shrew as well. Only a single locus, *Est-2*, was found to be diagnostic and three other loci (*Gpd-2*, *Mpi*, *Pgm-3*) appeared to be partially diagnostic between the two species (Macholán 1996). This finding urged us to reevaluate the individual studied by Filippucci and Simson since the kidney esterases were then not scored by them.

Material and methods

A single female of the shrew, supposedly belonging to the *Sorex araneus* group, was collected at Uludag, Bursa District, 1400 m a.s.l., on 22 May 1990. The animal was examined with standard horizontal starch gel electrophoresis at 33 presumptive enzymatic loci. Details of the methods and loci scored here are described in Macholán *et al.* (1994) with the only exception of *Pgm-3* which replaced *Acph*. Tissue homogenates were run on the same gels side by side with samples of both the common and Caucasian shrew.

Special attention was paid to esterase-2 (*Est-2*; kidney), phosphoglucomutase-3 (*Pgm-3*; kidney), and mannose phosphate isomerase (*Mpi*; kidney, muscle). Designation of esterases followed nomenclature suggested by Searle (1986). Allele frequencies in a reduced set of 27 loci were then compared with populations of *S. satunini* from NE Turkey and *S. araneus* from the Czech Republic, Slovenia and Macedonia (Macholán 1996) and a UPGMA phenogram was constructed on Nei's genetic distances (Nei 1972). BIOSYS-1 program of Swofford and Selander (1981) was used for all the analyses.

Results

None of all the scored loci was found to be heterozygous in the animal under study. Particularly, the Uludag shrew was homozygous for alleles Mpi^{120} and $Pgm\text{-}3^{85}$, and, more importantly, it was proven to be homozygous for $Est\text{-}2^{90}$, ie one of two alleles unequivocally diagnosing the Caucasian shrew. The zymogram of kidney esterases and its diagrammatic representation illustrates the diagnosis quite clearly (Fig. 2): whereas two faster alleles, $Est\text{-}2^{100}$ and $Est\text{-}2^{105}$, are typical of *S. araneus*, two slower alleles, $Est\text{-}2^{90}$ and $Est\text{-}2^{95}$ (the latter hitherto found only in the heterozygous condition) discriminate *S. satunini*. A UPGMA dendrogram based on Nei's distances (Fig. 3) shows genetic relationships of the studied animal with other *S. satunini* populations and *S. araneus* as well.

Discussion

According to Macholán (1996), alleles Mpi^{120} and $Pgm\text{-}3^{85}$ are prevailing or even exclusively present in *S. satunini* populations from north-eastern Turkey while they are rare in *S. araneus*. On the other hand, Mpi^{100} and $Pgm\text{-}3^{100}$, ie the most common alleles for *S. araneus* at the respective loci, have not at all been found in *S. satunini* up to now. This further strengthens the conclusion based on the presence of the diagnostic allele $Est\text{-}2^{90}$ that the Uludag specimen should be

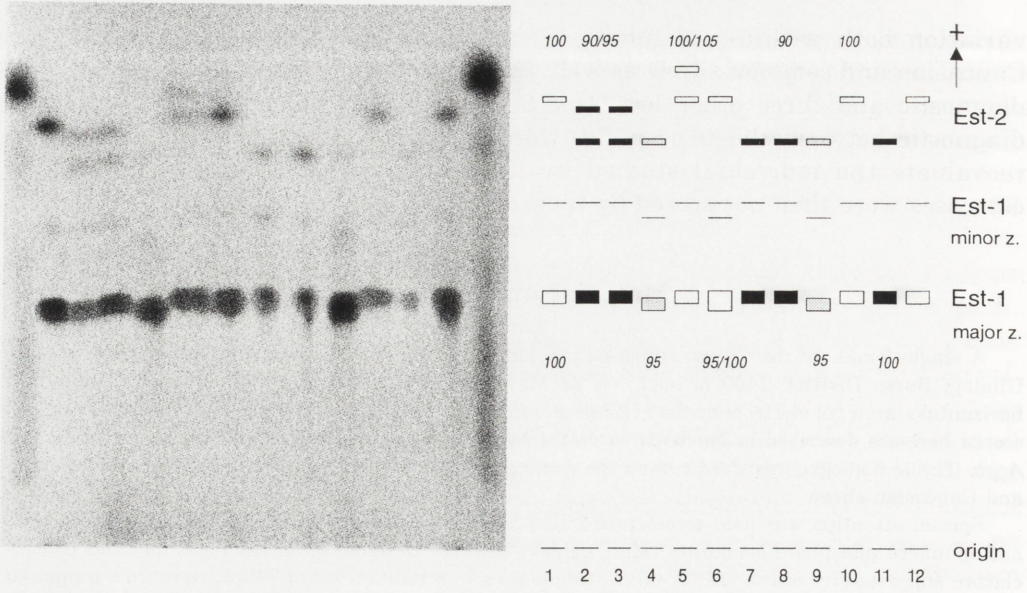

Fig. 2. Zymogram (left) and its diagrammatic representation (right) of the gel stained for kidney esterases using α- and β-naphthyl propionate as a substrate. From top to bottom: Est-2, Est-1 minor zone and Est-1 major zone (after Searle 1986). Samples 2, 3, 7, 8, 11 are *S. satunini* from NE Turkey (filled symbols); 1, 5, 6, 10, 12 are *S. araneus* from Kostelec (Czech Republic, open symbols); samples 4 and 9 represent a single individual from Uludag (cross-hatched symbols). References of the C57BL/6 mouse inbred strain are shown on the left and right sides of the zymogram.

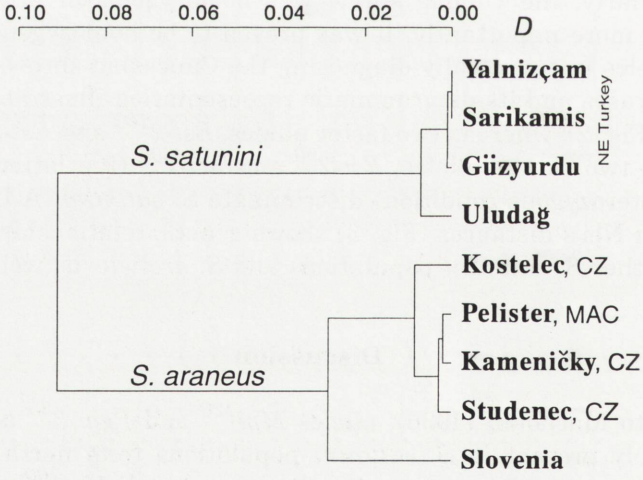

Fig. 3. UPGMA dendrogram based on Nei's genetic distances (*D*) at 27 loci. Allelic frequencies of both *S. araneus* and *S. satunini* (except Uludag) populations were taken from Macholán (1996). Abbreviations: CZ – Czech Republic, MAC – Macedonia; Yalnizçam denotes pooled localities 8 and 9 whereas Sarikamis denotes localities 6 and 7 in Fig. 1.

classified with *S. satunini*. This result corroborates morphological data by Spitzenberger (1968) and Şimşek (1986) but, at the same time and in spite of extremely limited material, it is the first and only unequivocal evidence that the westernmost distribution limit of the Caucasian shrew reaches north-western Anatolia (Pavlinov and Rossolimo 1987, Dogramaci 1989, Sokolov and Tembotov 1989, Hutterer 1993).

Obviously, one specimen from a single locality does not allow to reevaluate previous Turkish findings of *S. satunini* as well as to exclude with certainty a possibility of the occurrence of the common shrew in the western parts of Asian Turkey. None the less, according to descriptions by Spitzenberger (1968) and Şimşek (1986), specimens investigated by those authors seem to have been morphologically very similar (especially in coloration) to those from north-eastern Turkey studied by Macholán (1996). Moreover, the Caucasian shrew prefers virtually the same habitats as the common shrew (Sokolov and Tembotov 1989) and thus the two species may be regarded as ecological vicariant counterparts like, for instance, another pair of shrew species, *Sorex minutus/S. volnuchini* (Zima *et al.* 1997).

On the other hand, results of karyological studies on a shrew population in the Istranca Mts., carried out by Zima and colleagues (Zima *et al.* 1994, 1997), suggest that *S. satunini* have not crossed the Bosporus to reach the European continent. Thus far, it can be hypothesized that *S. araneus* does not occur in Asia Minor at all and *S. satunini* is the only representative of the *S. araneus* group there.

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