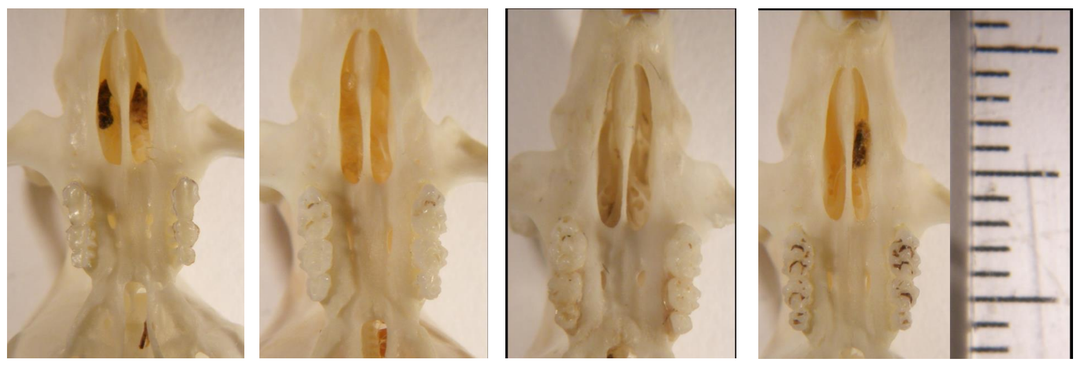
An application of morphometry in identification of *Apodemus sylvaticus* and *A. flavicollis* from Lithuania

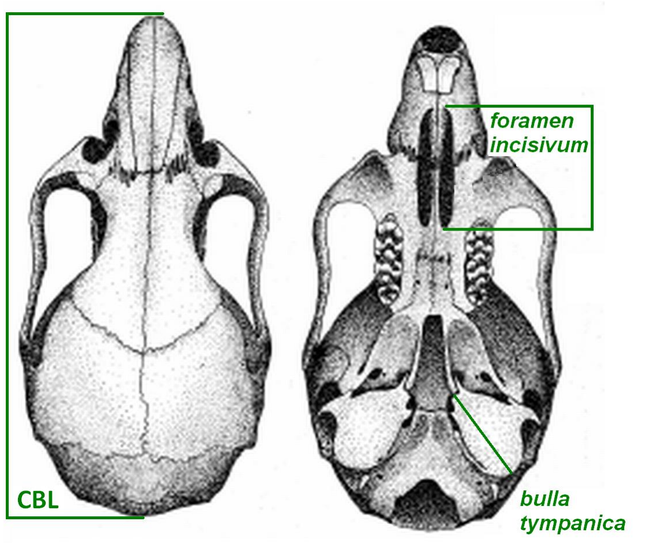
Laima Balčiauskienė, Linas Balčiauskas

Nature Research Centre, Akademijos 2, Vilnius, Lithuania, e-mail: laiba@ekoi.lt

For Lithuanian *Apodemus* species, identification keys were presented in "*Lithuania fauna. Mammals*" (1988), suggesting hind foot length (*A. sylvaticus* <22 mm, *A. flavicollis* > 22 mm), length and form of *foramen incisivum* (sleek and longer in *A.sylvaticus*, reaching middle of the crowns of M^1) as key traits. Our presentation is the first generalizing approach to identification of *A. sylvaticus* and *A. flavicollis* from Lithuanian populations, based on skull morphometry and indices. Atypical specimens were not screened out.

In the "*Fauna*" species description was based on the data from 11 individuals (and measurements of 4–7 skulls) of *A. sylvaticus*. We analyzed size of 42 skulls of *A.sylvaticus* and 514 skulls of *A. flavicollis*. We also had two *Apodemus* specimens, former identification of which was questionable (according *foramen incisivum* as *A.flavicollis*, but with small hind foot and length of *bulla tympanica*). Material of *A.flavicollis* was collected in 1987–2010, covering 22 districts in all parts of Lithuania. Material of *A. sylvaticus* was collected in 1978–1999 in south (Varėna, Alytus and Vilkaviškis districts) and east (Molėtai district) of Lithuania. Re-identified specimens confirmed existence of *A. sylvaticus* in east Lithuania. In 2010 species was registered in new locality (Tauragė district), widening distribution range to west Lithuania.

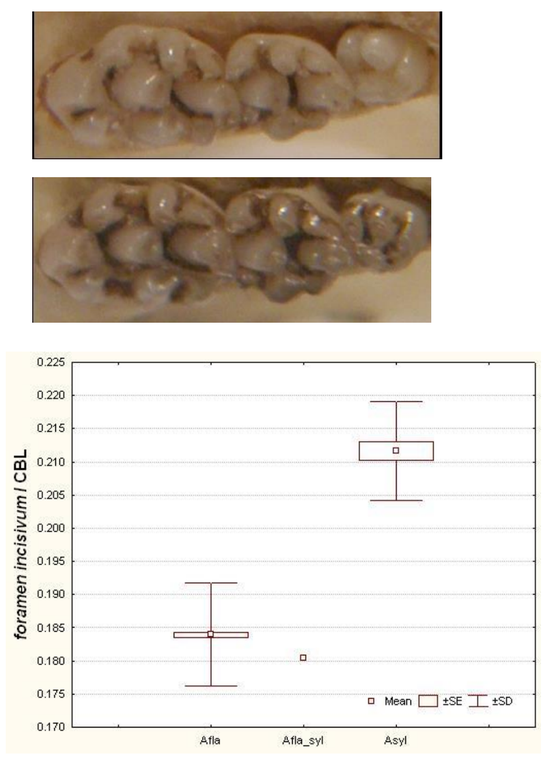




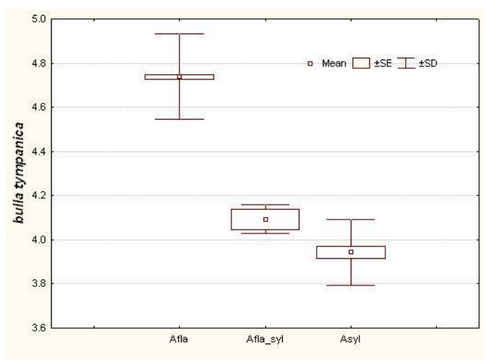
17 maxillary, 8 mandibular and 5 body measurements were examined. We also paired all skull characters into indices. Most suitable for identification of these two species (non overlapping) traits were selected from bivariate scatterplots and using pairwise comparison.

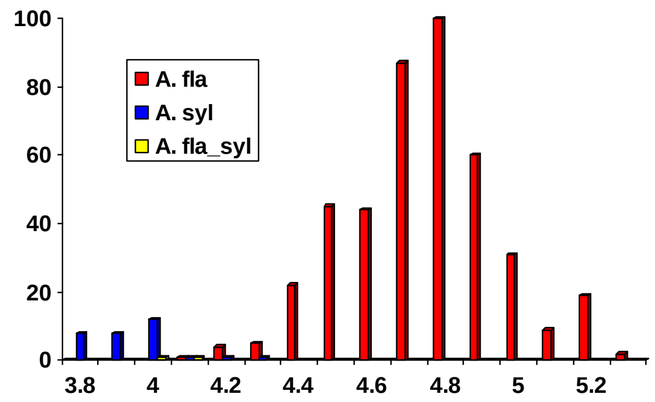
Differences in the body/tail length index were clearly expressed between two species, *A. sylvaticus* being relatively short-tailed (L/C=0.965±0.003 in *A. flavicollis*, 1.015±0.013 in re-identified and in 2010 trapped specimens, and 1.129±0.012 in *A. sylvaticus*). According average length of the hind foot, suspicious specimens did not differ from *A. sylvaticus* (22.4±0.55, and 21.2±0.24 mm), being significantly "lessfooted" than *A. flavicollis* (24.7±0.06 mm). Though, overlap in hind foot length (17.3–28.7, 21.4–23.3 and 18.7–27.8 mm, respectively) only gives good start for screening out *A. sylvaticus*.

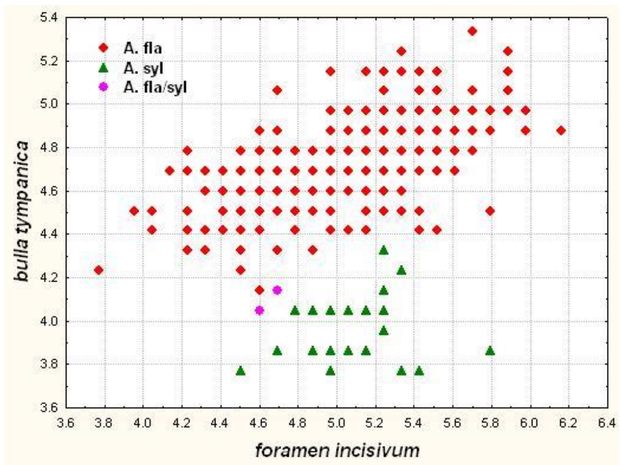
As the most useful single measurement we acknowledge length of *bulla tympanica*: for *A. flavicollis* average was 4.74±0.01 mm, *A. sylvaticus* – 3.94±0.03 mm, re-identified and in 2010 trapped specimens – 4.09±0.05 mm. In the zone of overlapping measurements, i.e., 4.1–4.3 mm, there were 2.33% of measured *A. flavicollis* and 9.68% of *A. sylvaticus*.

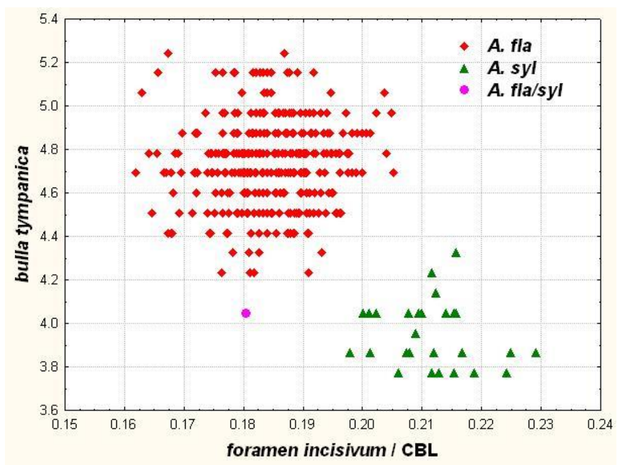


Though length of *foramen incisivum* and condylobasal length of the skull overlap widely between species, their ratio, or index (FI/CBL) was found useful for diagnostic purposes, *lim* in *A. flavicollis* being 0.16–0.22, in *A. sylvaticus* 0.20–0.23. In general, all indexes, constructed using length of *foramen incisivum* assigned suspicious specimens to *A. flavicollis*, while using length of *bulla tympanica* – to *A. sylvaticus*. Finally, bivariate scatterplot based on FI/CBL and *bulla tympanica* yielded full separation between two analyzed species.









***bulla tympanica*, mm**

Authors and country	Criterion	Comments*
Van der Straeten, 1976 (Belgium)	K1 = -11.03 x length of *foramen incisivum* + 7.48 x length of diastema +13.70x length of upper molar row + 27.73 x breadth I^1 K1<=79.88 = *A. sylvaticus*, K1>79.88 = *A. flavicollis*	Niethammer's data *A. fla* K1=76.5-101.5, *A. syl* K1=72.2-81.0 Our data: *A. fla* K1=70.4-121.6, *A. syl* K1=65.2-82.0
	K2 = -5.05 x length of *foramen incisivum* + 20.95 x length of lower molar row +36.96 x breadth I^1 K<= 98.7 = *A. sylvaticus*, K>98.7 = *A. flavicollis*	Our data: *A. fla* K2=83.6-118.7, *A. syl* K2=77.0-95.3
Niethammer, 1969 (Germany); Pucek, 1984 (Poland); Kryštufek & Stojanovski, 1996 (Balkans); Demeter & Lazar, 1984 (Hungary); Harrison & Bates, 1991 (Arabia); Qumsiyen, 1996 (USA)	Condylobasal length of skull	Niethammer's data: *A. fla* CBL=21.0-27.2 mm, *A. syl* CBL=19.6-24.3 mm Puceks's suggestion: *A. fla* > 25 mm, *A. syl* < 24 mm Our data: *A. fla* CBL=21.4-31.9 mm, *A. syl* CBL=20.1-25.5 mm
Niethammer, 1969	Length of foramen incisivum / condylobasal length of skull	Niethammer's data: *A. fla* 0.20-0.24, *A. syl* 0.21-0.25 Our data: *A. fla* 0.16-0.21, *A. syl* 0.20-0.23
Pucek, 1984 (Poland)	Breadth of upper incisors	Pucek's suggestion: *A. fla* <=1.3 mm, *A. syl* <1.25 mm Niethammer's data: *A. fla* 0.20-0.24, *A. syl* 0.21-0.25 Our data: *A. fla* 0.20-0.24, *A. syl* 0.21-0.25
	Breadth of the crown of first upper molar (M^1)	Pucek's suggestion: *A. fla* > 4 mm, *A. syl* < 4 mm Niethammer's data: *A. fla* 3.7-4.4 mm, *A. syl* 3.5-4.0 mm Our data: *A. fla* 3.4-4.7 mm, *A. syl* 3.5-4.1 mm
	Length of maxillary tooth-row	
Tvrtkovic 1976; Kryštufek & Stojanovski, 1996 (Balkans); Demeter & Lazar, 1984 (Hungary)	Distance betweenI^1 and M^3 (I^1M^3)	Not tested on our data
Filippucci *et al.*, 1984	Index *MI* = [(length of upper molar row + length of palatine bridge + interorbital breadth) – length of *foramen incisivum*]	Not tested on our data
Filippucci *et al.*, 1996 (Anatolia)	Scatterplot length of upper molar row / length of *bulla tympanica*	Our data: values overlap
Panzironi *et al.*, 1994	Scatterplot length of upper molar row / length of lower molar row	Our data: values overlap
Mezhzherin & Lashkova, 1992	Scatterplot length of *bulla tympanica* / condylobasal length of skull	Our data: values overlap
Storch & Lütt, 1989	Scatterplot [I^1 + length of upper molar row] / length of diastema	Not tested on our data
Steiner, 1968	[Length of upper molar row x breadth of M3] / [condylobasal length of skull x zygomatic breadth]	Not tested on our data
Barciová & Macholán, 2009 (Czech Republic)	Classification according length of lower molar row, condylobasal length of skull and length of *bulla tympanica*	Barciova's data: misclassification rate = 1.7% Our data: 100% *A. fla* = length of lower molar row >3.6 mm and length of *bulla tympanica* > 4.4 mm

* - calculations from raw data of Niethamer & Krapp, 1982 and comparison with our data