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RUSSIA

Mass reintroduction of sable (*Martes zibellina*): achievements and problems over 55 years

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The reintroduction of sable was undertaken in the USSR due to past overharvesting of some populations and extirpation from some locations. The sables that were used for reintroduction were caught in the habitats of the most valuable features (the Baikal region, the lower Amur River basin) in order to sustain high quality of fur (dark coloration).

The first translocation of 10 sables to Karaginsky Island (Kamchatka) took place in 1901; 20 and 3 more sables were translocated to Karaginsky Island in 1928 and 1930, respectively (Timofeev and Pavlov 1973). Twelve sables were reintroduced to Feklistov Island 1927, and an additional 5 and 45 sables reintroduced to Feklistov Island in 1928 and 1929, respectively.

The mass translocation program began later, in 1949, when it was found that districts could not be settled through natural reproduction in some geographic locations, *i.e.* Middle Ob basin, the left bank of Yenisei, the right bank of Lena River in Yakutia, and others. During the period from 1949 to 1959, 17,849 sables were reintroduced (representing 93% of the total number of sables translocated from 1901 to 1970) (Timofeev, Pavlov 1973, Powell *et al.* 2012).

Most translocations were successful (Timofeev, Pavlov 1973, Pavlov 1973, Monakhov 1995, 2006, Powell *et al.* 2012). As a result, they created several populations that grew larger and persist until today (Fig. 1). Among them are several populations between the Ob and Yenisei

Rivers (Tyumen Province, the Krasnoyarsk Krai), the ridge of Tannu-Ola in Upper Yenisei (Tuva Republic), and the basins of the Aldan, Kolyma, Yana, Maja, and Okhota Rivers (Yakutia-Sakha Republic, Khabarovsk Krai, Magadan Province).

From the zoological point of view, the main problem is the formation in some regions of several new populations that now demonstrate morphological properties that are not typical of local sable races. I will focus on this topic in more detail, because we studied a large amount of factual material in this direction.

We analyzed 537,894 sable skins. The color intensity is determined by commodity experts from Russian State fur-trade enterprises. The color intensity method they use is the fur Standard OST NKZag-414 for raw sable skins. All sable skins (in accordance with this Standard) are classified into 7 color groups. In their proportions (using weighted average method), we calculated the "color index," *I*c, proposed by Eremeeva (1952). To characterize the size of sables, we measured 4,416 skulls of adult animals on 17 dimensions. We classified 7,022 sables to reveal the expression the cranial phene FFCI (Monakhov 2006, 2010; Monakhov and Ranyuk 2009). For obtaining the morphological data I studied collections from many museums, institutions, and private collections throughout Russia. The result is a set of population and regional indicators (mean values) of those morphological traits, which can be seen in Table 1 and Figures 2 – 4.

My analysis revealed the differences in the skull sizes (Table 1, Fig. 2). For example, the condylobasal skull length for introduced males vs. local males was 82.43 – 84.62 mm vs. 84.45 – 85.98 mm in the Middle Ob Basin; 80.72 – 83.39 vs. 82.91 – 83.66 mm in the Yenisei Basin; 84.01 – 84.22 vs. 81.61 – 83.11 mm in Lena Basin; and 81.67 – 84.96 vs. 80.16 – 88.02 mm in the Far East. As a rule, the size of introduced animals is much smaller than the size of native sables. All differences are statistically significant (Table 1).

On the contrary, the frequency of cranial phene on males and females in introduced populations are greater than in the autochthonous groups (Fig. 3). Most of the differences in the expression of phenetic skull trait FFCI are statistically significant (Table 1).

The difference in the estimates of darkness of fur between introduced animals and autochtonous individuals is tangible. For example, the index of coloration (*I*c) for native vs. introduced sables is 1.68 – 1.73 vs. 2.60 – 2.85 in the Middle Ob basin; 1.91 – 2.23 vs. 2.59 – 3.20 in the north of the Yenisei Basin; 2.62 – 2.73 vs. 3.15 – 3.24 for Lena Basin; and 2.56 – 3.37 vs. 3.14 – 3.38 for the Far East (Fig. 4). All differences are statistically significant (Table 1).

Thus, following the results of morphological tests I revealed that the sables in reintroduced populations have retained the basic properties of the phenotype of immigrants, i.e. darker fur, the small size of the skull, and high expression of cranial phene FFCI.

Generally, changes in the morphology of immigrants resemble or even repeat the microevolutionary trends that took place during the historical formation of the species range. However, the special characteristics of the phenotype were formed in these populations, as governed by spatial isolation from the aboriginal groups and conservative mechanisms of heredity. As we observed in the studied regions, interpopulation differences in phenotype properties have a regular nature because they appear in large quantities and are similar in some areas of the range.

The main economic motivation for translocations of sables was to increase the harvest of fur production with more valuable and dark pelts, which have a high importance in the international trade. Therefore, assessments the economic aspects of the reintroduction of sable have been conducted. For example, in the Tyumen Oblast the total cost associated with the releases were paid off by pelts harvested in 17 years following the last translocation, in the Tomsk region in 5 years, in Northern Krasnoyarsk Krai in 6 years, and in Tuva in 15 years (Monakhov 1978, 1982).

The average price of pelts of introduced sables was 25 – 30% higher than that of local sable pelts. This can be explained by the preservation of the dark-colored fur in new populations. Thus, the reintroductions discussed here are found to be successful because the pelt quality in the new populations remains high even now (Gusev 1971; Tavrovsky 1971; Timofeev and Pavlov 1973; Monakhov and Monakhov 1978; Monakhov et al. 1982; Monakhov 2006, 2011, Powell *et al*. 2012).

Unfortunately mass reintroductions of sables brought some side effects. Some of relocations took place in districts where local sables already existed and new introduced animals changed the genetic structure of the population (*e.g.*, Ural Mts, Chulim River Basin, and East Kazakhstan). In particular, this was observed beyond the natural range of the species (Chelyabinsk Oblast in the Southern Urals, the Alatau Mts in Kazakhstan).

In some districts introduced sables inhabit the neighboring territories, but they are representatives of subspecies *M. z. princeps* (central part of area) and *M. z. shantarikus* (east of area), whereas the native subspecies are *M. z. zibellina* (in Middle Ob), *M. z. eniseensis* (north of the Yenisei Siberia), *M. z. sayanenzis* (Tuva Republic), and *M. z. ilimpienzis* (Lena Basin in Yakutia-Sakha Republic). Newly formed populations are violating the picture of intraspecific variation that has evolved as a result of evolution of *Martes zibellina*.

In recent decades the sable was rated as an invasive alien species in some areas (Bobrov *et al*. 2008). It is unclear now which action plans will be developed and what will be done with these imaginary "alien" sable in the future.

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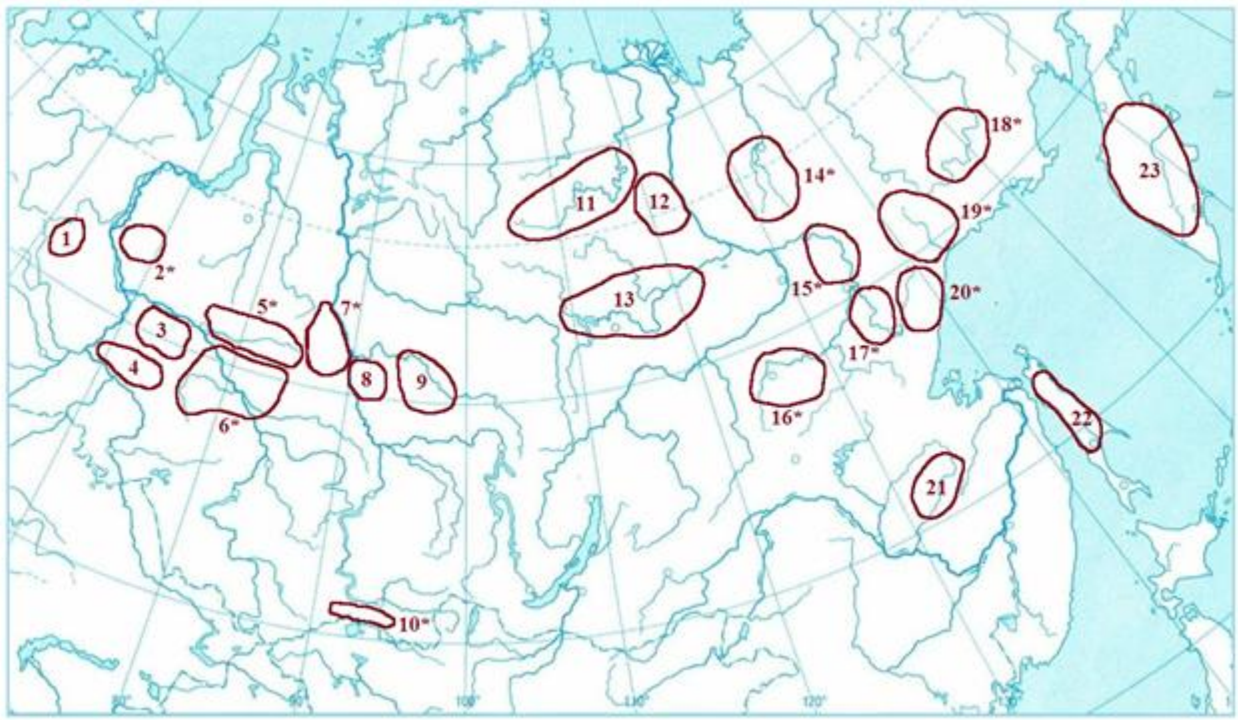

Figure 1. Sable study locations. Introduced populations marked with asterisk. The areas are numbered as follows: Tapsui (1), Kazym (2), Yugan (3), Demyanka (4), Vakh (5), Tomsk Province (6), Sym-Yelogui Rivers (7), Yarcevo (8), Podkamennaya Tunguska (9), Tannu-Ola Mts (10), Olenek River (11), Jigansk Vicinity (12), Vilui River (13), Yana (14), Low Aldan (15), Upper Aldan (16), Maya River (17), Upper Kolima (18), Okhota River (19), Ayano-Mayski District (20), Upper Bureya (21), Sakhalin Isle (22), and Kamchatka Penn. (23)

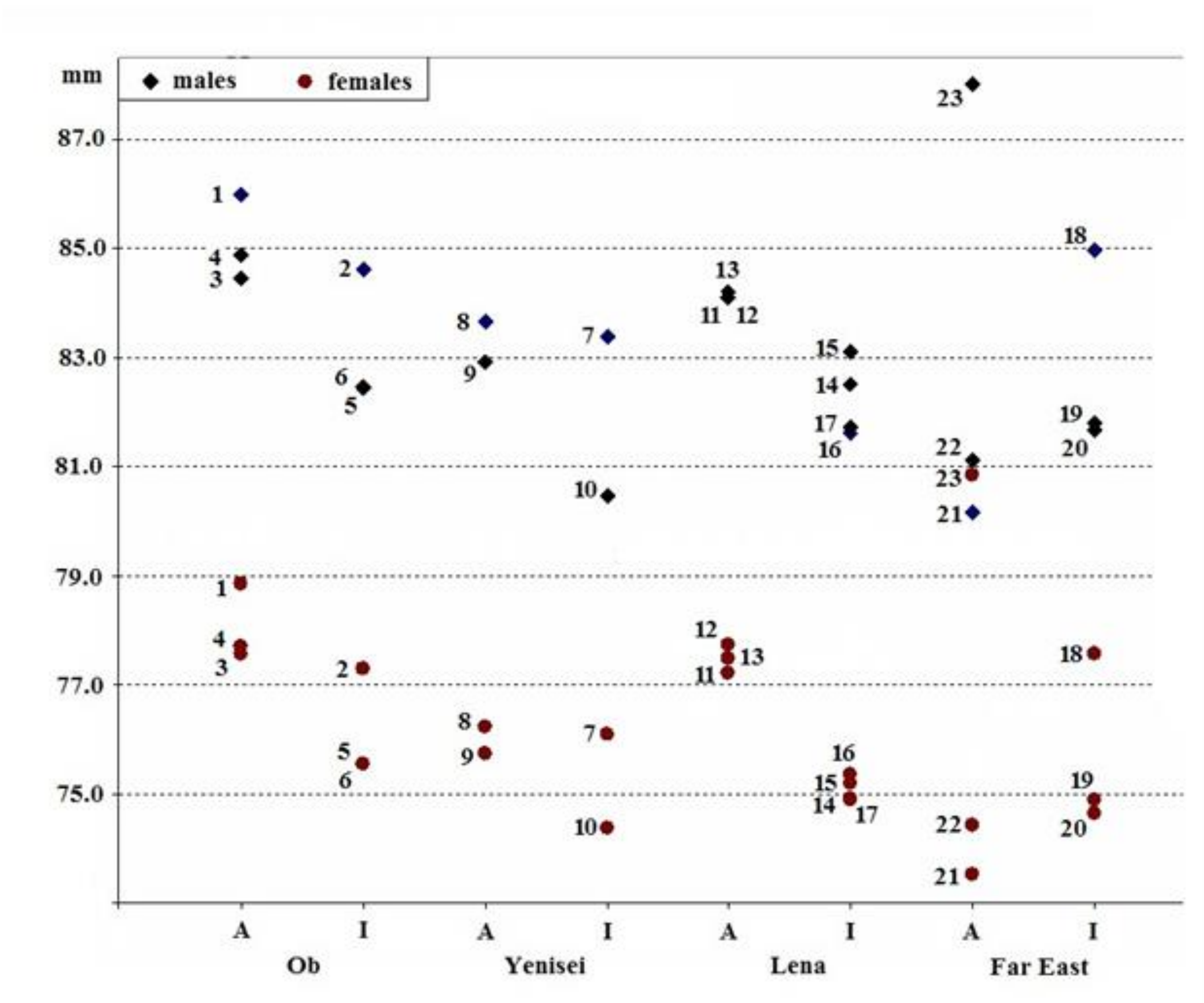

Figure 2. Mean measures of condylobazal length (mm) in aboriginal (A) and introduced (I) populations of sable in four parts of the specific area. Sable study area enumeration is the same as in Figure 1.

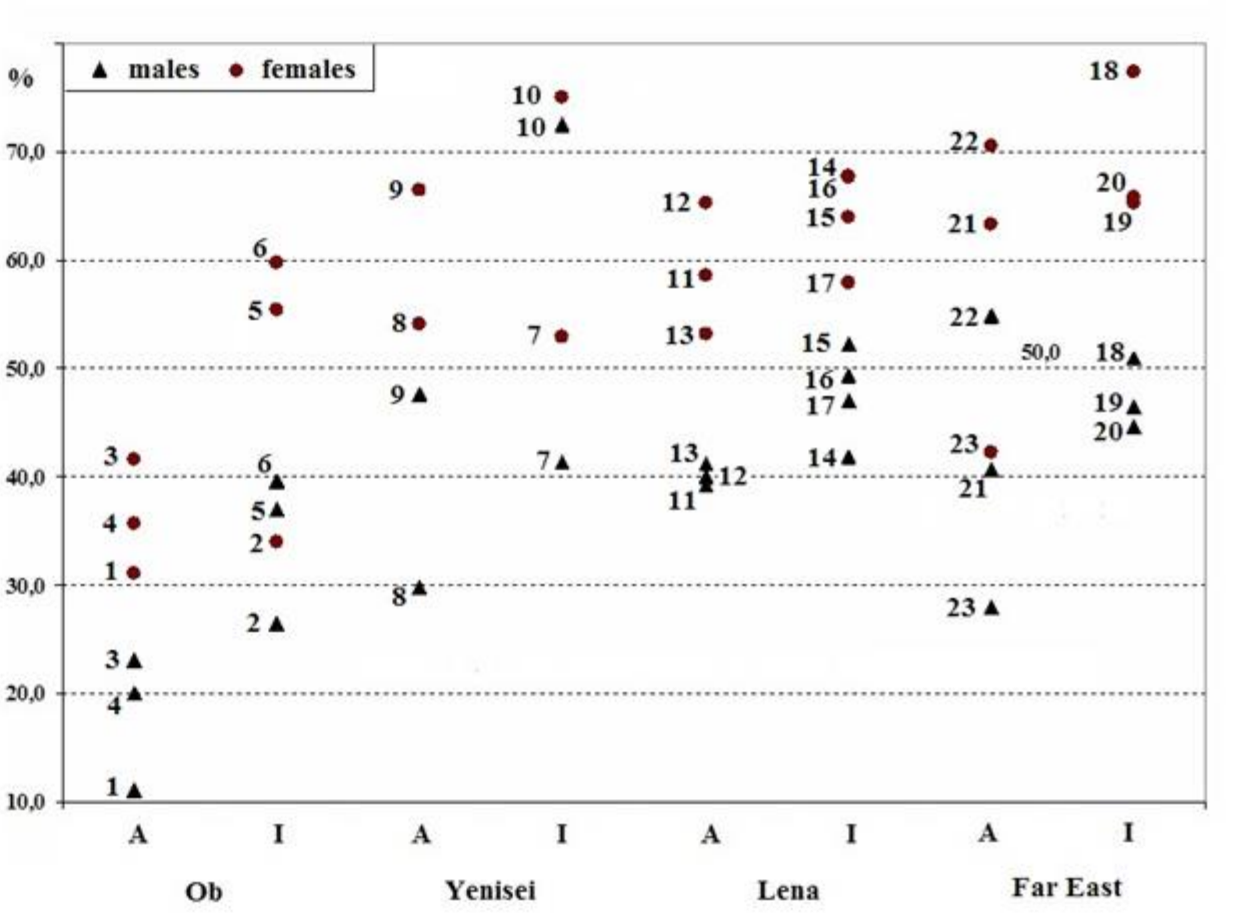

Figure. 3. Expression of cranial phene FFCI (%) in aboriginal (A) and introduced (I) populations of sable in 4 parts of the specific area. Sable study area enumeration is the same as in Figure 1.

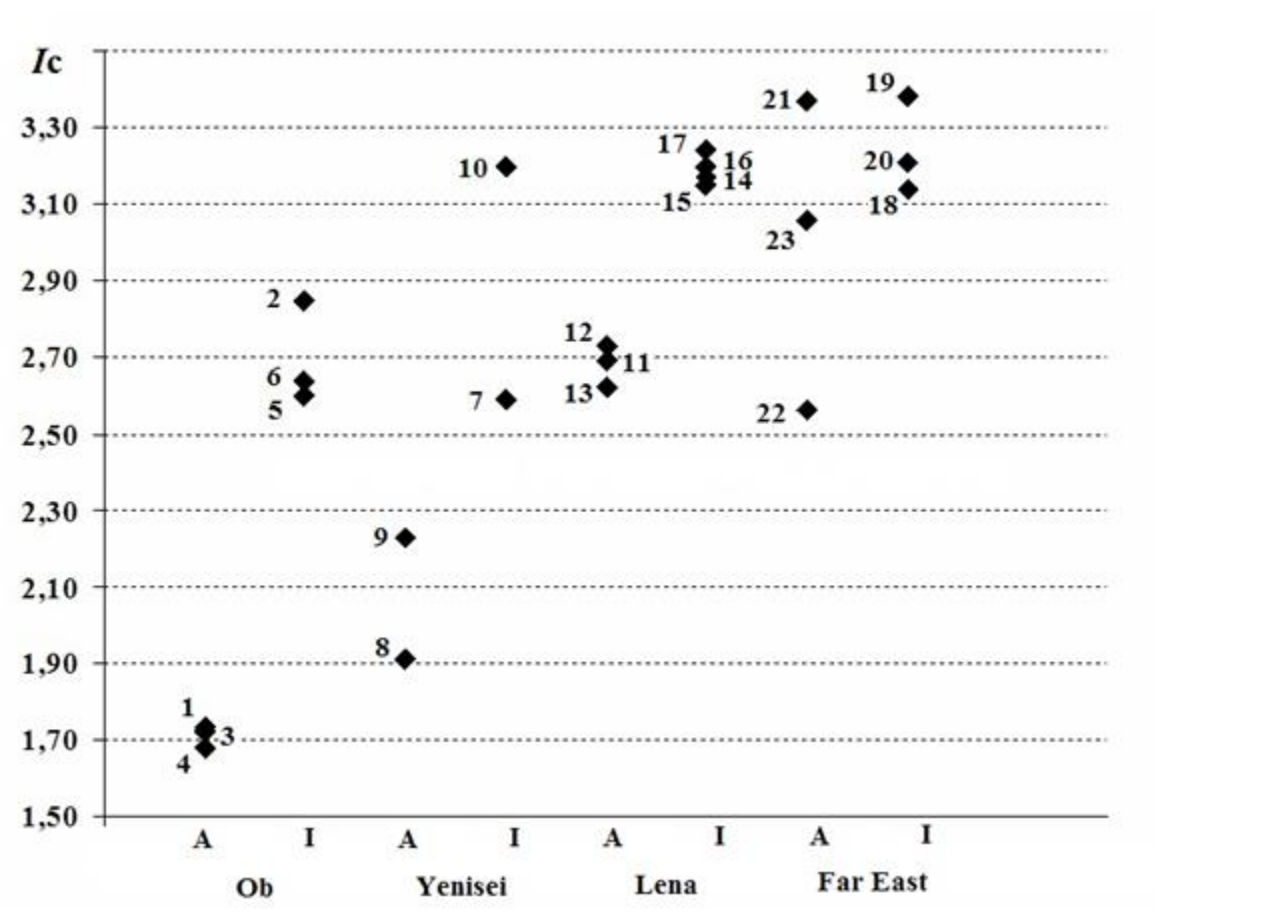

Figure 4. Means of colour index *I*c in aboriginal (A) and introduced (I) populations of sable in 4 parts of the specific area (without sexing). Sable study area enumeration is the same as in Figure 1.

Table 1. Morphological differences of sables in aboriginal and introduced populations in 4 parts of the specific area.

Condylobasal length (mm) (♂)

	Aboriginal Populations		Introduced Populations		Differences	
Regions	X♂±*SE*	n♂	X♂±*SE*	n♂	D♂,%	*p*-level ♂
Ob Basin	84.86±0.31	337	82.80±0.28	335	-2.42	0.001
Yenisei	83.18±0.28	167	81.70±0.29	185	-1.78	0.001
Lena	84.19±0.44	167	82.15±0.28	335	-2.43	0.001
Far East	83.63±0.20	667	82.70±0.42	179	-1.11	0.05

Condylobasal length (mm) (♀)

	Aboriginal Populations		Introduced Populations		Differences	
Regions	X♀±*SE*	n♀	X♀±*SE*	n♀	D♀,%	*p*-level ♀
Ob Basin	77.82±0.29	314	75.94±0.31	306	-2.27	0.05
Yenisei	75.93±0.26	148	75.04±0.36	102	-1.08	0.05
Lena	77.38±0.52	114	75.02±0.27	259	-2.86	0.001
Far East	76.60±0.19	629	75.49±0.41	172	-1.34	0.02

Frequency of cranial phene, FFCI (%) (♂)

	Aboriginal Populations		Introduced Populations		Differences	
Regions	♂	n♂	♂	n♂	D♂,%	*p*-level ♂
Ob Basin	0.21	776	0.37	441	77.8	0.00001
Yenisei	0.32	259	0.53	253	68.6	0.00001
Lena	0.46	258	0.47	497	3.3	0.695
Far East	0.39	718	0.46	396	18.1	0.0215

Frequency of cranial phene, FFCI (%) (♀)

	Aboriginal Populations		Introduced Populations		Differences	
Regions	♀	n♀	♀	n♀	D♀,%	*p*-level ♀
Ob Basin	0.37	750	0.54	396	44.7	0.00001
Yenisei	0.59	316	0.62	178	5.3	0.499
Lena	0.58	224	0.63	389	8.1	0.250
Far East	0.59	743	0.67	428	13.5	0.0067

Fur coloration, *I*c

	Aboriginal Populations		Introduced Populations		Differences	
Regions	I*c*±*SE*	% light pelts (n)	I*c*±*SE*	% light pelts (n)	DI*c*,%	*p*-level
Ob Basin	1.71±0.008	84.4 (80,332)	2.64±0.010	49.0 (123,364)	53.9	0.001
Yenisei	2.22±0.006	62.7 (98,336)	2.64±0.022	45.3 (13,626)	18.8	0.001
Lena	2.70±0.014	42.7 (36,577)	3.20±0.020	23.2 (36595)	18.3	0.001
Far East	2.95±0.007	27.8 (142,189)	3.21±0.030	17.8 (6,885)	8.8	0.001