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CLINEAL VARIATION IN CAUCASIAN TUR AND ITS TAXONOMIC RELEVANCE

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Abstract

Geographic variation in traits and features used in traditional morphology have been studied in Caucasian tur (e.g. degree of spiraling of horn sheaths and cores in males and females, shape of cross-section of adult males horn cores, dark stripe pattern on the legs etc.). Almost all the examined traits display clineal east-west variation, usually with sloping parts of the cline to the west and east (longer one) from the area around Mt. Elbrus, while in this area a steep part of the cline occurs, often with considerable fluctuations within. Resembling clineal variation occurs in tur females as well. Multiple correlating clineal variation in large and actively moving ungulate within a limited range (770 km long and up to 80 km wide) can hardly be explained by geographic dynamics of environmental factors. The shape of the cline is also very telling, suggesting a secondary contact and hybridization (Mayr 1968). Since there is one steep part of the cline, contact of two primary taxa may have occurred, initially separated by a geographic barrier, most probably a glaciation centre which was pulsating during Pleistocene in the area including Mnts. Elbrus in the west and Kazbek in the east, situated where the steep and fluctuating part of the cline occurs. This glaciation centre could periodically separate the all-Caucasus tur population into two and create conditions for evolving of two taxa: the East-Caucasian and West-Caucasian tur. Isolation periods probably were insufficiently long and populations contacted periodically (as now), hybridized and did not evolve mechanisms of effective reproductive isolation for shaping into "good" species.

Key words: *Capra*, Caucasian tur, clineal variation.

Resumen

Variación del gradiente ecológico en el caso del Tur del Cáucaso occidental y su significado taxonómico

Hemos estudiado la variación geográfica del tur del Cáucaso occidental con respecto a 8 características y rasgos empleados en la morfología tradicional (por ejemplo, el grado de espiral de las vainas y núcleos de los cuernos en machos y hembras, la forma del corte transversal del núcleo de los cuernos del macho adulto, la forma de la raya oscura de las piernas, la forma y longitud de la barba del macho adulto en invierno, etc.) Prácticamente todas las características estudiadas muestran una variación este-oeste del gradiente ecológico. Normalmente hay pendientes en el gradiente ecológico hacia el oeste y hacia el este (más prolongada) desde el área alrededor del Monte Elbrus; dentro del área hay una parte muy inclinada del gradiente ecológico, muchas veces con variaciones significativas. También ocurre una variación parecida del gradiente ecológico en el caso de las hembras del tur. A pesar de la variación individual marcada que ocurre entre las poblaciones locales alrededor del Monte Elbrus, no se pueden considerar poblaciones mezcladas compuestas por morfotipos occidentales y orientales. Las múltiples variaciones correlacionadas del gradiente ecológico en grandes ungulados activos que se mueven dentro de un rango muy limitado (770 km de largo y hasta 80 km de ancho) difícilmente se pueden explicar basándose en la dinámica geográfica de factores medioambientales. La forma del gradiente ecológico también es muy indicativa (pendientes cortas al oeste y largas al este con un centro muy inclinado fluctuante) y hace pensar en un contacto secundario e hibridación (Mayr 1968). Teniendo en cuenta que sólo existe una parte muy inclinada del gradiente ecológico, pueden haber ocurrido contactos entre dos taxones primarios que en principio estaban separados por una única barrera geográfica en el Cáucaso Central. La barrera más probable sería la glaciación durante las pulsaciones del Pleistoceno en el área del Monte Ebrus en el oeste y Kazbek en el este; la zona glaciar todavía existe parcialmente y está situada donde ocurre la parte inclinada y fluctuante del gradiente ecológico. Este centro de glaciación podría haber separado periódicamente a toda la población de tur del Cáucaso en dos poblaciones, creando condiciones para la evolución de 2 taxones: el tur del Cáucaso oriental y el tur del Cáucaso occidental. Debido a la pulsación, la barrera entre los dos taxones iniciales no era constante y probablemente los períodos de aislamiento no fueron lo suficientemente prolongados, por lo que las poblaciones entraban en contacto periódicamente (como ocurre ahora), hubo hibridación entre ellas y no les fue posible desarrollar mecanismos de aislamiento reproductivo efectivo que les permitieran llegar a especies "verdaderas".

Palabras claves: Tur del Cáucaso occidental, variación del gradiente ecológico, taxonomía.

Introduction

There have been hints at clineal geographic variation in endemic Caucasian tur since the beginning of 20th century when three tur species had been described, each presenting a separate adult male morphotype: the western (*Capra severtzovi*), males displaying scimitar-shaped horns and long beard, the eastern (*Capra cylindricornis*), males sporting spiraling horns and short broad beard, and the central-Caucasian (*Capra caucasica*) being intermediate (Lydekker 1913, Dinnik 1909). However, the idea of clineal variation in tur has been spelled distinctly much later (Tembotov 1974). Nevertheless, having described clineal variation in tur, Tembotov stuck to Sokolov's (1959) idea of one tur species with three subspecies. Tembotov never tried measuring or at least evaluating various clineally changing traits that he described.

That was done by his pupil, Ayunts (Ayunts & Kolomyts 1986), but only for one trait - maybe the most important one - the spiraling twist of the horn sheaths of adult males. Having found clineal variation in this trait, Ayunts dismissed ideas of several species or subspecies in Caucasian tur. However, idea of clineal variation was never popular in the Soviet Union and Russia.

The aim of this research was to (1) study geographic variation in Caucasian tur and (2) interpret its taxonomic implications. Collections of Zoological Institute (St-Petersburg), Zoological Museum of the Moscow University, Institute for Ecology of Mountain Areas (Nal'chik), Zoological Institute of Azerbaijan (Baku), Zakatala (Azerbaijan), North Ossetian, Kabardin-Balkarian, and Caucasus Nature Reserves, and materials in private possessions were examined. Field observations were carried out in Azerbaijan, North Ossetia, Kabardin-Balkaria, and Karachai-Circassia. Old observations performed at the Caucasus Reserve in 1970s, and materials collected in Daghestan in 1990s have been used.

Material and methods

Fifty-three male skulls or (106 pairs of horns) and 24 female skulls (56 pairs of horns) have been examined. Geographic variation was studied in: shape of horn sheaths and cores, horn divergence angle, cross-section of horn cores, shape of coronal suture, position of the highest point of forehead to the bases of horn cores in males, size and shape of beard in males, leg striping pattern, and difference of general winter coloration in adult males and females.

The <u>shape of curvature and twist in adult male horns</u> always remained the main feature in classification of *Capra*. Just a look at a series of tur horns reveals a process of scimitar-shaped single-plane horn sheath gradually obtaining 3-dimentional spiraling twist when moving eastwards (Figure 1). However, it is not a regular spiral and usually not completing a full curl even in animals from easternmost Caucasus. Horns of East-Caucasian tur are often called perverted, since they display weak homonym twist near the base that gets replaced by heteronym twist in the main, remaining part of the horn. Nevertheless, horn sheaths of adult tur males from North Ossetia, Daghestan and Azerbaijan fit a cone (Figure 2) and may be described as conical spirals. However, the changing shape of spiral and its irregularity prevents mathematical characteristics of the spiraling shape of horn sheath, unlike spiraling shells of mollusks (Thompson 1992). Therefore we modified the method of Ayunts (Ayunts & Kolomyts 1986) and measured deviation of sheath from 2-dimentional plane by height of the second annulus (Figure 3) above horizontal surface to which the lower, single-plane part of the sheath is pressed, because the first annulus, especially in spiraling horns, is usually broomed or broken off. These measurements essentially cannot be very precise, only up to 5 mm. H/L ratio was used as spiraling index. Apart from the spiraling, curvature of lower part of the sheaths varies too and can be characterized by K /F ratio.

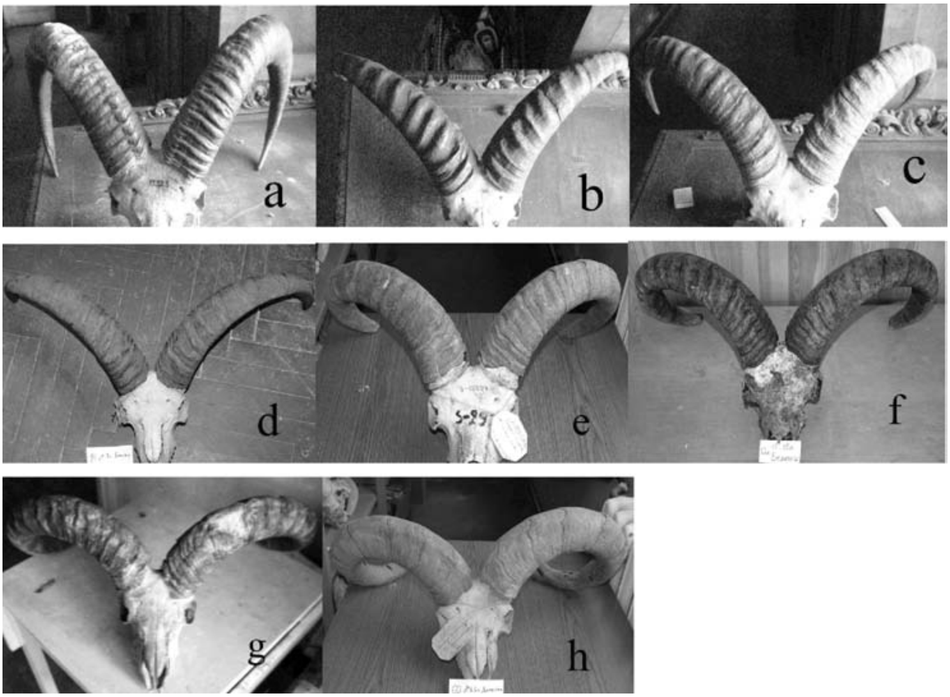

Figure 1. Horns of Caucasian tur (a: Caucasus Reserve; b: Teberda; c: Malka; d: Baksan; e: Chegem; f: Bezengi; g: North Ossetia; h: Daghestan).

Twist of female horns was more difficult to measure, because of smaller size. The first annulus was again ignored. Precision was up to 2 mm. Female horn sheaths being laterally flattened and acquiring frontal-inner keel from 4-5 years on, axis of sheath cross-section may be easily estimated in all annuli. Thus, the angle of twist can be measured (Figure 4), up to 5° precision. The upper cross-section was taken from the base of the first annulus.

Figure 2. Horn sheaths of adult tur males form North Ossetia (a: 11-year old, b: 7-year old

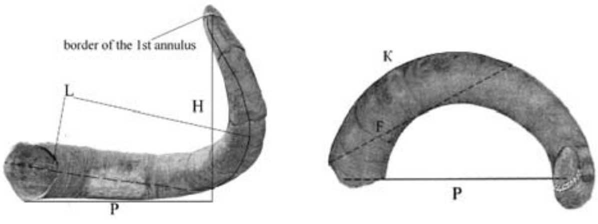

Figura 3. Measurements of horn sheath (L: length, H: height, P: chord of sheath projection, F: chord of the part of the sheath pressed to the plane, K: length of the pressed part).

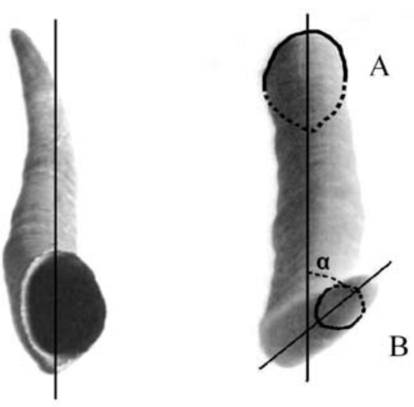

Figure 4. Spiraling twist in female horn sheath (A: cross-section at the base of the sheath; B: the upper cross-section at the base of the first annulus and its axis; C: the angle of twist).

The shape of core cross-section was taken from adult males, 1 cm above the core base, by means of a plastic tin wire. Cross-section was treated as triangle, and ratio of base (frontal surface) to height were compared (figure 5). In ibexes (Alpine *C. ibex* and Asiatic *C. sibirica*) and West-Caucasian tur, the bases are directed forward, while in males from North Ossetia the horns are turned to each other, so frontal-outer keel is directed forward. Shape of cross-section in females shows too high individual variation to display geographical trend.

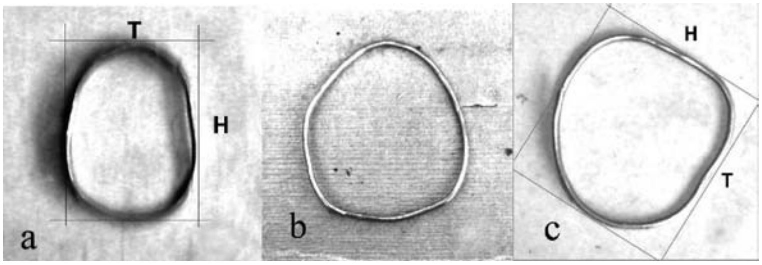

Figure 5. Cross-sections of the right horn cores of Siberian ibex (a), tur from the Caucasus Reserve (b) and tur from North Ossetia (c).

Divergence angle of horns are better measured not as angles between horn cores but as angles between the planes along which the cores (at least their basic parts) grow, because horns of West-Caucasian tur grow upwards and backwards, while horns of the East-Caucasian tur grow upwards and sideways. Thus, measurements of horizontal projections of horn cores proved more adequate and were easier to do on photos. Divergence angle in males was measured between the basic 10 cm of posterior keel of the cores, while in females the angle was measured between lines drawn through tips of cores and their mid-bases (Figure 6). The precision in both cases was up to 5^0.

According to Tsalkin (1955), coronal suture in adult West-Caucasian tur males display blunt angle formed by two straight lines not penetrating between the horn cores, while in East-Caucasian tur the angle is formed by two arcs almost duplicating the bases of sheaths and penetrates between the cores. This difference proved immeasurable and displayed unclear statistical difference.

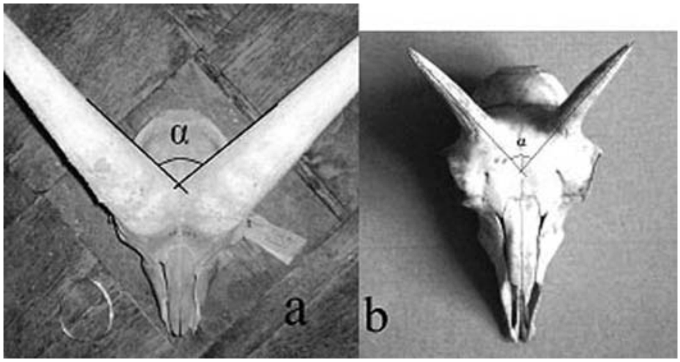

Figure 6. Horn core divergence angles of horizontal projections in tur (a: males, b: females).

Size and shape of beard is difficult to characterize because it's unclear how to measure it: the longest hairs, middle ones, etc. Also it is almost impossible to measure beard on collection specimens. Photos of live animals may be compared, where overall size of the beard can be scaled to the size of the head. Beards molt late and are evident till June.

Unlike beard, winter coloration doesn't remain long after the end of rutting season and fades quickly, particularly in adult males. In North Ossetia, adult males are much darker than females during the rut (end of November-mid-January), while in March they don't differ from females in intensity of coloration. This trait proved indefinite and unproductive.

Contrary to this, striping pattern on legs is easily seen in almost all seasons, in collection specimens as well, and displayed clear differences between local populations.

The listed features are essentially very different. Some can be measured, if not too precisely (shape of horns), others can be regarded as discreet or alternative (the shape of striping pattern on legs), the third ones are difficult to estimate at all (e. g. difference in winter coloration in males and females). If data proved close for neighboring valleys and were insufficient, they were amalgamated, and sometimes differently for different traits, depending on the occurrence and amount of these data.

"West-Caucasian tur" and "East-Caucasian tur" mean just morphotypes, not taxa, if not specifically stated.

TABLE 1
Parameters of spiraling twist of tur male horn sheaths (n=106).

Site, Distance from the Chugush Mt., km	Age, yrs	L, cm *M(n)* / min-max	H, cm *M* / min-max	H/L *M* / min-max	σ	t	P
Caucasus Reserve	8-15	69.0(4) / 58.0-82.0	3.0 / 10.5-4.5	0.04 / 0.02-0.06	0,02		
Teberda, 140	8-12	73.5(4) / 67,5-84,5	9,5 / 4.0-14.5	0.13 / 0.09-0.20	0,06	2,46	>0.95
Kuban', 180	6-12	65.5(2) / 49.0-82.0	10.5 / 7.0-14.0	0.16 / 0.14-0.17	0,01		
Malka, Balkaria, 200	5-11	53.0(5) / 43.0-66.0	4.0 / 2.5-5.5	0.08 / 0.04-0.12	0,03	2,94	>0.95
Baksan, Balkaria, 220	5-11	63.0(9) / 54.0-82.0	11.0 / 7.0-14.0	0.18 / 0.12-0.23	0,05	3,78	>0.99
Chegem, Balkaria, 260	5-7	51.0(6) / 42.5-54.0	7.0 / 4.5-10	0.14 / 0.09-0.19	0,04		
	12-16	75.5(3) / 67.0-92.0	16.0 / 12.5-18.0	0.21 / 0.19-0.25	0,02		
Bezengi, Balkaria, 280	6	50.5(3) / 48.5-53.5	8.0 / 6.5-10.0	0.16 / 0.13-0.21	0,04		
	9-15	73.5(18) / 56.0-88.5	18.5 / 8.0-28.0	0.25 / 0.14-0.33	0,05	1,25	
N. Ossetia, 340	4-6+	50.5(5) / 37.0-63.0	13.0 / 8.0-19.0	0.25 / 0.22-0.30	0,03		
	7-8	58.5(3) / 55.0-62.0	17.0 / 13.0-18.0	0.28 / 0.22-0.33	0,06		
	10-15	75.0(7) / 70.0-79.0	23.5 / 22.0-27.0	0.31 / 0.27-0.34	0,03	2,88	>0,999
Avar Koisu, Daghestan, and Chechnya, 540	5-6	60.0(6) / 52.0-67.0	16.5 / 14.0-20.0	0.28 / 0.25-0.30	0,02		
	7-14	73.5(16) / 59.0-84.0	23.0 / 17.5-29.0	0.32 / 0.28-0.35	0,02		
Lagodekhi, Georgia, and Zakatala, Azerbaijan, 560	4-5	46.5(5) / 38.0-58.0	11.5 / 4.0-18.0	0.24 / 0.11-0.31	0,08		
	6	72.0(2) / 70.5-72.0	27.5 / 27.0-28.0	0.39 / 0.38-0.39	0		
	11-12	90.0(6) / 77.0-106.0	33.0 / 28.0-40.0	0.37 / 0.33-0.41	0,03	3,83	>0,99

Note: indices differ significantly by Student's criterion when differing >0,5 while n>0.

Results

Index of spiraling in male horn sheaths characterized by deviation from a plane (H/L ratio) correlates with age, but within the given age group of a local population it doesn't correlate with length of the horn (Table 1). In the Caucasus Reserve, the index doesn't change with age and therefore younger age group is not shown at all. In Bezengi, North Ossetia, Daghestan, and Lagodekhi and Zakatala, mean indices of neighboring age groups differ noticeably, often significantly within each region (Table 1). In Teberda, Kuban', Malka, and Baksan, from 5-year age on, positive correlation with age doesn't show at all, though horns of younger 3-4-year-olds look absolutely scimitar-shaped, and they don't suggest acquiring spiraling twist with age. Indices for older age-groups were used for diagram (Figure 7) in each case.

Animals from Teberda, Chegem, Baksan and Bezengi display more variation than those from riverbasins to the west and east. This doesn't mean that scimitar-shaped horns cannot occur westwards of Malka R., but only as an utmost rarity. On the whole, the spiraling index grows almost intermittently from west to east

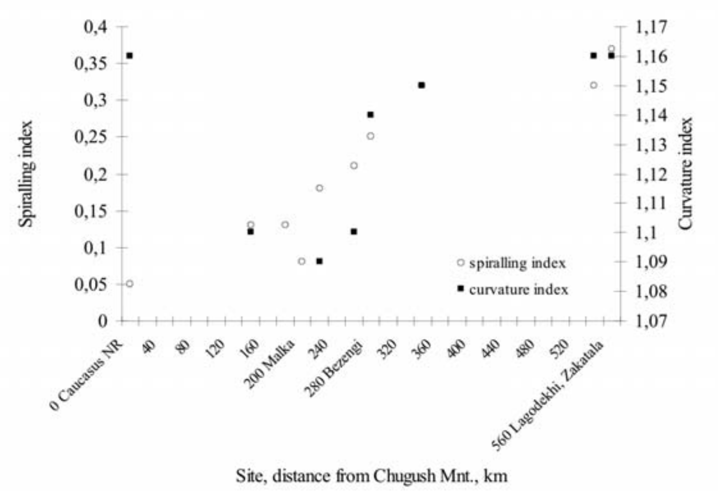

Figure 7. Geographic variation of horn sheath spiralling and curvature indices in adult tur males. Index of spiraling for Teberda, Malka and Kuban, and Caucasus Reserve differ significantly (P>0,95) by Student's criterion from index for Bezengi and Upper Balkaria, North Ossetia, Daghestan and Lagodekhi; while mean angles of twist for the Caucasus Reserve differ significantly from those for Bezengi and Upper Balkaria, North Ossetia, Daghestan and Lagodekhi.

(Figure 7), with the exception of Malka Valley, where animals display less twisted horns than those from Kuban and Teberda, situated westwards.

Besides the spiraling twist, the scimitar curvature of the basic part of the horn sheath curved in a single plane changes too (Figure 7.). Indices of spiraling twist and curvature do not depend upon size of horn within the given age group and site, even if the horn is abnormally small. Dynamics of geographic variation of twist and curvature do not coincide (Figure 7). In region from Teberda to Chegem, twisting fluctuates, then jumps in Bezengi and grows slowly farther on to the east, while dynamics of curvature is very different, being minimal, though fluctuating, in the Central Caucasus, around Elbrus Mt., but growing both to the west and east (Figure 7). Thus, there is some sort of break in dynamics of geographic variation in both indices in the area around Mt. Elbrus.

Horns from Balkaria form 2/3 of a curl at most, horns from North Ossetia almost 3/4 of a curl, and only horns of old males from Daghestan, East Georgia and Azerbaijan may display a full curl, only when preserving the first annulus.

Tur females have been usually regarded as morphologically uniform, and taxonomically insignificant (e. g. Dinnik 1909, Sokolov 1959, Veinberg 1993), however, this research revealed certain morphological variation in female horns along the Caucasus. Spiraling twist in female horns becomes noticeable only in specimens with abnormally twisted horn sheaths, looking like miniature male East-Caucasian horns. However, it shows even in some specimens from the westernmost Caucasus and grows eastwards (Figure 8) but displays more individual variation than in males. The angle of twist displays resembling dynamics (Figure 8). Thus, sexual dimorphism of tur horns is expressed not so much in presence or absence of the spiraling twist, as in its development.

By the shape of cross-section of adult male horn cores, West-Caucasian tur are close to ibexes (Figures 5a and 5b). It is an irregular oval in ibexes, having originated from isosceles triangle, narrow basis of which forms the frontal surface of the core. In West-Caucasian tur, triangular shape of the cross-section is expressed better and the basis is comparatively wider. Already in Baksan and Chegem the basis of the triangle gets longer than the sides, and this trend dominates further eastwards (Figure 9).

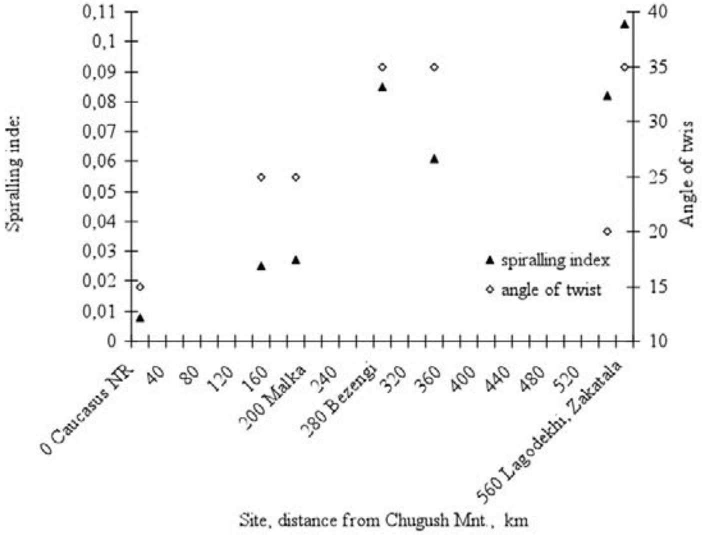

Figure 8. Geographic variation of indices of horn sheath spiralling in tur females. Ratios differ significantly by Student's criterion when difference >0,15.

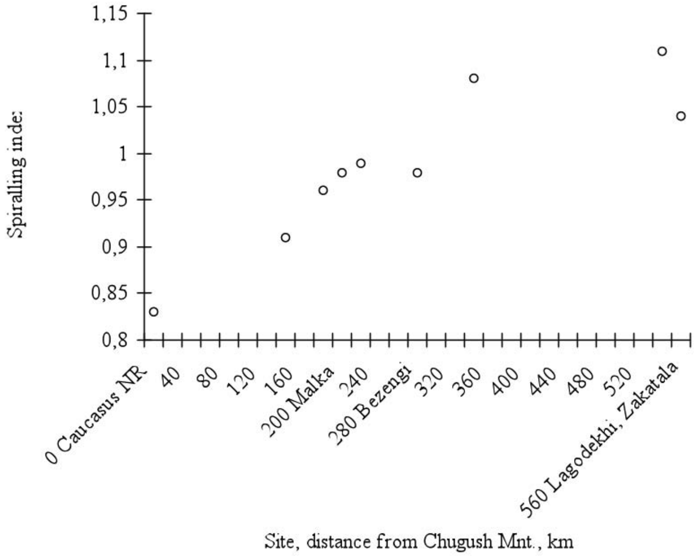

Figure 9. Geographic variation of horn cross-section in adult tur males. Differences in males are significant by Student's criterion (t) when reaching 10^0, while $\sigma = 5^0$, and also in all cases when differences $\geq 15^0$. Differences in females are significant (P>0,99) by Student's criterion (t), reaching 15^0, meaning that data for Caucasus Reserve significantly differ from those for Bezengi, Upper Balkaria, North Ossetia and Avar Koisu.

Angles of divergence of horns in animals from the westernmost Caucasus and animals from North Ossetia and areas eastwards of it differ but not so seriously as can be expected by external appearance of the horns and their position on the skull (Figure 10), both in males and in females. Nevertheless, there is dynamics, even if mostly mathematically insignificant. On the whole, dynamics in males and females are alike (Figure 10).

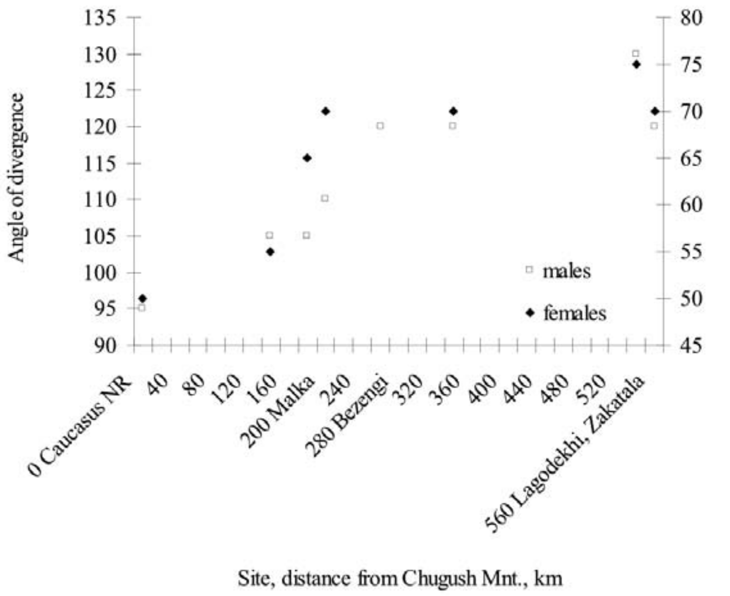

Figure 10. Geographic variation of angle of tur horn core divergence. Differences in males significant by Student's criterion (t) when $\geq 20^0$; differences in females significant when $\geq 15^0$ and $\sigma \leq 5^0$.

In skulls from the Caucasus Reserve, the highest point of forehead is situated between the front and middle of the cores (Table 2). In animals from Teberda, Kuban', Malka and Baksan, it is just in front of the middle, while in animals from Bezengi and all regions eastwards, it may be pushed even behind the middle line. Only adult males from the westernmost Caucasus differ noticeably by this trait from all the rest of studied populations. Everywhere, the highest forehead point in young males is closer to the core midline than in adult males.

TABLE 2
Position of the highest forehead point to horn cores.

Site	Age groups adult males	young males
Caucasus Reserve	(n= 7) between front and middle	(n= 1) in front of the middle
Teberda	(n= 5) in front of the middle	(n= 1) in front of the middle
Kuban'	(n= 4) in front of the middle	(n= 2) middle
Malka	(n= 2) in front of the middle	(n= 2) in front of the middle
Baksan	(n= 3) middle	
Chegem	(n= 3) middle	(n= 3) middle
Bezengi	(n= 17) middle	(n= 2) middle
N. Ossetia	(n= 6) middle	(n= 2) middle
Chechnya	(n= 1) in front of the middle	(n= 1) in front of the middle
Avar Koisu	(n= 3) behind the middle	(n= 1) middle
Lagodekhi and Zakatala	(n= 9) middle or behind the middle	(n= 2) middle

<u>Adult male beard</u> display four types:

a) eastern type occurs westwards of the Baksan Valley - monotonously colored, broad, pointed forward, about 8-10 cm long, if pressed to the chin, doesn't extend it; b) in Baksan and, probably, in Malka, the beard is short too, but narrow, and pointed not forward but down; c) in Teberda, the beard is about 12-15 cm, extends chin, is tapered and hanging; d) in the Caucasus Reserve, beard has the same shape as in Teberda, is longer still, up to 17-18 cm, and is dichromatic - its frontal part being dark and contrasting with the light remaining part of the beard. Resembling but smaller beards occur in winter pelage of females in the West Caucasus, unlike the rest of the range, where beards are very rare in females.

Thus, all over the East Caucasus, the shape and size of beard in adult males is about the same, while westwards of Bezengi it gets narrower and longer, and finally obtains dichromatic coloration. Beard in the Caucasus Reserve can be estimated at 4 points, in Teberda 3 points, in Malka and Baksan 2 points, and from Bezengi eastwards 1 point.

Majority of authors, describing head coloration in details, mention that tur, as other *Capra*, display dark striping along the front surface of the legs, not bothering about actual pattern of these stripes (e. g. Dinnik 1909, Tsalkin 1955). Judging by collections and photos, females, young males, yearlings and juveniles in the Caucasus Reserve possess branching pattern of striping both in winter and summer coats (Figure 11a), but adult males have darkened pattern. In Teberda, the branching type is displayed by females, yearlings and juveniles, while young males display both types, and adult males possess only darkened pattern. In winter coats, branching pattern occurs only in females, yearlings and juveniles, but is darkened in all males. In Baksan, branching pattern occurs only in summer pelage and just in yearlings, juveniles and part of females. No males were observed there in summer. In Bezengi, branching pattern occurs only in juveniles in summer pelage, and in North Ossetia and farther eastwards, branching pattern is exceptional even in them (Table 3). Estimates would be: 5 points in Caucasus Reserve, 4 in Teberda, 3 in Baksan, 2 in Bezengi and 1 eastwards (Figure 12).

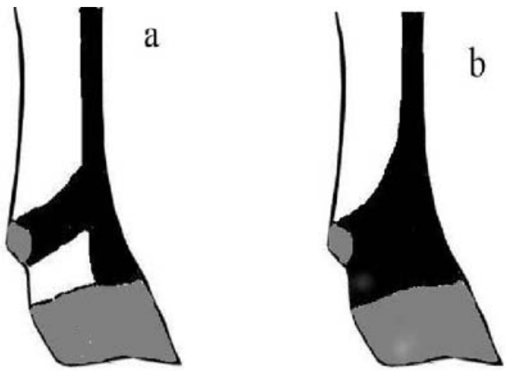

Figure 11. Pattern of stripes on tur legs (a: branching pattern, b: darkened).

Presented results indicate that there definitely are geographic gaps in our material: data are necessary from Arkhyz area situated between Caucasus NR and Teberda (sites 1 and 2 in 13) and, to a lesser extent, also from Chechnya and the easternmost tur distribution area in Azerbaijan, though tur are usually considered morphologically uniform all over Azerbaijan.

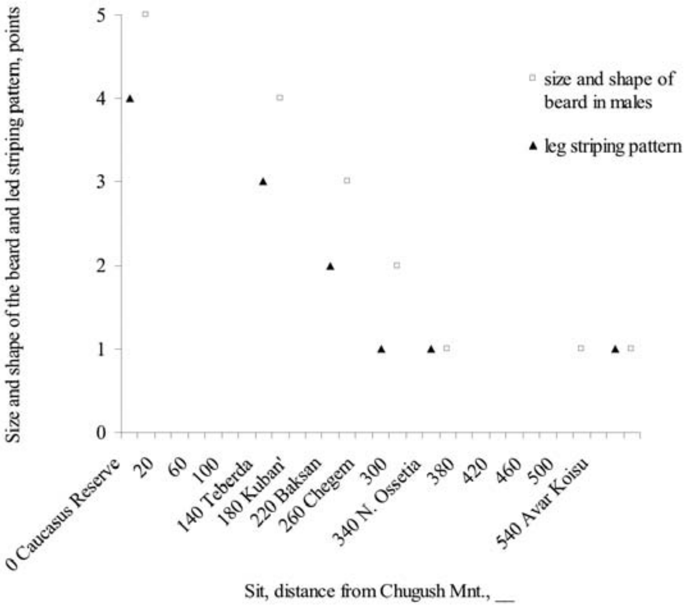

Figure 12 Geographic variaton of size and shape of the beard in males and leg striping pattern in tur.

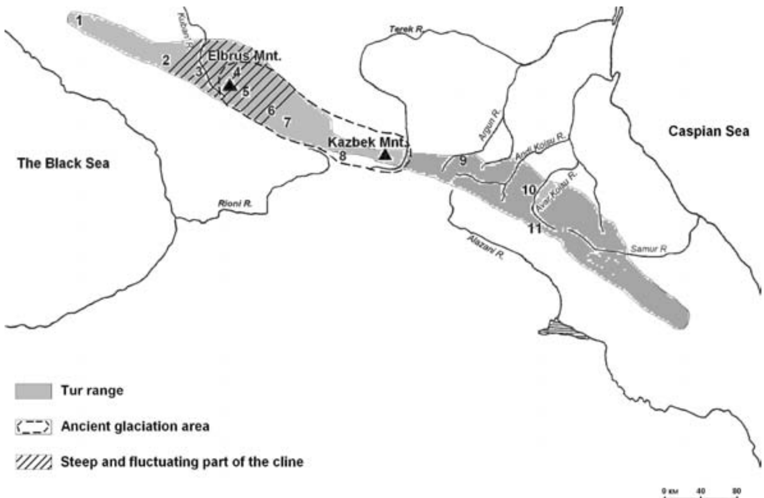

Figure 13. Tur range, area of ancient glaciation and localities of morphological material in the Greater Caucasus (1: Caucasus Reserve, 2: Teberda, 3: Kuban', 4: Malka, 5: Baksan, 6: Chegem, 7: Bezengi, 8: North Ossetia, 9: Chechnya, 10: Avar Koisu, 11: Lagodekhi and Zakatala).

TABLE 3
Distribution of leg striping patterns in tur.

Site	Age and sex groups									
	juveniles		yearlings		females		young males		adult males	
	summer	winter	summer	winter	summer	winter	summer	winter	summer	winter
Caucasus Reserve	+ +	++	+ +		+ +		+ +		– –	– –
Teberda	+ +	+ +	+ +	+ +	+ +	+	+ –	– –	– –	– –
Baksan	+ +	– –	++	– –	+ –	– –		– –		– –
Bezengi	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –
N. Ossetia	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –
Daghestan	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –
Azerbaijan	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –

Note: ++ present in all animals, +– present in part of animals, – – not present, empty slot - no data.

DISCUSSION

Almost all the examined traits display clineal east-west variation, with only two exceptions: position of the highest point of forehead and curvature index in adult male horn sheaths. In cases of clineal variation, there usually are sloping parts of the cline to the west and east (longer one) from the area around the massive of Elbrus Mt., from Teberda or Malka to Chegem, where a steep part of the cline occurs, often with considerable fluctuations within. Tur females also demonstrate resembling clineal variation. Our results correspond to those obtained for spiraling twist in male horn sheaths by Ayunts & Kolomyts (1986) and to some other traits, only treated quantitatively (Tembotov 1974).

Despite noticeable individual variation within local populations around Mt. Elbrus, they are not mixed ones, consisting of western and eastern morphotypes, met in definite proportions changing from west to east (Nasimovich 1950).

All measurable traits (spiraling indices of sheaths for males and females, shape of cross-section of cores in males and angle of divergence of cores in males and females) display strong correlation (R≥0,692 P>0,89). The only measurable trait displaying weak correlation with the rest is the angle of twist of horn sheaths in females.

Clineal geographic variation displayed by several traits, with steep and fluctuating part in the middle does not agree with lumping Caucasian tur into one species with three subspecies (Sokolov 1959, Tembotov 1974), the middle one occurring exactly in the area of 'jump' and fluctuations of the cline. However, multiple and correlating clineal variation in large and actively moving ungulate within a limited range (770 km long and up to 80 km wide) can hardly be explained by geographic dynamics of environmental factors. The shape of the cline is also very telling (short western and long eastern sloping parts with a steep and fluctuating centre), suggesting that this is in fact a pseudo-cline or a secondary cline created by secondary contact and hybridization (Mayr 1968). Since there is one steep part of the cline, contact of just two primary taxa may have occurred, initially separated by one geographic barrier in the Central Caucasus (Weinberg 2006). Most probable barrier would be a mighty glaciation centre which was pulsating during Pleistocene in the area including Mt. Elbrus in the west and Kazbek in the east (Figure 13), partly surviving up to now (Gerasimov & Markov 1939, Kotlyakov & Krenke 1980, Milanovsky 1966, Shcherbakova 1973), and situated where the steep and fluctuating part of the cline occurs. This glaciation centre could periodically separate the all-Caucasus tur population into two and create conditions for evolving of two taxa: the East-Caucasian and West-Caucasian tur.

Pulsating glaciation can also explain hybridization between the two initial taxa because the barrier was not constant and, probably, periods of isolation were insufficiently long. Populations contacted periodically (as now), hybridized and did not evolve mechanisms of effective reproductive isolation for shaping into "good" species. This situation has no parallels within *Capra* (as far as we know) and is valuable for fundamental biology, and also for biodiversity.

If we regard West- and East-Caucasian tur each as separate species, even if not quite "good" (because of suggested hybridization), the first one will assume the name *Capra severtzovi* Menzb., the second one will be *Capra cylindricornis*

Blyth, since name *Capra caucasica* Güld. et Pall. belongs to a hybrid population occurring within the steep part of the cline east of Elbrus (Figure 13). Presented results indicate that West-Caucasian tur – as a "pure and undiluted" morphotype - survives only in the westernmost Greater Caucasus, in the Caucasus NR, where its numbers are noticeably below 5000 now (Romashin 2001).

It should be noted that certain cranial features (including teeth morphology) quite unexpectedly indicate a resemblance between West-Caucasian tur and Spanish goat (*C. pyrenaica*). These data (though partly controversial) allow proposing existence of certain distance between West- and East-Caucasian tur and their origin from different immigration waves (Cregut-Bonnoure 2009). Such an idea has been proposed earlier as well, though usually it was the ibex group to which West-Caucasian tur was considered to be closest morphologically (e. g. Ellerman & Morrison-Scott 1966, Schaller 1977).

Unfortunately, gene sequencing cannot tell recent hybridization yet (Manceau *et al.* 1999, Pidancier *et al.* 2006, Zvychainaya 2008, also personal consultations). Thus, it is now hardly possible to claim having solved tur taxonomy without genetic corroboration.

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