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Anschrift des Verfassers: Dr. Alfred Diener, Fachbereich Biologie, Universität Marburg, Lahnberge, D-3550 Marburg/Lahn

Revision of *Rupicapra* Genus

IV. Horn biometrics of *Rupicapra rupicapra asiatica* and its relevance to the taxonomic position of *Rupicapra rupicapra caucasica*

By S. Lovari[1] and C. Scala[2]

Istituto di Zoologia, Università di Parma, and Istituto di Statistica, Università di Siena, Italy

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Abstract

Compared the horn biometrics of 13 male and 10 female adult Turkish chamois (*Rupicapra rupicapra asiatica* Lydekker, 1908) to assess the relevant sexual dimorphism. Out of 9 different measures, only the transverse and antero-posterior diametres at horn base proved significantly greater in males ($p < .05$). Furthermore, the male horn sample was compared with a sample of 12 adult male Caucasian chamois (*R. r. caucasica* Lydekker, 1910). No variable proved significantly different. Thus, horn biometrics does not allow the separation of these taxa in distinct subspecies, supporting Camerano's (1916) and Kumerloeve's (1975) suggestion that *caucasica* should be grouped with *asiatica*.

Introduction

So far only scant information has been published on the Turkish chamois (*Rupicapra rupicapra asiatica* Lydekker, 1908) (Fig. 1). Couturier (1938) published a short description of the animal itself and its range. Later on Kumerloeve (1967) provided further details on its geographic distribution; he also suggested (Kumerloeve 1974) that the taxonomic separation of the Caucasian chamois (*Rupicapra rupicapra caucasica* Lydekker, 1910) from *asiatica* might be questionable: a point previously made by Camerano (1916) as well. Finally, Huş (1974) published a short report on the general biology of this chamois.

Aim of the present paper is to shed some light on the horn biometrics of *asiatica* and to evaluate statistically the horn differences between this subspecies and *caucasica* for taxonomic purposes.

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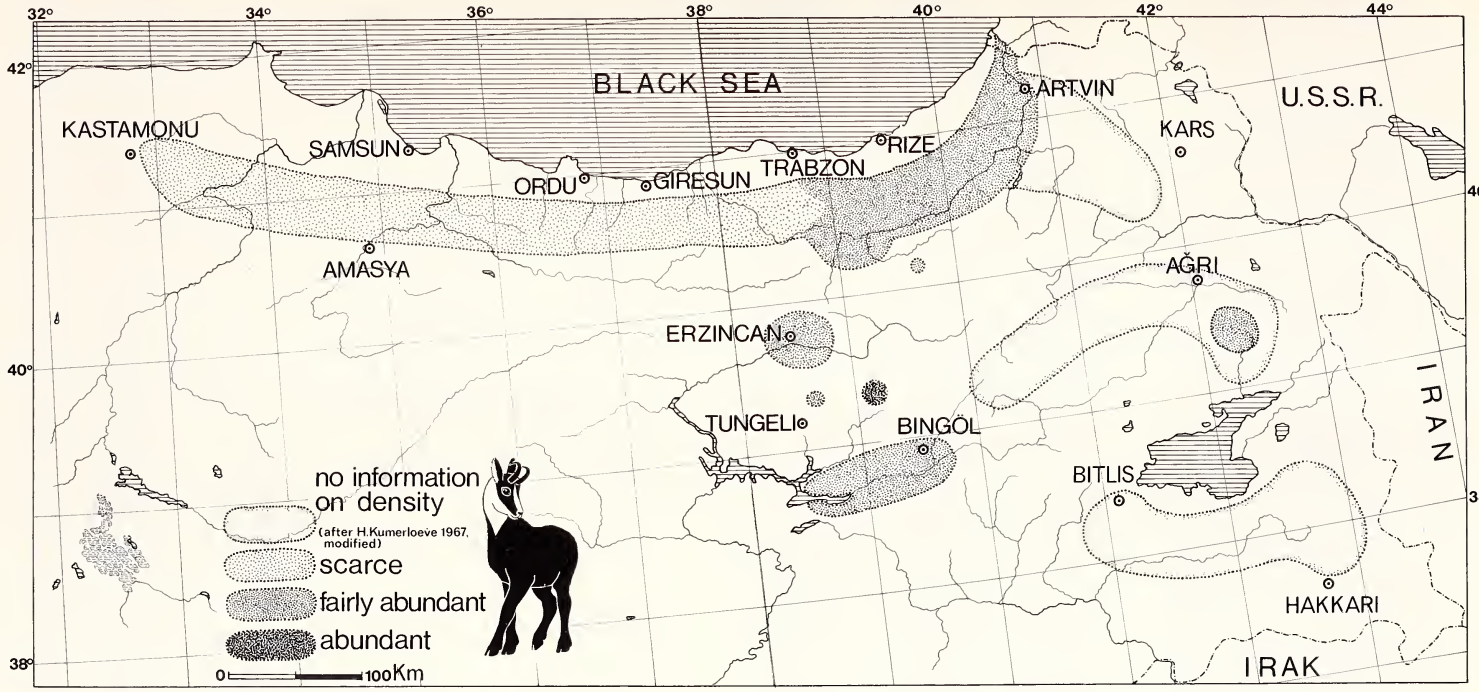

Fig. 1. Distribution range of *Rupicapra rupicapra asiatica* (from literature and original)

Material and methods

We were unable to trace any bone material of *asiatica* chamois in state collections. Relevant measures in literature are also lacking. Thus, we had to depend on the trophies kindly provided by hunters whom we met on an ad hoc journey through Northern Turkey in October 1982. As no whole skull was available, we had to restrict our analysis to horn measurements only. Eventually, we had access to a total of 13 pairs of horns of sexually mature (i.e. ≥ 4 year-old) male and 10 female *asiatica* chamois, which we used for our statistical evaluation. On the other hand, horn measurements of 12 adult males of *caucasica* could be collected partly in museums and partly in literature (Couturier 1938). Only males were used for the taxonomic comparison between *caucasica* and *asiatica* subspecies, as our sample of horns of female Caucasian chamois proved too skimpy to allow any statistical analysis.

The statistical manipulation of data was similar to that reported already in Lovari and Scala (1980) and Scala and Lovari (1984).

Results

The mean age (years) of our sample of *asiatica* males was 5.3 (SD: ± 1.7) whereas it was 6 (SD: ± 1.9) in the *caucasica* sample. Both samples showed the same range values: 4–10 year old individuals.

The basic descriptive statistics of our samples are summarized in Tables 1, 2, 3. Many other statistical measures are not reported here, but they are available on request[1]. Normal and beta-induced probability plots (Gnanadesikan and Ketterning 1972) were drawn for all variables examined to assess the multinormality of the horn systems. Dubious results were obtained and the outcome of statistical tests as well as the related probabilistic inferences should be taken with caution[1].

The analysis of principal components was used on the horn mixed samples (*asiatica* males + *asiatica* females; *asiatica* males + *caucasica* males) to assess the presence of spontaneous clustering (Fig. 2; Fig. 3). Such a technique of analysis allowed a graphic

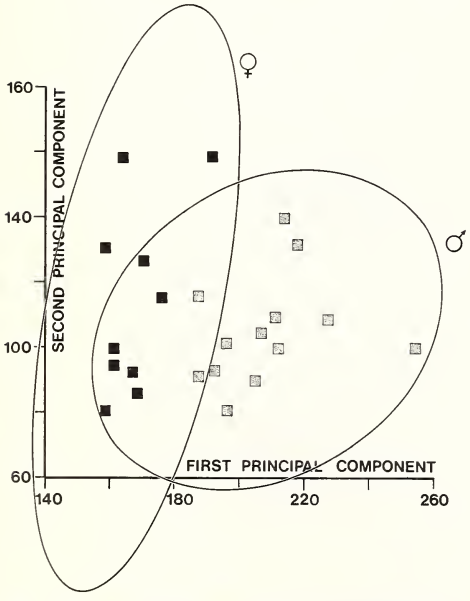

Fig. 2. Principal components scores and related tolerance ellipses of male and female *R. r. asiatica*

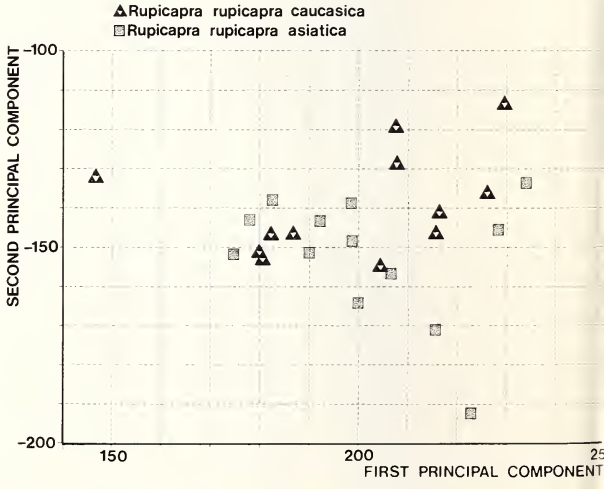

Fig. 3. Principal components scores of *R. r. asiatica* and *R. r. caucasica* males

[1] Statistical details and numerical results may be asked to C.S.

Table 1

Statistical description of horn data of *Rupicapra rupicapra asiatica* males

MIN: minimum value; MAX: maximum value; M01: arithmetic mean; SD: standard deviation; ALF3: coefficient of skewness; ALF4: coefficient of kurtosis. List of variables: 1 = Frontal length of horn; 2 = Distance between horn tips; 3 = Minimum distance between horn tops; 4 = Minimum distance between the medial points of horns; 5 = Minimum distance between horn bases; 6 = Antero-posterior diameter at base; 7 = Transverse diameter at base; 8 = Minimum distance between horn tip and base; 9 = Base circumference

VARIABLES

OBSERVATION MATRIX

Indiv.	1	2	3	4	5	6	7	8	9
1	233.00	62.00	73.00	23.00	12.00	28.00	24.00	125.00	82.00
2	213.00	58.00	52.00	26.00	11.00	28.00	24.00	101.00	81.00
3	270.00	73.00	75.00	27.00	8.00	27.00	24.00	95.00	80.00
4	245.00	72.00	80.00	22.00	8.00	30.00	27.00	123.00	90.00
5	218.00	80.00	71.00	14.00	9.00	26.00	25.00	95.00	80.00
6	203.00	66.00	64.00	25.00	14.00	27.00	26.00	100.00	87.00
7	204.00	62.00	62.00	17.00	9.00	26.00	25.00	109.00	80.00
8	211.00	68.00	70.00	25.00	9.00	29.00	25.00	115.00	85.00
9	230.00	75.00	73.00	26.00	11.00	25.00	24.00	118.00	77.00
10	221.00	50.00	70.00	46.00	22.00	26.00	22.00	112.00	79.00
11	210.00	81.00	69.00	22.00	13.00	26.00	20.00	129.00	73.00
12	227.00	94.00	94.00	20.00	11.00	28.00	27.00	112.00	86.00
13	220.00	96.00	101.00	33.00	14.00	29.00	26.00	116.00	90.00

SUMMARY OF RELEVANT STATISTICS

	1	2	3	4	5	6	7	8	9
MIN	203.00	50.00	52.00	14.00	8.00	25.00	20.00	95.00	73.00
MAX	270.00	96.00	101.00	46.00	22.00	30.00	27.00	129.00	90.00
M01	223.46	72.08	73.38	25.08	11.62	27.31	24.54	111.54	82.31
SD	18.41	13.38	12.77	7.87	3.75	1.49	1.94	11.14	5.04
ALF3	1.11	0.31	0.66	1.20	1.46	0.21	-0.78	-0.12	0.03
ALF4	3.55	2.09	2.89	4.33	4.72	1.70	2.97	1.62	1.94

VARIANCE - COVARIANCE MATRIX

Var.	1	2	3	4	5	6	7	8	9
1	338.93	30.71	79.06	13.71	-20.47	5.26	4.06	-13.26	6.84
2		178.91	134.96	-33.67	-14.30	3.89	8.62	19.04	18.64
3			163.09	11.63	1.49	7.45	10.44	40.52	33.04
4				61.91	23.94	-0.02	-4.79	7.87	0.97
5					14.08	-1.45	-3.10	6.55	-2.53
6						2.23	1.65	3.48	6.14
7							3.76	-5.39	8.40
8								124.10	-2.26
9									25.40

CORRELATION MATRIX

Var.	1	2	3	4	5	6	7	8	9
1	1.00	0.12	0.33	0.09	-0.29	0.19	0.11	-0.06	0.07
2		1.00	0.79	-0.31	-0.28	0.19	0.33	0.12	0.27
3			1.00	0.11	0.03	0.39	0.42	0.28	0.51
4				1.00	0.81	-0.00	-0.31	0.08	0.02
5					1.00	-0.25	-0.42	0.15	-0.13
6						1.00	0.57	0.20	0.81
7							1.00	-0.24	0.85
8								1.00	-0.04
9									1.00

evaluation in a R2 space (first and second principal components) with only a small loss of information, the full space of observations being R8 for asiatica (males and females) and R9 for *asiatica* and *caucasica* (males). Eigenvalues and eigenvectors were calculated on the variance-covariance matrix[1] and tolerance ellipses (95 % level) were traced to compare the *asiatica* males and females (Fig. 2). Through the size (first principal component) and shape (second principal component) vectors it was possible to evaluate the scores of specimens,

Table 2

Statistical description of horn data of *Rupicapra rupicapra asiatica* females
Abbreviations and variables as in Table 1

VARIABLES

OBSERVATION MATRIX

Indiv.	1	2	3	4	5	6	7	8	9
1	187.00	52.00	46.00	9.00	9.00	24.00	20.00	130.00	70.00
2	179.00	64.00	62.00	13.00	9.00	23.00	21.00	112.00	69.00
3	196.00	56.00	50.00	13.00	9.00	25.00	22.00	135.00	78.00
4	186.00	89.00	74.00	37.00	11.00	26.00	21.00	124.00	74.00
5	200.00	87.00	60.00	13.00	7.00	24.00	21.00	134.00	80.00
6	184.00	62.00	61.00	31.00	15.00	23.00	19.00	128.00	67.00
7	196.00	59.00	54.00	16.00	11.00	23.00	20.00	136.00	68.00
8	173.00	85.00	84.00	38.00	14.00	22.00	18.00	123.00	63.00
9	215.00	111.00	93.00	35.00	11.00	23.00	18.00	147.00	64.00
10	185.00	120.00	82.00	23.00	12.00	21.00	18.00	138.00	62.00

SUMMARY OF RELEVANT STATISTICS

	1	2	3	4	5	6	7	8	9
MIN	173.00	52.00	46.00	9.00	7.00	21.00	18.00	112.00	62.00
MAX	215.00	120.00	93.00	38.00	15.00	26.00	22.00	147.00	80.00
M01	190.10	78.50	66.60	22.80	10.80	23.40	19.80	130.70	69.50
SD	11.99	23.75	15.80	11.42	2.44	1.43	1.48	9.65	6.15
ALF3	0.58	0.47	0.30	0.20	0.25	0.18	-0.07	-0.26	0.42
ALF4	2.42	1.61	1.48	1.10	1.86	2.14	1.30	2.34	1.66

VARIANCE- COVARIANCE MATRIX

Var.	1	2	3	4	5	6	7	8	9
1	143.65	69.27	18.04	-12.08	-11.53	3.73	0.80	93.70	17.61
2		563.83	328.44	143.88	9.77	-13.44	-20.55	97.16	-58.05
3			249.60	143.46	17.24	-9.59	-16.64	34.97	-58.44
4				130.40	20.51	-1.79	-9.82	5.37	-33.55
5					5.95	-1.57	-2.48	-1.06	-10.66
6						2.04	1.64	-1.75	7.00
7							2.17	-4.73	8.11
8								93.12	-5.05
9									37.83

CORRELATION MATRIX

Var.	1	2	3	4	5	6	7	8	9
1	1.00	0.24	0.09	-0.08	-0.39	0.21	0.04	0.81	0.23
2		1.00	0.87	0.53	0.16	-0.39	-0.58	0.42	-0.39
3			1.00	0.79	0.44	-0.42	-0.71	0.22	-0.60
4				1.00	0.73	-0.11	-0.58	0.04	-0.47
5					1.00	-0.45	-0.69	-0.04	-0.71
6						1.00	0.77	-0.12	0.79
7							1.00	-0.33	0.89
8								1.00	-0.08
9									1.00

their cartesian coordinates being in R2, and to calculate the parametres of the separate couples of tolerance ellipses[1]. Homogeneous clusterings are apparent only in Fig. 2 and they show a remarkable morphometric difference between *asiatica* males and females. It may be worth pointing out that the clusterings are not disturbed by dubious multinormality and possible eteroskedasticity of samples, whereas ellipses may actually be.

Mahalanobis (squared) distances were calculated within the horn samples, but only the distance between *asiatica* males and females (32.22) proved significant ($p < .05$). Such a significance depends on the variables 6 and 7 (diametres at horn base) as shown by the analysis of simultaneous confidence intervals.

Table 3

Statistical description of horn data of *Rupicapra rupicapra caucasica* males
Abbreviations and variables as in Table 1

VARIABLES

OBSERVATION MATRIX

Indiv.	1	2	3	4	5	6	7	8
1	223.00	86.00	88.00	55.00	10.00	29.50	28.00	106.00
2	211.00	63.00	68.00	21.20	7.40	28.30	26.70	108.00
3	217.00	52.00	60.50	32.500	10.00	26.70	25.20	108.00
4	229.00	72.00	69.00	36.00	10.00	26.00	25.00	118.00
5	203.00	103.00	93.00	49.00	9.00	27.00	26.00	111.00
6	215.00	68.50	50.40	21.30	9.30	24.40	22.50	101.00
7	222.00	85.00	80.80	39.70	9.70	26.40	23.00	104.00
8	228.00	84.00	75.00	45.00	10.00	27.00	24.00	98.00
9	183.00	46.00	41.90	20.40	12.20	23.20	20.70	100.00
10	211.00	59.00	61.40	27.80	12.50	25.20	20.40	123.00
11	205.00	85.00	83.00	27.00	14.40	26.20	22.60	112.00
12	200.00	76.00	86.20	51.80	18.30	23.60	20.70	107.00

SUMMARY OF RELEVANT STATISTICS

	1	2	3	4	5	6	7	8
MIN	183.00	46.00	41.90	20.40	7.40	23.20	20.40	98.00
MAX	229.00	103.00	93.00	55.00	18.30	29.50	28.00	123.00
M01	212.25	73.29	71.43	35.56	11.07	26.12	23.73	108.00
SD	13.20	16.44	15.80	12.47	2.92	1.83	2.50	7.29
ALF3	-0.62	-0.03	-0.36	0.19	1.16	0.04	0.13	0.55
ALF4	2.55	1.90	1.80	1.37	3.52	2.06	1.57	2.30

VARIANCE - COVARIANCE MATRIX

Var.	1	2	3	4	5	6	7	8
1	174.20	65.42	53.76	51.05	-17.58	14.08	16.48	9.18
2		270.29	226.91	140.45	-2.26	12.94	15.20	-1.95
3			249.49	157.49	7.51	14.77	15.94	18.05
4				155.54	7.00	8.01	10.56	-4.62
5					8.54	-3.16	-4.91	2.93
6						3.34	4.11	0.83
7							6.25	-0.67
8								53.09

CORRELATION MATRIX

Var.	1	2	3	4	5	6	7	8
1	1.00	0.30	0.25	0.31	-0.45	0.58	0.49	0.09
2		1.00	0.87	0.68	-0.04	0.43	0.36	-0.01
3			1.00	0.79	0.16	0.51	0.40	0.15
4				1.00	0.19	0.35	0.33	-0.05
5					1.00	-0.59	-0.67	0.13
6						1.00	0.89	0.06
7							1.00	-0.03
8								1.00

Discussion

The antero-posterior and transverse diametres proved to be the only significant variables related to sexual dimorphism within the *asiatica* sample, the males bearing stouter horns than females. On the other hand, Sägesser (1967) and Hrabě and Koubek (1983) for *R. r. rupicapra* and Koubek and Hrabě (1983) for *caucasica* reported a significant sexual dimorphism occurring in other variables as well. Yet, these authors compared independently couples of means for each variable and this is not statistically correct as the

significance level of the overall comparison is actually different from that stated by them. In fact, the correct procedure involves the simultaneous confidence intervals (e.g. Morrison 1967). Thus, their conclusions may be questionable.

On the whole, *R. r. asiatica* shows shorter horns than all other chamois subspecies, but for *parva, pyrenaica* and *caucasica* (cf. Couturier 1938; Koubek and Hrabě 1983; Scala and Lovari 1984).

Lydekker (1910, in Couturier 1938) described *R. r. caucasica* as a separate subspecies on the basis of horn and skull characteristics. The horn features reported by this author as typical of *caucasica* were: **A** – short and stout male horns; **B** – slightly divergent horns; **C** – horns growing at right angles from the frontal bone. Our data (Fig. 3) would indicate that *asiatica* and *caucasica* cannot be separated from each other out of the eight horn variables we compared (inclusive of the **A** and **B** variables used by Lydekker to discriminate between the two chamois groups). Unfortunately the lack of any skull measure for *asiatica* prevented us from drawing any absolute conclusion. However, our data point out that *asiatica* and *caucasica* horn biometrics do not support the separation of these chamois in distinct subspecies.

Acknowledgements

We are indebted to P. Cemal and to the other members of the Hunting Club in Trabzon for providing information on the distribution range of the chamois in Turkey. In particular, grateful thanks are due to H. Pirselimoğlu whose precious help and trophy collection proved most useful. M. Serez and the Department of State Forestry (Trabzon) provided us with facilities and valuable information. Juliet Clutton-Brock, British Museum (Nat. Hist.), London, and R. Kraft, Zoologische Staatssammlung, München, kindly allowed us to measure horns and skulls of Caucasian chamois preserved in their collections. A. Giani and F. Parlanti helped greatly in computer data processing and Antje Fischer translated the German summary. Finally, we wish to thank A. Vigna-Taglianti who helped and encouraged us in many different ways throughout our data collection.

Zusammenfassung

Revision der Gattung Rupicapra IV. Gehörnbiometrie von Rupicapra rupicapra asiatica und ihre Bedeutung im Zusammenhang mit der taxonomischen Position von Rupicapra rupicapra caucasica

Vergleiche der Gehörnbiometrie von 13 männlichen und 10 weiblichen erwachsenen türkischen Gemsen (*Rupicapra rupicapra asiatica* Lydekker, 1908) wurden zur Untersuchung des Geschlechtsdimorphismus durchgeführt. Von 9 verschiedenen Maßen waren nur der Durchmesser an der Hornbasis in der Breite und von vorn nach hinten bei den Männchen signifikant größer ($p < .05$). Außerdem wurden die Gehörne der Böcke mit den Gehörnen von 12 erwachsenen kaukasischen Böcken (*R. r. caucasica* Lydekker, 1910) verglichen. Kein Merkmal war signifikant verschieden. Demzufolge erlaubt die Gehörnbiometrie keine Differenzierung dieser Taxa in verschiedene Unterarten, was die Annahme von Camerano (1916) und Kumerloeve (1975) bestätigt, daß *caucasica* mit *asiatica* gleichzustellen ist.

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Authors' addresses: Sandro Lovari, Istituto di Zoologia, Strada dell'Università 12, I-43100 Parma, Italy; Claudio Scala, Istituto di Statistica, Università di Siena, Piazza S. Francesco 17, I-53100 Siena, Italy

BEKANNTMACHUNGEN

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There will also be Special Interest Symposia on other topics, as well as sessions for contributed papers, films and poster papers.

For further information write to: Professor Barry Cox, ICSEB Congress Office, 130 Queen's Road, Brighton, Sussex DN1 3WE, UK.

Die Internationale Kommission für Zoologische Nomenklatur teilt mit:

The following Opinions have been published by the International Commission on Zoological Nomenclature in the Bulletin of Zoological Nomenclature, vol. 40, part. 4, on 30 December, 1983:

Opinion No.

1263 (p. 202) *Prototomus viverrinus* Cope, 1874 (Mammalia): refusal to designate a neotype under the plenary powers.

Bulletin of Zoological Nomenclature, vol. 41, part 1, on 29 March, 1984:

Opinion No

1268 (p. 17) *Simia leucophaea* F. Cuvier, 1807 (Mammalia, Primates): suppression of two senior synonyms.