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SEX IDENTIFICATION AND SEXUAL DIMORPHISM IN THE SKULL OF THE STONE MARTEN, *MARTES FOINA* (CARNIVORA, MUSTELIDAE)

IDENTIFICAZIONE DEL SESSO E DIMORFISMO SESSUALE NEL CRANIO DELLA FAINA, *MARTES FOINA* (CARNIVORA, MUSTELIDAE)

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ABSTRACT

Morphometric variation in 62 characters of 84 skulls of *Martes foina* from Italy was anaiyzed. Stepwise discriminant analysis was used to estimate three discriminant functions as craniometric keys for sex determination. The first two keys were based on absolute measurements, the third on absolute and relative measurements. This last key seems to be the best and provides 89.8 % correct classification for males and 91.4% for females. Parametric or nonparametric univariate methods, cluster analysis of cases, and principal component analysis (PCA) were used to investigate morphological differences between skulls of males and females. In *Martes foina* the sexual dimorphism is more due to the size than to the shape, unlike other Mustelids. The size dimorphism was shown to be related to the measurements of the masticatory apparatus, like in other Mustelids.

Key words *Martes foina*, Mustelidae, Morphometrics, Sexual dimorphism, Italy.

RIASSUNTO

Sono state analizzate statisticamente le variazioni morfometriche di 62 parametri su 84 crani di *Martes foina* provenienti da collezioni museali italiane. L'analisi discriminante "stepwise" è stata utilizzata per calcolare tre funzioni discriminanti quali chiavi craniometriche per l'identificazione del sesso. Le prime due chiavi sono basate su misurazioni assolute, la terza su misurazioni sia assolute che relative. Quest'ultima chiave sembra essere la migliore e fornisce nell'89,8% dei casi una corretta classificazione degli individui di sesso maschile e nel 91,4% dei casi degli individui di sesso femminile. L'analisi univariata di tipo paramctrico o non parametrico e l'analisi dei "cluster" dei casi e della componente principale (PCA) sono state utilizzate per valutare le differenze morfologiche esistenti tra i crani delle femmine e dei maschi. In *Martes foina* il dimorfismo

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sessuale è dovuto alle dimensioni più che alla forma, a differenza di altri Mustelidi. Si è osservato che tale dimorfismo nelle dimensioni può essere correlato con le misure relative all'apparato masticatorio, come in altri Mustelidi.

Parole chiave: *Martes foina*, Mustelidae, Morfometria, Dimorfismo sessuale, Italia.

INTRODUCTION

Sex identification is generally done from primary sex characters. When these characters are missing the variation in size between males and females can be used for a correct classification. There is very often a certain overlapping in size between sexes. Hence it is impossible to carry out a craniometrical investigation on museum collections having specimens with unknown sex (e.g. Zoological Museum of the University of Turin) or specimens with broken skulls.

Multivariate analysis based on many measurements can work out discriminant functions based on few measurements. Systems of craniometric indices have been developed by means of multivariate analysis only on specimens of Pine marten (*Martes martes* L.) and Stone marten (*Martes foina* End.) from Bulgaria (Gerasimov, 1985).

The purpose of this study was to develop craniometrical keys for sex identification of skull of *Martes foina* from Italy. Sexual dimorphism was also analysed. This is a characteristic feature of the family of Mustelidae (Moors, 1980), and that is more developed in *Mustela* than in *Martes* species.

Comparisons of skeletal measurements between sexes, particularly from skulls, have been carried out in various *Martes* species in different parts of their distribution ranges in Europe but not in Italy (Yurgenson, 1947; Rossolimo & Pavlinov, 1974; Gerasimov, 1983, 1985; Douma-Petridou, 1984; Marchesi, 1989; Reig & Ruprecht, in press).

METHODS

The study was based on 62 parameters as defined by Gerasimov (1983). The material consisted of the skulls of 84 italian specimens of *Martes foina* from Natural History Museum of Friuli in Udine (27 males and 13 females), Civic Museum of Natural History in Genoa (7 males and 8 females) and Zoological Museum of the University of Florence "La Specola" (16 males and 13 females). The specimens were collected in the following regions: Friuli-Venezia Giulia, Liguria, Toscana and Valle d'Aosta. For a faunistic list see Tab. 1.

Tab. 1 — List of the examined specimens of *Martes foina* Erxleben, 1777.
Elenco degli esemplari *esaminati di* Martes foina *Erxleben, 1777.*

NO. OF INVENTORY	SEX	LOCALITY (REGION OR PROVINCE CODE)	DATE OF CAPTURE
		MUSEO FRIULANO DI STORIA NATURALE - UDINE	
237	f	S.Vito di Fagagna (UD)	15/XI/79
441	f	Villanova dello Judrio (UD)	15/V/86
462	f	Feletto Umberto (UD)	14/V/85
476	f	Ceresetto di Martignacco (UD)	8/VIII/85
495	f	Canebola, Faedis (UD)	17/VII/84
507	f	(Friuli)	
668	f	Sequals (PN)	1/XI/84
L668	f	Sequals (PN)	1/XI/84
713	f	Mte Gemoia (PN)	VIII/87
714	f	Luvigliano (PN)	1987
735	f	Redipuglia (GO)	12/I/88
845	f	Attimis (UD)	
	f		
80	m	Branco (UD)	III/79
113	m		24/IV/68
356	m	Colloredo di Mte Albano (UD)	VIII/82
448	m	Moruzzo (UD)	28/IV/80
449	m	Susans (UD)	14/IX/87
461	m	Udine	4/VIII/82
502	m	Savergnano dei Torre (UD)	4-5/XI/85
505	m	Sedegliano (UD)	
506	m	(Friuli)	
555	m	S. Pietro del Natisone (UD)	I/86
562	m	Faedis (UD)	30/III/87
563	m	Savergnano dei Torre (UD)	25/III/86
564	m	Pagnacco (UD)	1/III/86
649	m	Arcano sup. (UD)	15/III/87
653	m	Resiutta, Moggio Udinese (UD)	15/VI/86
656	m	Campeglio, Faedis (UD)	IX/85
670	m	Arcano sup. (UD)	15/IV/87
701	m		
742	m	Attimis (UD)	25/X/87
743	m	Lumignacco (UD)	14/XI/87
774	m	Orcenico (PN)	15/XI/80
794	m	Segnacco (UD)	12/IX/88
800	m	Oborza (UD)	3/XI/88
846	m	Attimis (UD)	
	m	(Friuli centrale)	
	m	Sammardenchia di Tarcento (UD)	198711988
	m	Sammardenchia di Tarcento (UD)	198711988

Tab. 1- Continued.

MUSEO CIVICO DI STORIA NATURALE - GENOVA			
1150	f	Toirano (SV)	1908
1159	f	Genova	28/II/1889
1163	f	Toirano (SV)	14/X/1908
10323	f	Toirano (SV)	1908
10333	f	Cascineiie (SV)	20/VII/1909
10339	f	Toirano (SV)	24/XI/1908
10510	f	Appennino ligure,Selva Vobbia	22/III/68
44621	f	Arenzano (GE)	III/74
1155	m	Genova	
1161	m	(Liguria)	
2842	m	Albenga (SV)	
10321	m	Cascineile (SV)	1912
10329	m	Valenzona (Appennino ligure)	28/XI/1908
10335	m	Toirano (SV)	21/XI/1900
10341	m	Toirano (SV)	31/III/1909
MUSEO ZOOLOGICO DELL: UNIVERSITA' "LA SPECOLA? - FIRENZE			
4161	f	Tenuta di Castelfalfi (FI)	III/67
5567	f	Minucciano (LU)	3/IX/61
6833	f	Trespiano (FI)	3/IV/1900
7697	f	S. Giustino Valdarno (AR)	IV/73
7957	f	Val Gressoney (AO)	19/XII/73
8101	f	S. Giustino Valdarno (AR)	29/IV/74
8218	f	Weissmatten, Val Gressoney (AO)	24/III/75
8219	f	Weissmatten, Val Gressoney (AO)	4/XI/74
8812	f	Gressoney (AO)	IV/77
9425	f	Val Gressoney (AO)	22/XI/79
9426	f	(Alta Val d'Aosta)	1979
11794	f	Grassina (FI)	2/V/1900
12321	f	Scopeti (FI)	10/VIII/1899
3543	m	S. Casciano (FI)	15/IX/64
4170	m	Torniano (SI)	23/I/66
6511	m	Rignano sull'Arno (FI)	14/X/69
6589	m	Weissmatten,Gressoney (AO)	4-10/XI/70
6831	m	Monteripaldi (FI)	4/VIII/189
6832	m	Soffiano (FI)	20/XI/1900
7939	m	Weissmatten,Gressoney (AO)	15/II/73
8102	m	S.Giustino Valdarno (AR)	21/IX/74
8217	m	Weissmatten,Gressoney (AO)	5/XII/74
8242	m	S. Giustino Valdarno (AR)	1975
8243	m	S. Giustino Valdarno (AR)	1975
8244	m	S. Giustino Valdarno (AR)	1975
9878	m	Bagno a Ripoli (FI)	3/I/83
11795	m	Badia a Passignano (FI)	10/VIII/1904
12322	m	Borgo S. Lorenzo (FI)	10/XII/1899
12323	m	Calci (PI)	23/VIII/1902

The skull measurements were recorded to the nearest 0.01 mm by a digital caliper.

The statistical analysis was performed using BMDP software (Dixon, 1981): BMDP3D and BMDP3S for. univariate analyses, BMDP7M for stepwise discriminant analysis, BMDPKM for cluster analysis of cases, and BMDP4M for factor analysis (PCA with standardization of variables and with varimax rotations). BMDPAM (stepwise multiple regression) was applied to fill few gaps in the data matrix, due to some partially broken skulls.

RESULTS

UNIVARIATE ANALYSIS

Development of the sagittal crest is considered as one of the features that allows to distinguish between subadults and adults in most species of Mustelidae (Gerasimov, 1983; Wiig,1986; Blandford,1987; Reig & Ruprecht,1989). For a preliminary study, the material was divided into groups having or not such a feature. Using a t-test (or if necessary, a Wilcoxon-Mann-Whitney test) 22 parameters were found to be significantly different in the means (or medians) of the corresponding groups. Hence only the remaining 40 parameters were used for further analysis (Tab. 2).

Males were significantly bigger than females for all measurements used, except for foramen mentales interval (V62). The level of significance for almost all the variables is 0.01 or even higher, except for postpalatal length (V4), foramen magnum superior and protuberantia occipitalis externa interval (V27), foramen magnum height (V29), and os nasale length (V59) where the significance level is between 0.01 and 0.05.

MULTIVARIATE ANALYSES

These analyses were performed in order to distinguish between the two sexes on the basis of the whole complex of variables.

Cluster analysis of cases was applied on the whole data matrix with no a priori information about sex. Nevertheless, the two groups (clusters) were formed predominantly by individuals of the same sex, except for 5 males and 10 females.

Stepwise discriminant analysis allowed to obtain different keys for classifying the skulls into males or females. The first is based on the meatus auditorius externus width (V19), the braincase height per bullae

Tab. 2 – Means (x) and standard errors of means (S.E.M.) of the 40 parameters used for samples of males and females of *Martes foina* in Italy. Numbers of parameters are the same as in Gerasimov (1983).
Medie (x) ed errori standard delle medie (S.E.M.) relativi ai 40 parametri valutati sui campioni di maschì e di femmine di Martes foina *in Italia. I numeri che contrassegnano ciascun parametro sono gli stessi utilizzati da Gerasimov (1983).*

MEASUREMENT	Males (n = 49) $\bar{x}$ ± S.E.M.	Females (n = 35) $\bar{x}$ ± S.E.M.
Palatal length (Vi)	39.35-0.199	37.32-0.250
Palatal length incl. proc. hamulus (V2)	50.79-0.243	48.33-0.246
Spina nasalis and proc. hamulus interval (V3)	12.52-0.090	12.09-0.111
Postpalatal length (V4)	34.56-1.246	33.99-0.937
For.infraorb. and cond.occipit. interval (V5)	61.29-0.266	59.29-0.253
For.infraorb. and os maxillae interval over M1 (V6)	9.65-0.099	9.05-0.097
For.infraorb. width (V8)	21.84-0.127	20.56-0.111
Posterior zygomatic width (V13)	37.46-0.180	35.97-0.191
Condyiar width (V16)	19.85-0.102	19.13-0.113
For. jugulares width (V17)	18.83-0.102	18.24-0.107
For. carotici width (V18)	11.98-0.086	11.44—0.m
Meatus auditorius ext. width (V19)	35.02-0.205	33.00-0.227
For. ovales width (V20)	12.59-0.078	12.27-0.084
Smallest palatal width (V21)	9.77-0.064	9.24-0.071
Largest palatal width (V22)	22.65-0.120	22.52-0.133
Palatal width between C1 (V23)	9.55-0.080	9.04-0.082
Skull height behind M1 (V24)	23.01-0.100	21.86-0.131
Braincase height between bullae osseae (V25)	28.05-0.110	26.46-0.162
Braincase height per bullae osseae (V26)	30.90-0.127	29.36-0.147
For.magn.sp. and protub.occipit.ext.interval (V27)	12.13-0.114	11.71-0.155
For. magn. width (V28)	12.04-0.075	11.57-0.093
For. magn. height (V29)	9.29-0.064	9.08-0.059
Premolars P4 width (V35)	27.83-0.137	26.26-0.16
Maxillary teeth-row length (V36)	33.37-0.152	31.83-0.157
C1 length (V39)	4.27-0.033	3.81-0.042
P4 length (V41)	8.72-0.050	8.09-0.067
Total mandible length (V43)	52.63-0.247	50.13-0.282
Mandible height (V44)	24.05-0.179	22.64-0.174
Mandible height from proc.cond.inf. (V45)	20.27-0.142	19.27-0.166
Mandible cond. width (V46)	10.99-0.097	10.09-0.087
Mandibular teeth-row lengih (V47)	34.38-0.160	32.84-0.185
Mandibular body width at alveoli C1 (V48)	9.22-0.091	8.72-0.085
Skull-cap length (V49)	83.35-0.360	79.57-0.372
Total skull length (V54)	81.45-0.330	78.68-0.321
Condylobasal length (V55)	80.88-0.333	78.20-0.322
Basal length (V56)	74.09-0.317	71.32-0.303
Face length (V58)	37.17-0.198	35.59-0.192
Os nasale length (V59)	15.21-0.232	14.37-0.242
M1 width (V60)	8.55-0.049	8,03-0.051
For. mentales interval (V62)	2.78-0.060	2.70-0.089

osseae (V26) and **P4** length (V41) and provided a **89.8 %** correct classification for males and a **88.6 %** for females.

The classification functions are **as** follows:

M1 = 10.72175 x V19 + 29.56931 x V26 + 26.64568 x V41 - 761.36231

for males and

F1 = 10.05932 x V19 + 28.45197 x V26 + 23.67642 x V41 - 680.20685

for females.

To use the key in practice, one has to substitute the measured (individual) values for **V19, V26** and **V41** and assign the specimen to the group, showing higher value for its function (i.e., M1 > F1 for a male and vice versa). The discrimination between sexes is shown on Fig. 1, representing the key in terms of a canonical variable, standardized by the pooled within group variances.

Another discriminant key was based on the postpalatal length **(V4),** the premolars **P4** width (V35) and the skull-cap length (V49), and provided 85.7 % correct classification for both males **and** females.

It can be defined by means of the following functions:

M2 = 9.12083 x V4 + 15.44333 x V35 + 8.10985 x V49 - 711.14624

F2 = 10.27946 x V4 + 14.22729 x V35 + 7.31129 x V49 - 652.90351

for males and females, respectively.

In an attempt to improve the discrimination between sexes, 28 relative indices were constructed by dividing each variable by the condylobasal

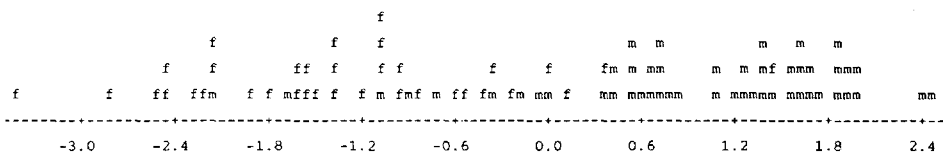

Fig. 1 – Scores of specimens of *Martes foina* along the canonical variable of the first discriminant key. Males are denoted by "m", while females by "P.

Relazioni esistenti tra gli esemplari di* Martes foina *e la variabile canonica della prima chiave discriminante. I maschi vengono indicati con "m" mentre le femmine con "f".

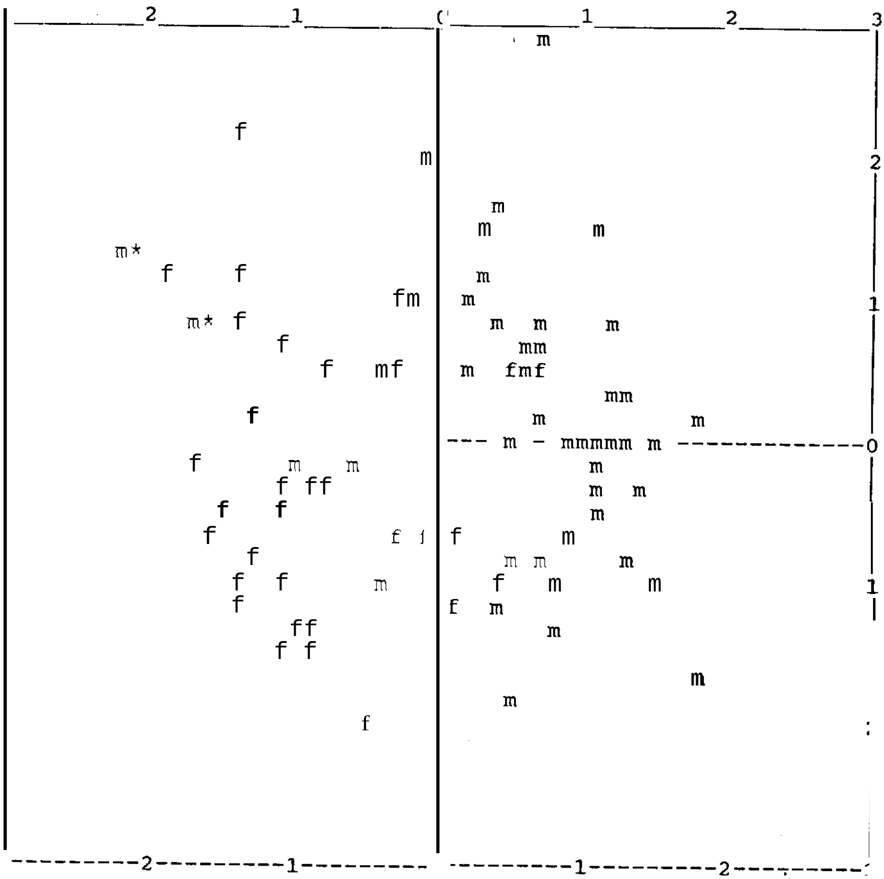

Fig. 2 – Factor scores or specimens of *Martes foina* with respect of sex (x axis, factor 1) and skull-shape (y axis, factor 2), obtained by a factor analysis. Males are denoted by "m" and females by "f".

Relazioni esistenti tra gli esemplari di Martes foina *tenendo conto del sesso (asse x, fattore 1) e della forma del cranio (asse y, fattore 2), ottenuti attraverso un' analisi dei fattori. I maschi vengono indicati con "m" mentre le femmine con "f".*

length, except C1 and **P4** lengths, M1 width, total **skull** length and all measurements regarding the mandible, for which such a procedure seemed meaningless. On the basis of both absolute and relative measurements a third key was obtained providing 89.8 % correct classification for males and **91.4 %** for females.

The functions are as follows:

M3 = 32.86684 x V25 + 52.11676 x V39 + 1967.80164 x V19 / V55 + 8885.32227 x V49 / V55 - 5577.35156

F3 = 31.13843 x V25 + 45.31976 x V39 + 1913.83459 x V19 / V55 + 8775.6543 x V49 / V55 - 5367.4126

for males and females, respectively.

The three keys above showed a very high statistical significance **(P** < 0.0005).

An important practical advantage of the stepwise discriminant analysis **is** that it provides keys involving only few measurements (e.g., **3** or *5* in our case). However, neither "factors" that explain the variability in the data can be drawn, nor the significance of all the parameters applied in the multivariate analysis can be estimated. For these purposes **a** factor (in this case a **PCA)** analysis based on both absolute and relative measurements was performed. The results presented below are for only two factors (Fig. 2). The first factor explained **as** much **as 77.5 %** of the total variance in the factor space, while the second one was responsible for only 22.5 %. The former could strongly be related with sex (see Fig. **2)** and involved only absolute measurements (Tab. 2). Males on the left part of Fig.2 are the same specimens which have been wrongly classified by the discriminant keys. These specimens, coming from the Museum "La Specola", Florence, had been captured more than 80 years ago. The second factor, instead, **was** based on relative measurements, mostly widths and was connected with the shape of the skull, not showing relation with the sex (Fig. 2).

The importance of variables used for sexual dimorphism was evaluated by means of the factor loadings on the first factor (Tab. **3).** Taking in consideration the three different dimensions of the skull (length, width and height) one could suggest the lengths playing a more significant role in the sexual dimorphism observed, then most of the parameters describing skull widths and heights. General skull lengths (total **V54,** skull-cap **V49,** basal **V56,** and condylobasal **V55)** showed loadings higher than 0.95, followed by palatal **(V2)** and maxillary teeth-row **(V36)** lengths, and by different measurements of the mandible **(V43, V47).** With loadings **on** factor one between **0.7** and 0.8 appeared measurements taken on the anterior part of the skull palatal widths (V21, V22), **P4** and C1 lengths **(V41, V39).** In general, measurements taken on the posterior part of the

Tab. 3 – Factor loadings on the first two factors based on skull measurements of *Martes foina* from Italy (only values above 0.5 for at least one of the factors are given in decreasing order).
Relazioni esistenti tra i primi due fattori e le misurazioni effettuate su crani di* Martes foina *provenienti dall' Italia (soltanto i valori superiori a 0.5 per almeno uno dei fattori vengono indicati in ordine decrescente).

No. Measurement	Description	Factor 1 'sex"	Factor 2 "shape"
v54	length	0.963	0.000
v49		0.959	0.000
V56		0.956	0.000
V55	"	0.952	-0.253
v2		0.949	0.000
V36		0.922	0.000
V5		0.917	0.000
v43		0.913	0.000
V1		0.890	0.000
v47		0.872	0.000
V24	height	0.869	0.000
V44		0.859	0.000
v45		0.825	0.000
V58	length	0.819	0.000
V46	width	0.807	0.000
V8		0.802	0.261
v35		0.789	0.393
V26	height	0.787	0.000
v21	width	0.785	0.270
V13		0.764	0.347
v39	tooth length	0.757	0.000
V41		0.757	0.000
V22	width	0.734	0.401
v4	length	0.725	-0.338
V25	height	0.724	0.000
V19	width	0.695	0.376
V16		0.649	0.000
V23		0.645	0.333
V48		0.621	0.000
V17		0.590	0.274
V18	"	0.576	0.000
v3	length	0.560	0.000
V20	width	0.551	0.285
V6	length	0.500	0.000
V35/V55	width	0.000	0.759
V22/V55		0.000	0.731
V13/V55		0.000	0.729
V19/V55		0.000	0.666
V8/V55	"	0.000	0.608
V21/V55	'	0.293	0.557
V23/V55		0.000	0.551
V17/V55		0.000	0.547
V16/V55		0.000	0.522
V24/V55	height	0.000	0522
V26/V55		0.000	0521
V28/V55	width	0.000	0518
V20/V55		0.000	0.511
V25/V55	height	0.000	0509

skull had less importance in determining differences between sexes than the ones from the anterior part. The construction of a third factor did not give further information with respect of sexual dimorphism, since it explained shape variation in the same manner like the second factor above but only in the posterior part.

DISCUSSION

Univariate analysis showed highly significant differences between the means for males and females in all but one measurements. The evaluation of them by a t-test is close to the one of Gerasimov (1983). In all the results from the multivariate analyses clearly appeared outliers in the data, which did not permit to obtain neither a good clustering by sex, nor 100% discrimination keys, nor total correspondence between sex and the first factor. The importance of outliers is well known in *Martes* sp. (Reig, 1989) and other Mustelids (Buchalczyk & Ruprecht, 1977). In relation to the existence of some strong outliers (marked by an asterisk on Fig. 2) one could suggest that the sex of some individuals (Nos. 6832, 12322), collected during the last two years of the 19th century, could had been recorded incorrectly, in the course of several revisions of the collection in the Museum "La Specola", Florence (Tab. 1).

The results of the stepwise discriminant analysis can be used to classify individuals with unknown sex, by means of three craniometric keys based on either absolute measurements, or both absolute and relative measurements.

Both cluster analysis and factor (PCA) analysis showed that sexual differences appear to be the main source of variation in our data. Sexual dimorphism is more related to absolute measurements and not much to relative measurements of the skull. The present results show hence that sexual dimorphism in the skull of *Martes foina* is due more to the size than to the shape, whereas in some other species of Mustelidae (*Lutra lutra* L., *Meles meles* L.) most of the differences between sexes are due to the shape of the skull (Wiig, 1986). Among the measurements determining the size-related sexual dimorphism, most of the lengths used are more important, when compared with the widths or the heights of the skull. This is in agreement with the findings of Gerasimov (1983) for *Martes* sp. in Bulgaria. Masticatory apparatus represents the region of the skull reflecting mostly sexual dimorphism like in other Mustelids (Yurgenson, 1947; Wiig, 1986; Reig & Ruprecht, in press).

Further studies on feeding behaviour of *Martes foina*, above all in Italy, could demonstrate if the sexual dimorphism is based on the exploitation of different food resources or on different reproductive roles of the sexes in the **mating** system, in relation to the two theories for the adaptive significance of sexual dimorphism in Mustelidae (Erlinge, **1979;** Moors, **1980).**

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REFERENCES

BLANDFORD, P.R.S. **1987.** Biology of the Polecat ***Mustela putorius***: a literature review. Mamm. Rev., **17 (4): 155-198.**

BUCHALCZYK, T. & A.L. RUPRECHT. **1977.** Skull variability of ***Mustela putorius*** Linaeus **1758.** Acta Ther., **22 (1): 87-120.**

DIXON, **W.J.** (ed.). **1981.** BMDP Statistical Software. University of California Press, Berkeley, Los Angeles, **727** pp.

DOUMA-PETRIDOU, E. **1984.** Contribution to the knowledge of ***Murtes foina*** Erxl. (Mammalia, Carnivora) from Achaia, Northern Peloponnesus Greece and rest southern Balkan Peninsula. Mammalia, 48 **(4): 564-572.**

ERLINGE, **S. 1979.** Adaptive significance of sexual dimorphism in weasels. Oikos, 33 **233-245.**

GERASIMOV, **S. 1983.** Specific pecularities and sexual demorphism of cranial measures of ***Martes murtes*** L. and ***Murtes foina*** Erxl. (Mammalia, Mustelidae) from Bulgaria. Acta zool. bulgarica, **22: 9-18** (in bulg.).

GERASIMOV, **S. 1985.** Species and sex determination of ***Murtes murtes*** and ***Martes foina*** by use of systems of craniometrical indices developed by stepwise discriminant analysis. Mammalia, **49 (2): 235-248.**

MARCHESI, P. **1989.** Ecologie et comportement de la Martre (***Martes martes*** L.) dans le Jura Suisse. Doct. thesis, Univ. of Neuchatel.

MOORS, P.J. **1980.** Sexual dimorphism in the body size of Mustelids (Carnivora): the roles of food habits and breeding systems. Oikos, 34: **147-158.**

REIG, **S. 1989.** Errors and misjudgements of outliers in morphometric studies. Fifth Intern. Ther. Congress (Rome, **22-29** August **1989),** Abstracts of papers and posters, vol. **II: 909-910.**

REIG, S. & A.L. RUPRECHT. (in press). Craniological variability of ***Murtes murtes*** and ***Martes foina*** from Poland. Acta Ther.

ROSSOLIMO, O.L. & I.Y. PAVLINOV. **1974. Sex** dimorphism in the development, size and the proportions of the skull in the pine marten (***Martes murtes*** L.: Mammalia, Mustelidae). In: King, C.M. (ed.), **1980.** Biology of Mustelids: some soviet research. British Lending Division. Vol.2 **180-191.**

WIIG, O. 1986. Sexual dimorphism in the skull of minks ***Mustela vison***, badgers ***Meles meles*** and otters ***Lutra lutra***. Zool. **J. Linn. Soc., 87: 163-179.**

YURGENSON, P.B. **1947.** Sexual dimorphism in feeding as an ecological adaptation of a species. In: King, C.M. (ed.), **1980.** Biology of Mustelids: some soviet research. British Lending Division, **1: 79-83.**