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SEXUAL DIMORPHISM IN BODY SIZE AND SHAPE IN PAVLOVIAN UPPER PALEOLITHIC GROUP: A POPULATION APPROACH

ABSTRACT: Pavlovian skeletal remains (DV 3, 13 to 16 and Pavlov 1) represent one of the largest and best preserved Upper Paleolithic human samples, permitting analysis of their body size, body shape and sexual dimorphism. To assess these, we have estimated stature, body mass, skeletal ponderal indexes plus epiphyseal and diaphyseal robusticity and shape from their long bones for these individuals and other earlier Upper Paleolithic human remains. Stature was computed as a mean value of 8 most reliable equations using femoral (6 equations) and humeral (2 equations) lengths only. Body mass was estimated on the basis of the femoral head, subtrochanteric, distal femoral, proximal and distal tibial products, and as a function of body height. BMI and Rohrer's indexes expressing general shape of the body were computed. The first step was the characterization of the Pavlovian sample using these parameters. Unfortunately, there are four undoubtedly male skeletons (DV 13, DV 14, DV 16 and Pavlov 1), one clearly female skeleton (DV 3) and one pathological individual of uncertain sex (DV 15). The males are relatively tall and slim. DV 3 and 15 are significantly smaller. DV 3 is relatively gracile. DV 15 is significantly more robust than the males. Despite many pathological features DV 15 is remarkably similar to the Sungir 3 girl which supports a female diagnosis of this pathological individual. To assess sexual dimorphism we compared the Pavlovian remains with the Předmostí sample. Předmostí males are smaller and more gracile. Both DV 3 and DV 15 do not differ significantly from the Předmostí females. However, the Předmostí females are relatively gracile but they are significantly more robust in comparison with the Předmostí males. Similarly, as in the Pavlovian sample, there is one unusually slim female (late adolescent Předmostí 5). To assess variability in body size and shape of the Moravian Gravettian populations, we compared the Central European and Mediterranean Gravettian samples. The Mediterranean Upper Paleolithic populations were probably taller and somewhat more robust but the direction of sexual dimorphism is the same. There are also hyper-robust females and one very slim female in the Mediterranean sample. The specific character of sexual dimorphism, i. e. small robust and hyper-robust females, was probably caused by the strong sexual selection of the somatotype. One model to explain the presence of slim females and the origin of the unusual robusticity can be based on our study of ontogeny of macaques and apes, in which the timing and rate of the adolescent growth spurt can have profound effects on body build. Such variance in the adolescent spurt in females could cause the specific body built in these Upper Paleolithic females.

KEY WORDS: Upper Paleolithic – Gravettian – Homo sapiens *– Pavlovian Hills – Předmostí – Body height – Body mass – Body shape – Sexual dimorphism – Central Europe – Mediterranean*

INTRODUCTION

Studies of the Upper Paleolithic human populations represent one of the "classical" fields of paleoanthropology and evolutionary anthropology. Origin of the Upper Paleolithic *Homo sapiens* is usually taken as a key evolutionary moment for the origin of modern human populations *sensu stricto* with developed biological, social and cultural human features (c.f. e.g., Aiello, Dean 1990, Bräuer 1989, Conroy 1997, Fleagle 1998, Foley 1987, 1995, 1996, Gamble 1995, Jones *et al.* 1995, Pearson 2001, Piontek 1989, 1993, 1999, Piontek, Marciniak 1990a, b, 1992, Ruff 1987, Ruff *et al.* 1984, 1997, Stringer 1989, 1990, 1992, Svoboda *et al.* 1994, Trinkaus 1989a, 1989b, 1992, 1997, Wolpoff 1999). Naturally this increases the demands for the complexity of analysis of skeletal remains and the Upper Paleolithic fossil sites as well. Fortunately, thera are dozens of well-preserved Upper Paleolithic localities and several hundreds skeletal remains representing Upper Paleolithic human populations (cf. e.g. Conroy 1997, Jones *et al.* 1995, Wolpoff 1999). Europe and Mediterranean regions of Africa and Asia are the most frequent sources of Upper Paleolithic sites, however, most of the best fossil sites with the best preserved skeletons come from Czech Republic, France and Italy (Conroy 1997, Jones *et al.* 1995, Wolpoff 1999). Namely Moravian localities of the Czech Republic are very abundant in Upper Paleolithic fossil finds and they are extraordinary important for the understanding of evolution of *Homo sapiens* before the last glacial maximum (Klíma 1963, 1987, 1990, 1995, Svoboda 1988, 1991, 1997, Svoboda *et al.* 1994, Trinakus, Jelínek 1997, Vlček 1992, 1994). Analyses of skeletal remains from two Moravian localities Předmostí (Matiegka 1938, Klíma 1990) and Pavlovian Hills (e. g., Jelínek 1954, 1987, 1992, Piontek, Vančata 2002, Sládek *et al.*, 2000, Svoboda *et al.* 1994, Trinkaus 1999, Trinakus, Jelínek 1997, Trinkaus *et al.* 2000, Vančata 1994, Vlček 1992, 1994) have yielded numerous new information. The high number of skeletons makes it possible to understand better both morphological pattern of Gravettian *Homo sapiens* and also the variability of Gravettian human populations (Churchill 1994, Černý 1994, Formicolla, Giannecchini 1999, Holliday 1995, 1997, 1999, Kuklík 1994, Novotný 1994, Piontek, Vančata 2002, Porter 1999, Sládek 2000, Trinkaus, Jelínek 1997, Vlček 1992, 1994, Vacca *et al.* 1992, Vampolová, Vančata in press, Vančata 1993, 1994, 1997).

After the burning of the whole Předmostí collection, Pavlovian skeletal remains (DV 3, DV 13, DV 14, DV 15, DV 16 and Pavlov 1) represent the largest and the best preserved Upper Paleolithic human sample. Most of them are almost completely preserved skeletons with an excellent archaeological and paleoecological documentation (Jelínek 1954, Klíma 1963, 1987, 1990, 1995, Svoboda 1997, Svoboda *et al.* 1994, Trinkaus, Jelínek 1997, Vlček 1962, 1992, 1994).

Pavlovian skeletal remains have been studied since the early fifties (Jelínek 1954, Trinkaus, Jelínek 1997, Vlček 1962), but the discovery of four new almost complete skeletons with an excellent archaeological documentation (Klíma 1987, Jelínek 1987, Svoboda 1988, 1997, Svoboda *et al.* 1994, Vlček 1992, 1994) has caused that the Pavlovian sample has been examined by the very competent research team which increased substantially the complexity and interdisciplinarity of the research (see e.g., Černý 1994, Formicolla, Giannecchini 1999, Holliday 1995, 1997, Kuklík 1994, Novotný 1994, Sládek 2000, Sládek *et al.* 2000, Svoboda 1997, Svoboda *et al.* 1994, Trinkaus, Jelínek 1997, Trinkaus *et al.* 2000, Trinkaus 1999, Trinkaus, Jelínek 1997, Vlček 1992, 1994, Vančata 1993, 1994, 1997).

After the detailed study of morphology of cranial and postcranial skeleton, pathology and sexual dimorphism of the Pavlovian sample by this international interdisciplinary group, many questions could be answered. Part of them concerns the general body build and body proportions, namely the body size and body shape of this Upper Paleolithic population, and the character of sexual dimorphism.

We have studied long bones of the Pavlovian sample and other European Upper Paleolithic fossil finds to estimate body size parameters, i. e. body height and body mass, and computed skeletal ponderal indexes (see Vančata 1997 for the results of a pilot study). We have examined also some general morphological features, like relative robusticity of epiphyses, diaphyseal shape etc. to get additional information on the body size parameters. The main goal of this study is to reconstruct basic ecological features, i.e. body shape and sexual dimorphism, of the Pavlovian human sample and to compare it with the other Gravettian populations.

MATERIAL

We have studied altogether 28 individuals from the Gravettian period of the Upper Paleolithic (*Table 1*). Morphology and morphometry of five of the six Pavlovian skeletons (DV 13, DV 14, DV 15, DV 16 and Pavlov) were examined on the original skeletons in Dolní Věstonice, data on DV 3 were taken from literature. Most important measurements on postcranial skeleton, taken independently by several persons, were revised by Erik Trinkaus (1999 – web page http://www.artsci.wustl.edu/~anthro/blurb/dv-metrics.html, Sládek *et al.* 2000).

Three skeletons from Sungir were studied several times on original material including reconstruction of long bones of the two subadult individuals, boy Sungir 2 and girl Sungir 3 (Vančata 1997, in press). Combe Capelle and La Rochette were available as casts only (Vančata 1988, 1993). Data on Předmostí were taken from the monograph on Předmostí skeletons written by Matiegka (1938). Special attention was paid to the photographs and comments on morphology and measurements in text.

The rest of the studied individuals were not available for the study and measurements were taken from literature (Formicolla 1988, Holliday 1995).

All the measurements used in this study have been published earlier by Vančata (1988, 1991, 1993, 1994, 1997), Trinkaus (Trinkaus, Jelinek 1997, Ruff *et al.* 1997) and Holliday (1995, 1997) and recently revised by Erik Trinkaus (1999, Sládek *et al.* 2000).

TABLE 1. Examined Gravettian Upper Paleolithic *Homo sapiens* individuals (PGM – Pre-Glacial Maximum group – up to last Glacial maximum, i.e. 18 000 BC).

Label	**Abbreviation**	**Group**	**Sex**	**Author**
Arène Candide 1-IP	*AC 1-IP*	*PGM*	*Male*	Holliday 1995
B. Caviglione 1	*BC 1*	*PGM*	*Male*	Holliday 1995
Barma Grande 2	*BG 2*	*PGM*	*Male*	Formicolla 1988
Barma Grande 4	*BG 4*	*PGM*	*Male*	Holliday 1995
Barma Grande 5	*BG 5*	*PGM*	*Male*	Holliday 1995
Baousse de Torre 2	*BdT 2*	*PGM*	*Male*	Holliday 1995
Crô-Magnon 1	*CM 1*	*PGM*	*Male*	Holliday 1995
Dolní Věstonice – 13	*DV-13*	*PGM*	*Male*	Vančata 1994, 1997
Dolní Věstonice – 14	*DV-14*	*PGM*	*Male*	Vančata 1994, 1997
Dolní Věstonice – 16	*DV-16*	*PGM*	*Male*	Vančata 1994, 1997
Grotte des Enfants 1	*GdE 1*	*PGM*	*Male*	Formicolla 1988
Grotte des Enfants 4	*GdE 4*	*PGM*	*Male*	Formicolla 1988
Kostenki 2	*Kos 2*	*PGM*	*Male*	Vančata, unpublished data
Mladeč 21	*Ml. 21*	*PGM*	*Male*	Holliday 1995
Mladeč 22	*Ml. 22*	*PGM*	*Male*	Holliday 1995
Neussing 2	*Neus.2*	*PGM*	*Male*	Holliday 1995
Ohalo II H2	*Oh II*	*PGM*	*Male*	Herzhkowitz *et al.* 1995
Paviland	*Pavil.*	*PGM*	*Male*	Holliday 1995
Pavlov 1	*Pav.1*	*PGM*	*Male*	Vančata 1997
Předmostí – 3	*PR-3*	*PGM*	*Male*	Matiegka 1938
Předmostí – 9	*PR-9*	*PGM*	*Male*	Matiegka 1938
Předmostí – 14	*PR-14*	*PGM*	*Male*	Matiegka 1938
Sungir 1	*SU 1*	*PGM*	*Male*	Vančata 1997, in press
Sungir 2	*SU 2*	*PGM*	*Male - subadult*	Vančata 1997, in press
Aurignac	*Aurig.*	*PGM*	*Female*	Vančata 1988, 1997
Barma Grande 3	*BG 3*	*PGM*	*Female*	Holliday 1995
Combe Capelle	*C.Cap.*	*PGM*	*Female*	Vančata 1988, 1997
Dolní Věstonice – 3	*DV-3*	*PGM*	*Female*	Vančata 1994, 1997
Dolní Věstonice – 15	*DV-15*	*PGM*	*Female*	Vančata 1994, 1997
Grotte des Enfants 5	*GdE 5*	*PGM*	*Female*	Holliday 1995
Grotte des Enfants 6	*GdE 6*	*PGM*	*Female*	Holliday 1995
La Rochette	*LaRoch*	*PGM*	*Female*	Vančata 1988, 1997
Ostuni	*Ost.*	*PGM*	*Female*	Vacca, Novotný, pers. comm.
Paglicci 25	*Pag.25*	*PGM*	*Female*	Holliday 1995
Předmostí – 1	*PR-1*	*PGM*	*Female*	Matiegka 1938
Předmostí – 4	*PR-4*	*PGM*	*Female*	Matiegka 1938
Předmostí – 5	*PR-5*	*PGM*	*Female*	Matiegka 1938
Předmostí – 10	*PR-10*	*PGM*	*Female*	Matiegka 1938
Sungir 3	*SU 3*	*PGM*	*Female - subadult*	Vančata 1997, in press

TABLE 2. Basic metric traits and body size and shape parameters used in this study (Abbreviations: metric traits [***x*** – *number of measurements*] – K ***x*** – Kunssman 1988, VV ***x*** – Vančata 1988, MC ***x*** – McHenry, Corruccini 1976, VG – VanGerven 1972, TH – Holliday 1995).

Abbreviation	Definitions
FEMLNGMX	Biomechanical length of femur (K2)
TIBLNGMX	Maximal tibial length (K 1a)
HUTOLE	Maximum length of humerus (K 1)
RAMALE	Maximum length of radius (K 1)
HEADBRTH	Medio-lateral head breadth (M 19)
NECKLNGH	Neck length (VG – c)
NCKLGBIO	Biomechanical neck length (MC 6)
SUBTROAP	Anterio-posterior subtrochanteric diameter (K 10)
SUBTROML	Medio-lateral subtrochanteric diameter (K 9)
INTEREPI	Bicondylar width (MC 12)
DSTEPIMX	Anterio-posterior of the distal femoral shaft (MC 13)
DIAMDLAP	Anterio-posterior diameter of midshaft (MC 15)
DIAMDLML	Medio-lateral diameter of midshaft (MC 14)
PRXEPIML	Anterio-posterior diameter of proximal tibial epiphysis (VV 47)
PRXEPIAP	Medio-lateral diameter of proximal tibial epiphysis (K3)
DIEPIBRT	Medio-lateral diameter of distal tibial epiphysis (VV 67)
MALEMLBR	Medio-lateral breadth of *maleolus medialis* (VV 66)
ARTBRLAT	Lateral antero-posterior diameter of distal tibial joint surface (VV 70)
ARTBRMED	Medial antero-posterior diameter of distal tibial joint surface (VV 71)
TDML	medio-lateral diameter of distal tibial joint surface (TH), it can be also computed by subtracting of medio-lateral breadth of maleolus medialis from of medio-lateral diameter of distal tibial epiphysis
TAPM	middle antero-posterior diameter of distal tibial joint surface (TH), it can be also computed as a mean of lateral antero-posterior diameter of distal tibial joint surface and medial antero-posterior diameter of distal tibial joint surface
Products	
MIDSHAFT	Midshaft product – product of medio-lateral diameter of midshaft and anterio-posterior diameter of midshaft
SUBTROCH	Subtrochanteric product – product of medio-lateral subtrochanteric diameter and anterio-posterior subtrochanteric diameter
DISTFEM	Distal tibial products – product of bicondylar width and anterio-posterior of the distal femoral shaft
PROXTIB	Proximal tibial product – product of anterio-posterior diameter of proximal tibial epiphysis and medio-lateral diameter of proximal tibial epiphysis
DISTATIB	Distal tibial product - product of medio-lateral diameter of distal tibial joint surface and middle antero-posterior diameter of distal tibial joint surface (can be calculated from computed values or from measured values (Holliday 1995)
Estimated parameters	
Body height	mean body height estimate from 8 regression equations (Vančata 1996, 1997, see *Table* 3 for details)
Body mass	mean body height estimate from 26 regression equations (Vančata 1996, 1997 see *Table 3* for details)
s-BMI	skeletal Body mass index (*s-BMI = body mass [g] /height* $[cm]^2$)
s-Rohrer	skeletal Rohrer's index (*s-Rohrer = body mass [g] /height* $[cm]^3$)

TABLE 3. Selected equations for estimates of body height in fossil *Homo sapiens*. (Average values of body height were computed for each individual from the below listed eight equations for the estimate of body height from femoral length and humerus length.)

Reference	**Parameter**	**Equations**
Feldesman *et al.* 1989, 1990	Length of femur	BH = 3.745*Femur
Feldesman, Fountain 1996	Length of femur	BH = 3.01939*Femur + 31.26332
Sjøvold 1990	Length of femur	BH = 3.10*Fem2 + 28.82
	Length of humerus	BH = 4.74*Hum2 + 15.26
	Length of femur	BH = 3.01*Fem2 + 32.52
	Length of humerus	BH = 4.62*Hum2 + 19.00
Olivier 1976	Length of femur	BH = 3.420*Fem2 + 17.1
Jungers 1988	Length of femur	BH = 3.8807*Fem – 51.0

TABLE 4. Selected equations for estimates of body mass in fossil *Homo sapiens*. (Average values of body height were computed for each individual from the below listed 26 equations for the estimate of body mass from femoral and tibial parameters and the body height.)

Reference	**Parameter**	**Equations**
Ruff, Walker 1993	Stature	BM = 0.689*Stat – 53.1
Jungers, Stern 1983	Stature	BM = 0.00013*Stat^2.554
Wolpoff 1983	Stature	BM = 0.00011*Stat^2.592
	Stature	BM = 0.00062*Stat^2.241
McHenry 1988	subtrochanteric product	logBM = 0.624*log*Subtroch – 0.0562
McHenry 1991	femoral head	logBM = 1.7125*logHead – 1.048
	subtrochanteric product	logBM = 0.7316*logSubtroch – 0.4527
	distal femoral product	logBM = 0.960*logDistFem – 1.5678
	proximal tibial product	logBM = 1.0583*logProxTib – 1.9537
	distal tibial product	logBM = 0.9005*logSubtroch – 0.8790
McHenry 1992	femoral head	logBM = 1.7125*logHead – 1.0480
		logBM = 1.7754*logHead – 1.1481
		logBM = 1.7538*logHead – 1.1137
	subtrochanteric product	logBM = 0.7927*logSubtroch – 0.5233
		logBM = 0.8069*logSubtroch – 0.5628
		logBM = 0.8107*logSubtroch – 0.5&33
	distal femoral product	logBM = 0.9600*logDistFem – 1.5678
		logBM = 0.9919*logDistFem – 1.6754
		logBM = 0.9921*logDistFem – 1.6762
	proximal tibial product	logBM = 1.0583*logProxTib – 1.9537
		logBM = 1.0689*logProxTib – 1.9903
		logBM = 1.0683*logProxTib – 1.9880
	distal tibial product	logBM = 0.9005*logDistTib – 0.8790
		logBM = 0.9227*logDistTib – 0.9418
		logBM = 0.9246*logDistTib – 0.9473

METHODS

We have studied the lengths of the bones and various measurements of lower and upper limb long bones that enable us to conduct a detailed analysis of robusticity and biomechanical structure of the lower and upper limb long bones.

The length of bones and selected metrical traits and indexes on femur, tibia, humerus and radius were examined (see Vančata 1988, 1991, 1997, Knussmann 1988, Holliday 1995 for the definition of measurements, *Table 2*) and the body height, body mass and skeletal ponderal indexes were computed (Vančata 1996, 1997).

A reconstruction of body shape parameters is one of the most important goals of the study. Accordingly, several important issues should be mentioned. Body height and body mass are integral body parameters. Body height represents the long bones growth and the body mass then basic physiologic and biomechanic features of the body or its parts. Due to the different long bone proportions between different human populations, body height cannot be represented by the individual long bones (e.g., Formicolla 1993, Formicolla, Giannecchini 1999, Piontek 1999, Piontek, Vančata 2002, Porter 1999, Ruff *et al.* 1997, Vančata 1988, 1991, 1993, 1997). Similarly, specific allometric differences in proportions of individual epiphyses or diaphysis of long bones among sexes or different human groups do not allow to use these metric traits as simple indicators of body mass (McHenry 1992, Ruff 2000, Vančata 1988, 1991, 1993, 1997).

Body height and body mass were computed for each examined individual by various regression equations that were published earlier by several authors (e.g. Feldesman *et al.* 1990, Sjøvold 1990, McHenry 1992, Ruff, Walker 1993, *Tables 3, 4*).

In our opinion there is no ideal universal formula for computing of body height and/or body mass and the confidence of estimates cannot be precisely checked in Paleolithic *Homo sapiens* skeletal remains (cf. also Vančata 1996, 1997). Therefore we recommend:

1) Use a stochastic approach in the body height and body mass reconstruction, it means a consistent system of formulas should be used for the estimate of body height or body mass where the body height and body mass should be computed as mean values from these formulas for any examined skeleton together with their relation that is best expressed by skeletal ponderal indexes (Rohrer's index and Body mass index have been used – formulas are mentioned below),
2) The body shape parameters should be related also to the individual limb lengths and their proportions.

From the above mentioned reasons we have computed the body parameters as mean values of several most reliable equations and they were computed by the same methods for any individual. In this point our approach differs from other studies (see e.g., Aiello, Wood 1994, Formicolla 1983, 1993, Formicolla, Franceschi 1996, Formicolla, Giannecchini 1999, Konigsberg *et al.* 1998, Sjøvold 1990, for the review) that usually recommend to use individual "best optimal" equation.

We do not prefer selection of one, or few, optimal equations published by one author for the estimates of stature and body mass for the following reasons:

1) A potential incompatibility of basic statistical parameters of a sample on the basis of the used equations had been computed with those of an examined fossil human skeletal sample,
2) biological characters of recent skeleton samples and fossil ones differ in many important parameters, recent skeletons represent a relatively homogenous population from a short time period while the fossil ones originate from larger time and regional ranges and, furthermore, skeletal sample is usually small and fragmentary,
3) there is different proportionality of long bones in the individual studied samples (see e.g., Sjøvold, 1990 for the discussion) that can be very marked in comparison of phylogenetically different groups,
4) we should use sufficiently robust methods for the estimates because the estimates of body size parameters in fossil human populations cannot be checked precisely (see Formicolla, Franceschi 1996, Formicolla, Giannecchini 1999, Sjøvold 1990, Vančata 1997).

This approach allows to be free of random errors of the estimates of body size for the individual and it is very suitable for the description of population body size variability. In any case we cannot state for sure which method is the best because individual methods are relatively precise for some populations only (see e.g., Aiello, Wood 1994, Feldesman *et al.* 1989, 1990, Feldesman, Fountain 1996, Formicolla 1983, 1993, Formicolla, Franceschi 1996, Formicolla, Giannecchini 1999, Scieulli, Giesen 1993, Sjøvold 1990, Vančata 1996, 1997 for the discussion) and we have really no exact guideline for fossil human populations. Furthermore, the data computed by our method are fully statistically comparable because they all originated by the identical method and, consequently, such data are statistically very appropriate for any kind of comparative or evolutionary study.

Body height has been computed by MA and RMA formulas (*Table 3*) published by Feldesman and colleagues (Feldesman *et al.* 1989, 1990, Feldesman, Fountain 1996), Jungers (1988), Olivier (1976) and Sjøvold (1990). We computed mean values from six equations based on femoral length and two formulas for humeral length. Humeral formulas are less precise then the femoral ones (Sjøvold 1990), but they decrease the influence of random errors connected with unexpected values of femoral length of the individual.

We have also used a calibration method for the estimate of confidence of method for body height computing as a mean of eight regression equations. On the basis of the longitudinal growth study from Poznań (Cieslik *et al.* 1994), we estimated that body height can be also computed like the sum of femoral, tibial, humeral and radial length plus 20 % of the sum that should roughly represent height of foot and head and length of the neck. These values represent an approximation to the skeletal body height and need no rather problematic anatomical reconstruction of vertebral column. This calibration method was designed for Upper Paleolithic skeletal populations only. It should be slightly modified for the post-Paleolithic human groups because they have significantly shorter tibial and radial limb segments.

The body mass was computed by 22 formulas (*Table 4*) from the following metric traits: femoral head, the subtrochanteric product, the distal femoral product, the proximal tibial and distal tibial products (McHenry 1988, 1991, 1992). In addition, 4 formulas based on body height estimate (Jungers, Stern 1983, Ruff, Walker 1993, Wolpoff 1983) were also included to decrease the influence of random errors resulting from possible unusual morphology of individual epiphyses of the long bones. Body mass is then an average value of the 26 equations.

Ponderal indexes have been computed from the estimated body height and body mass. They can be taken as integral parameters expressing relations of body linearity and body volume and body mass as well as general body shape (Vančata 1996, 1997).

TABLE 5. Upper Paleolithic *Homo sapiens* – comparison of computed and anatomical body height estimates for selected individuals.

Label	Sex	Body height – anatomical	Body height – computed	Difference
Arène Candide 1-IP	*male*	167.8	*170.2*	2.45
B. Caviglione 1	*male*	176.2	*174.2*	–2.02
Barma Grande 2 L	*male*	196.2	*196.3*	0.14
Dolní Věstonice-13 L	*male*	169.2	*168.2*	–1.02
Dolní Věstonice-13 r	*male*	170.4	*169.4*	–1.01
Dolní Věstonice-14 L	*male*	190.2	*190.0*	–0.19
Dolní Věstonice-14 r	*male*	188.5	*186.3*	–2.20
Dolní Věstonice-16 L	*male*	173.0	*176.2*	3.11
Grotte des Enfants 4 L	*male*	194.4	*191.7*	–2.71
Neussing 2	*male*	164.9	*165.5*	0.58
Ohalo II H2	*male*	173.3	*174.2*	0.96
Předmostí-3 L	*male*	185.6	*182.5*	–3.17
Předmostí-3 r	*male*	184.9	*181.9*	–3.01
Předmostí-9 L	*male*	168.5	*167.8*	–0.67
Předmostí-9 r	*male*	168.7	*168.8*	0.12
Předmostí–14 L	*male*	173.9	*171.7*	–2.21
Předmostí-14 r	*male*	173.3	*170.3*	–3.00
Sungir 1 L	*male*	186.8	*183.9*	–2.95
Sungir 1 r	*male*	187.7	*185.2*	–2.49
Dolní Věstonice-3	*female*	159.5	*160.8*	1.33
Dolní Věstonice-15 L	*female*	151.4	*149.9*	–1.53
Dolní Věstonice-15 r	*female*	150.2	*146.9*	–3.30
Grotte des Enfants 5	*female*	158.8	*160.7*	1.97
Grotte des Enfants 6	*female*	150.2	*154.0*	3.74
Předmostí-4 L	*female*	162.3	*160.5*	–1.82
Předmostí-4 r	*female*	163.2	*161.1*	–2.14
Předmostí-10 L	*female*	160.6	*160.7*	0.10

For this study skeletal Body mass index and skeletal Rohrer's index were computed (s-BMI = body mass [g] / height [cm]^2, s-Rohrer = body mass [g] /height [cm]^3) for all the studied Upper Paleolithic individuals. Due to the large sexual differences in body height the s-Rohrer's index is more suitable for the estimate of body robusticity because it is less sensitive to random fluctuations of body mass estimates.

RESULTS

Reliability of the body size estimates

Reliability of methods used for the reconstruction of body size is a crucial problem for any study dealing with the problem of body size and shape.

As we do not know exactly the part of muscles, body fat and lean body mass in individual human ancient populations, there is no possibility how to prove reliably the confidence of body mass estimates for fossil human skeletal remains. The only solution is to use exactly the same methods for any studied individual that enable us to get really comparable results.

However, the estimate of body height could be, at least up to some degree, proved by the anatomical reconstruction (cf. Formicolla 1983, 1993, Formicolla, Franceschi 1996, Formicolla, Giannecchini 1999). To avoid the problem with reconstruction of vertebral column and incompleteness of fossil skeletons in general, we have developed a simpler method based on the length of long bones only (see the Methods chapter). The confidence of the anatomical estimates of the body height with the computed values in all the available individuals with complete set of long bones is surprisingly high (*Table 5*).

The difference of estimates is lesser than one cm in 9 cases, and it is between 3 and 4 cm in four cases only (*Figure 1*). Imprecise estimates are mainly caused by unusual length of humerus or tibia, as can be seen from the indexes and length of bones in *Table 6.* This test has proved our method as highly reliable for the estimate of body height not only for population description, but also for the estimate of individual body height.

Body size and proportions in Pavlovian and Předmostí samples

Body height, body mass, ponderal indexes and other necessary indexes were computed for the entire Pavlovian sample and other examined individuals (*Tables 1, 6a, 6b*). Analysis of the body shape parameters and other morphometric traits was made step by step from the basic description and analysis of the Pavlovian skeletal remains trough the comparison of Pavlovian and Předmostí population up to the general comparative analysis of body size and sexual dimorphism in European Gravettian populations.

Unfortunately, there are four undoubtedly male skeletons (DV 13, DV 14, DV 16 and Pavlov 1) in the Pavlovian sample and one most probably female skeleton (DV 3) with some very unusual features on the lower limb skeleton (*Tables 6a, 6b, 6c, 6d*, Trinkaus, Jelínek 1997, Vančata 1994, 1997, in press). The last skeleton from the Pavlovian skeletal sample is a pathological individual Dolní Věstonice 15 (DV-15) where the sex is difficult to assess by the classical morphological methods (Novotný 1994, Vančata 1993, 1994, 1997, in press).

The analysis of results (*Tables 6 a, 6b, 6c, 7, 9*) has shown that males from Pavlovian Hills are pretty tall and relatively slim. The last two mentioned skeletons, i.e.

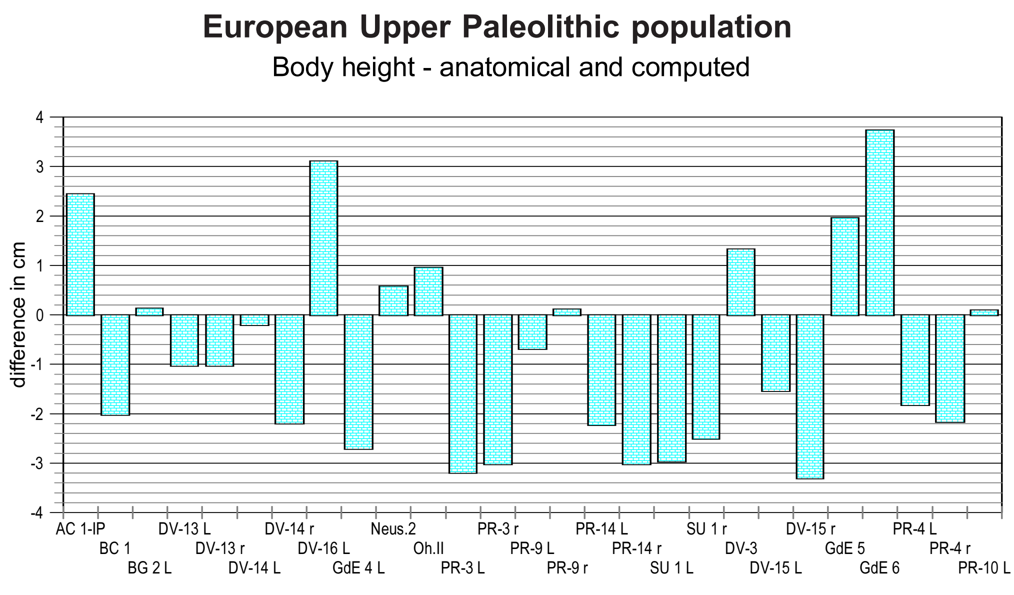

FIGURE 1. The differences among the computed body height and the anatomical reconstruction of body height for the selected Gravettian Upper Paleolithic individuals (abbreviations for the examined individuals see *Table 1*).

TABLE 6a. Upper Paleolithic *Homo sapiens* – Gravettian Upper Paleolithic group – individual data for body shape parameters.

Name	Region	Moravian Reg.	Sex	Body height	Body mass	s-BMI	s-Rohrer
Dolní Věstonice-13	Central Europe	Pavlovian Hills	Male	168.8	63.1	22.32	1.322
Dolní Věstonice-14	Central Europe	Pavlovian Hills	Male	188.2	68.5	19.34	1.028
Dolní Věstonice-16	Central Europe	Pavlovian Hills	Male	177.0	69.5	22.18	1.255
Pavlov 1	Central Europe	Pavlovian Hills	Male	181.8	73.2	22.16	1.216
Předmostí - 3	Central Europe	Předmostí	Male	182.2	63.5	19.11	1.049
Předmostí - 9	Central Europe	Předmostí	Male	168.3	51.7	18.24	1.084
Předmostí - 14	Central Europe	Předmostí	Male	171.0	57.4	19.62	1.148
Sungir1	Central Europe		Male	184.1	71.9	21.1	1.144
Arène Candide 1-IP	Mediterranean		Male	*170.2*	*61.6*	*21.28*	*1.250*
B. Caviglione1	Mediterranean		Male	*174.2*	*62.4*	*20.57*	*1.181*
Barma Grande 2	Mediterranean		Male	*196.3*	*83.6*	*21.68*	*1.104*
B. deTorre 2	Mediterranean		Male	*187.3*	*80.3*	*22.87*	*1.221*
Grotte des Enfants 4	Mediterranean		Male	*191.7*	*85.5*	*23.26*	*1.213*
Grotte des Enfants 1	Mediterranean		Male	*193.8*	*79.6*	*21.20*	*1.094*
Ohalo IIH2	Mediterranean		Male	*174.2*	*68.8*	*22.66*	*1.301*
Paviland	Mediterranean		Male	*177.3*	*61.8*	*19.67*	*1.109*
Dolní Věstonice-3	Central Europe	Pavlovian Hills	Female	160.8	51.5	19.91	1.238
Dolní Věstonice-15 L	Central Europe	Pavlovian Hills	Female	149.9	56.7	25.23	1.683
Předmostí-1	Central Europe	Předmostí	Female	151.7	50.9	22.1	1.456
Předmostí-4	Central Europe	Předmostí	Female	160.8	57.2	22.11	1.375
Předmostí-5	Central Europe	Předmostí	Female	156.7	47.2	19.21	1.227
Předmostí-10	Central Europe	Předmostí	Female	158.1	53.5	21.25	1.339
Aurignac	Mediterranean		Female	*160.8*	*57.2*	*22.10*	*1.374*
Combe Capelle	Mediterranean		Female	*157.1*	*57.6*	*23.33*	*1.484*
Grotte des Enfants 5	Mediterranean		Female	*160.7*	*49.9*	*19.30*	*1.201*
Grotte des Enfants 6	Mediterranean		Female	*154.0*	*50.1*	*21.15*	*1.373*
La Rochette	Mediterranean		Female	*157.8*	*62.5*	*25.09*	*1.590*
Paglicci 25	Mediterranean		Female	*171.2*	*61.7*	*21.07*	*1.231*

DV-3 and DV-15, are significantly smaller. The analysis of their body shape is, however, quite confusing. DV-3 is relatively very gracile and slim (Trinkaus, Jelínek 1997) while DV-15 is significantly more robust than males (Vančata 1994, 1997).

So the natural question is what is the body constitution of a Gravettian female? Despite many pathological features the DV-15 individual is remarkably similar to the Sungir 3 girl by the morphology of femoral and tibial diaphyses and by the large size of epiphyseal metric traits (*Tables 6c, 6d,* Vančata 1997). This is supporting a female status of the pathological individual DV-15 (Vančata 1997).

If we do have two really so different females, so what is the variability in female sample and which is the nature of sexual dimorphism in PGM Upper Paleolithic populations? These questions cannot be answered on the basis of the study of Pavlovian remains themselves. Also the Sungir sample has a limited use because the girl Sungir 3 is far to be fully adult.

To learn more on the character of sexual dimorphism of Pavlovian Upper Paleolithic humans, we have only one possibility. The Pavlovian population must be compared with that of Předmostí that included for sure both male and female individuals.

Analyzing the male similarities and differences (*Table 7*), then the Předmostí males are somewhat smaller (173.8 cm) and more gracile (57 kg, BMI = 19.0) but comparable to the males from Dolní Věstonice and Pavlov (178.9 cm, 68.6 kg, BMI = 21.5).

Both DV 3 and DV 15 (155.4 cm, 54.1 kg, BMI = 22.6) do not differ significantly (*Table 8*) from the Předmostí females (157.0 cm, 52.2 kg, BMI = 21.2). Our analysis

TABLE 6b. Upper Paleolithic *Homo sapiens* – Gravettian Upper Paleolithic group – individual data for limb bones length and some important proximal femoral morphometric traits.

Name	Sex	Femur	Tibia	Humerus	Radius	Head breadth	Neck length	Biom. neck length
Arène Candide 1-IP	*Male*	458.0	379.0	316.0	245.0	48.5		
B. Caviglione 1	*Male*	465.0	410.0	335.0	258.5	46.1		
Barma Grande 2	*Male*	531.0	431.0	382.0	291.0	52.5		
Baousse de Torre 2	*Male*	504.0		363.0	264.0			
Dolní Věstonice-13	*Male*	445.0	384.0	337.0	254.0	47.7	54.0	99.8
Dolní Věstonice-14	*Male*	495.0	422.0	374.0	280.0	49.7	51.5	107.6
Dolní Věstonice-16	*Male*	476.0	375.0	328.0	263.0	50.6	54.5	100.0
Grotte des Enfants 4	*Male*	520.0	455.0	366.0	279.0	55.0		
Grotte des Enfants 1	*Male*	523.0	444.0			53.5		
Kostenki 2	*Male*	438.0	375.0			48.0		
Neussing 2	*Male*	445.0	368.5	304.0	257.0	48.5		
Ohalo II H2	*Male*	461.0	387.0	344.0	252.0	52.0		
Pavlov 1	*Male*	479.0		371.0	285.0			
Předmostí-3	*Male*	484.0	419.0	360.0	278.0	47.0		104.0
Předmostí-9	*Male*	447.0	373.0	328.0	258.0	42.0		88.0
Předmostí-14	*Male*	449.0	394.0	336.0	265.0	46.0		94.0
Paviland	*Male*	476.0	398.0	338.0		48.7		
Sungir 1	*Male*	497.0	425.0	360.0	282.0	49.7	60.5	104.0
Aurignac	*Female*	425.0	379.0			42.0	47.5	78.0
Barma Grande 3	*Female*		353.0	303.0				
Combe Capelle	*Female*	414.0	345.0			44.2	53.0	86.8
Dolní Věstonice-3	*Female*	424.0	359.0	309.0	237.0	40.5		
Dolní Věstonice-15	*Female*	384.0	346.0	302.0	230.0	47.3	47.3	95.8
Grotte des Enfants 5	*Female*	432.0	367.0	291.0	233.0	39.8		
Grotte des Enfants 6	*Female*	415.0	350.0	270.0	217.0	42.8		
Ostuni	*Female*	465.0	410.0			53.0		
Předmostí-1	*Female*	397.0				41.0		
Předmostí-4	*Female*	418.0	365.0	324.0	253.0	47.0		97.0
Předmostí-5	*Female*	415.0	360.0					
Předmostí-10	*Female*	422.0	359.0	312.0	245.0	48.0		95.0
Paglicci 25	*Female*	459.0		322.0	260.0	43.3		

has shown that even Předmostí females, who are relatively gracile by their body mass index, are significantly smaller and more robust in comparison with the Předmostí males (*Table 10*). The degree of differences is similar to that described in the Pavlovian sample (*Tables 7–10*). These results again support the high probability of the female status of the DV-15 based on the analysis of body size and shape of the Gravettian skeletal remains.

Similarly to the Pavlovian sample (DV-3) there is one unusually slim female (PR-5, *Tables 6a, 6b, 6c, 6d*). Předmostí 5 female is, according to Matiegka (1938), 14–16 years old, it means mid or even late puberty. Consequently, she is developmentally comparable with the adult female DV-3. This fact suggests that Gravettian Upper Paleolithic females from Central Europe were usually small and robust, but also slim small females could occasionally appear.

This analysis of the two Moravian samples is showing also probable body size and shape variability in Moravian Gravettian populations. We can state that Moravian Upper Paleolithic hunters had a marked sexual dimorphism with

TABLE 6c. Upper Paleolithic *Homo sapiens* – Gravettian Upper Paleolithic Central European group – individual data for some important morphometric traits (r – right limb, L – left limb, abbreviations – see *Table 1, 2*; values for Sungir 2 and Sungir 3 are in bold italics).

Label	Sex	HEADBRTH	SUBTROAP	SUBTROML	INTEREPI	DSTEPIMX	DIAMDLAP	DIAMDLML	PRXEPIAP	PRXEPIML	NEC
DV-13 L	*Male*	47.8	26.1	33.5	81.8	39.8	30.0	27.2	43.0	71.2	
DV-13 r	*Male*	47.7	26.1	33.6	80.0	40.0	29.8	26.7	49.8	74.1	
DV-14 L	*Male*	51.2	28.2	34.7	80.3	38.5	31.0	25.9	46.0	76.0	
DV-14 r	*Male*	49.7	26.0	37.5	86.7	37.5	29.3	26.0	54.5	75.5	
DV-16 L	*Male*	50.6	29.0	33.5	75.0	35.9	34.5	26.3			
Pav.1 L	*Male*	49.0	29.0	38.5	80.0	40.0	31.5	29.7			
PR-3 L	*Male*	47.0	24.0	38.0	84.0	41.0	31.0	29.0		77.0	
PR-3 r	*Male*	47.0	24.0	38.0	85.0	41.0	30.8	30.0		79.0	
PR-9 L	*Male*	42.0	23.0	33.0		38.0	27.5	26.0		70.0	
PR-9 r	*Male*	42.0	23.0	33.0	78.0	37.0	27.0	25.0			
PR-14 L	*Male*	46.5	23.5	35.0	81.0	37.0	26.0	27.5			
PR-14 r	*Male*	46.0	22.5	33.0	81.0	38.0	26.5	26.0		76.0	
SU 1 L	*Male*	51.7	32.0	34.2	95.0	37.3	33.1	30.7	53.0	79.5	
SU 1 r	*Male*	49.7	31.8	36.0	92.0	37.3	34.0	31.0	45.0	78.0	
SU 2 L	*Male*	*40.5*	*22.3*	*26.7*	*75.3*	*34.3*	*25.8*	*21.3*	*38.5*	*66.0*	
SU 2 r	*Male*	*40.0*	*21.5*	*24.9*	*79.8*	*34.1*	*25.9*	*22.0*	*39.5*	*63.2*	
DV-3	*Female*	40.5	19.8	29.8			25.5	22.5			
DV-15 L	*Female*	47.3	28.2	30.0	79.3	38.0	28.2	24.9	46.3	67.5	
SU 3 L	*Female*	*39.5*	*24.9*	*21.5*	*70.0*	*33.5*	*29.0*	*19.0*	*38.0*	*57.0*	
SU 3 r	*Female*	*39.5*	*23.8*	*24.9*	*72.8*	*33.5*	*31.0*	*20.3*	*39.7*	*59.5*	
PR-1 L	*Female*	41.0	23.0	29.0	69.0	36.0	27.0	22.0			
PR-1 r	*Female*	41.0	23.0	30.0		36.0	27.0	23.0			
PR-4 L	*Female*	47.4	25.0	34.0	83.0	38.0	29.0	28.0		77.0	
PR-4 r	*Female*	47.0	25.0	35.8	82.0	38.0	29.0	28.0		74.0	
PR-5 L	*Female*		19.0	26.0		31.0	22.0	20.0			
PR-5 r	*Female*		19.0	26.0		30.0	21.0	21.0			
PR-10 L	*Female*	48.0	23.0	35.3		33.0	24.5	27.3		77.0	
PR-10 r	*Female*	47.6	22.6	35.0		34.0	25.4	27.5			

TABLE 6d. Upper Paleolithic *Homo sapiens* – Gravettian Upper Paleolithic Central European group – individual data for important products, indices and body size and shape parameters (r – right limb, L – left limb, abbreviations – see *Tables 1, 2*; values for Sungir 2 and Sungir 3 are in bold italics).

Label	Sex	MIDSHAFT	SUBTROCH	DISTATIB	HEADFEMIN	HEADNCBIO	NCKBIOFEM	Crural index	Body height	Body n
DV-13 L	*Male*	816.000	874.350	902.880	1.079	0.479	2.251	0.867	168.2	6
DV-13 r	*Male*	795.660	876.960	1032.000	1.072	0.478	2.243	0.863	169.4	6
DV-14 L	*Male*	802.900	978.540	918.655	1.002	0.477	2.100	0.818	190.0	6
DV-14 r	*Male*	761.800	975.000	758.480	1.004	0.462	2.174	0.853	186.3	6
DV-16 L	*Male*	907.350	971.500		1.063	0.506	2.101	0.788	176.2	6
Pav.1 L	*Male*	935.550	1116.500		1.027				181.7	7
PR-3 L	*Male*	899.000	912.000	646.000	0.961	0.461	2.086	0.865	182.5	6
PR-3 r	*Male*	924.000	912.000	589.000	0.971	0.452	2.149	0.866	181.9	6
PR-9 L	*Male*	715.000	759.000	445.500	0.950	0.483	1.968	0.846	167.8	5
PR-9 r	*Male*	675.000	759.000	418.750	0.940	0.477	1.969	0.834	168.8	5
PR-14 L	*Male*	715.000	822.500	592.500	1.022	0.479	2.132	0.868	171.7	5
PR-14 r	*Male*	689.000	742.500	585.000	1.024	0.489	2.094	0.878	170.3	5
SU 1 L	*Male*	1016.170	1094.400	984.370	1.055	0.512	2.061	0.865	183.9	7
SU 1 r	*Male*	1054.000	1144.800	953.205	1.000	0.478	2.093	0.855	185.2	7
SU 2 L	*Male*	*549.540*	*595.410*	*842.340*	*0.993*	*0.476*	*2.083*	*0.882*	*155.1*	*5*
SU 2 r	*Male*	*569.800*	*535.350*	*704.730*	*0.973*	*0.465*	*2.092*	*0.871*	*156.1*	*4*
DV-3	*Female*	573.750	590.040		0.955			0.847	160.8	5
DV-15 L	*Female*	702.180	846.000	753.375	1.232	0.494	2.495	0.901	149.9	5
SU 3 L	*Female*	*551.000*	*535.350*	*767.000*	*1.129*	*0.493*	*2.291*	*0.903*	*135.6*	*4*
SU 3 r	*Female*	*629.300*	*592.620*	*710.200*	*1.162*	*0.503*	*2.309*	*0.909*	*132.3*	*4*
PR-1 L	*Female*	594.000	667.000		1.028	0.477	2.155		152.1	5
PR-1 r	*Female*	621.000	690.000		1.033				151.4	5
PR-4 L	*Female*	812.000	850.000	585.000	1.133	0.484	2.342	0.870	160.5	5
PR-4 r	*Female*	812.000	895.000	558.250	1.124	0.485	2.321	0.873	161.1	5
PR-5 L	*Female*	440.000	494.000					0.868	155.8	4
PR-5 r	*Female*	441.000	494.000					0.867	157.5	4
PR-10 L	*Female*	668.850	811.900	506.250	1.137	0.505	2.251	0.851	160.7	5
PR-10 r	*Female*	698.500	791.000	494.000	1.170	0.496	2.359		156.6	5

TABLE 7. Gravettian Upper Paleolithic males – Comparison of Dolní Věstonice and Předmostí.

	Mean Males DV	Mean Males PR	t-value	p	t separ. var. est.	p 2-sided	Valid N Males DV	Valid N Males PR	Std. dev. Males DV	Std. dev. Males PR
Head breadth	**49.2**	**45.1**	3.544	0.0036	3.410	0.0078	9	6	2.02	2.42
Femur length	**475.1**	**461.0**	1.201	0.2529	1.223	0.2447	8	6	22.81	20.25
Tibial length	**393.8**	**396.3**	–0.207	0.8405	–0.207	0.8405	6	6	20.58	21.33
AP subtroch. diameter	**27.4**	**23.3**	6.194	0.0001	6.194	0.0004	6	6	1.49	0.61
ML subtroch. diameter	**35.2**	**35.0**	0.160	0.8758	0.160	0.8758	6	6	2.23	2.45
Biepicondylar breadth	**80.6**	**81.8**	–0.573	0.5804	–0.591	0.5692	6	5	3.76	2.77
AP midshaft femoral diam.	**31.4**	**28.1**	2.805	0.0171	2.779	0.0195	7	6	1.96	2.20
ML midshaft femoral diam.	**26.9**	**27.3**	–0.356	0.7289	–0.344	0.7385	7	6	1.30	1.94
TDML	**30.9**	**29.5**	0.816	0.4381	0.978	0.3657	4	6	1.01	3.15
TAPM	**29.5**	**18.4**	9.440	0.0000	9.440	0.0000	6	6	2.49	1.42
Biomechanical neck length	**103.1**	**95.3**	2.375	0.0389	2.375	0.0449	6	6	3.76	7.03
Humerus length	**355.0**	**340.5**	1.420	0.1833	1.475	0.1709	7	6	21.70	13.26
Radius length	**269.8**	**267.3**	0.335	0.7445	0.335	0.7453	6	6	15.35	9.91
Body height	**178.9**	**173.8**	1.301	0.2178	1.330	0.2082	8	6	7.65	6.61
Body mass	**68.6**	**57.5**	4.173	0.0009	4.121	0.0021	10	6	5.05	5.29
BMI index	**21.499**	**18.990**	3.873	0.0022	4.310	0.0015	8	6	1.4780	0.6284
Rohrer's index	**1.206**	**1.093**	2.135	0.0541	2.401	0.0399	8	6	0.1218	0.0448

TABLE 8. Gravettian Upper Paleolithic females – Comparison of Dolní Věstonice and Předmostí.

	Mean Females DV	Mean Females PR	t-value	p	t separ. var. est.	p 2-sided	Valid N Females DV	Valid N Females PR	Std. dev. Females DV	Std. dev. Females PR
Head breadth	**43.9**	**45.3**	–0.481	0.6477	–0.391	0.7629	2	6	4.81	3.37
Femur length	**404.0**	**410.8**	–0.652	0.5329	–0.336	0.7935	2	8	28.28	9.25
Tibial length	**352.5**	**360.8**	–1.879	0.1190	–1.237	0.4327	2	5	9.19	3.70
AP subtroch. diameter	**24.0**	**22.5**	0.649	0.5345	0.362	0.7788	2	8	5.94	2.32
ML subtroch. diameter	**29.9**	**31.4**	–0.485	0.6406	–1.012	0.3450	2	8	0.14	4.15
Biepicondylar breadth	**79.3**	**78.0**	0.144	0.8986			1	3	0.00	7.81
AP midshaft femoral diam.	**26.9**	**25.6**	0.545	0.6008	0.722	0.5452	2	8	1.91	2.99
ML midshaft femoral diam.	**23.7**	**24.6**	–0.349	0.7361	–0.528	0.6256	2	8	1.70	3.43
TDML	**28.7**	**28.0**	0.343	0.7543			1	4	0.00	1.83
TAPM	**26.3**	**19.1**	19.745	0.0003			1	4	0.00	0.32
Biomechanical neck length	**95.8**	**94.4**	0.265	0.8043			1	5	0.00	4.83
Humerus length	**305.5**	**316.0**	–2.017	0.1139	–2.226	0.1124	2	4	4.95	6.32
Radius length	**233.5**	**250.0**	–3.960	0.0288	–3.828	0.0620	2	3	4.95	4.36
Body height	**155.4**	**157.0**	–0.456	0.6609	–0.286	0.8229	2	8	7.70	3.76
Body mass	**54.1**	**52.2**	0.631	0.5457	0.660	0.5769	2	8	3.67	3.93
BMI index	**22.572**	**21.163**	0.998	0.3474	0.523	0.6933	2	8	3.7582	1.2747
Rohrer's index	**1.461**	**1.349**	1.009	0.3423	0.496	0.7066	2	8	0.3144	0.0905

TABLE 9. Upper Paleolithic *Homo sapiens* from Dolní Věstonice – Comparison of males and females.

	Mean Males	Mean Females	t-value	p	t separ. var. est.	p 2-sided	Valid N Males	Valid N Females	Std. dev. Males	Std. dev. Females
Head breadth	**49.2**	**43.9**	2.702	0.0243	1.516	0.3712	9	2	2.02	4.81
Femur length	**475.1**	**404.0**	3.819	0.0051	3.298	0.1874	8	2	22.81	28.28
Tibial length	**393.8**	**352.5**	2.643	0.0384	3.892	0.0115	6	2	20.58	9.19
AP subtroch. diameter	**27.4**	**24.0**	1.498	0.1849	0.801	0.5700	6	2	1.49	5.94
ML subtroch. diameter	**35.2**	**29.9**	3.204	0.0185	5.816	0.0021	6	2	2.23	0.14
Biepicondylar breadth	**80.6**	**79.3**	0.328	0.7562			6	1	3.76	0.00
AP midshaft femoral diam.	**31.4**	**26.9**	2.884	0.0235	2.935	0.0991	7	2	1.96	1.91
ML midshaft femoral diam.	**26.9**	**23.7**	2.949	0.0214	2.489	0.2432	7	2	1.30	1.70
TDML	**30.9**	**28.7**	1.907	0.1525			4	1	1.01	0.00
TAPM	**29.5**	**26.3**	1.192	0.2868			6	1	2.49	0.00
Biomechanical neck length	**103.1**	**95.8**	1.788	0.1337			6	1	3.76	0.00
Humerus length	**355.0**	**305.5**	3.059	0.0183	5.550	0.0009	7	2	21.70	4.95
Radius length	**269.8**	**233.5**	3.142	0.0200	5.061	0.0023	6	2	15.35	4.95
Body height	**178.9**	**155.4**	3.891	0.0046	3.874	0.0606	8	2	7.65	7.70
Body mass	**68.6**	**54.1**	3.787	0.0036	4.741	0.0417	10	2	5.05	3.67
BMI index	**21.499**	**22.572**	–0.708	0.4989	–0.396	0.7597	8	2	1.4780	3.7582
Rohrer's index	**1.206**	**1.461**	–2.026	0.0773	–1.126	0.4623	8	2	0.1218	0.3144

TABLE 10. Upper Paleolithic *Homo sapiens* from Předmostí – Comparison of males and females.

	Mean Males	Mean Females	t-value	p	t separ. var. est.	p 2-sided	Valid N Males	Valid N Females	Std. dev. Males	Std. dev. Females
Head breadth	**45.1**	**45.3**	–0.148	0.8856	–0.148	0.8859	6	6	2.42	3.37
Femur length	**461.0**	**410.8**	6.255	0.0000	5.645	0.0008	6	8	20.25	9.25
Tibial length	**396.3**	**360.8**	3.647	0.0053	4.008	0.0102	6	5	21.33	3.70
AP subtroch. diameter	**23.3**	**22.5**	0.901	0.3855	1.030	0.3330	6	8	0.61	2.32
ML subtroch. diameter	**35.0**	**31.4**	1.890	0.0832	2.036	0.0645	6	8	2.45	4.15
Biepicondylar breadth	**81.8**	**78.0**	1.031	0.3423	0.813	0.5018	5	3	2.77	7.81
AP midshaft femoral diam.	**28.1**	**25.6**	1.737	0.1079	1.818	0.0941	6	8	2.20	2.99
ML midshaft femoral diam.	**27.3**	**24.6**	1.690	0.1168	1.830	0.0945	6	8	1.94	3.43
TDML	**29.5**	**28.0**	0.852	0.4189	0.952	0.3690	6	4	3.15	1.83
TAPM	**18.4**	**19.1**	–0.963	0.3639	–1.177	0.2838	6	4	1.42	0.32
Biomechanical neck length	**95.3**	**94.4**	0.251	0.8078	0.260	0.8009	6	5	7.03	4.83
Humerus length	**340.5**	**316.0**	3.396	0.0094	3.907	0.0045	6	4	13.26	6.32
Radius length	**267.3**	**250.0**	2.819	0.0258	3.637	0.0083	6	3	9.91	4.36
Body height	**173.8**	**157.0**	6.077	0.0001	5.611	0.0008	6	8	6.61	3.76
Body mass	**57.5**	**52.2**	2.173	0.0505	2.078	0.0675	6	8	5.29	3.93
BMI index	**18.990**	**21.163**	–3.816	0.0025	–4.191	0.0015	6	8	0.6284	1.2747
Rohrer's index	**1.093**	**1.349**	–6.320	0.0000	–6.938	0.0000	6	8	0.0448	0.0905

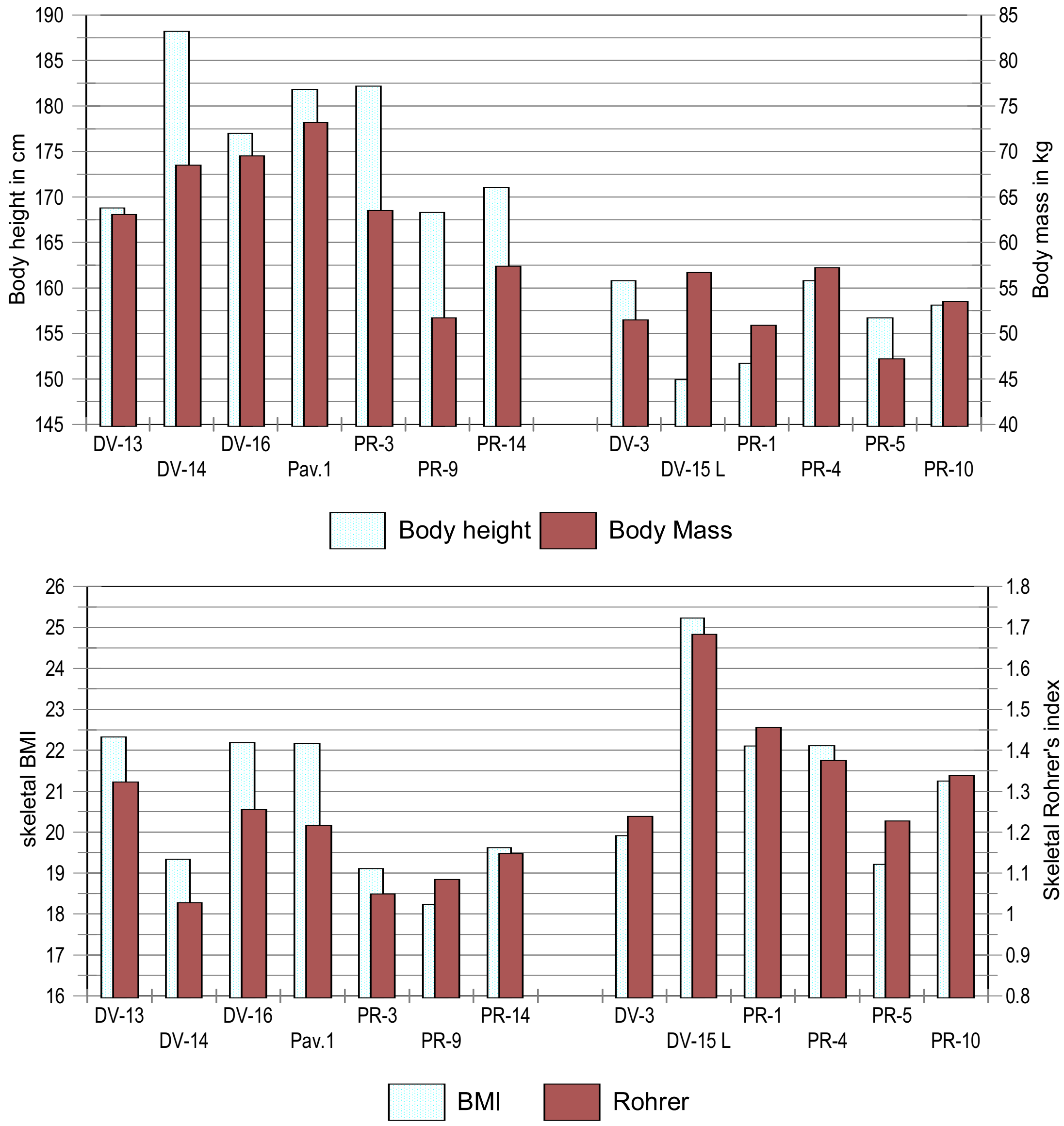

FIGURE 2. Body height and body mass (above) and BMI and Rohrer's index (below) for the Moravian Upper Paleolithic group (abbreviations for the examined individuals see *Table 1*).

relatively slim, mostly tall males and small or very small, mostly robust females (*Tables 7–10, Figure 2*). The pattern of body size and shape sexual dimorphism in Gravettian populations from Moravian regions does not correspond to the classical model of human sexual dimorphism, i.e. large robust males and small gracile females (see also Vančata 1997, Vančata, Charvátová 2001).

Comparative analysis of Central European and Mediterranean samples

It is very important to learn what features of Central European and Pavlovian populations are general and which features are specific to the Moravian Gravettian *Homo sapiens*. To get more information on this problem we have made a comparative analysis of the body size and shape of the Central European and Mediterranean samples. The results must be taken carefully because the described differences, if they were found, are in many cases over 5% up to 10% of probability level for the t-test (*Tables 11, 12*). So in a strict biostatistical sense most differences are not statistically significant for various reasons. A low number of individuals in a group is one of the most frequent reasons.

The analysis shows (*Tables 11, 13, Figures 3, 4, 5*) that Mediterranean Upper Paleolithic males were significantly taller (they are higher by almost 7 cm in average and some of them were extremely tall, *Tables 6a, 11*) and somewhat more robust (approximately by 7 kg heavier, *Tables 6a, 11*) than the Central European ones. The higher robusticity of the body in Mediterranean males, however, could be caused also by their higher body height. Mediterranean females are higher by 3 cm and heavier by 1 kg than the Central European ones (*Table 12, Figures 4, 5*). With the

TABLE 11. Gravettian Upper Paleolithic *Homo sapiens* – Comparison of Mediterranean and Central European males.

	Mean Males M	Mean Males CE	t-value	p	t separ. var. est.	p 2-sided	Valid N Males M	Valid N Males CE	Std. dev. Males M	Std. dev. Males CE
Head breadth	**51.3**	**47.9**	2.598	0.0161	2.549	0.0242	8	17	3.12	2.97
Femur length	**495.7**	**472.1**	2.228	0.0360	2.040	0.0622	9	16	30.32	22.28
Tibial length	**414.3**	**399.3**	1.442	0.1627	1.380	0.1853	11	14	30.66	21.29
AP subtroch. diameter	**29.7**	**26.3**	2.223	0.0401	2.998	0.0096	5	14	1.64	3.23
ML subtroch. diameter	**38.3**	**35.1**	2.911	0.0097	2.855	0.0245	5	14	2.17	2.09
Biepicondylar breadth	**89.8**	**83.1**	2.002	0.0637	1.761	0.1529	4	13	6.95	5.53
AP midshaft femoral diam.	**37.1**	**30.4**	4.828	0.0002	9.411	0.0000	4	15	0.25	2.74
ML midshaft femoral diam.	**29.1**	**27.6**	1.534	0.1425	1.632	0.1414	5	15	1.75	1.97
TDML	**28.2**	**30.6**	–1.535	0.1471	–1.505	0.1928	4	12	2.81	2.70
TAPM	**26.4**	**24.6**	0.595	0.5603	1.029	0.3187	4	14	1.54	5.86
Biomechanical neck length		**99.7**					0	14		6.33
Humerus length	**349.8**	**350.1**	–0.046	0.9641	–0.044	0.9657	8	15	20.79	18.36
Radius length	**264.9**	**270.3**	–0.798	0.4352	–0.692	0.5110	6	14	17.23	12.21
Body height	**184.3**	**177.7**	1.865	0.0750	1.701	0.1127	9	16	10.24	7.41
Body mass	**72.2**	**65.2**	1.926	0.0647	1.714	0.1072	11	18	12.21	7.40
BMI index	**21.6**	**20.5**	1.754	0.0927	1.934	0.0661	9	16	1.16	1.64
Rohrer's index	**1.2**	**1.2**	0.462	0.6482	0.502	0.6206	9	16	0.08	0.10

TABLE 12. Gravettian Upper Paleolithic *Homo sapiens* – Comparison of Mediterranean and Central European females.

	Mean Fe.Med.	Mean Fe. CE	t-value	p	t separ. var. est.	p 2-sided	Valid N Fe.Med.	Valid N Fe. CE	Std. dev. Fe. Med.	Std. dev. Fe. CE
Head breadth	**43.0**	**45.0**	–1.227	0.2435	–1.317	0.2123	6	8	2.09	3.44
Femur length	**426.8**	**409.5**	2.315	0.0363	2.141	0.0647	6	10	17.24	12.79
Tibial length	**358.8**	**358.4**	0.063	0.9510	0.056	0.9578	5	7	13.94	6.29
AP subtroch. diameter	**27.7**	**22.8**	2.786	0.0177	4.261	0.0021	3	10	1.21	2.92
ML subtroch. diameter	**30.4**	**31.1**	–0.304	0.7666	–0.438	0.6749	3	10	1.82	3.71
Biepicondylar breadth	**77.1**	**78.3**	–0.288	0.7847	–0.306	0.7722	3	4	4.47	6.41
AP midshaft femoral diam.	**29.4**	**25.9**	2.114	0.0581	3.226	0.0104	3	10	1.15	2.76
ML midshaft femoral diam.	**26.8**	**24.4**	1.271	0.2300	2.369	0.0420	3	10	0.25	3.10
TDML	**27.0**	**28.1**	–1.088	0.3083	–1.088	0.3083	5	5	1.59	1.61
TAPM	**27.3**	**20.6**	2.330	0.0482	2.330	0.0587	5	5	5.68	3.20
Biomechanical neck length	**86.8**	**94.6**	–1.855	0.1060	–1.455	0.2416	3	6	8.80	4.36
Humerus length	**296.5**	**312.5**	–1.692	0.1291	–1.412	0.2529	4	6	21.79	7.64
Radius length	**236.7**	**243.4**	–0.618	0.5591	–0.506	0.6475	3	5	21.73	9.86
Body height	**160.3**	**156.6**	1.438	0.1723	1.320	0.2235	6	10	5.91	4.25
Body mass	**53.9**	**52.5**	0.448	0.6606	0.394	0.7039	7	10	8.50	3.77
BMI index	**22.005**	**21.445**	0.581	0.5704	0.563	0.5857	6	10	2.0076	1.7850
Rohrer's index	**1.376**	**1.371**	0.055	0.9566	0.055	0.9575	6	10	0.1476	0.1399

TABLE 13. Gravettian Upper Paleolithic *Homo sapiens* – Comparison of Moravian Gravettian males and females.

	Mean Males	Mean Females	t-value	p	t separ. var. est.	p 2-sided	Valid N Males	Valid N Females	Std. dev. Males	Std. dev. Females
Head breadth	**47.9**	**45.0**	2.185	0.0394	2.067	0.0610	17	8	2.97	3.44
Femur length	**472.1**	**409.5**	8.066	0.0000	9.105	0.0000	16	10	22.28	12.79
Tibial length	**399.3**	**358.4**	4.913	0.0001	6.624	0.0000	14	7	21.29	6.29
AP subtroch. diameter	**26.3**	**22.8**	2.750	0.0117	2.799	0.0108	14	10	3.23	2.92
ML subtroch. diameter	**35.1**	**31.1**	3.388	0.0026	3.093	0.0086	14	10	2.09	3.71
Biepicondylar breadth	**83.1**	**78.3**	1.448	0.1681	1.333	0.2534	13	4	5.53	6.41
AP midshaft femoral diam.	**30.4**	**25.9**	4.019	0.0005	4.013	0.0007	15	10	2.74	2.76
ML midshaft femoral diam.	**27.6**	**24.4**	3.131	0.0047	2.863	0.0125	15	10	1.97	3.10
TDML	**30.6**	**28.1**	1.910	0.0755	2.354	0.0349	12	5	2.70	1.61
TAPM	**24.6**	**20.6**	1.461	0.1622	1.922	0.0768	14	5	5.86	3.20
Biomechanical neck length	**99.7**	**94.6**	1.766	0.0944	2.053	0.0592	14	6	6.33	4.36
Humerus length	**350.1**	**312.5**	4.798	0.0001	6.634	0.0000	15	6	18.36	7.64
Radius length	**270.3**	**243.4**	4.412	0.0004	4.900	0.0008	14	5	12.21	9.86
Body height	**177.7**	**156.6**	8.154	0.0000	9.209	0.0000	16	10	7.41	4.25
Body mass	**65.2**	**52.5**	5.041	0.0000	6.006	0.0000	18	10	7.40	3.77
BMI index	**20.509**	**21.445**	–1.369	0.1835	–1.342	0.1963	16	10	1.6405	1.7850
Rohrer's index	**1.156**	**1.371**	–4.520	0.0001	–4.210	0.0008	16	10	0.1033	0.1399

TABLE 14. Gravettian Upper Paleolithic *Homo sapiens* – Comparison of Mediterranean males and females.

	Mean Males	Mean Females	t-value	p	t separ. var. est.	p 2-sided	Valid N Males	Valid N Females	Std. dev. Males	Std. dev. Females
Head breadth	**51.3**	**43.0**	5.571	0.0001	5.909	0.0001	8	6	3.12	2.09
Femur length	**495.7**	**426.8**	5.009	0.0002	5.589	0.0001	9	6	30.32	17.24
Tibial length	**414.3**	**358.8**	3.814	0.0019	4.975	0.0002	11	5	30.66	13.94
AP subtroch. diameter	**29.7**	**27.7**	1.810	0.1203	1.971	0.1058	5	3	1.64	1.21
ML subtroch. diameter	**38.3**	**30.4**	5.251	0.0019	5.518	0.0027	5	3	2.17	1.82
Biepicondylar breadth	**89.8**	**77.1**	2.732	0.0412	2.930	0.0326	4	3	6.95	4.47
AP midshaft femoral diam.	**37.1**	**29.4**	13.403	0.0000	11.403	0.0076	4	3	0.25	1.15
ML midshaft femoral diam.	**29.1**	**26.8**	2.229	0.0673	2.937	0.0425	5	3	1.75	0.25
TDML	**28.2**	**27.0**	0.805	0.4472	0.754	0.4851	4	5	2.81	1.59
TAPM	**26.4**	**27.3**	–0.309	0.7661	–0.345	0.7442	4	5	1.54	5.68
Biomechanical neck length		**86.8**					0	3		8.80
Humerus length	**349.8**	**296.5**	4.122	0.0021	4.051	0.0067	8	4	20.79	21.79
Radius length	**264.9**	**236.7**	2.145	0.0691	1.964	0.1443	6	3	17.23	21.73
Body height	**184.3**	**160.3**	5.165	0.0002	5.751	0.0001	9	6	10.24	5.91
Body mass	**72.2**	**53.9**	3.455	0.0033	3.749	0.0018	11	7	12.21	8.50
BMI index	**21.598**	**22.005**	–0.501	0.6246	–0.449	0.6667	9	6	1.1591	2.0076
Rohrer's index	**1.174**	**1.376**	–3.483	0.0040	–3.074	0.0180	9	6	0.0771	0.1476

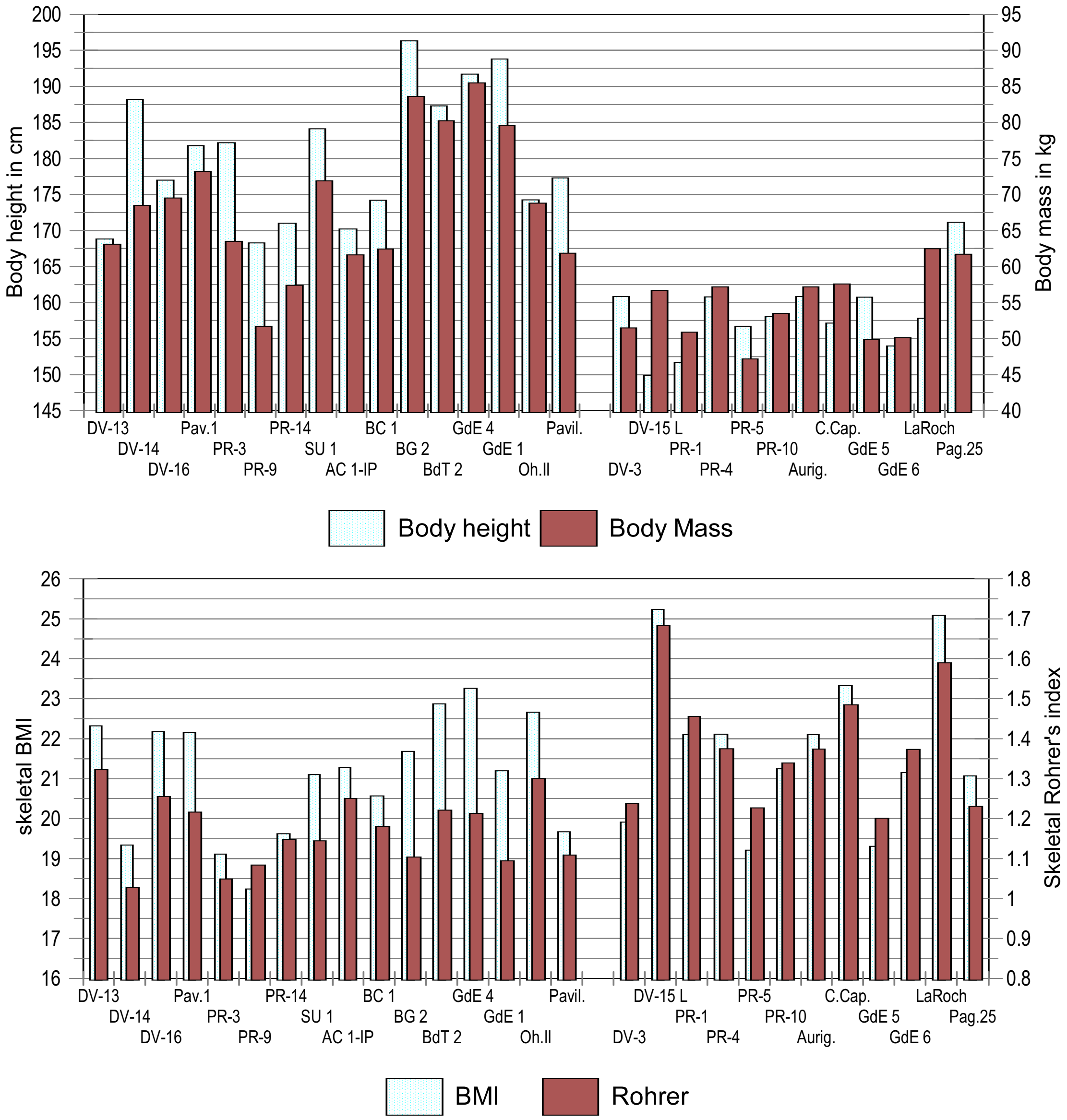

FIGURE 3. Body height and body mass (above) and BMI and Rohrer's index (below) for the European Gravettian Upper Paleolithic *Homo sapiens* (abbreviations for the examined individuals see *Table 1*).

exception of some femoral parameters, the female skeletons from Central Europe and Mediterranean regions are metrically very similar (*Figures 12, 13*). If we analyze the character of sexual dimorphism, it is exactly the same in both examined populations at least in metrical features (*Figures 13, 14*).

However, the detailed analysis of individual metric traits shows also some specific differences among the Central European and Mediterranean groups. While the femoral head is significantly larger in Mediterranean males than in the Central European ones, the situation is opposite in the females where the head is somewhat larger in Central European females (*Table 11, Figure 5*). Tibia and the upper limb bones are relatively longer in both Central European males and namely in Central European females (*Tables 11, 12, Figures 6, 7*). We have found also important differences on the femoral diaphyses. The subtrochanteric region is much more flattened in the Central European Gravettian males and namely in females in comparison to the Mediterranean ones (*Tables 11, 12*). The femoral diaphysis in the midshaft region is markedly flattened in the Mediterranean males and females, but it is almost rounded in Central European ones (*Tables 11, 12, Figure 8*).

Slight differences in the pattern of sexual dimorphism can be also found between the Central European and Mediterranen groups. The differences between Mediterranean males and females seem to be more in size than in shape, while important differences between Central European males and females are both in size and in shape (*Tables 13, 14*).

The detailed analysis of the examined individuals from the Mediterranean population has shown one important

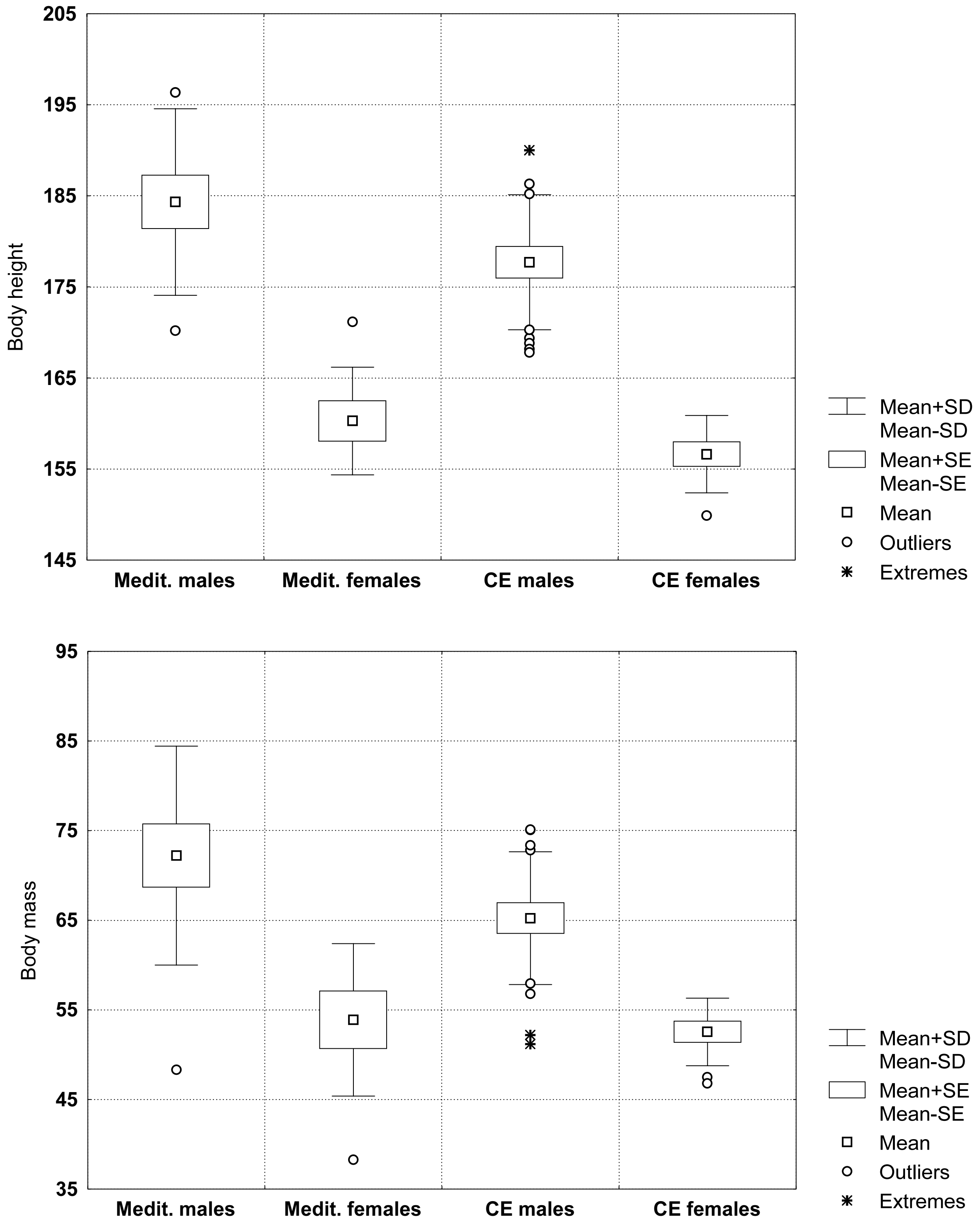

FIGURE 4. Body height and body mass in males and females in Central European and Mediterranean Gravettian Upper Paleolithic groups (Medit. – Mediterranean group, CE – Central European group; SD – standard deviation, SE – standard error of mean; outliers – cases out of one SD interval).

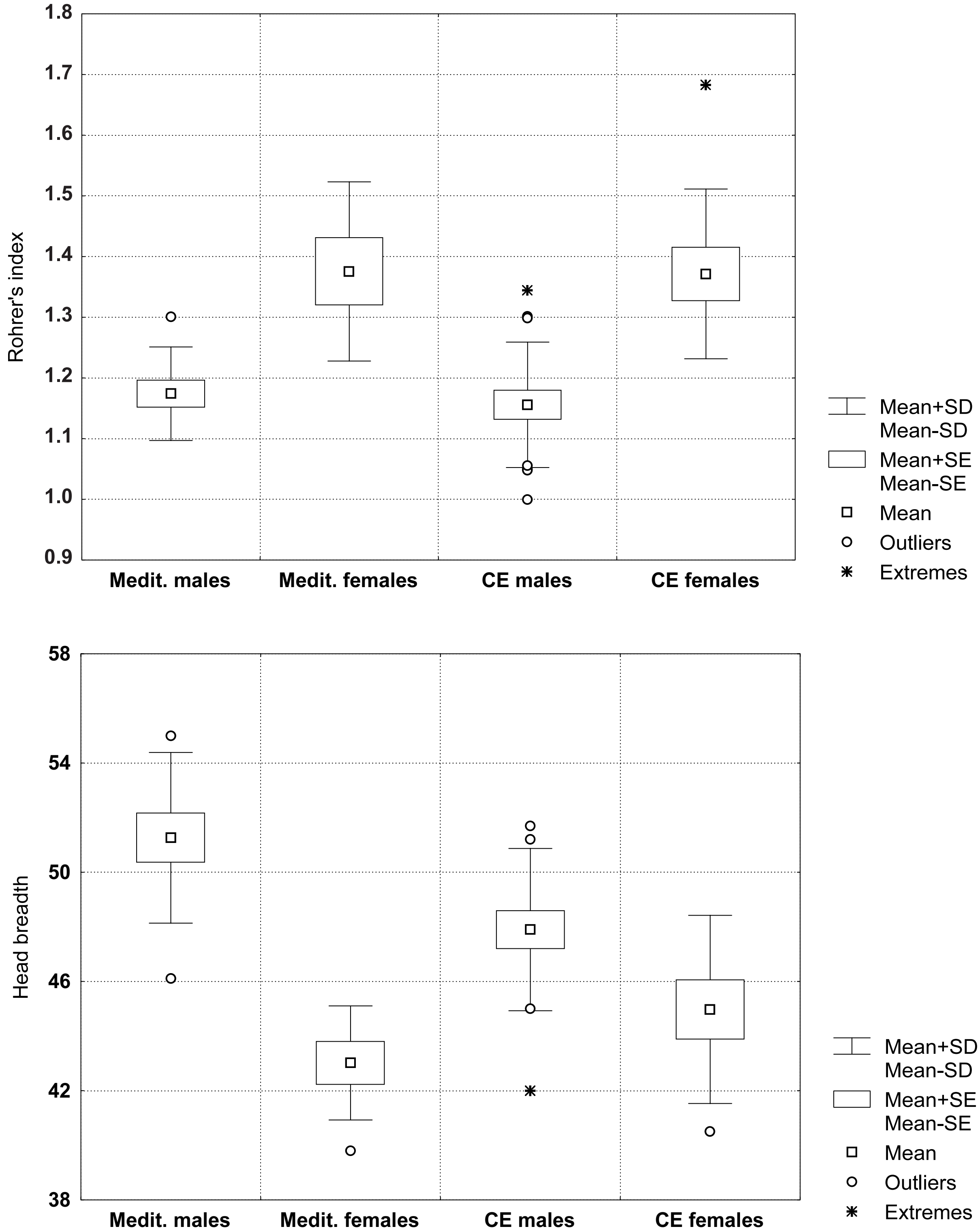

FIGURE 5. Skeletal Rohrer's index and femoral head breadth in males and females in Central European and Mediterranean Gravettian Upper Paleolithic groups (Medit. – Mediterranean group, CE – Central European group; SD – standard deviation, SE – standard error of mean; outliers – cases out of one SD interval).

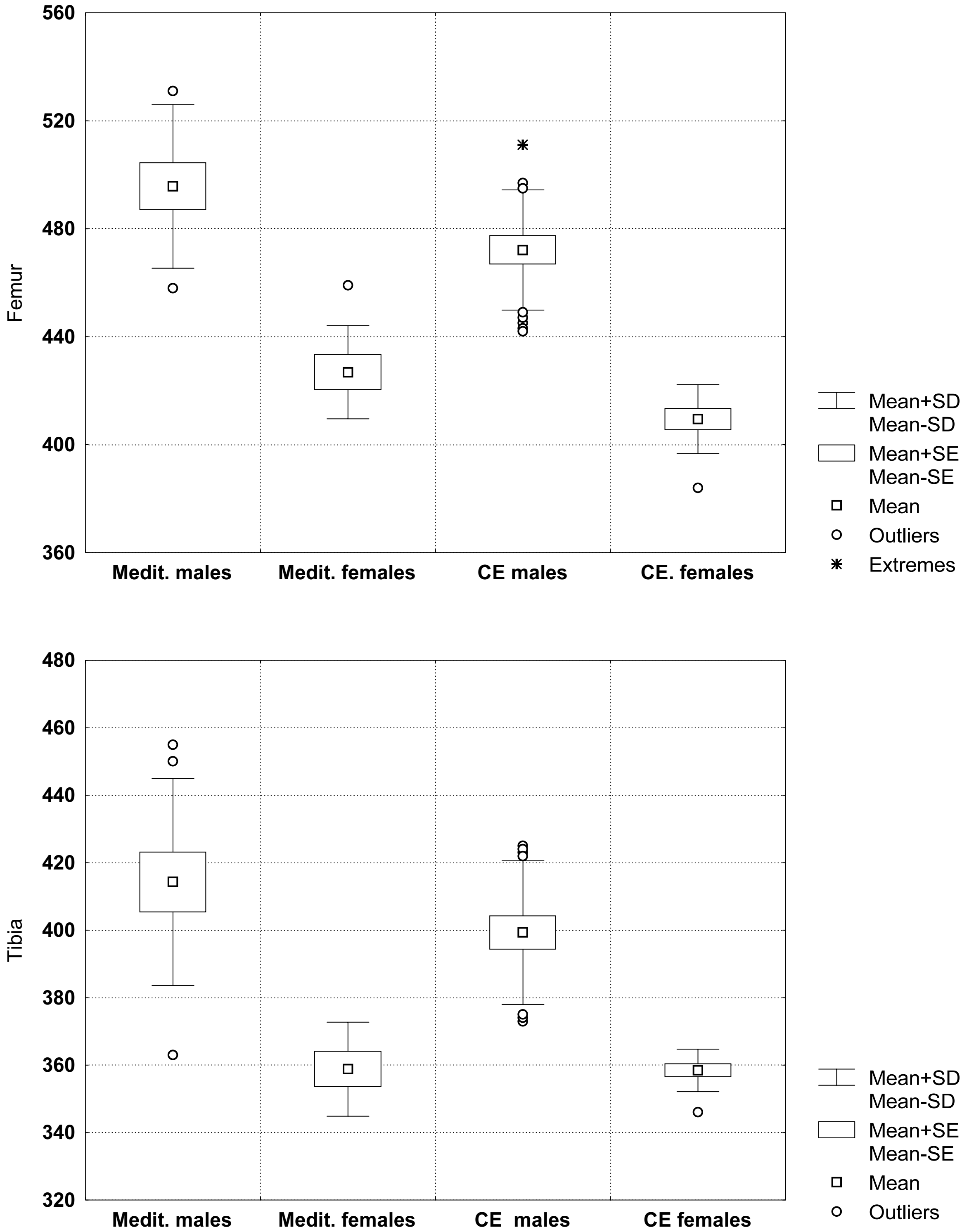

FIGURE 6. Length of femur and tibia in males and females in Central European and Mediterranean Gravettian Upper Paleolithic groups (Medit. – Mediterranean group, CE – Central European group; SD – standard deviation, SE – standard error of mean; outliers – cases out of one SD interval).

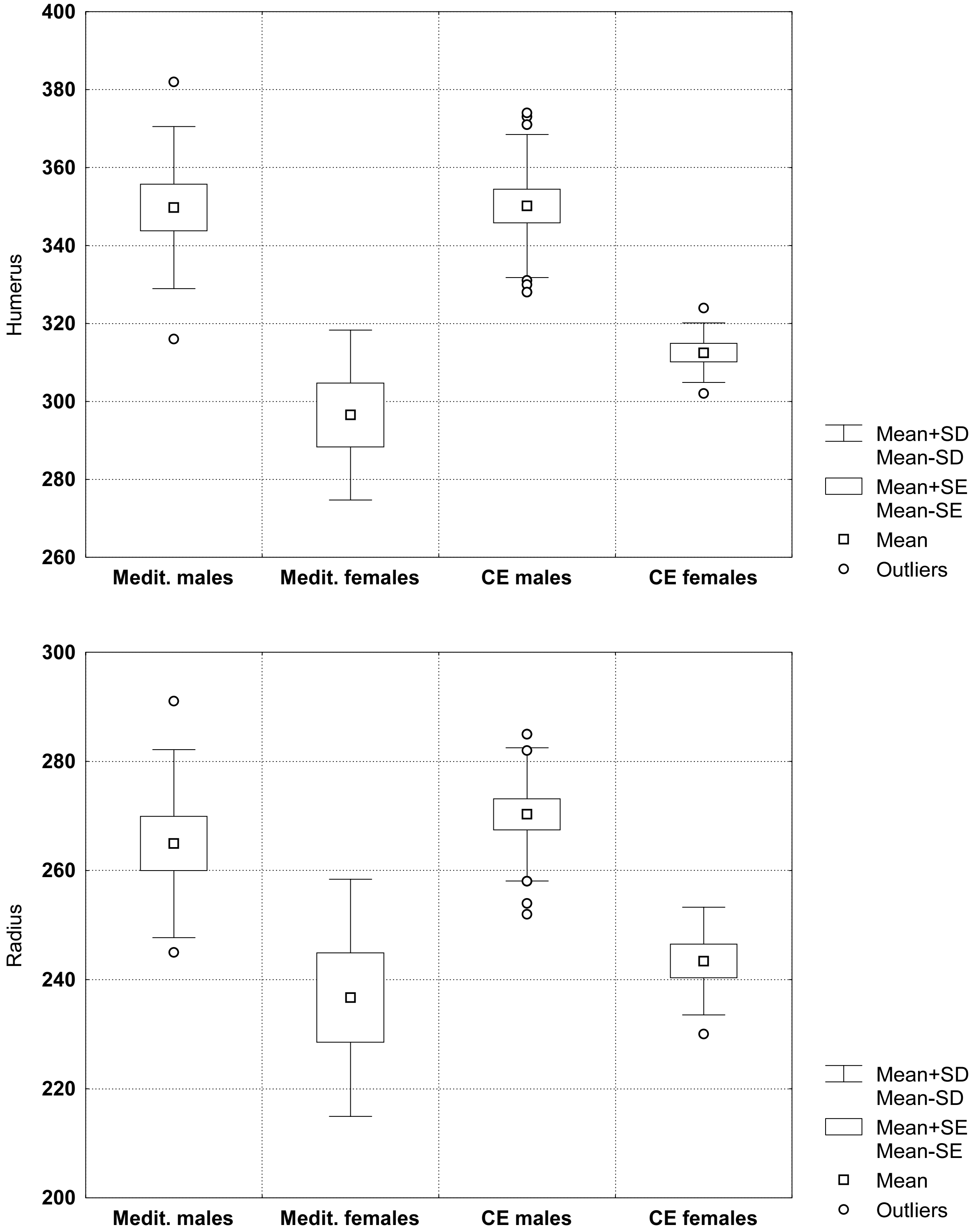

FIGURE 7. Length of humerus and radius in males and females in Central European and Mediterranean Gravettian Upper Paleolithic groups (Medit. – Mediterranean group, CE – Central European group; SD – standard deviation, SE – standard error of mean; outliers – cases out of one SD interval).

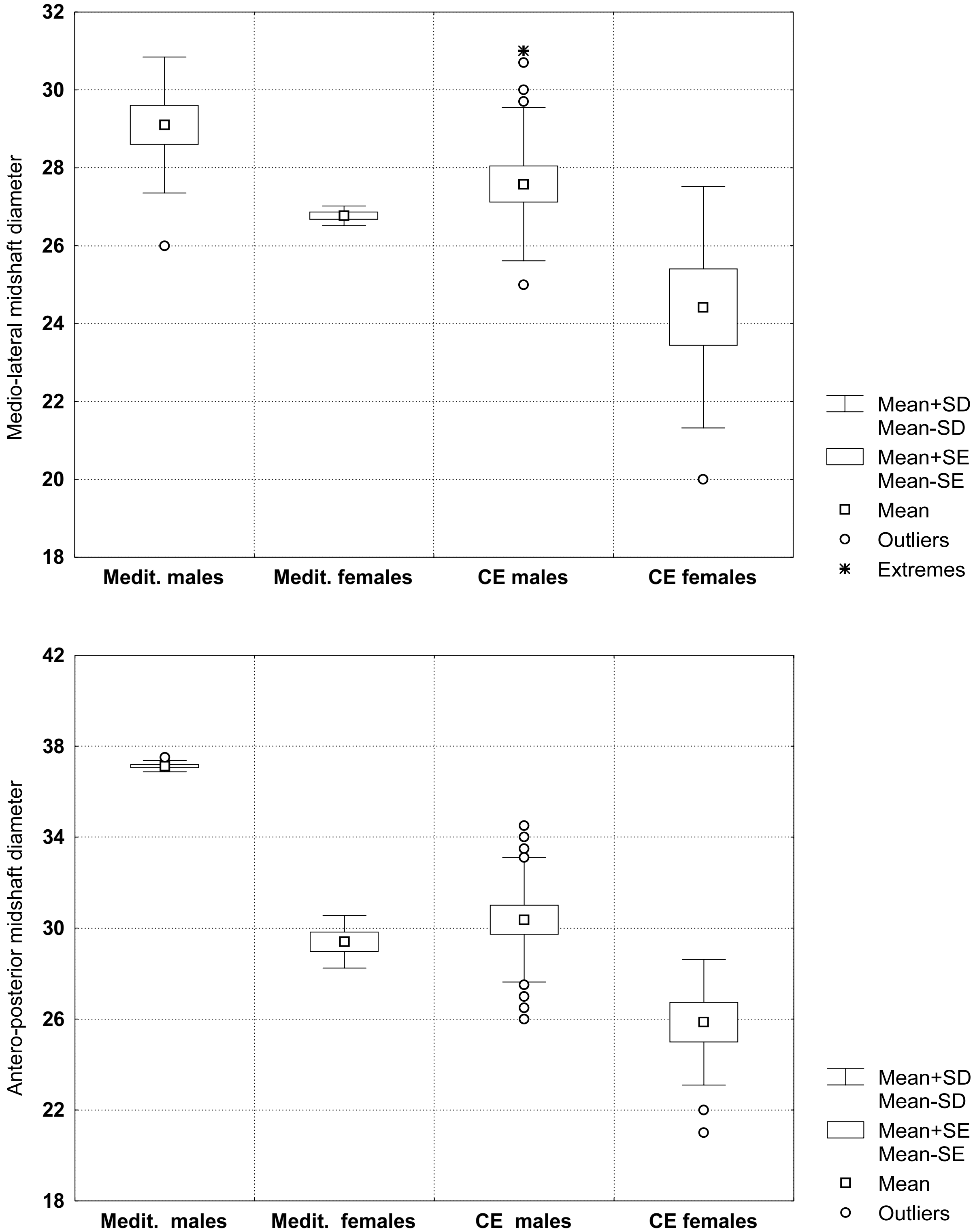

FIGURE 8. Medio-lateral and antero-posterior midshaft diameters of femoral diaphysis in males and females in Central European and Mediterranean Gravettian Upper Paleolithic groups (Medit. – Mediterranean group, CE – Central European group; SD – standard deviation, SE – standard error of mean; outliers – cases out of one SD interval).

feature in females. Similarly to the Central European population, we have found also a hyper-robust female (La Rochette) and one very slim female (Grotte des Enfants 5) in the Mediterranean sample (*Tables 6a, 6b*).

DISCUSSION AND CONCLUSIONS

The problems of sexual dimorphism in Upper Paleolithic *Homo sapiens* have been discussed by numerous authors (e.g. Aiello, Dean 1990, Formicolla 1993, Formicolla, Giannecchini 1999, Frayer 1980, 1981, Frayer, Wolpoff 1985, Holliday 1995, 1997, Jacobs 1985, Novotný 1994, Piontek 1999, Piontek, Vančata 2002, Ruff 1991, Ruff *et al.* 1997, Sládek 2000, Trinkaus, Jelinek 1997, Vančata 1988, 1993, 1997, Wolpoff 1999). In fact there is no definitive consensus about the method of sexing of this sample. Some propose features based on body shape (Ruff 1991, Ruff *et al.* 1997), others features based on recent *Homo sapiens* sexual differences (Frayer 1980, 1981, Frayer, Wolpoff 1985, Jacobs 1985, Wolpoff 1999). Various combinations of both approaches are proposed as well (Formicolla, Giannecchini 1999, Holliday 1995, 1997, Novotný 1994, Porter 1999, Sládek 2000, Vančata 1988, 1993).

There is no doubt that the character of sexual dimorphism in the Gravettian European *Homo sapiens* is not identical with that of recent or post-Paleolithic human populations (Conroy 1997, Formicolla, Giannecchini 1999, Frayer, Wolpoff 1985, Holliday 1995, 1997, Jacobs 1985, 1993, Vančata 1988, 1993, Wolpoff 1999) and the "classical approaches" of sexing on the basis of recent population models are not really useful (cf. e.g., Formicolla 1983, 1993, Formicolla, Franceschi 1996, Formicolla, Giannecchini 1999, Ruff *et al.* 1997, Vančata 1993, 1997). Therefore, we have proposed a different approach to the sexual diagnosis in fossil hominid populations based on body size, body shape and limb proportions differences (see also Piontek, Vančata 2002, Vančata 1996, 1997, Vančata, Charvátová 2001) that is free of *à priori* sexual assessments and prejudgements.

This approach has helped us to analyze body size, body shape and basic body proportions in Pavlovian and Předmostí samples as general body parameters that should be based on different ontogenetic pathways in males and females. We have found that Moravian Gravettian males and females differ mainly in body size, body built and epiphyseal robusticity. Males are tall and relatively slim, while females are small or very small and mostly robust or very robust.

The character of body size and body shape of the whole examined Upper Paleolithic sample and the supposed character of sexual dimorphism confirms our conclusions concerning Pavlovian skeletal remains and those of Předmostí sample as well (*Tables 6a, 6b, 6c, 6d, 11, 12, Figures 3–8*). The specific character of sexual dimorphism, i. e. tall slim males and namely small robust and hyper-robust females, was probably caused by the strong sexual selection of the somatotype of females (Vančata 1997).

The somatotype we have described in the Gravettian females could be more convenient for the prolonged maternal care that is supposed in the Upper Paleolithic hunters-gatherers way of life in PGM period and also for the regular starvation of females during winter period, when the food resources could be very limited (Přívratský, Vančata 1996).

However, how to explain the presence of slim females in the sample of very robust females and how could the unusual robusticity in most females have originated? Answering these questions is extraordinary important to clearly define the character and variability of basic body size parameters of the examined Upper Paleolithic females.

First, we have to state that besides the marked differences in body robusticity among the slim and robust females (*Figures 2, 3, Table 6a*), there are also numerous similarities, like body height and proportions (*Tables 6b, 6c, 6d*, Vančata 1997). Second, very slim individuals can be found also in the male Gravettian skeletal sample, DV-14 for example, however, there are no really hyper-robust males (*Tables 6a, 6b, 6c, 6d*, Vančata 1997) who are quite usual in post-Paleolithic populations (Jacobs 1993, Vančata, Charvátová 2001).

We have proposed the model based on our study of ontogeny and growth of macaques and apes (Vančata *et al.* 1999, 2000a, 2000b, 2001, Vančata, Vančatová 2002, Vančatová *et al.* 1999a, 1999b). A specific adolescent spurt that causes additional growth of skeleton and body mass has been described in most female individuals of the studied macaque groups from the Konárovice and Sochi primate centers, also been influenced by the genetic profile and its variability in a given population (Vančata *et al.* 2001).

However, some individuals stop the growth immediately after the puberty and some even accelerate growth after puberty (Vančata *et al.* 2001). As the ethological study has shown (Vančata *et al.* 2000a, 2000b, Vančata, Vančatová 2002, Vančatová *et al.* 1999b), some of the differences are probably correlated with a social status of the individual and, consequently, sexual selection of individuals with certain body parameters can be one of the important mechanisms in life history of the group of higher primates. Adolescent spurt, however, for post-pubertal males, has also been proved in our study of ape ontogeny (Vančata, Vančatová 2002, Vančatová *et al.* 1999a).

A similar adolescent spurt can be supposed in the Gravettian Upper Paleolithic females. It was based most probably on specific behavioural and ontogenetic mechanisms in Gravettian populations, closely connected with their ecology and way of life. This life history pattern resulted, as it is shown by the results of our study (*Table 6a, Figure 3*), in a higher incidence of a robust body built among the Gravettian Upper Paleolithic females, while the slim females became relatively exceptional. Such specific somatotype in Gravettian females, partly of hereditary and partly of a social nature, could become easily a subject of sexual selection in small social units of the Gravettian Upper Paleolithic humans.

We can conclude that the Pavlovian skeletal remains are compatible by their reconstructed body size and body shape with other Upper Paleolithic populations in both Central Europe and in Europe as a whole. Moravian Gravettian males are significantly smaller and somewhat less robust than those from the Mediterranean region. Central European Gravettian females were also smaller than those from the Mediterranen region, but they were more robust.

General pattern of sexual dimorphism in Pavlovian skeletal sample is basically identical with that of other examined Gravettian groups from Central Europe and Mediterranean region, where skeletal remains of females occurred. Despite some local variability and specific features in individual regional groups, the basic pattern of sexual dimorphism described for the Pavlovian Gravetian skeletal population, i.e. relatively slim tall males and small usually robust females, has remained the same. The occurrence of slim females in all the examined Gravettian samples could be explained by a deceleration of pubertal and/or adolescent spurt in some females, resulting in their lower robusticity in body built. This phenomenon has also been described in our growth study of *Macaca mulatta* (Vančata *et al.* 2000a, 2001, unpublished data – research project GA ČR 206/99/1697), showing that some females stop the growth during puberty without any adolescent spurt.

The only open problem is the sex assessment of the Dolní Věstonice 15 pathological individual. There are many different opinions on the sex of this pathological individual based on cranium, pelvis, long bones or metrical trait analyses (e.g. Černý 1994, Kuklík 1994, Jelínek 1987, Klíma 1987, Novotný 1994, Sládek 2000, Vančata 1993, 1994, 1997, Vlček 1992, 1994, Wolpoff 1999) where the sexing varies from female to male sex. Many really contradictory statements have appeared since the discovery of the triple burial in Dolní Věstonice. It seems that sexing of DV-15 on the basis of individual traits or skeletal parts, like cranium or pelvis, is not able to solve this problem and, consequently, we prefer sexing connected with the ontogenetic development and sexual differentiation in ontogeny, i.e. sexing based on the body size and shape parameters. In this light, the enigmatic Dolní Věstonice 15 individual has, despite extensive pathologies, clearly female character.

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