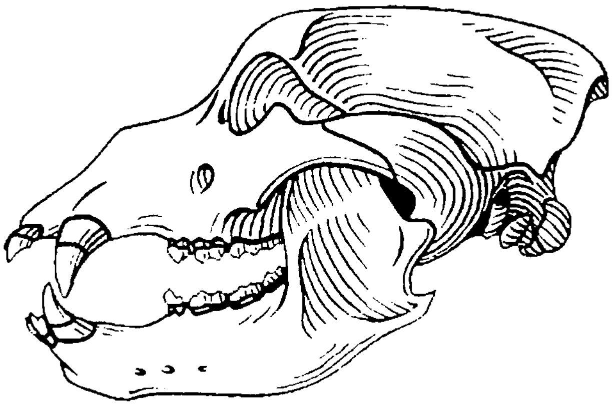
6th International Cave Bear Symposium



COMMUNICATIONS
EXCURSION GUIDE

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Through time Iberian *Ursus spelaeus* Ros. Hein. cheek-teeth size distribution

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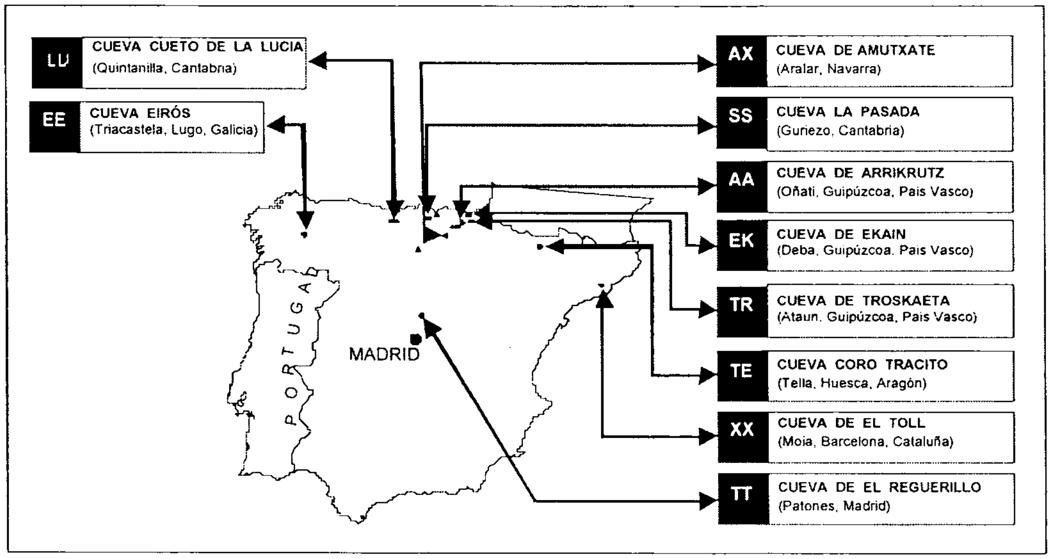
Introduction

This paper deals with a metrical comparison of cheek-teeth length of *Ursus spelaeus* Ros.-Hein.Iberian population representatives. Spanish cave bear localities are grouped in four different areas, Torres 1989) which we can tentatively suppose were connected during palaeoenvironmental optimi periods, but were isolated during the most of their existence. It is possible to interpret that the cave bear population was on borrowed time in the Iberian Peninsula, in fact at the species border, being strongly affected by sudden palaeonvironmental worsenings and growing human (middle and lower Palaeolithic representatives) pressure. In any case to compare dental sizes was a process full of uncertainties because of the lack of radioactive datings. Sex-dimorphism and size-trends were the origin of constraints too.

Iberian *Ursus spelaeus* chronology

According to Torres *et al.* (1999, 2000, in press) aminochronological data Iberian *U. spelaeus* localities are grouped in two very well differentiated aminochronostratigraphical periods. El Reguerillo (TT) and Arrikrutz (AA) can clearly be placed at the 6th Oxygen Isotope Stage (uppermost Riss) while La Lucia cave (LU) appeared at the end of the 5th Oxygen Isotopic Stage (Eem). The remaining localities are scattered at the uppermost part of the 4th Oxygen Isotope Stage. Probably one can think that this occupation time span could be reflected into dental size differences.

Sampling



Teeth from caves from the four iberian occupation areas, figure 1, Atlantic Border, Mediterranean Border, Outback and Pyrenees have been measured: In the Atlantic Border area *U. spelaeus* appear in Eirós-EE (Triacastela, Lugo), La Lucia-LU, La Pasada-SS (Guriezo, Cantabria), Arrikrutz-AA (Oñate, Guipuzcoa), Ekain-KK (Deba, Guipuzcoa), Troskaeta-TR (Ataun, Guipuzcoa) and Amutxate-AX (Aralar, Navarra). In the Mediterranean Border there are not many caves with cave bear remains El Toll-XX (Moiá, Barcelona). In the Outback: El Reguerillo-TT (Torrelaguna, Madrid) is the only important *U.spelaeus* locality in the area. In the Pyrenees: Coro Tracito-TE (Tella, Huesca) represents the only high mountain locality. Almost the whole metric data come from Torres 1980, 1989) Torres *et al.* (1991, 1998) and unpublished data (Amutxate cave). Data fro Eiros cave came from Grandal d´Anglade (1993) *pro parte.*

About size dimorphism in cheek teeth

Kurten (1955 a,b,1969,1972) published a very impressive number of data concerning sex dimorphism on dentition, skull and postcranel skeleton. Their influence can be seen in Torres (1984) where possible sex dimorphism on lower cheek teeth was described in a nonhomogeneous iberian sample of mandibles previously sexed through eitheir lower canine transversal diameter or mandible measurements. In fact some sex-linked differences were found in the average values of the fourth lower premolar male and female lengths. Trying to avoid sex dimorphism influence Grandal d'Anglade (1993) and Grandal d'Anglade and Vidal Romaní (1997), through histograms and principal component analysis of Eirós cave material distinguished between male and female teeth.

In the present paper we raise a different possibility: there is not any sex dimorphism in the length of most of the cave bear cheek teeth, making it unnecessary to establish a previous sex differentiation in the sample. There are some references supporting this hypotesis: Spahni (1941) after some hundred of jaws analyses concluded that there is not a univoque metrical relationship between the lengths of cheek teeth from the same mandible: the longest lower carnassials can coexist either with long or short lower second molars. Probably more significant is Abel's (1992) assertion that in the Mixnitz material it was possible to observe small mandibles (females with long cheek teeth, which produced a characteristic teeth torsion ("kulissenstlung"), confirmed in Edbrink (1956).

Sex dimorphism, if present, must be determined through statistical methods that allowed to ascertain if a variable, tooth measurement, shows an unquestionable bimodal character. To check this we have selected teeth from two localities which, according to the canine transversal diameter, showed an opposite sex ratio distribution and the sample size was big enough to have statistical significance.

The two analyzed localities were Arrikrutz-AA cave where, according to the canine transversal diameter size, an overwhelming male dominancy (83%) was found, Torres (1984), and Ekain-KK cave where female strong dominancy (75%) was registered. Torres *et al.* (1995). The analyzed variables were: P^4 length and width; M_1 total length and talus width; M_2 total length and trigonid with; P_4 total length and width; M_1 total length and talonid width; M_2 total length and talonid width; M3: maximum length and maximum width. For comparison the canine transversal diameter distribution was analyzed also.

The obtained results appear in table 1. There it is possible to observe that, with the sole first upper molar talus width exception, the calculated standard skewness values of the different measurement taken on cheek teeth from both sites are comprised between 2 and –2, meaning that a normal unimodal distribution can be interpreted for both cave bear population cheek teeth measurements.

Ekain Cave (KK)																
	$C^S + C_I$	P^4		M^1		M^2		P_4		M_1		M_2		M_3	
		L	W	L	W	L	W	L	W	L	W	L	W	L	W
N	96	119	110	124	113	110	110	117	117	190	186	208	200	134	129
Ave.	17.78	21.24	14.97	29.30	20.20	45.35	23.36	15.64	11.38	30.89	14,72	31.32	16.14	27.10	19.36
Var.	5.44	1.67	1.33	3.37	1.80	6.57	1.67	18.20	9.53	2.53	0.83	2.81	1.33	3.19	1.48
Std.	2.33	1.29	1.15	1.83	1.34	2.56	1.30	1.35	0.98	1.59	0.91	1.68	1.13	1.78	1.22
Min.	14.60	18.20	12.20	25.20	17.00	40.00	20.50	12.20	9.30	27.10	12.70	27.40	13.50	21.80	16.30
Max.	23.20	24.30	17.70	34.00	23.80	52.80	26.60	18.40	14.20	34.70	17.50	36.30	19.20	31.60	22.50
Std skw.	3.62	0.65	0.09	0.72	0.70	1.55	1.06	-0.58	0.77	0.92	1.47	1.07	1.47	0.71	0.67
Std. kurt.	-0.85	-0.67	-0.72	-1.46	-0.78	-0.47	-0.62	-0.52	-1.16	-1.21	-0.22	-0.01	-0.48	-0.30	-0.27
Arrikrutz Cave (KK)															
	$C^S + C_I$	P^4		M^1		M^2		P_4		M_1		M_2		M_3	
		L	W	L	W	L	W	L	W	L	W	L	W	L	W
N	134	49	49	55	49	61	61	32	32	54	52	97	90	83	79
Ave.	21.08	20.43	14.11	28.95	20.11	45.15	23.40	15.86	10.65	30.44	14.90	30.42	16.82	26.65	19.76
Var.	7.18	2.30	1.13	3.50	1.84	4.63	1.22	0.99	0.82	2.87	9.33	2.14	2.09	3.78	1.53
Std.	2.68	1.52	1.06	1.86	1.36	2.15	1.11	0.99	0.90	1.69	0.97	1.46	1.44	1.94	1.24
Min.	15.50	17.50	11.70	25.60	16.70	41.30	19.90	13.50	9.00	25.90	12.60	26.60	12.20	22.20	17.30
Max.	25.00	23.60	16.30	33.00	23.00	49.70	25.40	17.60	12.90	33.20	16.60	33.90	20.00	30.50	22.50
Std skw.	-4.09	0,01	-0,44	-0,087	-2,16	0.97	-1,46	-0,20	0,94	-1,88	-0,64	-1,86	-1,20	-0,48	-0,38
Std. kurt.	-0,99	-0,70	-0,91	-0,98	0,76	-0.76	0,63	0,022	0,17	-0,46	-0,97	0,12	0,99	-1,11	-1,52

Table.-2. Descriptive statistics (N=number; Ave=average; Var=variance, Std=standard deviation; Min=minimun; Max=maximun; Std.skw.=standad skewness; Std.kur.=standard kurtosis) from *U. spelaeus* canine and cheek teeth (C-transversal diameter of the crown; P4-length and width; M1-lentgh and heel width; M2-length and trigon width; P4 length and width; M1 and M2-length and trigonid width;M3 length and width). Measures are in mm.

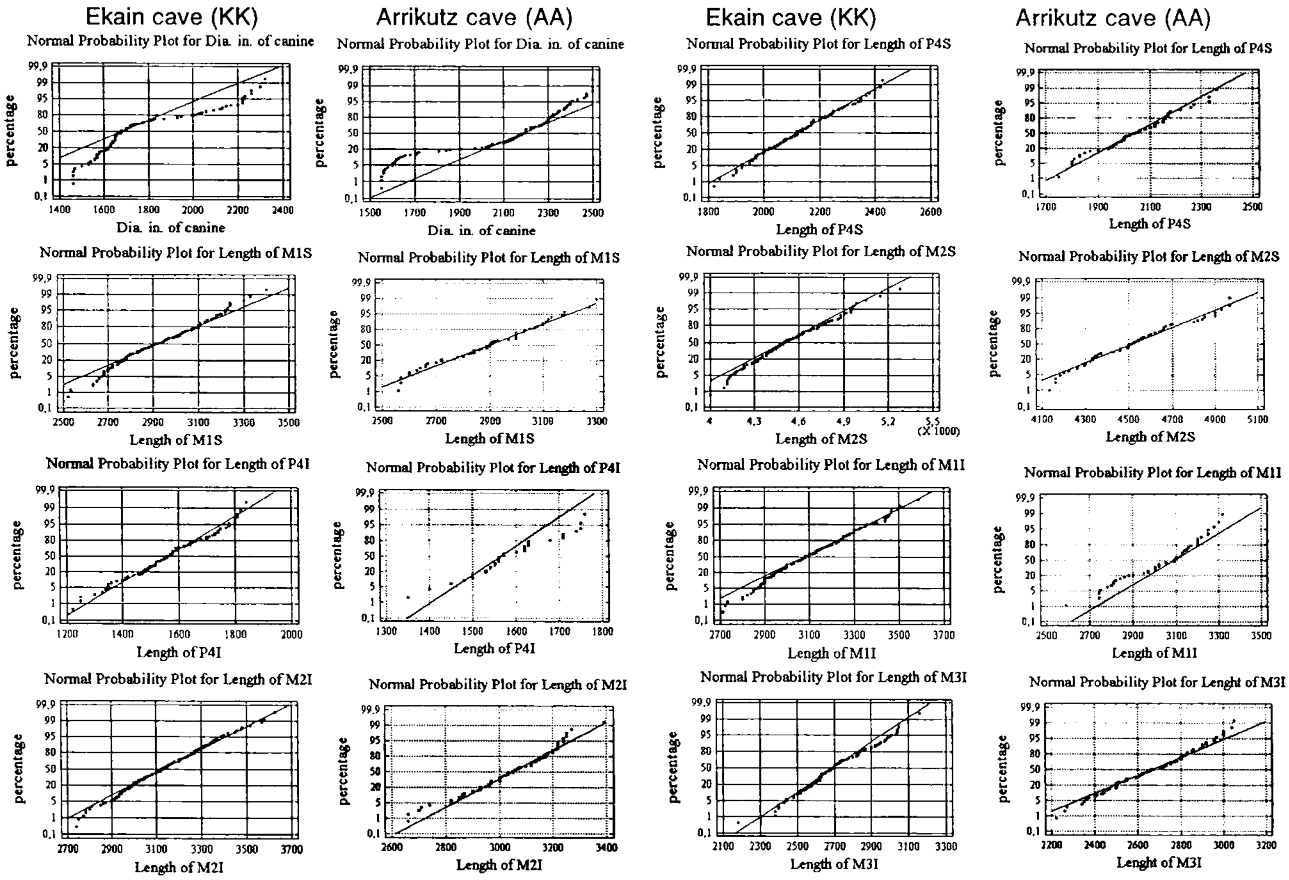


Figure 2. Normal probability plots for Arrikrutz and Ekain teeth measurements: Canine (transversal diameter); fourth upper premolar-P4S (total lenjgth and mximun width); first upper molar-M1S (total length and heel width); second upper molar-M2S (totallength and trigon width): fourth lower premolar-P4I (total length, maximun width); first lower molar-M1I(total length and talonid width); second lower molar-M2I(Ytotal length and talonid width) and third lower molar-M3I (Total length and maximun width).

Metrical comparison

Cave	P4 M01(N) M02(N)	M1 M01(N) M08(N)	M2 M01(N) M05(N)	P4 M01(N) M02(N)	M1 M01(N) M12(N)	M2 M01(N) M07(N)	M3 M01(N) M03(N)
KK	21.3(120) 15.0(110)	29.3(124) 20.2(116)	45.3(110) 23.3(137)	15.6(117) 11.4(119)	31.0(195) 14.8(207)	31.3(110) 18.7(137)	27.1(135) 19.4(133)
EE	20.4(23) 14.8(21)	28.2(43) 20.1(35)	45.7(45) 22.9(33)	14.8(19) 10.5(10)	30.6(35) 14.6(30)	30.9(42) 18.8(40)	26.2(24) 18.8(21)
TE	19.9(36) 13.6(31)	28.8(56) 19.2(45)	45.0(36) 23.2(31)	15.3(23) 9.8(24)	29.8(38) 14.3(35)	30.5(39) 18.6(36)	27.0(28) 19.0(25)
AX	19.7(8) 13.6(8)	28.7(14) 19.9(12)	45.2(9) 23.1(10)	14.2(6) 10.8(6)	31.4(8) 15.2(10)	31.3(14) 18.5(14)	25.6(4) 18.9(4)
TR	19.9(31) 14.1(28)	27.1(41) 18.9(35)	43.4(49) 21.9(47)	14.4(32) 10.0(32)	28.7(50) 14.1(56)	29.7(74) 18.4(64)	24.8(52) 18.4(48)
SS	20.4(12) 14.7(12)	28.2(16) 19.4(16)	44.7(22) 22.7(23)	15.2(16) 10.5816)	30.3(21) 14.9(21)	30.4(32) 18.3(32)	25.7(24) 18.9(24)
XX	20.3(38) 13.7(38)	29.0(55) 19.9(51)	44.7(45) 22.8(54)	15.3(45) 10.7(44)	30.2(88) 14.7(98)	29.9(112) 18.6(99)	26.2(72) 19.3(65)
LU	21.5(6) 15.6(6)	27.9(10) 19.8(10)	44.7(8) 22.9(9)	16.0(14) 10.5(14)	30.2(6) 15.0(6)	31.2(20) 18.9(29)	25.3(17) 19.1(17)
AA	20.4(49) 10.6(49)	28.9(55) 20.1(49)	45.4(63) 23.5(64)	15.9(32) 10.6(32)	30.4(54) 14.9(52)	30.4(97) 19.2(90)	26.7(86) 20.0 (82)
TT	19.5(58) 13.6(59)	28.6(84) 19.8(70)	44.4(84) 22.6(81)	15.9(39) 10.6(39)	30.1(43) 14.0(42)	30.1(87) 18.5(80)	26.8(89) 19.0(73)

Table 3. Average values and data number of U. spelaeus cheekk teeth (P4-length-M01 and width-M02; M1-lentgh-M01 and heel width-M08; M2-length-M01 and trigon width-M05; P4 length-M01 and width-M02; M1 and M2-length-M01 and trigonid width-M12 and M07;M3 length-M01 and width-M03 from: Ekain (KK); Eirós (EE), Amutxate (AX), Troskaeta (TR), La Pasada (SS), El Toll (XX) La Lucia LU), Arrikrutz (AA) and El Reguerillo (TT).

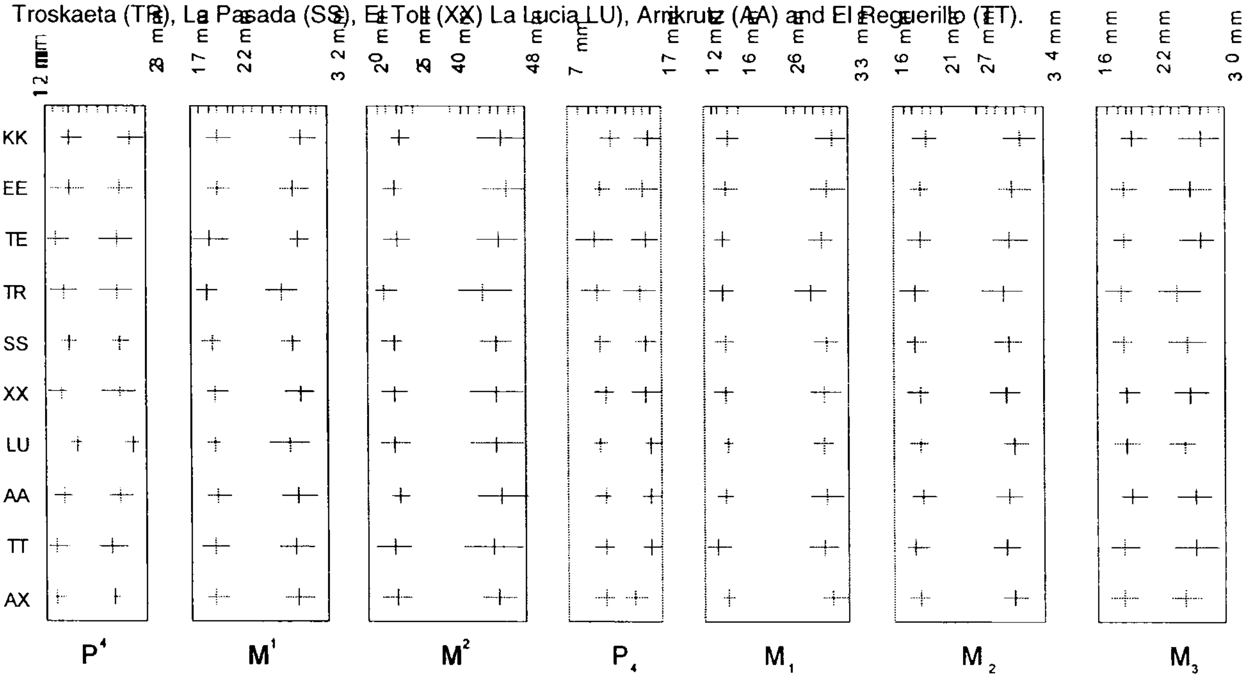


Figure 3.- Average ± 1σ values U. spelaeus cheekk teeth sizes (P4-length and width; M1-lentgh and heel width; M2-length and trigon width; P4 length and width; M1 and M2-length and trigonid width;M3 lengthand width-M03 from: Ekain (KK); Eirós (EE), Amutxate (AX), Troskaeta (TR), La Pasada (SS), El Toll (XX) La Lucia LU), Arrikrutz (AA) and El Reguerillo (TT)(.

The first step for metrical differences analysis was to calculate mean values of length and width of every premolar and molar of each locality, see table 3, in spite of some samples from la Lucia cave LU and Amutxate cave-AX being shorter than desirable for a statistical analysis. In a first visual interpretation differences seemed to be not very important.

The next step was to plot average value ± 1σ of each measurement of each premolar and molar from the different sites (figure 3) where it is easy to observe that Troskaeta-TR values are usually shifted towards the smaller sizes and premolar and molar individual lengths mainly appear as the smallest ones of all localities distribution.

Taking all this into account, the next step was to check if the metrical differences related in table 3 and figure 3, have a real statistical signifiance. To do that we have applied the t-Student test for the mean values taking as reference the average values from Ekain-KK where the higher average values were usually reached and the sample size is very big.

The obtained results are in table 4 were we have distinguished signifiant differences p>0.05), very signifiant differences (p 0.01) and higly signifiant differences (p 0.001).

	KK	AA	TE	EE	LU	XX	SS	TR	TT	AX
P^4 L	(120) 21.2	(50) >***	(35) >***	(23) >***	(6) <	(38) >***	(13) >**	(27) >***	(58) >***	(15) >
W	(110) 15.0	(48) >	(31) <***	(21) <	(6) <	(38) >	(12) >	(23) >*	(42) >	(17) <
M^1 L	(124) 29.3	(57) >	(56) >	(43) >***	(10) >*	(56) >	(15) >**	(38) >***	(82) >*	(21) >*
W	(113) 20.2	(48) =	(45) >***	(33) =	(10) >	(51) >	(16) >	(33) >**	(64) >***	(18) >
M^2 L	(110) 45.3	(65) >	(36) >	(45) >	(8) >	(45) >	(22) >**	(46) >****	(94) >**	(27) >***
W	(110) 23.4	(61) =	(31) >***	(33) >***	(8) >	(46) >*	(22) >	(42) >***	(78) >***	(15) =
P_4 L	(117) 15.6	(32) >	(23) >	(10) >	(14) <	(45) >	(19) >	(30) >***	(39) <	(09) >
W	(117) 11.4	(32) >***	(10) >***	(10) >***	(14) >***	(44) >***	(16) >***	(30) >***	(40) >***	(10) >
M_1 L	(124) 31.0	(55) >***	(36) >	(34) >**	(6) >	(87) >***	(20) >**	(45) >**	(88) >**	(25) <***
W	(102) 18.2	(49) <***	(35) <***	(30) <***	(6) <***	(87) <***	(21) <***	(44) <***	(87) <***	(26) <***
M_2 L	(208) 31.3	(98) >***	(39) >**	(42) >	(20) >	(88) >***	(21) >***	(47) >***	(42) <***	(20) =
W	(200) 18.8	(89) <	(35) =	(40) =	(20) =	(54) >***	(09) >***	(33) <***	(42) >***	(19) =
M_3 L	(135) 27.1	(87) >	(28) >	(24) >**	(17) >***	(82) >***	(24) .>***	(50) >***	(89) >	(10) >***
W	(129) 19.3	(80) >	(25) >	(22) >**	(17) =	(65) >	(24) >	(46) >*	(73) >***	(11) <

Table 4.- Results of t-Student's test (* signifiant, ** very signifiant and *** highly signifiant) of cheeck teeth length and width average values taking as standard Ekain cave values.

According to this, it seems evident that a tardive population, as Ekain-KK was, which, according to the canine transversal diameter, had very high female dominancy; the premolar and molar mean sizes were bigger than those from the other localities.

If we compare premolar and molar sizes from Arrikrutz-AA and el Reguerillo there are a higher number of significant differences between Ekain-KK and El Reguerillo-TT than between the former and Arrikrutz. This suggesting a size trend between a northern population with oceanic influence on their environment and a hipercontinental one surviving in a very hard ecological environment. Both populations have been dated at the end of Middle Pleistocene times (Upper Riss or 6^{th} Oxygen Isotope Episode). The material from la Lucia-LU is so scarce that the lack of significant metric differences can be ascribed to the low sample size.

In the group of samples from localities from the 4^{th} Oxygen Isotope Episode the situation is netly different: Troskaeta cave bears had a dentition smaller than the Ekain and (not included calculation) most of the other localities. That means that Troskaeta cave (TR) was inhabited by a netly different cave bear population whose representatives had small teeth and other skeletal peculiarites that allowed Torres *et al.* (1991) to describe a new subspecies, *Ursus spelaeus parvilatipedis* Torres.

The mean widths of the fourth lower premolar and first lower molar talonid from Ekain-KK are netly bigger than all the other locality ones of the same age: Coro Tracito-TE, Eirós-EE, La Lucia-LU, Amutxate-AX but the bulk of the remaining measurement average values are quite similar, suggesting the existence of "local tribes" with wide isolation periods. In the cave bear remains from El Toll-XX with the sole exception of first and second upper molar average measurement values, the remaining ones are significantly smaller than the Ekain-KK ones. El Toll (XX) cave is located on the Mediterranean Border of the Iberian Peninsula and these differences can be explained because of geograhycal trend. In any case we are sampling material for DNA analysis which will allow us to obtain a clearer scope about this species.

Conclusions.

Statistical analysis made on length and width of premolars and molars of *Ursus spealeus* from the Iberian Peninsula, allowed us to reject the sex dimorphism effect on size.

Based on average size comparison throughout the t-Student test, it has been possible to prove that older bears (6th Oxygen Isotope Episode) show some metrical bears differences which can be explained as a latitudinal-linked size trend.

Coeval 4th Oxygen Isotope Episode show some significant metrical differences which can be explained in terms of early isolation Troskaeta being the best example of this. The cave bears from Cueva de El Toll XX show etrical differences which can be explained as a size trend linked to the situation of the cave on the Mediterranean Border of the Iberian Peninsula.

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