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ECOLOGICAL AND CULTURAL PRESSURE ON MARRIAGE SEASONALITY IN THE PRINCIPALITY OF ANDORRA

A. GONZÁLEZ-MARTÍN

Departamento de Zoología y Antropología Física, Facultad de Biología, Universidad Complutense, Madrid, Spain

Summary. The Principality of Andorra is a small European state located in the central Pyrenees. Since the Middle Ages, it has retained political independence from its two neighbouring countries, France and Spain. Until recently, Andorra maintained a relative stable population and was dependent upon agriculture and livestock. Since 1940, however, a marked change in these conditions has given rise to an explosive increase in the size of the population and traditional systems of production have been replaced by tourism, commerce and service industries. These changes have influenced the model of nuptial seasonality. Based on data from 10,188 marriage certificates covering a period from 1606 to 1960, nuptial seasonality was assessed by estimating Henry's seasonality coefficient. Temporal and geographic changes in the seasonality model were assessed using linear regression analysis and analysis of variance. In addition, the $\tilde{U}_h$ index – an estimate of the intensity of the seasonality model – is proposed to assess changes in the different seasonality models. The results indicate a relaxation of seasonality over time and in those parishes in which substantial demographic and socioeconomic change has occurred in recent years, suggesting a strong dependence of seasonality on the system of production.

Introduction

Andorra is a small European state with an area of 468 km^2. It is located on the southern side of the central Pyrenees and shares a border with France to the north and Spain to the south (Fig. 1). Geographically, it consists of three valleys surrounded by steep mountains, in some cases as high as 3000 m. The 43 nuclei that make up Andorra are grouped into six parishes and are distributed in a manner that takes advantage of the characteristics of the terrain: maximum insulation zones, accessibility to water and land suitable for agriculture, etc. (Gómez & Vila, 1990). Its cultural and economic proximity to the regions of the southern slopes of the Pyrenees is reflected in its official language, Catalan (Valmaseca, 1991). Although its economy has

Fig. 1. Map of the Andorra Valley, divided into six parishes.

traditionally been based on agriculture and livestock, this has been substituted, since the 1940s, by commerce and tourism. This substitution led to a considerable increase in the population, from a mean of 5000 inhabitants to 8400 in 1960 (Adellach & Ganyet, 1977; Calvo *et al.*, 1990).

One of the peculiarities of the Principality of Andorra is that, due to its special system of government, it has maintained political independence since the Middle Ages. Thus, the geographic, political and economic peculiarities of Andorra have made it a useful paradigm in various areas of biodemography.

Andorran society in general, and marriage in particular, has traditionally centred on the concept of the *casa* (family or 'house'). The Andorran *casa* is the result of an interaction between the physical environment and economic conditions, and has been responsible for the management of communal land and demographic surplus through strict rules of inheritance. In addition, it has played an essential role in territorial structuring. The importance of this structuring, agreed for two or three generations, centres on the maintenance of values such as the perpetuity of structures, conservation of traditions and uses, continuity of the family, consecration of historical legacies, and the priority of group privileges over individual freedoms (Becat, 1991). Within this social context, marriage represented a tool with which to maintain that structure. Andorran marriages are based on Catalan law, although with certain regional variations; in fact, it is a particular case with nuances specific to the valleys of Andorra.

Marriage settlements in Andorra did not traditionally obey strict rules. The general custom was to name a single heir, who could be either male – *el hereu* – or female – *la pubilla*. This form of transmission of property to a single person retained substantial freedom in the appointment a beneficiary and a total absence of legislation. The transmission of the estate also included the practice of extracting a quarter of the total family estate and sharing it equally among the remaining children (other than the heir) who form part of the *casa*. Since family estates were usually neither extensive nor valuable, the non-inheriting children obtained the *Consell de les Boïgues*, which consisted of the assignment of communal land for cultivation in return for the payment of a small tax. This was one of the options available to siblings of heirs in order to obtain access to new land for exploitation and be able to remain in the family home. The other options were either to marry an heir or look for permanent or temporal work outside of the country.

Nuptial seasonality – the differential distribution of marriages according to the month of the year – is a phenomenon often detected in human populations. It has been studied in a number of communities distributed throughout the world, including America (García-Moro *et al.*, 1992), Australia (Gunn, 1990), Europe (Chiassimo & Di Comite, 1972; Houndaille, 1978; Henry & Blachet, 1983; Rottat, 1987; Zavattaro & Nicolini, 1988; Abade, 1992; Luchetti *et al.*, 1996; González-Martín, 1997) and, within Europe, with a particular intensity in the Iberian Peninsula (Álvarez, 1983; Toja, 1987; Pallarés, 1990; Cuevas, 1991). The phenomenon of nuptial seasonality is influenced by a number of social, cultural and religious factors (Bourgeois-Pichat, 1946; Sardon, 1979; Siri & Luchetti, 1989; Danubio, 1995; Grech *et al.,* 2003), as well as by agricultural activities (Marín, 1977, Calderón *et al.,* 1978; Rodríguez, 1980; Pallarés 1985; Anasagasti, 1987) and cycles of livestock production (Toja, 1986; Toja *et al.,* 1986; Sánchez, 1989; Coppa *et al*., 2001; González-Martín, 1992). In this study, the particular characteristics of the Principality of Andorra have been exploited to allow a detailed evaluation of both the impact of social and economic change on nuptial seasonality and the relationship between environmental conditions, cycles of production and the seasonality pattern.

Methods

An analysis was performed of 10,188 marriage certificates taken from the parish files of the six parishes of Andorra. The marriage registers included records from 1606 to 1960. The marriage registers started at different dates in each parish: 1060 in Canillo, 1627 in Encamp, 1651 in Andorra la Vella and 1673 in La Massana. In Sant Julià de Lòria and Ordino they started in the XVIIIth century, concretely in 1700 and 1729 respectively.

To assess temporal changes in the number of marriages per month, the data were organized into seven groups, each of 50 years (Table 1). Geographical analysis involved a study of the distribution of marriages over the months of the year for each

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Table 1. Distribution of marriages in Andorra by month and fifty-year period

Month	Period						
	1601–1650	1651–1700	1701–1750	1751–1800	1801–1850	1851–1900	1901–1960
January	15	63	74	81	94	115	144
February	18	90	156	131	147	143	139
March	1	22	33	52	81	66	121
April	8	20	75	79	163	177	215
May	14	44	61	148	206	225	260
June	20	78	168	253	253	266	271
July	41	77	184	228	226	245	249
August	29	76	120	144	144	170	224
September	21	50	67	117	121	154	237
October	35	83	142	122	113	154	232
November	45	61	110	104	119	184	230
December	8	73	69	71	110	148	261
Total	255	737	1259	1530	1777	2047	2583

of the six parishes that make up the Principality of Andorra (Table 2). This monthly distribution of marriages, either according to temporal periods or parishes, was used to calculate Henry's seasonality coefficient (Henry, 1976). This method has traditionally been used to study seasonality patterns and is based on the following equation:

$$H = \frac{\left(\frac{N_m}{D_m}\right)}{\left(\frac{\sum_{1}^{12} N_m}{D_m}\right)}$$

where N_m is the number of marriages celebrated in a given month and D_m is the number of days in that month. The month of February is taken as having a mean number of 28·5 days. This equation distributes a total value of 1200 over the months of the year according to the number of marriages celebrated in each month and taking into account the number of days in that month. Thus, if the distribution of weddings occurs at random and there is, therefore, no seasonality, each month will have a Henry's coefficient of 100.

According to some authors, Henry's coefficient is useful for the analysis of both temporal and geographic variation in marriages (Perrenoud, 1983; Lutinier, 1987). Nevertheless, this study proposes a more rigorous mathematical analysis. This analysis involves a comparison of the seasonality models through regression analysis (Seber, 1977) and analysis of variance (ANOVA), which indicates whether the similarities or differences between the seasonality models are statistically significant

Table 2. Distribution of marriages by month and parish for the years 1606 to 1960

	Parish						
Month	Andorra la Vella	Canillo	Encamp	La Massana	Ordino	Sant Julià de Lòria	Principality
January	195	62	87	57	47	138	586
February	265	91	103	116	53	196	824
March	123	29	41	52	31	100	376
April	214	86	85	101	85	166	737
May	291	109	111	142	113	205	958
June	323	235	152	232	162	192	1309
July	301	303	107	213	144	182	1250
August	248	209	121	133	97	99	907
September	241	147	93	78	81	127	767
October	233	196	136	96	75	145	881
November	232	199	103	123	89	147	853
December	218	115	80	101	63	163	740
Total	2885	1741	1219	1444	1040	1860	10,188

(Abraira & Pérez de Vargas, 1996). In addition, another two methods have been used. The first assesses intensity and consists of the application of the following formula:

$$\tilde{U}_h = \sqrt{\frac{\sum_{i=1}^{12}\left(\ln\left(\frac{x_i}{100}\right)\right)^2}{12}}$$

where x_i is Henry's coefficient for each month.

The $\tilde{U}_h$ coefficient provides an estimate of the degree of oscillation of the seasonality. When values for Henry's coefficient are all equal to 100, the value for the $\tilde{U}_h$ coefficient will be 0, thereby implying an absence of seasonality. However, it provides no information about the structure and direction of variations in the seasonality pattern. To solve this problem a second method was applied based on multivariate statistics (Salvat *et al.,* 1996). This method, based on Henry's seasonality coefficient, involves two steps. The first involves calculation of the Euclidean distance, which evaluates the differences that exist between the seasonality models compared. The second step involves a graphical representation of the distances in a UPGMA tree. The tree should be interpreted as representing the similarities or differences that exist between seasonality models: the closer two models appear on the tree, the greater the similarity between them. This is the most appropriate algorithm for use with continuous quantitative variables (Sudman & Blair, 1998). The obtained matrix of distances is represented as a UPGMA tree (Sneath & Sokal, 1973), which indicates the degree of similarity of seasonality patterns between parishes and periods. This is a method of analysis that is easy to interpret and has been widely used with demographic data, both from isonymic studies (Rodríguez-Larralde & Barrai, 1997; Rodrí guez-Larralde *et al.,* 2003; Dipierri, *et al.,* 2005) and studies of seasonality (Salvat *et al.,* 1996).

Finally, Pearson's coefficients of correlation were assessed between geographic or demographic variables and some indicators of seasonality for different parishes. The aim was to determine whether significant associations exist between the seasonality models and social, economic and demographic conditions in the parishes of Andorra.

Results

Andorra has maintained a stable population of, on average, 5000 inhabitants throughout most of its history (Llobet, 1947; Adellach & Ganyet, 1997). This demographic characteristic has changed in recent decades, giving rise to a progressive increase until a figure of more than 40,000 inhabitants was reached in the 1980s (Calvo *et al.*, 1990), a situation that is reflected in changes in the number of marriages according to period (Table 1) and parish (Table 2). The increase in the size of the population has not been proportional in all parishes within the principality; in fact, the majority have occurred in the parishes of Andorra la Vella and Sant Julià de Lòria, traditional destinations for immigrants (Riba Sabaté, 2004). Table 3 shows demographic and geographic data on each of the parishes. This unequal increase is mainly due to changes in the production strategy, passing from traditional dedication to agriculture and livestock to production based on services, commerce and tourism (Ferrer i Altamira, 1985).

Statistical analysis by χ^2 test revealed significant differences in marriage frequency according to the month of the year ($\chi^2=854{\cdot}2$; $p<0{\cdot}001$), indicating seasonality for marriages in Andorra. Henry's seasonality coefficient was highest in May, June and July (110·6, 156·2 and 144·3, respectively), revealing a tendency for marriages to occur in these months. The lowest values were obtained for March, January and December (43·4, 67·66 and 85·4, respectively). All parishes, and periods, showed a significant seasonality ($p<0{\cdot}001$).

Temporal variation in the seasonality model

Overall, the temporal changes in the seasonality coefficient (Table 4) reveal a model with a maximum in summer, between the months of June and July, and a minimum in the months of March and April that coincides with the end of the winter and the beginning of the spring. Nevertheless, each period presents a slightly different model. The first period (1601–1650) shows a maximum in November (211·76) and a second maximum in July (192·94). In the next period (1651–1700), the model changes slightly, shifting the maxima to the months of February (146·54) and October (135·14). The periods from 1701 to 1900 maintain a fairly similar model, with maxima in June and July and minima in March. The last period shows marked changes compared with the four previous ones, shifting its second maximum (121·25) to December and maintaining the minimum in March.

These variations are confirmed by ANOVA performed based on the linear regressions used to compare the seasonality models in all of the periods. The results

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Table 3. Demographic, geographic and social data on parishes in Andorra

	Andorra la Vella	Canillo	Encamp	La Massana	Ordino	Sant Julià de Lòria
Main current activities	Services, commerce and culture	Tourism, agriculture and livestock	Tourism and service industry	Tourism	Tourism, agriculture and livestock	Services and retail commerce (supermarkets)
Altitude, m	1013	1526	1238	1230	1311	908
Latitude	42° 30′ 0N	42° 34′ 0N	42° 31′ 60N	42° 32′ 60N	42° 32′ 6N	42° 28′ 0N
Longitude	1° 31′ 0E	1° 36′ 0E	1° 34′ 60E	1° 31′ 0E	1° 31′ 60E	1° 30′ 0E
Latitude	42·5000	42·5557	42·5333	42·5500	42·5500	42·4667
Longitude	1·5167	1·6000	1·5833	1·5167	1·5333	1·5000
Population in 1838	800	600	500	600	700	600
Population in 1960	4777	404	806	581	432	1392
Migration in 1826*	18·67	5·17	17·05	13·36	10·13	30·72
Migration in 1960*	78·72	56·07	60·17	48·75	50	68·31

*Calculated as the number of immigrants entering into a marriage contract.

Table 4. Distribution of Henry's seasonality coefficient and $\tilde{U}_h$ by period

Month	Period 1601–1650	1651–1700	1701–1750	1751–1800	1801–1850	1851–1900	1901–1960
January	70·59	102·58	70·53	63·53	63·48	67·42	66·90
February	84·71	146·54	148·69	102·75	99·27	83·83	64·58
March	4·71	35·82	31·45	40·78	54·70	38·69	56·21
April	37·65	32·56	71·49	61·96	110·07	103·76	99·88
May	65·88	71·64	58·14	116·08	139·11	131·90	120·79
June	94·12	127·00	160·13	198·43	170·85	155·94	125·90
July	192·94	125·37	175·38	178·82	152·62	143·62	115·68
August	136·47	123·74	114·38	112·94	97·24	99·66	104·07
September	98·82	81·41	63·86	91·76	81·71	90·28	110·10
October	164·71	135·14	135·35	95·69	76·31	90·28	107·78
November	211·76	99·32	104·85	81·57	80·36	107·87	106·85
December	37·65	118·86	65·77	55·69	74·28	86·76	121·25
$\tilde{U}_h$	1·038	0·491	0·504	0·454	0·342	0·358	0·267

Table 5. Comparison of seasonality models in Andorra according to period

	1601–1650	1651–1700	1701–1750	1751–1800	1801–1850	1851–1900
1601–1650						
1651–1700	0·065					
1701–1750	0·018*	0·003*				
1751–1800	0·117	0·089	0·002*			
1801–1850	0·493	0·508	0·044*	0·000*		
1851–1900	0·135	0·329	0·036*	0·000*	0·000*	
1901–1950	0·227	0·493	0·382	0·074	0·046*	0·002*

The lower portion of the matrix shows the p value obtained by analysis of variance following linear regression.
*Statistically significant correlations ($p<0{\cdot}05$).

suggest temporal heterogeneity in the seasonality model (Table 5). These variations are mainly significant between the earlier periods and the most recent. Thus, the model in the period 1601 to 1650 is significantly different from the models in the other periods, with the exception of 1701 to 1750. The period 1701 to 1750 displays a unique behaviour, since it does not differ from any other model, with the exception of 1901 to 1960. The periods 1751 to 1800, 1801 to 1850, and 1851 to 1900 present a similar behaviour without significant differences between them. The period from 1751 to 1800 differs from the model for the final period (1901–1960). This situation is not repeated in the periods that correspond to the nineteenth century;

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Table 6. Distribution of Henry's seasonality coefficient and $\tilde{U}_h$ by parish

	Parish						
Month	Andorra la Vella	Canillo	Encamp	La Massana	Ordino	Sant Julià de Lòria	Principality
January	79·5	41·0	83·9	46·4	53·2	83·6	67·6
February	118·5	66·1	109·1	103·7	65·9	136·2	104·4
March	50·1	19·2	39·5	42·3	35·1	63·3	43·3
April	90·1	58·8	84·7	85·0	99·5	108·6	87·9
May	118·6	72·1	107·1	115·6	128·0	129·8	110·6
June	136·0	160·1	151·5	195·3	189·6	125·7	156·2
July	122·7	200·6	103·2	173·5	163·1	115·3	144·3
August	101·1	138·4	116·7	108·3	109·9	62·7	104·7
September	101·5	100·6	92·7	65·6	94·8	83·1	91·5
October	94·9	129·8	131·2	78·2	84·9	91·8	101·7
November	97·7	136·2	102·7	103·5	104·2	96·2	101·8
December	88·8	76·1	77·2	82·3	71·3	103·2	85·4
$\tilde{U}_h$	0·251	0·654	0·326	0·449	0·459	0·249	

both maintain the same model as in the period corresponding to the twentieth century.

The $\tilde{U}_h$ coefficient provides complementary information (Table 4). A progressive reduction in this index is observed, with the highest values being obtained in the first period ($\tilde{U}_h$=1·038) and the lowest in the most recent ($\tilde{U}_h$=0·267). The values of $\tilde{U}_h$ remain more or less stable between the middle of the seventeenth century and the beginning of the twentieth, with values that vary between 0·504 and 0·342, but then display a marked reduction in the most recent period.

Geographic variation in the seasonality model

The six parishes present a maximum in the summer months of June and July, and a minimum in March (Table 6). This model contains two exceptions: the parish of Encamp – which presents a second summer maximum displaced to the month of October – and Sant Julià de Lòria – which behaves atypically, with a maximum in February and a second maximum in May. This peculiarity is confirmed by linear regression used to compare the seasonality models between parishes. Significant differences were only detected when Sant Julià was compared with Canillo, Encamp and Ordino (p>0·05 by ANOVA; Table 7).

Figure 2 shows the UPGMA tree, which displays the relationship between the seasonality models of the different parishes in terms of their similarities. Two clear groupings are seen, one associating the parishes of Sant Julià, Andorra la Vella and Encamp, and the other linking the more northern parishes of La Massana, Ordino and Canillo. This analysis reveals a south–north structure in the seasonality model.

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Table 7. Comparison of seasonality models in the six parishes of Andorra

	Andorra	Canillo	Encamp	La Massana	Ordino	Sant Julià
Andorra						
Canillo	0·016*					
Encamp	0·001*	0·012*				
La Massana	0·000*	0·003*	0·011*			
Ordino	0·001*	0·002*	0·009*	0·000*		
Sant Julià	0·006*	0·559	0·140	0·038*	0·111	

The lower portion of the matrix shows the p value obtained by analysis of variance following linear regression.
*Statistically significant correlations ($p<0.05$).

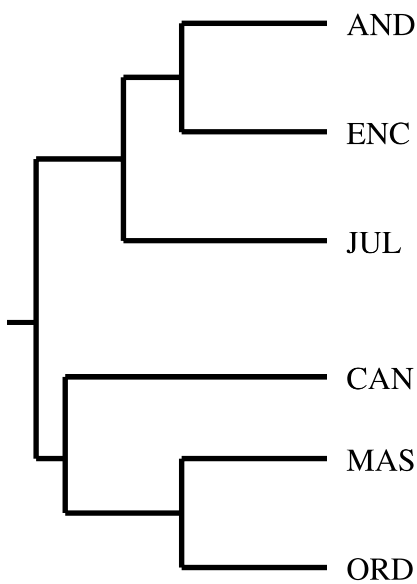

Fig. 2. UPGMA analysis of marriage seasonality for the seven parishes of Andorra. AND indicates Andorra la Vella; JUL, Sant Julià de Lòria; ENC, Encamp; MAS, La Massana; ORD, Ordino; CAN, Canillo.

These findings are supported by analysis of the $\tilde{U}_h$ index (Table 6). The indexes of variation or attenuation of the seasonality model show a clear geographic distribution. The lowest values are found in the most southern parishes: 0·249 and 0·251 for the parishes of Sant Julià and Andorra, respectively. Intermediate values are obtained for the two parishes situated in a geographically intermediate position: 0·326 and 0·449 for Encamp and La Massana, respectively. The highest values for $\tilde{U}_h$, corresponding to the most pronounced seasonality models, are found in the northern parishes of Ordino (0·459) and Canillo (0·654).

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Table 8. Pearson's coefficient for correlations between geographic and demographic variables and $\tilde{U}_h$, an estimator of attenuation of the seasonality

	Altitude	Latitude	Longitude	Pop 1838	Pop 1960	Mig 1826	Mig 1960	$\tilde{U}_h$
Altitude								
Latitude	0·104							
Longitude	0·104	**0·999****						
Pop 1838	−0·273	−0·624	−0·632					
Pop 1960	−0·595	−0·322	−0·321	**0·729***				
Mig 1826	−**0·937****	−0·057	−0·053	−0·028	0·362			
Mig 1960	−0·685	−0·396	−0·387	0·448	**0·881****	0·603		
$\tilde{U}_h$	**0·937****	−0·052	−0·058	−0·200	−0·613	−**0·870***	−0·692	

Pop, population; Mig, migration.
*$p<0{\cdot}05$, $p>0{\cdot}01$; **$p<0{\cdot}01$.

These results seem to indicate that the seasonality models have a distribution that is directly related to demographic and geographic factors. To confirm this hypothesis, the relationship between the $\tilde{U}_h$ index and demographic or geographic variables was assessed (Table 8). Significant correlations were detected between different variables. The strongest correlation was observed between latitude and longitude ($r=0{\cdot}999$; $p<0{\cdot}01$), suggesting that the populations situated in the valleys of Andorra are distributed in a south-western to north-eastern direction. For demographic variables, positive correlations were observed between the population in 1835 and that in 1960 ($r=0{\cdot}729$, $p<0{\cdot}05$) and between the rate of migration calculated for the year 1960 and the size of the population for the same year ($r=0{\cdot}881$, $p<0{\cdot}01$). In addition, there was a negative correlation between the altitude of the parish and the rate of migration for the year 1826 ($r=-0{\cdot}937$, $p<0{\cdot}01$). The $\tilde{U}_h$ index was positively correlated with a geographic variable, namely altitude ($r=0{\cdot}937$, $p<0{\cdot}01$), and negatively correlated with a demographic variable, migration calculated for the year 1926 ($r=-0{\cdot}8720$, $p<0{\cdot}01$).

Seasonality and ecology

The results presented above clearly suggest a relationship between the nuptial seasonality and the geographic distribution of the populations. The interpretation of this result is interesting since it suggests that at the same latitude the seasonality models are more similar. This may suggest that the variability in the seasonality patterns is directly related to the distribution of the populations. In support of this hypothesis, the most distantly related parishes in the UPGMA tree are Sant Julià and Ordino. In addition to being the populations that have had the highest and lowest rates of immigration, respectively, they also represent the southernmost and northernmost parishes. This clearly demonstrates that the seasonality pattern depends on demographics and exploitation systems that are grouped according to location.

If production patterns explain seasonality, and agricultural production depends on geographic factors, can local spatial variations be found in seasonality patterns? The

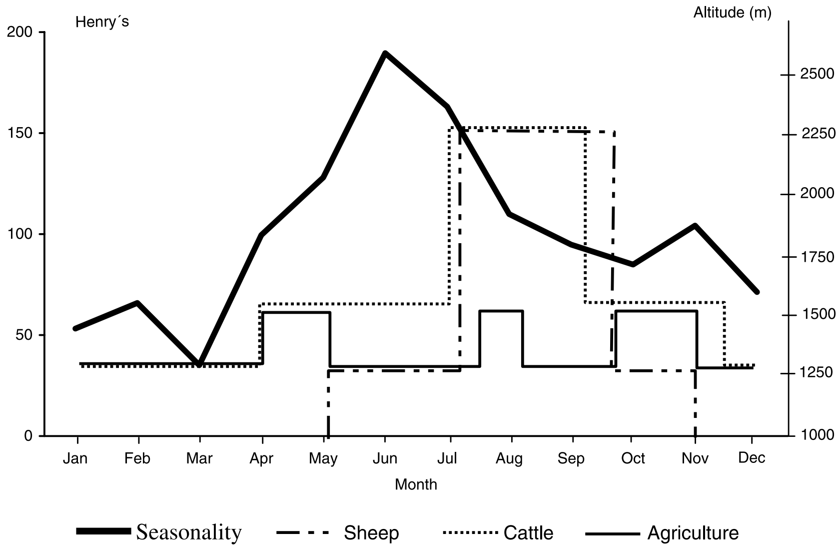

Fig. 3. Nuptial seasonality (thick line) in the parish of Ordino-Serrat shown in relation to annual movement of individuals associated with agricultural activities (continuous line) or livestock (sheep, broken line; cattle, dotted line).

geographic parameters of the populations that make up the Andorra valley show no notable differences. For instance, its latitude varies between 42° 39′ 15″ at Basers of Font Blanca (northernmost end) and 42° 5′ 38″ at Conangle (southern boundary), and its longitude varies between 1° 47′ 19″ at the eastern end (conflence of Riu de la Palomera) and 1° 4′ 34″ at the western end (Coll d'Aquell). The altitudes of the parishes range from 1027·5 m for Andorra la Vella to 1630·9 m in Canillo. Starting from the logical premise that social, cultural and, in particular, religious factors are uniform throughout the country, the hypothesis that these small geographic variations have been significant in shaping local differences in seasonality patterns between parishes can be tested. Thus, if there are any spatial variations, these would be assumed to reflect the agricultural and livestock production activities of each parish, and indirectly, the environmental conditions.

To test this hypothesis, the patterns of annual mobility related to livestock and agriculture, described by Llobet in 1947, were compared with seasonality patterns for marriages in the two northernmost parishes of Andorra: Canillo and Ordino. These two parishes have also maintained a closer relationship with traditional production methods and have been less affected by the demographic growth effect of recent years. In Figures 3 and 4, agriculture and livestock activities are shown alongside seasonality patterns for Canillo and Ordino parishes, respectively. The activities of both parishes are centred on displacements related to agricu1ture and livestock production. In the first pattern, corresponding to Canillo and designated Canillo-Inclès type by Llobet, the cattle are kept in the town during winter and are moved to the outskirts in spring and to higher grazing in the summer. In contrast, peasants reside in town until they have finished the harvest. Sheep, which arrive in the town from the lower valleys in

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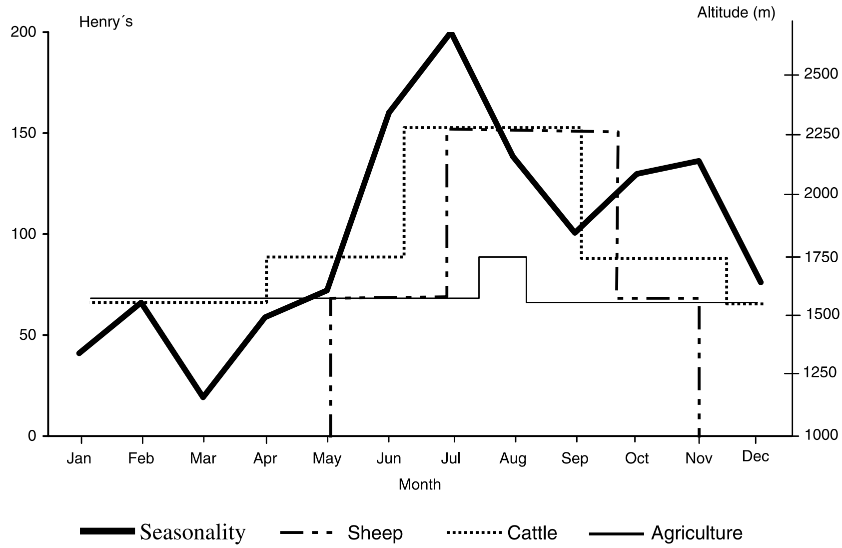

Fig. 4. Nuptial seasonality (thick line) in the parish of Canillo-Inclès shown in relation to annual movement of individuals associated with agricultural activities (continuous line) or livestock (sheep, broken line; cattle, dotted line).

May, stay in the surrounding area until the end of July, when they are moved to higher grazing. By the end of September, cattle return to the area surrounding the town and feed on hay and young grass shoots. Sheep later return to town and stay there until November, when they once again begin to be moved towards the plains of France and Spain. This same pattern, with subtle monthly differences, is seen in Fig. 4, which describes the population movements in relation to agriculture and livestock in Ordino; this corresponds to the Ordino-Serrat type described by Llobet.

Graphical comparison of the migratory displacement patterns and the evolution of seasonality coefficients reveals a significant overlap between summer seasonality maximums and the increased presence of shepherds and peasants in towns and surrounding areas. Likewise, the reduction of the seasonality maximum during summer coincides with migratory displacement to high grazing and maximum agricultural labour. The winter seasonality maximum also coincided, for both patterns, with the end of the migratory cycle and always occurred prior to livestock displacement to the plains in neighbouring countries.

In general, both patterns show a correlation between migration and seasonality coefficients. Moreover, the geographic and environmental variations that affect migration cycles also reflect seasonality patterns.

Discussion

In general terms, two periods can be defined in the Principality of Andorra based on demographic, social and economic characteristics. The first encompasses the period from the beginning of the seventeenth century to the beginning of the twentieth century and is characterized by a demographically stable population, with relatively low rates of migration and a society largely dependent upon agriculture and livestock production. The second period would encompass the years from 1930 to 1960 and would be characterized by a marked increase in the population due mainly to a high level of immigration and the substitution of traditional production methods, focusing the economy on services, commerce and in particular, tourism. Furthermore, this change did not occur evenly throughout the principality and the socioeconomic change has been more drastic in certain parishes. The southernmost populations, which have traditionally also been the largest and have represented the social centres of the country, have received the majority of the immigrants entering Andorra, at the same time as undergoing more profound social changes. The northernmost populations have undergone less marked, more gradual changes. It should be remembered that Andorra has a very particular orography, with the altitude of the population nuclei increasing in a gradient from south to north.

Analysis of the distribution of marriages, expressed in terms of Henry's seasonality coefficient, may reflect these profound socioeconomic changes. Seasonality is controlled by multiple environmental, demographic and socioeconomic factors. A detailed study of this parameter provides indirect information on important aspects of human populations and their relationship with the environment.

The general seasonality pattern detected in the Principality of Andorra is related, among other parameters, to the agricultural and livestock activities of the population (Danubio & Amicane, 2001). The seasonal migration, practised in most rural communities in the Pyrenees (Violant i Simorra, 1989), implies the absence of a number of male individuals in the valley. Agricultural activities are associated with displacement over shorter distances for less time. Thus, livestock migration, based on the need to feed sheep and cattle during winter, leads to the absence in the towns of a significant number of men of marrying age. Consequently, during winter there is no contact between men and women in the towns, thereby leading to a decrease in the number of marriages. A clear example in support of this hypothesis is the seasonality model of the two northernmost parishes in the principality, Canillo and Ordino.

Are there other factors that might account for seasonality patterns? Canonical legislation, which we can classify as a cultural factor, may also influence the unequal distribution of the number of marriages. The church forbids the celebration of marriages during Lent, which commonly includes the entire month of March. The minimum in December may be influenced by the religious festival of Christmas and reinforced by the period of Advent, which implies a religious vigil during the four Sundays leading up to Christmas. Therefore, seasonality depends upon a mixture of environmental and cultural factors.

Analysis of temporal changes in seasonality indicates a clear trend towards relaxation of the seasonality model. In addition, a new model is generated in which the maxima and minima are shifted. This new model is not so intimately related to agricultural and livestock activities, suggesting that there is a clear association between seasonality and production systems.

The information provided by geographic analysis of seasonality shows similarities to that obtained from analysis of temporal variation. The southern populations are seen to have undergone more intense demographic and socioeconomic changes than the others. This situation is reflected in their seasonality models. On the one hand, the $\tilde{U}_h$ index is greater in populations situated at higher altitudes (r=0·937), which in turn correspond to the most northern parishes. In addition, a significant negative correlation is observed between the $\tilde{U}_h$ index and rates of migration (r= −0·870), which have also been lower in the northern parishes.

The hypothesis that environmental conditions have more specific weight is supported by the observation that the seasonality pattern is changed significantly by alterations in the mode of production. Populations that are still devoted to agriculture and livestock production exhibit more acute nuptial seasonality than those parishes in which production has shifted towards service industries.

A population that has substituted its production system will, nevertheless, maintain its traditions. Thus, the relaxation of the seasonality pattern detected in the parishes of Andorra la Vella and Sant Julià is associated with the changes in economic strategy that have occurred in recent years in the Principality of Andorra.

A further indication of the importance of the environment in the control of seasonality is provided by the inter-parish variations in seasonality observed in this study. Although the pattern is very similar for all parishes, with maxima and minima that more or less coincide over the course of the year, interesting variations are, nevertheless, detected. Andorra is formed by two valleys in the northern region that join to form a single, larger valley in the south. This particular orography is crucial to explaining the inter-parish variations in seasonality. The northern valleys have slightly different microclimates, each of which imply slight variations in the temporal distribution of agricultural and livestock production activities. These variations are clearly detected in the Ordino-Serrat and Canillo-Inclès models. While the only appreciable difference between the two parishes is that one is situated in the north-western valley and the other is situated in the north-east, the agricultural and livestock production activities are out of phase by a number of weeks. The latitude and altitude are very similar, as are the demographic changes that have occurred in recent years, and the extent to which agriculture has been abandoned in favour of tourism and the service sector is comparable between the two parishes. Therefore, the small differences detected in the seasonality models are clearly accounted for by activities that are directly regulated by environmental conditions.

Andorra is a clear example of the changes that have occurred in Pyrenean populations in recent years, characterized by the substitution of traditional exploitation methods in favour of tourism and service industries, leading to an exponential demographic increase. These changes are reflected in the marriage distribution over the course of the year and have generated a relaxation of the seasonality pattern. In addition, a detailed analysis, facilitated by the particular characteristics of Andorra, has revealed that patterns of nuptial seasonality are intimately related to exploitation activities, which are regulated by environmental conditions acting within the cultural and religious framework of the population.

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