

# Biodemography and Alpine Populations: the Human Isolate of the Queyras (1670-1830)

M. Prost<sup>1</sup>, M. Girotti<sup>\*2</sup>, R. Boano<sup>2</sup>, E. Rabino<sup>2</sup>, S. De Iasio<sup>3</sup>

<sup>1</sup> UMR 6578 «Unité d'Anthropologie Bioculturelle», Université de la Méditerranée – CNRS-EFS, Faculté de Médecine, Secteur Nord, CS 80011, Marseille, France

<sup>2</sup> Dip. Scienze della Vita e Biologia dei Sistemi - Laboratorio di Antropologia - Università di Torino.

\* E-mail: marilena.girotti@unito.it

<sup>3</sup> Dipartimento di Bioscienze - Università di Parma

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## Introduction

Many studies have focused on Alpine populations. The aim was to demonstrate whether they represented real cases of "human isolates" or whether their isolation was merely geographical and not only genetic and reproductive. Several factors make a community feel "isolated": geographical aspects of the land such as mountains, water flows, lack of roads; these are all physical boundaries affecting people's ability to move from one place to another and making relationships amongst populations difficult [1, 2, 3, 4]. Being part of religious groups or different ethnic groups can cause a restriction to marriages [5, 6]. Furthermore, subgroups with an endogamic matrimonial attitude, usually due to social and occupational structure of the population, can bring about isolation within the same community [7, 8]. The populations living in disadvantaged ecosystem such as high mountains, must adapt their lifestyle in order to survive hard climate conditions. Alpine populations are often small groups, with little or no immigration at all, with considerable emigration of working age people. This can lead to a reduction of young people at their reproductive age who normally maintain continuity to communities. The lack of incoming genic flow increases the level of homozygosis within the population (Wahlunf effect) which can increase, as a consequence, the probability of deleterious recessive alleles.

## Materials and methods

In this paper we considered the biodemographical evolution of the population of the Alpine community of the Queyras area (Département des Hautes-Alpes) (fig.1) using the surname frequencies of couples extracted from marriage certificates (digitized by AG05<sup>1</sup>) for a period of about 5 generations, from 1670 to 1850. The marriage certificates are used in order to evaluate the genetic isolation since couples represent effective population of

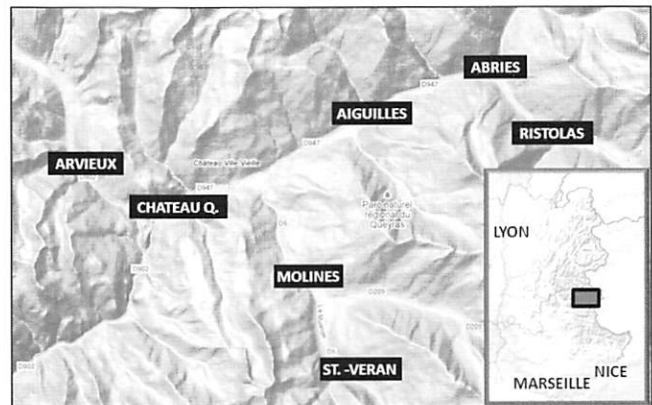


Figure 1. Location of community of Queyras

human groups: they guarantee the generational dynamic transferring the genetic heritage to their children [9]. The Queyras area is made of 7 villages at different altitude from 1350 to over 3000 mt (tab.I); nowadays the village of Ceillac is included, but it was not considered because anciently it didn't belong to the Queyras.

The area of Queyras is passed through by the Guil river. A valley bottom road connects the area to the Durance Valley, the Guil river is an affluent of. In the east, the Queyras is surrounded by alpine tops of more than 3000 mt. high which do not completely isolate the area because some crossing roads (the Agnel Col and some smaller ones), on the Avignon-Rome route, connect it to Italy (Piedmont). Another passage, the Izoard Col, connects it to Briançon, the previous capital city of the Republic of Escarton, which the Queyras area was part of.

The anthropization process of the area has strongly been affected by the rugged nature of the land, tough for cultivation and dwelling.

The data source is made of 5959 records of marriages celebrated in the 8 parishes of the community [10]. In the village of Château Queyras two parishes were included (which are here unified), while in the others there was just one parish each.

Reliable data on demographic evolution of Queyras were found since the end of XVI century when a survey on Escartons population highlighted 4960 inhabitants (tab.I). For each parish only the number of household heads is available,

Table 1. Characteristics of the parish community of Queyras

Municipalities	Mean altitude	1698 (*)	1730	1774 (*)	1790	1820	1831
Abriès	1538	304	1365	274	1812	1803	1838
Aiguilles	1470	140	808	180	980	960	983
Arvieux	1525	185	983	141	1034	907	965
Château Queyras	1350	215	1251	288	1344	1276	1378
Molines	1782	130	782	177	911	970	1030
Ristolas	1590	106	663	175	880	673	643
Saint Véran	2040	100	600	122	708	640	800
Total Queyras		4960 1180 (*)	6452	6175 1357(*)	7669	7229	7637

(\*) N households

which varies from 100 (Saint Véran) to 304 (Abriès). During the XVIII century the population increases of about 1400 units in just one generation period (6452 inhabitants in 1730). The development had to be supported by an important reproductive strategy, which, on the other hand, could not be supported by any advantageous migration, since the Alps had witnessed only emigration processes for a long time. About the end of the XVIII century, the population was made of about 7700 units, enlarged with 1250 individuals. According to early census, the increase in the number of the population stopped and the size of the community fluctuates around the numbers of late 1700. The most populated parish was permanently Abriès which was also the one to increase the most during the same period (34.7%); we refer to 1730 because in 1698 the data of residents per each parish is not available. At the same time, the other villages expanded as well, increasing from +10.2 (Château Queyras) to +33.3% (Saint Véran), except Arvieux and Ristolas which, on the contrary, decreased (-1.8% and -3% respectively). In general, in the same period, the community of Queyras increased its population by 18.4%.

The evolution of the genic pool of the population of the Queyras has been studied by considering the origin of the married couple and the variation of the frequency of their surnames. When the couple comes from the same village the marriage is called "endogamic". When less than a half of endogamic marriages is observed, the trend of marriages within the community is called "exogamic"; when endogamic marriages are almost 100%, it means that the matrimonial market is limited within the community; as a consequence, there is no entry of new genes and the population can be considered as isolated from a genetic and reproductive perspective. No standardization of surnames has ever been worked out and in fact their original forms, which have been registered, have remained; it must be also noticed that similar surnames have been considered as variants of the same form. An important reason for *bias* is due to the fact that exogamic marriages were traditionally celebrated (and then registered) in the parish of the bride while the subsequent residence became the husband's one (virilocal residence).

We have calculated several indexes from the frequencies of originals surnames.

- Index of patronymic diversity  $I_{dp} = (P-1)/\log(N)$  in which N is the number of marriages and P is the number of surnames from marriages. This index is used in ecology in order to measure the species richness [11]. A high  $I_{dp}$  reveals a great number of different surnames, which can be related to an open matrimonial market in a wide area; *vice versa*, a low  $I_{dp}$  reveals a number of marriages celebrated in restricted areas, generally in genetic isolation conditions.
- $I_{10}$  and  $I_{20}$  are the ratio of couples (males or females or both) with the most recurring 10 or 20 surnames in respect to the total number of marriages. The higher the number of the indexes, the more isolated was the population.
- $P_U$ : the ratio of the surnames with single repetition. This index reveals exogamy because such surnames are usually related to single immigrants *allochthonous*. The higher is  $P_U$  and the bigger is the number of new surnames, usually from external areas.
- $P_{ISO}$ : consanguinity [12], from the matrimonial isonymy. Based on the concept that should a couple have the same surname, they have a common ancestor. The methods overestimates the consanguinity due to the polyphyletic nature of the surnames [13].
- $P_{REPEAT}$  (the ratio of Repeated Pairs): division level of a population into endogamic subgroups, expressed by the number of couples of surnames which repeats in marriages [14].

## Results and discussion

The mountains which surrounds the Queyras might show how isolated the area was. In reality, alpine people had been able to adapt the landscape and also the issue of traveling from one place to another of the Alps had been solved by creating communication networks which permitted free traveling both in France and in Italy. If there was any isolation, this was a consequence of the reproductive behavior of the inhabitants in the Guil Valley who chose their partners within their village or in the

nearby villages; nevertheless, they were not able to enlarge their matrimonial market beyond the boundaries of their valley. Anyone who found his/her partner out of Queyras, did not come back to the native village; and so those who remained, continued the population by maintaining their surnames, since new surnames were not given the opportunity to get in. The rooting of native people explains the poverty of the pool of patronyms.

We now enter into details of biodemographical analysis. Each parameter has been calculated per each parish for the whole period 1698-1830, separately by husbands, brides and ensemble. Outcomes are represented in tab. II.

$P_u$  increases in relation to both immigration and to the characteristics of newlocal or virilocal exogamic marriages. The variety of surnames of husbands, expressed by  $I_{dp}$  <sup>husb</sup> is higher than wives' surnames, especially in Abriès ( $I_{dp}^{husb}=39.3$  vs.  $I_{dp}^{wives}=23.6$ ) and less in Arvieux (23.4 vs 19.2), while higher values of  $I_{dp}^{husb}$  are still located in Abriès (39.3) and in Molines (32.1). Molines shows the maximum variety of  $I_{dp}^{wives}$  (34.1). Abriès and Molines are a passage way to the other parishes (toward Italy and the Durance Valley) and it is possible that this condition had supported the encounter and the mixing up with other people of the Queyras area. The two isolated villages,

Table II Biodemographic parameters of the population of the Queyras villages

	Abriès	Aiguilles	Arvieux	Château Queyras	Molines	Ristolas	Saint Véran	Mean
$I_{dp}$ husb.	39,3	27,4	23,4	27,8	32,1	17,9	18,2	26,6
$I_{dp}$ wives	23,6	27,8	19,2	24,9	34,1	15,4	21,5	23,8
$I_{dp}$ ensem.	36,6	34,4	27,1	33,3	42,2	20,7	24,6	31,3
$P_u$ husb.	4,2	3,3	3,9	10,1	3,9	3,9	2,9	4,6
$P_u$ wives	3,0	3,2	2,9	7,3	4,7	2,9	3,8	4,0
$I_{10}$ husb.	65,1	68,5	73,8	63,3	53,7	82,8	69,2	68,1
$I_{10}$ wives	70,5	69,8	73,7	59,2	57,1	87,2	63,2	68,7
$I_{10}$ ensem.	67,7	69,0	73,6	58,0	55,2	84,6	66,2	67,8
$I_{20}$ husb.	86,4	83,6	91,0	79,6	74,0	93,1	89,0	85,2
$I_{20}$ wives	89,7	82,7	91,0	79,2	75,8	95,3	85,4	85,6
$I_{20}$ ensem.	88,1	82,3	90,7	77,8	74,7	93,4	87,2	84,9
P. isonymes	10,8	7,6	10,1	6,8	10,4	12,6	5,1	9,1
P. répétées	67,7	57,8	64,7	35,0	49,7	60,9	56,2	56,0
P. uniques	21,5	34,6	25,2	58,2	39,9	26,5	38,7	34,9
Inhabitants (*)	1714	872	606	1327	741	729	597	6586

(\*) Mean values of 1698-1830 computed by Moheau method

The average population of each parish has been estimated by using Moheau method starting from the number of celebrated marriages multiplied by 114 [15].

In Alpine communities the number of surnames has generally been limited due to the absence of immigration and present quite high frequencies. In these conditions both the index of species richness  $I_{dp}$  and the ratio of unique surnames  $P_u$  show low values. When exogamic marriages were celebrated, the couple usually moved to the native place of the husband (virilocal marriage) while the marriage was celebrated in the bride native parish. If the husband was allochthonous, the surname of the husband can be found only once in the registers where the celebration took place as if he was an immigrant; instead children were raised in the native place of the husband and their paternal surname was not repeated in the parish where the marriage had taken place. If the wife was allochthonous, the marriage is still virilocal but the marriage took place in the parish of the husband, the wife's surname occurred only once as if she was an immigrant, while the husband's surname was repeated in his own parish. The values of

Ristolas and Saint Véran, are in fact those with a lower variety of surnames both in their entirety ( $I_{dp}$ ) and their unique appearance ( $P_u$ ). On the other side, the iteration of unique surnames is very scanty everywhere: less than 5% for all parishes except for Chateau Queyras ( $P_u$  of 10.1 for husbands and 7.3 for wives), located in an ideal position in order to allow the meeting of people from the entire area. The values of  $I_{dp}$  (and  $P_u$ ) observed (from 20.7 to 42.2) reveal poor species richness and are lower than those found in other communities in the Hautes-Alpes (Valgaudemard, Embrunais, Briançonnais), included between 47 and 78 [13].

The ratio of people that can be identified with 10 ( $I_{10}$ ) or 20 ( $I_{20}$ ) most frequent surnames are also markers of the genetic pool's variety: as already mentioned, closed communities are made of few high frequency surnames and then  $I_{10}$  and  $I_{20}$  turn out to be high. Both parameters are affected by the sample size and in general the values are in opposite relation with the sample size.  $I_{10}$  varies from 60% to 70% and  $I_{20}$  from 79% to 89%. The parish with the most variable patronymic pool is Molines, which shows

the lowest values of  $I_{10}$  (53%-57%) and  $I_{20}$  (74%-76%); on the contrary, the village with the most homogeneous and least wide patronymic stock is Ristolas whose  $I_{10}$  values are included between 82-87 and  $I_{20}$  values between 93-95. It must be highlighted that Molines and Ristolas both have very similar mean sample sizes (741 and 729) and their  $I_{10}$  and  $I_{20}$  show diversity in the structure of the surnames. The ten most frequent surnames in each parish are differently spread all over the area (tab. III) Each parish is

evidence can be provided, that some matrimonial strategies in Ristolas and Saint Veràn were different; which means that in Ristolas, marriages between blood related people were supported in order to keep the property within the family. The mean ratio of isonymic marriages in the Queyras area (9.1% average) is certified in the 8%-11% variation range of the nearby Villar S.Panrace, Montgenèvre, la Salle and Vallouise. About one marriage out of ten celebrated in the Alpine area presented isonymic features.

Table III. Surnames with ten frequencies up to the single parishes of Queyras

Abries	Aiguilles	Arvieux	Château Q.	Molines	Ristolas	Saint Véran
Peyras	Jouve	Eymar	Philip	Garcin	Laurens	Blanc
Toye	Guérin	Blanc	Borel	Vasserot	Gerard	Vasserot
Audier	Vasserot	Albert	Thiers	Berge	Albert	Isnel
Martin	Loubet	Philip	Gondret	Martin	Borel	Mathieu
Avieny	Villan	Meissimilly	Martin	Borel	Brun	Jouve
Vial	Bertrand	Simond	Puy	Blanc	Blanc	Barthélémy
Richard	Challe	Borel	Meyer	Eme	Bues	Arnaud
Vasserot	Bellon	Martin	Nel	Arnaud	Reynaud	Brunet
Bessey	Laurens	Dalmas	David	Fine	Flandin	Berge
Bellon	Jayme	Faure	Marcou	Bellon	Alberton	Marrou
67,7%	69,0%	73,6%	58,0%	55,2%	84,6%	66,2%

made of specific patronymics: no surname is at the top of the frequencies in more than one village and very few are those repeated in the top three places. Molines and Ristolas share, amongst the top ten, just Blanc and Borel, two very old surnames spread in southern France and with sure polyphyletic origins. Other patronymics have been found in only one village and might have a monophyletic origin: for example, Toye and Avieny can be found only in Abriès; or Isnel only in Saint Veràn. This might be because surnames' exchange also within the communities in the Queyras area was quite inadequate and circumscribed to nearby villages. The difference of  $I_{10}$  and  $I_{20}$  between male and female in the same village are minimal (less than 1%) which might be caused by both a strong endogamic marriage attitude and an equal attitude between genders in the choice of partners. In order to summarize, from the analysis of the 10 and 20 most frequent surnames, we can deduce that the contribution of surnames from outside the Queyras area was very limited while the mixing up within the area seemed to be a little higher even if mainly among nearby villages.

Isonymic marriages  $P_{ison}$  (tab.II) represent from 5% to 12.6% of the overall for the parish of the Queyras area. The factors which increased their iteration are: limited size of village, the low species richness (patronymic diversity) and the attitude to celebrate marriages between consanguineous people. The highest frequencies of  $P_{ison}$  can be found in Ristolas which is also the village with lowest  $I_{dp}$  values and highest  $I_{10}$  e  $I_{20}$  values. In other villages  $P_{ison}$  is about 10%. It is hard to understand the low ratio of isonymic marriages in Saint Veràn, which has mean biodemographical values but the smallest sample size. It is possible, although no documentary

It is possible to identify particular structures of matrimonial strategies by searching for and analyzing couples of surnames repeated many times in the same parish which point out preferential unions among the population. The ratio of repeated couples in the 7 parishes of Queyras is widely variable (Tab.II,  $P_{repeat}$ ) from 35% (Château Q.) to almost 68% (Abriès). In this last parish the matrimonial strategies had a great importance if we add isonymic couplet (10,8%) to the fraction of repeated couple (68%): about 80% of marriages turns out to not satisfy the panmixia condition. On the other hand, Abriès is the most populated parish with the highest patronymic diversity. Beside the kinship criteria, other mechanisms (*in primis* the social-occupational homogamy) divided the population into "subpopulations" with endogamic behaviour. On the contrary, Château Queyras presents "only" 35% of repeated couples; this it is the village with the highest fraction of unique surnames and also  $I_{10}$  and  $I_{20}$  are the lowest. The percentage of repeated couples  $P_{repeat}$  in the Dauphiné Alpine area was instead very variable: if in Queyras the general average of the period was 56%, in Chiomonte (Torino, Italy) was only 6% and in Vallouise 24% [16].

In the last line of Tab. IV, the ratio of the couples observed only once in the *corpus* of marriages is highlighted ( $P_{uniq} = 100 - \Sigma(P_{ison} + P_{repeat})$ ). This identifies "unique" couples, mainly with exogamic origins for at least one of the partners. About 60% of the couples in Château Queyras are not neither isonymic nor repeated and almost certainly at least one of the partner comes from out of the village. *Vice versa*, in Abriès, Ristolas and Arvieux only 25% has a unique combination of surnames in the patronymic pool.

Table IV . Geographic endogamy into parish and into community

Parish	Observed (and expected) endogamy (in %)		(\$)Queyras contribution
	Into parish	Into community	
Abries	86,2 (149**)	96,3 (167**)	+ 10,1
Aiguilles	82,7 (79 ns)	96,2 (89 ns)	+ 13,5
Arvieux	88,3 (58**)	92,6 (64**)	+ 4,3
Château Queyras	86,8 (117**)	96,0 (131**)	+ 9,2
Molines	79,5 (68 ns)	91,7 (77*)	+ 12,2
Ristolas	87,8 (68**)	98,1 (76**)	+ 10,3
Saint Véran	84,7 (57**)	96,4 (64**)	+ 11,7

(\*\*) P level &lt;0.01

(ns) P level &gt; 0.05

(\$) Endogamy into community - Endogamy into parish

One of the main aspect of the biodemographical study of matrimonial market consists of the analysis of the endogamic and exogamic unions since the genic pool depends on the contribution of new alleles' structures which can enter the community through immigration due to occupational reasons but mainly through matrimonial immigration (tab.IV). For the case study there are different levels of endogamy and exogamy: the single parish one, involving marriages between native people in each village; the community one, involving partners from the Queyras area in general. With endogamy rate into parish  $\geq 80\%$  the villages in the Queyras reveal their condition of marriage and reproductive isolation which lasted for more than two centuries. If we also consider the "Queyras contribution" (percentage of marriages between partners from different parishes but always from the Queyras area) the level of endogamy exceeds 90% all over the area, the top being in Ristolas (98.1%). Only Molines reveals a non substantial closure, as it was highlighted in the analysis of biodemographical parameters in tab.II: although it is very high (79.5%) endogamy within the parish is the lowest among all but matrimonial openness is mainly addressed to the other villages in the area ("Queyras contribution" equal to 12.2%).

Similar levels of endogamy can be only found in the valleys around Briançon (84.7%), while in other locations in the Dauphinée area (Champsaur, Valgaudemar, Oisans) the values exceed 50% [13]. These differences are probably due to the twist among different matrimonial strategies and management or transmission of estates: the community in Briançon was made of small holders who could freely manage their lands and they could transmit, sell, donate their goods as they pleased.

In Alpine society, the matrimonial behaviors, developed in different social and working classes (craftsmen, merchants, landholders, farmers, physicians...), diverged [17] and affected endogamy (or exogamy): the general level depended on the distribution of occupations amongst the inhabitants in the Valley. Also religious aspects can lead the couples toward different structure of homogamy [5] but this might have partially involved the Queyras since almost all the inhabitants were Catholic.

Only 4.5% of the marriages celebrated in the parishes we studied, involved partners from out of Queyras. The genic contribution of these strangers must have been minimal if we think that at least until the half of the XIX century, mortality rate was still high and one of the two partners could die soon, just like their children could die before the reproductive age. We point out the story of an immigrant from Palermo who got married to a French woman in Saint Veràn but left no children in any of the Queyras parishes: a lost occasion. The isolation in the area must have lasted for a long time since there was no evidence of marriages in Vallouise (on the opposite shore in Durance) involving partners from the Queyras for about 500 years [18], 8 were the celebrations in the area between native people and people from Vallouise; the reconstruction of the families in this country has highlighted how, after three generations, their lineage extinguished and the genes from Vallouise disappeared from Queyras populations. In the end, consanguinity has been marginally analyzed, since we do not have any information on matrimonial booklets neither for Château Queyras nor for Molines; furthermore, the effectiveness of computed data are being doubted for the other 5 parishes. The ratio of marriages is around 23% of the overall. These are high values and they put Queyras close to Oisans (22,4%) [19]. In the French Alps, the tradition of choosing their own partners among people of the same kinship was maintained (about  $\frac{1}{4}$  of partners) for a long time.

Previously, the hypothesis of the proximity of the parishes and their position along a given road affected matrimonial exchanges and on biodemography of the population of the Queyras area. We have tried to verify it by clustering the villages according to their proximity and making three new geographical units (Guil low Valley, Guil high valley, Aigue Agnelle Valley) and recalculating biodemographical parameters described in Tab. II. Two new indexes are added:  $\alpha$  of Bernstein (level of consanguinity =  $\sum p_i F_i$  in which  $p_i$  is the relative frequency of consanguineous marriages of  $i$  degree and  $F_i$  is the respective coefficient of inbreeding) and  $F_{iso}$  (non random consanguinity assessed through the matrimonial isonymy), density of villages, the mean population size and the mean altitude (tab.V).

Table V. Average of biodemographic indexes for near villages of Queyras

	Arvieux & Château Q.	Molines & St. Véran	Aiguilles & Abries & Ristolas	Max differ.
$I_{dp}$	30,2	33,4	30,6	3,2
$I_{10}$ (%)	65,8	60,7	73,8	13,1
P. ison. (%)	8,5	7,8	10,3	2,5
P. repeat. /%	49,9	53	62,1	12,2
Endogamy (%)	87,6	82,1	85,6	5,5
$F_{iso}$ (%)	2,14	1,94	2,6	0,7
$\alpha$ Bernstein (%)	0,72	0,91	0,62	0,3
Density (inhab/ha)	8,5	7,4	6,8	1,7
Pop. size	967	669	1105	436
Altitude (m)	1438	1911	1533	473

Data are different among the communities clustered by density, altitude and size. Instead, the highest variance of biodemographical indexes  $I_{dp}$  (3.2),  $I_{ison}$  (2.5) and isonimy (5.5) reveal a certain similarity among the three clusters. The most frequent surnames  $I_{10}$  and the percentage of repeated couples  $P_{repeat}$  diversify Guil low Valley and Aigue Agnelle Valley, with a variance of 13,1% and 12.2%. Outcomes are opposing: some indexes put the three clusters closer, others separate them.

In fig. 2 the outcomes of the Multiple Correspondence Analysis (ACM) on the 7 parishes by using only the biodemographical indexes is represented. Both the first and the second axis sum up the 17% of the variance; from the bidimensional representation is missing an important quota of the overall information. On the first axis we identify the sequence of the parishes in the Guil Valley (black line) although Ristolas does not array, we have remarked that this village had its own features. On the second axis we notice the villages of cross valleys (solid grey line) are separate from the Guil Valley toward the lowest part of the graphic. The ACM retraces the biodemographical relationships among the villages so that it can be compared to the geographical map, although it sums up only 34% of the overall variance.

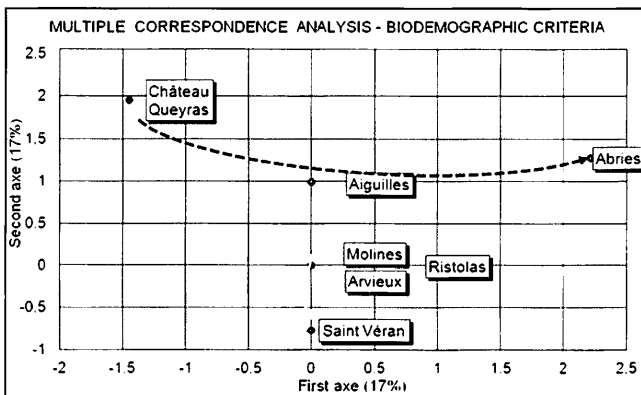


Figure 2. Multiple Correspondence Analysis. Biodemographic variables.

### Conclusions

The use of the partners'surnames has been a helpful criteria for the analysis of the Alpine population in the Queyras area. Most of the biodemographical indexes drawn from the repetition of the surnames lead to similar interpretations.

The lack of partonymic pool (low  $I_{dp}$ ); the ability to summarize with few surnames an important quota of genetic heritage ( $I_{10}$  and  $I_{20}$  high values); the high ratio of repeated couplet ( $P_{repeat}$ ); the almost non existing exogamy, they all represent this alpine population's old and closed matrimonial market. Endogamy is within every parish and when one of the two partners comes from out of the parish always comes from the same Queyras area. Very rare are allochthonous contributions from the rest of France. From this matrimonial behavior, which lasted for centuries, a genetic pool has been created with little differences between the parishes. The geographical proximity has played an important role in differentiate the populations in the villages: few matrimonial exchanges took place especially in the nearby parishes in the same sub-areas in the Queyras area.

In the end, the high Alpine environment widely affected the matrimonial market. The analysis of surnames have confirmed that in XVII-XIX centuries, the Queyras area has really turned out to be a genetic isolated. Each parish or village adopted a substantially uniform matrimonial attitude through homogeneous marriage and reproductive strategies in order to maintain their communities. By choice or by necessity, the populations had to make it by their efforts, with very little help from outside.

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## Notes

1. Association Généalogique des Hautes Alpes, 19 rue de France, 05000 Gap.