Surnames in Uruguay. The structure and migration patterns of the population of Uruguay through isonymy

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The structure and migration patterns of the population of Uruguay through isonymy

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Abstract

Surname distribution can be a useful tool for studying the genetic structure of human population. In South America, Uruguay population has traditionally been considered as from European ancestry, despite its trihybrid origin has been proved through genetics. The aim of this study was to investigate the Uruguayan population, for detecting its structure resulting from population movements and surname drift in the country. The distributions of the surnames of 2,501,774 electors were studied in the 19 Departments of Uruguay. Multivariate approaches were used to estimate isonymic parameters. Isolation by distance was measured by the correlation between isonymic and geographic distances. In the sample the most frequent surnames were consistently Spanish, reflecting that the first immigration waves occurred before the Uruguayan independence. Only few surnames with Native origin have been recognized. Effective surname number (α) estimated for the entire Country was 302, the average for departments was 235.8 ± 19. Inbreeding estimates were lower in the south-western, and in the densely populated Montevideo area. Isonymic distances between departments were significantly correlated with linear geographic distance ($p < 0.001$) showing that there is a continuous increase of surname distances up to 400 kilometres. Surnames form clusters related to geographic regions with different historical processes. The isonymic structure of Uruguay showed a radiation toward East and North, with short range migration playing a major role while the contribution of drift, considering the small variance of α, appears to be minor.

Introduction

Studies of the genetic structure of the population of the South American nations are relatively recent, and refer mainly to the frequencies of traditional DNA markers. This is true also for Uruguay, whose population has been analyzed using classical genetic markers as well as nuclear and mitochondrial DNA markers (Sans *et al.,* 1994, 1997; Bravi *et al,.* 1997; Sans *et al.,* 2002, 2006, 2011; Bertoni *et al.,* 2003; Bonilla *et al.,* 2004; Gascue *et al.,* 2005). Genetic data has shown that the continental contributions to Uruguayan populations are around 10-14% Native American populations, 7-9% sub-Saharian African, and the rest, from Europe or the Mediterranean sea (Hidalgo et al 2005, Bonilla et al 2015). However, Uruguay lacks of data about its genetic structure using surnames, with only one study that includes isonymy related to a small population derived from a former a Native reduction: Villa Soriano (Barreto 2011).

The use of surnames has been controversial as several evidences show their have been changed or taken from others non-related individuals. For example, in Uruguay present populations lack of Native-origin names, with very few exceptions. That is the case of the descendents of Charrúa Chief (cacique) Sepé, who used initially Sepé as a surname but changing it lately to García as can be seen at present (Acosta y Lara 1981). Gonzalez-Rissotto and Rodríguez-Varese (1989) state that the Indians from the Jesuit Missions that come to Uruguay changed their habits and their names hiding their Native ancestry. Also, African slaves and their descendents took different surnames, as those from their owners or others, as can be seen in some examples done by Rosal (2009) referred to African or African-descents in Buenos Aires, Argentina. However, few studies were performed on that topic in Uruguay, and in general terms, focused in particular issues as for example, the Africans or African descendants that took the name of the national hero Artigas (Yarza Rovira 2009). Moreover, some surnames from Europe, the Mediterranean region or others were changed or spelled in different ways (Flores 2010). By last, paternal surnames are frequently lost because of illegitimate unions (see for example, Barreto 2011), the lost of surnames due to adoption, and the inversion of the order of maternal and paternal surnames as consequence of the influence of the Portuguese- Brazilian system of surnames, especially near the Brazilian border. Moreover, since 2004, in Uruguay it is possible to choose the paternal or maternal surname as first surnames, and children with only one last name receive either the two maternal (or paternal) surnames or the assignation of a "common name" when the child has only one parent, and this parent only has one surname (Law 17.823 2004). However, all individuals considered here were born before 1993, that is, before the application of the LawThen aim of this work is to perform a comprehensive study of the present isonymic structure of Uruguay, resulting from population movements and surname drift in the country. For that purpose, the Uruguayan population was investigated for detecting its structure through the study of isonymy (Crow and Mange 1965; Yasuda and Morton 1967) in the main administrative level of the nation, namely its 19 Departments. Isonymic distances between departments were analyzed in relation with geography. Moreover, by studying the geographic heterogeneity of surnames based on the analysis of different isonimic parameters, it is possible to obtain signs of the direction of migrations.

Materials and methods

Data. The República Oriental del Uruguay is one of the smallest countries in South America, surrounded by Argentina and Brazil, and with coast to the Atlantic Ocean. At its maximum, it is about 700 kilometres long and 500 wide, for an area slightly larger than 176,000 square kilometres, inhabited by approximately 3.3 (3,286,314) million persons according to the 2011

National Census (INE, 2011). It is divided in 19 Departments, political entities at the level of subnation.

In Uruguay, surnames originated and have been established generally in the same way as in most South American countries. However, Uruguay and Argentina make an exception to the Spanish biparental surname system, the maternal surname being generally not mentioned although it appears on official documents.

In 2012, authors JED and EA obtained from the Corte Electoral of the Uruguay the data suitable for describing the isonymy structure of the country with the methodologies developed by us. In the data which were made available, the list of the electors of the 2011 presidential general election, a total of 2.5 million electors (that is, all individuals over 18 years old) were distributed in the 19 departments of the country.

According to the 2011 National Census, 7.8 % of those interviewed reported having African descent, while the percentage of Amerindian descent was 4.9 %; 90.8 % stated European descent and only 0.5% recognized an Asian descent, while 3.6% gave no data (INE 2012). These percentages take into account multiple descents. Since the ethnic origin, as mentioned above, is only weakly related to surnames, in the present analysis, ethnicity was ignored and departments (subnational level) were taken as statistical units. The geography of departments is well defined, and all the individuals in the sample available are classified according to the department in which they are enrolled to vote. This location is usually the place of residence, and not always coincides with the place of birth inside Uruguay. For the analysis, we had available 2,501,774 paternal surnames, that is, the total number of paternal surnames.

The area studied covered the entire nation. The 19 departments differ in position, area, and population (Fig. 1). There are three main rivers, Río de la Plata, Uruguay, and Río Negro, and most departments border with them. Río Negro divides the country in North and South, and this fact is related to the country's peopling: while the South was mainly populated from the harbor of Montevideo, the North (at least the North East) was mainly populated from Brazil (Pi Hugarte and Vidart 1969). In the following subsections, Uruguayan surnames are considered briefly, and some of the statistics derived from the surname distributions were revised, as well as its meaning in the study of microevolution in human groups.

Surnames frequencies and occurrence. The surname distribution for the whole Uruguay was studied, fitting a regression line to the log-log transformation of the number of surnames (S) which are represented k times (Fox and Lasker, 1983).

Isonymy theory. The main statistics derived from the surname distributions are: Isonymy within (I_{jj}) and between (I_{ij}) groups, the effective surname number corresponding to Fisher's Alpha (α), Karlin-McGregor ν(ν) and Isolation by distance, as measured by the correlation of geographic with Lasker's (L), Euclidean (E) and Nei's (Nd) distances. The definitions of these statistics and their meaning in the study of microevolution in human groups were detailed before Barrai *et al.,* 1996, 2000; Rodriguez-Larralde *et al.,* 2011; Dipierri *et al.,* 2005; but also Herrera Paz *et al.,* 2014 for Fisher's α corresponding to the effective surname number); for an exhaustive review see Relethford (1988).

Random kinship. Random kinship $\Phi_{\mathbf{IJ}}(x)$ between any two localities I and J at distance x is given by

$$\Phi_{\mathbf{IJ}}(x) = K \exp(-Bx)$$ (Malécot 1955; Kimura 1960)

where K is the average kinship at geographic distance x=0, say average F_{ST}, and B is a function of average mutation rate and of the variance of x. The value of $\Phi_{IJ}(x)$ is always positive and is expected to decrease exponentially to 0 with increasing distance. Random kinship between groups I and J was estimated as

$$\Phi_{\mathbf{IJ}}(x) = I_{IJ}(x)/4$$

(Barrai *et al.,*, 2012) with average $F_{\mathbf{ST}}$ as the average kinship at distance x=0.

Linear geographic distances were obtained from the ArcGis® (ESRI) software.

The significance of correlations was assessed with the Mantel's test using 1000 permutations (Mantel 1967; Smouse *et al.,* 1986). For a graphic representation of the surname relationship between surname distributions of different locations, these were mapped on the first and second dimensions of the Multidimensional Scaling (MDS) of Nei's distance matrix. To this purpose, the R® software package was used (R Development Core Team 2012). In order to detect the direction of surname diffusion, following Menozzi *et al.,* (1978), the first three components from the Principal Component Analysis (PCA) of the same matrix were also projected individually on the Uruguay map, again with the ArcGis® (ESRI) software package. To clarify and complement the clusterings obtained with the MDS dendrograms of departments were built, obtained from the matrices of isonymic distances between these administrative sections. The dendrograms were considered only as an additional option for the clustering, and do not imply that our results were generated by subsequent splits of preexisting clusters.

Results and discussion

The most frequent surnames

The distribution by department of the surname numbers used in the analysis, with the main parameters derived from the isonymy theory, are given in Table 1.

The distribution of the logarithm of the number of surnames over the logarithm of the number of times (Fox and Lasker 1983) was fairly linear.

Some convexity of the distribution is apparent and a possible explanation is the immigration of independent family groups with uncommon surnames, which has been observed in Uruguay. In Table 2 the average number of persons carrying the same paternal surname is 36, the lowest type-token ratio (Adamic and Huberman 2002) observed in previous studies which overall cover 6 countries and more than 77 million surnames from Spanish-speaking populations. However, this value is similar to those from Spain, and comparable to other European countries.

The low type-token ratio as well as the high presence of uncommon surnames in Uruguay is coherent with the several migration waves that make up Uruguayan population, together with and the slave trade and over the Native background. Differently to Latin American countries more related to the first time of the conquest, Uruguay was lately populated by the Europeans, being the first settlements founded during the end of the 17th Century by Iberians (Spanish and Portuguese) who brought some African or African-descendents slaves. At that moment, a relatively small quantity of Natives, mostly form Pampean or Guarani origin, occupied the whole territory. In 1662, Spanish founded Villa Soriano, initially a Native Indian reduction, and in 1680, Portuguese founded Colonia del Sacramento. Lately, in 1724-27, Spanish (mostly from the Canary Islands) founded the capital city of Montevideo. After the installation of the Republic (1830) during the 19- 20th centuries, waves of immigrants came from different European and Near Eastern countries (in order, French – mostly Basques –, , Spanish, Italian, Slaves, Armenian, Jews and Syrian-Lebanese (Pi Hugarte and Vidart 1969). These migrations lasted until de 1960 decade and have restarted recently.

The 50 most frequent surnames were studied in some detail. In the series, the most frequent surnames were Rodríguez with 75,039 occurrences, González with 50,573, Martínez with 37,637, Fernández with 31,769, Pérez with 28,511, and García with 27,331. After these, one finds Silva (27,070), López (21,959), Pereira (21,337), and in the tenth place Sosa (20,257). Overall the first ten surnames comprised 341,483 individuals, or 13.6 per cent of the total number of electors.

The most frequent surnames were consistently Spanish. The main difference is represented by Portuguese surnames, frequent in the North East of the Country near the Brazilian border. So, surnames like Ferreira (15,624), the mentioned Pereira (21,137) and Silva (27,070) are highly represented. These surnames however are frequent also in Spain. Iberian surnames reflect the conquerors and colonizers that entered the country since the 17-18th centuries, as it has been mentioned above. Moreover, an alert should be done, as Iberian surnames also applied to Natives and Africans who take names from conquerors, owners, or others, during the Spanish/Portuguese domination, with some exceptions as caciques Brown and Rondeau who take names from Almiral George Brown and General Jose Rondeau, military who participate in the Independence war against Spain (Lucas 1992)**.**

Italian surnames were less represented. The most frequent is Ferrari (2,206), followed by Rossi (1,746), and Bianchi (1,176), the three ubiquitous in Italy, and then Parodi (1,390), typical of the Genoa area, and Sanguinetti (1,249) from Eastern Ligury. Two Basque surnames: Duarte (forty-third, with 6,300 representations) and Larrosa (forty-ninth, with 5,632) were among the most frequent fifty surnames. Italian migration was mainly related to the first waves after Independence, following French (mostly Basque) and Spanish (Pi Hugarte and Vidart, 1969).

These fifty most common surnames did not include anyone related to the latest immigration waves that took place during the end of the 19th and the first half of the 20th centuries, from different regions including Central-East Europe and the Near East. However, it is possible to identify some that denote those different origins, as Muller/Moller (German, 627 representations), Armand Ugon (Waldensian, 317), Miller (English, 310), Schmidt (German, 216), Cohen (Jew, 154), Garabedián (Armenian, 59). Moreover, as spelling have usually several ways, it is possible to consider terminations: “ián”, usually Armenian, had 5,800 appearances, termination “sky/ski” (Slavic, mostly Polish), 2,958, termination “berg” (German/German Jew), 913, and termination “skas” (Lithuanian), 276. We also detected at least two Native Indian surnames, originally from the Jesuitic Missions: Yasuiré, with 111 representations, and Barité, with 64. No African-origin surnames were identified, despite special attention was taken to the possible use the names of places of birth or ethnic groups, as described by Cuba Manrique (2002) in her study about the surnames of African slaves in Perú. A detailed analysis of the origin of surnames and their mutations will be done in a future article.

Isonymy parameters in Departments

In the following, values of the isonymy parameters in the country were given as a unit and at the departmental level.

Fisher's α and inbreeding by isonymy. α is one of the estimates the effective surname number. It estimates the number of surnames which, having the same frequency would result in the same isonymy as the one actually observed.

In Uruguay, departmental α is correlated (r= 0.736, P<0.00033) with longitude, but not with latitude (r=0.24, non-significant). So, high α and low F_{ST} are clustered in the South-Western departments, while lower α and higher inbreeding are observed in the North-Eastern ones. This fact can be explained taking in account immigration and regional history: the North-East region was populated mainly from Brazil, while the South-West received European (besides Iberians, Italian and Basques: Germans, Waldesians, British, Russians, Armenians) and Near East immigration waves (Turkish, Syrian, Libanese), some of them funding colonies in the West and South West of Uruguay (Pi Hugarte and Vidart 1969; Vidart and Pi Hugarte 1969; Barrán and Nahum 1971).

The effective surname number, α, in Uruguay was estimated at 302 for the Country considered as a unit. The average for the 19 Departments was 235.8 ± 19.1.

The difference between administrative levels, and the country as a unit, is observed when different subdivisions of the same area and population are considered. This constitutes the "Prefecture Effect", identified for F_{ST} by Nei and Imaizumi (1966) in Japan, and so named by Scapoli *et al.,* (2007). Nei and Imaizumi observed that, for the same area and population, small subdivisions have larger F_{ST}, and larger subdivisions have smaller F_{ST} . In their study, the effect was seen in towns and in the Japanese prefectures where the towns were located; hence the name. In Uruguay, Departments are analogous to Japanese Prefectures. So the difference in α between the country as a whole (302) and the departmental average (235.8) is a standard 'Prefecture effect'.

Values of the inbreeding coefficients and of α for departments are given in Table 1. The highest value of α (393.4), corresponding to the lowest random inbreeding, $F_{\mathbf{ST}}$ (0.000637) are observed in Paysandú, followed by Soriano and (376.5, 0.000666 respectively) and Colonia (361.5, 0.000692). These three departments are in the Argentinean border, along the Uruguay river. The opposite values correspond to the North-East, being minimum in Rocha (121.8) with the highest Fst (0.002040) followed by Cerro Largo (154.8, 0.001608 respectively) and Rivera (161.1, 0.001545), all these departments in the Brazilian border. In Montevideo, the Department with more quantity of electors, α is 346.1, while at the other extreme, the department of Flores, with about fifty time less electors than the capital, α is 208.8, indicating a minor effect of sample size on α.

Isolation by distance. Isolation by distance was studied through the correlation of geographic with surname distances at the department level. Nei's, Euclidean, and Lasker's distances between the 19 departments were significantly correlated with linear geographic distance, highest for Nei's (r=0.57 ± 0.073), intermediate for Euclidean (r=0.46 ± 0.079) and lowest for Lasker's (r=0.17 ± 0.097). As an example, the scatter diagram of Nei's distance between departments over the geographic one is given in Figure 2. Nei's distance had the largest correlation.

The signal extracted from the scatter diagram of Nei's distance for departments is given in Figure 3. A clear tendency toward an asymptote is not observed, as it was in Spain, Bolivia, Chile and Honduras (Rodriguez-Larralde *et al.,* 2003, 2011; Barrai *et al.,* 2012; Herrera Paz *et al.,* 2014). In these countries the relation between isonymic and geographic distance flattens after 100 kms. In Uruguay there is a continuous increase of surname distance up to four hundred kilometers, which gives indication of the presence of increasing isolation and drift up to that distance. 171 pairs of isonymic-geographic distances were obtained, a number too small for strong considerations, particularly in comparison other South American countries. These data can be related with two facts: 1) the lack of natural barriers inside the country, and 2) because during historic times the country was mainly populated from Montevideo area, radiating from the South, to the rest of the territory.

Kinship. Random kinship between departments was plotted as a function of geographic distance (Fig. 4). Kinship tends to decrease with distance as predicted by Malécot (1955, see also Kimura 1960). However, given the very small number of points relating isonymic and geographic distances, we cannot describe the kinship decay as exponential., Specifically, the exponential decay should be characteristic of structures more linear than Uruguay, for example as observed by us in Chile (Barrai *et al.,* 2012) and Honduras (Herrera-Paz *et al.,* 2014), and in Albania (Mikerezi *et al.,* 2013). In the case of Uruguay kinship decreases with distance, but it is not possible to determine the shape of the decay function.

Relations between departments of Uruguay

In order to obtain a general idea on the movements of population groups in Uruguay, MDSs and PCAs were performed on the matrix of Nei's isonymic distances between departments. The PCA projection on the first two axes of Nei's matrix between departments (Fig. 5) indicates one South-Center cluster formed by Colonia, Soriano, Flores, San José, Florida and Lavalleja, and then, another cluster down South, with Montevideo, Canelones, and Maldonado. The other departments are projected less closely.

Figure 6 shows the dendrogram obtained from Nei's matrix. From right to left, a first cluster composed by 2 subclusters, the most southern one (Maldonado, Canelones, Montevideo and Lavalleja) and the most eastern one (Cerro Largo, Treinta y Tres, associated with coastal Rocha). A second cluster, also with two subclusters, is formed by West-Central Departments: Durazno, Soriano, Río Negro and Paysandú on the right bank of river Uruguay, on one hand, and by South-Central Flores, Florida, San José and Colonia, on the other. Finally, the last departments to join the dendrogram are the most north western ones: Salto and Artigas bordering with Rivera and Tacuarembó. All these clustering are related with historical events, and despite the lack of some data, seems to be related also with molecular information (Sans *et al.,* 1997, 2006, 2011, 2015; Bonilla *et al.,* 2004; Gascue *et al.,* 2005; Hidalgo et al 2014). In this sense, in the first subcluster, Montevideo has only 1% of Native contributon using classical markers and 21% considering mitochondrial DNA (mtDNA), in the second subcluster Cerro Largo has 8% of Native contribution using classical markers and 32% with mtDNA, and in the last cluster, Tacuarembó has 20% and 62% respectively (Sans *et al.,* 1997, 2006; Bonilla *et al.* 2004; Gascue *et al.* 2005).

Mapping of the first three components of Nei's matrix.

The structures revealed by the MDSs and the dendrograms are only partially indicative of the possible movements of the population, therefore, to have a general idea if any, of the direction of population movements in Uruguay(following Menozzi *et al.* 1978) ,the first three components of the matrix of Nei's distance, obtained from the PCA and from the MDS, were mapped on the nation (following Menozzi *et al.,* 1978). PCA components were provided because the relative importance of each component is given by the corresponding eigenvalue, while the MDS provides the value of the stress for a judgement of the overall fitting on the dimensions. The resulting maps are given in Figure 7. The intensity of colour in each map is proportional to the deviation of the department on the respective axis.

The map variation of the first component of the PCA, which accounts for almost half the variability (44.36%) in the North-South direction, indicates the sense of movement from the South of the country toward North and the East along the Río de la Plata. This might mean that the main immigration passed through Montevideo, in the extreme south of the country, as seen when analyzing isolation by distance. The second and third components (26.03% and 13.86%) give a somewhat similar indication, although with minor intensity, because of their size. Overall, the three components account for more than 84% of the surname variation as obtained from Nei's distance matrix.

Then, the sense of movement may be postulated from the South toward North and from West toward East. This might be inferred also from looking at the PCAs in Figure 7.

The mappings of the first three dimensions of the MDS are compatible with those obtained from the PCA. The indication of possible movement toward East and North seems clear enough for the first and second dimension, and less so for the third. So, the isonymic structure of Uruguay seems to be mainly due to migration from the Plata regions, with radiation toward East and North, and with subsequent isolation and drift, with short range migration playing a major (and drift a minor) role in the generation of the present geographical variation of surnames.

At present, most internal migration seems to take place toward the Capital and the other main towns upstream the left bank of the river Uruguay. Although these movements are not documented, recent internal migrations show that Montevideo is not anymore the main centre of internal population movements and, moreover, part of its population has migrated to the neighbour area of Canelones (Pellegrino, 2003). These results are an addition to the available knowledge which has been developed in the course of time to meet the challenges of planning and organization of the territory in Uruguay (Yagüe and Díaz Puente 2008).

Comparisons with other populations worldwide.

The methodology described in this paper was used to analyze the isonymic structure of several South American countries (Rodríguez-Larralde *et al.,* 2000, 2011; Dipierri *et al.,* 2005, 2011; Barrai *et al.,* 2012) and in Central American Honduras (Herrera Paz *et al.,* 2014). In these countries, 4 (Venezuela), 24 (Argentina), 23 (Bolivia), 4.5 (Paraguay), 4.5 (Honduras) and 16.5 (Chile) million surnames from censuses and from the registers of electors were used, similar to the study performed in Uruguay. Differently, in European countries and in the USA surnames were taken from of telephone users (Barrai *et al,*. 2001; Rodríguez-Larralde *et al.,* 2007; Scapoli *et al.,* 2005, 2007).

The average value of α for different population unities (cities, states, districts, provinces or departments depending on the country, divisions that are relatively comparable), and the isolation by distance measured by the correlation between isonymic and geographic distances, are given in Table 2 for the countries studied up to now. Several features emerge from the comparisons reported in Table 2. First, the general similarity among European nations and USA in profusion of surnames as measured by α, with the exceptions as Albania and Spain. Uruguay has an intermediate position between these two countries and the rest of Europe/USA, and different to South American countries with the exception of Argentine.

Second, for isolation by distance as measured by the linear correlation, Spain and USA have the lowest values and Italy, France and Venezuela, the highest, and being Uruguay close to the average. Finally, the relation sample size/surnames (SS/S) is the lowest in Uruguay when related to South or Central American countries, being similar to those from Spain and little higher than those of most of the rest of Europe.

Conclusions

Surnames can be used for discover social patterns related to geographic spread and distance, ancient or recent migration movements, population dynamics, ethnic or geographic origins, ethnicity or other historical facts (*Colantonio et al.,* 2003; Darlu *et al*., 2012; Cheshire, 2014). Despite the lack of Native or African origin names, illegitimate unions, as well as different spellings or surname changes, isonymy studies can work with a great amount of data allowing comprehensive analysis of present and past populations. The present first analysis performed in Uruguay showed some interesting information related to different facts.

The general similarity among European nations in profusion of surnames as measured by α and for isolation by distance as measured by the linear correlation. Moreover, in Uruguay, the average number of persons having the same surname (measured by the ratio Sample Size/Surnames, given as the index SS/S in Table 2) is small (36) for a South American country.

Different regions can be defined in Uruguay mostly separated by longitude. Random inbreeding estimates (Fst) was lower and effective quantity of surnames (α) higher in the more densely populated South-West area, and in Montevideo, having Paysandú, Río Negro, Soriano, and Colonia the lowest inbreeding. It is possible to state that currently the population structure of this country is the result of the action of short range directional migration, particularly along the river Uruguay and along the Río de la Plata. The North-East (Rivera, Tacuarembó, Cerro Largo) has the highest inbreeding Fst and the lowest α, denoting more isolation than the previous mentioned regions. Differently to those which were populated by several migration waves with different origins, the North East reveals the historic penetration from the Brazilian border and also, the inheritance of land (Carvalho Neto, 1965; Rama, 1967).

It should be mentioned that in Uruguay electors are registered according with their residence when they are around 18 years old; if they move, even to neighbouring countries, they do not always change their addresses. Then, internal migrations that took place cannot be always seen from the available registers.

Nevertheless, from our analysis it appears that migration is a major contributor to surname differentiation, while the contribution of drift, considering the small variance of α, seems to be minor. While the limitations mentioned at the beginning of this article cannot be ignored, as the change or loss of surnames, the results are coherent with other data as genetic information or historic migrations. More detailed analysis about regions, as well as the origin of surnames, will be object of future articles.

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References

Adamic, L. A. & Huberman, B. A. (2002) Zipf law and the Internet. *Glottometrics*, **3**, 143-150.

Acosta y Lara, E. (1981) Un linaje Charrúa en Tacuarembó. *Revista Facultad de Humanidades y Ciencias (Montevideo*), *serie Ciencias Antropológicas*, **1**, 1-30.

Barrai, I., Scapoli, C., Beretta, M., Nesti, C., Mamolini, E. & Rodriguez-Larralde, A. (1996) Isonymy and the genetic structure of Switzerland. I: The distributions of surnames. *Annals of Human Bioogy*, **23**, 431-455.

Barrai, I., Rodriguez-Larralde, A., Mamolini, E., Manni, F. & Scapoli, C. (2000) Elements of the surname structure of Austria. *Annals of Human Bioogy.,* **27**, 607-622.

Barrai, I., Rodríguez-Larralde, A., Mamolini, E., Manni, F. & Scapoli, C. (2001) Isonymy structure of USA population. *American. Journal of Physical Anthropology*, **114**, 109-123.

Barrai, I., Rodriguez-Larralde, A., Dipierri, J., Alfaro, E., Acevedo, N., Mamolini, E., Sandri, M., Carrieri, A. & Scapoli, C. (2012) Surnames in Chile. A study of the population of Chile through isonymy. *American. Journal of Physical Anthropology*, **147**, 380-388.

Barrán, J.P. & Nahum, B. (1971) *Historia rural del Uruguay moderno.* Banda Oriental, Montevideo.

Barreto, I. (2011) *Estudio biodemográfico de la población de Villa Soriano*. Biblioteca Plural, Montevideo.

Bertoni, B., Budowle, B., Sans, M., Barton, S.A. & Chakraborty, R. (2003) Admixture in Hispanics Distribution of ancestral population contributions in the Continental United States. *Human Biology*, **75**, 1-11.

Bonilla, C., Bertoni, B., González, S., Cardoso, H., Brum-Zorrilla, N. & Sans, M. (2004) Substantial Native American female contribution to the population of Tacuarembó, Uruguay, reveals past episodes of sex-biased gene flow. *American Journan of Human Biology*, **16**, 289-97.

Bravi, C. M., Sans, M., Bailliet, G., Martínez-Marignac, V. L., Portas, M., Barreto, I., Bonilla, C. & Bianchi, N. O. (1997) Characterization of mitochondrial DNA and Y-chromosome haplotypes in a Uruguayan population of African ancestry. *Human Biology*, **69**, 641-52.

Carvalho Neto, P. (l965) *El Negro uruguayo.* Editoral Universitaria, Quito.

Chesire, J. (2014) Analysing surnames as geographic data. *Journal of Anthropological Sciences, **92**, 99-117*

Crow, J.F. & Mange, A. (1965) Measurements of inbreeding from the frequency of marriages between persons of the same surname. *Eugenics Quarterly*, **12**, 199-203.

Cuba Manrique, M. C. (2002). Antroponimia e identidad de los negros esclavos en el Perú. *Escritura y Pensamiento,* **5,** 123-134.

Dipierri, J.E., Alfaro, E.L., Scapoli, C., Mamolini, E., Rodriguez-Larralde, A. & Barrai, I. (2005) Surnames in Argentina. A population study through isonymy. *American. Journal of Physical Anthropology*, **128**, 199-209.

Dipierri, J.E., Rodriguez-Larralde, A., Alfaro, E.L., Scapoli, C., Mamolini, E., Salvatorelli, G., Caramori, G., De Lorenzi, S., Sandri, M., Carrieri, A. & Barrai, I. (2011) Surnames in Paraguay: A study of the population of Paraguay through isonymy. *Annals of Human Genetics*, **75**, 678-687.

Flores, R.D. (2010) Familias británicas en la sociedad rural argentina, 1866-1912. *Epocas (Revista de Historia, USAL)*, **3**, 95-132

Fox, W.R. & Lasker, G.W. (1983) The distribution of surname frequencies. *International Statistical Review*, **51**, 81-87.

Gascue, C., Mimbacas, A., Sans, M., Gallino, J.P., Bertoni, B., Hidalgo, P. & Cardoso, H. (2005) Frequencies of the four major Amerindian mtDNA haplogroups in the population of Montevideo, Uruguay. *Human Biology*, **77**, 873-878.

Gonzalez-Rissotto, R. & Rodríguez-Varese, S. (1989) La importancia de las Misiones Jesuíticas en la formación de la sociedad uruguaya. *Estudos Ibero-Americanos (PUCRS)*, **15**, 191-214.

Herrera Paz, E. F., Scapoli, C., Mamolini, E., Sandri, M., Carrieri, A., Rodríguez-Larralde, A. & Barrai, I. (2014) Surnames in Honduras: A study of the population of Honduras through isonymy. *Annals of Human Genetcis*, **78**, 165-177.

Hidalgo, P.C., Bengochea, M., Abilleira, D., Cabrera, A. & Alvarez, I. (2005) Genetic admixture estimate in the Uruguayan population based on the loci LDLR, GYPA, HBGG, GC and D7S8. *International Journal of Human Genetics,* **5**, 217-222.

Hidalgo, P. C., Mut, P., Ackermann, E., Figueiro, G. & Sans, M. (2014) Questioning the "melting pot": analysis of Alu inserts in three population samples from Uruguay. *Human Biology*, **86**, 83-92.

INE (2011) Censos 2011**.** URL: http://www.ine.gub.uy/censos2011/index.html (accessed 6th Novembre 2017).

INE (2012) *Uruguay en cifras. 2012*. Instituto Nacional de Estadísticas, Montevideo. URL: http://www.ine.gub.uy/documents/10181/39317/Uruguay+en+cifras+2012.pdf/8a922fc6-242a-4ecc-a145-c334825c8dbd.

Kimura, M. (1960) *Outline of population genetics*. Baifukan, Tokio.

Law 17.823. (2004) *Código de la niñez y la adolescencia*. IMPO, Uruguay, 14/09/2004.

Lucas, K. (1992) *Rebeliones indígenas y negras en América Latina: entre viento y fuego*. Abya Yala, Quito.

Malécot, G. (1955) Decrease of relationship with distance. *Cold Spring Harbour Symposyum*, **20**, 52-53.

Mantel, N. (1967) The detection of disease clustering and a generalized regression approach. *Cancer Research*, **27**, 209-220

Menozzi, P., Piazza, A. & Cavalli-Sforza, L.L. (1978) Synthetic maps of human gene frequencies in Europeans. *Science*, **201**, 786-792.

Mikerezi., I, Xhina., E, Scapoli, C., Barbujani, G., Mamolini, E., Sandri, M., Carrieri, A., Rodríguez-Larralde, A. & Barrai, I. (2013) Surnames in Albania. A study of the population of Albania through isonymy. *Annals of Human genetics*, **77**, 232-243.

Nei, M. & Imaizumi, J. (1966) Genetic structure of human populations. I. Local differentiation of blood groups gene frequencies in Japan. *Heredity*, **21**, 9-36.

Pellegrino, A. (2003) *Caracterización demográfica del Uruguay*. UNFPA-Facultad de Ciencias Sociales, Universidad de la República, Montevideo.

Pi Hugarte, R. & Vidart, D. (1969) *El legado de los inmigrantes, I*. Nuestra Tierra, **29**. Banda Oriental, Montevideo.

R Development Core Team (2012) *R: A language and environment for statistical computing. R Foundation for Statistical Computing*, Vienna.

Rama, C. (1967) *Los Afrouruguayos*. El Siglo Ilustrado, Montevideo.

Relethford, J. H. (1988) Estimation of kinship and genetic distance from surnames. *Human Biology*, **60**, 475-492.

Rodriguez-Larralde, A., Barrai, I. & Alfonzo, J. C. (1993) Isonymy structure of four Venezuelan states. *Annals of Human Biology.*, **20**, 131-145.

Rodriguez-Larralde, A., Scapoli, C., Beretta, M., Nesti, C., Mamolini, E. & Barrai, I. (1998) Isonymy and the genetic structure of Switzerland. II. Isolation by distance. *Annals of Human Biology*, **25**, 533-540.

Rodríguez-Larralde, A., Morales, J. & Barrai, I. (2000) Surname frequency and the isonymy structure of Venezuela. *American Journal of Human Biology*, **12**, 352-362.

Rodríguez-Larralde, A., González-Martín, A., Scapoli, C. & Barrai, I. (2003) The names of Spain: a study of the isonymy structure of Spain. *American Journal of Physical Anthropology*, **121**, **280-292.**

Rodríguez-Larralde, A., Scapoli, C., Mamolini, E. & Barrai, I. (2007) Surnames in Texas: A population study through isonymy. *Human Biology,*, **79**, 215-239.

Rodríguez-Larralde, A., Dipierri, J., Gómez, E. A., Scapoli, C., Mamolini, E., Salvatorelli, G., De Lorenzi, S., Carrieri, A. & Barrai, I. (2011) Surnames in Bolivia: A population study through isonymy. *American. Journal of Physical Anthropology*, **144**, 177-184.

Rosal, M. A. (2009) *Africanos y afrodescendientes en el Río de la Plata, Siglos XVIII-XIX*. Dunken, Buenos Aires.

Sans, M,, Alvarez, I., Callegari-Jacques, S. M. & Salzano, F. M. (1994) Genetic similarity and mate selection in Uruguay. *Journal of Biosocial Sciences*, **26**, 285-289.

Sans, M., Salzano, F.M. & Chakraborty, R. **(**1997) Historical genetics in Uruguay: estimates of biological origins and their problems. *Human Biology*, **69**, 161-170.

Sans, M., Weimer, T. A., Franco, M. H., Salzano, F. M., Bentancor, N., Alvarez, I., Bianchi, N. O. & Chakraborty, R. (2002) Unequal contributions of male and female gene pools from parental populations in the African descendants of the city of Melo, Uruguay. *American. Journal of Physical Anthropology,* **118**, 33-44.

Sans, M., Merriwether, D. A., Hidalgo, P. C., Bentancor, N., Weimer, T. A., Franco, M. H., Alvarez, I., Kemp, B. M. & Salzano, F. M. (2006) Population structure and admixture in Cerro Largo, Uruguay, based on blood markers and mitochondrial DNA polymorphisms. *American Journal of Human Biology*, **18**, 513-524.

Sans, M. (2009) "Raza", adscripción étnica y genética en Uruguay. *Runa*, **30**, 163-174.

Sans, M., Figueiro, G., Ackermann, E., Barreto, I., Egaña, A., Bertoni, B., Poittevin-Gilmet, E., Maytia, D. & Hidalgo, P. C. (2011) Mitochondrial DNA in Basque descendants from the city of Trinidad, Uruguay: Uruguayan- or Basque-like population? *Human Biology*, **83**, 55-70.

Sans, M., Mones, P., Figueiro, G., Barreto, I., Motti, J..M., Coble, M. D., Bravi, C. M. & Hidalgo, P. C. (2015) The mitochondrial DNA history of a former native American village in northern Uruguay. *Amercian Journal of Human Biology,* **27,** 3, 407-416.

Scapoli, C., Goebl, H., Sobota, S., Mamolini, E., Rodríguez-Larralde, A. & Barrai, I. (2005) Surnames and Dialects in France: population structure and cultural evolution. *Journal of Theoretical Biology*, **237**, 75-86.

Scapoli, C., Mamolini, E., Carrieri, A., Rodríguez-Larralde, A. & Barrai, I. (2007) Surnames in Western Europe: A comparison of the subcontinental populations through isonymy. *Theoretical Population Biology*, **71**, 37-48.

Smouse, P. E., Long, J. C. & Sokal, R. R. (1986) Multiple regression and correlation extensions of the Mantel test of matrix correspondence. *Systematic Zoology*, **35**, 627-632.

Tarskaya, L., El'chinova, G.I., Scapoli, C., Mamolini, E., Carrieri, A., Rodríguez-Larralde, A. & Barrai, I. (2009) Surnames in Siberia. A study of the population of Yakutia through isonymy. *American. Journal of Physical Anthropology*, **138**, 190-198.

Vidart, D. & Pi Hugarte, R. (1969) *El legado de los inmigrantes, II.* Nuestra Tierra, **39**. Montevideo.

Yagüe, J. L. & Díaz Puente, J. M. (2008) Tres siglos de planificación regional en Uruguay: lecciones de experiencia para afrontar los retos de desarrollo en el siglo XXI. *Estudios Geográficos,* **LXIX/264**, 247-280.

Yarza Rovira, E. J. (2009). Los Artigas de Casupá. La estirpe de Pedro Mónico Artigas. *Revista del Instituto de Estudios Genealógicos del Uruguay*, **32**, 420-453.

Yasuda, N. & Morton, N. E. (1967) Studies on Human Population Structure. In Crow, J .F. & Neel, J. V. (eds) *Proceedings of the 3rd Congress of Human Genetics, Chicago 1966*. University of Chicago Press, Chicago, pp. 249-265.

Table 1. Department, code, number of surnames N, number of different surnames S, Fisher's α, Karlin-McGregor ν, isonymy I, and FST in Uruguay. In the last two columns, average Longitude and Latitude.

Department	N	S	α	ν	I	Fst	Long	Lat
Montevideo	1030800	53858	346.2	0.00034	0.00288	0.000720	-56.227	-34.826
Canelones	361446	22909	250.6	0.00069	0.00398	0.000994	-55.959	-34.519
Maldonado	121442	10814	213.7	0.00176	0.00467	0.001167	-54.862	-34.547
Rocha	58386	3964	121.8	0.00208	0.00816	0.002040	-54.023	-33.943
Treinta y Tres	39743	2702	181.5	0.00455	0.00550	0.001376	-54.305	-33.001
Cerro Largo	67956	3697	154.8	0.00227	0.00643	0.001608	-54.375	-32.402
Rivera	82983	5113	161.1	0.00194	0.00618	0.001545	-55.034	-31.647
Artigas	58761	3653	172.0	0.00292	0.00580	0.001449	-56.951	-30.547
Salto	98384	5840	237.6	0.00241	0.00420	0.001050	-57.049	-31.237
Paysandú	90667	6588	393.5	0.00432	0.00255	0.000637	-57.379	-32.033
Río Negro	42702	4255	329.4	0.00766	0.00305	0.000762	-57.466	-32.717
Soriano	69446	4950	376.5	0.00539	0.00266	0.000666	-57.764	-33.478
Colonia	100687	6797	361.5	0.00358	0.00277	0.000692	-57.679	-34.112
San José	78072	6232	198.2	0.00253	0.00503	0.001258	-56.746	-34.274
Flores	21715	2310	208.9	0.00953	0.00481	0.001203	-56.936	-33.510
Florida	55357	4165	188.6	0.00340	0.00529	0.001323	-55.902	-33.703
Durazno	46297	3638	222.0	0.00477	0.00451	0.001126	-56.108	-32.935
Lavalleja	50396	3528	194.9	0.00385	0.00512	0.001281	-55.009	-33.868
Tacuarembó	26526	2503	168.6	0.00631	0.00590	0.001483	-55.807	-32.040

Table 2. Comparison of isonymy parameters in nine European countries, in five SouthAmerican countries, in the USA and Texas, and in Yakutia, Siberia.

Country	Sample Size (SS, Millions)	Surnames (S)	α (average)	Isolation by distance	SS/S (%)	Source
EUROPE						
Austria	1	140766	854	0.59	7.1	1
Albania	3	37184	123	0.71	82	2
Belgium	1.1	137442	997	0.74	8	1
France	6	495104	1615	0.69	12.1	1
Germany	5.2	462526	1596	0.51	11.2	1
Netherland	2.4	126485	787	0.46	19	1
Italy	5.1	215623	1236	0.61	23.7	1
Spain	3.6					
Paternal		94886	134	0.21	38	3
Maternal		110034	144	0.26	33	3
Switzerland	1.7	166116	891	0.72	10.2	1
ASIA:						
Yakutia	0.5	44625	107	0.69	11.1	4
NORTH AMERICA						
Texas	3.6	235740	734	0.42	15.3	5
USA	18	899585	1366	0.24	20	6
SOUTH AMERICA						
Argentina	22.6	414441	422	0.47	54.5	7
Bolivia	23.2	174922	122	0.5	144.6	8
Chile	16.4	72,667	209	0.63	224.0	9
Paraguay	4.8	39047	108	0.42	122.9	10
Uruguay	*2.5*	*70,395*	*301*	*0.56*	*35.5*	*Present study*
Venezuela	3.9	68665	122	0.78	56.8	11
CENTRAL AMERICA						
Honduras	4.3	14,665	113	0.43	296.5	12

1: Scapoli et al. 2007; 2. Mikerzi et al. 2013; 3. Rodríguez-Larralde et al. 2003; 4. Tarskaia et al. 2009; 5. Rodríguez-Larralde et al. 2007; 6. Barrai et al. 2001; 7. Dipierri et al. 2017; 8. Rodriguez-Larralde et al. 2011; 9. Barrai et al. 2012; 10. Dipierri et al. 2011; 11. Rodríguez-Larralde et al. 2000; 12. Herrera Paz et al. 2012.

Figure captions

Figure 1. Map of Uruguay and the 19 departments.

Figure 2. Variation of Nei's distance between departments with geographic linear distance.

Figure 3. Signal extraction from the variation of Nei's distance (± s.d.) between departments over geographic distances.

Figure 4. Decay of random kinship (± s.d.) in Uruguay over geographic distance. Pairwise distances between departments.

Figure 5. Projection of Nei's distance matrix on the first two components of the PCA. The first component removes 44.36 % of variability, and the second component 26.03 %.

Figure 6. Dendrogram of Uruguay Departments. Nei's distance, Complete Linkage.

Figure 7. Projection of Nei's matrix of surname distances on districts in Uruguay by mapping (**a**) the first three PCA's factors (I: Factor 1= 44.36.5%; II**:** Factor 2 = 26.03%; III**:** Factor 3 = 13.86%); (**b**) the first three MDS's dimensions (I**:** Dimension 1; II**:** Dimension 2; III**:** Dimension 3. Stress=10.47%).