



Evidence for Assortative Mating and Selection in Surnames: A Case from Yucatan, Mexico

By John M. McCullough,¹ Eugene Giles,² and Richard A. Thompson³

ABSTRACT

Surnames are often used as metaphors for genetic material on the assumption of neutrality and general immunity from systematic pressures. The Yucatec Maya use surnames of both Maya and Spanish origin. We find evidence of positive assortative mating by ethnic origin of surname and a slight bias away from marriage of women to men with Maya surnames for parents of cohorts born from 1878 to 1970 ($\chi^2 = 11.0$ to 46.6 ; $p < .001$). Selective neutrality of surnames apparently cannot be assumed in all cases.

Surname analysis has proven methodologically useful in genetic studies in three ways. First, relative rates of inbreeding may be indirectly estimated using isonymy analysis (e.g., Crow and Mange, 1965; Friedl and Ellis, 1974). A second use is testing for effects of random evolutionary processes, using surnames for which historical information of great time depth may be available (e.g., Yasuda, et al. 1974; Lotka 1931; 1939). A third use is to estimate relative genetic relationship or isolation through surname distributions (Morton et al. 1971, 1976; Lasker 1977, 1978a, 1978b, 1980; Lasker and Mascie-Taylor, 1983). Surnames in patronymic societies are inherited as if they were Y-linked, or haploid traits, except that females may inherit but not pass them on. In all cases, surnames serve as metaphors for genetic material, and may be useful because of safe assumptions of selective neutrality, easy access, the small expense of surname analysis, data availability, and time depth, sometimes for 10 to 15 generations (Yasuda et al. 1974; Zei et al. 1983).

However, on occasion surnames may be subject to systematic processes such as selection. The modern Yucatecs use both Maya and Spanish surnames (Roys 1940; Redfield and Villa-Rojas 1934; Goldkind 1966) and Goldkind reports a conscious process of surname change from Maya

¹Laboratory of Biological Anthropology, Department of Anthropology, University of Utah, Salt Lake City, Utah 84112 Affiliation for 1984-85: Visiting Fellow, Department of Human Genetics, 19 Claremont Road, University of Newcastle-upon-Tyne, Newcastle-upon-Tyne NE2 4AA, United Kingdom

²Department of Anthropology, University of Illinois, Urbana, Illinois 61801

³Department of Anthropology, University of Arizona, Tucson, Arizona 85721

to Spanish. In a study of social stratification and mobility in the city of Ticul, Thompson (1974) reported that Maya surnames carry a lower status than Spanish surnames and that males with Maya surnames had a lower probability of marrying a woman with a Spanish surname than the reverse. This would constitute assortative mating and selection were it true. In order to quantitatively test this assertion, a study was made of surname combinations in Ticul, Yucatan for persons born from approximately 1878 to 1970.

Cultural and Historical Background

At the beginning of the 16th century the northern Yucatec plain was divided into a series of small kingdoms, each ruled by a royal family. These dynasties used surnames, many of which are common today. Pre-colonial surnames include Abnal, Cahuich, Xiú, Chi, Tun, Couoh, May, Koh, and Pech (Roys 1940). Several other surnames were also names of provinces—Cupul, Ekab, Chakan, Tax and Lochuah (de Landa 1978, pp. 136-137). Numerous colonial documents mention Maya surnames, especially those of the Maya nobles—Cocom, Canul, Chan, Xiú, Pech, Pacab, and Ek in 1567. A genealogy of the Xiú family begins with one Tutul Xiú born about 1380 A.D. (de Landa 1978, pp. 114; 119; 121).

At the time of the Spanish Conquest Maya individuals used three proper names. The first was a given name (*paal kaba*), corresponding to the Christian name. A second name was the *naal*, or mother's name; Roys believes that this was a true matronym, passed from mother to child. It was ordinarily preceded by a *Na*-prefix, with the stem word one of a number of patronyms. The third name was the patronym, (*ka' ch'a k'aba'*, *hach k'aba*, or *winikil*) (Barrera Vásquez 1980, pp. 280, 924), inherited from the father. A person was referred to by the matronym-patronym combination, as in several examples given by Roys (1940) (e.g., *Nacab Chí*, *Nacamal Moan*, *Nacouoh Bé*, *Nachan Tzek*, but also *Tutul Xiú*). Sometime after the conquest this system was abandoned and the Spanish patronymic system adopted, but with persistence of the Maya patronyms. The matronyms do not survive in Yucatan.

Spanish surnames became current by the fifteenth century and include forms such as Álvarez, Gómez, Martínez, Gutiérrez, Rojas, Lima, Alemán, Amador, and Arreola, all ultimately of Latin, Germanic (Visigoth), Moorish or Basque origin. Clearly, with the exception of several equivocal terms, the names are different and easily distinguishable by non-speakers of both languages. Yucatecs who speak one or both languages, are well aware of the origin of each surname.

Full surnames in Yucatan today include both paternal and maternal surnames, in that order. Thus, Carlos Rojas Chan has the Christian name of Carlos, the paternal surname Rojas, and maternal surname Chan. Only the paternal surnames of each parent are passed down to their children.

MATERIAL AND METHODS

Study Location

Ticul, the study site, is a small city of approximately 18,000 people today located on the southern flank of the North Yucatan plain, a flat karstic region, approximately 85 km from Merida, the peninsular capital (Shattuck, 1933). It is predominantly an agricultural zone, although Ticul has been economically differentiated for well over a century (Thompson, 1974). It has been the subject of previous human biological studies (Giles, et al. 1968; McCullough, 1982; McCullough and McCullough, 1984).

Samples

The total sample size is 1276 and the data come from two sources. One is a 1976 anthropometric survey of 444 school children native to Ticul, Yucatan (McCullough and McCullough, 1984). All were born between 1958 and 1970.

A second sample consists of 852 individuals who participated in a genetic survey of Ticul in 1965 (Giles et al. 1968). All persons in the sample were 8 years of age or over and thus all were born before 1957, and some as early as 1878. Because families participated in the genetic survey, it was necessary to generate an unrelated surname sample, eliminating all but one sibling of the same nuclear family. The subjects in both studies were not selected for the study according to surname although this information was collected routinely.

Analysis

Presence of assortative mating was tested using X^2 analysis (Blalock, 1960) with names classified by order of the paternal and maternal patronyms, i.e., Maya-Maya, Maya-Spanish, Spanish-Maya, Spanish-Spanish. Unlike genes in a heterozygous state, surname order is important because it is the father's surname which is positioned first and which is passed on while the mother's surname is lost in the F_2 generation.

In the case of several "equivocal" names, we resorted to a list of Maya surnames compiled by Roys (1940) current in Eastern Yucatan in 1936, and from historical sources. We also consulted works on Spanish surnames (Thayer Ojeda, 1917; García Carraffa and García Carraffa, 1952-1963) as a double-check for surnames not listed in Roys. The few Arabic names of recent Lebanese origin were classified as Spanish.

Selection was tested by comparing proportions of Spanish and Maya maternal surnames with the proportions of paternal patronyms which would be the pool of surnames available in the subsequent marriage cycle. Yasuda et al. (1974) note that maternal surnames may be used to generate an unbiased estimate of surname distribution in the previous generation. The difference in proportions should provide an estimate of expected change, and therefore an estimate of the fitness of any surname class. A change of zero would, of course, indicate the absence of selection.

RESULTS

Results are summarized in Table 1, by cohort. The 1958-1970 cohort derives from the school survey, while the remaining information comes

Table 1

Number of Persons (and Percent) Carrying Maya and Spanish Surnames Living in Ticul, Yucatan in 1965 and 1976 With χ^2 Values (All $p < .001$)

Approximate Cohort Years	Maya-Maya	Maya-Spanish	Spanish-Maya	Spanish-Spanish	Total	χ^2
1958-1970	104 (23.4)	64 (14.4)	80 (18.0)	196 (44.1)	444	46.63
1946-1957	86 (28.4)	52 (17.2)	62 (20.5)	103 (33.9)	303	18.42
1936-1945	60 (33.1)	24 (13.3)	34 (18.8)	63 (34.8)	181	23.86
1926-1935	57 (41.0)	24 (17.3)	19 (13.7)	39 (28.1)	139	19.29
1916-1925	33 (30.6)	15 (13.9)	22 (20.4)	38 (35.2)	108	10.98
1878-1915	61 (50.4)	16 (13.2)	15 (12.4)	29 (24.0)	121	24.41
TOTAL					1296	

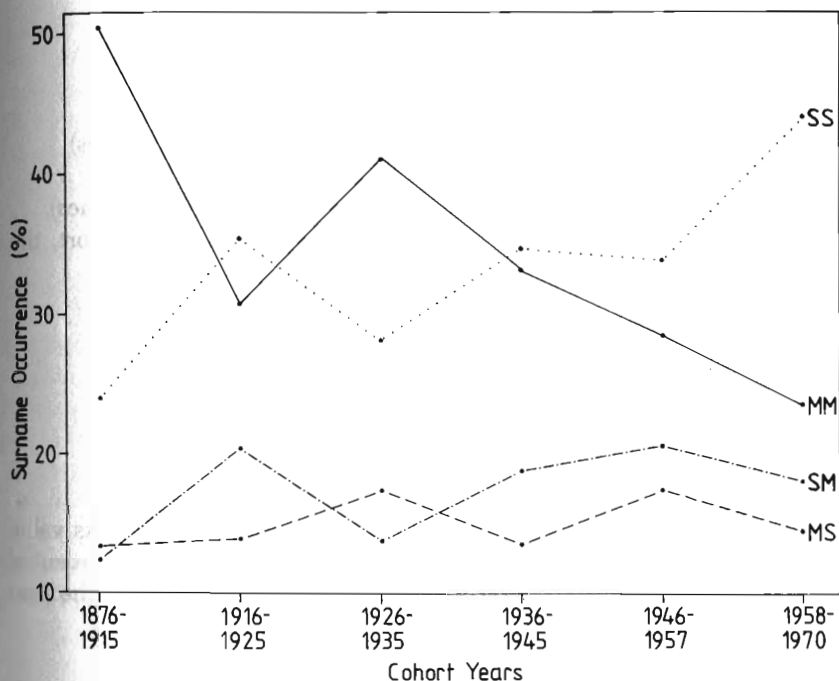


FIG. 1. Surname frequency in Ticul, birth cohorts of 1876-1970. Key: SS = Spanish-Spanish; MM = Maya-Maya; SM = Spanish-Maya; MS = Maya-Spanish

from the genetic survey of 1965. There are three important observations of the results. First, there is consistent and statistically significant ($p < .001$) tendency throughout the entire series of persons carrying paternal surnames of like ethnic origin to marry, and for persons carrying surnames of different ethnic origin not to marry. Second, there is a trend toward a reduction of the proportion of Maya surnames in the sample and a concomitant increase in Spanish surnames (Figure 1). The increase is erratic but significant if only paternal patronyms are considered (Table 2). Third, there is no apparent change through time in the proportion of persons with mixed surname, either of the Maya-Spanish or the Spanish-Maya categories. Both categories of mixed surnames are well below expectation for random mating.

Speiss (1977, pp. 406-408) calculates fitness of a haploid trait in the following manner. If we take s to be the measure of selection pressure against an allele, s can be calculated as:

$$s = \left| \frac{P^1 - P^0}{P^0} \right|$$

where

P^1 = proportion in the present generation (paternal surnames)
and

P^0 = proportion in the previous generation (maternal surnames).

Substituting the values of Maya surnames in the 1958–1970 cohort, the following values are derived:

$$s = \left| \frac{37.8-41.4}{41.4} = 0.087 \right|$$

The relative fitness of the Maya surnames thus becomes

$$w = 1-s = 0.913$$

or a value well below 1.

Iterating the proportion of Maya surnames against this fitness value indicates that if the cultural environment does not change, the percent of carriers of Maya surnames will drop from an estimated 40% in the pre-

Table 2

Numbers of Persons (and Percents) Carrying Maya and Spanish Paternal and Maternal Patronyms, and Estimated Fitness Values for Each Birth Cohort

Cohort	Paternal Patronyms		Maternal Patronyms		Fitness Values of Maya Surnames
	Maya	Spanish	Maya	Spanish	
1958–1970	168 (37.8)	276 (62.1)	184 (41.4)	260 (58.5)	0.9130
1946–1957	138 (45.6)	165 (54.4)	148 (48.9)	155 (51.1)	0.9325
1936–1945	84 (46.4)	97 (53.6)	94 (51.9)	87 (48.1)	0.89402
1926–1935	81 (58.3)	58 (41.8)	76 (54.7)	63 (45.4)	1.0658
1916–1925	48 (44.5)	60 (55.6)	55 (51.0)	53 (49.1)	0.8725
1878–1915	77 (63.6)	44 (36.4)	76 (62.8)	45 (37.2)	1.0127

Table 3

*Estimated Frequency of Maya
Surnames Assuming a Constant
Fitness Value of 0.91313*

Generation	Maya Surname Frequency
0	.4144
1	.3783
2	.3454
3	.3154
4	.2879
5	.2629
6	.2400
7	.2191
8	.2001
9	.1827
10	.1668
11	.1523
12	.1390
13	.1269
14	.1159
15	.1058

vious generation to just over 10% in 15 generations exclusive of other systematic changes (Table 3).

DISCUSSION

Part of Mexican cultural modernization is the homogenization of many local Indian cultures into a more uniform national culture. The obvious common cultural denominator in Mexico is the Spanish language and associated terminology, including surnames.

In Yucatan today, Maya surnames are common and in Ticul, Maya surnames carry a lower status than Spanish surnames (Thompson, 1974). For a woman with a Spanish paternal surname to marry a man with a Maya paternal patronym would involve a loss in status and the perception of a lowered chance of success for her children. For a woman with a Maya patronym to marry a man with a Spanish patronym, the reverse would be true. The male's patronym is therefore most important; males with Spanish surnames appear to have a wider choice of potential mates with either

Spanish or Maya surnames while males with Maya surnames have a more restricted choice. This social bias against Maya surnames in general explains the systematic pressures on individuals carrying Maya surnames seen in the results.

There is a strong tendency for persons to marry individuals carrying a paternal patronym of similar ethnic origin. In the school sample, 104 children had two Maya surnames (23.4% of sample) and 196 had two Spanish surnames (44.1%), accounting for 67.5%. The same basic pattern characterizes the earlier cohorts. Using the assumption of Yasuda et al. (1974) that maternal surnames are an unbiased sample of surnames, random mating should follow a binomial expansion and would allow 16.2% of the sample to have two Maya and 34.3% of the sample to have two Spanish surnames, or, between them, only 50.5% of the total sample. Clearly this is below the observed proportion in both samples.

The effect of selection is also seen in the decreasing frequency of Maya surnames expected in the following generation. There is almost a 35% decrease in the anticipated total number of Maya surnames over the study period (Table 2).

For calculation of future changes in the frequency of Maya surnames, we may be incorrect in assuming a constant "fitness" value. Aside from expected random fluctuations, the fitness value may be changed downward by increased pressure to conform to a Spanish-speaking or non-Yucatec environment. Alternatively, as the frequency of Maya surnames decreases, the fitness value may drift toward 1.0, acting as if frequency-dependent selection were in operation.

Surname "mutation" is occurring, although its rate is difficult to measure. In Yucatan, three factors favor mutation. One is the difficult application of Spanish orthography to the Maya language, in which tone has phonemic value (R. A. Freeze, personal communication). Tonal languages do not lend themselves readily to conventional European orthographies. A second factor is the ubiquitous problem of poor spelling (Weiss et al. 1980). A third factor is the intentional practice to Hispanicize Maya surnames. Hispanization is equivalent to a directed mutation as it takes the simple form of direct translation from Maya to a Spanish word that is only rarely used, if at all, as a surname. Thus, Ek becomes Estrella, and Xiú becomes Yerves or Llerves. Rarely, some other Spanish surname is simply borrowed, or the Spanish surname of a Godfather may be adopted. Goldkind (1966) and Thompson (1974) describe the process in more detail.

One possible explanation for the observed behavior is prejudice against the Maya as an ethnic group by those of putative Spanish background. However, dark skin is much more commonly associated with occupation (agriculture) than with ethnic group, and there is very little apparent prejudice against skin color or the Maya ethnic group, *per se* (Thompson, 1974). While prejudice against skin color is common in Western and some Eastern cultures (Hulse, 1957), this would be uncharacteristic of Latin America where ethnicity, measured by pigmentation is seriously confounded by wealth and dress (Mörner, 1967; Wagley, 1953, pp. 128-9; Lasker, 1953; Kaplan, 1953). In Ticul, status depends on many factors, the most important of which is self-accepted membership in the traditional *mestizo* or the westernized *catrin* group, wealth and general behavior (Thompson, 1974).

A critical assumption of our analysis is lack of immigration which could change the surname frequencies through external systematic pressure. Because of the differential male-female migration patterns which are characteristic elsewhere, the accepted assumption of maternal surnames serving as an unbiased sample of surnames may be questionable (Lasker 1969). We do not believe that our results will be seriously changed if immigration is considered in a subsequent analysis. Migration to Ticul is low; in Thompson's (1974) random sample less than 10% of people were born elsewhere. It originates from the surrounding region, especially the towns east of Ticul. These towns are historically similar to Ticul and are expected to have surname proportions similar to that of Ticul. The areas further east of the large towns are culturally conservative and more likely to be a source of Maya than Spanish surnames (Redfield and Villa Rojas 1934). Migration is less likely to flow from the more desirable location of Mérida, where Spanish surnames are much more frequent. Thus, an increase in Spanish surnames is actually counter to the expected effects of immigration.

In conclusion, surnames may occasionally be subject to systematic pressures which would invalidate the assumption of neutrality. Among the Yucatec Maya, who use both Maya and Spanish surnames, there is a systematic bias in mating combinations indicating a strong tendency toward positive assortative mating. There is also a more subtle bias toward an increase in Spanish surnames through time, seen by comparing maternal and paternal surnames and by viewing long-term trends of surname incidence. We do not denigrate the usefulness of isonymy studies (Lasker, 1980), but suggest that care should be taken in communities

having surnames of bi-ethnic origin to evaluate the degree to which neutrality may be violated.

ACKNOWLEDGEMENTS

This research was partially supported by the University of Illinois Research Board, the Instituto Interuniversitario para Investigaciones en Ciencias Sociales en Yucatan, A.C., by U.S. Public Health Service research grant MH 11980-01 from the National Institutes of Health, and a sabbatical leave from the University of Utah. We wish to thank Inga Giles and Christine S. McCullough for extensive technical and other assistance, Professors Fred L. Strodbeck and Victor Castillo Vales, Dr. David Arjona, Dr. Pedro Daniel Martinez, Subsecretario de Salubridad Secretaria de Salubridad y Asistencia, República Mexicana, Dr. Jose D. Bargas Villanueva, Jefe de Servicios Coordinados de Salud Pública del Estado de Yucatan, the late Dr. Alfredo Barrera Vásquez, former director, Instituto Yucateco de Estudios Antropológicos, Dr. Norberto Gonzales Crespo, director, Centro Regional del Sureste, Mérida, Dr. Eduardo A. Laviada Arrigunaga, Jefe de Enseñanza, Hospital O'Horan, Mérida, Professor D. F. Roberts, Department of Human Genetics, University of Newcastle-upon-Tyne, and the kind people of Ticul.

Received: 30 August 1984; revision received 8 January 1985.

LITERATURE CITED

- BARRERA VÁSQUEZ, A. (AND COLLABORATORS) 1980 *Diccionario Maya Cordemex. Maya-Español-Maya*. Ediciones Córdemex. Mérida, Yucatán, México.
- CROW, J. F. AND A. P. MANGE 1965 Measurement of inbreeding from the frequency of marriages between persons of the same surname. *Eugenics Quarterly*, 12: 199-203.
- BLALOCK, H. M. 1960 *Social statistics*. McGraw-Hill, New York.
- FRIEDL, J. AND W. S. ELLIS 1974 Inbreeding, isonymy and isolation in a Swiss community. *Human Biol.* 46: 699-712.
- GARCIA CARRAFFA, A. AND A. GARCIA CARRAFFA 1952-1963 *Diccionario Heráldico y Genealógico de Apellidos Españoles y Americanos* (86 vols.) Nueva Imprenta Radio, S.A., Madrid.
- GILES, E., A. T. HANSEN, J. M. MCCULLOUGH, D. G. METZGER AND M. H. WOLPOFF 1968 Hydrogen cyanide and phenylthiocarbamide sensitivity, mid-phalangeal hair and color blindness in Yucatan, Mexico. *Am. J. Phys. Anthropol.* 28: 203-212.
- GOLDKIND, V. 1966 Class conflict and cacique in Chan Kom. *Southwestern J. Anthropol.* 22: 325-345.
- HULSE, F. S. 1967 Selection for skin color among the Japanese. *Am. J. Phys. Anthropol.* 27: 143-156.

- KAPLAN, B. A. 1953 Ethnic identification in an Indian Mestizo community. I. Socio-cultural factors. *Phylon*, 14: 179-186.
- DE LANDA, FR. D. (W. GATES, TRANS.) 1978 Yucatan before and after the conquest. Dover Publications, New York.
- LASKER, G. W. 1953 Ethnic identification in an Indian Mestizo community. II. Racial characteristics. *Phylon*, 14: 187-190.
- LASKER, G. W. 1969 Isonymy (recurrence of the same surnames in affinal relatives): A comparison of rates calculated from pedigrees, grave markers and death and birth registers. *Human Biol.* 41: 309-321.
- LASKER, G. W. 1977 A coefficient of relationship by isonymy: A method for estimating the genetic relationship between populations. *Human Biol.* 49: 489-493.
- LASKER, G. W. 1978a Increments through migration to the coefficient of relationship between communities estimated by isonymy. *Human Biol.* 50: 235-240.
- LASKER, G. W. 1978b Relationships among the Otmoor villages and surrounding communities as inferred from surnames contained in the Current Register of Electors. *Ann Hum. Biol.* 5: 105-111.
- LASKER, G. W. 1980 Surnames in the study of human biology. *Am. Anthrop.* 82: 525-538.
- LASKER, G. W. AND C. G. N. MASCIE-TAYLOR 1983 Surnames in five English villages: Relationships to each other, to surrounding areas, and to England and Wales. *J. Biosoc. Sci.* 15: 25-34.
- LOTKA, A. J. 1931 The extinction of families. *J. Wash. Acad. Sci.* 21: 377-380, 453-459.
- LOTKA, A. J. 1939 *Theorie analytique des association biologiques*. Deuxième Partie. Hermann & Co., Paris.
- MCCULLOUGH, J. M. 1982 Secular trend for stature in adult male Yucatec Maya to 1968. *Am. J. Phys. Anthrop.* 58: 221-225.
- MCCULLOUGH, J. M. AND C. S. MCCULLOUGH 1984 Age-specific variation in the secular trend for stature: A comparison of samples from industrialized and nonindustrialized regions. *Am. J. Phys. Anthrop.* 65: 169-180.
- MORNER, M. 1967 *Race mixture in the history of Latin America*. Little, Brown, Boston.
- MORTON, N. E., C. SMITH, R. HILL, A. FRACKIEWICZ, P. LAW AND S. YEE 1976 Population structure of Barra (Outer Hebrides). *Ann. Hum. Genet.* 39: 339-352.
- MORTON, N. E., S. YEE, D. E. HARRIS AND R. LEW 1971 Bioassay of kinship. *Theoretical Population Biology*, 2: 507-524.
- REDFIELD, R. AND A. VILLA ROJAS 1934 Chan Kom, a Maya village. Carnegie Institute of Washington, Publication 448. Washington, D.C.
- ROYS, R. L. 1940 Personal names of the Maya of Yucatan. Carnegie Institute of Washington, Publication No. 523, Washington, D.C.
- SHATTUCK, G. C. 1933 The peninsula of Yucatan: Medical, biological, meteorological and sociological studies. Carnegie Institute of Washington, Publication No. 431. Washington, D.C.
- SPEISS, E. B. 1977 *Genes in populations*. Wiley, New York.
- THAYER OJEDA, L. 1917 Oríjen de los apellidos en Chile. Second Pan American Science Congress, 1915, 1916. Section 1, Anthropology, Vol. 1, pp. 61-112. Washington, D.C.
- THOMPSON, R. A. 1974 The winds of tomorrow. Social change in a Maya town. University of Chicago Press, Chicago.
- WAGLEY, CHARLES 1953 Amazon town. A study of man in the tropics. Macmillan, New York.

- WEISS, K. M., D. L. ROSSMAN, R. CHAKRABORTY AND S. L. NORTON 1980 Wherefore art thou, Romeo? Name frequency patterns and their use in automated genealogy assembly. In: B. Dyke and W. T. Morrill, (eds.), *Genealogical demography*, pp. 41-61. Academic Press, New York.
- YASUDA, N., L. L. CAVALLI-SFORZA, M. SKOLNICK, AND A. MORONI 1974 The evolution of surnames: An analysis of their distribution and extinction. *Theoret. Pop. Biol.* 5: 123-142.
- ZEI, G., C. R. GUGLIELMINO, E. SIRI, A. MORONI, AND L. L. CAVALLI-SFORZA 1983 Surnames as neutral alleles: Observations in Sardinia. *Human Biol.* 55: 357-365.