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Post marital Residence Pattern in Ancient Populations of the North of Chile

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ABSTRACT

Although kinship relationships and residence patterns in current native communities in northern Chile are known, there is little information available on ancient populations. In this paper, social relationships and postmarital residence pattern are investigated through the analysis of phenotypic traits of six localities (Punta de Teatinos, El Cerrito, CaletaHuelén 42, Pisagua, Calama and San Pedro de Atacama). These localities include 21 archaeological sites and 946 individuals dated from 3000 BC to AD 1450. The distributions of mean phenotypes between localities and between sexes by locality were evaluated using discriminant analysis and phenotypic divergence by the Fst statistic. The residence pattern was determined by the estimation for each sex of Fst statistics between localities and archaeological periods. The results allow to infer a pattern of matrilocal or bilocal residence in the Archaic and Agroalfarero periods. The female group integrates a highly structured population model with fewer migrants per generation and the male group a less structured model with more migrants per generation. In general, the observed residential pattern depends on the differences in migration rates and the effective sizes of both sexes.

Keywords: *Kinship, Genetic structure, Migration, Postmarital residence, northern Chile*

INTRODUCTION

The current development of archaeology and biological anthropology allowed us to reconstruct key aspects of the history of the peoples and cultures that developed in the South Central Andean Area. However, important issues of social organization such as kinship relationships and post marital residency pattern were scarcely considered with respect to existing contributions [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14]. Subsistence strategies, kinship relationships, residence patterns and settlement patterns were important factors in determining the genetic structure of populations modeled by genetic drift and migration. According to Ensor [13], the use of bio archaeological models for the determination of kinship is an important resource for establishing social relationships and past residence patterns. Once the marriage is consummated, the couple can reside in the area of the husband's family (patrilocal residence), in the area of the wife's family (matrilocal residence) or in either of the two residences, in which case the residence pattern is called ambilocal or bilocal. In hunter-gatherer societies of South America, residence patterns were registered with a proportion of 63% matrilocal, 17% patrilocal and 16% of other cases [15]. In general, according to Oyarce and Del Popolo [16], in Native American peoples kinship can be structured on the basis of monogamous or polygamous marriages, of paternal, maternal or bilateral descent, and the rules of residence can be patrilocal or matrilocal. In the Aymara of southern Peru, in times before the conquest, the residence was dual or bilocal and now is neolocal: both men and women can share activities related to subsistence in highland or lowland environments [17], besides the care of the animals was an almost exclusive job of the wives since the husbands had salaried jobs outside the community [18]. In Isluga (northern Chile), in groups of the Aymara-Spanish-speaking community dedicated to camelid breeding, the residence is virilocal[19]. In the Macro-Pano ethnic groups of Bolivia (Chimanes) the family is nuclear, although a sporadic bigamy of the male is admitted and the residence

is matrilocal and neolocal by the seminomadism, since the individuals move constantly within their territory [20]. In ethnographic groups of Tierra del Fuego integrated by Selk'nam terrestrial nomadic hunters, and Yámana and Halakwulup canoe hunters of marine fauna, a pattern of matrilocal residence was established based on phenotypic traits [21].

For ancient populations of the South Central Andean Area no information is available on the pattern of residence from archaeological research, except in a recent experience in which a pattern of matrilocal residence [22] was determined based on craniometric variables. The results obtained in that opportunity stimulated the present study, in order to extend the proof obtained by the determination of the pattern of residence in a several sites in northern Chile of the Archaic and Agroalfarero periods and their relationship with different migratory models.

Material and Methods

The investigation was carried out with the information obtained in six localities in northern Chile (Figure 1, Table 1): Pisagua includes a group of sites from the Agroalfarero period (300 BC to AD 1450) [23, 24, 25], CaletaHuelén 42 is assigned to the Archaic period (4780 ± 100 BP) [26, 27], San Pedro de Atacama includes sites from the Early, Middle and Late periods (300 BC to AD 1532) [28, 29, 30], Calama (Chunchuri) is a site that corresponds to the pre Inca Period dated in AD 1390 (Dupont-1 site) [31, 32, 33, 34]; Punta de Teatinos and El Cerrito are assigned to the Archaic period of the Semi-arid North of Chile (4905 ± 100 BP, 4560 ± 95 BP and 3780 ± 550 BP)[35, 36, 37, 38].

The analysis included a sample of 946 individuals, of both sexes, of post-reproductive age (adult, mature and senile), with and without artificial deformation of the skull. The determination of sex, age and artificial deformation was carried out according to Genovés[39], Dembo and Imbelloni[40] and Buikstra and Ubelaker[41]. We used 27 cranial metric traits (Table 2) obtained according to the International Convention of Monaco [42], Wilder [43] and Bass [44], using original instruments (Siber and Hegner, Switzerland).

Figure1. *Northern Chile localities (bold text)*

Table1. *Distribution of the Sample by Sex*

Localities	Males	Females	Total
Pisagua	35	19	54
CaletaHuelén 42	11	20	31
San Pedro de Atacama	319	305	624
Calama	116	45	161
Punta de Teatinos	26	26	52
El Cerrito	11	13	24
Total	**518**	**428**	**946**

Table2. *Craneometric variables*

Maximum cranial length	Basion-nasion length	Maxillo-alveolar length
Maximum cranial breadth	Basion-prosthion length	Palate length
Basion-bregma height	Upper facial height	Palate breadth
Porion-bregmaheigth	Nasal height	Orbito-alveolar height
Minimun frontal breadth	Nasal breadth	Foramen magnum length
Maximum frontal breadth	Biorbital breadth	Foramen magnum breadth
Frontal malar breadth	Orbital breadth left	Sagital curve nasion-bregma
Bizygomatic breadth	Orbital height left	Sagital curve bregma-lambda
Bimaxillary breadth	Maxillo-alveolar breadth	Sagital curve lambda-opistion

The available information allowed the analysis of the differences between the average phenotypes of the localities and between sexes of each locality with multivariate statistical methods: MANOVA and Discriminant Analysis [45]. To determine the genetic differentiation magnitude, from the relationship between the average within and between-group variances, the Fst statistic for quantitative traits was used according to Relethford and Blangero[46], Relethford[47, 48], Relethford and Har pending [49],Relethford et al. [50] and Konigsberg and Ousley[51]. A heritability (h^2) of 0.55 was used, an acceptable value according to Relethford [47] and Relethford and Har pending [49]. The h^2 value chosen is compatible with the maximum genetic variance estimated for quantitative traits in populations of the region [52, 53, 54] according to Falconer and Mackay [55]. In addition, the calculation of the migration rate was included in agreement with the original development of Sewall Wright's as Nm = 1/4 * [(1 / Fst) -1], with Nm being the number of migrant individuals per generation from which it was possible to evaluate the most probable migratory model for each sex[56]. The RMET program was used (version 5.0, see http: //employees.oneonta.edu/relethjh/programs/).

With the aim of evaluating the relationship and type of post marital residence the following experimental designs were developed: 1) between localities and between sexes by locality, 2) between periods and between sexes by period and 3) between sites and sexes of the Archaic and Agroalfarero periods. The quotient between the average variances within groups of male and female individuals (1-Fst♂ / 1-Fst♀) allowed to infer the post marital residence pattern. A matri local pattern was determined if the average male value within groups between localities (1-Fst♂) was greater than the female value (1-Fst♀) and if it was smaller, a patrilocal residence pattern was assigned. If a sex has greater migratory mobility, it will have a lower Fst value and a lower between-group genetic variance than the less migratory sex, which will have a higher Fst value and a greater between-group genetic variance [2].

RESULTS

The territorial segment analyzed in northern Chile (Figure 1) includes a set of different populations from the phenotypic point of view, among which (Table 2) a majority of male individuals stands out (Pearson Chi-square = 30.862, df = 5, p=0.00001) with the greater difference for Calama (72% vs. 28%). The differences of the average phenotypes between localities evaluated by the D^2 statistic are significant (Wilks' Lambda=0.11985 approx. $F_{135,4513}$=17.967, p<0.001) (Table 3). The D^2 values between CaletaHuelén42 and the other localities stand out. Figure 2 shows the distribution of localities based on the three average canonical variables that accumulate 86% of the variation explained by the discriminant analysis. The evaluation of the differences between sex pairs by locality (Table 4) also showed significant results in general (Wilks' Lambda=0.04378 approx., $F_{297, 9308}$=11.229, p<0.001) and in particular for the D^2 values (F -values; df = 27, 912).

Table3. *Localities, differences between mean phenotypes and D^2 values (F-values; df = 27,914)*

Localities	Pisagua	CaletaHuelén 42	San Pedro de Atacama	Calama	Punta de Teatinos	El Cerrito
Pisagua	0.00	30.25	6.87	7.86	11.92	12.39
CaletaHuelén 42	30.25	0.00	34.89	31.28	38.29	34.06
San Pedro de Atacama	6.87	34.89	0.00	5.11	10.72	12.09
Calama	7.86	31.28	5.11	0.00	14.28	13.77
Punta de Teatinos	11.92	38.29	10.72	14.28	0.00	7.84
El Cerrito	12.39	34.06	12.09	13.77	7.84	0.00

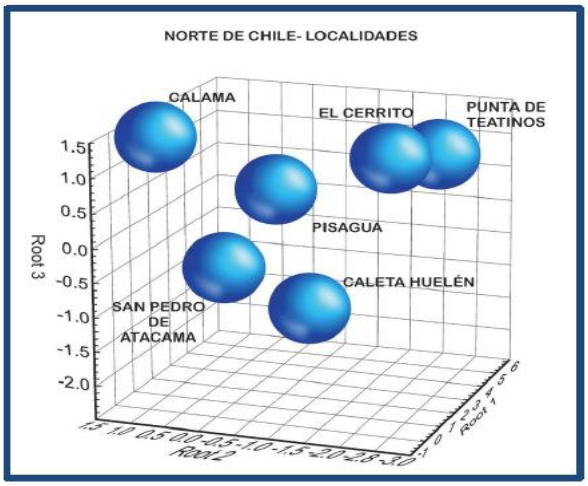

Figure2. *Distribution of localities based on the three average canonical variables that accumulate 86% of the variation explained by the discriminant analysis (Wilks' Lambda = 0.11985 approx. $F_{135,4513}$ = 17.967, p<0.0001)*

Figure 3 shows the distribution of sexes by locality based on the D^2 values by Ward's grouping method. The association of the sexes of each locality and the closer relations between Punta de Teatinos with El Cerrito and Pisagua with San Pedro de Atacama and Calama stands out.

Table4. *Differences between individuals of both sexes and between localities. D^2values (F-values; df = 27,912)*

Localities		Pisagua		Caleta Huelén 42		San Pedro de Atacama		Calama		Punta de Teatinos		El Cerrito	
	Sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Pisagua	♂	0.00	8.93	33.77	34.74	7.91	16.55	10.27	18.42	13.19	23.11	13.87	23.98
	♀	8.93	0.00	43.04	34.41	9.19	8.30	9.57	9.68	15.33	13.09	13.50	14.33
Caleta Huelén 42	♂	33.77	43.04	0.00	11.07	41.07	55.41	39.00	55.80	44.55	61.97	46.17	56.66
	♀	34.74	34.41	11.07	0.00	33.75	41.48	31.34	40.49	34.77	45.88	34.42	36.79
San Pedro de Atacama	♂	7.91	9.19	41.07	33.75	0.00	5.08	5.63	11.51	11.08	15.96	13.48	16.63
	♀	16.55	8.30	55.41	41.48	5.08	0.00	7.53	6.39	17.83	12.96	19.34	12.73
Calama	♂	10.27	9.57	39.00	31.34	5.63	7.53	0.00	4.36	15.46	17.88	14.96	17.27
	♀	18.42	9.68	55.80	40.49	11.51	6.39	4.36	0.00	22.21	17.75	20.36	16.44
Punta de Teatinos	♂	13.19	15.33	44.55	34.77	11.08	17.83	15.46	22.21	0.00	9.75	9.26	17.65
	♀	23.11	13.09	61.97	45.88	15.96	12.96	17.88	17.75	9.75	0.00	12.89	9.52
El Cerrito	♂	13.87	13.50	46.17	34.42	13.48	19.34	14.96	20.36	9.26	12.89	0.00	8.37
	♀	23.98	14.33	56.66	36.79	16.63	12.73	17.27	16.44	17.65	9.52	8.37	0.00

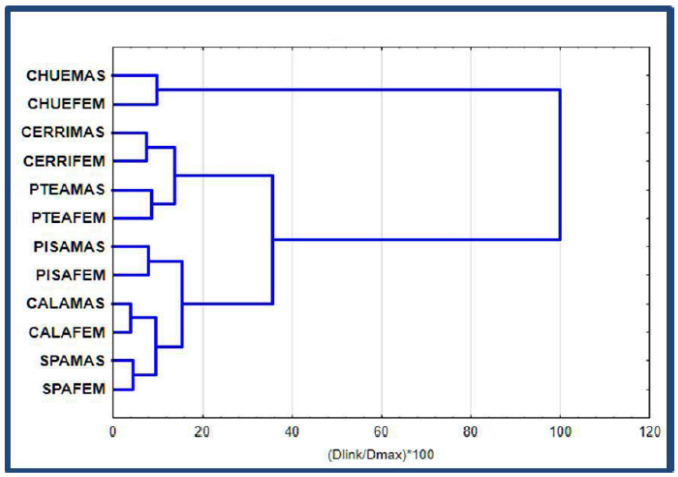

Figure3. *Sexual dimorphism by locality based on D^2 values by Ward's grouping method (Wilks' Lambda = 0.04378 approx. $F_{"297, 9308"}$ = 11.229, p<0.0001). CHUE (Caleta Huelén 42), CERRI (El Cerrito), PTEA (Punta de Teatinos), PISA (Pisagua), CALA (Calama), SPA (San Pedro de Atacama). The suffixes MAS (males) and FEM (females) are added as appropriate.*

The structure of the regional population measured by the Fst statistic revealed the magnitude of the genetic divergence and the estimated number of migrants per generation (Nm) for different experimental designs. Between localities a marked phenotypic dispersion is observed with a general value of Fst = 0.2041 ± 0.0057 and Nm = 0.98 (Table 5). Between periods, the divergence is lower with values of 0.0613 ± 0.003 and Nm = 3.83. In the Archaic period in relation to the Agroalfarero period, a marked deviation from the expected equilibrium stands out with a different and more homogeneous genetic composition (Figure 4) while in the Early, Middle and Late periods the genetic drift and the greater interaction with local migratory circuits influenced in its composition. In the Archaic period values of Fst = 0.3229 ± 0.0086 and Nm = 0.52 were estimated, while in the Agroalfarero period the divergence between sites is much smaller (Fst = 0.0598 ± 0.0035) and the migration rate is higher (Nm = 3.93) (Table 5).

Table5. *Fst values, standard error (se) between localities and periods, number of migrant individuals per generation (Nm) and quotient between the average variances within groups of male and female individuals (1-Fst♂ / 1-Fst♀)*

	Fst	se	Nm	(1-Fst♂) / (1-Fst♀)
Localities	0.2041	0.0057	0.98	
Localities♂	0.2280	0.0092	0.85	1.051
Localities♀	0.2656	0.0075	0.69	
Periods	0.0613	0.0030	3.83	
Periods ♂	0.0618	0.0043	3.79	1.018
Periods ♀	0.0787	0.0048	2.93	
Archaic	0.3229	0.0086	0.52	
Archaic ♂	0.4235	0.0117	0.34	1.220
Archaic ♀	0.5274	0.0078	0.22	
Agroalfarero	0.0598	0.0035	3.93	
Agroalfarero♂	0.0663	0.0046	3.52	1.030
Agroalfarero♀	0.0932	0.0075	2.43	

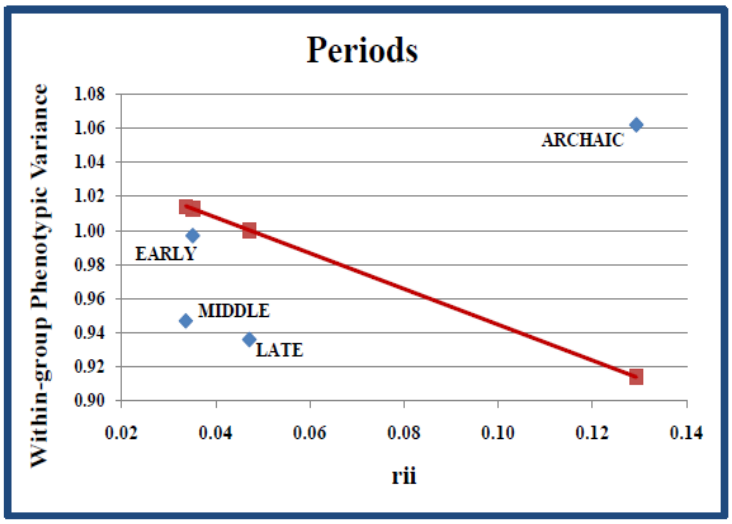

Figure4. *Phenotypic variance observed (diamond) and expected (square) for Archaic, Early, Middle and Late periods. Values rii: distance to the centroid of the distribution. Fst value = 0.0613± 0.0030, Nm=3.83*

With regard to the sexes in general, the divergence for each case is greater in female than in male individuals (Table 5): between localities (Fst♂ = 0.2280 ± 0.0092 with Nm = 0.85 and Fst♀= 0.2656 ± 0.0075 with Nm = 0.69) and between periods (Fst♂ = 0.0618 ± 0.0043 with Nm = 3.79 and Fst♀ = 0.0787 ± 0.0048 with Nm = 2.93). The deviation from the expected equilibrium between genetic drift and migration significantly involves both sexes of the Archaic period, while the position of the female sexes of the early, middle and late periods below the equilibrium line indicates a greater local gene flow (Figure 5).

In the Archaic period (Table 5) the sexes have the highest values of divergence and lower migration rates (Fst♂ = 0.4235 ± 0.0117 with Nm = 0.34 and Fst♀ = 0.5274 ± 0.0078 with Nm = 0.22) and in all cases the deviation from the equilibrium line is significant.

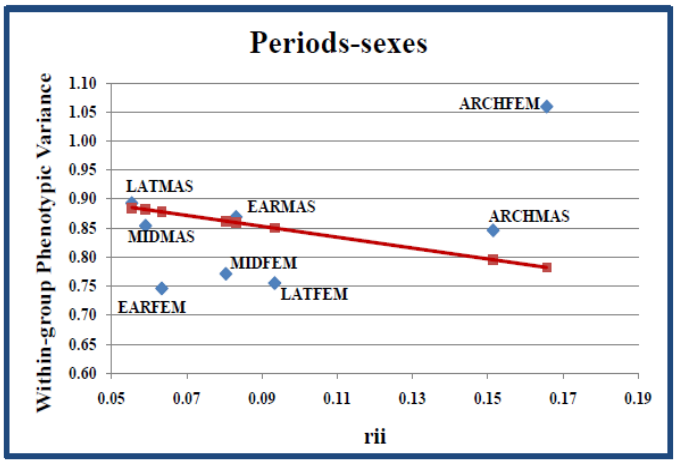

Figure5. *Phenotypic variance observed (diamond) and expected (square) for periods and sexes. ARCH (Archaic), EAR (Early), MID (Middle) and LAT (Late) periods. The suffixes MAS (males) and FEM (females) are added as appropriate.Values rii: distance to the centroid of the distribution. Fst value = 0.0940±0.0036, Nm=2.4*

A greater contribution of foreign variability or a larger effective size in the sexes of CaletaHuelén42 and in the women of El Cerrito is highlighted (Figure 6), while a more restricted circuit influenced the variance of both sexes of Punta de Teatinos and in the men of El Cerrito.

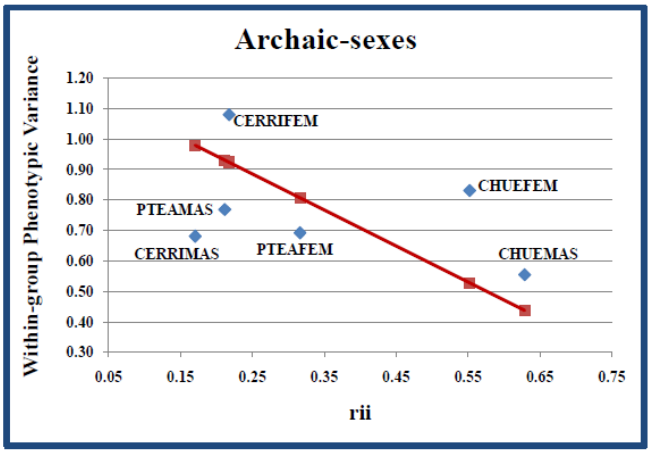

Figure6. *Phenotypic variance observed (diamond) and expected (square) for sexes and localities of Archaic period.CHUE (Caleta Huelén 42), CERRI (El Cerrito), PTEA (Punta de Teatinos), PISA (Pisagua). The suffixes MAS (males) and FEM (females) are added as appropriate. Values rii: distance to the centroid of the distribution. Fst value = 0.3495±0.0086, Nm=0.47*

In the Agroalfarero period (Fst♂ = 0.0663 ± 0.0046 with Nm = 3.52 and Fst♀ = 0.0932 ± 0.0075 with Nm = 2.43) the contribution of external variation to the system is integrated into the male individuals of Pisagua and Calama, while the women of the three localities share a more homogeneous genetic variation or a smaller effective size (Figure 7).

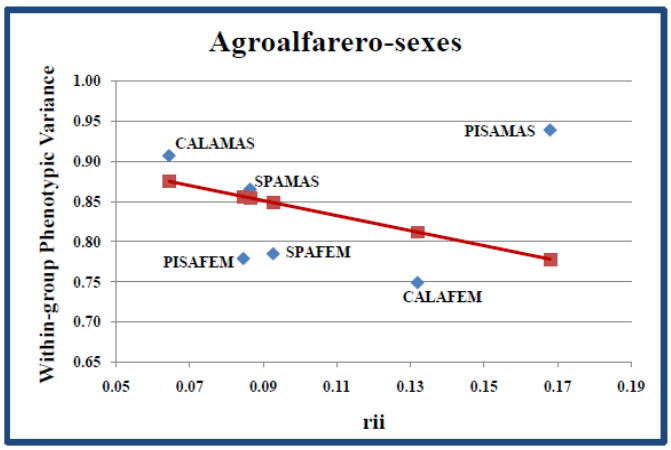

Figure7. *Phenotypic variance observed (diamond) and expected (square) for sexes and localities of Agroalfarero period.PISA (Pisagua), CALA (Calama), SPA (San Pedro de Atacama). The suffixes MAS (males) and FEM (females) are added as appropriate.Values rii: distance to the centroid of the distribution. Fst value = 0.1047±0.0047, Nm=2.14*

The evaluation carried out on the level of mobility of both sexes allowed inferring in all cases a matrilocal residence pattern: for the regional level (1.051), for periods (1.018) and in particular for the Archaic period (1.220)and Agroalfareroperiod (1.030). In general, such observations can also be inferred by observing the differences between the migratory proportions of both sexes in Table 5.

Discussion and Conclusions

The phenotypic differences that characterize the structure of the sample reflect the effect of spatial and temporal distance between localities and between sexes (tables 3 and 4, Figure 2), and repeat similar results of previous experiences on the relations between northern Chile and northwestern Argentina [57, 58, 22].

The Archaic period marks an early time of the settlement of northern Chile by groups of hunters and fishermen whose members experienced a marked founder effect, with a slow demographic growth and a strong dispersive process for more than 12,000 years. As a consequence, the greatest phenotypic differences and the lowest migratory proportions are highlighted (Table 5). In particular, the differences between CaletaHuelén 42 and the other localities suggest the result of a singular occupation event, related to early archaic groups of Arica [27] and its dispersion during the colonization of the Arreica coast of Northern Chile, involving sites such as Copaca 1, La Fundición 1 and Huentelauquén [59, 60]. For this stage, a model of post marital residence similar to that of Agroalfarero development was revealed. A set of factors related to social organization, kinship, rules of descent and residence rules guaranteed the availability and management of resources that influenced the subsistence of local populations.

The Agroalfarero period (figures 4 and 5), integrated with spatially and temporally closer localities, probably due to higher population growth, presents a lower phenotypic divergence and a greater migratory activity (Figure 6). In this period (Table 5 and Figure 7) the female Fst value exceeds the male value by 41% and the proportion of male migrant individuals is higher (45%) than the female proportion. The men of Pisagua and Calama move away from the balance between genetic drift and migration, while among the female groups the kinship is greater, with an effective size and a smaller variance than the masculine one. This result may be related to different sex-specific activities linked to the obtaining of resources from hunting and gathering of fruits, the practice of agriculture, the raising of llamas and the traffic of products in a vast territorial network. In addition, it is possible to infer patterns of matrilocal residency and male interaction in a larger territorial circuit related to transhumant practices [61], related to the exchange and trade of goods [62] including relations with the northwestern Argentine [58].The residency guidelines reveal the action of evolutionary mechanisms related to migrations, mating patterns and different effective sizes that supported and designed the local and regional genetic configuration. The analysis is interesting because it shows a pattern compatible with a model of matrilocal residence (Table 5) that in the current experience is revealed as an associated practice in archaic groups of Punta de Teatinos, El Cerrito and CaletaHuelén 42, and in agricultural societies of the Agroalfarero period as Calama, Pisagua and San Pedro de Atacama.

However, these results should not be generalized since, in fact, the information obtained in ancient and current communities indicates the practice of variable patterns appropriate to the traditions and local social and economic reality. For example, observations made in the Ilave river (Jiskairumoko, an Archaic site in the Lake Titicaca basin), the post marital residence may have been patrilocal or bi local[63], as well as in exploration groups of South America [15]. These results suggest the possibility that new research in northern Chile may reveal other patterns of residences different from the one proposed in this paper.

The evidence provided by the bibliographic information and by current experience show that the study of the evolution of kinship and residence patterns is an important objective for the reconstruction of social relations in ancient communities based on different subsistence models and their evolution with the impact of the European conquest.

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