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Helping Patterns and Reproductive Success in Aymara Communities

E. CROGNIER,[1]* M. VILLENA,[2] AND E. VARGAS[2]
[1]UMR 6578 CNRS et Université de la Méditerranée, Faculté de Médecine, 13385 Marseille Cedex 05, France
[2]Instituto Boliviano de Biologia de Altura, calle Claudio Sanjines, Miraflores, La Paz, Bolivia

ABSTRACT "Helpers at the nest," young adults remaining in their parents home to take care of younger siblings, are known in many species of birds and mammals. Similar behaviors are occasionally observed in human societies but their frequency and significance for parental reproductive success are still not fully appraised. This study was designed to document this issue in a traditional Aymara peasant society of the Bolivian Altiplano. It is based on 359 reproductive life histories of women 45 years of age or older and on a survey of children's workload in 1998 and 1999. The presence of "potential helpers" in the household is significantly associated with higher fertility and with improved survival of siblings to sexual maturity. Caretaking is not particularly assigned to older daughters. The positive relationship between the availability of offspring help and reproductive success does not demonstrate a causal role for child caretaking because, in contrast with nonhuman helpers, workloads of children range from housekeeping to agricultural tasks, instead of being focused on feeding or protecting younger siblings. Correlation and multiple regression analyses, however, suggest that the total amount of care given by the older offspring and the amount of care received by each recipient are, along with offspring contribution to household economy, among the determinants of parental reproductive success. Am. J. Hum. Biol. 14:372–379, 2002.

Studies in behavioral ecology have shown that helping behaviors are not exceptional in many species of birds or mammals, and that they may have a direct influence on reproductive success. Some of these behaviors from young individuals, usually members of a preceding brood (helpers at the nest), or from cooperative adult breeders (plural breeders; see Krebs and Davies, 1993), contribute to increase the reproductive success of the breeding pair(s), sometimes to the detriment of the helper's direct reproductive success (e.g., in hunting dogs who may remain helpers life-long; Trivers, 1985). However, this kind of altruism is also an indirect strategy to promote one's own genes (e.g., by increasing the number of full siblings who share with ego a coefficient of relationship of 0.5).

Several studies have shown that environmental constraints may be determining factors of helping behaviors (e.g., the lack of vacant territories for the establishment of young adults in populations of the Florida scrub jay; Woolfenden and Kirkpatrick, 1984). This ecological-economical constraint delaying the onset of independent adult life is also obvious in many human societies (Clarke and Low, 1992; Clarke, 1993; Strassman and Clarke, 1998), and may subsequently favor the development of helping patterns.

The nature of human helping behaviors is contentious. Do they originate in specialized animal behaviors (protection, defense, feeding, etc.) that would have been shaped by culture, or are they a mere application of social interaction? Most available observations of helping behaviors in traditional human societies are examples of plural breeders, involving adult cooperation. Flinn (1989), for example, observed that the principal helpers on the island of Trinidad were adult females of the family other than the mother. This organization of infant caretaking is also found in the familial network of Hungarian gypsies (Bereckzei, 1998). In Africa, Borgerhoff Mulder and Milton (1985) described a collective organization of adults to assume infant care in the Kipsigis of Kenya. This is also found among the Sara of Chad (Crognier, 1998) as part of

*Correspondence to: E. Crognier, CNRS Rodriguez Peña 1146, 7600 Mar Del Plata, Rep. Argentina.
E-mail: crognier@statics.com.ar

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African lineage organization and polygynic structure.

As far as "helping at the nest" provided by elder offspring to younger siblings is concerned, the notion that increased parental reproductive success through offspring manipulation may be a frequent strategy, particularly in traditional peasant societies, seems to have been readily accepted. The reason is probably that the number of desired offspring often appears to be a trade-off between parental investment and expected economic or social returns.

If a tacit consensus prevails that "helpers at the nest" occur in human societies and that, as in other animal groups (Trivers, 1985), they would enhance the reproductive success of close kin, usually parents, it lacks observational support. Among the scarce attempts is the study of the Micronesian atoll of Ifaluk (Turke,1988), in which a positive influence of elder daughters on their parents' reproductive success was ascertained. A quantitative study of 794 reproductive histories in a traditional Berber society of Southern Morocco (Crognier et al., 2001) suggested that "potential helpers" offspring who were in situation to provide help) were associated with higher parental reproductive success. The current study was designed to apply the same methodology to the reproductive histories of Aymara peasant women in Bolivia. It considers whether the particular circumstances of the constitution of each family were compatible or not compatible with the presence of one or several helpers at the nest, and assesses whether the help that they could have brought to the parents is associated with a higher reproductive success, i.e., a higher number of offspring surviving to 15 years (considered by convention to be the age of sexual maturity). This improvement in reproductive success would better result of: 1) an increase in the number of live births subsequent to the extension of the mother's reproductive span or to the shortening of birth intervals; 2) the enhancement of offspring survival; or 3) a combination of both factors.

MATERIALS AND METHODS

From August 1998 to December 1999, a survey designed by the Bolivian Institute of Altitude Biology of the University Mayor San Andres of La Paz, on behalf of the Ministry of Health and with the approval of the Committee of Ethics of the Academy of Science, was developed in 12 Aymara peasant communities ("Ayllu") remotely settled at high altitude (4,000 m) on the Altiplano, 30 km southwest of the city of La Paz. Each community council approved the content of the project, which was principally directed to improve medical assistance. A database of social, cultural, and biological information was established from information collected in 868 families representing the total population of the area surveyed, on the basis of voluntary participation. Reproductive life histories of all women (married or not) were recorded and this oral information was crossed-checked with other sources (baptism and marriage registers, familial booklet, genealogies) to obtain data as precise as possible. The present study is based on the reproductive histories considered as complete of all women 45 years of age and older. Each subject was also asked to describe what they considered to be the care requirements of the offspring and who were the caregivers among the members of the family. The answers, transcribing common cultural conceptions, were generally similar. They permitted discarding the hypothesis of the existence of a system of plural breeding by a community of adults and affirmed the existence of child help. The average characteristics of child involvement in familial tasks described by the parents were used to build an algorithm (see below). Moreover, an independent survey in which children themselves were asked to describe their participation in household chores, agriculture, or herding was also carried out.

A computer program was developed with the SAS package in previous research (Crognier et al., 2001), and adapted to local characteristics. The program evaluates whether the particular circumstances of the constitution of each family were compatible or not compatible with the presence of one or several helpers at the nest. It considers, following parental estimates, that an offspring is able to provide help to a younger sibling from the age of 5 to 18 years (mean age of the beginning of independent labor) with two conditions: 1) that the recipient of help is at least 6 months of age (before this age, infants remain, most of the time, in the immediate dependence of their mother), and 2) that the age interval between the

	N	Mean	SD	Range
Age at menarche (years)	359	15.4	1.3	12–20
Age at first birth (years)	334	24.3	1.2	16–44
Interval menarche, first birth (years)	305	8.6	4.3	1–19
Age at menopause (years)	278	47.1	2.9	38–56
Age at last birth (years)	334	37.9	6.0	19–53
Interval last birth, menopause (years)	246	9.9	5.7	0–25
Span of reproductive life (years)	334	13.1	6.2	0–29
Mean birth interval (months)	346	35.6	7.4	15–59
Mean breastfeeding extent (months)	346	19.6	6.1	1–36
Number of live births	359	5.4	2.1	1–13
Number offspring ≥15 years	359	4.1	1.9	0–10

helper and the recipient is at least 3 years (parents declarations and field observations show that smaller intervals impair the efficiency of the helper to solve problems met by the younger sibling, such as cleaning oneself, dressing, or eating, so that he will consequently not be useful to adult members of the family). The program takes into account the possible death of either the helper or the recipient and records the number of siblings that were potentially cared for by the helper, the number of days for this total amount of help represents, and the number of deceased offspring among the recipients. It accounts for the relationship of the helper to his/her siblings up to the 15th parity level.

Subprograms were developed to evaluate the potential help provided by the first- and the second-born and to estimate if a community of siblings could play a significant part in the care of later-born children. A subprogram was also designed to evaluate the potential help brought by the community of the four first-born (i.e., the program routine cumulated the individual amounts of help, number of siblings helped, and number of siblings deceased, estimated from the first four successive children, contrasting families in which none of the first four born could provide help with those in which at least one to four could be helpers).

RESULTS

Aymara reproductive pattern

The reproductive life histories of 359 fertile women of 45 years and older at the time of the survey were available. Childless women represented 2.6% of the total postmenopausal female population. The histories offer some insight into the reproductive pattern of Aymara during the 1960s to the 1990s (Table 1).

With an average of 13 years, the reproductive span is short, compared to many traditional groups in which it often exceeds 20 years (Crognier et al., in press). This is the outcome of a very late puberty, a late onset of fertility, and an early end of childbearing. Considering also that the mean birth interval is larger than in the majority of traditional societies, despite a similar practice of breast feeding, the total number of live births is not as high as could be expected. This moderate fertility has often been ascribed to the fertility-depressing action of high altitude hypoxia (Abelson, 1976; Baker, 1978; Bangham and Sacherer, 1980), although others reduce the emphasis on hypoxia and emphasize the part played by behaviors (Goldstein et al., 1983; Kashiwazaki et al., 1988). Aymara effectively control births through regulation of intercourse, abortive practices, or eventual infanticide (Collins, 1983). When questioned about the use of contraception, 70 couples (20%) declared having employed traditional methods of contraception at one moment or another, leading to a contrasting number of live births by comparison with nonbirth controlling pairs (Table 2). The information did not allow more precision with respect to contraceptive behaviors. However, Table 2 suggests that contraception is not employed to postpone the onset of fertility; it is used to bring the end of fertility. The data show that it shortens the reproductive span, lowers the number of offspring who survive to sexual maturity, but it does not seem to favor a higher survival rate.

	Contraceptive (n = 70)		Non contraceptive (n = 271)		
	Mean	SD	Mean	SD	P(t)
Age at first birth (years)	24.9	5.0	24.2	5.0	ns
Age at last birth (years)	36.5	5.0	39.9	5.4	***
Interval last birth, menopause (years)	13.6	5.5	7.7	5.9	***
Reproductive span (years)	11.7	4.2	15.5	5.6	***
Mean birth interval (months)	36.7	7.6	35.3	7.2	ns
Number of live births	4.0	1.4	6.0	2.2	***
Number of offspring ≥ 15 years	2.8	1.1	4.4	1.9	***
Proportion of survivors	0.7	0.2	0.7	0.2	ns

Ns = not significant. ***$P < 0.001$.

TABLE 3. Comparison of reproductive histories (means and standard deviations) of two subsamples of Aymara women, 45 years and older, according to the sex of the first-born child and to potential helping at the nest

	No possible help		Possible help					
	Both sexes (n = 100)		Son (n = 145)			Daughter (n = 114)		
	Mean	SD	Mean	SD	P(t)	Mean	SD	$P > F$
Age of women (years)	58.1	10.8	57.4	8.5	ns	57.7	8.9	ns
Age at first birth (years)	25.8	6.0	24.4	4.6	ns	23.8	4.5	**
Age at last birth (years)	39.9	5.4	39.1	5.2	*	38.5	5.2	*
Reproductive span (years)	12.9	8.1	14.7	4.9	ns	14.7	5.2	***
Birth interval[a] (months)	34.1	1.3	38.6	1.3	**	36.4	1.3	**
Number of live births	5.30	2.5	5.5	1.8	ns	5.90	2.3	*
Number of offspring >15 years	3.30	1.8	4.2	1.7	ns	4.48	1.9	***

[a]Transformed into decimal logarithms.
P(t) = significance of Student's t-test between sex subsamples (ns, not significant; *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$).
F = significance of F coefficient of variance analysis (ns, not significant; *$P < .05$; **$P < 0.01$; ***$P < 0.001$).

Helpers at the nest and fertility

Depending on whether the elder offspring in each of the 359 families could have provided help or not (according to the identification of "potential helpers" by the program), samples of helpers and of nonhelpers were identified. The sample of helpers was further divided into two subsamples by sex. Analysis of variance indicates a significantly larger reproductive span in helpers of both sexes, which is related to a younger age at first birth (Table 3). The data do not support the hypothesis that offspring's help would either contribute to shorten birth intervals or lengthen the mother's reproductive span. Significantly higher numbers of live births in the samples with helpers merely relate to a longer reproductive span, whereas the improved survival of offspring to sexual maturity suggests a role for caretaking in the increase of parental reproductive success. The mean values for male and female helpers do not differ, thus rejecting the hypothesis that daughters more than sons should be the helpers at the nest. The same result was obtained in Moroccan Berber groups (Crognier et al., 2001)

The characteristics observed in relation to help provided by the first-born are also confirmed when the second-born is considered (Table 4). There is a wide discrepancy between the reproductive spans of mothers with a helper and without a helper. This is the expression of an earlier onset and a later ending of childbearing in families with a helper second child.

Despite their longer birth intervals, families with helpers attain a higher final number of live births and their reproductive success is almost twice that observed in the other group. The influence of the second offspring (whatever the sex), therefore, confirms a relationship between reproductive success and helping potential.

Sex is not a pertinent factor when the community of the four first-born is considered. Families whose fertility did not allow interactions between offspring were compared with those in which interactions

TABLE 4. Comparison of reproductive histories (means and standard deviations) of two subsamples of Aymara women, 45 years and older, according to the sex of the second-born child and to potential helping at the nest

	No possible help		Possible help					
	Both sexes (n = 97)		Son (n = 163)			Daughter (n = 125)		
	Mean	SD	Mean	SD	$P(t)$	Mean	SD	$P > F$
Age of women (years)	58.3	9.5	57.8	9.2	ns	57.2	9.1	ns
Age at first birth (years)	26.9	6.2	23.8	4.4	ns	24.1	4.4	***
Age at last birth (years)	38.0	7.5	39.5	4.6	ns	39.5	5.2	***
Reproductive span (years)	11.1	6.6	15.7	4.9	ns	15.5	4.9	***
Birth interval* (months)*	35.4	1.5	36.2	1.3	*	38.1	1.5	***
Number of live births	3.62	1.9	6.0	2.0	ns	6.2	2.0	***
Number of offspring > 15 years	2.35	1.2	4.5	1.8	ns	4.5	1.7	***

*Transformed into decimal logarithms.
$P(t)$ = significance of Student's t-test between sex subsamples (ns, not significant; $^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$).
F = significance of F coefficient of variance analysis (ns, not significant; $^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$).

TABLE 5. Comparison of reproductive histories (means and standard deviations) of two subsamples of Aymara women, 45 years and older, according to potential helping provided by four firstborn offspring

	No possible help		Possible help		
	n = 29		n = 317		
	Mean	SD	Mean	SD	$P(t)$
Age women (years)	56.1	9.6	57.8	9.2	ns
Age at first birth (years)	29.0	6.3	24.3	4.8	***
Age at last birth (years)	37.5	5.5	39.2	5.1	**
Reproductive span (years)	8.4	1.8	14.9	5.1	***
Birth interval (months)*	33.3	1.7	37.1	1.3	***
Number of live births	2.2	1.9	5.7	2.1	***
Number of offspring >15 years	1.5	0.6	4.2	1.8	***

*Transformed into decimal logarithms.
$P(t)$ = significance of Student's t- test between sex subsamples (ns, not significant; $^{*}P < .05$; $^{**}P < 0.01$; $^{***}P < 0.001$

were possible. The results confirm and increase those obtained successively with the first- and the second- born (Table 5).

A marked difference in the extent of the reproductive span, and in the number of live births and of survivors, is observed in families who benefited from an interacting community of children. However, the absence of any possible helper at the nest among the four first-born in a family also suggests that difficulties were met by the parents in the fulfillment of their reproductive plans, or that they did not aim at having a large family.

Which helping pattern?

The data indicate that conditions necessary for the development of caretaking are met, but they do not appraise its effectiveness. Results can, therefore, be interpreted either by assuming that because helpers are present and do effectively help (in particular, in taking care of younger siblings), they produce more reproductive success, or that because reproductive success is another expression of family size, the potential for interactions between offspring is necessarily met when reproductive success is high.

Indications of the causal sequence of several proximate determinants of reproductive success—number of live births, total amount of caretaking potentially provided, mean individual amount of care potentially received (both issued from the computer program), and number of survivors to maturity—may be derived from the correlations (Table 6). The correlation is high between the number of offspring surviving to-maturity and the total amount of care given. This correlation remains high after controlling for the number of survivors

TABLE 6. Pearson's coefficients of correlation between the total amount of help provided to siblings (in days), the mean amount of help per sib (days/nb sibs cared), and the number of offspring reaching maturity and among variables after removal of the influence of the number of live births by partial correlation

Correlations and partial correlations	Correlations nb ≥ 15 years	Partial correlations nb ≥ 15 years/nb live births removed
First-born		
total amount of help	0.75***	0.50***
mean amount of help per sib	0.13*	0.30***
Second-born		
total amount of help	0.69***	0.39***
mean amount of help per sib	0.08 ns	0.21***
Four first-born		
total amount of help	0.63***	0.43***
mean amount of help per sib	0.12*	0.23***

Significance of Pearson's coefficient of correlation (*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$).

and the total amount of help with the number of live births. The correlations support the hypothesis that caretaking favors the survival of siblings.

The mean amount of help received by each siblings is weakly correlated with the number of survivors. The association, however, increases and is significant when the number of live births is controlled, accounting for no more than 9% of the respective variances. This relatively weak interdependence leaves some doubt about a direct effect of help on the recipient's survival.

Stepwise regressions of several independent variables (number of live births, mean amount of care given to each sibling by the first-born, by the second-born, or by the four first-born offspring, number of deaths among recipients cared for by the first-born, by the second-born or by the four first-born offspring, span of reproductive life, age at first birth, age at last birth, mean birth interval, number of persons living in the household, number of rooms in the house) on the number of offspring surviving to sexual maturity do not remove this doubt (Table 7). The best predictive equation is obtained with the model established for the elder offspring. The variables account for 63% of the variance of survivors to sexual maturity (R^2), of which 54% and 9% are respectively, explained by the number of live births (NLB) and the mean amount of care received by each offspring (MCI). An additional 3% is explained by the number of persons living in the household. This result, as well as those of the other models in Table 6, confirms the role of childcare in the improvement of parental reproductive success. The weak predictive value of the amount of care received by each recipient, equivalent to the influence of the number of persons living in the household, may, however, signify that differences in survival are not primarily related to this variable. The association between help and survival could, therefore, follow indirect pathways, probably through improvement of life conditions.

Offspring's workload

The participation of children in household or agricultural tasks was explored in an independent survey. Questionnaires were completed during direct interviews by the

TABLE 7. Stepwise multiple regressions of offspring survival to sexual maturity (Nb ≥ 15)

Stepwise multiple regressions
Including the first-born:
Nb ≥ 15 = 7.27 + 0.499 (NLB) + 0.001 (MC1)-0.165 (NPH) + 0.131 (SPR) – 0.0142 (ALB) *contributions to* R^2: (NLB) = 0.54 (MC1) = 0.04 (NPH) = 0.025 (SPR) = 0.01 (ALB) = 0.009 total R^2 = 0.63
Including the second-born:
Nb ≥ 15 = –0.213 + 0.641 (NLB) + 0.008 (MC2) –0.147 (NPH) *contributions to* R^2: (*NLB*) = 0.433 (*NPH*) = 0.032 (MC2) = 0.026 total R^2 = 0.49
Including the four first born:
Nb ≥ 15 = –0.273 + 0.678 (NLB) + 0.008 (MC4) –0.178 (NPH) *contributions to* R^2: (*NLB*) = 0.495 (*NPH*) = 0.030 (MC4) = 0.025 total R^2 = 0.55

Predictive variables: the number of live births (NLB); the mean amount of care per sib (by the eldest = MC1; by the second-born = MC2; by the four first-born = MC4), the number of persons in the household (NPH), span of reproductive life (SPR), and age at last birth (ALB).

TABLE 3. Percentages of children participating in household provisioning, maintenance, agricultural tasks, or caretaking of siblings, by age group and sex

Age and Sex	N	Provisioning	Maintenance	Cattle herding	Agriculture	Caretaking
5–7 years F	15	93%	40%	100%	40%	40%
5–7 years M	6	100%	50%	83%	33%	50%
8–10 years F	8	100%	63%	100%	87%	87%
8–10 years M	10	100%	90%	100%	100%	80%
11–13 years F	10	100%	90%	90%	90%	80%
11–13 years M	13	100%	85%	100%	100%	46%

schoolmaster in cooperation with the local nurse. The sample included the total population of children 5 to 13 years of age (32 boys and 31 girls) of a single community (the community of Tuni, in which the health station of the area is located). The rationale of the survey was to draw a qualitative estimate of children's constraints other than schoolwork and to explore the main activities in which they could cooperate. The number of hours spent daily in several activities (e.g., caretaking) was grossly estimated from direct questions. The results are consistent with those previously obtained in Aymara groups of Southern Peru (Collins (1983). Activities begin early in life (Table 8): children 5 years of age participate in provisioning the household with fuel and water, in helping to clean and order the house, and in care for pigs and poultry. The workload increases with age irrespective of sex until preadolescence, when boys progressively focus on agricultural activities (cattle herding, plowing, sowing, harvesting, and stocking the crops), and girls divide their workload between some agricultural tasks (sowing and harvesting) and home activities. As far as caretaking is concerned, each child attends to a younger sibling daily, either by watching, feeding, clothing, cleaning, or playing (a mean 1.5 hours per day before the age of 10 years and 2.5 hours per day for older helpers). This caregiving is irrespective of sex, being only determined by need and by family composition. However, preadolescent girls tend to also teach younger sibs to read, to clean clothes, or to cook.

DISCUSSION

The picture given by the workload of children in Aymara communities is consistent with observations gathered in many traditional peasant societies, e.g., in Bangladesh (Cain, 1977), Nepal (Nag White and Peet, 1978), Indonesia (White, 1975; Nag et al., 1978), or Peru (Collins, 1983). Self-subsisting peasant economies need all possible labor contributions. Cross-cultural studies also indicate that if caregiving is one of among many activities expected from children's labor, it is because both sexes perform primarily women's nonproductive activities (Bradley, 1993).

On the other hand, some studies (Mueller, 1982; Robinson, 1987; Tiefenthaler, 1997) estimate that in these societies time and effort represented by a new offspring is a load which does not impair the mother's activity beyond the first months following birth. In particular, it would not be associated with a significant decrease of familial income. This would mean that the family is able to find substitutes for several activities of the mother (including infant care) unless mothers can simultaneously do infant care and normal work. The increase of parental reproductive success would consequently depend on the extension of familial links (e.g., Bereczkei, 1998) and, obviously, on the support available from the progeny.

Aymara reproductive patterns show a clear relationship between family size or reproductive success and the availability of offspring's help. The influence of offspring help could be either by their contribution to household activities or through culturally channeled assistance to younger siblings, but more probably by a combination of both. Aymara society does not offer a picture of helping at the nest as clear as has been reported for nonhuman groups. Culture and social organization probably make each human behavior an outcome of a complex causality, in which education and familial economy, along with support received from kin, are relevant factors.

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