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Traditional Knowledge of Edible Wild Native and Exotic Plants in the Context of Cultural Change in Human Populations of Arid Patagonia

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ABSTRACT

Traditional plant knowledge can be defined as being dynamic and flexible. In this work it is suggested that this body of knowledge assimilates the experience of change in systems involving humans and plants. Taking the case of Mapuche communities in arid Patagonia (Argentina) as a study base, I analysed the effect of maintaining or not practices associated with the use and/or transformation of the environment, such as hunting, transhumance, Pewen seed collection (called *piñoneo*) and small-scale family horticulture, on traditional knowledge of edible wild plants, both native and exotic. Information from interviews was analysed by means of logistic regression. The maintenance of certain traditional practices, such as hunting and speaking the native language, which on the one hand represent direct experience of the environment, and on the other hand familiarity with the linguistic categories which represent the Mapuche world vision, are associated with a greater diversity of native and exotic plant knowledge. This greater diversity implies greater resilience of the traditional plant knowledge possessed by different populations. In contrast, the practice of *piñoneo* is differentially linked to greater knowledge of native, but not of exotic species. The role played by horticulture and transhumance in wild plant knowledge is discussed, since conflicting and/or unclear relationships were found. In these communities, the social memory of plants is dynamic, in tune with the dynamics of the Patagonian ecosystem, which has incorporated numerous exotic plants into its natural ecosystems. The importance of studies that show how human communities have the capacity to adjust and adapt their bodies of plant resource knowledge is emphasised.

Keywords: hunting, transhumance, horticulture, language, wild plant gathering

INTRODUCTION

In a word, "change" summarises case studies in ethnobiology and ethnobotany (Moreno Fuentes *et al.* 2010; Costa Neto *et al.* 2009; Ladio and Molares 2010). Changes may increase or decrease the vulnerability of human-environment systems so that, depending on the situation, this transformation may lead to the weakening or strengthening of resilience.

The resilience concept applied to ethnobotany has been related to the ability of a body of plant knowledge to cope with disturbance and change, and the degree to which the human being-plants system is capable of self organization, learning and adaptation (Berkes *et al.* 2000; Berkes and Folke 2002; Tengö and Belfrage 2004; Ladio and Lozada 2008). In this context, my general hypothesis is that when changes are inevitable in a society, resilient cultural plant systems contain the components and mechanisms necessary for the revitalization and re-organization of the people's corpus of plant knowledge.

In Patagonia, the processes of change in traditional knowledge have been analysed systematically, as have the ecological and social factors which influence its construction and dynamics (Ladio and Lozada 2004a, 2004b; Molares and Ladio 2009a). We considered traditional plant knowledge as part of traditional ecological knowledge (TEK), defined as a collective body of information, actions and beliefs which evolves through adaptive processes and is handed down for generations by cultural transmission (Berkes and Turner 2006). This wisdom is active in nature, acquired by communities throughout their history by means of direct experience and contact with the environment. As a consequence, it is particularly prone to reorganization and oscillations (Begossi *et al.* 2002; Davidson-Hunt and Berkes 2003).

In these studies, resilience has been mainly associated with the diversity of plant species known and used in a society (Ladio and Lozada 2008, 2009). For example, Ladio and Lozada (2008) showed that an isolated rural population located in North-western Patagonia utilized 63 species that are important internal resources for healing themselves and helping to heal other family members. Even more important is the fact that possessing knowledge of these resources has positive psychological effects for the people given that they propitiate solutions for dealing with illness in autonomous way (found in 70% of informants). These results, therefore, imply that the diversity of plant knowledge possessed by inhabitants effectively promotes the psychological resilience of the individual, in a way that allows them to respond in a flexible way to stressful experiences such as illness.

The diversity necessary to maintain the resilience of traditional plant knowledge refers to components and processes that keep the history and accumulated experience of a culture alive, and which promote a richness of responses and solutions for survival (Davidson-Hunt and Berkes 2003). This is the case of culturally relevant practices in a population which has direct contact with nature, as in the subsistence activities of hunting, transhumance, gathering and horticulture for the Mapuche communities living in Northwest Patagonia (Ladio and Lozada 2004a, 2004b; Eyssartier *et al.* 2008; Ladio and Lozada 2009; Eyssartier *et al.* 2011; Ladio 2011). In addition, in this region some Mapuche communities experienced another significant cultural practice, travelling in autumn from the lowlands (their homes) to the pre-Andean forest highlands in search of monkey-puzzle, *Araucaria araucana*, seeds ("pewen" seeds,

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called "ngüilliw" in the Mapudumgum language). This Pewen seed gathering tradition plays a fundamental role in their subsistence (Aagesen 1998; Ladio and Lozada 2000) as it possesses unique traits, (for example, high nutritional value) in comparison with other gathered wild plant resources, and so is named separately, *piñoneo* or *ngümitun* in the Mapudungum language.

For these Mapuche communities, activities such as hunting, transhumance, Pewen seed gathering and horticulture form unique, distinct cultural domains that are different from each other and reflect different contexts of action, exploration and appropriation of the landscape, and therefore of plant knowledge acquisition. In addition, given that language is a reflection of the order a culture gives to its universe, organising its perceptions, aptitudes and behaviours (Costa Neto and Santos Fita 2009), the use of the traditional language (named "Mapudumgum" among Mapuches) is a basic way of expressing meanings and values (Villagrán 1998). At present, these traditional practices are significantly changing, due to diverse factors, but principally related to processes of deagrarianisation and greater dependence on a market society (Ladio and Lozada 2009; Eyssartier *et al.* 2011; Ladio 2011).

In the north of Patagonia, the landscapes of various regions close to human populations are also undergoing change, mainly due to overgrazing (Bisigato and Bertiller 1997, Torrejón and Cisternas 2002), but also partly due to the invasion of exotic plant species (Damascos *et al.* 1999; Ladio and Damascos 2000; Sarasola *et al.* 2006). Plants of foreign origin now form part of the environment, particularly those parts subjected to greater anthropic intervention, such as vacant lots, roadside verges, the areas around homes, etc. (Rapoport and Brion 1991; Díaz-Betancourt *et al.* 1999). Local populations, such as the Mapuche, have incorporated these exotic resources into their daily lives as food and medicines (Ladio and Lozada 2000, 2001; Ladio *et al.* 2007; Molares and Ladio 2009a, 2009b; Ladio 2011); however, the implications of their incorporation into the body of traditional knowledge have been limited.

In this study, therefore, using a quantitative model to test the probability of inhabitants' knowing more or less about native and exotic wild edible plants, the effects of maintaining cultural practices such as hunting, transhumance, Pewen seed gathering, horticulture and the Mapuche language on edible wild plant knowledge will be analysed. Indirectly, the resilience of this corpus of knowledge will be examined, as well as the people's socio-cultural vulnerability.

MATERIALS AND METHODS

Study site

The study area is a dryland, characterized by the mixed vegetation of the Patagonian and Monte phytogeographical province of Argentina (Cabrera and Willink 1980). Mean annual precipitation varies from 100 to 270 mm, concentrated in autumn and winter (March-September) and mean annual temperature is 8°C. The entire region suffers from moderate to serious levels of overgrazing due to sheep farming (Bisigato and Bertiller 1997; Ladio 2002). Three small Mapuche communities of Paineo (51 families), Rams (25 families) and Cayulef (40 families), distributed in the Catan-lil Department (Neuquén Province, Argentina) were included in this study. The main economic activity is livestock breeding, with sheep and goats for the production of wool and meat, and to a lesser extent, the sale of handcrafts in wood and wool. Some dwellers are illiterate or semi-literate, whereas others have completed primary school. Most children attend government schools (with a bilingual system since only few years ago) in their communities. Most dwellers inhabit single room houses with almost no furniture and bare-ground floors; they have no electric power, no running water and no sewage system. All households use firewood for heating and cooking. These communities are characterized by the strong maintenance of ancestral traditions such as religious ceremonies, the continued use of the Mapuche language "Mapudumgum" and the Mapuche health system. According to the Mapuche World Vision, "Mapu" (the land where they live and from which their basic supplies are obtained) is the main spiritual and material resource for their subsistence and identity. More socio-cultural data on these three Mapuche communities are found in Ladio and Lozada (2000), Ladio (2002) and Ladio and Lozada (2004a, 2004b).

Methodology

Between 1998 and 2001 several field studies were conducted, which constituted the foundation of this work (Ladio and Lozada 2000, 2004a, 2004b). These data were totally re-examined with the addition of unpublished data. In this investigation, data from three communities were included, with a total of 98 adult informants: 32 from Cayulef, 41 from Paineo and 25 from Rams (adding up to 80% of the three populations). Interviewees were 54 women (55%) and 44 men (45%) of different ages ($X = 49 \pm 16.5$, minimum 16, maximum 85 years). Semi-structured and open interviews were conducted in which we documented plant knowledge (lists of all wild edible species known per person) (Albuquerque *et al.* 2010). Informants mentioned species using traditional names. We later used specimen vouchers and photographs to identify them as native or exotic (Ladio and Lozada 2000; Ladio 2002; Ladio and Lozada 2004a, 2004b). In addition, it was registered whether during the previous year these informants had carried out the following activities: domestic home gardens, small-scale animal husbandry with transhumance, "*piñoneo*" or plant gathering of *A. araucana* in pre-Andean forest, and hunting. It was also recorded whether the informants spoke the Mapudumgum language or not. Voucher plant collection and specimen identification was carried out by A. Ladio and deposited in the Ecotono Laboratory herbarium.

Data analysis

The maintenance of the different cultural practices was analysed considering the proportion of informants in relation to the total interviewed population. A binary logistic regression analysis was carried out with the SPSS 10.0® programme in order to obtain two models which describe the importance of each of the cultural practices in relation to traditional wild plant knowledge of native and exotic edible species, and the probability of knowing more or less about wild edible plants according to the cultural activities carried out by inhabitants. The dependent variable used in each model was the number of species known by each informant, considering native and exotics separately. For the binomial model, the categorisation was: little plant knowledge = 0-10 native species cited by person and greater plant knowledge = more than 10 species known by the informant. For exotic species, the categorisation was: little plant knowledge = 0-3 exotic species cited by informant and greater plant knowledge = more than 3. These grouping corresponded to the range of both variables. As independent variables (or main effects), binary states such as presence/absence of hunting, home garden, transhumance, *piñoneo* and use of the language were utilized. Given the importance of the effects of gender in the activities under consideration, this was included as male/female in each case, and was included in both models as a covariant. The calculations of the odds ratios (i.e., the probability of an event happening) are shown in **Table 1** by means of e^{beta} = Exp (beta). The adjustment for the binomial logistic regression models was tested with the -2 Loglikelihood Pearson test (Agresti 1996).

RESULTS AND DISCUSSION

Our results showed that the hunting of wild animals is carried out by 53% of the informants, followed by the gathering of *A. araucana* seeds (*piñoneo*) in the Andean pre-cordillera (44%), family horticulture (43%), and finally, to a much lesser extent, transhumance (25.5%). It was also found that 52% of informants speak the Mapuche language. Characterization of these cultural practices can be found in Ladio (2002). In both studies, cultural, socio-political, economic and ecological reasons are given as the principal factors that lead to changes in the persistence of these traditio-

Table 1 Binary logistic regression models taking a higher or lower level of knowledge of wild native edible plants as dependant variable. Presence or absence of hunting, home-gardens, Mapuche language use, transhumance and *piñoneo* were considered as main effects, and gender as covariable (C).

Cultural practice and identity	**β**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(β)**
Gender (C)	-1.11	0.56	3.98	1	0.046*	0.33
Hunting	1.64	0.51	10.37	1	0.001*	5.15
Home garden	-1.03	0.54	3.66	1	0.056*	0.36
Mapuche Language	1.10	0.48	4.79	1	0.029*	2.89
Transhumance	-0.62	0.73	0.71	1	0.400	0.54
Piñoneo	2.00	0.70	8.17	1	0.004*	7.41

* Significant inclusion in the model following Wald statistic ($P < 0.05$).

Abbreviations: β=beta, S.E= standard error, Wald is the chi-square that tests the null hypothesis, df= degrees of freedom, Sig= level of significance and Exp (β)= Odds radios calculated by the exponentiation of the coefficients.

Table 2 Binary logistic regression models taking a higher or lower level of knowledge of wild exotic edible plants as dependant variable, and gender as covariable (C). Presence or absence of hunting, home-gardens, Mapuche language use, transhumance and *piñoneo* were considered as main effects.

Cultural practice and identity	**β**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(β)**
Gender (C)	-0.90	0.53	2.91	1	0.088	0.41
Hunting	1.58	0.49	10.18	1	0.001*	4.86
Home garden	-1.16	0.52	4.94	1	0.026*	0.31
Mapuche Language	1.18	0.47	6.23	1	0.013*	3.27
Transhumance	0.06	0.69	0.008	1	0.93	0.94
Piñoneo	1.07	0.64	2.83	1	0.09	2.92

* Significant inclusion in the model following Wald statistic ($p < 0.05$).

Abbreviations: β=beta, S.E= standard error, Wald is the chi-square that tests the null hypothesis, df= degrees of freedom, Sig= level of significance and Exp (β)= Odds radios calculated by the exponentiation of the coefficients.

nal activities (not included in the main objectives of this study).

The principle results show that cultural practices carried out by inhabitants affect their reservoir of wild plant knowledge in different ways. As shown in **Table 1** in the case of inhabitants' knowledge of native species, and in **Table 2**, in the case of exotic plants, the most important variables associated with greater knowledge of these wild plants were the practice of hunting ($P < 0.05$), speaking the language ($P < 0.05$) and not having a home garden ($\beta = -1.0$ and -1.15, respectively at $P < 0.05$). Our results showed that the gathering of Pehuen seeds (*piñoneo*) plays a unique and significant role in native plant knowledge ($\beta = 2$ at $P < 0.005$) but is insignificant with respect to exotic plants ($P = 0.085$). Whether or not inhabitants practice transhumance was not significant in either case ($P = 0.400$ and $P = 0.928$ respectively, **Tables 1, 2**).

By means of the analysis of Exp (B), we find that the probability of knowing more about native and exotic edible plants increases in both cases by a factor of almost 5 if the person practices hunting (all values were rounded off, for example in this case: 5.15 for natives and 4.86 for exotics), and increases by 3 if they speak the language (**Tables 1, 2**). It was also found in both models that those who have a home garden know 70% less about native and exotic plants than those who do not carry out family horticulture (**Tables 1, 2**). In contrast to exotic species, the probability of knowing more about native resources increases by a factor of 7 when *piñoneo* is practised.

It has been extensively documented that hunting favours greater and more detailed exploration of an environment (Milliken *et al.* 1999; Costa Neto *et al.* 2009), promoting access to ecologically diverse environments, such as scrublands, wetlands, rivers or streams where plants are fundamental as refuges and food for animals. Expertise in the recognition of these sites is therefore of fundamental importance to both hunting and plant gathering. In addition, the Mapuche language, and particularly plant names in this language, include a complex range of denominations involving ecological, utilitarian, morphological and organoleptic aspects, as well as references to magic-religious symbols (Villagrán 1998; Molares and Ladio 2009b), constituting an essential, unique vehicle which cannot be translated into another culture's logic.

In this sense, an evaluation revealed that 40% of species cited (both native and exotic) are named in Mapudumgum by informants of these communities (Ladio and Morales 2006), showing the current importance of these resources in the cultural universe of these populations. If exotic plants already have a lexical and semantic structure to define them, it means that they are already part of the cognitive organisation of the landscape experienced by this society. Costa Neto and Santos-Fita (2009) have pointed out that new resources which are of practical use to a society are incorporated more quickly into the local classification and taxonomy.

Special attention should be paid to the interpretation of the negative relationship between native and exotic wild plant knowledge and horticulture. It is possible that individuals who have a preference for horticulture and spend a lot of time on this activity feel that their time for exploration and learning in wild environments is limited. It may be that the higher value placed on cultivated species by those who practise horticulture indirectly generates a more restricted listing of wild plants. The lack of interest in talking about edible wild plants in these cases is revealed by the fact that most of the informants during the interview were keen for us to visit their vegetable garden, showing us all the fruits of their labours with great pride. We will continue to follow this line of investigation, evaluating the possible factors involved, but there is no doubt that attitudinal factors such as those of an emotional nature, and the relative lack of appreciation of wild resources must be considered, especially following lines like that of Nolan and Robbins (2001).

It is notable that transhumance was not found to be an important variable in the determination of wild native or exotic plant knowledge. These results go against a previous study carried out in the Paineo community alone, which distinguished the importance of transhumance as the main point of access to diverse ecological environments, and consequently, to greater knowledge of edible wild plants (Ladio and Lozada 2004b). In this study, our recent results include three communities in the region, which reflect more clearly the abandonment of the practice of transhumance in Mapuche communities (only 25.5% of the population interviewed still practise it). In addition, the logistic models used here (in contrast to the previous study) distinguished transhumance practice from *piñoneo*, considering whether the informants use the journeys to the Pewen forest for both activities in combination or not.

In the past, these activities complemented each other much more than now, when families went out for transhumance at the beginning of the summer and did not return until the end of April after the *piñoneo* (Ladio 2002; Ladio and Lozada 2004b) At the present time, these activities have become separated due to the difficulty of sustaining such

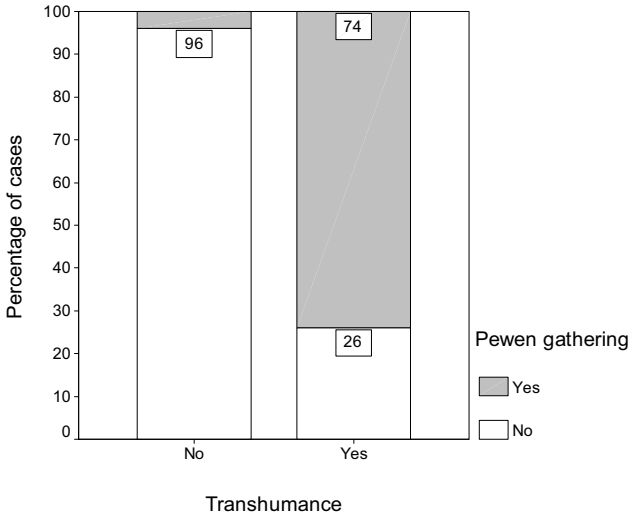

Fig. 1 Comparison between transhumance and Pewen gathering (*piñoneo*) cases (frequency of mention expressed in percentages). Transhumace is a subsistence activity in that Mapuche families used to travel seasonally from arid lands to the forest moving cattle for new pastures using specific routes.

long absences from winter residence sites, where the children attend school during the summer (the transhumance season), and from the numerous activities associated with social assistance programmes currently provided by the state, which the inhabitants depend on to a greater extent than before. Nowadays, carrying out these two activities means two journeys, and there are often inhabitants who only participate in the *piñoneo*, and no longer practise transhumance, or inhabitants who carry out both activities together, as in the past. Indicative of the ancestral bond between both activities is the fact that 74% of those who practise transhumance also carry out *piñoneo* (**Fig. 1**).

This study reveals the cultural importance of *piñoneo* as an activity that plays a significant role in the knowledge of wild plants. A close link was found between the gathering of a staple resource (Pewen seeds) and the gathering of other, secondary native plant species in the same environment, but it appears to have no effect on exotic species ($P > 0.05$, **Table 2**). These results could indicate how *piñoneo* represents a vital mechanism for the maintenance of knowledge of native species associated with the cultural and ancestral landscape of the Mapuche people in this region. The ancestors of the Mapuche communities we studied once lived in Pewen forests, but with successive processes of colonisation and cultural and territorial attempts to dominate them, they were forced to live in the steppe region, in conditions which limit development (Bandieri 2005). Knowledge of exotic plants does not seem to be particularly increased by the practice of *piñoneo*, perhaps showing that these plants, which are mostly cosmopolitan (for example, dandelion (*Taraxacum officinale*), plantain (*Plantago lanceolata*), etc.) are found in all environments and that the business of learning about them is wider and more generalised.

In terms of resilience, the results show that those inhabitants who hunt, participate in *piñoneo* and/or maintain and speak the Mapuche language have significantly more diverse knowledge about wild edible native plants (principally), but also about exotics. They thus have a greater capacity for self-sufficiency, keeping alive the components and mechanisms that favour the finding of solutions to food (subsistence), in response to the demands of their limiting environment. These people put their ancestral wisdom into practice, renewing it constantly through the daily experience of direct contact with the environment.

CONCLUDING REMARKS

This work has shown that the learning and knowledge of native and exotic plants of Mapuche people is revealed by and increases with the maintenance of cultural practices associated with contact with nature. This know-how is also recreated in a rich way through the use of the language, encoded in ways that can be understood by others by means of the Mapuche botanical nomenclature, traditional tales, and ceremonies that bring their identity alive and foster the development of perception and appreciation of the environment.

This work also suggests that the social memory of plants is dynamic, in tune with the dynamics of the Patagonian environments Mapuche inhabitants have access to, and so plants of exotic origin which are becoming more abundant in the region now form part of their cultural reservoir. Given that cultural practices are based on individual experience of the environment, the inhabitants may bring about changes in social memory, incorporating new items into the set of known native plants, since these activities involve mechanisms that allow learning, renewal and innovation.

Up to now the use of exotic plants has been related with the loss of traditional knowledge, especially due to the effects of replacement, which has been seen in many cases in human populations (Ladio and Lozada 2001; Estomba *et al.* 2006; Ochoa *et al.* 2010). However, they should be considered as alternative sources of food, offering redundancy, i.e., a superimposition of useful functions with those already offered by native species (Albuquerque and Ferreira de Oliveira 2007). Redundancy may play a crucial role in the conservation of native environments as it offers alternatives which could diminish the exploitation of native resources and also serve as a buffer for disturbances leading to reorganisation of the body of plant knowledge if a species becomes locally extinct or in other situations of sociocultural change. Further work should be carried out in this direction, investigating the role of diversity and the factors that provoke the loss of traditional knowledge resilience. Local populations are more vulnerable if they lose this diversity of know-how and practices, therefore the evaluation of this should be a focus point for action in future sustainable development projects. It is of vital importance that the progress desired by these Mapuche inhabitants, which involves the urgent recuperation of their lands, greater social inclusion and access to technology, should not ignore their ancestral wisdom and ability to interpret the dynamics of the environment.

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