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Evaluating traditional wild edible plant knowledge among teachers of Patagonia: Patterns and prospects

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ABSTRACT

The objectives of this study were to characterise the body of knowledge of wild edible plants possessed by teachers working in rural and urban areas of arid Patagonia. We also evaluated whether the different age classes of teachers have different likelihoods of citing plants in relation to different aspects of their ecological and socio-cultural attributes. Study subjects were 85 female and 14 male 21 to 66 year-old teachers from Dolavon, Gaiman, Trelew, Rawson and Puerto Madryn, who were interviewed using written free listing questionnaires. A multinomial logistic regression model including different age classes of teachers as a dependent variable, and as independent categorical variables: informant gender, plant life form, ubiquity, presence of medicinal use and global socio-economic importance of the cited plant species, yielded results which were both significant and predictive. A total of 96 native and exotic species were cited, including plants growing in the immediate surroundings (39 spp.), those from more distant forest environments (9 spp.) and cultivated plants (48 spp.). Most cited species are cosmopolitan herbs which have edible aerial parts, play a significant role in the past and present global economy, have additional medicinal uses, and are associated with the nearest landscapes. The importance of the complementary medicinal use of the edible plants cited, their significance in the global market, and their local ubiquity did not seem to vary between age categories of teachers. The traditional ecological knowledge possessed by Patagonian teachers seems to consist of a body of knowledge constructed on a foundation of accumulated experience of the local environment and the cultural values that have prevailed since the initiation of formal education. This work shows the importance of logistic models as a tool in the study of traditional knowledge, given that they reflect, in a predictive way, the variation existing in different subgroups in relation to a complex network of multiple factors. In addition, in this work we emphasise the importance of considering the cultural capital of the teachers themselves as a highly significant dimension, which can have a direct influence on the schools in terms of education and learning about Nature.

1. Introduction

Cross-cultural studies around the world have shown the importance of studying the body of knowledge in key stakeholders about useful wild plants and their patterns on transmission processes and cultural learning (Camou-Guerrero, Reyes-García, Martínez-Ramos, & Casas, 2008; Eyssartier, Ladio, & Lozada, 2008; Ladio, 2011a, 2011b; Lozada, Ladio, & Weigandt, 2006). Evidence from psychological and cognitive ethnobotanical studies has shown that parents are most important in the transmission of wild plant knowledge early in life, but other people (extra-familiar learning) become increasingly significant during cultural life history, for example, when children and adolescents go to school (Auger, 2000; Eyssartier et al., 2008; Lozada et al., 2006). This non-vertical transmission depends on the richness and quality of episodes of cultural learning (or re-learning), hence the embodied wild plant knowledge of teachers plays a significant role in their maintenance and preservation.

Teachers are key players in the transmission of knowledge related to the environment. Nevertheless, little research has been done on the body of traditional ecological knowledge (TEK) they sustain with regard to useful wild plants, and how they integrate this into the teaching process (e.g. Ladio, Molares, & Rapoport, 2007; Martínez & Pochettino, 1998–99; Valdés, Moreno, & Gil de Marrupe, 2008). TEK is defined as a flexible and shared body of information, behaviours and beliefs, which evolves through adaptive processes and is handed down for generations by cultural transmission. It has been largely proposed that TEK is acquired by populations throughout their history by means of direct experience and contact with the environment (both ecological and socio-cultural) (Berkes & Folke, 2002; Berkes & Turner, 2006; Davidson-Hunt & Berkes, 2003; Ladio, 2011b).

Wild edible plant knowledge learned and accumulated by teachers constitutes part of the corpus of their traditional ecological knowledge. For effective teaching, especially in the case of rural schools or in locations where societies are in particularly close contact with natural

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areas, we must understand what they know about wild plants, and which pre-conceived notions and values are being brought to the classroom concerning the edibility of these wild plants. Learning can be hindered if there is misinformation, different opinions, or if the subject is not shared with students (Gemeinhardt, Nolan, Noltie, & Robbins, 2001). In relation to this, many studies recognise the importance of integrating local knowledge into the formal educational system, since rates of intergenerational knowledge transmission could be increased by legitimising TEK for younger generations, according it the same status as the other subjects on the formal school curriculum (Kraipeerapun & Thongthew, 2007; Ladio, Lozada, & Weigandt, 2007; Ladio, Molares, & Rapoport, 2007; Martínez & Pochettino, 1998–99; Mc Carter & Gavin, 2011).

It has been widely suggested that plant knowledge is based essentially on human recognition of the perceptual and functional attributes that characterise the plant kingdom (Molares & Ladio, 2009a, 2009b; Nolan, 2001; Shepard, 2004). How people, in this case teachers, perceive and value plant features seems to be principally related to levels of informant expertise or experience, where experts have access to more kinds of information than novices, resulting in different patterns of knowledge (Nolan, 2001, 2002). In general, older informants recognise more plants than younger ones and have a more diversified understanding of the natural world, generating intra-cultural variation within a group (Begossi, Hanazaki, & Tamashiro, 2002; Ladio, 2006; Ladio & Lozada, 2004a, 2004b; Nolan, 2001). Perceptible morphological/biological plant features such as the size and shape of plant life forms (for example tree versus herb), or their ecological abundance or ubiquity (more versus fewer apparent resources) are common referential traits among novices, whereas experts seem to use additional, more abstract and utilitarian characteristics (Nolan, 2001; O'Brien, 2010).

Multiple factors influence which elements become part of the body of plant knowledge. In addition to the significant role played by gender and age in intra-cultural variation with respect to preferred useful plant species (Camou-Guerrero et al., 2008; Garro, 1986; Reyes-García, Vadez, Huanca, Leonard, & Wilkie, 2005), it has been suggested that individuals learn about, and use most frequently, wild species which are close by and accessible (Nolan, 1998; O'Brien, 2010; Phillips & Gentry, 1993). In Patagonia, coincidentally, several studies have demonstrated that ethnobotanical knowledge in rural populations reflects the diversity of their habitat, as well as the species richness of the forest ecosystems they have had access to historically, and which form part of their cultural identity (Ladio & Lozada, 2001, 2003, 2004a, 2004b; Ladio, Lozada, & Weigandt, 2007; Ladio, Molares, & Rapoport, 2007).

In addition, gathering and edible wild plant knowledge is closely associated with the complementary medicinal use of these resources in many cultural settings (Etkin & Ross, 1982; Ladio, Molares, & Rapoport, 2007; Pieroni & Price, 2005). The prevalence of medicinal plant use in ethnobotanical free listing studies has been linked mainly to a perception associated with the holistic use of plants as nutraceuticals, where medicine, health and nutrition are inseparable (Etkin & Ross, 1982; Ogle, Tuyet, Duyet, & Dung, 2003). Furthermore, in urban populations a greater interest has been witnessed in the use of plants as home remedies, together with a greater predilection for natural medicine (Nolan, 2001; Melo, Rocha Martins, Amorim, & Albuquerque, 2007; Cuassolo, 2009).

Shared traditions play a significant role in wild plant use and cognition (Ladio, Lozada, & Weigandt, 2007; Ladio, Molares, & Rapoport, 2007; Nolan, 2001; Reyes-García et al., 2003). A great number of edible plants commonly mentioned in different cultural settings around the world can be traced both historically and economically (Duke, 1992; Peterson, 1977; Rapoport & Drausal, 2001). These are useful, cosmopolitan plants that have been used since ancient times, mainly in Eurasian societies, and whose cultivated forms are, or were, part of the global commercial market (Hurrel, Ulibarri, Delucchi, & Pochettino, 2009). The cultural continuity of these shared traditions of plant use in South America following the colonisation process has been extensively documented in numerous ethnobotanical studies (Eyssartier, Ladio, & Lozada, 2011a; Ladio, 2005; Molares & Ladio, 2009a, 2009b; Rapoport, Margutti, & Sanz, 1997).

In this study we characterised the body of knowledge about traditional wild edible plants of teachers in arid areas of Patagonia. Because wild plant knowledge is affected by more than ecology and traditions, this paper examines multiple variables — socioeconomic, biological and cultural, thought to be associated with teachers' predilection for edible wild plants. In addition, we try to understand how the socio-cultural experience of different age classes of teachers shapes the understanding and predilection of these useful resources. Using a quantitative logistic model to test the probability of different age classes of teachers citing edible wild plants, the effects of gender, the complementary medicinal importance of edible plants, their significance in the global market, life form and local ubiquity will be analysed in a multiple way.

2. Study site

The study area is a dryland, characterised by the mixed vegetation of the Patagonian and Monte phytogeographical provinces of Argentina (Cabrera & Willink, 1980). Mean annual precipitation varies from 100 to 270 mm, concentrated in autumn and winter (March–September). The climate is cold temperate and dry, with a mean annual temperature of 8 °C. Plant diversity is characterised by the following shrubs: *Prosopis alpataco* Phil., *Prosopis denudans* Benth. ("algarrobos"), *Larrea cuneifolia* Cav., *Larrea divaricata* Cav. ("jarillas"), *Atriplex lampa* (Moq.) D. Dietr. ("zampa") and *Monttea aphylla* (Miers) Grisebach; grasses such as *Festuca* spp. and *Pappostipa* spp. ("coirones"), and subshrubs such as *Mulinum spinosum* (Cav.) Pers. ("neneo"), *Senecio filaginoides* DC. ("charcao") and *Nassauvia* spp. ("colapiche"). The relief is sandy or stony plains and plateaus.

The group of teachers studied belongs to towns and cities situated on highways 3 and 25 of Chubut province, Argentina. These populations are found along a stretch of approximately 100 km, and are: Dolavon (pop. 2929), Gaiman (pop. 5753), Trelew (pop. 89,547), Rawson (pop. 26,183) and Puerto Madryn (pop. 57,791) (INDEC (Instituto Nacional De Estadística & Censos), 2001). The local population is made up of a high proportion of indigenous Mapuche and Tehuelche individuals, followed by Creoles, descendants of Chileans, Welsh, and other European immigrants (Fig. 1).

The teachers who participated in this study were primary and secondary school teachers from rural and urban schools. Most were born in urban areas of Chubut or other regions, while a few were originally from rural areas.

3. Materials and methods

In April of 2003 a refresher course on wild edible plants was carried out by Ana Ladio and her collaborators, in the form of three workshops. At the beginning of the workshop in each town, with the previous consent of all who attended, the teachers were asked to draw up free lists of the wild species they knew before the course, saying which parts of the plants were used and how they could be prepared, indicating their scientific name where possible (Albuquerque & de Lucena, 2010; Nolan, 2001). Informants were asked to list plants according to their own judgement of what is considered a wild edible plant. This concept includes edible plants that grow naturally in the wild, and are not cultivated (without distinction of their biogeographical origin, whether native or exotic). The number of individuals in each town who spontaneously attended the course was directly related to the number of teachers living in each location: Dolavon–Gaiman (14 participants), Trelew (39 participants), Pto. Madryn–Rawson (46 participants). It is important to note that self-selection in the sampling method probably introduced a bias in parameter estimates, since the teachers who did not want to participate, for various reasons, were not included. This methodological limitation could be partially counterbalanced by the fact that most of

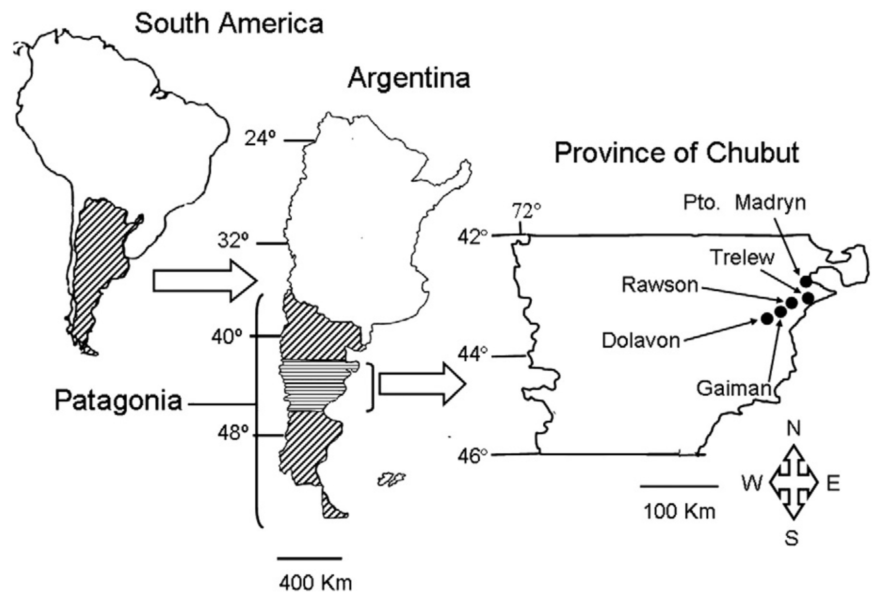

Fig. 1. The study area, comprising the towns of Dolavon, Trelew, Gaiman, Rawson and Puerto Madryn, Chubut province, Argentina.

the teachers were required to participate in this course as part of their compulsory training programme. For this reason, whether teachers knew a little or a lot about wild plants, they were all able to attend, and therefore the sample would still have been representative of the teaching population.

Study subjects totalled 85 females and 14 males, who were 38 ± 11 year-old teachers. The teacher's gender was categorised as (1) female, (2) male, and age was subdivided into three categories: (1) young teachers (20–30 years old, $n = 46$), (2) middle-aged teachers (31–50 years old, $n = 39$) and (3) older teachers (over 50 years old, $n = 14$). It is assumed that these categories represent the teachers' different stages of experience at an individual level. The age and gender categories are representative of the teaching population in Patagonia. Few teachers over 60 are still working in a classroom situation, and there are more female teachers than male in the general teaching population.

In general, the common names noted in the free listings belonged to plants whose taxonomy is well known in the region (Correa, 1969, 1971, 1978, 1984, 1988, 1998, 1999; Ezcurra & Brion, 2005). Furthermore, the total number of plants cited by each informant, and independently for each species ($N = 682$) were categorised according to the following criteria: A) Life form: (1) herbs and climbing plants, (2) shrubs and hemicryptophytes and (3) trees (following Zuloaga & Morrone, 2004). B) Part used: (1) non-reproductive aerial organs (principally leaves and stems), (2) fruit, (3) seeds, (4) underground organs (rhizomes, roots, tubers, corms, etc.), (5) whole plant and (6) extract. C) Preparation method: (1) raw (salads, snacks, desserts), (2) cooked (boiled, cooked in the embers of the fire, hot drink, marmalade) and (3) both.

Following this, total plant cites were subdivided into nominal ethical categories, according to the following factors: D) Ubiquity in the area: the characteristic for being everywhere, we have counted the presence in the bibliography of each species in all around environments and then categorised as: (1) native and exotic species present in all environments: Patagonian Steppe and Monte and neighbouring anthropized environments, (2) exotic plants only cultivated in kitchen gardens and gardens and (3) native and exotic plants only from the Andean–Patagonian forest ecotone (following Ezcurra & Brion, 2005; Ladio & Lozada, 2000, 2004a, 2004b, 2009; Zuloaga & Morrone, 2004). E) The medicinal uses of the species: presence (1) and absence (0) (according to Eyssartier, Ladio, & Lozada, 2011b; Molares & Ladio, 2009a, 2009b; Ochoa, Ladio, & Lozada, 2010). F) Significance on a global scale in western market societies: (1) of economic and cultural importance since ancient times and/or currently in Eurasia (2) of no commercial importance or historical relevance in countries of Eurasia in the past or during the present (according to Duke, 1992; Hurrel et al., 2009; Peterson, 1977; Rapoport, Ladio, & Sanz, 1999, 2003; Rapoport, Sanz, & Ladio, 2001; Rapoport et al., 1997). It is important to note that in Ladio, Molares and Rapoport (2007) aspects of the environmental variation at botanical species level mentioned by participants and other teachers from wooded areas of the province are described. For the purpose of this study, part of the data was totally re-examined with the addition of unpublished data, placing greater emphasis on the sociocultural and biological nature of the total proportion of plant cites rather than species diversity.

4. Data analysis

Firstly, Patagonian teachers' wild plant knowledge was analysed globally, considering the proportion of plant cites in relation to the total cited ($N = 682$) using Chi-Square Tests with $p < 0.05$ (Agresti, 1996). In addition, a multinomial logistic regression analysis was carried out with the SPSS 10.0® programme in order to obtain a model which describes how the probability of knowing wild plants varied with the teacher's age class (dependent categorical variable) in relation to the different categorical factors such as life form, ubiquity, additional medicinal use, global economic significance of the plants, and the teacher's gender (independent variables or principal effects) (Agresti, 1996; Chan, 2005). Thus, the algebraic model was $\ln p/1\text{-}p = \beta_0 + \beta_1$ life form $+ \beta_2$ ubiquity $+ \beta_3$ additional medicinal use $+ \beta_4$ global economic significance $+ \beta_5$ gender where p/1-p is the odds ratio, i.e., the probability that an event will happen in relation to the probability it will not. In this kind of regression, the tendencies are established according to the categories for comparison (in this case, it is with respect to the older teachers, category 3). The model allows us to see the impact of each of the factors in terms of controlling the other factors, and so the probability of each event occurring can be established. A description of the variables in the model and the distribution of all cases are shown in Table 1. The model we found was significant ($p < 0.05$), with a high goodness of fit measure (Pearson and Deviance indices are with $p > 0.05$). The calculations of the odds ratios (i.e., the probability of an event happening) are shown in Table 3 by means of e^{beta} = Exp (beta) (Agresti, 1996; Chan, 2005).

Table 1
Summary of cases for variables of multinomial logistic model about the knowledge of wild plants among Patagonian teachers. Age was subdivided into three categories: (1) young teachers (20–30 years old, n = 46), (2) middle-aged teachers (31–50 years old, n = 39) and (3) older teachers (over 50 years old, n = 14). Frequency represents the total number of plant cites about each sub-category. Ubiquity represents plant characteristic for being everywhere, and global socioeconomic significance represents importance in western market societies (more details see Materials and methods).

Variables	Categories	Frequency	Percentage
Dependent variable			
Age	1-Young teachers	227	33
	2-Middle aged teachers	239	35
	3-Older teachers	216	32
Independent variables			
Life form	1-Herbs	378	55
	2-Shrubs	259	38
	3-Trees	45	7
Global socioeconomic significance	1-With global significance	423	62
	2-Without global significance	259	38
Ubiquity	1-Surroundings	435	64
	2- Cultivated	136	20
	3-Far away	111	16
Medicinal use	0-No	173	25
	1-Yes	509	75
Gender of informant	1-Female	563	82
	2-Male	119	18
Total		682	

5. Results and discussion

5.1. Characterisation of traditional wild plant knowledge among teachers

The pattern of edible wild plant knowledge among teachers shows a predilection for listing plants with high ubiquity and nearby available (Table 1). The majority of species cited were those from neighbouring wild environments or from around the study towns, those cultivated in the region, and finally those from environments at a distance from the study area (χ^2: 286, $df = 2$, $p < 0.05$, Table 1). The results presented above agree with the psychological and cognitive perspective that considers ethnobotanical knowledge to emerge from a process that basically stems from everyday experiences in the environmental landscapes of action and reference (Brodt, 2002; Davidson-Hunt & Berkes, 2003; Moerman, 1998). Moreover, numerous studies have indicated the importance of environments of anthropic origin in the construction of ethnobotanical knowledge, given that they offer accessible resources that include native species, adapted exotics or invasive species with great medicinal and edible potential (Albuquerque, Cavalcanti, & Silva, 2005; Ladio, Lozada, & Weigandt, 2007; Ladio, Molares, & Rapoport, 2007; Voeks, 1996).

The teachers cited a total richness of 96 species (22 native and 74 exotic) of which the majority (79%) coincide with the species most frequently cited as part of herbal medicine in ethnobotanical studies carried out in rural Patagonian populations, revealing a marked association of both type of usage (Tables 1 and 2). The species mentioned belong to 41 different botanical families, the most frequently mentioned were: Rosaceae, Asteraceae, Lamiaceae, Fabaceae, Brassicaceae and Apiaceae (Table 2). With respect to the life forms of the plants cited, the majority were herbs (54%), shrubs (30%) and to a lesser extent, trees (16%). These results coincide with the preference for multipurpose, medicinal and edible herbs documented in studies of Patagonian indigenous populations (Ladio, Molares, & Rapoport, 2007; Molares & Ladio, 2009a, 2009b). In addition to this, the environmental availability of the plants is once again reflected in these numbers, since the Patagonian Monte and Steppe vegetation is characterised by the dominance of herbs and shrubs (Cabrera, 1971).

It is interesting to note that although asked to mention wild species, 20% of the plants cited by the teachers were cultivated plants. The majority of these (77%) were tree species, followed by shrubs and herbs. Many of these plants have begun to grow wild in the region, such as the apple, plum, black cherry and raspberry, and are exotic members of the natural Patagonian landscape, commonly collected by local inhabitants (Ladio, Lozada, & Weigandt, 2007; Ladio, Molares, & Rapoport, 2007). In the case of the other species, although we don't know if this error is due to an erroneous interpretation of the instructions or to other factors, we consider it relevant to highlight that in the teachers' corpus of edible plant knowledge, cultivated plants play a significant role, in particular the trees that bear edible fruit.

The wild species cited (9% of the total) that grow far away in the Cordilleran forests which lie between 600 and 900 km to the west of the populations studied, are plants which enjoy great prestige throughout the entire country as an edible resource, and in some cases also medicinal. Many are sold in health food shops or greengrocers, and even sold as jams: *Potentilla chiloensis*: "frutilla" ("strawberry"), *Rosa rubiginosa*: "rosa mosqueta" ("rosehip") and *Rubus ulmifolius*: "murra" ("elm leaf blackberry"), flour or whole dried fruit: *Araucaria araucana*: "araucaria" ("monkey puzzle tree"), and nutraceutical pills: *Aristotelia chilensis*: "make" (Chilean Wineberry), and *Fabiana imbricata*: "palo piche". When they travel the teachers can collect or buy these plants easily in their areas of distribution.

The body of knowledge accumulated by the teachers includes a high proportion of exotic species (Table 2), mainly species of economic and cultural significance in the global market, both in the past and in the present time (χ^2: 39, $df = 1$, $p < 0.05$; Table 1). Of the total number of plants cited, the majority were herbs and the smallest group was trees (χ^2: 250, $df = 2$, $p < 0.05$; Table 1). The aerial parts are the most commonly used (e.g., *Chenopodium album*, *Sonchus oleraceus*, *Malva sylvestris*, *Carduus thoermeri*, *Taraxacum officinale*), followed by the fruit and seeds (e.g., *A. araucana*, *P. chiloensis*, *P. alpataco*, *Condalia microphylla*, *Schinus molle*), underground organs (e.g., *Tragopogon dubius*, *Arjona tuberosa*, *Armoracia rustican*) and the whole plant (e.g., *Nasturtium officinale*, *Portulaca oleracea*, *Humulus lupulus*) (χ^2: 1015, $df = 5$, $p < 0.05$, Table 1). Once again, the high proportion of herbs named in the listing of Patagonian communities has been related to the preponderance of this life form in the Patagonian flora (Ezcurra & Brion, 2005; Molares & Ladio, 2009a, 2009b), a tendency which supports the importance of the greater ubiquity of the species in the traditional knowledge of local groups.

The most common methods of preparation are: raw (330 cites), followed by cooked (258) and finally the mixed preparations (65 cites) (χ_2: 188, $df = 2$, $p < 0.05$, Table 1). These are distinguished by their rapid preparation, at low temperatures. This pattern of behaviour is possibly associated with a logic related to energy costs, where the costs of searching (giving priority to the closest resources) and processing (giving priority to the most rapid) are minimised, and has also been seen among the local rural population, possibly showing a preference and shared reasoning which goes beyond local cultural contexts and converges with other cultures at a global level (Ladio, 2011b; Ladio & Lozada, 2000; Pieroni, Nebel, Quave, Münz, & Heinrich, 2002).

Another characteristic of the Patagonian teachers' body of knowledge on wild plants is the additional medicinal use of cited plants (χ^2: 166, $df = 1$, $p < 0.05$; Table 1). As previously mentioned, in recent decades the strong relationship between the edible use of wild plants and their medicinal properties has been studied extensively (Etkin, 1996; Pieroni & Price, 2005; Pieroni et al., 2002). In this work, plants generally considered as medicinal (e.g., *Verbascum thapsus* and *Marrubium vulgare*) have also been mentioned as edible.

In addition to this, the cosmopolitan nature of many of the exotic species, and the fact that many of these plants have been widely advertised in terms of their active medicinal components (Pieroni et al., 2002), has given them a wider dominion, and they are more highly valued among educators in the region. All these results could be linked to Nolan's (1998) findings in accordance with the concept of "delocalisation" as a process through which groups become increasingly dependent on exogenous, commercially distributed resources, as a result of extensive cosmopolitan cultural influence in the region.

Table 2
Edible plants cited by teachers of Patagonia from different ubiquities (surroundings, cultivated and far away). Origin, (Na): native, (Ex): exotic from Patagonia. Other ethnobotanical references correspond to citations of the use of the species in local communities (rural and suburban) from Patagonia (n = 99 teachers).

Scientific name	Botanical family	Origin	Common name	Life form	Part used	Other ethnobotanical references of edible use
Surroundings plants						
Acantholippia seriphioides (A. Gray) Molina	Verbenaceae	Na	Tomillo del campo	Shrub	Aerial part	Casamiquela (1998); Ladio and Lozada (2004a, 2004b, 2009)
Apium graveolens L.	Apiaceae	Ex	Apio cimarrón	Herb	Aerial part	Eyssartier et al. (2011a, 2011b); Mösbach (1992)
A. tuberosa Cav.	Schoepfiaceae	Na	Macachín	Herb	Underground organ	Conticello, Gandullo, Bustamante, and Tartaglia (1997); Ladio (2006); Mösbach (1992)
A. rusticana G. Gaertn., B. Mey. & Scherb.	Brassicaceae	Ex	Kren, rábano picante	Herb	Underground organ	
Artemisia absinthium L.	Asteraceae	Ex	Ajenjo	Shrub	Aerial part	
Berberis darwinii Hook.	Berberidaceae	Na	Michay	Shrub	Fruit	Conticello et al. (1997); Funes (1999); Mösbach (1992)
Berberis microphylla G. Forst.	Berberidaceae	Na	Calafate	Shrub	Fruit	Ladio (2006); Ladio and Lozada (2001, 2004a, 2004b)
Brassica rapa L.	Brassicaceae	Ex	Nabo silvestre	Herb	Entire plant	Ladio (2005); Ladio and Lozada (2004a, 2004b);Rapoport and Ladio (1999)
C. thoermeri Weinm.	Asteraceae	Ex	Cardo	Herb	Aerial part	
C. album L.	Chenopodiaceae	Ex	Quinhuilla	Herb	Aerial part	Ladio and Lozada (2000, 2001); Rapoport and Ladio (1999)
C. microphylla Cav.	Rhamnaceae	Na	Piquillín	Shrub	Fruit	Casamiquela (1998); Ladio and Lozada (2009); Steibel (1997)
Diplotaxis tenuifolia (L.) DC.	Brassicaceae	Ex	Ruculeta	Herb	Aerial part	Ladio (2005); Ladio and Lozada (2000, 2001)
Complejo Cactaceae	Cactaceae		tuna	Shrub	Fruit	Ladio (2006); Ladio and Lozada (2009);
Dysphania ambrosioides (L.) Mosyakin & Clemantsioides	Chenopodiaceae	Na	Paico	Herb	Aerial part	Estomba, Ladio, and Lozada (2006); Ladio (2005)
Ephedra ochreata Miers.	Ephedraceae	Na	Efedra	Shrub	Fruit	Casamiquela (1998); Ladio (2006); Ladio and Lozada (2009)
Erodium cicutarium (L.) L'Hér. ex Aiton	Geraniaceae	Ex	Alfilerillo	Herb	Aerial part	Ladio (2006); Ladio and Lozada (2004a, 2004b); Rapoport et al. (1997)
Lycium chilense Miers ex Bertero	Solanaceae	Na	Yaoyín	Shrub	Fruit	Casamiquela (1998); Ladio and Lozada (2009); Rapoport et al. (2003)
M. sylvestris L.	Malvaceae	Ex	Malva	Herb	Aerial part	Rapoport and Ladio (1999)
M. vulgare L.	Lamiaceae	Ex	Malvarubia	Herb	Aerial part	
Matricaria recutita L.	Asteraceae	Ex	Manzanilla	Herb	Fruit, aerial part	Estomba et al. (2006)
Medicago sativa L.	Fabaceae	Ex	Alfalfa	Herb	Aerial part	Rapoport et al. (1997)
Mentha spp.	Lamiaceae	Ex	Menta	Herb	Aerial part	Rapoport and Ladio (1999)
N. officinale R. Br.	Brassicaceae	Ex	Berro	Herb	Entire plant	Ladio (2005, 2006); Mösbach (1992)
Pastinaca sativa L.	Apiaceae	Ex	Chirivía	Herb	Underground organ	Eyssartier et al. (2011a, 2011b)
Plantago lanceolata L.	Plantaginaceae	Ex	Llantén	Herb	Entire plant	Ladio (2005); Ladio and Lozada (2001); Rapoport and Ladio (1999)
Plantago major L.	Plantaginaceae	Ex	Llantén mayor	Herb	Entire plant	Rapoport et al. (2001)
P. alpataco Phil.	Fabaceae	Na	Alpataco	Shrub	Fruit	Casamiquela (1998); Ladio and Lozada (2009); Rapoport et al. (2003)
P. denudans Benth.	Fabaceae	Na	Algarrobo	Shrub	Fruit, seed	Ladio and Lozada (2000, 2009)
Rumex acetosella L.	Polygonaceae	Ex	Acedera	Herb	Aerial part	Ladio (2005); Ladio and Lozada (2004a, 2004b); Rapoport and Ladio (1999)
Rumex crispus L.	Polygonaceae	Ex	Lengua de vaca	Herb	Aerial part	Casamiquela (1998); Ladio (2005); Ladio and Lozada (2004a, 2004b)
Salicornia sp.	Chenopodiaceae	Na	Salicornia	Herb	Aerial part	
S. molle L.	Anacardiaceae	Na	Aguaribay	Tree	Fruit	Ladio and Lozada (2001, 2009); Mösbach (1992)
Schinus spp.	Anacardiaceae	Na	Molle	Shrub	Fruit, extracto	Ladio and Lozada (2001, 2009); Mösbach (1992)
S. oleraceus L.	Asteraceae	Ex	Cerraja	Herb	Aerial part	Ladio (2005); Martínez-Crovetto (1980); Rapoport and Ladio (1999)
T. officinale G. Weber ex F.H. Wigg.	Asteraceae	Ex	Achicoria	Herb	Aerial part	Martínez-Crovetto (1968, 980); Mösbach (1992)
T. dubius Scop.	Asteraceae	Ex	Salsifí	Herb	Underground organ	Ladio (2005); Rapoport and Ladio (1999); Rapoport et al. (2001)
Trifolium repens L.	Fabaceae	Ex	Trébol blanco	Herb	Aerial part	Ladio (2005); Rapoport and Ladio (1999); Rapoport et al. (2001)
Urtica sp.	Urticaceae	Ex	Ortiga	Herb	Aerial part	Eyssartier et al. (2011a, 2011b); Rapoport et al. (2001)
V. thapsus L.	Scrophulariaceae	Ex	Tabaco de indio	Herb	Aerial part	
Cultivated plants						
Allium cepa L.	Alliaceae	Ex	Cebolla	Herb	Underground organ	Funes (1999); Eyssartier et al. (2011a, 2011b)
Allium sativum L.	Alliaceae	Ex	Ajo	Herb	Underground organ	Eyssartier et al. (2011a, 2011b)
Aloe spp.	Asphodelaceae	Ex	Aloe vera	Shrub	Fruit, aerial part	
Arctium minus (Hill) Bernh.	Asteraceae	Ex	Bardana	Herb	Aerial part	Rapoport et al. (2001)
Asparagus officinalis L.	Asparagaceae	Ex	Espárrago	Herb	Aerial part	
Beta vulgaris L.	Chenopodiaceae	Ex	Acelga	Herb	Aerial part	Eyssartier et al. (2011a, 2011b)

(continued on next page)

Table 2 (*continued*)

Scientific name	Botanical family	Origin	Common name	Life form	Part used	Other ethnobotanical references of edible use
Borago officinalis L.	Boraginaceae	Ex	Borraja	Herb	Aerial part	
Cichorium intybus L.	Asteraceae	Ex	Radicheta	Herb	Aerial part, entire plant	Ladio and Lozada (2001); Rapoport and Ladio (1999); Rapoport et al. (1997)
Citrus limonum Risso	Rutaceae	Ex	Limón	Tree	Aerial part	
Crathaegus sp.	Rosaceae	Ex	Crataegus	Tree	Fruit	
Daucus carota L.	Apiaceae	Ex	Zanahoria	Herb	Underground organ	Eyssartier et al. (2011a, 2011b); Funes (1999)
Ficus carica L.	Moraceae	Ex	Higo	Tree	Fruit	
Foeniculum vulgare Mill.	Apiaceae	Ex	Hinojo	Herb	Aerial part, entire plant	Estomba et al. (2006); Eyssartier et al. (2011a, 2011b); Funes (1999);
H. lupulus L.	Cannabaceae	Ex	Lúpulo	Herb	Entire plant	
Laurus nobilis L.	Lauraceae	Ex	Laurel	Tree	Aerial part	Eyssartier et al. (2011a, 2011b)
Lonicera japonica Thunb.	Caprifoliaceae	Ex	Madreselva	Shrub	Aerial part	
Lupinus spp.	Fabaceae	Ex	Lupine	Shrub	Fruit	
Malus sylvestris Mill.	Rosaceae	Ex	Manzano	Tree	Fruit	Eyssartier et al. (2011a, 2011b); Funes (1999); Ladio (2006)
Melissa officinalis L.	Lamiaceae	Ex	Melisa	Herb	Aerial part	Estomba et al. (2006)
Mentha pulegium L.	Lamiaceae	Ex	Poleo	Herb	Aerial part	Rapoport and Ladio (1999)
Mentha spicata L.	Lamiaceae	Ex	Herb buena	Herb	Aerial part	Rapoport and Ladio (1999)
Mespilus germanica L.	Rosaceae	Ex	Níspero	Tree	Fruit	Eyssartier et al. (2011a, 2011b)
Morus alba L./*M. nigra* L.	Moraceae	Ex	Mora	Tree	Fruit	
Origanum vulgaris L.	Lamiaceae	Ex	Orégano	Herb	Aerial part	Eyssartier et al. (2011a, 2011b)
Petroselinum crispum (Mill.) A.W. Hill	Apiaceae	Ex	Perejillón	Herb	Entire plant	Eyssartier et al. (2011a, 2011b)
Pimpinella anisum L.	Apiaceae	Ex	Anis	Herb	Fruit, seed	
Pinus sp.	Pinaceae	Ex	Pino	Tree	Aerial part	
P. oleracea L.	Portulacaceae	Ex	Verdolaga	Herb	Entire plant	Rapoport et al. (2001)
Prunus avium (L.) L.	Rosaceae	Ex	Cereza	Tree	Fruit	Eyssartier et al. (2011a, 2011b); Funes (1999)
Prunus domestica L.	Rosaceae	Ex	Ciruela	Tree	Fruit	Eyssartier et al. (2011a, 2011b); Funes (1999)
Prunus dulcis (Mill.) DA Webb.	Rosaceae	Ex	Almendra silvestre	Tree	Seed	
Prunus persica (L.) Batsch	Rosaceae	Ex	Duraznero	Tree	Fruit	Eyssartier et al. (2011a, 2011b)
Raphanus sativus L.	Brassicaceae	Ex	Rabanito	Herb	Entire plant	Eyssartier et al. (2011a, 2011b); Funes (1999)
Rheum rhabarbarum L.	Polygonaceae	Ex	Ruibarbo	Shrub	Aerial part	Eyssartier et al. (2011a, 2011b)
Ribes rubrum L.	Grossulariaceae	Ex	Corinto	Shrub	Fruit	Eyssartier et al. (2011a, 2011b)
Ribes uva-crispa L.	Grossulariaceae	Ex	Grosella	Shrub	Fruit	Eyssartier et al. (2011a, 2011b)
Rosa spp.	Rosaceae	Ex	Rosa	Shrub	Aerial part	
Rosmarinus officinalis L.	Lamiaceae	Ex	Romero	Shrub	Aerial part	Eyssartier et al. (2011a, 2011b)
Rubus idaeus L.	Rosaceae	Ex	Frambuesa	Shrub	Fruit	Eyssartier et al. (2011a, 2011b); Funes (1999); Ladio and Lozada (2001)
Sambucus nigra L.	Adoxaceae	Ex	Sauco	Tree	Fruit	Funes (1999); Eyssartier et al. (2011a, 2011b); Martínez-Crovetto (1980)
Sanicula graveolens Poepp. ex DC.	Apiaceae	Ex	Cilantro	Herb	Aerial part	Ladio and Lozada (2000, 2001, 2004a, 2004b)
Sarothamnus scoparius (L.) Koch	Fabaceae	Ex	Retama	Shrub	Aerial part	Ladio (2005)
Solanum lycopersicum L.	Solanaceae	Ex	Tomate	Herb	Fruit	Eyssartier et al. (2011a, 2011b); Funes (1999); Mösbach (1992)
S. lycopersicum var. cerasiforme (Dunal) Spooner G.J. Anderson et R.K. Jansen.	Solanaceae	Ex	Tomatito	Herb	Fruit	
Solanum tuberosum L.	Solanaceae	Na	Papa	Herb	Underground organ	Funes (1999); Eyssartier et al. (2011a, 2011b); Mösbach (1992)
Triticum aestivum L.	Poaceae	Ex	Trigo	Herb	Fruit	Mösbach (1992)
Vaccinium myrtillus L.	Ericaceae	Ex	Arándano	Shrub	Fruit	
Vitis vinifera L.	Vitaceae	Ex	Parra	Shrub	Aerial part	Eyssartier et al. (2011a, 2011b)
Far away plants						
A. araucana (Molina) K. Koch	Araucariaceae	Na	Araucaria	Tree	Seed	Ladio and Lozada (2000, 2001); Mösbach (1992)
A. chilensis (Molina) Stuntz	Elaeocarpaceae	Na	Maqui	Shrub	Fruit	Ladio (2006); Ladio and Lozada (2001); Martínez-Crovetto (1980)
F. imbricata Ruiz & Pav.	Solanaceae	Na	Palo piche	Shrub	Aerial part	
Gunnera tinctoria (Molina) Mirb.	Gunneraceae	Na	Nalca	Herb	Aerial part	Ladio (2006); Martínez-Crovetto (1980); Rapoport et al. (1999)
P. chiloensis (L.) Mabb.	Rosaceae	Na	Frutilla	Herb	Fruit	Funes (1999); Martínez-Crovetto (1968); Mösbach (1992)
Ribes magellanicum Poir.	Grossulariaceae	Na	Parrilla	Shrub	Fruit	Ladio and Lozada (2001); Martínez-Crovetto (1968, 1980)
R. rubiginosa L.	Rosaceae	Ex	Rosa mosqueta	Shrub	Fruit	Funes (1999); Ladio and Lozada (2001); Martínez-Crovetto (1980)
R. ulmifolius Schott	Rosaceae	Ex	Murra	Shrub	Fruit	Eyssartier et al. (2011a, 2011b); Funes (1999);Ladio (2005)
Ugni molinae Turcz.	Myrtaceae	Na	Murtilla	Shrub	Fruit	Martínez-Crovetto (1980); Villagrán, Meza, Silva, and Vera (1983); Mösbach (1992)

5.2. Multinomial logistic regression model

The model showed that wild plant knowledge varied between young, middle-aged and older teachers, as a function of the variables analysed (Table 3, $p < 0.05$). The factors which carried most weight in the explanation of the variation across the different age categories were the life form of the plants and the gender of the teacher (Table 3). In contrast, factors such as additional medicinal use,

Table 3
Parameters estimates of the multinomial logistic regression model ln p/1-p = $\beta_0 + \beta_1$ life form + β_2 ubiquity + β_3 additional medicinal use + β_4 global economic significance + β_5 gender where p/1-p is the odds ratio, the probability of an event happening in relation of the probability of not. 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.

Age classes[#]		B	Std. error	Wald	*df*	Sig.	Exp(B)
1-Young teachers	Intercept	0.34	0.58	0.34	1	0.56	
	Life form						
	Herbs	−1.12	0.46	6	1	0.01*	0.32
	Shrubs	−0.55	0.47	1.39	1	0.24	0.58
	Trees (a)	0	,	,	0	,	,
	Global socioeconomic importance						
	Yes	0.44	0.23	3.67	1	0.06	1.56
	No (a)	0	,	,	0	,	,
	Ubiquity						
	Surroundings	0.54	0.30	3.27	1	0.07	1.72
	Cultivated	0.20	0.34	0.36	1	0.55	1.22
	Far away (a)	0	,	,	0	,	,
	Medicinal use						
	No	0.12	0.23	0.29	1	0.59	1.13
	Yes (a)	0	,	,	0	,	,
	Gender						
	Female	−0.18	0.23	0.65	1	0.42	0.83
	Male (a)	0	,	,	0	,	,
2-Middle-aged teachers	Intercept	−0.74	0.62	1.42	1	0.23	
	Life form						
	Herbs	−0.88	0.48	3.44	1	0.06	0.41
	Shrubs	−0.39	0.48	0.66	1	0.42	0.67
	Trees (a)	0	,	,	0	,	,
	Global socioeconomic importance						
	Yes	0.38	0.23	2.68	1	0.10	1.46
	No (a)	0	,	,	0	,	,
	Ubiquity						
	Surroundings	0.29	0.29	0.99	1	0.32	1.33
	Cultivated	−0.20	0.34	0.35	1	0.56	0.82
	Far away (a)	0	,	,	0	,	,
	Medicinal use						
	No	0.15	0.23	0.45	1	0.50	1.16
	Yes (a)	0	,	,	0	,	,
	Gender						
	Female	1.24	0.30	16.94	1	.000*	3.48
	Male (a)	0	,	,	0	,	,

(a) This parameter is set to zero because it is redundant.
* Significant results in the model following Wald statistic ($P < 0.05$).
\# Reference category is older teachers.

ubiquity and the significance in global market terms of the plants cited did not vary with teachers' ages (Table 3). In other words, the general tendency was maintained across the teachers' age categories: the teachers mainly knew the plants with medicinal uses, plants of relevant global significance and those easily found in the landscape (in the close surroundings).

Nevertheless, young teachers in comparison with older ones cited fewer herbs, with a lower chance of citing herbs than trees (exp B = 0.325 = 67% fewer), although they cited shrubs and trees equally ($p > 0.05$). Comparing the young teachers with the older ones, the chance of men or women citing wild edible plants was the same (Table 3, $p > 0.05$). The results indicate that among young teachers this knowledge is more homogeneous between the sexes, with a higher chance of listing large, conspicuous plants, and those which can be found easily. Nolan (2001) has found that useful weed-like herbs are not immediately obvious to untrained individuals, and so our results would indicate that in this population of teachers, knowledge of herbs increases with experience.

In the case of middle-aged compared with older teachers, the chance of citing herbs, shrubs and/or trees varied marginally in statistical terms ($p = 0.06$), but we can show that middle-aged teachers cited 59% fewer herbs than older ones. Moreover, in this category, when comparing middle-aged and older teachers, the chance of a wild plant cite coming from a woman was higher (Exp B = 3.48, 3 times, Table 3) than from a man. In other words, during this stage the chance of citing herbs increases and plant knowledge begins to differ between genders, women showing more interest in this resource, learning about new items and listing them in greater detail. This tendency, linked with greater ethnobotanical knowledge of edible and medicinal plants among women, has been pointed out by numerous authors in association with the female role in health care and food preparation for the family group (Reyes-García et al., 2009; Voeks, 2007).

In addition, no significant difference were found when comparing young teachers and middle-age teachers, the chance of citing wild edible plants is the same ($p > 0.05$).

6. Conclusions and implications

Our study reveals the corpus of edible wild plant knowledge for teachers in arid areas of Patagonia, and which plant type is relevant for this group. Our quantitative study would suggest a certain degree of TEK uniformity; the overall pattern found showing a high proportion of collective, commonly shared wild edible plant knowledge. Even though age classes presented some differences, the cultural consensus model (sensu Romney, Weller, & Batchelder, 1984) revealed the presence of a common system dominated by exotic plants when teachers cited ethnobotanical domains. The differences between age classes of teachers suggests that a knowledge structure exists as a single shared system which is enriched throughout their lives, particularly in the case of women, who have greater knowledge of herbs than men. Nevertheless, even when the selection of teachers was at random and representative in this study, this kind of sampling could have a bias, because none individual was followed during different stages of her/his life. More research is needed, with more empirical testing, to explain long-run changes along personal experience of teachers from Patagonia.

From this study, it was clear that many of the teachers used local perceptions and values as a criterion upon which they judged the importance of wild edible plants, food resources that are suffering a severe eroding process in the region. Biological factors such as life forms (which includes size and shape of plant resources), and ecological appearance in terms of ubiquity had a great influence on their perceptions. Moreover, sociocultural factors such as complementary medicinal use and global socioeconomic importance mould the body of traditional plant knowledge.

In general, it is proposed that wild plant knowledge is mainly learned through sustained contact with Nature and from parents and grandparents, and is scarcely taught through formal abstract education (Lozada et al., 2006; Ohmagari & Berkes, 1997). Despite formal education systems often removing children from this learning context at an early age, and the fact that western-style formal education contrasts with traditional systems of cultural transmission (Mc Carter & Gavin, 2011), the teacher's knowledge about wild edible plants could be a key driver for TEK, if an appropriate format for inclusion in classrooms is developed.

The body of knowledge held by the teachers could play a key role in contextualising locally relevant information, in part through linking the theoretical knowledge of the classroom with the personal, practical wisdom of the local community, empowering pupils and reinforcing their cultural identity. This is particularly relevant since the maintenance of wild edible plant knowledge and local food system are essential aspects in traditional societies. This initiative has been proposed by various scholars and institutions, such as UNESCO, and they have made reference to the importance of the incorporation of local botanical knowledge into the school curriculum, and its implications for the development of pupils' ethical attitudes towards the environment and local wisdom (Martínez & Pochettino, 1998–1999; Mc Carter & Gavin, 2011; Valdés et al., 2008).

In particular, we would highlight the need to articulate the views of western science expressed in the school curriculum with the vernacular, in order to favour dialogue and promote the construction of a pluralistic, inclusive teaching model. In addition, in this work we emphasise the importance of considering the cultural capital of the teachers themselves as a highly significant dimension, which can have a direct influence on the schools in terms of education and learning about Nature.

Recognising and valuing this traditional knowledge (for example if the teachers learn more about native plants and the local cosmovision), as well as valuing the practice and experience of other TEK holders in the community (perhaps by encouraging access of local experts to the school system), can contribute to an enrichment of both, and a real strengthening of dialogue between local and academic knowledge.

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