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Plant communities and phytogeographical units from NW San Juan Province (High Central Andes of Argentina)

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Abstract

MARTÍNEZ CARRETERO, E., A. DALMASSO, J. MÁRQUEZ & M. MARTINELLI (2010). Plant communities and phytogeographical units from NW San Juan Province (High Central Andes of Argentina). *Candollea* 65: 69-93. In English, English and French abstracts.

Vegetation of the High Central Andes of Argentina was studied in NW San Juan Province (MAB Reserve of San Guillermo) from a phytosociological point of view. Four new associations are proposed: two shrubland associations, *Artemisietum paramilloensis* and *Lycio-Ephedretum rupestri*, and two grassland associations, *Jaravetum chrysophyllae* and *Jaravetum absconditae*. The latitudinal and altitudinal boundaries of the Monte, Puna and High Andean phytogeographic provinces were established for the study area. This area constitutes the floristic and biogeographic transition between northern (Bolivia) and southern (Mendoza, Argentina) Puna elements, belonging to the *Calamagrostietea vicunarum* class, and to the *Stipo-Lycietea* class, respectively.

Key-words

Argentina – San Juan province – Wetlands – Phytosociology

Résumé

MARTÍNEZ CARRETERO, E., A. DALMASSO, J. MÁRQUEZ & M. MARTINELLI (2010). Les communautés végétales et les unités phytogéographiques du NO de la Province de San Juan (Hautes Andes Centrales, Argentine). *Candollea* 65: 69-93. En anglais, résumés anglais et français.

La végétation des Hautes Andes Centrales d'Argentine a été étudiée au NO de la Province de San Juan (MAB Réserve de San Guillermo) sur un plan phytosociologique. 4 nouvelles associations sont proposées: 2 associations arbustives, *Artemisietum paramilloensis* et *Lycio-Ephedretum rupestri*, et 2 associations herbacées, *Jaravetum chrysophyllae* et *Jaravetum absconditae*. Les limites latitudinales et altitudinales du Monte, de la Puna et des provinces phytogéographiques élevées des Andes ont été établies pour la zone d'étude. Cette zone constitue une transition floristique et biogéographique entre le Nord (Bolivie) et le Sud (Mendoza, Argentine) des éléments de la Puna appartenant aux classes *Calamagrostietea vicunarum* et *Stipo-Lycietea*.

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Introduction

The arid Puna region, bordered by Andean ranges in the southeast of Peru, southwest and centre of Bolivia and northwest of Argentina, is characterized by xerophytic steppe vegetation. In Argentina, the Puna extends southwards to La Rioja, San Juan and North of Mendoza (Roig, 1985, 1987; Ambrosetti & al., 1986; Roig & Martínez Carretero, 1998). Cold, drought and summer frost characterize both the Puna and High Andean regions.

The Central Andes of Argentina comprise two mountain ranges: the western range with Paleozoic metamorphic rocks, and the eastern one with Devonian sedimentites and Permo-Triassic intrusive rocks, that border high Andean valleys covered, in part, with aeolian sands. According to Furque (1972) the Llanos de San Guillermo (San Guillermo plains) would have originated from sediments resulting from the uplift of an ancient foothill. Phytogeographically this region belongs to the Arid Puna (Martínez Carretero, 1995) that reaches the southern altiplano in Bolivia (Navarro, 1993).

Geologically the study area is included in the Cordillera Frontal, separated from the Precordillera by the Blanco river. Faults are the most common structures; those located north of 29°S are north/northeast-south/southwest in direction, whereas the southern ones are oriented north-south and north/northwest-south/southeast. All faults are parallel or sub-parallel to the hill ranges and separated by distances of 5 to 20 km. They are inverse faults due to compressive forces starting since the Miocene. Devonian deposits appear intensively folded, whereas intrusive and Permian-Triassic vulcanite rocks show traces of a distensive pre-Tertiary tectonic activity (Caminos, 1972; Zambrano, 2007).

In relation to the vegetation, few studies have been conducted in the study area, particularly in the North-West of San Juan and South-West of La Rioja provinces; most of those studies consist of plant collections with general comments on the phytogeography (Roig, 1960; Cabrera, 1971, 1976; Cabrera & Willink, 1973; Martínez Carretero, 1995).

The northwest of San Juan province is important from the phytogeographic and floristic points of view; in addition, due to the interest in mining (copper and gold) and the impact of this activity on natural resources (water, vegetation), it is necessary to study the plant communities and their distribution in the area. In this study, we present a floristic analysis of the vegetation along the whole altitudinal gradient, and establish the boundaries between the vegetation belts of the Monte, the arid Puna and the High Andean belts.

Material and methods

Study area

The North-West area of San Juan province (28°25'N 30°25'S - 70°00'W 69°05'E), that includes the San Guillermo MAB Reserve, is a wide high Andean region with extensive areas covered by detritus and aeolian sands called ''pampas or llanos'' (i.e Llano de los Leones, Llano Negro, Llano de San Guillermo). On occasions, foothills show considerable development (10-12 km long). Wetlands constitute an important water reservoir and are spots of high biodiversity.

Altitude in the study area varies from 1700 m (East) to more than 5000 m (West), which means that megathermic elements belonging to the Monte formation as well as elements of cryogenic environments in the High Andean region can be found.

Scarce climate information is available for the study area. Winds reach 120 km/h, and snow accumulation is 33 cm in May, 27 cm in June, 33 cm in July, 47 cm in August and 37 cm in September (Salvioli, 2007). Data recorded in the Zancarron area (28°36'31.89"S - 69°14'55.16"W, 3700 m) during the period 1987-1989 are shown in Table 2.

Solar radiation is the main variable controlling the daily and seasonal temperatures. Mean annual temperature in the studied area is 0° C, and the mean maximum and minimum temperatures are 7° C and -6° C, respectively. Rainfall varies along the altitudinal gradient, from 40 mm, in the Rodeo valley (30°12'55.28"S - 69°07'03.27"W, 1700 m) increasing to the West and Southwest. Snowfalls decrease from South to North, from 300 mm to 200 mm in the Blanco river (in San Guillermo). Between 3000 and 6000 m, precipitations occur mostly as snow, hailstones and hoarfrost, associated with wet winds from the Pacific Ocean (Salvioli, 2007). According to Minetti & al. (1986) mean annual rainfall in the high Andean sector varies from 300 mm in the southern part of the area to 50 mm in the North. According to the Koeppen index, the climate belongs to the high desert arid type (Quintela, 1977). The boundary between different rainfall regimes is the Frontal Cordillera; Atlantic Subtropical continental rainfall (summer rainfall) dominates to the East and a Pacific Subtropical regime (winter precipitations, mostly snow and hailstorm) to the West.

Methods

For each physiographic unit, determined by both satellite image analysis (LANDSAT TM, 1: 250'000) and topographic maps (1: 100'000), 117 floristic surveys were performed during the field work. All collected plants were determined. For taxon names, the contributions of Zuloaga & Morrone (1999) and Peñailillo (2002) were followed. For syntaxa names, the International Code of Phytosociological Nomenclature was followed (Weber & al., 2000).

The phytogeographical units present in the area and their distribution were established based on the floristic-geomorphological analysis of plant communities and on plant species distribution. A data matrix was constructed from the floristic data and the specific plant cover (Table 1). This matrix was analyzed using classification and ordination methods (MUELLER DUMBOIS & ELLENBERG, 1974; ORLOCI, 1978). Data on plant cover were transformed according to: +: 2.5, 1: 5, 2: 17.5, 3: 37.5, 4: 64.5, 5: 84.5. Pearson's correlation was used as a distance algorithm, using complete linkage for clustering, and in the Principal components analysis for ordination.

Results

Dominant geomorphologic processes are: cryoturbation, gelivation, water erosion, debris flow and thermoclastism (SUVIRES, 2007). The Llanos de San Guillermo region is formed from sediments originating from the uplift of the ancient foothill, up to a constant 3500 m level.

Plant communities

From the floristic matrix data (Table 1) four groups of communities were obtained using cluster analysis (Fig. 1):

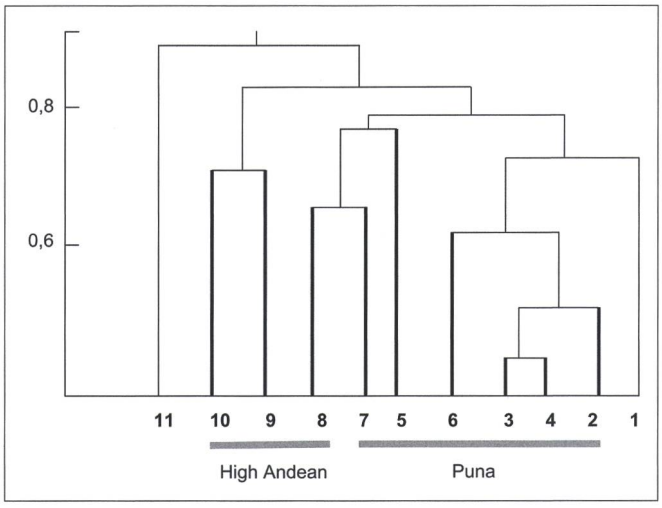

Fig. 1. – Cluster of plant communities.

Puna shrublands: 1. *Artemisia echegarayi* Roig & Martínez Carretero 1998; 2. *Artemisietum paramilloensisi* ass. nov.; 3. *Larrea divaricata* community; 4. *Lycio-Ephedretum rupestri* ass. nov.; 5. *Jaravetum chrysophyllae* ass. nov.

Saxicolous shrublands: 6. *Trycicla spinosa* community; 7. *Adesmia pinifolia* community.

High Andean vegetation: 8. *Jaravetum absconditae* ass. nov.; 9. *Adesmia subtrranea* community; 10. *Stipa frigida* community.

11. Wetlands communities.

Puna shrublands on sandy soils (*Artemisia echegarayi, Artemisia mendozana* var. *paramilloensis, Larrea divaricata, Lycium chanar-Ephedra rupestris);*

Saxicolous shrublands (*Adesmia pinifolia* and *Trycicla spinosa* communities);

High Andean vegetation (*Jarava speciosa* var. *abscondita, Adesmia subterranea,* and *Stipa frigida* communities);

Wetland vegetation.

The ordination analysis highlights the same phytogeographical relationships. Axis I distinguishes Puna shrublands on sandy soils from those on rocky outcrops; whereas axis II follows a xericity gradient, from wetlands to communities on sandy and deflated soils such as the *Artemisia mendozana* var. *paramilloensis* community (Fig. 2).

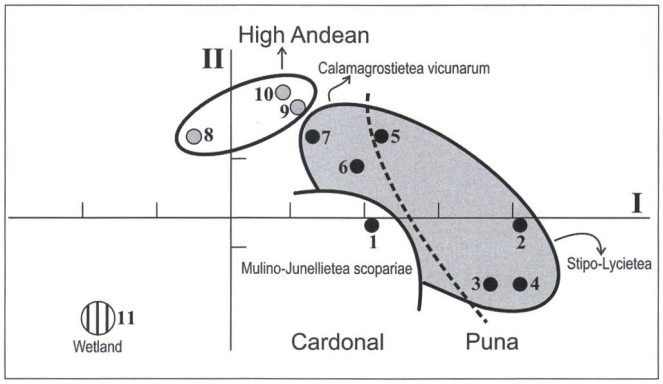

Fig. 2. – Ordination of plant communities [for abbreviations see Fig. 1].

Puna communities

The distribution of plant communities in the northwest of San Juan is shown in the vegetation map on a 1: 350'000 scale (Fig. 3).

All the species and the plant communities observed may be found in Table 1: the plant communities are ordered following the whole altitudinal gradient studied and considering their phytogeographical position; showing, in addition, the transition between the classes *Calamagrostietea vicunarum* and the *Sipo-Lycietea* in the Puna belt:

A phytosociological conspectus follows, with the plant communities described and presented (C: class; O: order; L: alliance; A: association):

C: *Mulino-Junellietea scopariae* Roig 1989

O: *Mulino-Junellietalia scopariae* Roig 1989

L: *Saturejo-Adesmion uspallatensis* Roig 1989

A: 1. *Artemisietum echegarayi* Roig & Martínez Carretero 1998

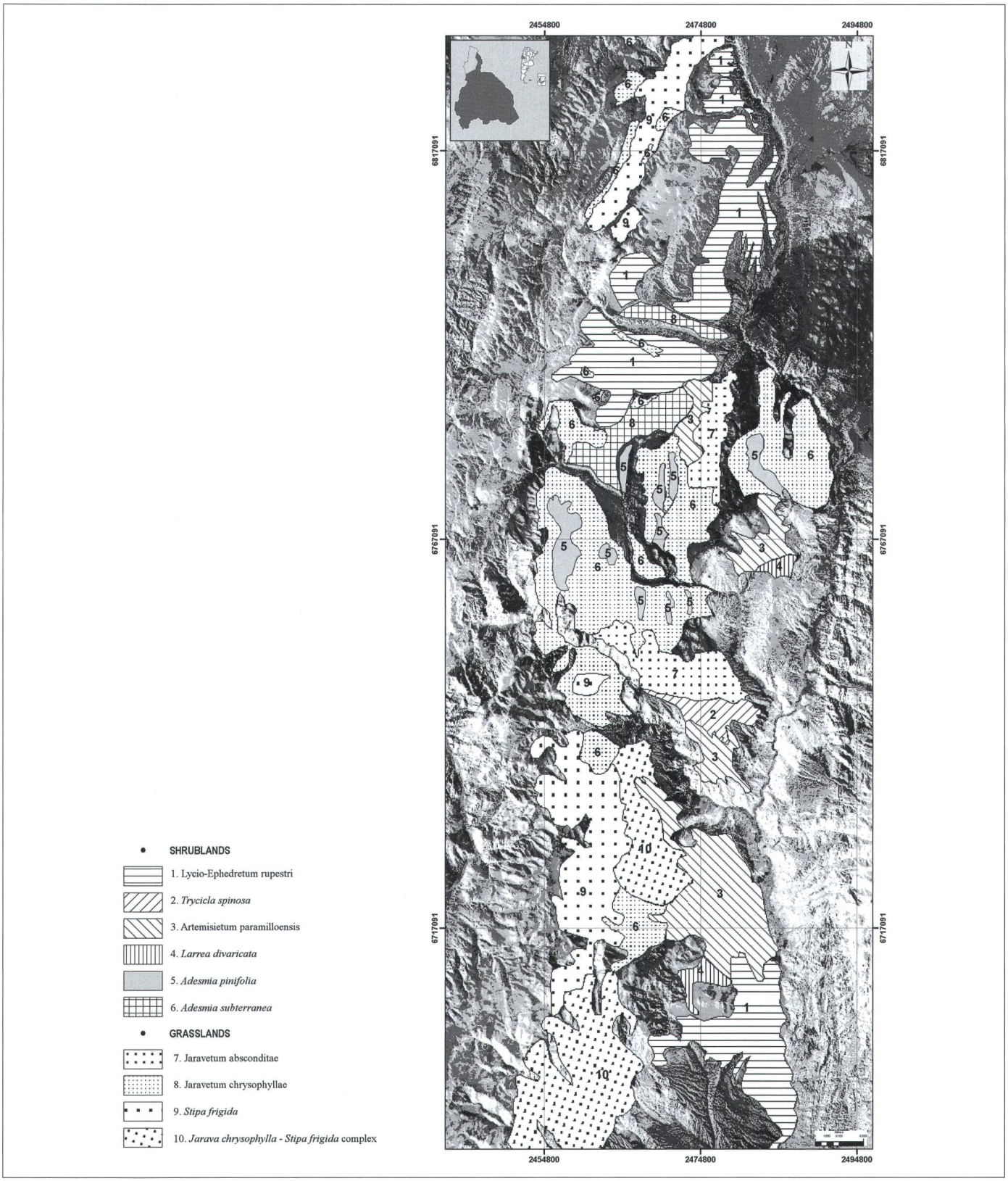

Fig. 3. – Map of plant communities for northwest area (San Juan province, Argentina).

C: *Stipo-Lycietea fusci* Roig & Martínez Carretero 1998

O: *Stipo-Lycietalia fusci* Roig & Martínez Carretero 1998

L: *Chuquirago-Lycion fusci* Roig & Martínez Carretero 1998

A: 2. *Artemisietum paramilloensis*

3. *Larrea divaricata* community

4. *Lycio-Ephedretum rupestri*

5. *Jaravetum chrysophyllae*

C: *Calamagrostietea vicunarum* Rivas Martínez & Tovar 1982

O: *Parastrephietalia lepidophyllae* Navarro 1993

L: *Lobivio-Fabianion densae* Ruthsatz 1993

A: 6. *Trycicla spinosa* community

7. *Adesmia pinifolia* community

L: *Urbanio papigerae-Stipion frigidae* Navarro 1993

A: 8. *Jaravetum absconditae*

9. *Adesmia subterranea* community

10. *Stipa frigida* community

1. *Artemisietum echegarayi* (Table 3)

This association belongs to the *Saturejo-Adesmion uspallatensis* alliance that comprises evergreen pre-Andean shrublands on deep sandy soils (Roig & Martínez Carretero, 1998). In the study area this community occupies lower levels of the Puna between 3200-3300 m, primarily on shady water-eroded slopes. It appears as a low shrubland 0.6-0.8 m in height, and with a total plant cover lower than 20%. Accompanying species are *Mulinum ulicinum, Fabiana* af. *densa, Stipa leptostachya, Lycium chilense* var. *vergarae, Trycicla spinosa,* amongst others. This community extends southwards to 32°S, in the Precordillera of Mendoza with a similar topography (Martínez Carretero, 2000) (Table 3).

2. *Artemisietum paramilloensis*, ass. nov. hoc loco (Table 4, survey type no. 16)

This Association is included in the *Chuquirago-Lycion fusci* alliance that occurs from the South (North of Mendoza province) up to this latitude. It comprises communities of sparse shrubs, with 30-40% cover, generally growing on alluvial fans and at the bottom of slopes covered with Quaternary deposits. In the study area this alliance occurs between 3000-3500 m.

The *Artemisietum paramilloensis* appears on local piedmonts with Quaternary cover, intense water erosion and soil disturbed by rodents. On occasions it is found along temporary rivers and in ancient overblown piedmonts. *Artemisia mendozana* var. *paramilloensis* is a flashy shrub due to its gray foliage, although it is no more than 0.3-0.4 m high and has a mean plant cover of 25%. *Nardophyllum armatum, Atriplex oreophylla* and *A. mendozana* var. are differential species. Accompanying species are *Jarava sepciosa* var. *breviglumis, Argylia uspallatensis, Tarasa antofagastana* and *Malesherbia lirana,* etc.

3. *Larrea divaricata* community (Table 5)

It occurs on local piedmonts and alluvial fans with laminar erosion, and on slopes of about 3-4% inclination. Rocks show incipient desert varnish. Soils are sandy with clay, debris and gravel. In sectors, such as Quebrada de Alcaparrosa, this community occupies Carbonic clay outcrops with intense water erosion. *L. divaricata* appears as a shrub 0.4 m in height, with concave profile. Accompanying species are: *Acantholippia deserticola, Junellia echegarayi, Ephedra rupestris* on long downslopes deeply dissected by water erosion, etc.

4. *Lycio-Ephedretum rupestri*, ass. nov. hoc loco (Table 6, survey type no. 24)

It is the most extensive community in the study area. It occupies wide sandy flatlands with heterometric gravels, top of sandy downslopes, proximal sectors of alluvial fans, and granitic outcrops covered with sand. Total plant cover is 25-30%. The lower plant layer is poor or absent.

Lycium chanar is the dominant species with a 10-15% cover, and with 0.8 m tall plants growing 3-5 m apart. *Adesmia guttulifera, Glandularia microphylla, Atriplex myriophylla, Ephedra rupestris,* among others, are characteristic species. Accompanying species are *Fabiana denudata, Chuquiraga erinacea* subsp. *hystrix, Maihueniopsis ovata, Acantholippia deserticola, Cryptantha diplotricha, Nassella grabripoda*, etc. with cover lower than 5%.

5. *Jaravetum chrysophyllae*, ass. nov. hoc loco (Table 7, survey type no. 40)

This community is of important extent in the protected area. It is located on flatlands (Llano de Los Leones), extensive downslopes and slopes with black and angled material affected by gelifluxion processes. Soils have a sandy matrix. This community commonly occurs at the top of frozen domes in wetlands, where aeolian sand accumulates. *J. chrysophylla* var. *chrysophylla* forms grasslands of low cover, between 5-10%, with plants 0.2 m tall. On occasions *Adesmia subterranea* forms cushions, together with *Lepidium nitidum, Muhlenbergia fastigiata, Senecio oreophyton,* etc. (Table 7). Characteristic species are: *Jaborosa parviflora, J. caulescens* var. *pinnatifida, Muhlenbergia fastigiata,* and *Jarava humilis.*

6. *Trycicla spinosa* community (Table 8)

At this latitude many elements belonging to the *Lobivio ferocis-Fabianion densae* reach their most southern distribution. This alliance is constituted by communities on stony slopes, rocky outcrops, and flatlands with gelifluxion processes, between 3000-3500 m.

It appears on the upper part of andesitic or very meteorized granitic ranges, with a sandy matrix and intense aeolian erosion. *Trycicla spinosa* forms facies together with *Junellia echegarayi* and *Phacelia setigera.* The extreme environmental conditions of these sites are highlighted through the isolateral growth of the cambium, the stem taking shape of a racquet, with strongly reduced leaves, and with fruits rich in antocians.

7. *Adesmia pinifolia* community (Table 9)

This community occurs on rocky outcrops, especially with South and Southwest exposure, where snow remains until late summer. The soil is composed of very meteorized granite or black and diaclased schists, as in the El Fierro mine. It is common that the shrubland follows the water courses, marking their way on the rocky slope.

This community is noted for the yellow colour of the branches of *A. pinifolia*, contrasting with the dark soil materials. *A. pinifolia* reaches up to 2.5 m in height, and the community achieves a cover of 15-18%. Among accompanying species are: *Haploppapus marginalis, Nasella grabifolia, Lecanophora ameghinoi, Descurainia cumingiana,* etc.

8. *Jaravetum absconditae,* ass. nov. hoc loco (Table 10, survey type no. 64)

The *Urbanio-pappiegrae* alliance reaches its southernmost boundary in the northwest of San Juan and southwest of La Rioja provinces. In general it consists of grasslands with small and sparse pulvinate shrubs, between 4000-4500 m. It extends from south-western Bolivia (Sajama region, 18°l'S) (NAVARRO, 1993) to 30°S latitude.

This is a community of small coverage. It occupies the bottom of valleys and sandy soils among very diaclased rocks or on covered glaciers (as the beginning of the Santa Rosa river). It appears in distal parts of local foothills and lower edges of lateral moraines. The grassland of *J. speciosa* var. *abscondita* extends up to 4000 m. Mean plant cover is 25%. Differentials species are: *Chaptalia similis, Astragalus* af. *crypticus, Cistanthe frigida, Tetraglochin cristatum,* among others. Among accompanying species are: *Jarava nicorae, Cajophora coronata* and *Phacelia setigera.*

9. *Adesmia subterranea* community (Table 11)

It occurs on diverse types of soils: sandy soil among moraine deposits, on loose slopes with clasts in a sandy matrix, on proximal parts of large local foothills (such as the Sapito river). In general, it is present in areas with evidence of intense cryoturbation processes, between 3700-4200 m. Plant cover is lower than 15-18%. *Nototriche compacta, Lenzia chamaepitys* and *Huarpea andina,* amongst others, are accompanying species.

10. *Stipa frigida* community (Table 12)

This community occurs on the upper part of slopes, on runoff edges on long downslopes, and on sandy soils with angled clasts. Plant cover varies between 2-5%. *Senecio volckmanii, Kurzamra pulchella, Arenaria serpens, Festuca weberbaueri, Jarava nicorae, Lenzia chamaepitys*, etc. are accompanying species.

Wetland vegetation

Wetlands are found in both Puna and High Andean vegetation belts (Table 13). They show different vegetation belts according to the water saturation degree of soils, belonging to the minerothrophic type (IGARZABAL, 1984). The following plant communities can be mentioned for wetlands in the study area.

Juncus arcticus community: in soils dry on the surface, with a water table 20-30 cm deep, accompanied by *Astragalus* af. *famatinae, Polypogon interruptus, Puccinelia frigida, Nastanthus caespitosum, Ranunculus cymbalaria* f. *exilis,* etc.

Carex incurva community: in over-saturated soils with water near the surface, with puddles on occasions. This community usually appears as a mosaic on drier soils. Accompanying species are *Poa annua, Ranunculus* af. *flagelliformis, Deyeuxia velutina,* etc. *Festuca nardifolia* is a variant with higher cover on small cryogenic domes (10-15 cm high).

Patosia clandestina community: on over-saturated soils, without free water, and with a 0-15 cm deep water table. *Werneria pygmaea, Caltha sagittata, Juncus depauperatus, Triglochin palustris, Carex subantarctica, Oxychloe andina,* among others, are accompanying species.

Juncus balticus community: on over-saturated soils with water in puddles. The important moss stratum indicates a water-saturated environment. Other species of the community are *Plantago tomentosa, Carex atropicta, Heleocharis sp.*, etc.

Potamogeton pectinatus communty: in both stagnant and moving water, with *Myriophyllum aquaticum* and mosses.

Plant species on granitic bedrock covered by organic matter 5-15 cm deep; where water runs very slowly on the rocky outcrop keeping the soil over-saturated, where *Urtica buchtienii, Deschampsia caespitosa, Calceolaria glacialis,* amongst other species, occur.

Some species from contact communities tend to occupy habitats where aeolian sand is deposited, indicating more xeric conditions, such as *Stirpa frigida* and *Festuca weberbaueri* in the upper part of cryogenic domes inside wetlands (MARTÍNEZ CARRETERO, 1997).

Phytogeographical units

Three phytogeographical provinces are present in the study area: Monte, Puna and High Andean provinces, with transitions between them that vary according to exposure and inclination. The Cardonal unit appears on North-exposed slopes, close to the area.

1. Monte

It is located in the South of the area, reaching up to 2800 m. Species such as *Larrea divaricata, Bulnesia retama, Bredemeyera colletioides, Atriplex deserticola*, among others, are dominant. In the Quebrada de Alcaparrosa, the Monte Formation reaches 2800 m. and shows an ecotone with Puna elements up to 3000 m.

2. Cardonal

This unit appears on the eastern border of the area, on sunny slopes, between 2500-2800 m in a narrow strip of between 100-150 m wide. Some plant species indicate the extent of the unit from Bolivia southwards (LÓPEZ, 2000). Species indicative of the Cardonal are: *Dipyrena glaberrima, Deuterocohnia longipetala, Denmoza rhodacantha, Dolichlasium lagascae, Mentzelia parvifolia, Satureja parviflora, Aphyllocladus san-martinianus, Gymnophyton polycephalum, Caesalpinia pumilio,* etc.

3. Puna

It is the best represented vegetation belt in the study area. It appears between 2900-3800 m with an ecotone with the High Andean belt between 3800-4000 m, depending on the topography. Species such as *Lycium chanar, Atriplex myriophylla, Jaravetum chrysophylla* var. *chrysophylla*, among others are indicative of the Puna region.

4. High Andean region

It lies above 4000 m up to the vegetation boundary (4400 m in the study area). Species adapted to soils with cryogenic processes are *Stipa frigida, Chaetanthera spathulifolia, Cistanthe picta, Barneoudia chilensis,* etc.

Discussion and conclusions

The Central Andes of Argentina, at 30°S, show an interesting confluence of elements belonging to two vegetation classes: *Calamagrostietea vicunarum,* from the North (Peru, Chile and Bolivia), and *Stipo-Lycietea fusci* from the South (Mendoza). The former consists mostly of grasslands on sandy soils, and the latter of shrublands on stony slopes and downslopes, both with scarce plant cover. The *Jaravetum chrysophyllae* is the main vegetation unit linking both classes. The phytogeographical boundaries of the High Andean (3800-4400 m), Puna (3800-2900 m) and Monte (< 2800 m) provinces are proposed for the study area.

The Puna belt is in agreement with the altimetry and floristic composition suggested by MARTÍNEZ CARRETERO (1995) for Argentina. Within this belt, the study area corresponds to the Cuyano District. On the other hand, both altitudinal zones proposed by MARTÍNEZ CARRETERO (1997) for the Puna of Catamarca province are present: the lower shrubby zone, between 3600-3800 m with *Acantholippia deserticola, Lycium chanar,* etc., and the higher one, with grasslands of *Stipa* and *Jarava* species. Syntaxonomically, syntaxa proposed by ROIG & MARTÍNEZ CARRETERO (1998) for the Puna of Mendoza province fit the study area, especially the *Stipo-Lycietalia fusci,* which includes shrub and grass associations such as *Chuquirago-Lycietum fusci, Baccharidetum incari, Ephedretum breanae.* A similar floristic coincidence appears in communities proposed by RUTHSATZ & MOVIA (1975) for the Jujuy province. The Puna region shows reduced specific diversity toward the South, from 119 species in Jujuy (RUTHSATZ, 1977), to 85 species in northwest San Juan (Table 1) and 89 in Mendoza (ROIG & MARTÍNEZ CARRETERO, 1998). Similar values between the last two localities justify their being included by MARTÍNEZ CARRETERO (1995) in the Cuyano District of the arid Puna, which is characterized by the presence of *Lycium fuscum, L. chanar, Stipa frigida, Artemizia mendozana* var. *paramilloensis, Stipa nicorae,* among other common species.

From the syntaxonomical point of view four new associations are described for the Central Andes of Argentina: *Artemisietum paramilloensis, Lycio-Ephedretum rupestri, Jaravetum chrysophyllae,* and *J. absconditae,* all of them included in the Puna and High Andean belts.

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Table 1. – Synthetic table of surveys.

Phytogeographical position	**Cardonal**	**Puna**						**High Andean**		
Group of surveys	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mulino-Junellietea scopariae										
Saturejo-Adesmion uspallatensis										
Artemisietum echegarayi										
Artemisia echegarayi Hieron.	V	.	.	I	.	.	.	.	.	.
Haplopappus sp.	I	.	.	.	.	.	.	.	.	.
Lepidium nitidum Torr. & A. Gray	III	.	.	.	I	.	.	.	.	.
Mulinum ulicinum Gillies & Hook.	III	.	.	.	II	.	.	.	.	.
Senecio oreophyton J. Remy	III	.	.	.	II	.	I	.	.	.
Stipo-Lycietea fusci										
Fabiana denudata Miers	I	II	I	II	I	I	I	I	.	.
Leymus erianthus (Phil.) Dubcovsky	.	.	.	I	.	.	.	.	.	.
Maihueniopsis glomerata (Haw.) R. Kiesling	.	II	I	I	I	II	I	.	I	.
Stipo-Lycietalia fusci										
Cisthante picta (Arn.) Hershkovitz	.	.	.	I	I	.	I	.	I	.
Jarava vaginata f. *contracta* (F. Roig) Peañail.	.	.	.	.	.	.	I	.	.	.
Chuquirago-Lycion fusci										
Bougainvillea spinosa (Cav.) Heimerl	I	II	I	.	.	V	.	.	.	.
Lycium chilense var. *vergarae* (Phil.) Reiche	I	II	.	II	.	.	I	.	.	.
Chuquirago-Lycietum fusci										
Lycium fuscum Miers	I	I	.	II	I	.	II	.	I	.
Chuquiraga erinacea subsp. *hystrix* (Don) C. Ezcurra	.	II	I	II	.	.	.	.	.	.
Chuquirago-Lycietum atriplicetosum										
Atriplex deserticola Phil.	.	I	.	I	.	.	I	.	.	.
Baccharidetum incari										
Baccharis incarum (Wedd.) Cuatrec.	.	.	.	I	I	.	.	.	.	I
Glandulario-Phacelietum sinuatae										
Phacelia cumingii (Benth.) A. Gray	.	.	.	I	.	.	I	I	.	.
Astragalus-Ephedretum breanae										
Tarasa antofagastana (Phil.) Krapov.	.	.	.	.	.	.	I	.	.	.
Glandulario-Ipomopsion gossypiferae								.	.	.
Ipomopsis gossypifera (Benth.) V. E. Grant	.	.	.	I	.	.	.	.	.	.
Chenopodium frigidum Phil.	.	.	.	.	.	.	I	I	.	.
Dolichlasietum lagascae										
Dolichlasium lagascae D. Don	.	.	.	I	.	.	.	.	.	.
***Artemisietum paramilloensis* ass. nov.**										
Artemisia paramilloensis F. A. Roig & Ambrosetti	I	V	.	.	I	.	.	.	.	.
Nardophyllum armatum (Wedd.) Reiche	.	II	.	.	.	.	I	.	.	.
Atriplex oreophila Phil.	.	II	.	I	.	.	I	.	.	.
Maihueniopsis ovata (Pfeiff.) F. Ritter	.	II	.	I	.	.	.	.	II	.
***Larrea divaricata* community**										
Larrea divaricata Cav.	.	III	V	.	.	.	.	.	.	.
Eupatorium patens Hook. & Arn.	.	.	II	.	.	.	.	.	.	.
Acantholippia deserticola (Phil.) Moldenke	.	.	I	.	I	.	.	.	.	.
Jaborosa laciniata (Miers) Hunz. & Barboza	.	.	II	.	.	.	I	.	.	.
***Lycio-Ephedretum rupestri* ass. nov.**										
Lycium chanar Phil	.	III	III	V	.	I	.	.	.	.
Ephedra rupestris Benth.	.	I	.	II	.	.	.	.	.	.
Adesmia af. *guttulifera* Sandwith	.	.	.	I	.	.	.	.	.	.
Atriplex myriophylla Phil.	.	.	.	I	.	.	.	.	.	.
Ephedra multiflora Stapf	.	.	.	II	.	.	.	.	.	.
Azorella monantha Clos	.	.	.	I	.	.	.	.	.	.
Calandrinia compacta Barnéoud	.	.	.	I	.	.	.	.	.	.
Cryptantha diplotricha (Phil.) Reiche	.	.	.	I	.	.	.	.	.	.

Table 1 (cont.). – Synthetic table of surveys.

Phytogeographical position	Cardonal	Puna						High Andean		
Group of surveys	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Glandularia microphylla (Kuntze) Cabrera	.	.	.	I	.	.	.	.	.	.
Urtica chamadryoides subsp. *microsperma* Hauman	.	.	.	I	.	.	.	.	.	.
Stipa durifolia Torres	.	.	.	I	.	.	.	.	.	.
***Jaravetum chrysophyllae* ass. nov.**										
Jarava chrysophylla (E. Desv.) Peñail. var. *chrysophylla*	.	.	.	.	V	.	I	II	II	.
Jarava vaginata (Phil.) F. Rojas	.	.	.	.	I	.	.			
Viola volcanica Hook. & Arn.	.	.	.	.	I	.	.	.	.	II
Hordeum pubiflorum subsp. *halophyllum* (Griseb.) Baden & Bothmer	.	.	.	.	I	.	.	.	.	.
Euphorbia sp.	.	.	.	.	II	.	.	.	.	.
Jaborosa parviflora (Phil.) Hunz. & Barbosa	.	.	.	.	II	.	.	.	.	.
Jaborosa caulescens var. *bipinnatifida* Dunal (Reiche)	.	.	.	.	II	.	.	.	.	.
Muhlenbergia fastigiata (J. Presl) Henrard	.	.	.	.	II	.	.	.	.	.
Jarava humilis (Cav.) Peñail.	.	.	.	.	II	.	.	.	I	.
Calamagrostietea vicunarum										
Parastrephietalia lepidophyllae										
Lobivio-Fabianion densae										
Adesmia echinus C. Presl	I	V	III	V	.	I	II	II	I	.
Fabiana densa J. Remy	III	II	.	I	.	.	.	.	.	.
Fabiana punensis S. C. Arroyo	I	II	.	I	.	.	I	.	.	.
Ephedra chilensis C. Presl	.	.	.	I	.	I	.	.	.	.
Malesherbia lirana Gay	.	I	.	I	.	.	I	.	.	.
Jarava leptostachya (Griseb.) F. Rojas	I	.	.	.	.	.	I	.	.	.
Lobivia formosa (Pfeiff.) Dodds	.	.	.	I	.	.	I	.	.	.
Nicotiana petunioides (Griseb.) Millán	.	.	.	I	.	.	I	.	.	.
***Trycicla spinosa* community**										
Jarava speciosa var. *media* (Torres) Peñail.	.	.	.	.	.	IV	I	.	.	.
Phacelia setigera Phil.	.	.	.	.	.	III	.	.	I	.
Oxalis hypsophila Phil.	.	.	.	.	.	III	.	I	.	.
Jarava neaei (Steud.) Peñail.	.	I	.	.	.	III	I	.	.	.
***Adesmia pinifolia* community**										
Adesmia pinifolia Hook. & Arn.	I	.	.	II	II	I	V	.	.	.
Adesmia hemisphaerica Hauman	.	.	.	.	I	.	I	.	.	.
Haplopappus af. *marginalis* Phil.	.	.	.	.	.	.	I	.	.	.
Lecanophora ameghinoi (Speg.) Speg.	.	.	.	.	.	.	I	.	.	.
Melica chilensis J. Presl	.	.	.	.	.	.	I	.	.	.
Descurainia cumingiana (Fisch. & C. A. Mey.) Prantl	.	.	.	.	.	.	I	.	.	.
Nasella grabifolia Torres	.	.	.	.	.	.	I	.	.	.
Calceolaria pinifolia Cav.	.	.	.	.	.	.	I	.	.	.
Acaena magellanica (Lam.) Vahl	.	.	.	.	I	.	I	.	.	.
Urtica buchtienii R. Ross	.	.	.	.	.	.	I	.	.	.
***Jarava nicorae* community**										
Jarava nicorae (Roig) Peñail.	.	.	.	I	.	.	I	.	II	II
Lenzia chamaepitys Phil.	.	.	.	.	.	.	.	I	I	II
Adesmia aegiceras Phil.	.	.	.	.	.	.	I	I	.	II
Caiophora coronata (Arn.) Hook. & Arn.	.	.	I	.	II	.	.	.	I	.
Urbanio papigerae-Stipion frigidae										
***Jaravetum absconditae* ass. nov.**										
Jarava speciosa var. *abscondita* Roig	.	.	.	II	.	.	.	V	I	.
Chaptalia similis R. E. Fr.	.	.	.	.	.	.	.	I	.	.
Astragalus af. *crypticus* I. M. Johnst.	.	.	.	.	I	.	.	II	.	.
Gayophyton micranthum Hook. & Arn.	.	.	.	.	.	.	.	II	.	I
Cistanthe frigida (Barnéoud) Peralta	.	.	.	.	.	.	.	I	.	.

Table 1 (cont.). – Synthetic table of surveys.

Phytogeographical position	**Cardonal**	**Puna**						**High Andean**		
Group of surveys	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Adesmia nanolignea Burkart	.	.	.	.	.	.	.	II	.	.
Adesmia quadripinnata (Hicken) Burkart	.	.	.	.	.	.	.	III	.	.
Tetraglochin cristatum (Britton) Rothm.	.	.	.	I	II	.	.	II	.	.
***Adesmia subterranea* community**										
Adesmia subterranea Clos	.	.	.	.	I	.	I	.	V	I
Huarpea andina Cabrera	.	.	.	.	.	.	I	.	III	I
Pachylaena atriplicifolia Hook. & Arn.	.	.	.	.	.	.	I	I	II	.
Oxalis erythrorhiza Hook. & Arn.	.	.	.	.	.	.	.	.	II	.
Nototriche compacta (A. Gray) A. W. Hill	.	.	.	.	.	.	.	.	II	I
***Stipa frigida* community**										
Stipa frigida Phil.	.	.	.	I	.	.	.	.	.	V
Senecio volckmannii Phil.	.	.	.	.	.	.	.	.	.	III
Kurzamra pulchella (Clos) Kuntze	.	.	.	.	.	.	.	II	.	IV
Arenaria serpens Kunth	.	.	.	.	.	.	.	.	.	II
Menonvillea virens (Phil.) Rollins	.	.	.	.	.	.	.	.	.	II
Festuca weberbauerii Pilg.	.	.	.	.	.	.	.	.	.	I

Table 2. – Climatic data for Zancarron area: absolute and mean temperatures, period 1987-1989.

Temperature [°]	**Mean**	**Max. mean**	**Min. mean**	**Abs. max.**	**Abs. min.**
May	1.1	12.3	-9.9	30	-22
June	1.1	12	-9.8	30	-27
July	-1.3	7.4	-9.9	35	-26
August	0.7	9.5	-8.1	34	-23
September	2.3	13.1	-8.5	40	-20

Table 3. – Floristic surveys for the *Artemisietum echegarayii* Roig & Martínez Carretero 1998.

Altitude [m]	**3300**	**3220**	**3200**	**3277**	**3358**	**3277**
Location	**29°33 69°66**	**29°30 69°65**	**29°29 69°65**	**29°32 69°68**	**29°35 69°68**	**29°32 69°68**
Survey No.	**1**	**2**	**3**	**4**	**5**	**6**
Mulino-Junellietea scopariae						
Artemisietum echegarayii						
Artemisia echegarayi Hieron.	1	1	1	+	2	2
Haplopappus sp.	.	.	.	.	+	.
Lepidium nitidum Torr. & A. Gray	1	.	+	.	+	.
Mulinum ulicinum Gillies & Hook.	.	+	+	.	+	.
Senecio oreophyton J. Remy	1	.	+	.	+	.
Stipo-Lycietea fusci						
Fabiana denudata Miers	.	.	.	.	.	+
Stipo-Lycietalia fusci						
Chuquirago-Lycion fusci						
Bougainvillea spinosa (Cav.) Heimerl	.	.	.	.	.	1
Lycium chilense var. *vergarae* (Phil.) Reiche	.	.	.	+	.	.
Lycium fuscum Miers	.	.	.	.	+	.
Artemisietum paramilloensis						
Artemisia paramilloensis F. A. Roig & Ambrosetti	.	.	.	+	.	.
Lobivio-Fabianion densae						
Adesmia echinus C. Presl	.	.	.	+	.	.
Fabiana densa J. Remy	.	.	.	2	1	+
Fabiana punensis S. C. Arroyo	.	.	.	.	.	+
Jarava leptostachya (Griseb.) F. Rojas	.	.	.	.	+	.
***Adesmia pinifolia* community**						
Adesmia pinifolia Hook. & Arn.	.	.	.	.	1	.

Table 4. – Floristic surveys for the *Artemisietum paramilloensis* ass. nov.

Altitude [m]	**3277**	**3325**	**3070**	**3171**	**3328**	**3190**	**3169**	**3252**	**3067**	**2900**
Location	**29°32 69°18**	**29°32 69°18**	**29°46 69°17**	**29°38 69°16**	**29°32 69°15**	**29°37 69°16**	**29°42 69°15**	**29°35 69°16**	**29°46 69°17**	**29°41 69°16**
Survey No.	**7**	**8**	**9**	**19**	**11**	**12**	**13**	**14**	**15**	**16**
***Artemisietum paramilloensis* ass. nov.**										
Artemisia paramilloensis F. A. Roig & Ambrosetti	2	2	3	2	2	+	2	2	2	3
Nardophyllum armatum (Wedd.) Reiche	.	.	.	.	.	+	.	1	.	.
Atriplex oreophila Phil.	.	.	.	.	+	2	.	+	.	.
Maihueniopsis ovata (Pfeiff.) F. Ritter						1				2
Stipo-Lycietea fusci										
Fabiana denudata Miers	.	.	.	+	.	.	+	.	+	1
Maihueniopsis glomerata (Haw.) R. Kiesling	.	+	.	+	.	+	+	.	.	.
Stipo-Lycietalia fusci										
Chuquirago-Lycion fusci										
Bougainvillea spinosa (Cav.) Heimerl	+	.	.	.	+	.	.	.	+	.
Lycium chilense var. *vergarae* (Phil.) Reiche	.	+	.	.	.	+	.	+	.	.
Chuquirago-Lycietum fusci										
Lycium fuscum Miers	.	.	.	.	.	.	.	.	.	+
Chuquiraga erinacea subsp. *hystrix* (Don) C. Ezcurra	+	.	.	.	.	.	+	.	+	.
Atriplex deserticola Phil.	.	.	.	.	.	1	.	.	.	.
***Larrea divaricata* community**										
Larrea af. *divaricata*	.	.	.	.	+	.	+	1	+	1
Lycio-Ephedretum ruspestri										
Lycium chanar Phil	+	.	1	.	+	+	+	.	1	.
Ephedra rupestris Benth.	.	.	.	.	.	.	.	1	.	.
Lobivio-Fabianon densae										
Adesmia echinus C. Presl	+	+	+	+	2	2	+	+	1	.
Fabiana densa J. Remy	.	+	.	.	.	.	.	+	.	.
Fabiana punensis S. C. Arroyo	.	.	.	.	.	+	.	.	.	.
Malesherbia lirana Gay	.	.	.	.	.	+	.	.	.	.
***Trycicla spinosa* community**										
Jarava neaei (Steud.) Peñail.	.	.	.	.	.	.	+	.	.	.

Table 5. – Floristical surveys for the *Larrea divaricata* community.

Altitude [m]	**3050**	**3025**	**3122**	**3060**	**3255**	**3210**
Location	29+25 69+12	29+29 69+16	29+43 69+15	29+41 69+16	28+36 69+16	28+32 69+10
Survey No.	**17**	**18**	**19**	**20**	**21**	**22**
Larrea divaricata Cav.	1	2	+	+	2	1
Eupatorium patens Hook. & Arn.	+	+		.	.	.
Acantholippia deserticola (Phil.) Moldenke	.	1	.	.	.	.
Jaborosa laciniata (Miers) Hunz. & Barboza	+	.		.	.	+
Stipo-Lycietea fusci						
Fabiana denudata Miers	.	.	.	.	.	+
Maihueniopsis glomerata (Haw.) R. Kiesling		.		+	.	.
Stipo-Lycietalia fusci						
Chuquirago-Lycion fusci						
Bougainvillea spinosa (Cav.) Heimerl	.	+	.	.	.	.
Chuquiraga erinacea subsp. *hystrix* (Don) C. Ezcurra	.	.	.	.	.	+
Lycio-Ephedretum rupestri						
Lycium chanar Phil.	.	+	.	.	+	1
Lobivio-Fabianon densae						
Adesmia echinus C. Presl	.	+	.	.	+	1
***Jarava nicorae* community**						
Caiophora coronata (Arn.) Hook. & Arn.	.	.	.	.	.	+

Table 6. – Floristic surveys for the *Lycio-Ephedretum rupestri* ass. nov.

Altitude [m]	**3358**	**3354**	**3341**	**3430**	**3438**	**3375**	**3552**	**3515**	**3684**	**3170**	**3325**	**3070**
Location	**29°15 69°21**	**29°21 69°17**	**28°58 69°16**	**28°56 69°15**	**29°15 69°21**	**29°03 69°22**	**29°00 69°19**	**28°59 69°24**	**29°09 68°44**	**29°32 69°18**	**29°46 69°17**	**29°38 69°16**
Survey No.	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**
***Lycio-Ephedretum rupestri* ass. nov.**												
Lycium chanar Phil	+	1	2	1	1	2	1	2	1	1	2	+
Ephedra rupestris Benth.	1	.	.	.	.	1	.	.	.	.	+	1
Adesmia af. *guttulifera* Sandwith	.	1	+	.	.	.	.	.	.	.	.	.
Atriplex myriophylla Phil.	.	+	.	.	.	.	.	.	.	.	.	.
Ephedra multiflora Stapf	.	.	+	+	+	.	.	.	.	.	.	.
Azorella monantha Clos	.	.	.	.	.	.	.	.	.	2	.	.
Calandrinia compacta Barnéoud	.	.	.	.	.	.	.	+	.	.	.	.
Cryptantha diplotricha (Phil.) Reiche	.	.	.	.	.	.	.	.	+	.	.	.
Glandularia microphylla (Kuntze) Cabrera	.	.	+	.	.	.	.	.	.	.	.	.
Urtica chamadryoides subsp. *microsperma* Hauman	.	+	.	.	.	.	.	.	.	.	.	.
Stipa durifolia Torres	.	+	.	.	.	.	.	.	.	.	.	.
Stipo-Lycietea												
Stipo-Lycietalia fusci												
Cisthante picta (Arn.) Hershkovitz	.	.	.	.	.	.	.	.	+	.	.	.
Chuquirago-Lycion fusci												
Lycium chilense var. *vergarae* (Phil.) Reiche	.	.	.	+	.	.	1	.	.	1	+	.
Chuquirago-Lycietum fusci												
Lycium fuscum Miers	.	1	.	.	.	.	.	+	.	.	+	.
Chuquiraga erinacea subsp. *hystrix* (Don) C. Ezcurra	.	.	.	+	+	+	.	.	+	.	.	.
Atriplex deserticola Phil.	.	1	.	.	.	.	.	+	.	.	.	.
Baccharidetum incari												
Baccharis incarum (Wedd.) Cuatrec.	.	+	.	.	.	.	.	.	.	.	.	.
Phacelia cumingii (Benth.) A. Gray	.	+	.	.	.	.	.	.	.	.	.	.
Astragalo-Ephedretum breanae												
Ipomopsis gossypifera (Benth.) V. E. Grant	.	+	.	.	.	.	.	.	.	.	.	.
Dolichlasietum lagascae												
Dolichlasium lagascae D. Don	+	.	.	.	.	.	.	.	.	.	.	.
Artemisietum paramilloensis												
Artemisia paramilloensis F. A. Roig & Ambrosetti	.	.	.	.	.	.	.	.	.	.	.	.
Nardophyllum armatum (Wedd.) Reiche	.	.	.	.	.	.	.	.	.	.	.	.
Atriplex oreophila Phil.	.	.	.	.	.	.	.	.	1	.	.	.
Maihueniopsis ovata (Pfeiff.) F. Ritter	.	.	+	.	.	.	.	.	.	.	.	.
Lobivio-Fabianion densae												
Adesmia echinus C. Presl	+	1	2	1	1	2	1	2	1	1	2	+
Fabiana densa J. Remy	+	.	.	.	.	.	.	.	.	.	.	.
Fabiana punensis S. C. Arroyo	.	+	.	.	.	.	.	.	.	.	.	.
Ephedra chilensis C. Presl	.	+	.	.	.	.	.	1	.	.	.	.
Malesherbia lirana Gay	.	.	.	.	.	.	.	.	+	.	.	.
Lobivia formosa (Pfeiff.) Dodds	1	2	.	.	.	.	.	.	.	.	.	1
Nicotiana petunioides (Griseb.) Millán	.	+	.	.	.	.	.	.	.	.	.	.
***Adesmia pinifolia* community**												
Adesmia pinifolia Hook. & Arn.	.	+	.	.	.	.	.	+	.	+	.	.
***Jarava nicorae* community**												
Jarava nicorae (Roig) Peñail.	.	.	.	.	.	.	.	+	.	.	.	.
Lenzia chamaepitys Phil.	.	.	.	.	.	.	.	.	.	.	.	.
Adesmia aegiceras Phil.	.	.	.	.	.	.	.	.	.	.	.	.
Caiophora coronata (Arn.) Hook. & Arn.	.	.	.	.	.	.	.	.	.	.	.	.

Table 6 (cont.). – Floristic surveys for the *Lycio-Ephedretum rupestri* ass. nov.

Altitude [m]	**3358**	**3354**	**3341**	**3430**	**3438**	**3375**	**3552**	**3515**	**3684**	**3170**	**3325**	**3070**
Location	29°15 69°21	29°21 69°17	28°58 69°16	28°56 69°15	29°15 69°21	29°03 69°22	29°00 69°19	28°59 69°24	29°09 68°44	29°32 69°18	29°46 69°17	29°38 69°16
Survey No.	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**
Jaravetum abscondite												
Jarava speciosa var. *abscondita* Roig	.	.	+	.	.	.	.	+	+	.	1	1
Tetraglochin cristatum (Britton) Rothm.	.	+	.	.	.	.	.	.	.	.	+	.
***Stipa frigida* community**												
Stipa frigida Phil.	.	.	.	.	.	+	.	.	.	.	.	.
Mulino-Junellietea scopariae												
Artemisietum echegarayi												
Artemisia echegarayi Hieron.	+	.	.	.	.	.	.	.	.	.	.	.
Fabiana denudata Miers	.	+	2	.	.	+	.	.	1	.	.	.
Leymus erianthus (Phil.) Dubcovsky	.	.	.	.	.	.	.	+	.	.	+	.
Maihueniopsis glomerata (Haw.) R. Kiesling	+	.	.	.	.	.	.	.	.	.	.	+

Table 7. – Floristic surveys of the *Jaravetum chrysophyllae* ass. nov.

Altitude [m]	**3518**	**3470**	**3771**	**3420**	**3470**	**3471**	**3471**	**3500**	**3490**
Location	29°10 69°21	29°03 69°20	29°26 69°26	29°15 69°21	29°03 69°20	29°11 69°21	29°11 69°21	29°21 69°18	29°05°69°19
Survey No.	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**
***Jaravetum chrysophyllae* ass. nov.**									
Jarava chrysophylla var. *chrysophylla* (E. Desv.) Peñail.	1	1	2	1	1	+	1	2	2
Jarava vaginata (Phil.) F. Rojas	.	.	.	.	1	.	.	.	.
Viola volcanica Hook. & Arn.	.	.	.	.	+	.	.	.	.
Hordeum pubiflorum susp. *halophyllum* (Griseb.) Baden & Bothmer	.	.	.	.	+	.	.	.	.
Euphorbia sp.	.	+	.	.	+	.	.	.	.
Jaborosa parviflora (Phil.) Hunz. & Barbosa	.	.	.	.	+	.	.	+	.
Jaborosa caulescens var. *bipinnatifida* Dunal (Reiche)	.	.	.	.	+	.	.	.	+
Muhlenbergia fastigiata (J. Presl) Henrard.	.	+	.	.	.	.	+	.	+
Jarava humilis (Cav.) Peñail.	.	.	.	.	1	1	.	.	.
Stipo-Lycietea fusci									
Fabiana denudata Miers	.	.	.	+	.	.	.	.	.
Maihueniopsis glomerata (Haw.) R. Kiesling	.	+	.	.	.	.	.	.	.
Stipo-Lycietalia fusci									
Cisthante picta (Arn.) Hershkovitz	.	.	.	.	+	.	.	.	.
Jarava vaginata f. *contracta* (F. Roig) Peñail.	.	.	.	.	.	.	.	.	.
Chuquirago-Lycietum fusci									
Lycium fuscum Miers	.	.	.	.	.	+	.	.	.
Chuquiraga erinacea subsp. *hystrix* (Don) C. Ezcurra									
Baccharidetum incari									
Baccharis incarum (Wedd.) Cuatrec.	.	.	.	.	+	.	.	.	.
Artemisietum paramilloensis									
Artemisia paramilloensis F. A. Roig & Ambrosetti	1	.	.	.	.	.	.	.	.
Comunidad de *Larrea divaricata*									
Acantholippia deserticola (Phil.) Moldenke	.	.	.	.	.	+	.	.	.
Mulino-Junellietea scopariae									
Artemisietum echegarayi									
Lepidium nitidum Torr. & A. Gray	.	.	.	+	.	.	.	.	.
Mulinum ulicinum Gillies & Hook.	.	.	+	.	.	.	.	+	.
Senecio oreophyton J. Remy	.	.	.	+	.	.	+	.	.
***Adesmia pinifolia* community**									
Adesmia pinifolia Hook. & Arn.	1	.	+	.	.	.	.	.	.
Adesmia hemisphaerica Hauman	.	1	.	.	.	.	.	.	.
Acaena magellanica (Lam.) Vahl.	.	.	1	.	.	.	.	.	.
Jaravetum absconditae									
Caiophora coronata (Arn.) Hook. & Arn.	.	.	+	.	.	.	+	.	.
Tetraglochin cristatum (Britton) Rothm.	.	.	.	1	.	1	.	+	.
Astragalus af. *crypticus* I. M. Johnst.	.	.	.	+	.	.	.	.	.
***Adesmia subterranea* community**									
Adesmia subterranea Clos	.	+	.	.	.	.	.	.	.

Table 8. – Floristic surveys for the *Trycicla spinosa* community.

Altitude [m]	**3320**	**3250**	**3300**	**3600**	**3308**	**3277**	**3552**
Location	**29°31 69°10**	**29°30 69°17**	**29°00 69°18**	**29°12 69°16**	**29°33 69°13**	**29°32 69°18**	**29°03 69°22**
Survey No.	**44**	**45**	**46**	**47**	**48**	**49**	**50**
Jarava speciosa var. *media* (Torres) Peñail.	+	+	.	+	+	+	.
Phacelia setigera Phil.	.	+	+	.	.	.	+
Oxalis hypsophila Phil.	+	.	+	.	+	.	.
Jarava neaei (Steud.) Peñail.	+	+	.	.	+	.	.
Stipo-Lycietea fusci							
Fabiana denudata Miers	.	.	.	.	+	.	.
Maihueniopsis glomerata (Haw.) R. Kiesling	.	.	.	.	+	+	.
Chuquirago-Lycion fusci							
Bougainvillea spinosa (Cav.) Heimerl	1	+	2	2	2	2	2
Lycio-Ephedretum rupestri							
Lycium chanar Phil.	.	.	.	.	1	.	.
Lobivio-Fabianion densae							
Adesmia echinus C. Presl	.	.	.	.	1	.	.
Ephedra chilensis C. Presl	.	.	.	.	.	1	.
***Adesmia pinifolia* community**							
Adesmia pinifolia Hook. & Arn.	.	.	.	.	+	.	.

Table 9. – Floristic surveys for the *Adesmia pinifolia* community.

Altitude [m]	**3496**	**3601**	**3656**	**3771**	**3780**	**3475**	**3656**	**3470**	**3738**	**3550**	**3420**
Location	28°55 69°16	29°03 69°22	28°59 69°24	29°26 69°26	29°26 69°26	29°08 69°21	28°59 69°24	29°26 69°28	29°00 69°25	29°15 69°21	29°15 69°21
Survey No.	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**
Adesmia pinifolia Hook. & Arn.	2	2	1	1	1	2	2	1	2	1	1
Adesmia hemisphaerica Hauman	.	1	.	.	.	+	.	.	.	.	.
Haplopappus af. *marginalis* Phil.	.	.	+	.	.	.	.	.	.	.	.
Lecanophora ameghinoi (Speg.) Speg.	.	+	.	.	.	.	.	+	.	.	.
Melica chilensis J. Presl	.	.	.	+	.	.	.	.	.	.	.
Descurainia cumingiana (Fisch. & C. A. Mey) Prantl	.	.	+	.	.	.	.	.	.	.	.
Nasella grabifolia Torres	.	.	.	.	.	+	.	.	.	.	.
Calceolaria pinifolia Cav.	.	.	.	+	.	.	.	.	.	.	.
Acaena magellanica (Lam.) Vahl.	.	.	.	.	3	.	.	.	.	.	.
Urtica buchtienii R. Ross.	.	.	.	.	.	.	.	.	.	+	.
Chuquirago-Lycion fusci											
Lycium chilense var. *vergarae* (Phil.) Reiche	.	+	.	.	.	.	.	.	1	.	.
Lycium fuscum Miers	1	1	.	.	.	.	.	.	.	.	+
Atriplex deserticola Phil.	+	.	.	.	.	.	.	.	2	.	.
Baccharidetum incari											
Baccharis incarum (Wedd.) Cuatrec.	.	.	.	.	.	.	.	.	.	.	.
Glandulario-Phacelietum sinuatae											
Phacelia cumingii (Benth.) A. Gray	.	.	+	.	.	.	.	.	.	.	.
Astragalus-Ephedretum breanae											
Tarasa antofagastana (Phil.) Krapov.	+	.	.	.	.	.	.	+	.	.	.
Ipomopsis gossypifera (Benth.) V. E. Grant											
Chenopodium frigidum Phil.	.	.	.	.	.	.	.	.	+	.	.
Artemisietum paramilloensis											
Nardophyllum armatum (Wedd.) Reiche	.	.	.	.	.	.	.	+	.	.	.
Atriplex oreophila Phil.	.	.	.	.	.	.	.	.	+	.	.
***Larrea divaricata* community**											
Jaborosa laciniata (Miers) Hunz. & Barboza	.	.	.	.	.	.	+	.	+	.	.
Lobivio-Fabianion densae											
Adesmia echinus C. Presl	+	+	+	.	.	.	.	.	+	.	.
Fabiana punensis S. C. Arroyo	.	.	.	.	.	.	.	.	1	.	.
Malesherbia lirana Gay	.	.	.	.	.	.	.	.	+	.	.
Jarava leptostachya (Griseb.) F. Rojas	.	.	.	.	.	.	.	.	+	.	.
Lobivia formosa (Pfeiff.) Dodds	.	.	.	.	.	.	.	.	.	+	.
Nicotiana petunioides (Griseb.) Millán	.	.	+	.	.	.	.	.	.	.	.
Stipo-Lycietalia fusci											
Cisthante picta (Arn.) Hershkovitz	.	.	+	.	.	.	.	.	+	.	.
Jarava vaginata f. *contracta* (F. Roig) Peñail.	.	.	.	.	3	.	.	.	+	.	.
***Trycicla spinosa* community**											
Jarava speciosa var. *media* (Torres) Peñail.	.	.	.	.	.	.	.	.	+	.	.
Jarava neaei (Steud.) Peñail.	.	.	.	+	.	.	.	.	.	.	.
Jaravetum chrysophyllae											
Jarava chrysophylla var. *chrysophylla* (E. Desv.) Peñail.	.	.	.	.	.	.	.	.	.	.	1
***Jarava nicorae* community**											
Jarava nicorae (Roig) Peñail.	.	.	+	.	.	.	.	.	.	.	.
Lenzia chamaepitys Phil.											
Adesmia aegiceras Phil.	.	.	.	.	.	.	.	.	+	.	.

Table 9 (cont.). – Floristic surveys for the *Adesmia pinifolia* community.

Altitude [m]	3496	3601	3656	3771	3780	3475	3656	3470	3738	3550	3420
Location	28°55 69°16	29°03 69°22	28°59 69°24	29°26 69°26	29°26 69°26	29°08 69°21	28°59 69°24	29°26 69°28	29°00 69°25	29°15 69°21	29°15 69°21
Survey No.	51	52	53	54	55	56	57	58	59	60	61
***Adesmia subterranea* community**											
Adesmia subterranea Clos	.	.	.	.	.	.	.	.	+	.	.
Huarpea andina Cabrera	.	+	.	.	.	.	.	.	.	.	.
Pachylaena atriplicifolia Hook. & Arn.	.	.	.	.	.	.	.	.	+	.	.
Mulino-Junellietea scopariae											
Artemisietum echegarayi											
Senecio oreophyton J. Remy	.	.	+	.	.	.	.	.	.	.	+
Stipo-Lycietea fusci											
Fabiana denudata Miers	.	+	.	.	.	.	.	.	.	.	.
Maihueniopsis glomerata (Haw.) R. Kiesling	.	.	+	.	.	.	.	.	+	.	.

Table 10. – Floristic surveys for the *Jaravetum absconditae* ass. nov.

Altitude [m]	**4356**	**3341**	**3550**	**4130**	**4000**	**4200**	**4150**	**3800**	**3850**	**4000**
Location	28°34 69°23	29°21 69°17	29°15 69°21	28°48 69°22	28°48 69°22	29°20 69°18	28°25 69°19	28°43 69°18	29°12 69°19	29°18 69°15
Survey No.	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**
***Jaravetum absconditae* ass. nov.**										
Jarava speciosa var. *abscondita* Roig	2	3	2	+	2	2	2	+	+	2
Chaptalia similis R. E. Fr.	+	.	.	.	.	.	+	.	+	.
Astragalus af. *crypticus* I. M. Johnst.	.	.	+	.	.	+	.	.	+	.
Gayophyton micranthum Hook. & Arn.	.	.	.	+	.	.	.	.	.	.
Cistanthe frigida (Barnéoud) Peralta	.	.	.	+	.	.	.	+	.	+
Adesmia nanolignea Burkart	.	.	.	+	.	.	.	+	.	.
Adesmia quadripinnata (Hicken) Burkart	+	.	+	.	.	+	.	.	.	.
Tetraglochin cristatum (Britton) Rothm.	.	.	1	.	.	.	.	.	+	.
Stipo-Lycietea fusci										
Fabiana denudata Miers	.	.	+	.	.	.	.	.	.	.
Glandulario-Phacelietum sinuatae										
Phacelia cumingii (Benth.) A. Gray	+	.	.	.	.	.	+	.	.	.
Astragalus-Ephedretum breanae										
Chenopodium frigidum Phil.	.	.	.	+	.	.	.	.	.	.
Lobivio-Fabianion densae										
Adesmia echinus C. Presl	.	+	+	.	.	.	.	.	.	.
***Trycicla spinosa* community**										
Oxalis hypsophila Phil.	.	.	.	+	.	.	.	.	.	.
Jaravetum chrysophyllae						.	.	.	.	.
Jarava chrysophylla (E. Desv.) Peñail. var. *chrysophylla*	+	.	.	1	.	+	.	.	.	.
Community of *Jarava nicorae*										
Lenzia chamaepitys Phil.	.	.	.	+	.	.	.	.	.	.
Adesmia aegiceras Phil.	.	.	.	+	.	.	.	.	.	.
***Adesmia subterranea* community**										
Pachylaena atriplicifolia Hook. & Arn.	.	.	+	.	.	.	.	.	.	+
***Stipa frigida* community**										
Kurzamra pulchella (Clos) Kuntze	.	.	.	+	1	.	.	.	.	.

Table 11. – Floristic surveys of *Adesmia subterranea* community.

Altitude [m]	**3550**	**3500**	**3880**	**4420**	**3600**	**3670**	**4205**
Location	**29°00 69°17**	**28°50 69°15**	**28°45 69°18**	**28°48 69°22**	**29°08 69°21**	**29°07 69°21**	**28°30 69°22**
Survey No.	**72**	**73**	**74**	**75**	**76**	**77**	**78**
Adesmia subterranea Clos	1	+	2	2	1	1	1
Huarpea andina Cabrera	+	+	.	.	.	+	+
Pachylaena atriplicifolia Hook. & Arn.	.	.	+	+	.	.	.
Oxalis erythrorhiza Hook. & Arn.	+		+	.	.	.	.
Nototriche compacta (A. Gray) A. W. Hill	.	+	.	+	.	.	.
Stipo-Lycietea fusci							
Maihueniopsis glomerata (Haw.) R. Kiesling	.	.	+	.	.	.	.
Stipo-Lycietalia fusci							
Cisthante picta (Arn.) Hershkovitz	.	.	.	.	+	.	.
Chuquirago-Lycietum fusci							
Lycium fuscum Miers	.	.	+	.	.	.	.
Artemisietum paramilloensis							
Maihueniopsis ovata (Pfeiff.) F. Ritter	.	.	.	.	+	+	.
Lobivio-Fabianion densae							
Adesmia echinus C. Presl	.	.	.	.	.	+	.
***Trycicla spinosa* community**							
Jarava speciosa var. *media* (Torres) Peñail.	.	.					
Phacelia setigera Phil.	.	.	+	.	.	.	.
Jaravetum chrysophyllae							
Jarava chrysophylla (E. Desv.) Peñail. var. *chrysophylla*	.	.	+	.	.	.	.
Jarava humilis (Cav.) Peñail.	.	.	.	.	.	.	2
Community of *Jarava nicorae*							
Jarava nicorae (Roig) Peñail.	.		.	+	.	.	.
Lenzia chamaepitys Phil.	.	.	.	+	.	.	.
Caiophora coronata (Arn.) Hook. & Arn.	.	.	+	.	.	.	.
Jaravetum absconditae							
Jarava speciosa var. *abscondita* Roig	.	.	.	1	.	.	.

Table 12. – Floristic surveys of the *Stipa frigida* community.

Altitude [m]	**4100**	**4320**	**3980**	**4055**	**4330**	**4050**	**4006**	**3800**
Location	**28°43 69°19**	**28°46 69°19**	**28°42 69°20**	**28°47 69°20**	**28°48 69°22**	**28°47 69°20**	**28°40 69°20**	**28°40 69°19**
Survey No.	**76**	**80**	**81**	**82**	**83**	**84**	**85**	**86**
Stipa frigida Phil.	1	1	1	+	.	1	1	2
Senecio volckmannii Phil.	+	.	+	.	.	+	+	.
Kurzamra pulchella (Clos) Kuntze	+	+	.	2	1	2	.	.
Arenaria serpens Kunth	+	.	.	+	.	.	.	.
Menonvillea virens (Phil.) Rollins	.	+	.	+	.	.	.	.
Festuca weberbauerii Pilg.	.	.	.	1	.	.	.	.
Stipo-Lycietea fusci								
Stipetum chrysophyllae								
Viola volcanica Hook. & Arn.	+	.	.	+	.	.	.	.
***Jarava nicorae* community**								
Jarava nicorae (Roig) Peñail.	.	.	+	.	+	+	.	.
Adesmia aegiceras Phil.	.	.	.	+	.	.	.	1
Jaravetum absconditae								
Gayophyton micranthum Hook. & Arn.	.	.	.	.	+	.	.	.
***Adesmia subterranea* community**								
Adesmia subterranea Clos	.	.	.	.	+	.	.	.
Huarpea andina Cabrera	.	.	.	.	.	.	1	.
Nototriche compacta (A. Gray) A.W. Hill	.	.	.	.	.	.	.	+

Table 13. – Floristic surveys of the wetlands communities.

Altitude [m]	**4150**	**3470**	**3420**	**3470**	**3172**	**3684**	**4000**	**4260**	**4150**	**4000**	**3730**
Location	28°40 69°31	29°03 69°20	29°15 69°21	29°03 69°20	29°55 69°19	28°59 69°24	28°48 69°22	28°41 69°20	28°40 69°31	28°48 69°22	29°00 69°26
Survey No.	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**
Community			**A**				**B**				
Lilaeopsis macloviana (Gand.) A.W. Hill	+	.	.	.	.	.	.	.	.	.	.
Spergula pissisi (Phil.) Volponi	+	.	.	.	.	.	.	.	.	.	.
Nasthantus caespitosum (Phil.) Reiche	+	.	.	.	.	.	.	.	.	.	.
Ranunculus cymbalaria f. *exiilis* (Phil.) Lourteig	+	.	.	.	.	.	.	.	.	.	.
Deyeuxia af. *velutina* Nees & Meyen	+	.	.	.	.	.	.	.	.	.	.
Juncus balticus subsp. *andicola* (Hook.) Snogerup	.	5	4	2	2	1	.	.	.	.	.
Astragalus af. *famatinae* I. M. Johnst.	.	.	+	.	.	.	.	.	.	.	.
Muhlenbergia fastigiata (J. Presl) Henrard	.	.	1	.	.	.	.	.	.	.	.
Polypogon af. *interruptus* Kunth	.	.	.	.	2	.	.	.	.	.	.
Carex incurva Lightf.	.	.	.	.	.	5	5	5	.	.	.
Festuca nardifolia Griseb.	.	.	.	.	.	.	.	2	.	.	.
Patosia clandestina (Phil.) Buchenau	.	.	.	.	.	.	.	5	5	4	5
Poa annua L.	.	.	.	.	.	2	.	.	.	.	.
Werneria pygmaea Hook. & Arn.	.	.	.	.	.	.	.	.	.	.	.
Cerastium arvense L.	.	.	.	.	.	.	.	.	.	.	.
Heleocharis af. *melanomphala* C. B. Clarke	.	.	.	.	.	.	.	.	.	.	.
Caltha sagittata Cav.	.	.	.	.	2	.	.	.	.	.	.
Carex subantarctica Speg.	.	.	.	.	.	.	.	.	.	.	.
Oxychloe andina Phil.	.	.	.	.	.	.	.	.	.	.	.
Juncus depauperatus Phil.	.	.	.	.	.	.	.	.	.	.	.
Triglochin palustris L.	.	.	.	.	.	.	.	.	.	.	.
Juncus stipulatus Nees & Meyen	.	.	.	.	.	.	.	.	.	.	.
Carex af. *gayana* E. Desv.	.	.	.	.	.	.	.	.	.	.	.
Deschampsia caespitosa (L.) P. Beauv.	.	.	.	.	.	.	.	.	+	.	.
Urtica buchtienii R. Ross	.	.	.	.	.	.	.	.	.	.	.
Calceolaria glacialis Wedd.	.	.	.	.	.	.	.	.	.	.	.
Plantago tomentosa Lam.	.	.	.	.	.	.	.	.	.	.	.
Juncus balticus subsp. *andicola* (Hook.) Snogerup	.	.	.	.	.	.	.	.	.	.	.
Heleocharis albibracteata Nees	.	.	.	.	.	.	.	.	.	.	.
Carex atropicta Steud.	.	.	.	.	.	.	.	.	.	.	.
Musci	.	.	.	.	.	.	.	.	.	.	.
Plantago paralias Decne	.	.	.	.	.	.	.	.	.	.	.
Hepatica	.	.	.	.	.	.	.	.	.	.	.
Hordeum halophilum Griseb.	.	.	.	.	.	.	.	.	.	.	.
Potamogeton pectinatus L.	.	.	.	.	.	.	.	.	.	.	.
Myriophyllum aquaticum (Vell.) Verdc.	.	.	.	.	.	.	.	.	.	.	.
Puccinellia frigida (Phil.) I. M. Johnst.	+	.	.	.	.	.	.	.	.	.	.
Deyeuxia eminens J. Presl	.	.	.	.	.	.	.	.	.	.	.
Mimulus luteus L.	.	.	.	.	.	.	.	.	.	.	.
Ranunculus af. *flagelliformis* Sm.	.	.	.	.	1	.	+	.	.	.	.

3470	3730	3550	3470	3868	3550	3780	3550	3550	3280	3868	3771	4006	3868	3172	3730	4150	4150	4006	3684
29°03 69°20	29°00 69°26	29°15 69°21	29°03 69°20	28°41 69°19	29°15 69°21	29°26 69°26	29°15 69°21	29°15 69°21	29°35 69°18	28°41 69°19	29°26 69°26	28°40 69°20	28°41 69°19	29°55 69°19	29°00 69°26	28°40 69°31	28°40 69°31	28°40 69°20	28°59 69°24
98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117
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