

A PHYTOSOCIOLOGICAL STUDY OF THE HYGROPHILOUS VEGETATION OF SIERRA NEVADA (SOUTHERN SPAIN)

Carlos SALAZAR *, Juan LORITE **, Antonio GARCÍA-FUENTES *, Juan Antonio TORRES *, Eusebio CANO * and Francisco VALLE **

* Dpto. Biología Animal, Biología Vegetal y Ecología. Facultad de Ciencias Experimentales. Universidad de Jaén. Campus Las Lagunillas, s/n. 23071-Jaén (SPAIN). E-mail: csalazar@ujaen.es ** Dpto. Biología Vegetal. Facultad de Ciencias. Universidad de Granada. Campus Fuentenueva. 18071-Granada (SPAIN).

Keywords: Chorology, Dynamics, Ecology, Edapho-hygrophilous communities, Riparian vegetation.

Abstract: A study on the vegetation related to streams and rivers of the Nevadense sector of Sierra Nevada (Southern Spain) has been carried out by determining its main structural, floristic, ecological, chorologic and dynamic characteristics. A total of nine new syntaxa have been highlighted: four associations (*Caricetum camposii-cuprinae*, *Ranunculo granatensis-Cochlearietum megalospermae*, *Cirsio micranthi-Scirpetum holoschoeni*, *Carici camposii-Salicetum atrocinereae*), two subassociations (*Myrrhoidi-Alliarietum petiolatae nepetosum granatensis*, *Carici camposii-Salicetum atrocinereae salicetosum capreae*), two variants (*Rubo-Rosetum corymbiferae* variant with *Adenocarpus decorticans*, *Rubo-Coriarietum myrtifoliae* variant with *Adenocarpus decorticans*) and one community (*Cratoneuron commutatum* and *Anagallis tenella* community).

Introduction

The vegetation of Sierra Nevada, and particularly that of the siliceous nucleus (the so-called Nevadense sector) has been the subject of numerous studies carried out during the second half of the last (e.g. Quézel 1953; Rivas-Martínez 1961; Rivas Goday & Mayor 1966; Prieto 1971; Valle 1985; Rivas-Martínez *et al.* 1986; Losa-Quintana *et al.* 1986; Martínez-Parras *et al.* 1987a, 1987b; Mota & Valle 1987; Molero-Mesa 1988; Pérez-Raya *et al.* 1990; Molero-Mesa *et al.* 1992; Aallali *et al.* 1998 and Molero-Mesa 1999). However, none of these works deals with the hygrophilous vegetation, with the exception of Casares *et al.* (1986), Martínez-Parras *et al.* (1987c) and Losa-Quintana *et al.* (1987), who studied the cryoro-Mediterranean and oro-Mediterranean peat-bog communities (the typical Nevadense "borreguil", a high-mountain hygrophilous pasture) as well as the riparian communities of the Genil River basin.

The studies of the riparian vegetation in other basins with Nevadense tributaries, such as those of the rivers Andarax (Salinas & Blanca 1996) and Gadiana Menor (Salazar 1996; Salazar *et al.* 1999), provided new data on traditionally little-studied phytocoenoses, but generally only single floristic, ecological and landscape aspects were considered.

In this study we will discuss data concerning

some interesting plant communities related to streams and rivers of the Nevadense sector of Sierra Nevada, developed mainly in areas of the meso-Mediterranean and supra-Mediterranean thermotypes but in some cases reaching the oro-Mediterranean, which had been completely ignored, or has only been briefly discussed by previous authors.

Study area

The Sierra Nevada massif (Fig. 1) is situated in the south-eastern Iberian Peninsula and belongs to two political provinces, Granada and Almería. It has an oval shape with an E-W main axis. Altitudes range from less than 700 m at the Alpujarras level up to 3.481 m (Mulhacen peak, the highest mountain of the Iberian Peninsula).

The massif, which belongs to the inner areas of the Baetic Mountains, was formed during the Alpine folding and is lithologically heterogeneous. The peripheral areas of the range have a limestone edge, whereas the central siliceous nucleus is dominated by mica-schists, quartzites and phyllites, clearly defining what is known as the Nevadense sector.

Watercourses flowing through Sierra Nevada correspond to two hydrographic basins: the Guadalquivir, which is the main river of the



southern part of the Iberian Peninsula, with the Genil and Guadiana Menor as main tributaries, and the South basin, flowing directly into the Mediterranean Sea, with the Guadalfeo and Andarax as most important rivers.

According to Rivas-Martínez *et al.* (1997), Sierra Nevada biogeographically belongs to three sectors of the Baetic province. The limestone edge and the southern slopes belong to the Malacitano-Almijarensis and Alpujarreño-Gadorensis sectors respectively, whereas our study area, consisting of the central siliceous part, belongs to the Nevadense sector. The latter is divided into two districts: Nevadense – mostly towards the West and to which Sierra Nevada pertains – and Filábrico – mostly towards the East, to which the Sierra de Filabres pertains. Although this study deals with the vegetation of rivers and streams of both districts, the riparian vegetation is better developed in the Nevadense district due to higher rainfall, whereas in the Filábrico it is scarcer and poorer as the water level is slightly lower.

Bioclimatically, the Sierra Nevada is dominated by the Mediterranean macrobioclimate of the pluviseasonal type, with continental or oceanic influences (Rivas-Martínez 1996), being characterised by a prolonged period of summer drought and precipitations (rain or snow) restricted to winter and spring. The following thermotypes are present: cryo-Mediterranean, oro-Mediterranean, supra-Mediterranean, meso-Mediterranean and, occasionally, thermo-Mediterranean, as well as the hyperhumid, humid, subhumid and dry ombrotypes.

From the floristic point of view, the Sierra Nevada massif is considered to be the most important area for plant diversity in the western

Mediterranean region, gathering over 7% of the Mediterranean flora in just 0.01% of its surface (Blanca *et al.* 1998). The Sierra Nevada's rate of endemic taxa is outstanding: the massif constitutes one of the most important "hot spots" in Europe, with endemism rates reaching 30-40% in culminant areas or even surpassing 80% in certain ecosystems (Blanca *et al.* 1998). Nearly 6% of the flora (116 taxa) is endangered, in the majority of cases being included in the IUCN's higher risk categories. Over 30 species are found in the edapho-hygrophilous vegetation of the Nevadense sector described in this paper. These taxa are partly protected by regional, national and international laws on account of their relevance.

Data and methods

The vegetation was studied following the phytosociological method of the Zurich-Montpellier school (Braun-Blanquet 1979), as modified by Géhu & Rivas-Martínez (1982). Relevés of the edapho-hygrophilous communities of banks and watercourses were carried out between 1993-1999 in different localities of the study area.

In the tables, species have been generally clustered into two groups: characteristics of association plus higher syntaxa, and accompanying species. Exceptionally, other groups such as characteristics of subassociation, characteristics of variant, etc. have been included.

The relevés have been classified according to phytosociological criteria, revealing the associations present in the area. The relevés, which could not be related to any known syntaxon, have been described and classified as new associations and subassociations. Where information was scarce, they have been referred to as "communities".

Each association has been described by taking the following elements into consideration: structure, ecology, physiognomy, ecological characteristics, chorology (specifying the biogeographical distribution up to the district level by using the classification of Rivas-Martínez *et al.* 1997). Finally, the study deals with the phytocoenosis dynamics, dynamic significance and relationships with other communities.

Two units, subassociation and variant, have been considered to belong to a lower hierarchical rank than that of association. As for subassociation, the concept of geographical race (Alcaraz 1996) has been used when the floristic combination does not hold sufficient characteristics to be considered as an association. On the other hand, when a community

is diversified within the same territory for bioclimatic, edaphic, ecotonal situations, etc., it has been considered as a variant.

The nomenclature of syntaxa follows the International Code of Phytosociological Nomenclature (Barkman *et al.* 1988). The phytosociological typology used up to the suballiance level follows Rivas-Martínez *et al.* (1999).

Nomenclature of taxa follows, when possible, *Flora ibérica* (Castroviejo *et al.* 1986, 1990, 1993a, 1993b, 1997a, 1997b; Muñoz-Garmendia & Navarro 1998; Talavera *et al.* 1999), otherwise *Flora Europaea* (Tutin *et al.* 1964-1980). Monographs have been used for *Agrostis* (Romero *et al.* 1988), *Carex* (Luceño 1994), *Cirsium* (Talavera & Valdés 1976), *Juncus* (Fernández-Carvajal 1981, 1982a, 1982b, 1983) and *Salix* (Díaz González & Llamas 1987).

The taxa for which different criteria have been followed are indicated herein:

Digitalis purpurea L. var. *nevadensis* (Kunze) Amo [Flora Fanerogámica de la Península Ibérica III:350 (1872)]. *Festuca trichophylla* (Ducros ex Gaudin) K. Richter subsp. *scabrescens* (Hackel ex Trabut) Catalàn & Stace [Anales Jard. Bot. Madrid 50(2): 219 (1992)]. *Lotus pedunculatus* Cav. subsp. *granadensis* (Zertová) Molero Mesa & Pérez Raya [La Flora de Sierra Nevada: 152 (1987)]. *Luzula campestris* (L.) DC. subsp. *nevadensis* P. Montserrat [Anales Inst. Bot. Cavanilles 21(2)]. *Scrophularia auriculata* Loefl. ex L. [Sp. Pl. 620 (1753)].

Results and discussion

A) Spring, amphibious and peat-bog vegetation

Cratoneuron commutatum and *Anagallis tenella* community (Tab. 1)

Bryo-cormophytic community in which the moss stratum (*Cratoneuron commutatum* and *Philonotis seriata*) forms a continuous carpet 5-10 cm thick, on which abundant plants of *Anagallis tenella* develop. The presence of *Pinguicula grandiflora* in the community should also be highlighted. It occurs in permanently waterlogged areas on distric gleysols or along watercourses, carpeting stones splashed by water. Its oligotrophic nature is revealed by the presence of *Calliergonella cuspidata* and *Parnassia palustris*.

This community appears at least in the Nevadense district (its presence in the Filábrico district has yet to be detected) where it covers small areas in the upper meso-, supra- and oro-Mediterranean thermotypes. A similar community

developed on carbonated substrata and waters (*Cratoneuron filicinum* and *Anagallis tenella* community) was described by Ríos (1996:521) from Sierra de Segura (Sub-Baetic sector).

In waterlogged soils it comes into contact with the helophytic *Caricetum camposii-cuprinae* and *Festuca ampla* grass communities (*Euphrasio-Festucetum amplae* Martínez-Parras, Peinado *et Alcaraz* 1987). In less humid areas it comes into contact with *Juncion acutiflori* rush-beds or with the more sciophilous *Aquilegio-Ranunculetum granatensis* Martínez-Parras, Peinado *et Alcaraz* 1987 grass formations.

Caricetum camposii-cuprinae Salazar, Lorite, Cano *et Valle ass. nova* (Tab. 2, *holotypus* rel. n. 9)

An association dominated by large hemicryptophytes of the genus *Carex* occupying slopes which are permanently humid due to water coming from adjacent streams. It develops on base-poor, peat-bog like substrata that are often removed by animals, which form numerous, permanently flooded micro-depressions. With optimum in the supra-Mediterranean and oro-Mediterranean thermotypes, it may occasionally be found above the meso-Mediterranean belt.

The most characteristic and predominant species is the Nevadense endemism *Carex camposii*, accompanied by *Carex cuprina*, *Juncus articulatus*, *Eleocharis palustris*, *Cyperus longus*, *Alchemilla straminea*, *Primula elatior* subsp. *lofthousei*, etc. The aggressive livestock action (mainly by cattle) makes it difficult to identify with clarity the abundant different species of *Cyperaceae*, in many cases even preventing the community from reaching normal development. Because of the predation of its inflorescences, *Carex camposii* undergoes strong vegetative propagation, thus increasing its cover. Furthermore, livestock activity favours the enrichment in *Agropyro-Rumicion crispae* elements, above all in the less flooded areas.

The new association was previously reported by Losa-Quintana *et al.* (1986:228) as "*Carex camposii* community", but they did not provide either relevés or information regarding its ecology and floristic composition. It was also cited by Casares *et al.* (1986:450) as a new association called *Laserpitio longiradii-Caricetum camposii* Molero-Mesa *et Pérez-Raya* (unpublished), but these authors report neither relevés nor a description of the community. Furthermore, *Laserpitium longiradium* was considered as a characteristic species, but this Nevadense endemic is not related to helophytic formations.

Tab. 1 - *Cratoneuron commutatum* and *Anagallis tenella* community

Rel. number	1	2	3	4	5	6	7
Altitude (m)	1300	2050	1690	1750	1710	1740	2000
Area (m ²)	2	2	1	2	2	2	4
Average height (cm)	15	10	5	10	5	15	5
Cover (%)	100	100	100	100	95	100	75
Number of taxa	15	15	14	17	18	19	17
Characteristics of association and higher units:							
<i>Cratoneuron commutatum</i>	1	3	4	3	3	4	1
<i>Anagallis tenella</i>	3	.	1	3	1	1	.
<i>Philonotis seriata</i>	3	1	1	1	.	2	1
<i>Parnassia palustris</i>	.	2	1	2	+	+	+
<i>Pinguicula grandiflora</i>	.	2	2	.	1	+	1
<i>Calliergonella cuspidata</i>	.	.	.	1	2	1	.
<i>Pholia cruda</i>	.	.	.	.	.	.	1
<i>Jungermannia exsertifolia cordifolia</i>	.	.	.	.	.	.	1
<i>Reboulia hemisphaerica</i>	.	.	.	.	.	.	1
Accompanying species:							
<i>Trifolium repens</i>	1	2	1	+	1	2	+
<i>Sagina procumbens</i>	.	1	2	1	1	2	1
<i>Luzula campestris nevadensis</i>	.	1	+	+	1	+	+
<i>Viola palustris palustris</i>	.	3	.	2	+	+	1
<i>Euphrasia wilkommii</i>	.	+	1	+	+	.	.
<i>Ranunculus repens</i>	.	+	+	+	.	+	.
<i>Prunella vulgaris</i>	1	.	.	1	+	.	.
<i>Holcus lanatus</i>	+	.	.	.	+	+	.
<i>Lotus pedunculatus granadensis</i>	.	2	.	.	+	1	.
<i>Carex camposii</i>	.	.	.	+	+	+	.
<i>Juncus articulatus</i>	.	.	.	+	+	+	.
<i>Lotus uliginosus</i>	1	.	.	1	.	.	.
<i>Hypericum tetrapterum</i>	+	.	+	.	.	.	.
<i>Agrostis nevadensis</i>	.	2	.	.	.	.	+
<i>Festuca tricophylla scabrescens</i>	.	1	.	.	.	.	+
<i>Cerastium fontanum</i>	.	.	+	+	.	.	.
<i>Primula elatior lofthousei</i>	.	.	.	+	+	.	.
<i>Festuca ampla</i>	.	.	.	.	+	+	.
<i>Epilobium obscurum</i>	.	.	.	.	+	+	.
<i>Lotus corniculatus</i>	2	.	.	.	.	.	.
<i>Carex lepidocarpa</i>	1	.	.	.	.	.	.
<i>Blackstonia perfoliata</i>	1	.	.	.	.	.	.
<i>Leontodon microcephalus</i>	.	1	.	.	.	.	.
<i>Carex capillaris</i>	.	.	.	.	.	.	1

Sporadic species: Rel.1: *Epilobium parviflorum* +; *Dactylorrhiza elata sesquipedalis* +; *Cirsium pyrenaicum micranthum* +; *Sonchus maritimus aquatilis* +. Rel.2: *Sedum melanantherum* +. Rel.3: *Juncus inflexus* +; *Lythrum portula* +. Rel. 6: *Leontodon carpetanus nevadensis* +; *Mentha spicata* +. Rel. 7: *Galium sp.* +; *Gentiana verna sierrae* +; *Epilobium alsinifolium* +.

Localities: 1: Granada: Río Alhama de Lugros, Dehesa del Camarate, VG7716. 2: Almería: Abrucena, Barranco de la Campana, WG1005. 3: Almería: Fiñana, barranco del Rosal. WF0706. 4: Almería: Bayárcal, Arroyo Anchuelo, WG0002. 5: Almería: Fiñana, barranco del Rosal, WF0706. 6: Almería: Laujar de Andarax, Barranco del Horcajo, WG0802. 7: Almería: Abrucena, barranco de Peña Horadada, WG1205.

Tab. 2 - *Caricetum camposii-cuprinae* Salazar, Lorite, Cano et Valle *ass. nova*

Rel. number	1	2	3	4	5	6	7	8	9	10	11
Altitude (m)	1700	1690	1720	1550	2270	1540	1800	1800	1900	1900	2120
Area (m ²)	10	10	10	15	15	10	2	2	50	4	6
Average height (cm)	50	100	50	50	50	50	25	25	25	40	60
Cover (%)	100	100	100	100	100	100	85	90	90	90	100
Number of taxa	16	16	22	15	9	15	10	18	28	10	24
Characteristics of association and higher units:											
<i>Carex cuprina</i>	4	2	3	4	4	3	1	2	2	1	3
<i>Carex camposii</i>	3	3	2	1	1	2	4	5	5	4	4
<i>Veronica beccabunga</i>	.	2	+	.	.	.	+	+	1	.	.
<i>Juncus articulatus</i>	.	.	.	.	.	.	1	1	1	1	1
Accompanying species:											
<i>Holcus lanatus</i>	1	2	1	2	.	1	+	1	1	2	2
<i>Hypericum tetrapterum</i>	1	+	1	.	.	2	.	1	+	.	1
<i>Trifolium repens nevadense</i>	1	.	1	1	.	.	.	2	1	2	2
<i>Juncus inflexus</i>	.	1	1	+	.	.	2	2	+	.	+
<i>Mentha longifolia</i>	.	2	.	1	.	2	+	1	1	.	1
<i>Cirsium pyrenaicum micranthum</i>	1	.	1	+	.	1	1	.	2	.	.
<i>Lotus uliginosus</i>	2	.	1	.	.	2	.	2	.	.	2
<i>Dactylorrhiza elata</i>	+	.	+	+	.	1	.	.	.	.	+
<i>Aquilegia vulgaris nevadensis</i>	+	.	.	.	.	+	.	.	1	+	1
<i>Primula elatior lofthousei</i>	2	.	1	.	.	1	.	.	1	.	.
<i>Anthoxanthum odoratum</i>	2	.	.	.	.	+	.	1	.	.	+
<i>Agrostis castellana castellana</i>	+	+	.	+	.	.	.	.	+	.	.
<i>Carum verticillatum</i>	+	.	.	.	+	.	.	.	+	.	2
<i>Alchemilla straminea</i>	+	.	2	.	.	.	.	.	+	.	1
<i>Ranunculus granatensis</i>	.	1	.	+	.	.	.	.	1	.	1
<i>Peucedanum hispanicum</i>	.	.	+	.	.	1	.	.	+	.	2
<i>Ranunculus repens</i>	.	.	1	.	.	.	.	+	1	1	.
<i>Geum urbanum</i>	.	.	.	.	.	.	1	2	.	1	+
<i>Epilobium obscurum</i>	.	2	+	1	.	.	.	.	.	.	.
<i>Anthriscus sylvestris</i>	.	+	1	.	.	+	.	.	.	.	.
<i>Myosotis decumbens teresiana</i>	.	+	+	.	.	.	.	.	.	.	+
<i>Prunella vulgaris</i>	.	.	.	.	.	.	1	2	+	.	.
<i>Trifolium pratense</i>	.	.	.	.	.	.	.	1	1	.	1
<i>Cerastium fontanum</i>	.	.	.	.	.	.	.	+	+	.	+
<i>Carex nigra</i>	+	.	.	+	.	.	.	.	.	.	.
<i>Festuca ampla</i>	.	2	2	.	.	.	.	.	.	.	.
<i>Urtica dioica</i>	.	+	.	.	.	+	.	.	.	.	.
<i>Mentha suaveolens</i>	.	.	+	1	.	.	.	.	.	.	.
<i>Juncus effusus subglomeratus</i>	.	.	.	.	.	.	.	.	.	1	+

Sporadic species: Rel.1: *Brachypodium sylvaticum* +; Rel.2: *Rumex conglomeratus* +; *Lathyrus pratensis* +; Rel.3: *Aconitum vulparia neapolitanum* +; *Epilobium tetragonum tetragonum* +; *Cirsium x nevadense* +; Rel.4: *Scirpus holoschoenus* +; *Mentha spicata* +; Rel.5: *Nardus stricta* 1; *Potentilla nevadensis* 1; *Lotus glareosus* 1; *Juncus conglomeratus* 1; *Carex lepidocarpa* +; *Galium verum verum* +; Rel.6: *Athyrium filix-foemina* 1; Rel.8: *Epilobium atlanticum* +; *Montia fontana fontana* +; Rel.9: *Scirpus cernuus* 2; *Cirsium pyrenaicum longespinosum* 1; *Cirsium pyrenaicum pyrenaicum* 1; *Cochlearia megalosperma* +; *Ligusticum lucidum* +; *Parnassia palustris* +; *Juncus conglomeratus* +; Rel.10: *Stellaria alsine* 1; Rel. 11: *Dryopteris filix-mas* +; *Poa trivialis* +; *Briza media* 1.

Localities: 1: Almería: Paterna del Río, Barranco de los Cerezos WG0303. 2 and 3: Almería: Fíñana, Barranco del Rosal, WF0706. 4: Almería: Bayárcal. Arroyo del Palancón, VG9801. 5: Almería: Laujar de Andarax, cabecera del Barranco del Horcajo. WG0704. 6: Almería: Beires, cabecera del río Ohanes, WG1801. 7 and 8: Granada: Dehesa del Camarate, VG7614. 9: Granada: Dehesa del Camarate, VG7613. 10: Granada: Río Barrio, VG8708. 11: Granada: Río Dilar, VG6102.

The *Caricetum camposii-cuprinae* is a typical association of the Nevadense sector, being widely distributed due to the large amount of gullies where peat-bog like soils are formed and *Carex camposii* can proliferate. Its presence has been observed in Sierra Nevada (Nevadense district) and in Sierras of Baza and Filabres (Filábrico district), in the latter with less hygrophilous endemic species.

In more sloped areas with non-waterlogged soils, this helophytic formation comes into contact with the megaforbic association *Aconito-Senecietum elodis* Quézel 1953. Towards areas closer to rivers and streams, on compacted, flat, humid but non-waterlogged soils, it usually comes into contact with rush-beds of *Cirsio micranthi-Juncetum effusi* Salazar, Cano *et Valle* in Salazar *et al.* 1999 and *Aquilegio nevadensis-Ranunculetum granatensis* grass communities. Under stronger nitrification by livestock it comes into contact with rush-beds of *Cirsio-Juncetum inflexi* Vigo 1968. Where the association is directly in contact with streams and creeks, these will be carpeted with watercress silicicolous communities (*Glycerio declinatae-Apietum nodiflori* J.A. Molina 1996).

B) Wood-fringe and megaforbic vegetation

Ranunculo granatensis-Cochlearietum megalospermae Salazar, Lorite, Valle *et Cano* *ass. nova* (Tab. 3, *holotypus* rel. n. 6)

Thick megaforbic grass community developed on siliceous rocks, mainly mica-schists, which emerges within strongly flowing streams and clean, oligotrophic waters. It can occasionally appear on more or less developed humid soils, near streams with a stable water level which never undergo a deep decrease in their water level. With a supra-Mediterranean optimum, this association, in certain cases, can descend to the meso-Mediterranean belt.

It occupies shaded areas, being absent in open ones. Occasionally, *Cochlearia megalosperma* appears in sunnier areas, being integrated with the megaforbic grass communities of *Senecionion fluviatilis*. Faithful species to this formation are *Myosotis decumbens* subsp. *teresiana*, *Hypericum tetrapterum*, *Senecio jacobaea*, *Peucedanum hispanicum*, *Holcus lanatus* and *Lotus uliginosus*, besides the two principal species.

This association has been observed in Sierra Nevada and could theoretically be found -although poorer in species- in Sierra de Filabres (Filábrico district), or even in the Serrano-Bacense district (Baza Sierra). It may also be present in North Africa, because *Cochlearia megalosperma* is an Iberian-North-African endemism.

This association can be interpreted as a pioneer phase to the setting up of silicicolous *Salix atrocinerea* (occasionally, *Salix caprea*) willows since it occupies gravel along streambeds. When it occurs on deeper soils, it may come into contact with other Nevadense communities such as rushes (*Cirsio micranthi-Juncetum effusi*), megaforbic grass (*Aquilegio-Ranunculetum granatensis*) and sedge communities of flooded substrata (*Caricetum camposii-cuprinae*).

Myrrhoidi nodosae-Alliarietum petiolatae Rivas-Martínez *et Mayor ex V. Fuente* 1986 *nepetosum granatensis subass. nova* (Tab. 4, *holotypus* rel. n. 5) Synonym: *Alliario petiolatae-Laserpitietum longiradii* Losa-Quintana 1986

Scio-nitrophilous herbaceous community of clearings within deciduous forests. It develops on deep soils, with a certain nitrification and under cover of dead leaves. Of limited coverage and average size, this community has its optimum in the subhumid supra-Mediterranean belt. Phenologically, it has a clear maximum in spring, when the most important species (*Alliaria petiolata* and *Myrrhoides nodosa*) bloom; in summer they wither and sprout new shoots. The accompanying species are *Urtica dioica*, *Anthriscus sylvestris*, *Chaerophyllum hirsutum*, *Nepeta granatensis*, *Heracleum granatense*, etc.

This association was first described in the Guadalajara province by Fuente (1986) but it seems to have a wider distribution with its southernmost limit corresponding to our survey area. Losa-Quintana *et al.* (1986:181) consider the *Alliario-Laserpitietum longiradii* Losa-Quintana 1986 association as endemic to Sierra Nevada, but they had probably identified *Laserpitium longiradium* for *L. gallicum* or *L. latifolium*, since the only localities of *L. longiradium* are in the Monachil River gully (Malacitano-Almijareense sector), on scio-nitrophilous stratum limestone of evergreen oak groves (Blanca, *pers. comm.*). Therefore, it seems more appropriate to consider this community as a subassociation, called *nepetosum granatensis*, supported by Baetic elements such as *Nepeta granatensis* and *Heracleum granatense*, spreading at least over the Nevadense and Sub-Baetic sectors, in relation to which similar communities have been already cited (Ríos 1996).

This community, which has a rather short growing season, appears in the undergrowth of alder forests, athrocinereous willows and goat-willows of Sierra Nevada; when it occurs along streambeds, it comes into contact with *Aquilegio-Ranunculetum granatensis* communities or with different rushes or helophytic communities.

Tab. 3 - *Ranunculo granatensis-Cochlearietum megalospermae* Salazar, Lorite, Cano et Valle ass. nova

Rel. number	1	2	3	4	5	6	7	8	9
Altitude (m)	1600	1600	1980	1700	1520	1550	1700	1440	1460
Area (m ²)	2	1	4	10	2	1	2	2	1
Average height (cm)	150	70	120	100	100	100	100	25	100
Cover (%)	90	100	95	90	100	100	100	80	90
Number of taxa	11	11	10	8	9	13	15	10	11
Characteristics of association and higher units:									
<i>Cochlearia megalosperma</i>	4	2	4	4	4	3	2	2	2
<i>Hypericum tetrapterum</i>	1	+	2	1	2	2	+	+	1
<i>Peucedanum hispanicum</i>	.	2	.	.	3	+	.	1	.
<i>Senecio jacobaea</i>	.	+	1	.	.	.	1	.	.
<i>Ranunculus granatensis</i>	.	.	.	2	+	+	.	.	2
<i>Scrophularia auriculata</i>	.	.	.	.	.	.	1	+	.
Accompanying species:									
<i>Holcus lanatus</i>	2	.	2	.	3	4	4	4	3
<i>Myosotis decumbens teresiana</i>	.	.	1	2	.	1	1	+	+
<i>Lotus uliginosus</i>	+	.	1	.	.	1	1	.	+
<i>Mentha longifolia</i>	.	.	.	1	1	+	2	.	+
<i>Carex camposii</i>	.	.	1	.	1	2	+	.	.
<i>Geranium purpureum</i>	+	2	.	.	.	.	.	+	.
<i>Brachypodium sylvaticum</i>	+	+	.	.	+	.	.	.	.
<i>Poa nemoralis</i>	2	.	.	1	.	.	.	.	.
<i>Urtica dioica</i>	+	+	.	.	.	.	.	.	.
<i>Rubus ulmifolius</i>	+	+	.	.	.	.	.	.	.
<i>Athyrium filix-foemina</i>	.	1	.	.	.	.	.	+	.
<i>Dactylorhiza elata sesquipedalis</i>	.	.	+	.	.	.	+	.	.
<i>Cardamine flexuosa</i>	.	.	.	1	.	.	1	.	.
<i>Anthoxanthum odoratum</i>	.	.	.	.	.	1	.	+	.
<i>Clinopodium vulgare arundanum</i>	.	.	.	.	.	+	+	.	.
<i>Lonicera peryclimenum hispanica</i>	+	.	.	.	.	.	.	.	.
<i>Anthriscus sylvestris</i>	+	.	.	.	.	.	.	.	.
<i>Mentha suaveolens</i>	.	3	.	.	.	.	.	.	.
<i>Epilobium obscurum</i>	.	2	.	.	.	.	.	.	.
<i>Agrostis canina canina</i>	.	.	1	.	.	.	.	.	.
<i>Juncus inflexus</i>	.	.	+	.	.	.	.	.	.
<i>Apium nodiflorum</i>	.	.	.	1	.	.	.	.	.
<i>Juncus effusus subglomeratus</i>	.	.	.	.	+	.	.	.	.
<i>Ranunculus repens</i>	.	.	.	.	.	2	.	.	.
<i>Cerastium fontanum</i>	.	.	.	.	.	+	.	.	.
<i>Geranium columbinum</i>	.	.	.	.	.	.	1	.	.
<i>Hypochaeris radicata</i>	.	.	.	.	.	.	+	.	.
<i>Lapsana communis</i>	.	.	.	.	.	.	+	.	.
<i>Scrophularia scorodonia</i>	.	.	.	.	.	.	.	+	.
<i>Ligusticum lucidum</i>	.	.	.	.	.	.	.	.	1
<i>Cirsium pyrenaicum micranthum</i>	.	.	.	.	.	.	.	.	+
<i>Euphorbia characias</i>	.	.	.	.	.	.	.	.	+
<i>Heracleum sphondylium granatense</i>	.	.	.	.	.	.	.	.	+

Localities: 1: Almeria: Fiñana, Arroyo de Lubeire, WG0907. 2: Almeria; Bayárcal, Arroyo Anchuelo, WG0001. 3: Almeria: Paterna del Río, Barranco de los Murillos, WG0304. 4: Almeria: Paterna del Río, Barranco del Saltadero, WG0401. 5: Granada Arroyo del Alhori, VG8211. 6: Granada: Arroyo del Alhori, VG8111. 7: Granada: Barranco de las Rozas, VG7614. 8: Granada: Arroyo del Alhori, VG8312. 9: Granada: Río Dilar, VG5601.

Tab. 4 - *Myrrhoidi nodosae-Alliarietum petiolatae* Rivas-Martínez *et* Mayor *ex* V. Fuente *nepetosum granatensis* subass. nova.

Rel. number	1	2	3	4	5
Altitude (m)	1830	1830	1500	1600	1400
Area (m ²)	25	25	4	2	4
Average height (cm)	40	40	25	25	30
Cover (%)	95	95	75	85	80
Number of taxa	12	10	13	11	15
Characteristics of association and higher units:					
<i>Alliaria petiolata</i>	3	3	2	3	2
<i>Urtica dioica</i>	3	3	+	2	2
<i>Myrrhoides nodosa</i>	.	.	1	1	+
<i>Anthriscus sylvestris</i>	.	.	2	1	3
<i>Galium aparine</i>	.	.	.	1	2
Differentials of subass. <i>nepetosum granatensis</i>:					
<i>Heracleum sphondylium granatense</i>	.	.	1	.	2
<i>Nepeta granatensis</i>	.	.	+	.	1
Accompanying species:					
<i>Stellaria media</i>	2	2	.	2	1
<i>Saxifraga granulata</i>	1	.	1	.	2
<i>Galium spurium</i>	1	1	.	.	.
<i>Cerastium gibraltarium</i>	+	1	.	.	.
<i>Dactylis glomerata hispanica</i>	+	1	.	.	.
<i>Centaurea triumfetti lingulata</i>	1	+	.	.	.
<i>Geranium pyrenaicum</i>	1	2	.	.	.
<i>Cynosurus elegans</i>	1	.	.	+	.
<i>Geranium molle</i>	.	.	2	.	1
<i>Geranium columbinum</i>	.	.	1	.	1
<i>Veronica arvensis</i>	.	.	.	2	1
<i>Bunium alpinum</i>	.	.	.	1	+
<i>Holcus lanatus</i>	.	.	.	+	+
<i>Lapsana communis</i>	.	.	.	+	+
<i>Silene latifolia</i>	1	.	.	.	.
<i>Helleborus foetidus</i>	1	.	.	.	.
<i>Marrubium supinum</i>	.	1	.	.	.
<i>Vulpia alopecuroides</i>	.	1	.	.	.
<i>Arum italicum</i>	.	.	1	.	.
<i>Doronicum plantagineum</i>	.	.	+	.	.
<i>Primula elatior lofthousei</i>	.	.	+	.	.
<i>Ranunculus granatensis</i>	.	.	+	.	.

Localities: 1-2: Almería: Abucena, Prox. del Barranco del Diablo, WG1206. 3-5: Granada: Dehesa del Camarate, WG71.

C) Meadows and pastures

Cirsio micranthi-Scirpetum holoschoeni Lorite, Salazar, Cano *et Valle ass. nova* (Tab. 5, *holotypus* rel. n. 8)

Round-headed club rush-bed (*Scirpus holoschoenus*) accompanied by *Cirsium pyrenaicum* var. *micranthum* occurs on siliceous substrata in areas of the meso-Mediterranean thermotype, with soils drying out in summer.

This new association is endemic to the Nevadense sector, though it is rather poor in characteristic species. It is considered to be an edaphic vicariant of the *Cirsio-Holoschoenetum vulgaris* Br.-Bl. 1931 (meso-Mediterranean basophilic rush-beds).

It appears in the dominion of the Nevadense willow-alder forests (*Carici-Salicetum atrocineriae*). In drier areas it comes into contact with climatic formations, whilst in more humid areas it is related to the helophytic *Glycerio declinatae-Apietum nodiflori* communities. When a strong nitrification occurs due to increased livestock action, this community is possibly substituted by *Cirsio-Juncetum inflexi* rush-beds.

D) Serial shrub and wood-fringe vegetation

Rubo ulmifolii-Corietum myrtifoliae O. Bolòs 1954 variant with *Adenocarpus decorticans*

Thick, impenetrable bramble community dominated by *Rubus ulmifolius* together with numerous lianoid and climbing species, e.g. *Rosa* spp., *Lonicera peryclimenum* subsp. *hispanica*, *Clematis flammula*, *C. vitalba*, *Coriaria myrtifolia* and *Tamus communis*.

It surrounds and substitutes the athrocinerous willow and alder woods in middle river tracks, or appears along irrigation channels. As it appears in areas of meso-Mediterranean thermotype, thermophilous species such as *Dorycnium rectum*, *Salix pedicellata*, *Spartium junceum*, *Calystegia sepium*, *Euphorbia characias*, etc. are common. These formations are enriched in *Adenocarpus decorticans* which, although not a typical riparian species, is often linked to these bramble communities.

The *Rubo-Corietum myrtifoliae* has a wide distribution in non-continental Ibero-Levantine territories. This silicolous variant is rarely seen in the Nevadense sector, being more frequent in the Filábrico district or in the vicinity to the Alpujarreño-Gadorense sector, which are characterised by higher temperatures.

As bramble patches typically surround gallery forests, they become more vigorous when the removal of tree cover increase the light regime. These

thick sarmentous communities protect and offer the necessary shade for the sprouting of new trees, and their degradation mainly leads to the appearance of meso-Mediterranean rush-beds (*Cirsio micranthi-Scirpetum holoschoeni*).

There is scant information on this community. We provide the following relevé:

Locality: Granada, Narila, Río Guadalfeo, VF8390. Altitude: 980 m. Area: 30 m². Average height: 200 cm. Coverage: 100%. Characteristics of association and higher units: *Coriaria myrtifolia* 4, *Rubus ulmifolius* 2, *Spartium junceum* 2, *Tamus communis* 1, *Euphorbia characias* 1, *Brachypodium sylvaticum* 1, *Lonicera peryclimenum hispanica* +. Acidophilous variant differentials: *Adenocarpus decorticans* 2, *Salix pedicellata* 1. Accompanying species: *Clematis flammula* 1, *Dorycnium rectum* +, *Mentha suaveolens* +, *Asparagus acutifolius* +, *Equisetum ramosissimum* +.

Rubo ulmifolii-Rosetum corymbiferae Arnáiz *et* Rivas-Martínez in Arnáiz 1979 variant with *Adenocarpus decorticans* (Tab. 6)

Thick bramble communities surrounding supra-Mediterranean willow and alder woods. Lianoid, climbing and thorny species such as *Rubus ulmifolius*, *Crataegus monogyna*, *Rosa* spp., *Lonicera peryclimenum* subsp. *hispanica*, *Clematis vitalba*, *Vitis vinifera*, etc. are predominant. Other species of climatic vegetation needing great humidity, such as *Rhamnus catharticus*, *Prunus insititia*, *Berberis vulgaris* subsp. *australis*, etc. can also appear.

This association is distributed over a large area of the peninsular Northern Sub-Plateau, reaching the southernmost boundary through the eastern Baetic province. As it develops on base-poor substrata, in the Nevadense sector it is enriched in silicolous species, such as *Salix caprea*, *Alnus glutinosa*, *Scrophularia scorodonia*, *Pteridium aquilinum*, *Athyrium filix-foemina*, and *Adenocarpus decorticans*, which although not characteristic of the riparian vegetation, is commonly found in this community.

The ecological significance and dynamics of bramble communities within the ripicolous vegetation has been previously discussed. In this case, the only exception is that the rush-beds originated through successive degradation and belong to the supra-Mediterranean rush-beds of *Cirsio micranthi-Juncetum effusi*.

E) Mediterranean and Euro-Siberian climactic vegetation

Carici camposii-Salicetum atrocineriae Salazar, Lorite, Cano *et Valle ass. nova*

Tab. 5 - *Cirsio micranthi-Scirpetum holoschoeni* Lorite, Salazar, Cano et Valle *ass. nova.*

Rel. number	1	2	3	4	5	6	7	8	9
Altitude (m)	1000	1200	1180	1140	1150	1090	1300	1080	1250
Area (m ²)	8	60	15	15	20	12	30	40	24
Average height (cm)	75	70	100	120	80	75	70	120	70
Cover (%)	100	50	100	50	85	95	100	80	90
Number of taxa	9	16	14	15	14	12	20	24	22
Characteristics of association and higher units:									
<i>Scirpus holoschoenus</i>	3	3	4	3	4	3	3	4	2
<i>Cirsium pyrenaicum micranthum</i>	1	.	2	1	2	+	1	2	3
<i>Mentha suaveolens</i>	2	2	2	1	2	+	3	2	2
<i>Holcus lanatus</i>	1	1	1	+	1	1	2	1	3
<i>Ranunculus repens</i>	2	.	+	1	+	.	1	1	1
<i>Trifolium repens</i>	.	1	.	.	.	3	2	1	1
<i>Juncus inflexus</i>	.	2	.	.	.	2	1	.	1
<i>Lotus uliginosus</i>	.	.	.	+	.	2	2	1	+
<i>Agrostis castellana castellana</i>	.	.	+	.	.	+	2	1	2
<i>Mentha longifolia</i>	.	.	.	1	1	.	1	.	1
<i>Juncus effusus subglomeratus</i>	.	+	.	.	.	.	1	.	+
<i>Rumex conglomeratus</i>	.	+	.	.	.	.	.	+	+
<i>Hypericum tetrapterum</i>	.	1	.	.	.	.	.	.	+
<i>Pulicaria dysenterica</i>	.	+	1	.	.	.	.	.	.
<i>Dactylorrhiza elata</i>	.	.	+	.	.	+	.	.	.
<i>Anthoxanthum odoratum</i>	.	.	.	.	.	.	2	.	1
<i>Sonchus maritimus aquatilis</i>	.	.	.	.	.	.	+	.	+
<i>Lotus corniculatus</i>	.	.	.	.	.	.	.	1	2
Accompanying species:									
<i>Brachypodium sylvaticum</i>	.	.	.	1	1	.	1	1	1
<i>Medicago lupulina</i>	.	.	.	1	2	.	.	1	.
<i>Euphorbia characias</i>	1	+	.	.	.	.	.	.	.
<i>Epilobium parviflorum</i>	.	+	.	.	.	.	.	.	+
<i>Apium nodiflorum</i>	.	+	.	+	.	.	.	.	.
<i>Scrophularia scorodonia</i>	.	.	1	+	.	+	.	.	.
<i>Salix atrocinerea</i>	.	.	+	+	+	.	.	.	.
<i>Artemisia campestris glutinosa</i>	.	.	.	1	+	.	.	1	.
<i>Festuca scariosa</i>	.	.	.	+	+	.	.	.	.
<i>Ononis spinosa</i>	.	.	.	.	+	1	.	1	.
<i>Urtica dioica</i>	.	.	.	.	.	.	.	1	1
<i>Cirsium vulgare</i>	.	.	.	.	.	.	+	+	.

Sporadic species: Rel. 1. *Dorycnium rectum* 2, *Trifolium pratense*, +, *Plantago major* +. Rel. 2. *Lolium perenne* 1, *Cynosurus elegans* 1, *Mantisalca salmantica* +, *Digitalis purpurea nevadensis* +. Rel. 3. *Lotus pedunculatus granadensis* 1, *Cyperus longus* 1, *Epilobium hirsutum* +, *Hypericum perforatum* +. Rel. 4. *Equisetum telmateia* +. Rel. 5. *Crepis vesicaria* 1, *Dittrichia viscosa* +. Rel. 6. *Juncus bufonius* +. Rel. 7. *Lathyrus pratensis* +, *Festuca arundinacea* +, *Carex cuprina* +, *Carex camposii* +, *Juncus subnodulosus* +. Rel. 8. *Equisetum ramosissimum* 2, *Cynodon dactylon* 1, *Mentha spicata* 1, *Veronica anagallis-aquatica* 1, *Picnomon acarna* +, *Senecio malacitanus* +, *Silene latifolia* +, *Helleborus foetidus* +. Rel. 9. *Ranunculus granatensis* +, *Salix purpurea* +, *Rubus ulmifolius* +.

Localities: 1: Granada: Narila, Rio Guadalfeo, VF0998. 4 and 5: Almeria: Abrucena; rio Abrucena, WG1608. 6: Almeria: Fiñana, rio Nacimiento, WG0811. 7: Granada Lugro, Rio Alhama de Lugros, VG7716. 8: Almeria: Abrucena, rio Abrucena, WG1708. 9: Granada: Lugros; Rio Alhama de Lugros, VG7716.

Tab. 6 - *Rubus ulmifolii*-*Rosetum corymbiferae* Rivas Martinez *et* Amaiz in Amaiz 1979 variant with *Adenocarpus decorticans*.

Rel. number	1	2	3	4	5	6	7	8	9	10
Altitude (m)	1120	1140	1380	1620	1200	1460	1520	1350	1440	1440
Area (m ²)	100	160	100	100	150	50	40	135	30	20
Slope (°)	45	20	35	20	5	-	10	5	-	-
Exposition	N	O	NO	SE	S	-	S	N	-	-
Average height (cm)	150	250	250	200	200	200	250	200	175	175
Cover (%)	100	90	100	100	75	90	100	100	80	75
Number of taxa	19	17	11	19	9	13	15	14	9	12
Characteristics of association and higher units:										
<i>Rubus ulmifolius</i>	4	4	4	3	4	5	2	5	4	3
<i>Rosa corymbifera</i>	2	2	3	3	2	1	4	2	.	.
<i>Crataegus monogyna</i>	3	3	.	3	1	.	.	.	1	2
<i>Hedera helix</i>	2	.	+	1	.	1	.	.	.	+
<i>Rosa canina</i>	1	1	.	.	.	.	.	.	2	+
<i>Salix atrocinerea</i>	.	.	1	.	1	.	.	.	+	2
<i>Lonicera periclymenum hispanica</i>	.	.	.	2	.	1	.	.	.	+
<i>Berberis vulgaris australis</i>	.	.	.	.	.	2	1	.	1	.
<i>Rosa pouzinii</i>	1	1	.	.	.	.	.	.	.	.
Acidophilous variant differentials										
<i>Adenocarpus decorticans</i>	+	2	1	1	2	1	1	+	1	1
<i>Athyrium filix-foemina</i>	.	+	.	+	.	.	+	.	.	1
<i>Pteridium aquilinum</i>	.	.	.	1	.	1	+	2	.	.
Accompanying species:										
<i>Helleborus foetidus</i>	+	+	.	1	1	+	+	1	+	.
<i>Euphorbia characias</i>	.	.	+	+	1	+	1	.	.	.
<i>Brachypodium sylvaticum</i>	+	.	1	1	.	.	.	.	.	.
<i>Alnus glutinosa</i>	.	.	.	.	.	.	.	.	2	1
<i>Urtica dioica</i>	.	.	+	1	.	1	1	1	.	.
<i>Rubia peregrina</i>	1	+	+	.	.	1	.	.	.	.
<i>Scrophularia scorodonia</i>	+	.	1	.	+	.	+	.	.	.
<i>Mentha suaveolens</i>	.	.	.	.	+	+	+	1	.	.
<i>Festuca scariosa</i>	+	+	+	.	.	.	.	.	.	.
<i>Ballota hirsuta</i>	1	+	.	.	.	.	.	.	.	.
<i>Helichrysum italicum serotinum</i>	+	+	.	.	.	.	.	.	.	.
<i>Asparagus acutifolius</i>	+	+	.	.	.	.	.	.	.	.
<i>Cirsium pyrenaicum micranthum</i>	+	.	.	.	.	.	.	+	.	.
<i>Geranium purpureum</i>	.	.	.	+	.	.	+	.	.	.
<i>Hypericum tetrapterum</i>	.	.	.	+	.	.	1	.	.	.
<i>Holcus lanatus</i>	.	.	.	+	.	.	.	1	.	.
<i>Rumex conglomeratus</i>	.	.	.	.	.	.	+	+	.	.

Sporadic species: Rel. 1. *Populus nigra italica* 1. *Rumex induratus* +, *Artemisia campestris glutinosa* +. Rel.2. *Quercus rotundifolia* 1, *Ptilostemon hispanicus* +, *Thymus mastichina* +, *Cytisus grandiflorus* +. Rel. 4. *Prunus ramburii* 1, *Juglans regia* +, *Peucedanum hispanicum* +, *Festuca elegans* +. Rel. 6. *Campanula rapunculus* +. Rel. 7. *Cirsium pyrenaicum longespinosum* +. Rel. 8. *Sonchus maritimus aquatilis* +, *Ranunculus repens* +, *Agrostis canina canina* 1, *Equisetum ramossissimum* +. Rel. 9. *Prunus spinosa* 1. Rel. 10. *Clematis vitalba* +, *Rosa micrantha* +, *Rhamnus catharticus* +.

Localities: 1 and 2: Almería: Abrucena, río Abrucena, WG1507. 3: ibidem; Barranco de la Mina, WG1506. 4: Almería: Laujar de Andarax, Barranco de los Tejos, WG0403. 5: Almería: Bayácal, Arroyo del Palancón, VF9999. 6 and 7: Almería: Beires, río Ohanes, WG1801. 8: Granada: Lugros, río Alhama de Lugros, VG7716. 9 and 10: Granada: Arroyo Alhori, VG8312.

Tab. 7 - *Carici camposii-Salicetum atrocineriae* Salazar, Lorite, Cano *et* Valle *ass. nova*

Rel. number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Altitude (m, x 10)	146	160	120	140	160	185	168	164	144	115	155	122	150	170	170	162	100	150	
Area (m ²)	100	150	100	100	125	60	200	160	160	100	150	125	125	75	200	150	150	60	
Average height (cm)	400	600	500	200	900	300	250	900	900	900	900	800	400	900	600	600	600	300	
Cover (%)	90	80	100	100	100	100	100	100	75	90	80	75	75	60	100	90	90	100	
Number of taxa	20	26	14	24	15	22	18	21	16	24	19	14	18	13	23	22	31	38	
Characteristics of assoc. and higher units:																			
<i>Salix atrocineriae</i>	4	4	3	5	2	4	4	4	3	2	3	3	3	3	4	4	2	4	
<i>Carex camposii</i>	2	+	+	1	2	1	1	1			2	+	1		2	1	+	1	
<i>Alnus glutinosa</i>			4		5			4	2	1	4	3			3			+	
<i>Athyrium filix-foemina</i>	3	+	1		1	2	1	1	1	1	+		2	2	2	1	2	1	
<i>Brachypodium sylvaticum</i>	1	2		2	1		1	2		+	1	1						+	
<i>Scrophularia scorodonia</i>	+					+	+				+	1	+			+	+	1	
<i>Hedera helix</i>		1	+		1			2	+							1	+	1	
<i>Helleborus foetidus</i>				+	1		+	1		1	+						1	+	
<i>Euphorbia characias</i>			1	1						+					+		+	1	
<i>Populus x canadensis</i>		3	1					2			2	2							
<i>Populus nigra italica</i>				1				2		2		2						2	
<i>Lapsana communis</i>						+	+			+	+						+		
<i>Poa nemoralis</i>	1							+										+	
<i>Tamus communis</i>										1		+						+	
<i>Clinopodium vulgare</i>																+	+	+	
<i>Origanum vulgare</i>				+														+	
<i>Salix x quercifolia</i>						1						2							
<i>Geum urbanum</i>								1					1						
<i>Sorbus aucuparia</i>									+		1								
<i>Salix fragilis</i>									1									1	
<i>Origanum virens</i>										+		+							
Differentials of subass. salicetosum capreae:																			
<i>Prunus avium</i>													1	1	+		1	+	
<i>Salix caprea</i>													3	2		2		+	
<i>Lonicera arborea</i>													+	+				+	
<i>Acer opalus granatense</i>													2	2					
<i>Sorbus aria</i>													2	2					
<i>Betula pendula fontqueri</i>														1					
<i>Rhamnus catharticus</i>													1						
Accompanying species																			
<i>Rubus ulmifolius</i>	+	2	1	1	2	3	3	3	2	2	2	1	1		1	2	2	2	
<i>Crataegus monogyna</i>					1	2	1		2		2			1	1	1			
<i>Rosa corymbifera</i>	+		1				2							+		+			
<i>Lonicera periclymenum hispanica</i>					+	1			+	1					+				
<i>Berberis vulgaris australis</i>						+	+							1		+			
<i>Pteridium aquilinum</i>										+		2	1					1	
<i>Rosa pouzinii</i>		1		+														1	
<i>Rosa canina</i>									+		1						1		
<i>Clematis vitalba</i>									+			+						1	
<i>Spartium junceum</i>				+														+	

Tab. 7 - Continued.

Accompanying species:																	
<i>Holcus lanatus</i>	.	2	1	1	.	1	1	1	.	+	1	.	1	.	1	+	1
<i>Urtica dioica</i>	+	1	.	.	1	2	1	2	.	2	.	.	2	.	2	.	+
<i>Digitalis purp. nevadensis</i>	.	+	.	+	.	.	.	+	.	+	+	.	.	.	+	.	+
<i>Peucedanum hispanicum</i>	1	2	1	1	.	.	.	.	+	.	1	.	.	.	2	.	+
<i>Adenocarpus decorticans</i>	.	.	.	.	+	1	1	.	1	.	1	+	.	.	.	+	1
<i>Hypericum tetrapterum</i>	+	.	.	+	+	.	.	.	.	.	.	.	+	.	+	.	+
<i>Cochlearia megalosperma</i>	.	1	.	.	.	.	.	+	1	+	.	.	+	.	+	.	.
<i>Geranium purpureum</i>	.	+	.	.	.	+	+	+	.	.	.	.	.	.	1	.	.
<i>Scirpus holoschoenus</i>	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Epilobium parviflorum</i>	+	1	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.
<i>Senecio jacobaea</i>	+	.	.	.	.	2	.	.	.	.	+	.	.	.	.	1	.
<i>Lotus uliginosus</i>	1	.	.	+	.	.	.	.	1	.	.	.	.	.	.	.	.
<i>Mentha suaveolens</i>	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	+
<i>Ranunculus granatensis</i>	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	+	+
<i>Cardamine flexuosa</i>	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1
<i>Dactylorrhiza elata</i>	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Cytisus grandiflorus</i>	.	+	+	.	.	.	.	2	.	.	.	.	.	.	.	.	.
<i>Mentha longifolia</i>	.	+	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.
<i>Prunella vulgaris</i>	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+
<i>Juncus inflexus</i>	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	+
<i>Myosotis decumbens teresiana</i>	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	+
<i>Ranunculus repens</i>	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.
<i>Trifolium repens</i>	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Sonchus marit. aquatilis</i>	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Hebecladon sordidum gracile</i>	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.
<i>Dryopteris filix-mas</i>	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	+
<i>Cirsium pyrenaicum micranthum</i>	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.
<i>Carex cuprina</i>	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.
<i>Trifolium pratense</i>	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
<i>Tanacetum parthenium</i>	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	+
<i>Rubia peregrina</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
<i>Ficus carica</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+

Sporadic species: Characteristics of class: Rel. 4. *Asplenium oopteris* +. Rel. 5. *Viola suavis* +. Rel. 6. *Populus tremula* 1, *Fraxinus angustifolia angustifolia* 1, *Rosa montana* 2. Rel. 10. *Castanea sativa* 2. Rel. 15. *Rosa micrantha* 1. Rel. 18. *Quercus pyrenaica* +, *Equisetum temalteia* 1. Accompanying species: Rel.1. *Anthoxantum odoratum* 1, *Festuca arundinacea* +. Rel. 2. *Lathyrus pratensis* 1, *Agrimonia eupatoria* 1, *Festuca elegans* +, *Agrostis castellana castellana* +, *Viola reichembachiana* +, *Rumex conglomeratus* +. Rel. 3. *Equisetum ramosissimum* +, *Scrophularia canina canina* +. Rel. 5. *Cistus laurifolius* +. Rel. 6. *Anthriscus sylvestris* +. Rel. 7. *Potentilla reptans* +. Rel. 10. *Apium nodiflorum* +, *Parietaria judaica* +. Rel. 14. *Aconitum burnatii* +. Rel. 15. *Aquilegia vulgaris nevadensis* 1. Rel. 17. *Bupleurum fruticosum* 2, *Agrostis stolonifera* +, *Trachelium caeruleum* +.

Localities: 1: Almería: Beires, Río Ohanes, WG1801. 2: Almería: Fiñana, Arroyo de Lubeire, WG6808. 3: Almería: Laujar de Andarax, Río Andarax, WF0999. 4: Granada: Capileira, afluente del Poqueira, VF6891. 5: Granada: Aldeire, barranco de los Tejos, VG9308. 6: Granada: Río Barrio, VG8708. 7: Almería: Ohanes, Arroyo de Tices, WG1904. 8: Granada: Aldeire, arroyo de los Pasillos, VG9309. 9: Granada: Jeres del Marquesado, arroyo del Alhorí, VG3812. 10: Granada: Bérchules, río Guadalfeo, VF8391. 11: Granada: Lanteira, Río Pueblo, VG8610. 12: Granada: Río Alhama de Lueros, VG7819. 13: Granada: Dehesa del Camarate, VG7715. 14: Granada: Dehesa del Camarate, barranco de las Rozas, VG7614. 15: Almería: Bayárcal, Arroyo Anchuelo, WG0002. 16: Granada: Río Barrio, VG8809. 17: Granada: Río Bermejo, VF7188. 18: Granada: Las Cebadillas, Arroyo afluente Poqueira, VF6894.

subas. *salicetosum atrocineriae* (Tab. 7, rels. 1-12. *holotypus* rel. n. 11)

subas. *salicetosum capreae* (Tab. 7, rels. 13-18. *holotypus* rel. n. 13)

Thick, athrocinerous willow and alder forests developed on siliceous materials along streams of oligotrophic, permanently-flowing waters. Their optimum is found in very deep gullies of the subhumid supra-Mediterranean, descending to the meso-Mediterranean thermotype, where they become blurred because of the strong anthropic action.

Alder (*Alnus glutinosa*) is the predominant species of this community when it occurs in close vicinity of running water, however the greater part of the biomass is more frequently formed by *Salix atrocineria*. Other willows (e.g. *Salix fragilis*) and poplar trees (*Populus nigra*, *P. tremula*) may also be present. The species of the shrub and herbaceous layers which better characterise these alder forests are *Athyrium filix-foemina*, *Scrophularia scorodonia* (typical of the alliance *Osmundo-Alnion*), *Adenocarpus decorticans* (very common in the Nevadense sector), *Digitalis purpurea* subsp. *nevadensis* and *Carex camposii* (endemic). The deep shade and humidity of these environments allows for the growth of several ferns (*Athyrium filix-foemina*, *Pteridium aquilinum*, *Dryopteris filix-mas*, etc.).

The alder-tree forests of Sierra Nevada have been considerably altered by man, and it is often difficult to find well developed, typical stands. In several studies on the vegetation of the Nevadense massif they seem to have been neglected. The existence of alder forests along the Nevadense riversides has even been denied by Martínez-Parras *et al.* (1987a, 1987c). In other areas alder forests are probably of anthropic origin, but there are some evidences supporting their indigeneity in Sierra Nevada. For instance, the anthracitic remains found in the Millares site, which date back to the Copper Age, can have no other origin than the forests along the streams and rivers of the study area. At the same time, on the northern slope of this massif there are a few toponyma related to alder (Los Alisares of the Pueblo River, the Aliso gully in the Granada Alpujarra, etc). Certainly in the past alder was much more abundant than now, and nowadays a large part of alder forests can be interpreted as relictual. However, they should be considered as the climax of the Nevadense supra- and meso-Mediterranean riparian vegetation.

Contrary to alder forests, athrocinerous willow communities have often been reported by previous authors (Losa-Quintana *et al.* 1986, 1987; Martínez-Parras *et al.* 1987a; Molero-Mesa 1988; Pérez-Raya

et al. 1990; Molero-Mesa *et al.* 1992 and Salinas & Blanca 1996), generically referred to as “*Salix atrocineria* communities” without any precise syntaxonomic arrangement, and in the majority of cases even without the provision of phytosociological relevés.

The new association seems to be endemic to the Nevadense sector, where it is widely distributed, and is fragmentary in the Filábrico district due to the lower water level of its streams. The characteristic physiognomy of these communities, the existence of some relevés with a strong dominance of alder and the presence (sometimes with low cover values) of species characteristic of *Osmundo-Alnion* (*Alnus glutinosa*, *Salix atrocineria*, *Scrophularia scorodonia*, *Athyrium filix-foemina*) has led us to include the new association in the latter alliance, and more particularly in the *Osmundo-Alnion* suballiance, which was previously restricted to the Ibero-Atlantic province. Due to its isolation in relation to other alder forests of the suballiance, the new association can be regarded as very poor, even lacking typical taxa such as *Osmunda regalis*, *Clematis campaniflora*, *Galium broterianum* or *Carex broteriana*. The Nevadense athrocinerous willow and alder-tree communities have been characterised by *Carex camposii*, a faithful taxon to the herbaceous substratum present in both the meso- and supra-Mediterranean belts.

The *salicetosum capreae* subassociation develops in more humid situations (generally within the subhumid dominion of the mesophytic Pyrenean oak series) as on the northern slope of the Nevadense district. Interesting and rare taxa are present, such as *Prunus avium*, *Betula pendula* subsp. *fontqueri*, *Salix caprea*, *Acer opalus* subsp. *granatense*, *Taxus baccata*, *Sorbus aria*, *Lonicera arboorea*, *Rhamnus catharticus*, etc. For floristic and biogeographical reasons, this syntaxon can be properly considered a subassociation and not a simple ecological variant typical of the Nevadense district but absent from the Filábrico district.

The degradation of these gallery forests changes the ecological conditions, with the bramble community taking advantage. The following modifications are noteworthy: reduction in the pteridoflora, regression of *Origanetalia vulgaris* communities and increase of *Agropyro-Rumicion* species as a result of increased light condition and more frequent livestock access.

This association comes into contact with numerous herbaceous communities such as rush-beds (*Cirsio micranthi-Juncetum effusi*), megaforbic communities (*Aquilegio-Ranunculetum granaten-*

sis, *Ranunculo-Cochlearietum megalospermae*), helophytic formations (*Caricetum camposii-cuprinae*) and nitrophilous vegetation.

Conclusions

In the past the phytosociological studies on the hygrophilous vegetation of Sierra Nevada had traditionally been limited to pastures, peat-bogs, and streams of the upper bioclimatic belts (oro-Mediterranean and cryoro-Mediterranean).

In this study we discussed some interesting plant communities, developed mainly in areas of the meso-Mediterranean and supra-Mediterranean thermotypes but reaching in some cases the oro-Mediterranean, which had been completely ignored, or had been only briefly discussed by previous authors.

The following syntaxa (four associations, two subassociations, two variants and one community) needed to be described as new:

1. *Caricetum camposii-cuprinae* Salazar, Lorite, Cano et Valle ass. nova
2. *Ranunculo granatensis-Cochlearietum megalospermae* Salazar, Lorite, Cano et Valle ass. nova
3. *Cirsio micranthi-Scirpetum holoschoeni* Lorite, Salazar, Cano et Valle ass. nova
4. *Carici camposii-Salicetum atrocineriae* Salazar, Lorite, Cano et Valle ass. nova
5. *Myrrhoidi nodosae-Alliarietum petiolatae* Rivas-Martínez et Mayor ex V. Fuente 1986 *nepetosum granatensis subass. nova*
6. *Carici camposii-Salicetum atrocineriae salicetosum capreae* Salazar, Lorite, Cano et Valle subass. nova
7. *Rubo ulmifolii-Coriarietum myrtifoliae* O. Bolòs 1954 variant with *Adenocarpus decorticans*
8. *Rubo ulmifolii-Rosetum corymbiferae* Arnáiz et Rivas-Martínez in Arnáiz 1979 variant with *Adenocarpus decorticans*
9. *Cratoneuron commutatum* and *Anagallis tenella* community

The majority are endemic to the Nevadense sector, and are better developed in the Nevadense district. They have an important rate of relict and endemic species, and host several species with an arctic-alpine disjunction.

A suitable interpretation of the vegetation dynamics of these little-known plant communities, which usually occur in fragile, endangered environments, should be considered of major interest. With this knowledge, it will be possible to carry out an accurate study of the Nevadense vegetation series and geoseries and to offer possible solutions for its restoration.

Acknowledgements

We wish to thank M^{ra} Carmen Maestro for her support in the translation of this paper.

References

- Aallali A., López-Nieto J.M., Pérez-Raya F. & Molero-Mesa J., 1998. *Estudio de la vegetación forestal en la vertiente sur de Sierra Nevada (Alpujarra alta granadina)*. It. Geobot., 11:387-402.
- Alcaraz F., 1996. *Fitosociología integrada, paisaje y biogeografía*. In: Loidi, J. (ed.). *Avances en Fitosociología*: 59-94. Servicio Editorial de la Universidad del País Vasco, 191 pp.
- Barkman J.J., Moravec J. & Rauschert S., 1988. *Código de nomenclatura fitosociológica* (traducido por J. Izco & M. J. del Arco-Aguilar). Op. Bot. Pharm. Comp. 4: 9-74.
- Blanca G., Cueto M., Martínez-Lirola M.J., & Molero-Mesa J., 1998. *Threatened vascular flora of Sierra Nevada (Southern Spain)*. Biol. Conserv. 85: 269-285.
- Braun-Blanquet J., 1979. *Fitosociología*. Ed. Blume, Madrid, 820 pp.
- Casares M., Pérez-Raya F., Molero-Mesa J. & Losa-Quintana J.M., 1986. *La vegetación riparia en Sierra Nevada. I: la cuenca alta del río Genil, Catenas edáficas*. Ars Pharm. 27: 447-453.
- Castroviejo S., Laínz M., López-González G., Montserrat P., Muñoz-Garmendia F., Paiva J. & Villar L. (eds.), 1986. *Flora Ibérica. Plantas Vasculares de la Península Ibérica e Islas Baleares. Vol. I: Lycopodiaceae-Papaveraceae*. Real Jardín Botánico, CSIC, Madrid. 575 pp.
- Castroviejo S., Laínz M., López-González G., Montserrat P., Muñoz-Garmendia F., Paiva J. & Villar L. (eds.), 1990. *Flora Ibérica. Plantas Vasculares de la Península Ibérica e Islas Baleares. Vol. II: Platanaceae-Plumbaginaceae (partim)*. Real Jardín Botánico, CSIC, Madrid. 897 pp.
- Castroviejo S., Aedo C., Cirujano S., Laínz M., Montserrat P., Morales R., Muñoz-Garmendia F., Navarro C., Paiva J. & Soriano C. (eds.), 1993a. *Flora Ibérica. Plantas Vasculares de la Península Ibérica e Islas Baleares. Vol. III: Plumbaginaceae (partim)-Capparaceae*. Real Jardín Botánico, CSIC, Madrid. 730 pp.
- Castroviejo S., C. Aedo, Gómez-Campo C., Laínz M., Montserrat P., Morales R., Muñoz-Garmendia F., Nieto Feliner G., Rico E., Talavera S. & Villar L. (eds.), 1993b. *Flora Ibérica. Plantas Vasculares de la Península Ibérica e Islas Baleares. Vol. IV: Cruciferae-Monotropaceae*. Real Jardín Botánico, CSIC, Madrid. 730 pp.
- Castroviejo S., Aedo C., Laínz M., Morales R., Muñoz-Garmendia F., Nieto Feliner G. & Paiva J. (eds.), 1997a. *Flora Ibérica. Plantas Vasculares de la Península Ibérica e Islas Baleares. Vol. V: Ebenaceae-Saxifragaceae*. Real Jardín Botánico, CSIC, Madrid. 320 pp.
- Castroviejo S., Aedo C., Benedí C., Laínz M., Muñoz-Garmendia F., Nieto Feliner G. & Paiva J. (eds.), 1997b. *Flora Ibérica. Plantas Vasculares de la Península Ibérica e Islas Baleares. Vol. VIII: Haloragaceae-Euphorbiaceae*. Real Jardín Botánico, CSIC, Madrid. 375 pp.
- Díaz González T.E. & Llamas F., 1987. *Aportaciones al conocimiento del género Salix L. (Salicaceae) en la provincia de León (NW España)*. Acta Bot. Malac., 12: 111-150.
- Fernández-Carvajal M.C., 1981. *Revisión del género Juncus L. en la Península Ibérica I. Categorías supraespecíficas y clave para las especies*. Anales Jard. Bot. Madrid 38: 79-89.
- Fernández-Carvajal M.C., 1982a. *Revisión del género Juncus L. en la Península Ibérica II. Subgéneros Juncus y Genuini Buchenau*. Anales Jard. Bot. Madrid 38: 417-467.
- Fernández-Carvajal M.C. 1982b. *Revisión del género Juncus L. en la Península Ibérica III. Subgéneros Subulati Buchenau, Pseudotenageia Krecz. & Gonsteh. y Poiophylli Buchenau*.

- Anales Jard. Bot. Madrid 39: 79-151.
- Fernández-Carvajal, M.C. 1983. *Revisión del género Juncus L. en la Península Ibérica IV. Subgéneros Juncinella (Fourr.) Krecz. & Gostch., Septati Buchenau y Alpini Buchenau*. Anales Jard. Bot. Madrid 39: 301-379.
- Fuente V. de la, 1986. *Vegetación orófila del occidente de la provincia de Guadalajara (España)*. Lazaroa, 8: 123-219.
- Géhu J.M. & Rivas-Martínez S., 1982. *Notions fondamentales de Phytosociologie*. Ber. Internat. Symp. IAVS, Syntaxonomie: 1-33.
- Losa-Quintana J.M., Molero-Mesa J. & Casares M., 1986. *El paisaje vegetal de Sierra Nevada: la cuenca alta del río Genil*. Secret. Publ. Univ. Granada, 285 pp.
- Losa-Quintana J.M., Molero-Mesa J., Pérez-Raya F. & Casares M., 1987. *Comunidades higrófilas del piso supramediterráneo en la cuenca del río Genil*. Secr. Publ. Univ. La Laguna. Serie Informes, 22: 217-222. Tenerife.
- Luceño M., 1994. *Monografía del género Carex en la península Ibérica e Islas Baleares*. Ruizia 14. CSIC, Madrid. 139 pp.
- Martínez-Parras J.M., Peinado M. & Alcaraz F., 1987a. *Comunidades vegetales de Sierra Nevada (España)*. Serv. Publ. Univ. Alcalá, Madrid, 74 pp.
- Martínez-Parras J.M., Peinado M. & Alcaraz F., 1987b. *Datos sobre la vegetación de Sierra Nevada*. Lazaroa 7: 515-533.
- Martínez-Parras J.M., Molero-Mesa J., Peinado M. & Pérez-Raya F., 1987c. *La vegetación forestal de riberas en la provincia de Granada*. Secr. Publ. Univ. La Laguna. Serie Informes, 22: 55-66. Tenerife, 397 pp.
- Molero-Mesa J., 1988. *La vegetación en los pisos supra y oromediterráneo del sector Nevadense*. Monogr. Fl. Veg. Béticas 3: 143-152.
- Molero-Mesa J., 1999. *The vegetation of Sierra Nevada*. In: Rivas-Martínez S., Loidi J., Costa M., Díaz-González T.E. & Penas A. *Iter Ibericum A.D. MIM*. It. Geobot. 3: 105-118.
- Molero-Mesa J., Pérez-Raya F. & Valle F., 1992. *Parque Natural de Sierra Nevada. Paisaje, Fauna, Flora e Itinerarios*. Ed. Rueda, Madrid, 520 pp.
- Mota J.F., Valle F., 1987. *Estudio Botánico-Ecológico de las cuencas altas de los ríos Bayárcal, Paterna y Andarax (Sierra Nevada Almeriense)*. Serv. Publ. Excm. Diputación de Almería, 269 pp.
- Muñoz-Garmendia F. & Navarro C. (eds.), 1998. *Flora Ibérica. Plantas Vasculares de la Península Ibérica e Islas Baleares. Vol. VI.: Rosaceae*. Real Jardín Botánico, CSIC, Madrid. 592 pp.
- Pérez-Raya F., López-Nieto J.M., Molero-Mesa J. & Valle F., 1990. *Vegetación de Sierra Nevada*. Guía geobotánica de la excursión de las X Jornadas de Fitosociología. Ayuntamiento de Granada-Universidad de Granada, 121 pp.
- Prieto P., 1971. *Vegetación de Sierra Nevada: la cuenca del Monachil*. Secretariado de Publicaciones de la Universidad de Granada, 205 pp.
- Quézel P., 1953. *Contribution a l'étude phytosociologique et géobotanique de la Sierra Nevada*. Mem. Soc. Bot. 9: 5-82.
- Ríos S., 1996. *El Paisaje Vegetal de las Riberas del Río Segura (SE. de España)*. Tesis Doctoral. Universidad de Murcia, 711 pp.
- Rivas Goday S. & Mayor M., 1966. *Aspectos de la vegetación y flora orófila del Reino de Granada*. Anales Real Acad. Farmacia, 31: 345-400.
- Rivas-Martínez S., 1961. *Los pisos de vegetación de Sierra Nevada*. Bol. Real. Soc. Esp. Hist. Nat. 59: 55-64.
- Rivas-Martínez S., 1996. *Clasificación Bioclimática de la Tierra*. Folia Botanica Matritensis 6: 1-32.
- Rivas-Martínez S., Fernández-González F. & Sánchez-Mata D., 1986. *Datos sobre la vegetación del Sistema Central y Sierra Nevada*. Op. Bot. Pharm. Comp., 2: 3-136.
- Rivas-Martínez S., Asensi A., Díez-Garretas B., Molero-Mesa J. & Valle F., 1997. *Biogeographical synthesis of Andalusia (Southern Spain)*. J. Biogeogr. 24: 915-928.
- Rivas-Martínez S., Fernández-González F. & Loidi J., 1999. *Checklist of plant communities of Iberian peninsula, Balearic and Canary islands to suballiance level*. It. Geobot., 13: 353-451.
- Romero A.T., Blanca G. & Morales C., 1988. *Revisión del género Agrostis L. en la Península Ibérica*. Ruizia 7. CSIC, Madrid, 160 pp.
- Salazar C., 1996. *Aproximación al conocimiento de la vegetación riparia de los ríos nevadenses en la cuenca del Guadiana Menor (ríos Alhama de Lugros y Guadix)*. Actas Ier Conferencia Internacional Sierra Nevada, Vol. II: 353-372. 608 pp.
- Salazar C., García-Fuentes A., Torres J.A., Melendo M., Valle F. & Cano E., 1999. *Comunidades de Juncus effusus L. en Sierra Nevada (España)*. Quercetea, 1:117-122.
- Salinas M.J. & Blanca G., 1996. *Vegetación forestal riparia en la provincia de Almería (SE. España)*. Monogr. Fl. Veg. Béticas 9: 57-95.
- Talavera S. & Valdés B., 1976. *Revisión del género Cirsium (Compositae) en la Península Ibérica*. Lagasalia 5 (2):127-224.
- Talavera S., Aedo C., Castroviejo S., Romero Zarco C., Sáez L., Salvaggio F.J. & Velayos M. (eds.), 1999. *Flora Ibérica. Plantas Vasculares de la Península Ibérica e Islas Baleares. Vol. VII (I): Leguminosae (partim)*. Real Jardín Botánico, CSIC, Madrid. 578 pp.
- Tutin T.G., Heywood V.H., Burges N.A., Valentine D.H., Walters S.M. & Webb D.A. (eds.), 1964. *Flora Europaea. Vol. I. Lycoodiaceae to Platanaceae*. Cambridge University Press, Cambridge, 464 pp.
- Tutin T.G., Heywood V.H., Burges N.A., Moore D.M., Valentine D.H., Walters S.M. & Webb D.A. (eds.), 1968. *Flora Europaea. Vol. II. Rosaceae to Umbelliferae*. Cambridge University Press, Cambridge, 455 pp.
- Tutin T.G., Heywood V.H., Burges N.A., Moore D.M., Valentine D.H., Walters S.M. & Webb D.A. (eds.), 1972. *Flora Europaea. Vol. III. Diapensiaceae to Myoporaceae*. Cambridge University Press, Cambridge, 370 pp.
- Tutin T.G., Heywood V.H., Burges N.A., Moore D.M., Valentine D.H., Walters S.M. & Webb D.A. (eds.), 1976. *Flora Europaea. Vol. IV. Plantaginaceae to Compositae (and Rubiaceae)*. Cambridge University Press, Cambridge, 505 pp.
- Tutin T.G., Heywood V.H., Burges N.A., Moore D.M., Valentine D.H., Walters S.M. & Webb D.A. (eds.), 1980. *Flora Europaea. Vol. V. Alismataceae to Orchidaceae (Monocotyledones)*. Cambridge University Press, Cambridge, 439 pp.
- Valle F., 1985. *Mapa de series de vegetación de Sierra Nevada (España)*. Ecol. Medit. 11: 183-199.

Received October 18, 2000

Accepted May 28, 2001.