ISSN: 0211-9714

ROADSIDE VEGETATION IN THE CAMPO DE GIBRALTAR (SW SPAIN) AND ON THE TANGIER PENINSULA (NW MOROCCO)

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BIBLID [0211-9714 (2004) 23, 63-94]
Fecha de aceptación del artículo: 7-02-2005

RESUMEN: El presente trabajo es un estudio de la vegetación ligada a las veredas y bordes de carreteras de ambos lados del estrecho de Gibraltar. Para ello se han levantado 180 inventarios fitosociológicos en diferentes áreas de las penínsulas Gaditana y Tingitana con los que se ha realizado una clasificación fitosociológica en base a análisis de correspondencias (AC y ACD). Los bordes de las carreteras a menudo son colonizados por especies capaces de resistir grandes alteraciones en el sustrato donde a veces no podemos reconocer un elevado número de especies diagnósticas, lo que nos lleva a aplicar la aproximación deductiva de Kopecký & Hejný. Este empobrecimiento de táxones estenoicos aparece representado en los análisis de correspondencia. Debido a la gran variabilidad de medios físicos ligados al impacto humano, la vegetación de los bordes de las carreteras está florísticamente bien diferenciada y puede clasificarse en 12 asociaciones, 10 subasociaciones y algunas unidades de menor rango correspondientes a las clases *Polygono-Poetea annuae, Stellarietea, Artemisietea* y *Molinio-Arrhenatheretea*.

Palabras clave: fitosociología, análisis de ordenación y clasificación, hábitats antrópicos, vegetación ruderal, Región Mediterránea.

ABSTRACT: Roadside vegetation was studied on field paths and along road verges outside settlements on both sides of the Straits of Gibraltar. 180 phytosociological relevés have been sampled in different ecoregions of the Gaditanean and Tingitanean Peninsulas. CA and DCA were performed to evaluate the phytosociological classification. Stands at road verges are often dominated by species resilient to frequent disturbance. Such stands, poor in diagnostic species, are classified and named according to the deductive approach of KOPECKÝ & HEJNÝ. The lack of stenoic taxa is underlined by correspondence analyses. Due to the great variability of the physical environment and of human impact, roadside vegetation is floristically much differentiated and can be classified into 12 associations, 10 subassociations and some rank-less vegetation units. They belong to the classes *Polygono-Poetea, Stellarietea*, *Artemisietea* and *Molinio-Arrhenateretea*.

Key words: phytosociology, ordination and classification analysis, man-made habitats, ruderal vegetation, Mediterranean Region.

INTRODUCTION

With the expansion of the road network in the 20th century, roadside habitats became a field of interest for ecologists. In temperate Europe, the vegetation at road verges was studied quite intensively and under different aspects. Some authors asked to what extent the regional physical conditions (substrate, local climatic gradients) are reflected in the floristic composition of the roadside vegetation and in the distribution pattern of roadside plant communities (RATTAY-PRADE, 1988; ULLMANN & *al.*, 1990; HEINDL & ULLMANN, 1991; HEINDL, 1992; GODEFROID & TANGHE, 2000; SCHAFFERS & SÝKORA, 2002). From all these studies it became evident that the roadside vegetation reflects to some extent the regional ecological differentiation and varies from ecoregion to ecoregion. Moreover, the standardisation of the substrate for road construction and the strong anthropogenic impact near the tarred street results in a declining regionalization and increasing banalisation of the plant cover, the closer to the pavement (ULLMANN & HEINDL, 1989).

Publications dealing with roadside vegetation in Mediterranean areas are in most cases not oriented exclusively to the roadside environment, but to ruderal vegetation in general. In Andalusia for example, ruderal plant communities have been studied by BARTOLOMÉ ESTEBAN & *al.* (1988), PEINADO & *al.* (1986) and CANO CARMONA & GARCÍA FUENTES (1994), in Jaén by GARCIA-FUENTES & *al.* (1994) and in the Granada province by LADERO & *al.* (1981). Further records come from central and northern parts of Spain (LADERO & *al.*, 1983; RIVAS-MARTÍNEZ & *al.*, 1986; LADERO & *al.*, 1987; DÍAZ GONZÁLEZ & *al.*, 1988; PENAS MERINO & *al.*, 1988; LOIDI & *al.*, 1995; 1996).

In other Mediterranean countries and on Mediterranean islands such studies are rare (OBERDORFER, 1954; BRULLO & MARCENÒ, 1985; HRUŸKA, 1985a; 1985b; BIONDI & BALDONI, 1991; BRANDES, 1998a; 1998b; PIRONE, 2001). In the Mediterranean part of North Africa, roadside vegetation has not yet been analysed except in the Cyrenaica (Libya) (BRULLO, 1985) and with some preliminary observations in Algeria (ABDELKRIM, 2004).

The main objective of this paper is to provide a synopsis of the plant communities colonizing road verges in the Campo de Gibraltar (SW Spain) and on the Tangier Peninsula (NW Morocco). First information about roadside vegetation in this area is available in two regional vegetation monographs (GALÁN DE MERA, 1993; DEIL, 1997a). Some vegetation types are documented in the context of pasture communities (GALÁN DE MERA & *al.*, 1997) and therophytic ruderal vegetation (GALÁN DE MERA, 1994; 1995). Examples of contact series at roadsides, based upon two transects from Morocco and Spain, are illustrated by DEIL (1998).

The Gaditanean and the Tingitanean peninsula offer nearly identical physical conditions (ANDRÉ, 1971), but are submitted to different land-use systems and human impact. An analysis of the vegetation landscapes at both sides of the Straits of Gibraltar showed that most of the roadside plant communities belong to the culturally indifferent vegetation types. Frequency and spatial pattern however differ between Spain and Morocco (DEIL, 1997a; 2003a). The reasons for this phenomenon will be discussed after the description of the plant communities and an analysis of their distribution according to the bioclimatic differentiation and edaphic variability of the investigated area. The study will concentrate upon the modern road network and some observations from traditional field-paths ("veredas» and «cañadas»).

THE STUDY AREA

Topography: The peninsulas at both sides of the Straits of Gibraltar have been chosen as study areas (Fig. 1). The European part is the Campo de Gibraltar («Aljíbico and Gaditano-Onubense» sectors in phytogeography), located in Cádiz province. The African equivalent in northwestern Morocco is the Tangier Peninsula («Tangérois» in Moroccan geographical literature, «Tingitano» sector in phytogeography), belonging to the provinces Tanger, Larache and Tetouan (PÉREZ LATORRE & *al.*, 1996).

Geology and substrate: The Gibraltar Peninsulas are part of the Betic-Rifean mountainous arc. Common sedimentation processes and a synchronous orogenetic uplift resulted in identical geological structures (ANDRÉ, 1971; DIDON & *al.*, 1973). The sandstone ridges and Cretaceous Flysch Series of the «Unidad de Campo de Gibraltar» in Spain are equivalent to the «Unité numidienne» in Morocco. Vertisols

(black cotton soils), originating from calcareous-rich marls, are widespread in the thermomediterranean lowlands (CSIC-IARA, 1989; DEIL, 1997b).

Climate: The study areas are situated at the western side of high mountain chains and are therefore subjected to the influence of westerly winds and low pressure areas. According to the bioclimatic classification of RIVAS-MARTÍNEZ (www. globalbioclimatics.org) and the climatic data of MÜLLER (1982), the bioclimatic diagnosis of the study area is referenced in table 1.

Phytogeography: The identity of the two peninsulas in substrate, soils and climate and a land bridge across the Straits until the Pliocene resulted in a great floristic similarity (GALÁN DE MERA & VICENTE ORELLANA, 1997). VALDÉS (1991) and DEIL & GALÁN DE MERA (1996) underline the floristic and vegetational similarities by setting up a Tingitano-Onubo-Algarvian phytogeographical province. A few species, occurring also at road verges, are restricted to the African part of the study area: *Calendula stellata*, *Iris tingitana*, *Brassica souliei* and *Salvia mourettii*.

	Alt.	T	P	Ic	Tp	Itc	Io	Bioclimatic Diagnosis
Tarifa (36°01'N, 5°36'W)	20	18	794	10.1	2.163	448	3.7	Mediterranean Pluviseasonal-Oceanic, low thermomediterranean, low subhumid
Vejer de la Frontera (36°17'N, 5°52'W)	40	18	758	13.1	2.173	425	3.5	Mediterranean Pluviseasonal-Oceanic, low thermomediterranean, upper dry
Medina Sidonia (36°24'N, 5°55'W)	90	19	829	14.9	2.274	430	3.6	Mediterranean Pluviseasonal-Oceanic, low thermomediterranean, low subhumid
Tanger (35°43'N, 5°54'W)	15	17.2	895	11.0	2.026	370	4.4	Mediterranean Pluviseasonal-Oceanic, upper thermomediterranean, low subhumid

TABLE 1. Bioclimatic index and diagnosis of some meteorological stations of the study area. T= mean annual temperature (ºC), P= mean annual precipitation (mm), Ic= continentality index, Tp= annual positive temperature, Itc= compensated thermicity index, Io= ombrothermic index.

Human impact and land-use: Human influence on the vegetation cover is quite different on the European and African sides. In general, human pressure is higher in Morocco. The density of the rural population in Morocco is two to three times higher than in Spain. In arable land, agro-industrial management prevails in Spain, small-holder pre-industrial farming with remnants of a self-sustaining agricultural system in Morocco. The economic contrast between both countries becomes also visible in the technical effort for road construction. In Morocco, un-tarred roads and field-paths on autochthonous material are still quite common. In Spain, even the secondary road network and most of the access roads to big farmhouses («Cortijos») are paved or tarred (DEIL, 1993).

METHODS AND NOMENCLATURE

Roadside vegetation was studied on field paths (2-5 m^2) and along road verges outside settlements. A stratified sampling design was used to cover all the different ecoregions of the study area. Phytosociological relevés were sampled in the different microbiotopes observed in the roadsides, according to the BRAUN-BLANQUET method (BRAUN-BLANQUET, 1932): banquettes next to the asphalt, road shoulders and embankments, and in the field paths, too. A total of 180 relevés were made up in April-July of 2003, and were compared with others made up by authors in previous years (not published yet). All relevés were manually arranged and integrated into the syntaxonomic system. To evaluate the results of the phytosociological classification, we additionally performed Correspondence Analysis (CA) and Detrended Correspondence Analysis (DCA) with the software package CANOCO for Windows 4.5 (TER BRAAK & ŠMILAUER, 1998).

For plant species, taxonomic nomenclature is according to VALDÉS & *al.* (1987) and VALDÉS & *al.* (2002). For the names of plant associations and the syntaxonomic system we follow RIVAS-MARTÍNEZ & *al.* (2001, 2002) and FENNANE (2003), except for the *Cerintho-Fedion, Bromo-Oryzopsion* and *Molinio-Arrhenatheretea*. The results are presented in a syntaxonomic scheme.

Like in Central Europe, stands at road verges in the Mediterranean are often dominated by resilient species (GRUBB & HOPKINS, 1986). In habitats with a high frequency of disturbance and in unsaturated communities, stenoic species (character species at the association and alliance level) are missing. These fragmentary communities, poor in diagnostic species, are classified and named following the deductive approach proposed by KOPECKÝ & HEJNÝ (1974) and KOPECKÝ & *al.* (1995). A «basal community» (BC) is characterized by species of high-ranked syntaxa. If a companion becomes dominant, we use the term «derivat community» (DC).

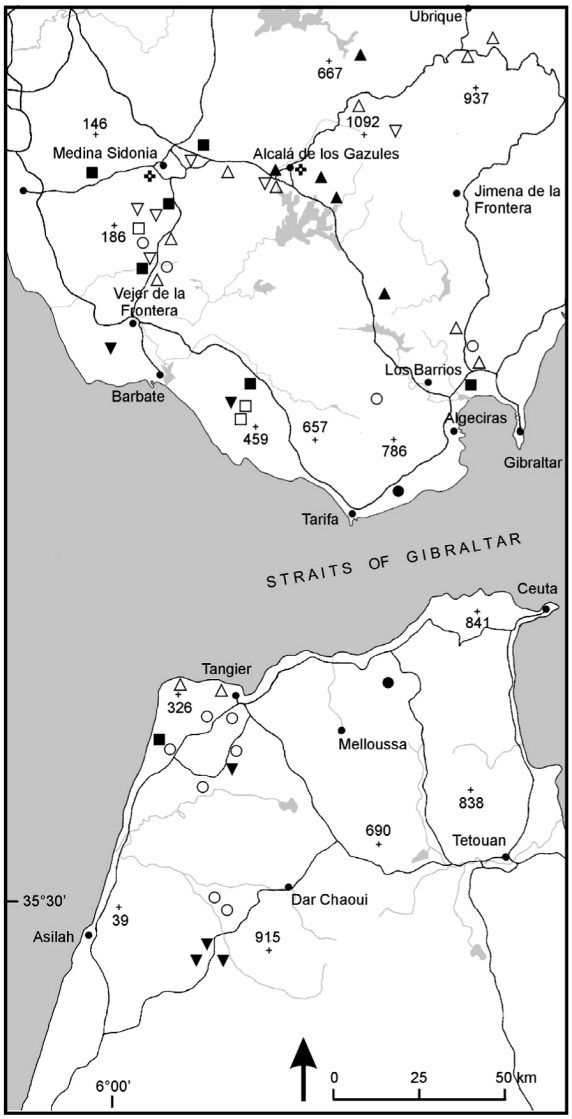

FIGURE 1. Sampling points of the *Polygono-Poetea*, the *Artemisietea* and the *Molinio-Arrhenatheretea* communities. ▼ *Poo-Coronopetum squamati*, ✚ *Solivetum stoloniferae*, ▽ *Crassulo-Saginetum apetalae*, □ *Ammi visnaga*-[*Carthametalia*]-DC, ○ *Notobasio-Scolymetum maculati*, ● *Chamaeleo-Echietum boissieri*, ■ *Scolymo-Silybetum mariani*, ▲ *Oryzopsio-Daucetum maximi*, Δ *Hedysaro-Phalaridetum coerulescentis*.

RESULTS

Pioneer communities on trampled ground (*Polygono-Poetea annuae*)

Field paths («veredas»), the fissures of paved roads and places in settlements are colonized by annuals and creeping perennials resistant to heavy trampling. Three associations and four subassociations of the *Polygono-Poetea annuae* are recorded from the study area.

Poo annuae-Coronopetum squamati (Tab. 2, col. 1-2): The community is distributed all over the Mediterranean region. From the study area, it is documented from the lowlands close to the coast, the Fahs and Arba Ayacha region in Morocco, and the surroundings of Almarchal and Vejer de la Frontera in Andalusia (Fig. 1). Constant companions are the grazing and trampling resistant perennial creeping grasses *Cynodon dactylon* and *Lolium perenne* (transgressives from the *Trifolio-Cynodontion*) and dwarf thistles like *Centaurea calcitrapa*. Cover values range from 25 to 70%.

Beside **subass. typicum** (Tab. 2, col. 1), the subtype ***hainardietosum cylindricae*** **subass. nov. hoc loco** (Tab. 2, col. 2) was observed. It occurs on Almarchal-clay with a certain salt content. Differentiating species are the halo-tolerant plants *Hainardia cylindrica*, *Hordeum marinum* and *Spergularia rubra* subsp. *longipes*. *Lythrum junceum* and *Pulicaria paludosa* indicate a better water supply than in subassociation typicum. The subassociation *hainardietosum* is the transition to the *Plantagini coronopodi-Hordeetum marini* (less ruderalized salty soils in the study area, see GALÁN DE MERA, 1993) **Holotypus:** *Coronopus squamatus* 2, *Hainardia cylindrica* 2, *Hordeum marinum* +, *Lythrum junceum* +, *Plantago coronopus* +, *Cynodon dactylon* 2, *Lolium perenne* 2, *Medicago polymorpha* 1, *Otospermum glabrum* 1, *Pulicaria paludosa* +, *Rumex pulcher* +, *Cichorium intybus* +, *Trifolium isthmocarpus* +, *Malva nicaeensis* 3, *Echium plantagineum* +, *Bromus hordeaceus* +, *Rapistrum rugosum* +. **Locality**: Spain, Cádiz, roadside between Vejer de la Frontera and Los Caños de Meca.

Solivetum stoloniferae (Tab. 2, col. 3): Trampled places in settlement and their surroundings are colonized by the *Solivetum*. It is documented from Medina Sidonia and Alcalá de los Gazules. It often grows in contact with the *Anacyclo-Hordeetum leporini* (GALÁN DE MERA, 1993). The sandy substrate is indicated by transgressive species from the class *Helianthemetea* like *Sedum rubens*, *Filago pyramidata* and *Aphanes microcarpa*. Short flooding in spring stimulates the germination of the dwarf rush *Juncus pygmaeus (Isoeto-Nanojuncetea)*. The *Solivetum* can be interpreted as a form of the *Crassulo-Saginetum*, enriched in the thermomediterranean bioclimate with the invasive neophytes *Gymnostyles stolonifera* and *Alternanthera caracasana*. *Gymnostyles stolonifera* has recently been recorded

from Morocco (FENNANE & EL OUALIDI, 2000) and the occurance of the *Solivetum* can be expected also from the African part of the study area. *Alternanthera* species and *Euphorbia* species from subgenus *Chamaesyce* (like *E. serpens*) are considered as character species of the alliance *Chamaesycion prostratae* (*Euphorbienea prostatae* Vicedo & *al.*, 1995). They also occur in the summer ecophase of the *Solivetum*.

Crassulo tillaeae-Saginetum apetalae (Tab. 2, col. 4-5): Similar edaphic conditions like the *Solivetum*, but a broader thermical amplitude (thermo- and mesomediterranean bioclimate) characterize the *Crassulo-Saginetum*. It is documented from Spain. The name-giving species *Crassula tillaea* and *Sagina apetala* occur with high constancy. The association is often in contact with the less nitrophytic communities of the *Helianthemetea*. Character species of this class like *Mibora minima* and *Tuberaria guttata* are constant companions. Besides the typical subassociation (col. 4), the subtype ***trifolietosum suffocati*** (col. 5) grows on sandy soils with organic material from shepperd activity (RIVAS-MARTÍNEZ, 1975).

Annual roadside vegetation of the class *Stellarietea mediae*

The extratropical cosmopolitic class *Stellarietea mediae* includes nitrophilous and subnitrophilous weed communities, dominated by therophytes and geophytes. CANO CARMONA & GARCÍA FUENTES (1994) give a synopsis of the associations occurring in Andalusia. A small spectrum of them can be found along roadsides.

***Aegilops geniculata*-[*Taeniathero-Aegilopion*]-basal community** (Tab. 2, col. 6-7): Low growing *Trifolium*- and erect *Aegilops*-annuals, both short-living in the favourable spring period, characterize the West-Mediterranean alliance *Taeniathero-Aegilopion*. Along roadsides, the stands are impoverished in comparison with those recorded from pasture ground. In the Spanish part of the study area, this community is observed from the Sierra de Grazalema. It occurs there on basic screes. The stands are not grazed and achieve cover values of 60 to 100%. A tall-growing grass layer with *Bromus* and *Avena* sp. overtops the *Aegilops* grasses of mid altitude and the low growing dicotyledonous herbs. The heavily grazed Moroccan stands are lower growing (approximately 20 cm) and more open. This community occurs on road embankments, on road shoulders, and at the fringes of small forests on different substrates (sandstone gravel, Aljibe-clay).

The *Aegilops geniculata-[Taeniathero-Aegilopion]*-BC is quite rich in species (> 50 species per relevé) due to many companions and species of higher units. It is floristically related to the *Trifolio-Taeniatheretum caput-medusae* [roadside verges, heavily grazed gravel terraces over silicate, mainly in mesomediterranean and continental areas of Central Spain (RIVAS-MARTÍNEZ & IZCO, 1977)]. Character species at the association level are however missing. This type is characterized by species of the alliance (*Aegilops geniculata*, *A. triuncialis*, *Trifolium cherleri*, etc.). Under

grazing pressure, *Carthametalia*-species are invading (*Cynara humilis*, *Carlina racemosa*, etc.) and the floristic composition is more and more a mixture of the classes *Stellarietea* and *Artemisietea*. Some floristic resemblances (for example by *Cleonia lusitanica*) can be stated with the *Velezio-Asteriscetum aquaticae* Rivas Goday 1964 (GALÁN DE MERA, 1993).

Trifolio pallidi-Vulpietum geniculatae (Tab. 2, col. 8): This community was described by GALÁN DE MERA (1995) from the study area. It is a subnitrophilous pasture community on sandy to sandy-loamy soils, distributed in the SW Iberian Peninsula and in Northern Morocco in the thermo- and mesomediterranean climatic belts. Along roadsides and on grazed fallow land it is differentiated by a number of species (*Malva hispanica*, *Biscutella baetica*, etc.) from the typical form. Under strong grazing impact, thistles *(Carlina racemosa, Cynara humilis)* become more and more abundant (transitions to the *Notobasio-Scolymetum*, see succession scheme in GALÁN DE MERA, 1995). *Cynodon dactylon* and *Plantago serraria* indicate the trampling and impact by cars, when this community occurs on the road shoulder. The *Trifolio-Vulpietum geniculatae* is vicarious with the Galactito-Vulpietum geniculatae O. Bolòs & Molinier 1969 (E of Spain, Balearic Islands, Corsica, Sardinia, Sicily and Italy) and the *Coleostepho myconis-Galactitetum tomentosae* Izco & Collado 1983 (N of Spain). In the Sierra Morena, these habitats are occupied by the *Tordylio officinalis-Vulpietum geniculatae* (TAMAJÓN & *al.*, 1999).

Gastridio-Trifolietum scabri: The *Gastridio-Trifolietum scabri* is an open roadside community on sandy soils. It is quite small-growing and reaches cover values between 20 and 70%. It is documented by two relevés from the surroundings of Almarchal in Spain. Although recorded here from the thermomediterranean, its optimum lies in the mesomediterranean bioclimate (CANO CARMONA & GARCIA FUENTES, 1994). The floristic position is in the transition from the alliance *Taeniathero-Aegilopion* (*Aegilops geniculata-[Taeniathero-Aegilopion]*-BC) to the *Echio-Galactition* (*Trifolium scabrum-[Echio-Galactition]*-DC).

***Trifolium scabrum-[Echio-Galactition]*-derivat community** (Tab. 2, col. 9-10): The creeping clover *Trifolium scabrum* is constant and abundant immediately along the tarred road, if the road shoulder was constructed with well-draining materials like sand or calcareous gravel. It is associated there with subnitrophytic annual grasses *(Bromus sp., Vulpia geniculata, Lagurus ovatus)*, small annual Dicots *(Trifolium stellatum, Campanula erinus, Silene colorata, Plantago afra, Petrorhagia nanteulii)*, and some herbs of medium size (*Galactites tomentosa*, *Scabiosa atropurpurea*, *Plantago lagopus*, etc.). This unique mixture of species can be interpreted as a derivate from the *Gastridio-Trifolietum scabri (Echio-Galactition)* with transgressives from *Hordeion* and *Hyparrhenietalia*. This banquette vegetation type is very common in the Spanish part of the study area, even along secon-

dary roads, field paths and access roads to farm houses. In Morocco, it is restricted to the main traffic axes and to secondary roads passing regions with sandy substrate (DEIL, 2003a). Along the road network in Morocco, passing through landscapes with heavy soils (clay, marl, tirs, etc.) like Fahs (the Tangier hinterland) and Habt (the Asilah hinterland), this community is missing because there minor roads are constructed with the autochthonous material. This material is not suitable for the development of the community, if it is not well-draining.

A **variant with *Lotus arenarius*** (Tab. 2, col. 10) of the *Trifolium scabrum*-[*Echio-Galactition*]-DC occurs at places where material from coastal sand dunes or calcareous sand from quarries in the Eocene sandstone layer is used for road construction. This variant is differentiated by a number of species, which are originally restricted to therophytic vegetation on sand dunes like *Lotus arenarius*, *Hedypnois arenaria*, *Jasione montana* subsp. *blepharodon* and *Crepis capillaris*. This is an example of rypochory (plant dispersal by transport of material for construction), one of the factor for viatic migration (KOPECKÝ, 1988). In a process of apophytisation, these species have expanded their ecological niche and distribution from the subnitrophytic, Gaditanian dune community *Loto arenarii-Diplotaxietum siifoliae* Peinado & Martínez-Parras 1989 respectively the *Linarion pedunculatae* (DÍEZ GARRETAS & *al.*, 2003), into a banquette community and from the coast further to the inland (Fig. 2).

Anacyclo radiati-Hordeetum leporini (Tab. 2, col. 11-13): The *Anacyclo-Hordeetum (Hordeion leporini)* is the most common roadside community in the study area. The association is of SW Iberian - NW Moroccan distribution, ranging from Lisbon through Alentejo, Algarve, Extremadura, and SW Andalusia to the Tangier Peninsula and Gharb Plain until Rabat. This is identical with the distribution of *Anacyclus radiatus*. The community occurs on various substrates (see subtypes). It is linked to the Atlantic variant of the Mediterranean climate and to the thermo- and mesomediterranean belt (Fig. 2) (for more details and a distribution map see RIVAS-MARTÍNEZ, 1978). The aspect in Spring is colourful. This species-rich community is taller growing and denser that the shoulder communities mentioned before. In the study area, the *Anacyclo-Hordeetum* is hard to separate from the *Hordeo leporini-Brassicetum nigrae* Bartolomé & al. 1988. The latter community can be considered as an early Spring facies of the *Anacyclo-Hordeetum*.

Three subtypes can be differentiated: The **subassociation typicum** (col. 11) grows along roadsides and traditional grazing tracks («Cañadas»), and on ruderal sites in villages, with preference of loamy and acid substrates (Aljibe sandstone, oversanded Almarchal clay). The stands are in contact with heathland communities, *Opuntia* hedges, *Silybum marianum*-stands, fallowland communities and weed phytocoenoses of the *Ridolfion*. The common contact to *Phalaridetalia*-pastures is reflected floristically by the introgression of taxa like *Hedysarum coronarium*, *Gaudinia fragilis* and *Trifolium isthmocarpum*.

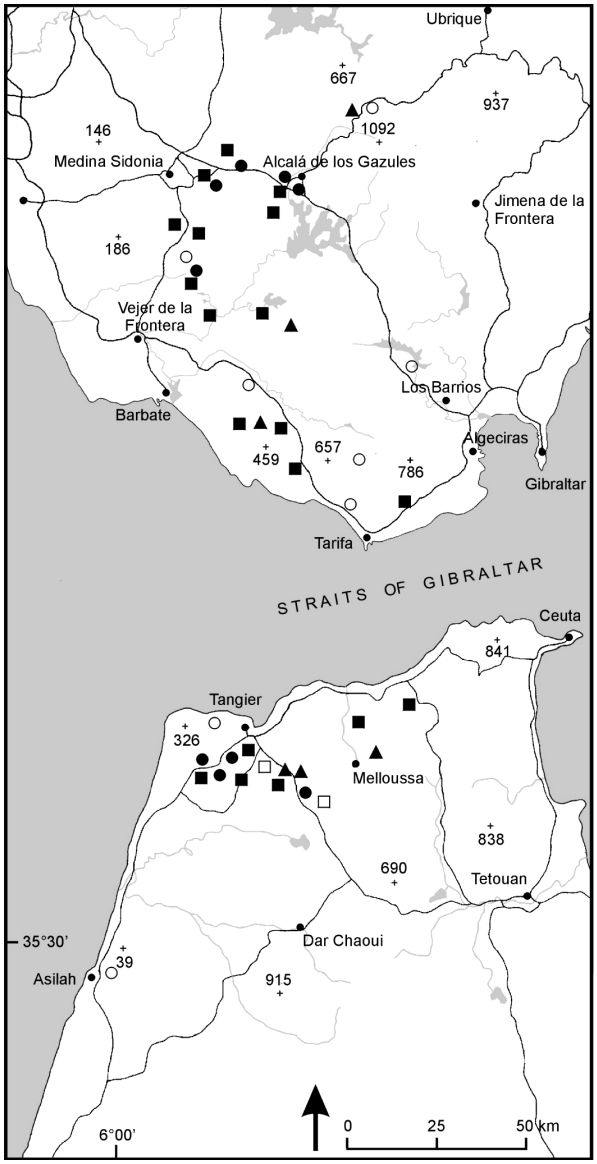

FIGURE 2. Sampling points of the *Stellarietea mediae* communities. ▲ *Aegilops geniculata*-[*Taeniathero-Aegilopion*]-BC, □ *Trifolio-Vulpietum geniculatae*, ○ *Trifolium scabrum*-[*Echio-Galactition*]-DC, ● *Hordeo-Glossopappetum macroti*, ■ *Anacyclo-Hordeetum leporini*.

The **subassociation *chrysanthemetosum coronarii*** (col. 12) is less acidophytic and needs a good soil water regime on sandy-loamy soils. This subtype is differentiated by the tall growing taxa *Chrysanthemum coronarium* and *Lavatera cretica* (up to 100 cm). It forms a dense vegetation cover when fully developed in spring. Beside road embankments and waste places in settlements in Spain and Morocco, this subassociation can also be found on the nitrophytic resting places of animals in Holy Forests in Morocco (DEIL, 2003b). Frequent contact communities are the *Notobasio-Scolymetum maculati* and the *Scolymo-Silybetum mariani*. In other regions of the Mediterranean area, this subassociation is substituted by the *Resedo-Chrysanthemetum* O. Bolòs & Molinier 1958 (E Spain and Baleraic Islands), the *Chrysanthemo-Convolvuletum* Négre 1964 (Algeria) and the *Malvo-Chrysanthemetum* Ferro 1980 (Sicily) (GALÁN DE MERA, 1993).

Roadside embankments submitted to a high grazing pressure (mostly in Morocco) are differentiated by a number of transgressive species from the class *Artemisietea*, especially from the association *Notobasio-Scolymetum* (*Scolymus maculatus*, *Notobasis syriaca*, *Carduus bourgeanus*, *Cichorium intybus*) and other grazing resistant species like *Cynodon dactylon* and *Daucus muricatus*. The stands belong to the new subassociation ***notobasetosum syriacae*** **subass. nov. hoc loco** (Tab. 2. col. 13). This subassociation is the floristic, ecological and spatial transition from roadside vegetation, dominated by annuals (Stellarietea) to communities dominated by perennials (Artemisietea). **Holotypus**: *Anacyclus radiatus* 3, *Hordeum leporinum* 2, *Notobasis syriaca* 1, *Scolymus maculatus* 1, *Urospermum picroides* +, *Carduus bourgeanus* 2, *Glossopappus macrotus* +, *Calendula arvensis* 1, *Plantago lagopus* 1, *Rumex pulcher s.l.* +, *Bromus matritensis* +, *Galactites tomentosa* 1, *Echium plantagineum* +, *Medicago polymorpha* +, *Lolium rigidum* +, *Bromus hordeaceus* 1, *Trifolium angustifolium* +, *Carlina racemosa* +, *Cynara humilis* +, *Scabiosa atropurpurea* +, *Daucus carota* subsp. *maximus* +, *Scolymus hispanicus* +, *Mantisalca salmantica* 1, *Carthamus lanatus* 1, *Eryngium campestre* 1, *Ononis mitissima* +, *Scabiosa semipapposa* 1, *Trifolium isthmocarpum s.str.* +, *Gaudinia fragilis* +, *Trifolium squamosum* +, *Polygarpon tetraphyllum* +, *Cynodon dactylon* 2, *Brachypodium distachyon* +, *Trifolium campestre* +, *Leontodon longirostris* +, *Otospermum glabrum* +, *Cichorium endivia* 1, *Rapistrum rugosum s.str.* 1, *Crepis vesicaria* subsp. *haenseleri* +, *Delphinium gracile* +, *Phalaris brachystachys* +, *Torilis nodosa* +, *Erodium moschatum* +, *Scrophularia sambucifolia* +, *Centaurea pullata s.str.* +, *Daucus muricatus* 1, *Convolvulus tricolor s. str.*, *Tragopogon hybridus* +, *Cuscuta planifolia* +. **Locality:** Spain, Cádiz, Medina Sidonia, near Cortijo Donadio (Puertos de Medina).

A further subtype, recorded by GALÁN DE MERA & *al.* (2000) from Gibraltar, is the subassociation *centaureetosum sonchifoliae*, colonizing sandy roadsides at the coast. These habitats are more and more invaded by the South African neophyte *Arctotheca calendula*. Such variants are synonymous with subass. *arctothecetosum calendulae* Rivas-Martínez 1978.

Hordeo leporini-Glossopappetum macroti (Tab. 2, col. 14-15): *The Hordeo-Glossopappetum* is the basiphilous vicariant to the acidophilous *Anacyclo-Hordeetum*. This colourful ruderal community is common in Spain and Morocco in the thermo- and mesomediterranean bioclimate. Most authors (RIVAS-MARTÍNEZ & *al*., 2001; 2002) include the *Hordeo-Glossopappetum* into the alliance *Hordeion leporini*. The constant occurrences of character species of the *Cerintho-Fedion* (*Borago officinalis*, *Fedia cornucopiae, Tetragonolobus purpureus*) (see also the *Tetragonolobo purpureae-Cerinthetum majoris* Abdelkrim 2004; ABDELKRIM, 2004) however and the missing of *Hordeion*-taxa are arguments to include this community in the first alliance. This is supported by the clear separation of the *Hordeo-Glossopappetum* from all other communities by the CA (see discussion). A final decision should be based on a supraregional analysis of the orders *Sisymbrietalia* and *Thero-Brometalia*.

Beside the **normal form**, observed in Spain (Tab. 2, col. 14), a **Mauretanian race** (Tab. 2, col. 15) occurs in Morocco. It is differentiated by species restricted to the African part of the study area like *Calendula stellata*, *Brassica souliei* subsp. *amplexicaulis, Iris tingitana* and *Salvia mouretii*.

Convolvulo meonanthi-Hedysaretum coronarii (Tab. 2 col. 16) was first described by PEINADO & *al*. (1986). It has many species in common with the *Hedysaro-Phalaridetum*, but is dominated by pioneer annual species. *Convolvulus meonanthus* occurs in the Aljibic-sector of Cádiz province (GALÁN DE MERA & *al*., 1997). This association is recorded from secondary roads and unpaved field paths near Los Barrios, Medina Sidonia and Alcalá de los Gazules with siliceous soils originating from Aljibe sandstone. Further inland and under more continental climatic conditions, the *Convolvulo meonanthi-Aegilopetum geniculatae* Bartolomé & al. 1989 seems to replace this association.

Convolvulo cupaniani-Malopetum trifidae (Tab. 2, col. 17) is characterized by *Convolvulus tricolor* subsp. *cupaniana*. This association is restricted to the African Side of the Straits of Gibraltar. It is also a pioneer community and occurs on road embankments and fallowland over clay and is documented with three relevés from Morocco. Further roadside and fallowland communities, characterized by *Convolvulus*-species from the *Convolvulus tricolor*-group are recorded from Sicily: *Convolvulo pentapetaloidi-Carduetum corymbosae* Brullo 1982 and *Convolvuletum tricoloris* Brullo 1982 *(Echio-Galactition)*. Many species are in common with the *Convolvulion tricoloris*, an alliance with communities of cultivated and abandoned fields and roadsides on heavy soils in the surroundings of Algiers (ABDELKRIM, 2004).

Perennial roadside vegetation, rich in thistles (*Artemisietea vulgaris*)

The *Artemisietea vulgaris*-communities, dominated by biennial and perennial forbs and grasses, have their centre of distribution in the Eurosiberian region (MUCINA, 1989). In the Mediterranean basin, these communities are characterized by tall-growing thistles of the families *Apiaceae (Eryngium, Ammi)*, *Dipsacaceae (Scabiosa)* and *Asteraceae (Cynara*, *Carthamus*, *Scolymus*, *Notobasis*, *Carduus*, *Silybum*, *Centaurea*, *Carlina*, *Echinops*, the majority of the *Compositae*-genera belonging to the tribus *Cynareae)*. Grasses and non-spiny herbs are of minor importance. The roadside communities of this class, occurring in the study area, belong to the Mediterranean order *Carthametalia lanati*. They colonize profound, nutrient rich soils of road embankments, ruderal places in settlements and heavily grazed pastures and fallowland. In the succession series on ruderal places, the *Artemisietea*-communities represent a more advanced phase and follow the therophytic, nitrophytic vegetation (LADERO & *al.*, 1983). In the contact series along road verges, they are more distant to the road than the *Stellarietea* and the *Polygono-Poetea*-communities (see Tab. 1 and 2 in DEIL, 1998).

Notobasio-Scolymetum maculati (Tab. 2, col. 18-19): This is a thermomediterranean roadside community, very constant in both parts of the study area (Fig. 1). Besides the upper herb layer dominated by *Scolymus maculatus*, *Notobasis syriaca*, *Carduus bourgeanus* and other species of the *Artemisietea* (*Onopordion nervosi*), ruderal annuals of the class *Stellarietea* occur in a second stratum. Stands in the Eastern parts of Andalusia (LADERO & *al.*, 1981) differ by *Echinops strigosus*, *Picnomon acarna* and *Echium pustulatum*.

Two subtypes can be distinguished: The **typical subassociation** (Tab. 2, col. 18) is quite poor in species and has a dense (80%) upper herb canopy. A variety of substrates (Almarchal clay, calcareous road-metal) is colonized. The subassociation ***menthetosum pulegii* subass. nov. hoc loco** (Tab. 2, col. 19,) is differentiated by species like *Mentha pulegium*, *Lythrum junceum*, *L. acutangulum*, *L. hyssopifolia*, *Centaurium pulchellum*, indicating temporary flooding or stagnant water in the rain season. The soils are rich in clay and silt. This vegetation unit occurs in road ditches, in small depression in overgrazed pasture ground, and at the lower part of the road embankment.

The *Notobasio-Scolymetum menthetosum* is documented in our data set for Morocco, but it also occurs in Spain. *Iris tingitana* is quite abundant in the surroundings of Tangier. This plant community is often in contact to arable land. It furthermore colonizes heavily grazed oldfields. This is indicated by the high frequency of succession relicts of the weed communities *Kickxio lanigeri-Tanacetum annui* Galán de Mera 1996, *Ridolfio segeti-Capnophylletum peregrini* Guinochet 1977 and *Chrozophoro tinctoriae-Teucrietum spinosi* Galán de Mera 1996 *(Ridolfion)*. By the mixture of early and later successional species, these stands are extre-

mely rich in species. **Holotypus:** *Scolymus maculatus* +, *Notobasis syriaca* 2, *Ammi visnaga* 3, *Carduus bourgaeanus* 1, *Mentha pulegium* 1, *Lythrum junceum* 2, *Centaurium pulchellum* +, *Lythrum hyssopifolia* 1, *Lythrum acutangulum* +, *Tanacetum annuum* 2, *Otospermum glabrum* 2, *Euphorbia medicaginea* 1, *Phalaris brachystachys* 1, *Capnophyllum peregrinum* +, *Teucrium resupinatum* 1, *Phalaris paradoxa* +, *Lolium temulentum* +, *Medicago intertexta* +. **Locality**: Morocco, Tangier, near Gzennaia.

***Ammi visnaga-[Carthametalia-]*-derivat community** (Tab. 2, col. 20): Fallowland near roads and settlements, heavily grazed by donkeys, mules and horses, and ruderalized dehesas used for breeding of fighting bulls, are often dominated by *Ammi visnaga*. This toxic species is associated with some biennials of the order *Carthametalia* and annuals of the class *Stellarietea*. This vegetation type is documented from the surroundings of Almarchal and Medina Sidonia (Spain), but also occurs in Morocco.

Scolymo maculati-Silybetum mariani (Tab. 2, col. 21): Deposits of excavated loamy or silty material along roadsides or *Opuntia*-hedgerows are often colonized by *Silybum marianum*. The tall-growing, luxuriant «milk thistle» dominates the upper stratum of these stands (up to 100% cover value) and is a strong competitor for short-living species. Only high-growing taxa like *Carduus pycnocephalus* can co-occur. Remnants of the earlier succession stage (for example *Anacyclus radiatus* and *Hordeum leporinum*) fill the gaps of the upper canopy. Mean species number is about 16. There are transitional stands to the *Notobasio-Scolymetum*. The habitat «heap of nitrified earth» is more common in Spain, and therefore is the *Scolymo-Silybetum*, too.

Oryzopsio miliacei-Daucetum maximi (Tab. 2, col. 22): *Daucus carota* subsp. *maximus*, *Piptatherum* (= *Oryzopsis*) *miliaceum* and *Dittrichia viscosa* dominate and characterize this community, occurring on roadside verges with preference to sandy soils in the thermomediterranean bioclimate. The *Oryzopsio miliacei-Daucetum*, first described from the Balearic Islands (BOLÒS, 1975), is documented from the Spanish part of the study area (Jerez de la Frontera, Alcalá de los Gazules). The stands are poor in species (4 to 11 per relevé). The species composition is closely related to the *Inulo-Oryzopsietum miliaceae* (A. & O. Bolòs) O. Bolòs 1957, recorded from roadsides in coastal regions all over the Mediterranean area [see RIVAS-MARTÍNEZ & *al.* (1992) and BRANDES (1998a) for the Balearic Islands, and BRULLO & *al.* (2001) for Calabria].

Pasture communities and hay meadows *(Molinio-Arrhenatheretea)*

Pastures and mown grasslands *(Molinio-Arrhenatheretea)* have their optimum in the Eurosiberian region. Some irradiations of this class (the order *Phalaridetalia coerulescentis*) however occur in those parts of the Mediterranean area, where an Atlantic subtype of the climate and deep soils with good water supply favour perennial herbs and grasses. In the study area, such stands are related to vertisols (tirs soils) and to the subhumid and perhumid thermomediterranean climate (GALÁN DE MERA & *al.*, 1997).

Hedysaro coronarii-Phalaridetum coerulescentis (Tab. 2, col. 23): This community, dominated by bulbous *Poaceae* (*Phalaris coerulescens*, *Hordeum bulbosum*) and perennial *Fabaceae* (*Hedysarum coronarium*, *Trifolium* sp.), is of Southwest-Iberian- Northwest-Moroccan distribution (Fig. 1). The productive grassland occurs on road verges, if the road network passes pasture ground or if the road embankment is mown from time to time. In comparison to the pasture ground, the vegetation cover at the roadside is less closed. This is reflected by a higher frequency of annuals of the class *Stellariatea mediae* like *Daucus muricatus*, *Calendula stellata*, *Hischfeldia incana*, *Galactites tomentosa*, *Stachys ocymastrum* and *Centaurea pullata*. *Artemisietea*-species like *Foeniculum vulgare* subsp. *piperitum* and *Daucus carota* subsp. *maximus* are transgressing into the roadside stands of the *Hedysaro-Phalaridetum*. This association is distributed over the whole altitudinal gradient from the coastal and interior lowlands (Los Barrios, Vejer de la Frontera, Medina Sidonia) to the Mountainous regions (Alcalá de los Gazules, Ubrique, Grazalema). It is a quite luxuriant, tall-growing community with a closed plant cover.

DISCUSSION

Due to the great variability of the physical environment (substrate, bioclimate) and the human impact (trampling, driving, herbicide application, burning, mowing, grazing with ruminants etc.), roadside vegetation on the peninsulas around the Gibraltar Straits is floristically much differentiated and can be grouped into a number of communities. These vegetation types belong to four different phytosociological classes: *Polygono-Poetea, Stellarietea, Artemisietea* and *Molinio- Arrhenateretea*. This sequence of the classes corresponds with a decreasing physical stress by trampling and driving on, and an increasing height and biomass of the vegetation. *Polygono-Poetea annuae* colonize trampled roads and pathways. The communities of the class *Stellarietea*, dominated by low-growing annuals, the *Artemisietea*, dominated by tall-growing biannuals to perennials, and the perennial pasture communities of

the class *Molinio-Arrhenateretea* are often arranged in a zonation complex, parallel to the road.

The «trampled habitat» of roads and field paths («veredas») is colonized by annuals and creeping perennials resistant to heavy physical stress. The three associations of the *Polygono-Poetea annuae*, recorded from the study area, differ clearly in floristic composition (see Fig. 3A). The substrate is the most important differentiating factor. The *Poo annuae-Coronopetum squamati (Sclerochloo-Coronopion squamati)* grows on vertisols (= tirs, «bugeos», «tierras de barros», black cotton soils), originating from clay and marl, the *Solivetum stoloniferae* and the *Crassulo-Saginetum (Polycarpion tetraphylli)* on better drained loamy and sandy soils. Invasive neophytes *(Gymnostyles, Alternanthera)* play a major role in *Polygono-Poetea* communities.

The comparative analysis of the *Stellarietea mediae*-data set (Tab. 2, Fig. 3B) shows a separation of the communities according to floristic dissimilarity. *Hordeo-Glossopappetum*, *Anacyclo-Hordeetum* and *Trifolio-Vulpietum* are clearly separated. The *Trifolium scabrum-[Echio-Galactition]*-DC and *Aegilops geniculata-[Taenatherio-Aegilopion]*-BC take a transitional position between *Trifolio-Vulpietum* and *Anacyclo-Hordeetum*. The main differentiating ecological factors are as follows: The horizontal axis reflects a gradient from acidic/neutral (*Anacyclo-Hordeetum*) to basic *(Hordeo-Glossopappetum)* conditions. The vertical axis reflects the transition from low- growing communities at open sites with well drained, sandy substrates *(Trifolio-Vulpietum/Echio-Galactition)* to more productive roadside communities of medium height and dense cover *(Anacyclo-Hordeetum/Hordeion, Hordeo-Glossopappetum/Cerintho-Fedion)*, developing on loamy soils with better water supply. The zonation from the banquette with an open vegetation cover, strong impact by driving and poor water supply on well drained and shallow substrates to the shoulder and embankment of the road with a closed plant canopy, a better water supply on deeper soils is to some extent related to the vertical axis.

The analysis of the road verges more distant to the tarred road *(Artemisietea)* resulted in four associations and one derivat community. The *Oryzopsio-Daucetum* within the *Ononidetalia ramosissimae* is weakly linked to the *Carthametalia* and subclass *Onopordenea*. Rivas-Martínez & *al*. (2002) placed the alliance *Bromo-Oryzopsion* into the *Carthametalia* (see the different proposals by Bolòs, 1975; Brullo, 1984). A correspondence analysis (not shown here) of the data set of table 2 proved the isolated position of the *Oryzopsio-Daucetum* and closer floristic similarities of the *Notobasio-Scolymetum* and *Scolymo-Silybetum* to the pasture communities of the alliance *Gaudinio-Hordeion* than to the *Bromo-Oryzopsion*.

After removing the *Oryzopsio-Daucetum* sampling, a DCA was performed with the *Artemisietea* and the *Molinio-Arrhenatheretea* relevés (Fig. 3C). *Hedysaro-Phalaridetum*, *Scolymo-Silybetum* and *Notobasio-Scolymetum menthetosum pulegii* cluster separately, while the relevés of the *Notobasio-Scolymetum typicum* and the

Ammi visnaga-[Carthametalia]-DC group in the centre. This reflects the fragmented floristic composition of the derivat community and the central ecological position of the *Notobasio-Scolymetum typicum*. The vertical axis in Fig. 3C can be interpreted as a gradient of anthropo-zoogenic impact (increasing grazing) from the *Hedysaro-Phalaridetum* to the *Notobasio-Scolymetum menthetosum*, corresponding with a shift from palatable to unpalatable (toxic, spiny) species. The differentiating factors for the horizontal axis might be water supply and physical disturbance (less humid conditions and higher disturbance to the right).

The fact that roadside habitats and ruderalized substrates are often colonized by species with a wide ecological and coenological amplitude (diagnostic species of syntaxa of higher rank and accompanying species) has been proved in many studies (see DOSTÁLEK, 1996). The lack of stenoic taxa (character species at the association level), which is the reason to treat them as derivat- and basal-communities, is underlined by the correspondence analyses (Fig. 3B and 3C). The deductive method (KOPECKÝ & HEJNÝ, 1974; KOPECKÝ & *al.*, 1995), often applied in roadside vegetation analysis in temperate Europe (see SZWED & SÝKORA, 1996), is a useful concept also to classify roadside communities in the Mediterranean climate. A precondition is a stabilized syntaxonomic system based upon the inductive approach. Such a system is available in the study area.

Even if many stands at road verges are poor in character species at the association level, they can have very high species numbers in general. The disturbances near roads creates open patches and germination niches for annuals even in plant communities dominated by biennials and perennials. This is reflected in the co-existence of species characteristic for quite different syntaxa, like *Thero-Brachypodietea, Stellarietea, Artemisietea* and *Molinio-Arrhenatheretea*. In our data set, the maximal species density (73 species per relevé) is obtained in the *Notobasio-Scolymetum*. Similar species numbers are recorded by LUCCHESE & PIGNATTI (1990) for the *Cynaro cardunculi-Cichorietum pumili*, a roadside and fallowland community in Central Italy.

Allochthonous material for road construction, water runoff from the tarred road surface, and stress by driving and trampling are factors which create a standardised environment close to the road. This is reflected in the wide distribution of the *Trifolium scabrum*-[*Echio-Galactition*]-DC. Viatic migration of the species (see KOPECKÝ 1988 for Central Europe) are processes which can be confirmed for the roadside vegetation in the study area. The synanthropic expansion of the areal can be a direct effect by the transport of material and seed bank (rypochory), as it is the case with the *Lotus arenarius*-variant of the *Trifolium scabrum-[Echio-Galactition]*-DC). Or human impact changes create favourable environmental conditions in secondary habitats, for example for halophytic species, expanding along roadsides in temperate Europe by the application of salt (SCOTT & DAVIDSON, 1985). With more distance from the road, the distribution of the communities is more and more linked to a certain ecoregion and vegetation series (Sigmetum).

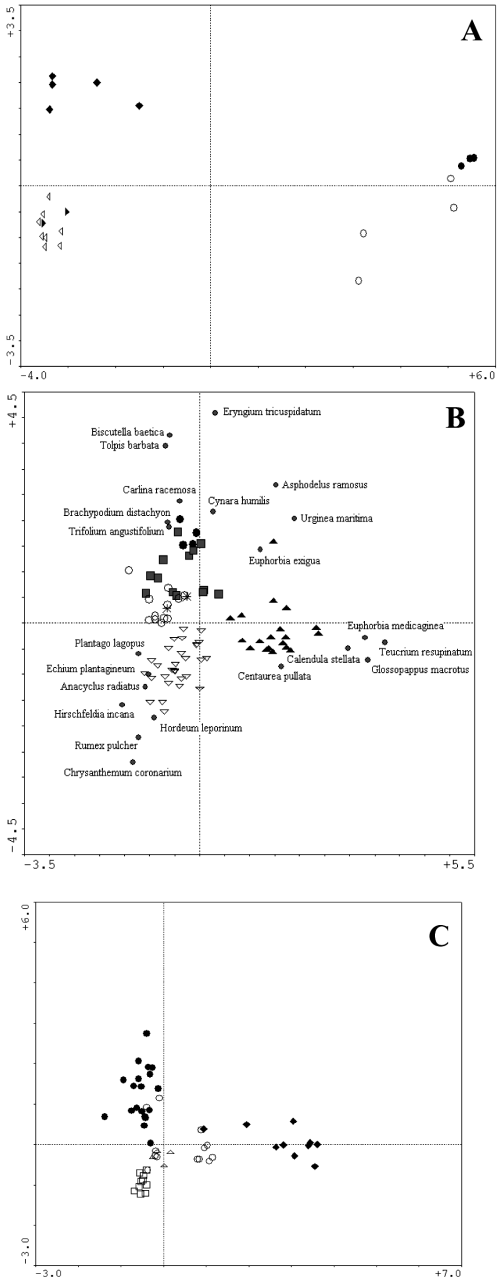

FIGURE 3. **A:** DCA of the *Polygono-Poetea* communities. Data square root transformed. Eigenvalues: axis 1 (X axis): 0,931, axis 2 (Y axis): 0,532. ● *Poo-Coronopetum squamati typicum*, ○ *Poo-Coronopetum squamati hainardietosum cylindricae*, ♦ *Solivetum stoloniferae*, ◁ *Crassulo-Saginetum apetalae typicum*, ▷ *Crassulo-Saginetum apetalae trifolietosum suffocati*.
B: CA of the *Stellarietea mediae* communities. Data square root transformed. Eigenvalues: axis 1 (X axis): 0,398, axis 2 (Y axis): 0,359. Shown are the positions of the relevés and those of the most important species (indicated by ü). ■ *Aegilops geniculata*-[*Taeniathero-Aegilopion*]-BC, ✷ *Gastridio-Trifolietum scabri*, ● *Trifolio-Vulpietum geniculatae*, ○ *Trifolium scabrum*-[*Echio-Galactition*]-DC, ▲ *Hordeo-Glossopappetum macroti*, ▽ *Anacyclo-Hordeetum leporini*.
C: DCA of the *Artemisietea* and *Molinio-Arrhenateretea* communities (except *Oryzopsio-Daucetum*). Data square root transformed. Eigenvalues: axis 1 (X axis): 0,526, axis 2 (Y axis): 0,484. Δ *Ammi visnaga*-[*Carthametalia*]-DC, ○ *Notobasio-Scolymetum maculati typicum*, □ *Notobasio-Scolymetum maculati menthetosum pulegii*, ♦ *Scolymo-Silybetum mariani*, ● *Hedysaro-Phalaridetum coerulescentis*.

Two catenal sequences diagonal to the road are documented in DEIL (1998, Tab. 1 and 2). At a National road near Tarifa (Spain), the sequence is *Trifolium scabrum*-[*Echio-Galactition*]-DC on the banquette, *Hedysaro-Phalaridetum* on the mown road shoulder and in the ditch, and *Notobasio-Scolymetum* on the embankment. At a National road near Arba Ayacha (Morocco), the contact series is *Polycarpion tetraphylli*-BC on the banquette, *Anacyclo-Hordeetum* on the shoulder, and *Notobasio-Scolymetum* on the embankment. Some similarities in the vegetation complexes can be concluded from LADERO & *al.* (1981; 1983) for the provinces of Granada and Salamanca.

TABLE 2. Synthetic table of plant communities in the study area.

Column number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Number of relevés	3	4	6	8	2	8	5	4	5	7	10	13	6	11	8	7	3	13	11	4	10	6	9
Poo annuae-Coronopetum squamati and Sclerochloo durae-Coronopion squamati																							
Coronopus squamatus	3	2																					
hainardietosum cylindricae																							
Hainardia cylindrica			4																				
Hordeum marinum			3																				
Spergularia rubra subsp. longipes			2	I	+	1																	
Solivetum stoloniferae																							
Gymnostyles stolonifera				V																			
Poa infirma				IV																			
Alternanthera caracasana				III																			
Euphorbia serpens				I																			
Crassulo tillaeae-Saginetum apetalae																							
Crassula tillaea				III	V	2																	
Sagina apetala				IV	V	2																	
trifolietosum suffocati																							
Trifolium suffocatum				I		2																	
Polycarpion tetraphylli																							
Polycarpon tetraphyllum				III	II	2																	
Herniaria cinerea					II	1																	
Polygono-Poetea annuae																							
Poa annua		1			IV	1																	
Coronopus didymus		2	III																				
Polygonum aviculare s.l.	1	1																					
Plantago coronopus s.str.		2																					
Polygonum arenastrum			II																				

Column number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Number of relevés	3	4	6	8	2	8	5	4	5	7	10	13	6	11	8	7	3	13	11	4	10	6	9
Aegilops geniculata-[Taeniathero-Aegilopion]-basal community																							
Aegilops geniculata	V	3	2	1			II	+		+	I	II											
Cleonia lusitanica	II	3									I												
Trifolium cherleri	II	3		1																			
Trifolium glomeratum		1	2		I																		
Atractylis cancellata		1									I												
Aegilops triuncialis	I									+													
Trifolium scabrum-[Echio-Galactition]-derivat community																							
Trifolium scabrum	5		4	V	+	+	I		II														
Silene colorata	1	1	3	III	+	+																	
Melilotus indica			2	III																			
Lagurus ovatus s.str.			3	III	+																		
Campanula erinus			2	IV																			
Petrorhagia nanteuilii	I		2	III																			
Linum strictum s.str.			2	II						+	I												
Arenaria emarginata			1	II																			
Rostraria cristata			2	I						+													
Stachys arvensis			1	II																			
Ononis natrix s.str.				I																			
form with Lotus arenarius																							
Lotus arenarius				V																			
Hedypnois arenaria				II																			
Crepis capillaris	I		1	I	+																		
Jasione montana subsp. blepharodon				I																			
Echio-Galactition																							
Vulpia geniculata	II	1	4	5	V	II	II	II	+	I													
Gastridium ventricosum	II	2	2					I															
Urospermum picroides	I	1		3	I	I	II	II	II	II	2												
Lotus ornithopodioides				1	I		+		+	I	I												
Trifolio pallidi-Vulpietum geniculatae form with Malva hispanica																							
Malva hispanica	I	2	4			II																	
Biscutella baetica		2	4																				
Ononis pendula subsp. boissieri			3							II													
Briza maxima	I		3	1	+																		
Ornithopus compressus			2																				
Paronychia echinulata			2																				
Anthoxanthum ovatum			2																				
Anacyclo radiati-Hordeetum leporini																							
Anacyclus radiatus		1		2	V	V	V	V			I												
Hordeum leporinum		1			II	IV	V	V	II		II												

Column number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Number of relevés	3	4	6	8	2	8	5	4	5	7	10	13	6	11	8	7	3	13	11	4	10	6	9
chrysanthemetosum coronarii																							
Chrysanthemum coronarium									1	II		V	I	+			1						
Lavatera cretica									2	II		II	I										
notobasetosum syriacae																							
Scolymus maculatus							3			I	II	V		II			V	V	1	II			
Notobasis syriaca											+	IV	+	II			V	V	1	II			II
Carduus bourgeanus s.str.							1			+	I	IV		II			II	IV	3	III			
Centaurea calcitrapa							1		1	II	II	II											
Hordeo-Glossopappetum																							
Glossopappus macrotus											+	I	V	V									
mauretanian race																							
Calendula stellata											+	II		V									
Brassica souliei subsp. amplexicaulis														II									
Iris xiphium var. tingitana														II									
Gladiolus italicus														II									
Stemmacantha acaulis														II									
Elaeoselinum meioides														III									
Salvia mouretii														II									
Convolvulo meonanthi-Hedysaretum coronarii																							
Convolvulus meonanthus																V							
Convolvulo cupaniani-Malopetum trifidae																							
Convolvulus tricolor subsp. cupanianus																	3						
Hordeion leporini																							
Plantago lagopus							I	2		4	IV	IV	IV	IV	+		II	1					
Hirschfeldia incana									2	III	II	III	I										
Brassica nigra										I	I	I	I				I	2					
Rumex pulcher s.l.											II	III	I		I	I							
Sisymbrietalia officinalis, Thero-Brometalia																							
Bromus matritensis							III	3		4	IV	III	III	IV	V	II	III						
Galactites tomentosa							II	3	4	3	IV	III	III	III	III	III	II						
Echium plantagineum								3	1	3	IV	IV	IV	II	I	I	III						
Medicago polymorpha							II	4	2		I	III	II	IV		III	I	1					
Hedypnois cretica								4	2	3	III	II	+	I	III	II	I						
Trifolium stellatum							II	4		5	IV	I	II		+	I							
Lolium rigidum							I	2	1	2	II	II	II	V	+	I	I	2					
Plantago afra								2		2	III	+	+		V	III		2					
Avena sterilis s.str.							II		1		I	II	III	III	+	II		3					
Bromus hordeaceus							II		1	1	II	II	III	II		I	II						
Trifolium angustifolium							II	5	4	2	I	+	+	I		I							
Avena barbata s.l.							II		3	3	V	+	I										

Column number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Number of relevés	3	4	6	8	2	8	5	4	5	7	10	13	6	11	8	7	3	13	11	4	10	6	9
Bromus diandrus									3	V		I			II		2						
Trisetaria panicea							2		1	II	I	II											
Desmazeria rigida									2	III			I		II								
Pallenis spinosa						I					+	+											
Stellarietea mediae																							
Leontodon longirostris						II	3	2	2	III	III	+	II	V	III	III							
Anagallis arvensis						II	3	1		III	II	II		IV	IV	III	1						
Stachys ocymastrum						I			2	II	II	II	II	II	II	V							
Otospermum glabrum							1			I	II	+	V	IV	II								
Cichorium endivia							4			I	II	II	III		II								
Sherardia arvensis						I	2		1	I	I	I	I	III	III	III							
Sonchus oleraceus									2	II	II	III	I	III	I	II	1						
Borago officinalis										II	I	II	I	IV	I								
Euphorbia exigua						II	3	3	1				I	II	III	II							
Rapistrum rugosum s.str.							1			II	I	III	II	I	I	1							
Crepis vesicaria subsp. haenseleri						I				+	III	II	II	I	III								
Scorpiurus muricatus						II	3			I	+		II	+	II	I							
Sonchus asper						I					I		I	II	II								
Delphinium gracile						I						I	III		III								
Fedia cornucopiae							1							V									
Bromus lanceolatus							1	2	1				I	II	II	II							
Ammi majus											+	II	III		II	I							
Salvia verbenaca									1	III	I			I	I								
Chamaemelum mixtum							2	3		II	+												
Phalaris brachystachys											+	I	II	I	I								
Euphorbia medicaginea												+	I		IV								
Torilis nodosa											II	+	I	+	I	III							
Scabiosa simplex subsp. dentata						I	1				+			+	II	II							
Ridolfia segetum											+		I		III								
Mercurialis annua (incl. ambigua)									2	II		+											
Erodium moschatum										I		II	I										
Teucrium resupinatum															IV								
Misopates orontium							1		1	I					IV		2						
Lolium multiflorum												I	I										
Scrophularia sambucifolia												+	I		I		1						
Medicago ciliaris												+	II										
Capnophyllum peregrinum														+	I								
Bupleurum lancifolium															II								
Torilis arvensis s.l.																I							
Geranium molle																I							

Column number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Number of relevés	3	4	6	8	2	8	5	4	5	7	10	13	6	11	8	7	3	13	11	4	10	6	9
Ammoides pusilla																I							
Geranium dissectum																I							
Tetragonolobus purpureus																I	2						
Ammi visnaga [Carthametalia] derivat community																							
Ammi visnaga													III					II	V	4	I		
Centaurea calcitrapa																		II			I		
menthetosum pulegii																							
Mentha pulegium																		+	IV				I
Lythrum junceum		3																+	V				
Centaurium pulchellum																			V				II
Lythrum hyssopifolia																			III				
Lythrum acutangulum																			III				
Iris tingitana																			II				
Scolymo-Silybetum																							
Silybum marianum																		+			V		
Carduus pycnocephalus																					II		
Oryzopsio-Daucetum and Bromo-Oryzopsion																							
Daucus carota subsp. maximus																		III	+		+	IV	III
Piptatherum miliaceum																		+				V	
Dittrichia viscosa																					+	V	II
Verbascum sinuatum																			+			II	
Carthametalia lanati, Artemisietea vulgaris																							
Carthamus lanatus																		I	II		+		II
Scolymus hispanicus																		IV	II	4	II	I	
Picris echioides																		IV	III	1	+		I
Carlina racemosa																		II	IV	2			I
Cynara humilis																		II	II	1	I		
Cichorium intybus																		III					I
Ononis mitissima																		II	+	2	+		II
Foeniculum vulgare subsp. piperitum																					+	II	III
Scabiosa atropurpurea																		+	+			III	II
Cynara cardunculus																		I		2	I		I
Carduus tenuiflorus																		II			I		
Echinops strigosus																		II					I
Scabiosa semipapposa																		I	I				
Lactuca viminea																		+	I				I
Phlomis herba-venti																		II					
Salvia barrelieri																		II					

Column number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Number of relevés	3	4	6	8	2	8	5	4	5	7	10	13	6	11	8	7	3	13	11	4	10	6	9
Hedysaro coronarii-Phalaridetum and higher units																							
Hedysarum coronarium																V	3	II	+	2			IV
Stegia trimestris																II	2	II	V	3	II		
Leontodon maroccanus																V	3	I	III	1	+		III
Gaudinia fragilis																I		I	V	2			II
Phalaris coerulescens																II	2	II	I			I	III
Hordeum bulbosum																II		I	+	1		I	III
Plantago lanceolata																III		+			II		II

SYNTAXONOMIC CONSPECTUS

POLYGONO ARENASTRI-POETEA ANNUAE Rivas-Martínez 1975.

POLYGONO ARENASTRI-POETALIA ANNUAE Tüxen in Géhu, Richard & Tüxen 1972 corr. Rivas-Martínez, Báscones, T. E. Díaz, Fernández-González & Loidi 1991.

Sclerochloo durae-Coronopion squamati Rivas-Martínez 1975.

Poo annuae-Coronopodetum squamati (Oberd. 1957) Gutte 1966.

typicum

hainardietosum cylindricae **subass. nov.**

Polycarpion tetraphylli Rivas-Martínez 1975

Solivetum stoloniferae Rivas-Martínez 1975

Crassulo tillaeae-Saginetum apetalae Rivas-Martínez 1975

typicum

trifolietosum suffocati Rivas-Martínez 1975

STELLARIETEA MEDIAE Tüxen, Lohmeyer & Preising ex von Rochow 1951

THERO-BROMETALIA (Rivas Goday & Rivas-Martínez ex Esteve 1973) O. Bolòs 1975 Rivas-Martínez & Izco 1977.

***Aegilops geniculata-[Taeniathero-Aegilopion]*-basal community**

Gastridio ventricosi-Trifolietum scabri Rivas Goday 1964

Echio plantaginei-Galactition tomentosae O. Bolòs & Molinier 1969

Trifolio pallidi-Vulpietum geniculatae Galán de Mera 1995

***Trifolium scabrum-[Echio-Galactition]*-derivat-community**

typical form

form with *Lotus arenarius*

Cerintho majoris-Fedion cornucopiae Rivas-Martínez & Izco ex Peinado, Martínez-Parras & Bartolomé 1986

Hordeo leporini-Glossopappetum macroti Peinado, Martínez-Parras & Bartolomé 1986

Normal form

Mauretanian race

Convolvulo meonanthi-Hedysaretum coronarii Peinado, Martínez-Parras & Bartolomé 1986

Convolvulo cupaniani-Malopetum trifidae Galán de Mera 1994

SISYMBRIETALIA OFFICINALIS J. Tüxen in Lohmeyer et al. 1962 em. Rivas-Martínez, Báscones, T.E. Díaz, Fernández-González & Loidi 1991

Hordeion leporini Br.-Bl. in Br.-Bl., Gajewski, Wraber & Wallas 1936 corr. O. Bolòs 1962

Anacyclo radiati-Hordeetum leporini O. Bolòs & Rivas-Martínez in Rivas-Martínez 1978

typicum

chrysanthemetosum coronarii Rivas-Martínez 1978

notobasetosum syriacae subass. nov.

ARTEMISIETEA VULGARIS Lohmeyer, Preising & Tüxen ex von Rochow 1951

ONOPORDENEA ACANTHII Rivas-Martínez et al. in Rivas-Martínez, T.E. Díaz, Fernández-González, Izco, Loidi, Lousã & Penas 2002

CARTHAMETALIA LANATI Brullo in Brullo & Marcenò 1985

***Ammi visnaga-[Carthametalia]*-derivat community**

Onopordion castellani Br.-Bl. & O. Bolòs 1958 corr. Rivas-Martínez, T.E. Díaz, Fernández-González, Izco, Loidi, Lousã & Penas 2002

Notobasio syriacae-Scolymetum maculati Rivas Goday ex Ladero, Socorro, Molero, M. López, Zafra, Marín, Hurtado & Pérez-Raya 1981

typicum

menthetosum pulegii **subass. nov.**

Silybo-Urticion Sissingh ex Br.-Bl. & O. Bolòs 1958

Scolymo maculati-Silybetum mariani Rivas-Martínez in Rivas-Martínez, Costa, Castroviejo & Valdés 1980

ONONIDETALIA RAMOSISSIMAE Galán de Mera, Sánchez García & Vicente Orellana 1997

Bromo-Oryzopsion miliaceae O. Bolòs 1970

Oryzopsio miliaceae-Daucetum maximi O. Bolòs & Vigo 1972

MOLINIO-ARRHENATHERETEA Tüxen 1937

PHALARIDETALIA COERULESCENTIS Galán de Mera, Haug, Deil & Vicente Orellana 1997

Gaudinio fragilis-Hordeion bulbosi Galán de Mera, Haug, Deil & Vicente Orellana 1997

Hedysaro-Phalaridetum coerulescentis Galán de Mera, Haug, Deil & Vicente Orellana 1997

ACKNOWLEDGEMENTS

Financial support for field work by the Universidad San Pablo-CEU (8/03 project), by the German Research Foundation (DFG Az. De 403) and by the German Academic Exchange Service (DAAD, PKZ D/03/18639) is gratefully acknowledged. We are indebted to R. J. BYER for the linguistic correction.

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