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Review of dolomitic thyme-scrub communities in the Baetic Sierras (S. Spain)

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Abstract

In this paper a study is made of dolomitic thyme-scrub communities (Ord. *Convolvuletalia boissieri*). Based on a total of 13 elements (associations, subassociations and communities) and using data correspondence analysis, a revised syntaxonomic scheme of these communities is proposed (to subassociation level), in which *Brassico almeriensis–Pterocephaletum spathulatae* and *Thymo granatensis–Arenarietum tomentosae* subass. *scorzoneretosum albicantis* are described as new syntaxa. The syntaxa *Arenario delaguardiae–Centaureetum bombycinae* and *Andryalo agardhii–Convolvuletum boissieri* subass. *centaeureetosum bombycinae* are synonymised.

Key words: correspondence analysis, *Rosmarinetea officinalis*, Spain.

Resumen

Revisión de los tomillares dolomíticos de las sierras béticas (S. Spain). En el presente trabajo se estudian los tomillares de dolomías (*O. Convolvuletalia boissieri*). Se parte de un total de 13 elementos (asociaciones, subasociaciones y comunidades) y mediante una serie de análisis de correspondencias de los datos, se establece un esquema sintaxonómico revisado de estas comunidades (hasta el rango de subasociación), en el que se describen como nuevos los sintaxones; *Brassico almeriensis–Pterocephaletum spathulatae* y *Thymo granatensis–Arenarietum tomentosae* subass. *scorzoneretosum albicantis.* Asimismo se sinonimizan los sintaxones: *Arenario delaguardiae–Centaureetum bombycinae* y *Andryalo agardhii–Convolvuletum boissieri* subass. *centaeureetosum bombycinae.*

Palabras clave: análisis de correspondencias, España, *Rosmarinetea officinalis.*

Introduction

One of the most selective habitats in the Baetic Sierras is made up of kakiritised or brechoid dolomites-rock formations presenting a high (CO_3)MgCa content.

Insofar as its vegetation is concerned, this substrate presents a number of limitations (Mota *et al.*, 1993), which may be summarised as including considerable resistance to alteration, which severely limits edaphogenetic processes, virtually no water-retention capacity, owing to the shallowness of the soil and high permeability (owing to its texture), high rate of reflection of incident light, which may cause leaf-burning phenomena, and high concentrations of Mg, which may lead to toxicity.

The plants that successfully colonise these habitats need to make several specific adaptations, which can be recognised as a typical adaptive "syndrome", characterised by the small size of the plant and a predominance of nano-chamaeophyte and hemicryptophyte biotypes, the highly abundant presence of tomentum and whitish or greyish colours, and a root system that is highly developed considering the size of the plant.

From a phytosociological viewpoint, numerous studies of dolomitic thyme-scrub communities have been carried out (Quézel, 1953; Rivas-Martínez, 1961; Rivas-Goday & Mayor, 1966; Martínez-Parras & Peinado, 1987; Mota & Valle, 1992; Sánchez-Gómez & Alcaraz, 1992; Mota *et al.*, 1993), providing a substantial knowledge base regarding the floristic and chorological typing and characterisation of these communities. However, none of the previously published studies has included a full synthesis of all the dolomitic thyme-scrub communities, with relevés for all the dolomitic sites in the Baetic Sierras. Therefore, in order to complete the information available, we have devised the synthesis in this paper.

Material and methods

Selection of study area and data collection

When first considering including all the dolomitic sites, we were faced with the problem that the reference geological maps often fail to distinguish between limestone dolomites and kakiritised dolomites (to which the communities that are the object of this study are linked). To solve this problem, we have used the distribution of strictly dolomitic taxa for which detailed cartography is available. This is the case for *Pterocephalus spathulatus* (Blanca *et al.*, 1990), *Rothmaleria*

granatensis (Blanca *et al.*, 1987) and *Thymus granatensis* (Blanca *et al.*, 1990). We then cross-referenced the resulting data with the phytogeographical units to district level recognised for the Baetic Sierras (Rivas-Martínez *et al.*, 1997), selecting a total of 131 relevés (see Appendix 1), such that all the biogeographical units to district level containing dolomitic sites were well represented.

All the relevés used were compiled following the methodology of the Zurich–Montpellier school (Braun-Blanquet, 1979; Gehú & Rivas-Martínez, 1981), using only the cover–abundance index and eliminating any occasional taxa (presence ≤2 %). The initial table, which was arranged with 131 columns (relevés) x 128 rows (taxa), is available from the authors upon request.

The nomenclature for the species follows the reference flora: Flora Iberica (Castroviejo *et al.*, 1986, 1990, 1993a, 1993b, 1997a, 1997b, 1998, 1999), for families included in the volumes published to date, and Flora Europaea (Tutin *et al.*, 1964-1980) for the remainder, with the exception of those taxa listed in Appendix 2.

Multivariate analysis

The data from the original table was grouped into 13 elements (Operational Syntaxonomical Units, *sensu* Török *et al.*, 1989) based on the following criteria: firstly, being defined in the literature as syntaxa (to subassociation level) or communities; and, secondly, regardless of whether or not they meet the first criterion, relevés corresponding to a different biogeographical unit (e.g. *Thymo–Arenarietum tomentosae*, which is distributed in the Serrano–Bacense and Serrano–Estanciense districts, has been considered as two separate elements; Th–Ar1 and Th–Ar2).

The original cover–abundance data (scale: ±5) was converted to Van der Maarel's ten-point scale (Westhoff & Van der Maarel, 1978). Based on the results, multivariate analysis was carried out, using the correspondence analysis (CA) technique. The ability of this technique to separate groups, based on relevés, has been demonstrated by several authors (e.g. Mucina & van der Maarel, 1989). For this analysis the BMDP y SYNTAX 5.0 (Podani, 1994) statistics-software packages were used. Two different applications were used because SYNTAX proves to be more versatile when it comes to analysing certain input tables (analysis 3). Which software package was used to generate which graph is indicated in the corresponding legends.

The following correspondence analyses were performed:

Analysis 1: Species appearing in only one of the 13 columns with cover–abundance values of 1 or 2 were eliminated to reduce any bias from insignificant taxa in the different elements. This table had 13 columns x 82 rows.

Analysis 2: To characterise the species with the most affinity for each of the elements (syntaxa or communities), a table was devised of the taxa most closely linked with each of the 13 elements studied at 13 x 40, on which the corresponding CA was carried out, simultaneously relating columns and rows.

Analysis 3: Preliminary analysis of the data showed that one of the groups obtained contained certain closely related elements, raising the question of whether these are independent elements. We therefore undertook the analysis of all the relevés included in this group. Thus, from the original table (131 x 128), a 78 x 48 table was obtained of all the relevés belonging to the "awkward" group.

Information synthesis

The results of analyses 1 and 2 were used to devise Tab. 1 (synthesis table), arranged according to the structure proposed by Géhu & Rivas-Martínez (1981), in which the 13 elements studied can be seen (without questioning the identity of these elements).

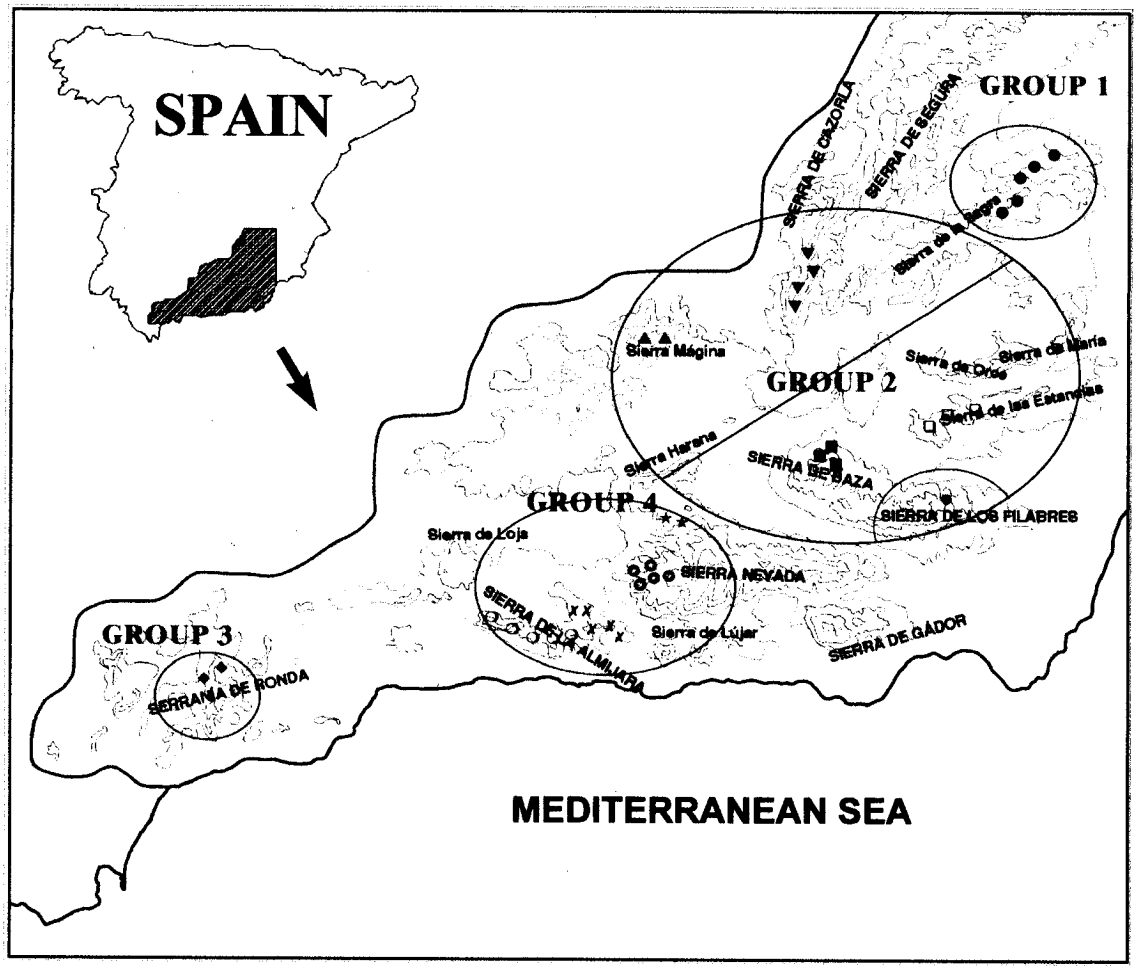
To conclude this paper, a syntaxonomic scheme of the Order *Convolvuletalia boissieri* (endemic to the Baetic Sierras) is proposed, based on the most recent work carried out on the syntaxonomy of the Iberian Peninsula (Rivas-Martínez *et al.*, 1999) and the review of the class *Rosmarinetea officinalis* (Díez *et al.*, 1998). For the names of the syntaxa the Phytosociological Nomenclature Code (Barkman *et al.*, 1986) was followed.

Results and Discussion

Analysis 1 (13 elements, 82 taxa)

From the correspondence analysis based on the groups (to subassociation level) of the 13 elements, the following groups were obtained (see Graph 1 and Map 1):

The first group to appear is composed of the association *Fumano paradoxae–Thymetum sabulicolae*, only barely related to the other elements, although it does present some affinity with the following group, based on the presence of *Scorzonera albicans* (a sub-Baetic taxon *s.l.*), and taxa that are widely distributed among

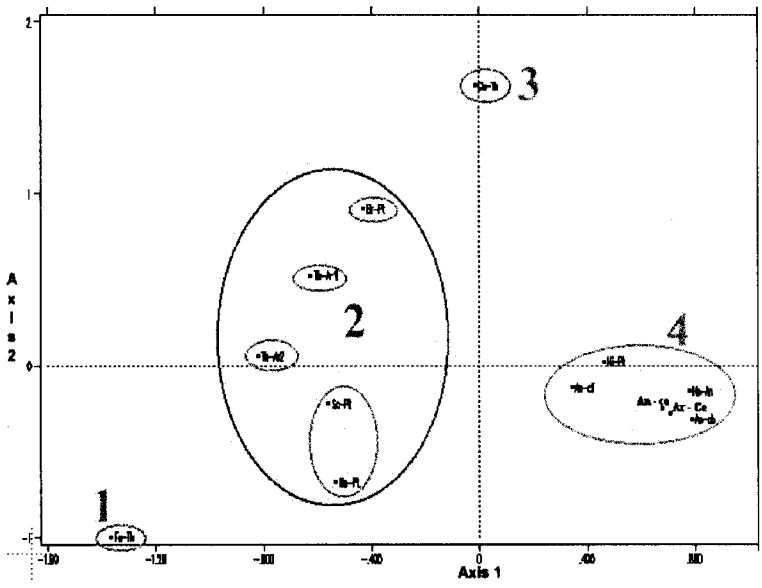


Communities
● *Fumano paradoxae-Thymetum sabulicolae*
▲ *Helianthemo frigiduli-Pterocephaletum spathulatae*
▼ *Scorzonero albicantis-Pterocephaletum spathulatae*
❑ *Thymo granatensis-Arenarietum tomentosae* subass. *scorzonerotosum albicantis*
■ *Thymo granatensis-Arenarietum tomentosae* subass. *arenarietosum tomentosae*
● *Brassico almeriensis-Pterocephaletum spathulatae*
◆ *Galio baetici-Thymetum granatensis*
○ *Hippocrepido eriocarpae-Pterocephaletum spathulatae*
✗ *Helianthemo visciduli-Anthyllidetum argyrophyllae*
☆ *Andryalo agardhii-Convolvuletum boissieri* subass. *convolvuletosum boissieri*
✪ *Andryalo agardhii-Convolvuletum boissieri* subass. *centaureetosum funkii*

Map 1 - Distribution of relevés studied, according to the results obtained

the dolomitic thyme-scrub communities dolomíticos, such as *Pterocephalus spathulatus* and *Centaurea granatensis*. Since this group occupies an outlying geographical position, its position in the analysis is supported.

A second five-element group with three subgroups, can be distinguished. The first of them consists of the associations *Helianthemo–Pterocephaletum spathulatae* and *Scorzonero–Pterocephaletum spathulatae*, both of which are sub-Baetic. The most closely related element is the Serrano–Estanciense variant of the association *Thymo–Arenarietum tomentosae* (Th–Ar2), which is positioned as close to the typical association (Th–Ar1: *Thymo granatensis–Arenarietum tomentosae*) as the first subgroup (*Scorzonero albicantis–Pterocephaletum spathulatae* and *Helianthemo frigiduli–Pterocephaletum spathulatae*), closely related to this subgroup by such taxa as *Scorzonera albicans*. There are



Graph 1 - CA of the 13 elements studied (axes 1 and 2, generated with BMDP; see correspondence with syntaxa and communities in Appendix 1)

also major links with the typical association because of the presence of *Arenaria tomentosa*, although *Thymus granatensis* subsp. *granatensis*, one of the most characteristic elements of the typical association, is replaced by *Thymus longiflorus*, an element of eastern influence in the Sierra de Estancias area, which, although not strictly linked to the dolomías communities, acts as a differential with respect to the typical association. The geographical position of this association coincide with the analysis made, since the Sierra de las Estancias where it appears occupies an intermediate position between the sub-Baetic Sierras and the Sierra de Baza (where the typical association is found). Finally, at a greater distance we find the community of *Brassica almeriensis* and *Pterocephalus spathulatus*. These relevés were obtained in the eastern part of the mountains adjacent to the Guadix–Baza depression (see Map 1).

There is a third group consisting of a single association: *Galio–Thymetum granatensis*, which is barely related to the closest groups (2nd and 4th). As occurs with *Fumano paradoxae–Thymetum sabulicolae*, this group occupies an outlying position within the dolomitic thyme-scrub formations. Such taxa as *Arenaria erinacea* enable this community to be linked to group 4 (*Hippocrepido–Pterocephaletum spathulatae*), the closest group from a geographical point of view. The link with the second group is due to the presence of taxa that are widely distributed in the dolomitic thyme-scrub communities, such as *Jurinea pinnata* and *Anthyllis vulneraria argyrophylla*.

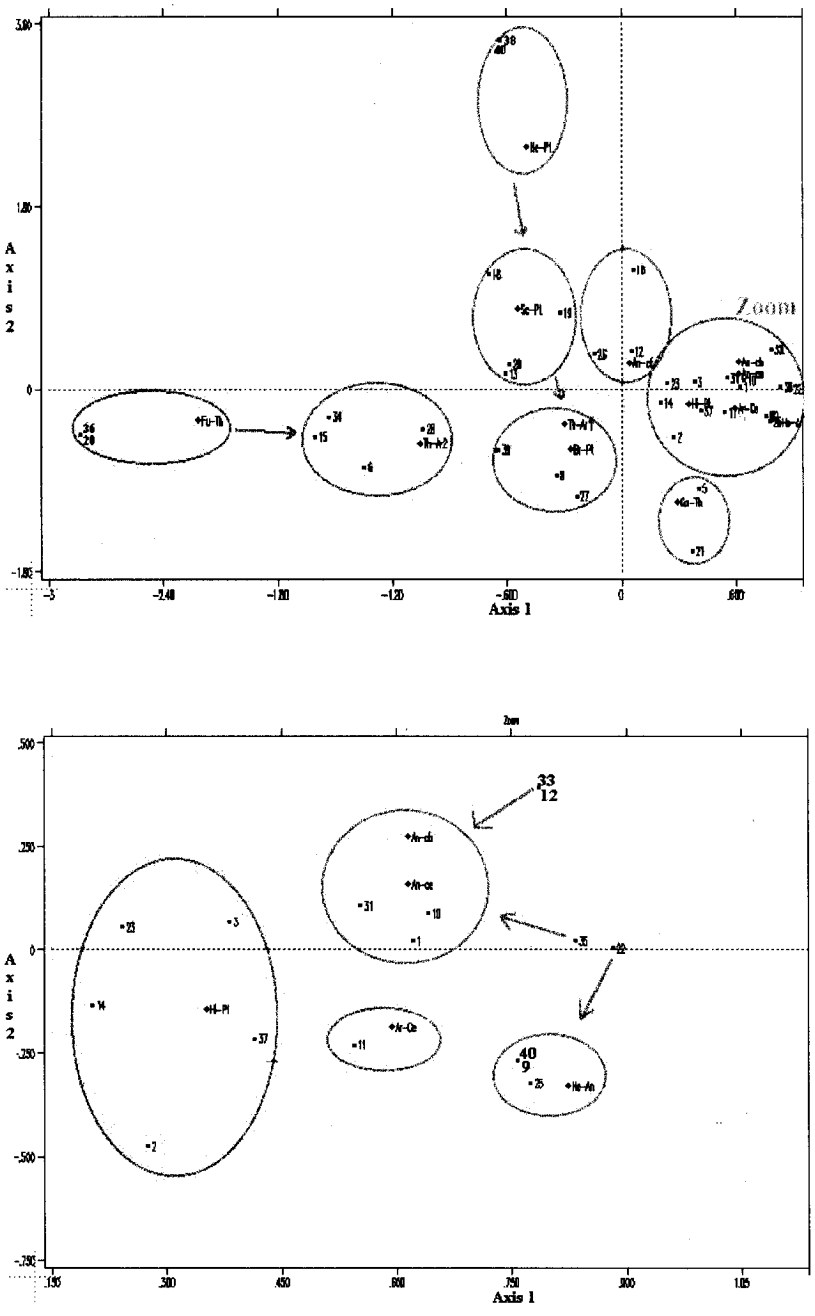
Finally, there is a fourth group with six closely interrelated elements, consisting of all the Malacitano–Almijarense syntaxa. This is a very compact group it's easily separated from the others by the presence of a number of endemic elements that are common to all the elements included: e.g. *Brachypodium boissieri*, *Helianthemum viscidulum* subsp. *viscidulum*, *Thymelea tartonraira* subsp. *angustifolia*... The negligible distances between some of the syntaxa, together with the appearance of coinciding areas and ecological factors in the original descriptions of certain syntaxa, make it questionable whether they should be maintained as separate individuals. This is discussed in the more detailed analysis of this group (analysis 2), based on 78 relevés, without any bias from external groups.

Analysis 2 (13 elements y 40 species)

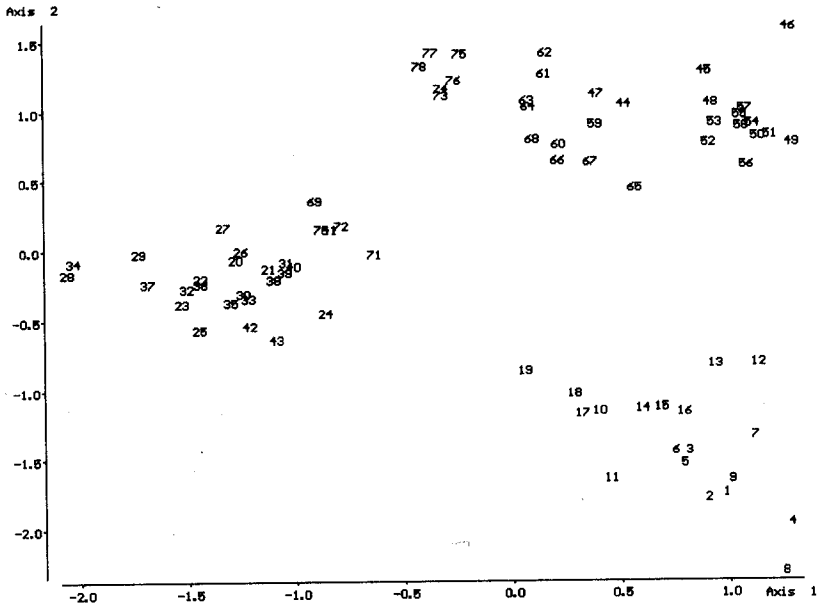
Graph 2 shows the results of the analysis of the 40 species with the greatest affinity for the elements. These results have been used to devise Tab. 1 and 2.

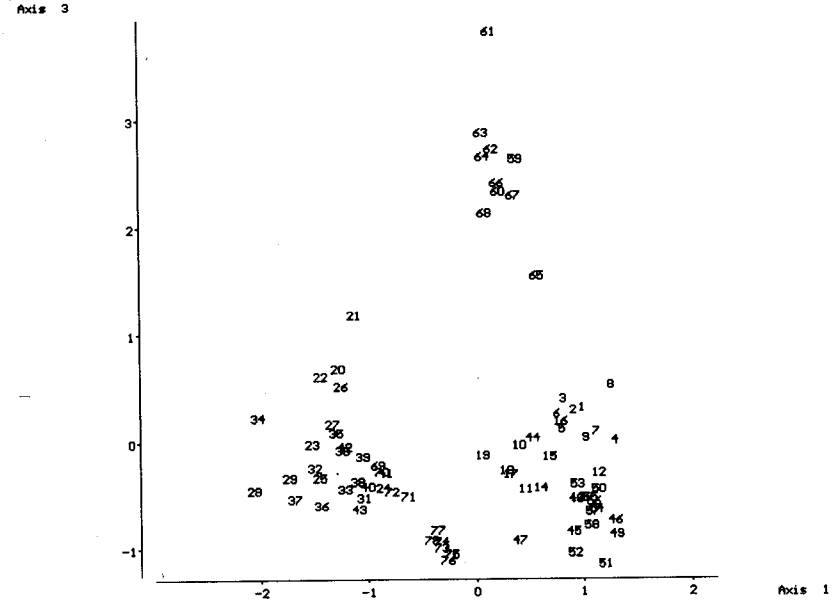
Analysis 3 (78 relevés)

The first group, composed of relevés 1–19 (see Graph 3), includes the typical association (*Andryalo agardhii–Convolvuletum boissieri* subass. *convolvuletosum*



Graph 2 - CA of the 13 elements studied with the 40 taxa with the greatest affinity (axes 1 and 2 and zoom of right-hand side).1. *Anthyllis tejedensis.* 2. *Anthyllis vulneraria* subsp. *argyrophylla.* 3. *Arenaria armerina* subsp. *caesia.* 4. *Arenaria delaguardiae.* 5. *Arenaria erinacea.* 6. *Arenaria tomentosa.* 7. *Armeria filicaulis* subsp. *trevenqueana.* 8. *Brassica repanda* subsp. *almeriensis.* 9. *Brassica repanda* subsp. *blancoana.* 10. *Brassica repanda* subsp. *latisiliqua.* 11. *Centaurea bombycina.* 12. *Centaurea funkii.* 13. *Centaurea granatensis* subsp. *granatensis.* 14. *Chaenorrhinu macropodum* subsp. *macropodum.* 15. *Chaenorrhinum macropodum* subsp. *degenii.* 16. *Convolvulus boissieri.* 17. *Erodium boissieri.* 18. *Erodium cazorlanum.* 19. *Erysimum myriophyllum.* 20. *Fumana paradoxa.* 21. *Galium baeticum.* 22. *Helianthemum apeninum* subsp. *estevei.* 23. *Helianthemum apeninum* subsp. *stoechadifolium.* 24. *Helianthemum marifolium* subsp. *frigidulum.* 25. *Helianthemum viscidulum.* 26. *Hippocrepis squamata* subsp. *eriocarpa.* 27. *Jurinea pinnata.* 28. *Paronychia aretioides.* 29. *Pterocephalus spathulatus.* 30. *Reseda paui* subsp. *almijarensis.* 31. *Rothmaleria granatensis.* 32. *Santolina elegans.* 33. *Scabiosa pulsatilloides.* 34. *Scorzonera albicans.* 35. *Thymelaea tartonraira* subsp. *angustifolia.* 36. *Thymus funkii* var. *sabulicola.* 37. *Thymus granatensis* subsp. *granatensis.* 38. *Thymus granatensis* subsp. *micranthus.* 39. *Thymus longiflorus.* 40. *Viola cazorlensis*





Graph 3 - CA of the 78 relevés making up the Malacitano–Almijarense group (axes 1 and 2; 1 and 3, generated with SYNTAX 5.0). 1–16: *Andryalo agardhii–Convolvuletum boissieri* subass. *convolvuletosum boissieri*. 17–19: *Andryalo agardhii–Convolvuletum boissieri* subass. *centaureetosum bombycinae*. 20–43: *Arenario delaguardiae–Centaureetum bombycinae*. 44–58: *Andryalo agardhii–Convolvuletum boissieri* subass. *centaureetosum funkii*. 59–68: *Hippocrepido eriocarpae–Pterocephaletum spathulatae*. 69–78: *Helianthemo visciduli–Anthyllidetum argyrophyllae*

boissieri and the subassociation *centaureetosum bombycinae*, the differences between which are minimal. Review of the relevés in which the latter association is described (Mota *et al.*, 1993), reveals that they were made at a lower altitude, thereby explaining the fairly frequent presence of *Centaurea bombycina*, a taxon that tends to be more frequent in the meso-Mediterranean belt. If we add to this the fact that they share the same geographical area as the typical subassociation, we may conclude that we are dealing with a simple variant in ecotones between the meso- and supra-Mediterranean belts.

Relevés 44–58, corresponding to the *Andryalo agardhii–Convolvuletum boissieri* subass. *centaureetosum funkii*, while closely related to the previous group, can be clearly distinguished. These relevés were made in the Sierra de Huétor, in the northernmost part of the limestone borders of the Sierra Nevada, i.e. this subassociation is a geographical entity.

From graph 3 it can be seen that the relevés of the *Arenario delaguardiae–Centaureetum bombycinae* association (20–43) partially overlap with those of the *Helianthemo visciduli–Anthyllidetum agryrophyllae* (69–78), an association that was described previously, under the same conditions (Almijarense distric, meso/supra-Mediterranean). When the relevés for the first association (Mota *et al.*, op. cit.: 36) are reviewed, the relevés that stand out most are those with a greater abundance of *Arenaria delaguardiae*, a taxon that had not been described when the first association was described.

The group of relevés belonging to the association *Hippocrepido ericarpae–Pterocephaletum spathulatae* (59–68) can clearly be distinguished, corresponding to the supra/oro-Mediterranean formations of the Sierra de Tejeda.

Conclusions

The groups and associations established as a result of the analyses performed are shown in Tab. 2 and Fig. 1, as well as in the following syntaxonomic scheme:

Syntaxonomic scheme proposed (to subassociation level)

ROSMARINETEA OFFICINALIS Rivas-Martínez, T. E. Díaz, Fernández-Prieto, Loidi & Penas 1991[Itinera Geobot. 5: 513]

\+ *Convolvuletalia boissieri* Rivas-Martínez, Pérez-Raya & Molero-Mesa ex Díez-Garretas & Asensi 1994 [Colloq. Phytosoc. 22: 544]

* *Andryalion agardhii* Rivas-Martínez ex Rivas-Goday & Mayor 1966 [Anal. Real Acad. Farmacia 31: 366–368]

1. *Fumano paradoxae–Thymetum sabulicolae* Sánchez-Gómez & Alcaraz 1992
2. *Helianthemo frigiduli–Pterocephaletum spathulati* Martínez-Parras & Peinado 1987
3. *Scorzonero albicantis–Pterocephaletum spathulati* Martínez-Parras & Peinado 1987
4. *Thymo-granatensis–Arenarietum tomentosae* Mota & Valle 1992
   - 4.a. subass. *arenarietosum tomentosae*
   - 4.b. subass. *scorzoneretosum albicantis nova* [holotypus Navarro & col. Monogr. Fl. Veg. Béticas, 11: 127, tab. 18b, rel. 1. 1999. Designied here].
5. Brassico almeriensis–Pterocephaletum spathulati nova [holotypus Mota *et al.* Vegetatio, 109: 37, tab. 6, rel. 6. 1993. Designied here].
6. *Galio baetici–Thymetum granatensis* Mota & Valle 1992
7. *Hippocrepido eriocarpae–Pterocephaletum spathulati* (Quézel 1953) Rivas Goday & Mayor 1966
8. *Helianthemo visciduli–Anthyllidetum argyrophyllae* Rivas Goday & Esteve 1972 [Syn: *Arenario delaguardiae–Centaureetum bombycinae* Mota *et al.*, 1993]
9. *Andryalo agardhii–Convolvuletum boissieri* Quézel 1953
   - 9.a. subass. *convolvuletosum boissieri* [Syn: subass. *centaureetosum bombycinae* Mota *et al.* 1993]
   - 9.b. subass. *centaureetosum funkii* Mota *et al.*, 1993.

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Tab. 1 - Synthesis table of the communities studied (see correspondence with Appendix 1). V: Present in 80–100% of the relevés. IV: 60–80 %. III: 40–60 %. II: 20–40. I: <20 %

	1	2	3	4	5	6	7	8	9	10	11	12	13
Characteristic taxa of ass. and subass.													
Fumana paradoxa	V	.	.	.	.	.	.	.	.	.	.	.	.
Thymus funkii sabulicola	V	.	.	.	.	.	.	.	.	.	.	.	.
Viola cazorlensis	.	IV	.	.	.	.	.	.	.	.	.	.	.
Helianthemum marifolium frigidulum	.	III	.	.	.	.	.	.	.	.	.	.	.
Thymus granatensis micranthus	.	I	.	.	.	.	.	.	.	.	.	.	.
Erodium cazorlanum	.	.	III	.	.	.	.	.	.	.	.	.	.
Scorzonera albicans	II	.	V	V	.	.	.	.	.	.	.	.	.
Arenaria tomentosa	.	.	.	V	V	.	.	.	.	.	.	.	.
Jurinea pinnata	.	.	.	I	IV	IV	IV	.	.	.	.	.	.
Brassica repanda almeriensis	.	.	.	.	.	V	.	.	.	.	.	.	.
Galium baeticum	.	.	.	.	.	.	III	.	.	.	.	.	.
Arenaria erinacea	.	.	.	.	.	.	III	V	.	.	.	.	.
Helianthemum viscidulum	.	.	.	.	.	.	.	V	V	V	.	.	.
Centaurea bombycina	.	.	.	.	.	.	.	.	II	III	.	.	.
Arenaria delaguardiae	.	.	.	.	.	.	.	.	.	IV	.	.	.
Armeria filicaulis trevenqueana	.	.	.	.	.	.	.	.	.	III	.	.	.
Reseda paui almijarensis	.	.	.	.	.	.	.	.	.	III	.	.	.
Centaurea bombycina	.	.	.	.	.	.	.	.	.	V	3	.	.
Helianthemum pannosum	.	.	.	.	.	.	.	.	.	.	.	IV	.
Scabiosa pulsatilloides	.	.	.	.	.	.	.	.	.	.	.	III	.
Erodium boissieri	.	.	.	.	.	.	.	.	.	.	.	III	.
Santolina elegans	.	.	.	.	.	.	.	.	.	.	.	III	.
Centaurea funkii	.	.	.	.	.	.	.	.	.	.	.	.	IV
Characteristic taxa of *Convolvuletalia boissieri*:													
Convolvulus boissieri	.	V	V	.	.	.	.	.	.	.	5	V	II
Hippocrepis squamata eriocarpa	II	V	.	.	.	.	.	IV	.	II	.	.	II
Pterocephalus spathulatus	I	IV	IV	I	II	V	.	V	.	.	.	.	IV
Centaurea granatensis granatensis	V	IV	.	II	III	.	.	.	.	.	3	IV	V
Thymus granatensis granatensis	.	.	.	.	V	.	V	III	.	III	4	V	IV
Anthyllis vulneraria argyrophylla	.	.	.	I	III	V	III	III	V	II	3	V	IV
Rothmaleria granatensis	.	.	.	.	.	.	.	II	.	III	4	III	III
Anthyllis tejedensis	.	.	.	.	.	.	.	V	I	II	2	II	IV
Arenaria armerina caesia	.	.	.	.	.	III	.	.	.	I	4	V	V
Thymelaea tartonraira angustifolia	.	.	.	.	.	.	.	.	III	II	3	II	.
Paronychia aretioides	III	.	.	III	II	I	.	.	.	.	.	.	III
Erysimum myriophyllum	.	.	II	.	.	.	.	.	.	.	.	.	III
Helianthemum apeninum estevei	.	.	.	.	.	.	.	.	IV	.	4	II	.
Brassica repanda latisiliqua	.	.	.	.	.	.	.	III	.	.	3	II	.
Chaenorrhinum macropodum degenii	III	.	.	.	II	.	.	.	.	.	.	.	.
Brassica repanda blancoana	.	.	.	.	.	.	.	.	.	II	.	.	.
Chaenorrhinum macropodum macropodum	.	.	.	.	.	.	.	.	.	.	2	.	.
Characteristic taxa of *Rosmarinetea officinalis*:													
Fumana ericoides	.	V	III	IV	V	V	.	.	III	II	3	IV	II
Asperula aristata scabra	.	.	IV	.	III	I	IV	III	.	II	2	V	IV
Alyssum serpyllifolium	III	III	.	.	.	.	.	III	II	.	2	II	IV
Coris monspeliensis	IV	III	.	I	.	.	.	.	II	III	3	III	.
Rosmarinus officinalis	IV	.	.	II	III	.	.	.	IV	II	.	.	II
Sideritis incana virgata	III	.	.	.	III	.	.	I	.	IV	.	III	IV
Erinacea anthyllis	IV	II	II	V	.	.	.	III	.	.	.	IV	IV
Helianthemum apeninum stoechadifolium	.	.	V	I	.	.	.	IV	.	II	.	III	.
Cistus clusii	.	.	.	II	II	.	.	.	III	III	.	.	II
Lavandula lanata	.	.	.	.	.	I	II	.	V	II	.	.	II
Ulex parviflorus	.	.	.	.	.	.	.	.	V	III	.	.	II
Arenaria armerina armerina	II	III	III	.	.	.	.	.	.	.	.	.	.
Aphylantes monspeliensis	II	III	.	.	II	.	.	.	.	.	.	.	.
Teucrium bicoloreum	.	III	IV	.	III	.	.	.	.	.	.	.	.
Echinospartum boissieri	.	III	III	.	.	.	.	II	.	.	.	.	.
Teucrium similatum	.	.	.	.	.	I	II	.	.	I	.	.	.
Lavandula latifolia	IV	.	.	.	III	.	.	.	.	.	.	.	.

Hormathophylla lapeyrousiana	II	.	.	.	.	.	.	.	.	.	.	.	.	IV
Thymus longiflorus	.	.	.	IV	.	.	.	.	.	III	.	.	.	
Genista lobelii longipes	.	.	.	.	.	V	.	II	.	.	.	.	.	
Helianthemum oelandicum incanum	.	.	.	.	.	.	IV	.	.	.	.	.	.	IV
Helianthemum neopiliferum	.	II	.	.	.	.	.	.	.	.	.	.	.	III
Ulex baeticus	.	.	.	.	.	.	V	.	.	.	.	.	.	
Teucrium leonis	III	.	.	.	.	.	.	.	.	.	.	.	.	
Hormathophylla longicaulis	.	.	.	.	III	.	.	.	.	.	.	.	.	
Linum suffruticosum	.	.	.	.	III	.	.	.	.	.	.	.	.	
Helianthemum syriacum	.	.	.	.	III	.	.	.	.	.	.	.	.	
Cistus albidus	.	.	.	.	.	.	.	.	III	.	.	.	.	
Teucrium lerrouxii	.	.	.	.	.	.	.	.	.	.	.	III	.	
Satureja obovata	II	.	.	.	.	.	.	.	.	.	.	.	.	
Genista scorpius	.	.	.	II	.	.	.	.	.	.	.	.	.	
Helianthemum cinereum guadicianum	.	.	.	.	II	.	.	.	.	.	.	.	.	
Lithodora fruticosa	.	.	.	.	.	.	.	II	.	.	.	.	.	
Thymus zygis gracillis	.	.	.	.	.	.	.	.	II	.	.	.	.	
Ptilostemon hispanicus	.	.	.	.	.	.	.	.	II	.	.	.	.	
Thymus orospedanus	.	.	.	.	.	.	.	.	.	.	.	.	II	
Santolina canescens	.	.	.	.	.	.	.	.	.	.	.	.	II	
Genista pumila	I	.	.	.	.	.	.	.	.	.	.	.	.	
Thymus serpylloides gadorensis	.	.	.	.	.	I	.	.	.	.	.	.	.	
Hippocrepis scabra	.	.	.	I	.	.	.	.	.	.	.	.	.	
Teucrium homotrichum	.	.	.	.	.	.	.	.	.	I	.	.	.	
Armeria filicaulis	.	.	.	.	.	.	.	.	.	I	.	.	.	
Companion taxa:														
Helianthemum cinereum rotundifolium	IV	III	III	V	IV	IV	V	.	IV	.	.	.	.	
Seseli granatense	II	IV	II	I	III	IV	.	.	.	I	3	.	.	
Dianthus pungens brachyanthus	.	.	.	II	II	.	.	III	.	III	2	V	III	
Koeleria vallesiana	III	.	.	I	V	.	V	.	.	.	3	II	II	
Brachypodium boissieri	.	.	.	.	.	.	.	I	V	V	5	V	II	
Jurinea humilis	.	IV	.	.	II	.	.	IV	.	.	4	III	IV	
Poa ligulata	.	.	.	I	II	.	II	II	.	.	4	III	V	
Carex halleriana	II	III	.	I	IV	.	.	.	.	II	4	.	.	
Avenula gervaisii	.	.	.	.	III	I	.	.	.	III	.	II	IV	
Helictotrichon filifolium	.	.	.	III	.	I	II	.	.	.	2	.	IV	
Festuca hystrix	II	.	V	I	.	V	.	.	.	.	.	.	.	
Sedum gypsicola	.	.	.	.	III	II	.	.	.	I	.	.	II	
Scabiosa turolensis	II	III	.	I	.	.	.	.	.	.	.	.	.	
Trisetum velutinum	.	.	.	.	.	.	.	.	.	II	2	V	.	
Odontites longiflora	.	.	.	.	III	III	.	.	.	.	.	II	.	
Globularia spinosa	III	III	.	.	.	.	.	.	.	.	.	.	.	
Bupleurum fruticescens	IV	.	.	V	.	.	.	.	.	.	.	.	.	
Polygala rupestris	.	II	.	III	.	.	.	.	.	.	.	.	.	
Biscutella valentina	III	.	.	II	.	.	.	.	.	.	.	.	.	
Echium albicans	.	.	.	.	.	.	.	.	.	.	1	IV	.	
Thymelaea elliptica	.	.	.	.	.	.	.	.	.	.	.	III	II	
Paronychia suffruticosa	.	.	.	II	.	.	.	.	.	.	2	.	.	
Andryala ramossisima	.	.	.	.	.	.	.	.	III	I	.	.	.	
Andryala ragusina	.	.	.	.	.	.	.	.	.	I	.	.	II	
Stipa tenacissima	.	.	.	IV	.	.	.	.	.	.	.	.	.	
Bupleurum spinosum	.	.	.	.	IV	.	.	.	.	.	.	.	.	
Centaurea antennatta	III	.	.	.	.	.	.	.	.	.	.	.	.	
Avenula bromoides pauneroi	.	.	.	.	.	.	.	.	III	.	.	.	.	
Alyssum montanum	.	.	.	.	.	.	.	.	.	.	.	III	.	
Corynephorus canescens	.	.	.	.	.	.	.	.	.	.	.	.	III	
Euphorbia nicaensis	II	.	.	.	.	.	.	.	.	.	.	.	.	
Jasonia glutinosa	.	.	.	II	.	.	.	.	.	.	.	.	.	
Arctostaphylos uva-ursi	.	.	.	II	.	.	.	.	.	.	.	.	.	
Sedum sediforme	.	.	.	.	II	.	.	.	.	.	.	.	.	
Sedum album	.	.	.	I	.	.	.	.	.	.	.	.	.	
Stipa offneri	.	.	.	.	.	.	.	.	.	I	.	.	.	

Tab. 2 - Synthesis of dolomitic thyme-scrub communities of the Baetic Sierras.

GROUP 1

**Fumano paradoxae–Thymetum sabulicolae*

DIAGNOSIS: Dolomitic thyme-scrub communities, Sub-Baetic–Murciano and Alcaracense, meso- and supra-Mediterranean, outlying.

CHARACTERISTIC TAXA: *Fumana paradoxa, Thymus funkii* var. *sabulicola, Scorzonera albicans.*

GROUP 2

SUBGROUP 2 A

**Helianthemo frigiduli–Pterocephaletum spathulatae*

DIAGNOSIS: Dolomitic thyme-scrub communities, Sub-Baetic–Maginense, supra/oro-Mediterranean.

CHARACTERISTIC TAXA: *Viola cazorlensis, Helianthemum marifolium* subsp. *frigidulum, Thymus granatensis* var. *micranthus.*

**Scorzonero albicantis–Pterocephaletum spathulatae*

DIAGNOSIS: Dolomitic thyme-scrub communities, Cazorlense and Alcaracense, supra/oro-Mediterranean.

CHARACTERISTIC TAXA: *Erodium cazorlanum, Scorzonera albicans*

SUBGROUP 2 B

**Thymo granatensis–Arenarietum tomentosae* subass. *arenarietosum granatensis*

DIAGNOSIS: Dolomitic thyme-scrub communities, Serrano–Bacense (Baza Sierra) meso/supra-Mediterranean.

CHARACTERISTIC TAXA: *Arenaria tomentosa, Jurinea pinnata, Thymus granatensis* subsp. *granatensis*

**Thymo-granatensis–Arenarietum tomentosae* subass. *scorzoneretosum albicantis*

DIAGNOSIS: Dolomitic thyme-scrub communities, Serrano–Estanciense, meso- and supra-Mediterranean; closely linked to the sub-Baetic group.

CHARACTERISTIC TAXA: *Arenaria tomentosa, Jurinea pinnata, Scorzonera albicans, Thymus longiflorus* (diff.).

SUBGROUP 2 C

**Brassico almeriensis–Pterocephaletum spathulatae*

DIAGNOSIS: Dolomitic thyme-scrub communities, Guadiciano–Bacense (Filabres) supra/oro-Mediterranean.

CHARACTERISTIC TAXA: *Jurinea pinnata, Brassica repanda* subsp. *almeriensis.*

GROUP 3

**Galio baetici–Thymetum granatensis*

DIAGNOSIS: Dolomitic thyme-scrub communities, Rondense, meso/supra-Mediterranean; extremely poor in characteristic elements.

TAXA DIFERENCIALES: *Galium baeticum, Jurinea pinnata, Arenaria erinacea*

GROUP 4

**Hippocrepido eriocarpae–Pterocephathuletum spathulatae*

DIAGNOSIS: Dolomitic thyme-scrub communities ,Almijarense, supra/oro-Mediterranean.

CHARACTERISTIC TAXA:*Arenaria erinacea, Helianthemum viscidulum*

**Andryalo agardhii–Convolvuletum boissieri* subass. *convolvuletosum boissieri*

DIAGNOSIS: Dolomitic thyme-scrub communities, Alfacarino–Granatense, supra/oro-Mediterranean.

CHARACTERISTIC TAXA: *Helianthemum pannosum, Scabiosa pulsatilloides, Erodium boissieri, Santolina elegans.*

**Andryalo agardhii–Convolvuletum boissieri* subass. *centaureetosum funkii*

DIAGNOSIS: Dolomitic thyme-scrub communities,Alfacarino-Granatense (Huetor Sierra).

CHARACTERISTIC TAXA:*Centaurea boissieri* subsp. *funkii*

**Helianthemo visciduli–Anthyllidetum argyrophyllae*

DIAGNOSIS: Dolomitic thyme-scrub communities, Malacitano–Almijarense (entire sector), meso-Mediterranean.

CHARACTERISTIC TAXA: *Helianthemum viscidulum, Centaurea bombycina*

Appendix 1

Sources of relevés

No.: Order number in synthesis table (Tab.1); Abbr.: Abbreviated name of syntaxa (as used in graphs 1 and 2); No. Invs.: Number of relevés for each syntaxon.

No.	Abbr.	Community	No. Invs.	Source
1	Fu–Th	*Fumano paradoxae–Thymetum sabulicolae*	9	Sánchez-Gómez & Alcaraz. (1992): 134–135. Tab. 7
2	He–Pt	*Helianthemo frigiduli–Pterocephaletum spathulatae*	5	Martínez-Parras *et al.* (1987): 198. Tab. 2
3	Sc–Pt	*Scorzonero albicantis–Pterocephaletum spathulatae*	5	Martínez-Parras *et al.* (1987): 299. Tab. 3
4	Th–Ar2	*Thymo-granatensis–Arenarietum tomentosae*	8	Navarro *et al.* (1999): 127. Tab. 18b
5	Th–Ar1	*Thymo granatensis–Arenarietum tomentosae*	12	Mota & Valle (1992): 287. Tab. 1
6	Br–Pt	Com. de *Brassica almeriensis* y *Pterocephalus spathulatus*	6	Mota *et al.* (1993): 37. Tab. 6
7	Ga–Th	*Galio baetici–Thymetum granatensis*	9	Mota & Valle (1992): 289. Tab. 3
8	Hi–Pt	*Hippocrepido eriocarpae–Pterocephathuletum spathulatae*	10	Mota & Valle (1992): 288. Tab. 2
9	He–An	*Helianthemo visciduli–Anthyllidetum argyrophyllae*	4	Pérez-Raya (1987). Tab. 61
		" "	6	Lorite (unpub.).
10	Ar–Ce	*Arenario delaguardiae–Centaureetum bombycinae*	10	Mota *et al.* (1993): 36. Tab. 5
		" "	14	Mota *et al.* (1993): 35. Tab. 4
11	An–ce	*Andryalo agardhii–Convolvuletum boissieri* subass. *centaureetosum bombycinae*	3	Mota *et al.* (1993): 33. Tab. 2
12	An–cb	*Andryalo agardhii–Convolvuletum boissieri* subass. *convolvuletosum boissieri*	15	Mota *et al.* (1993): 32. Tab. 1
13	An–cf	*Andryalo agardhii–Convolvuletum boissieri* subass. *centaureetosum funkii*	15	Mota *et al.* (1993): 34. Tab. 3

Appendix 2

Taxa not listed in the referenced flora

Avenula bromoides subsp. *pauneroi* Romero Zarco in *Lagascalia.* 13(1): 114. 1984.

Helictotrichum filifolium subsp. *velutinum* (Boiss.) Romero Zarco *in Anal. Jard. bot. Madrid.* 41(1): 118. 1984.

Santolina canescens Lag. *in Gen. Sp. Nov:* 25. 1816.

Teucrium bicoloreum Pau ex Vicioso *in Bol. Real Soc. Esp. Hist. Nat.* 216: 142. 1916.

Teucrium leonis Sennen *in Diagn. Nouv. Pl. Espagne Maroc:* 35. 1936.

Teucrium lerrouxii Sennen *in Diagn. Nouv. Pl. Espagne Maroc:* 266. 1936.

Teucrium similatum Navarro & Rosúa *in Candollea.* 45(2): 583. 1990.

Thymelaea tartonraira subsp. *angustifolia* (Boiss.) Rivas Goday & Esteve *in Anal. Real Acad. Farm.* 38(3): 462. 1972.

Thymus funkii var. *sabulicola* (Cosson) R. Morales *in Anal. Jard. Bot. Madrid.* 43(1). 1986.

Thymus granatensis subsp. *micranthus* (Willk.) O. Bolós & J. Vigo *in Collect. Bot.* 14: 95. 1983

Thymus zygis subsp. *gracillis* (Boiss.) R. Morales *in Anal. Jard. Bot. Madrid.* 41(1): 93. 1984.

Ulex baeticus Boiss. *in Elench. Pl. Nov.*: 88. 1838.