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Syntaxonomical approach for classification of the Californian serpentine annual grasslands

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Abstract: Rodríguez-Rojo, M. P., Sánchez-Mata, D., Rivas-Martínez, S. & Barbour, M. G. *Syntaxonomical approach for classification of the Californian serpentine annual grasslands. Lazaroa 22: 83-94 (2001).*

A preliminary syntaxonomical approach for the serpentine annual grasslands classification is presented. Our proposals include the phytosociological frame for the syntaxonomy of the annual plant communities growing on ultramafic substrata and distributed throughout the territories of the Californian biogeographical region. All the formal phytosociological high units newly proposed are justified and legitimated on the basis of previous reports and our own data. These are collected in a new phytosociological class: *Vulpio microstachyos-Hesperolinetea micranthi* that includes, so far, one new order: *Eriogono luteoli-Hesperolinetalia micranthi* and four new alliances: *Hesperevaco sparsiflorae-Hemizonion congestae*, *Hesperolinion clevelandii*, *Hesperolino micranthi-Navarretion filicaulis* and *Streptanthion polygaloidis*.

Resumen: Rodríguez-Rojo, M. P., Sánchez-Mata, D., Rivas-Martínez, S. & Barbour, M. G. *Sintaxonomía de los pastizales terofíticos serpentinícolas de California (EEUU). Lazaroa 22: 83-94 (2001).*

Se propone el esquema sintaxonómico preliminar de los pastizales terofíticos desarrollados sobre sustratos ultramáficos de la región biogeográfica Californiana. Se justifican y legitiman todas las propuestas fitosociológicas formales referentes a unidades superiores considerando tanto las publicaciones previas como nuestros propios datos. Los nuevos sintáxones propuestos se concretan en una clase: *Vulpio microstachyos-Hesperolinetea micranthi*, la cual se fundamenta, hasta el momento, en un orden: *Eriogono luteoli-Hesperolinetalia micranthi* y cuatro nuevas alianzas: *Hesperevaco sparsiflorae-Hemizonion congestae*, *Hesperolinion clevelandii*, *Hesperolino micranthi-Navarretion filicaulis* y *Streptanthion polygaloidis*.

INTRODUCTION

The distribution of Californian annual grasslands occupies large areas in the Central Valley and along a broad north-south transect throughout the coastal lands of California (BAKER, 1989; HEADY, 1995). In these Californian territories ultramafic outcrops are commonly distributed (Figure 1) from the Pacific coasts (Coast Ranges) to the Sierra Nevada foothills (west side) in a western-eastern transect, and in a northern-southern transect from the Klamath-Siskiyou Mountains to the South Coast Ranges. The distribution of ultramafic-related annual grasslands is limited by the patchy nature of the outcrops (mainly serpentine outcrops). Serpentine grasslands in California cover several types of habitats such as barrens, vernal pools, streambanks, edges of shrubby communities (chaparrals), etc., and have a high species diversity and high levels of endemicity (MCCARTEN, 1986, 1992; KRUCKEBERG, 1991; HARRISON, 1997, etc.).

The population dynamics and structure of serpentine plant communities have been the subject of several publications (HOBBS & MOONEY, 1985, 1991; HUENNEKE & *al*., 1990; MCCARTEN, 1992; MOLONEY & *al*., 1992) while the diversity patterns in these specialized communities have recently been studied by HARRISON (1997), HARRISON & *al*., (2000) and WOLF & *al*. (2000). The study of Californian serpentine vegetation (*sensu lato*) has several compulsory and diverse references such as KRUC-

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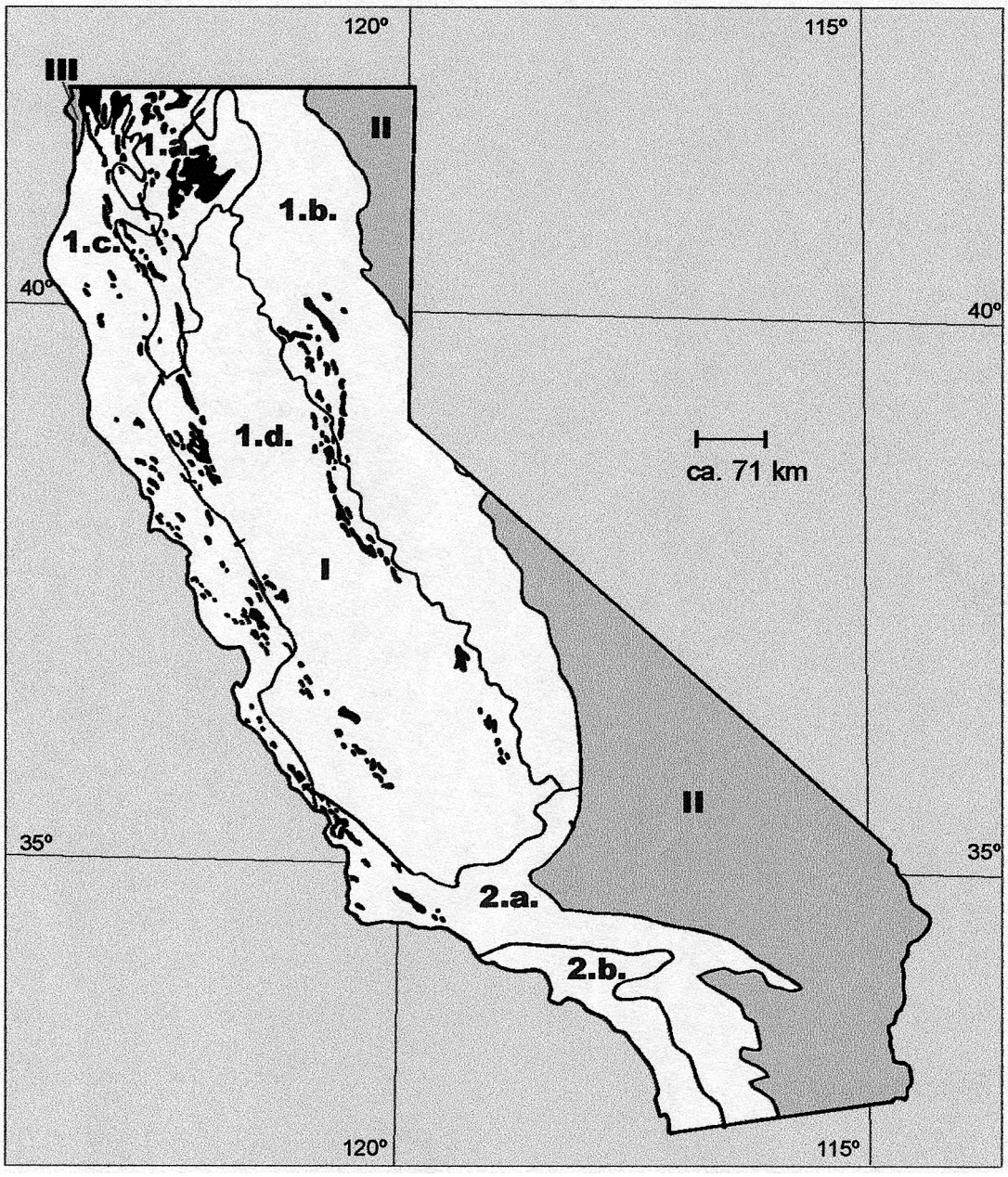

Fugure 1.—Biogeographical map of the Californian Region (I) with the distribution of the main serpentine outcrops. The biogeographical limits are adapted from Rivas-Martínez, Sánchez-Mata & Costa (1999) and the geological information from Kruckeberg (1984). II. Great Basin Region; III. Rocky Mountain Region. Northern Californian Province: I.1.a. Klamath Sector; I.1.b. Sierra Nevada Sector; I.1.c. Northern Californian Coastal Sector; I.1.d. Great Valley Sector. Southern Californian Province: I.2.a. Southern Californian Ranges Sector; I.2.b. Southern Coastal and Channel Islands Sector.

KEBERG, 1984; MCCARTEN 1986, 1987; BROOKS, 1987; BARBOUR & MAJOR, 1995; HANES, 1995; SAWYER-KEELER-WOLF, 1995; RIVAS-MARTÍNEZ, 1997, RIVAS-MARTÍNEZ & SÁNCHEZ-MATA, 1997; SÁNCHEZ-MATA, 1997 and KEELEY, 2000.

MATERIAL AND METHODS

We have recently published the first phytosociological approach to Californian serpentine annual grasslands based on the MD Thesis study done by RODRÍGUEZ-ROJO (1998), relating the community units described to environmental factors and to potential vegetation (RODRÍGUEZ-ROJO & *al*., 2001). In this previous paper we formally propose four associations, two subassociations and some provisional communities strictly following the last edition of the International Code of Phytosociological Nomenclature (WEBER & *al*., 2000).

In this paper, our proposals include the phytosociological frame for the syntaxonomy of the annual plant communities growing on ultramafic substrata and distributed throughout the territories of the Californian biogeographical region (RIVAS-MARTÍNEZ & *al*., 1999), mainly along the Northern Californian Province areas (Map 1). These are synthesized in a new phytosociological class: *Vulpio microstachyos-Hesperolinetea micranthi* that includes, so far, one new order: *Eriogono luteoli-Hesperolinetalia micranthi* and four new alliances: *Hesperevaco sparsiflorae-Hemizonion congestae*, *Hesperolinion clevelandii*, *Hesperolino micranthi-Navarretion filicaulis* and *Streptanthion polygaloidis* (Tabs. 1 and 2).

Nomenclature: BONAP/MIP (ANON., 2001) that basically follows the classic checklist of KARSTEZ (1994). The monographs of SHARSMITH (1961) for *Hesperolinon* taxa and MORIN (1993) for ferns were also considered. Collected specimens are deposited in the School of Pharmacy Herbarium at the Complutense University of Madrid (MAF), duplicates are conserved at the Herbarium of the University of California at Davis (DAV). Autoecology of taxa follows our own field experience and precise data provided by KRUCKEBERG (1984) and HICKMAN (1993).

RESULTS, DISCUSSION AND PROPOSALS

VULPIO MICROSTACHYOS-HESPEROLINETEA MICRANTHI classis nova

Typus nominis: ***Eriogono luteoli-Hesperolinetalia micranthi*** ordo novus.

This newly proposed class includes the annual communities rich in serpentine endemics and characteristics (Tab. 1) growing on soils from ultramafic, mainly serpentine metamorphic rocks. These specialized communities are broadly distributed throughout the Californian Region territories which are characterized by the Mediterranean macrobioclimate conditions.

This specialized vegetation-type is related to evergreen sclerophyllous and late-deciduous forests, woodlands or chaparrals (*Heteromelo arbutifoliae-Quercetea agrifoliae* Rivas-Martínez 1997) that constitute the potential vegetation of thermo- and mesomediterranean thermotype areas. In higher altitudes (supramediterranean thermotype territories) it is associated with the potential conifer and mixed evergreen forests (*Calocedro decurrentis-Pinetea jeffreyi* Rivas-Martínez & Sánchez-Mata 1997).

When the soils become richer in nitrogen, and disturbed by anthropic or animal activities, these communities can change into annual grasslands related to *Thero-Brometalia* (Rivas Goday & Rivas-Martínez ex Esteve 1973) O. Bolòs 1975 order (*Chenopodio-Stellarienea* Rivas Goday 1956, *Stellarietea mediae* Tüxen, Lohmeyer & Preising ex von Rochow 1951) and frequently including the vulgarization of the plant community floristic spectra.

The biogeographical assemblage of this peculiar vegetation is strictly related to the Californian region biogeographical provinces. In the northern Californian territories (Northern Californian Province) the serpentine annual communities are framed into the *Eriogono luteoli-Hesperolinetalia micranthi* order characterized by serpentine endemics (Tab. 1), and growing mainly under meso- and supramediterranean thermotype conditions. However, the southern Californian communities (Southern Californian Province) are linked to other potential vegetation-types and characterized by a

Table 1
Characteristic species of the newly proposed syntaxa

Vulpio microstachyos-Heperolinetea micranthi		
Agrostis microphylla	*Hesperolinon micranthum*	*Monolopia gracilens*
Campanula exigua	*Lepidium nitidum*	*Navarretia pubescens*
Campanula griffinii	*Linanthus ambiguus*	*Phacelia congdonii*
Caulanthus flavescens	*Linanthus dichotomus*	*Plagiobothrys infectivus*
Claytonia gypsophiloides	*Linanthus liniflorus*	*Plagiobothrys shastensis*
Claytonia rosulata	*Linanthus meridianus*	*Sidalcea diploscypha*
Claytonia saxosa	*Linanthus pharnaceoides*	*Sedella pentandra*
Coreopsis stillmanii	*Micropus amphibolus*	*Streptanthus breweri*
Gilia sinistra	*Mimulus douglasii*	*Streptanthus glandulosus*
Hesperevax sparsiflora	*Minuartia californica*	*Trichostema rubisepalum*
Hesperolinon breweri	*Minuartia douglasii*	*Vulpia microstachys*
Hesperolinon californicum	*Monardella douglasii*	
Eriogono luteoli-Hesperolinetalia micranthi		
Calycadenia oppositifolia	*Eriogonum luteolum*	*Polygonum spergulariiforme*
Camissonia lacustris	*Hesperolinum breweri*	*Sairocarpus vexillocalyculatus*
Castilleja lacera	*Hesperolinon didymocarpum*	*Sidalcea hartwegii*
Cordylanthus brunneus	*Hesperolinon disjunctum*	*Silene campanulata*
Cordylanthus viscidus	*Lagophylla minor*	*Streptanthus drepanoides*
Chaenactis heterocarpha	*Microseris douglasii*	*Mimulus layneae*
Eriogonum caninum	*Mimulus brachiatus*	
Hesperevaco sparsiflorae-Hemizonion congestae		
Acanthomintha duttonii	*Eriastrum brandegeae*	*Nemacladus montanus*
Astragalus breweri	*Gilia pinnatisecta*	*Phacelia greenei*
Astragalus jepsonianus	*Hemizonia congesta*	*Sairocarpus breweri*
Calycadenia pauciflora	*Hemizonia vernalis*	*Sairocarpus cornutus*
Campanula angustifolia	*Hesperolinon congestum*	*Sairocarpus virga*
Cistanthe quadripetala	*Hesperolinon drymarioides*	*Sidalcea viridis*
Clarkia franciscana	*Layia septentrionalis*	*Streptanthus barbiger*
Clarkia tracyi	*Lessingia arachnoidea*	*Streptanthus batrachopus*
Collinsia greenei	*Lessingia glabrata*	*Streptanthus brachiatus*
Collomia diversifolia	*Lessingia micradenia*	*Streptanthus hesperidis*
Cordylanthus capillaris	*Madia doris-nilesiae*	*Streptanthus hoffmanii* (1)
Cordylanthus hansenii	*Madia hallii*	*Streptanthus hoffmanii* (2)
Cordylanthus nidularis	*Madia stebbinsii*	*Streptanthus niger*
Cordylanthus pilosus	*Mimulus nudatus*	*Streptanthus pulchellus*
Cordylanthus pringlei	*Minuartia howellii*	*Streptanthus secundus*
Cryptantha dissita	*Navarretia heterodoxa*	*Streptanthus sonomensis*
Cryptantha hispidula	*Navarretia jepsonii*	*Triphysaria floribunda*
Hesperolinion clevelandii		
Hesperolinon adenophyllum	*Hesperolinon spergulinum*	*Streptanthus elatus*
Hesperolinon bicarpellatum	*Hesperolinon tehamense*	*Streptanthus hirtiflorus*
Hesperolinon clevelandii	*Navarretia rosulata*	*Streptanthus kruckebergii*
Hesperolinon serpentinum	*Sairocarpus subcordatus*	*Streptanthus morrisonii*
Hesperolino micranthi-Navarretion filicaulis		
Cryptantha mariposae	*Lupinus spectabilis*	*Monardella venosa*
Githopsis serpentinicola	*Navarretia filicaulis*	
Streptanthion polygaloidis		
Clarkia biloba	*Cordylanthus trifidus*	*Streptanthus polygaloides*
Cordylathus brunneus	*Githopsis glabra*	

(1), (2). See Floristic Appendix.

Tabla 2
Synoptic table for the Californian serpentine annual communities *(Vulpio microstachyos-Hesperolinetea micranthi),* only species present in more than two relevés are included. Indices are according to Géhu & Rivas-Martínez (1981)

Syntaxa	1a	1b	2	3	4	5	6	7	8	9
Number of relevés	23	9	4	14	20	4	18	6	6	11
Characteristic species:										
Vulpia microstachys	IV	II	5	IV	III	2	V	V	V	II
Eriogonum luteolum	+	.	.	.	I	.	V	V	V	.
Minuartia californica	.	.	.	.	I	.	II	V	V	.
Hesperevax sparsiflora	IV	IV	2	+	.	.	.	.	.	.
Hesperolinon micranthum	.	.	.	.	V	5	.	II	.	.
Streptanthus polygaloides	.	.	.	.	.	.	V	V	III	.
Trichostema rubisepalum	.	.	.	.	I	.	+	.	.	II
Calycadenia oppositifolia	.	.	.	.	I	.	II	.	.	.
Lagophylla minor	.	.	.	.	.	.	I	.	V	.
Minuartia douglasii	I	II	.	.	.	.	.	.	.	.
Microseris douglasii	I	II	.	.	.	.	.	.	.	.
Lepidium nitidum	I	III	.	.	.	.	.	.	.	.
Hemizonia congesta	+	.	.	.	.	.	.	.	.	.
Lasthenia californica	.	V	.	.	.	.	.	.	.	.
Hesperolinon drymarioides	.	.	5	.	.	.	.	.	.	.
Hesperolinon clevelandii	.	.	.	V	.	.	.	.	.	.
Navarretia filicaulis	.	.	.	.	IV	.	.	.	.	.
Cordylanthus brunneus	.	.	.	.	.	.	.	II	.	.
Polygonum spergulariiforme	.	.	.	.	.	.	.	.	V	.
Helianthus bolanderi	.	.	.	.	.	.	.	.	.	IV
Centaurium muehlenbergii	.	.	.	.	.	.	.	.	.	III
Centaurium trichanthum	.	.	.	.	.	.	.	.	.	I
Trichostema laxum	.	.	.	.	.	.	.	.	.	II
Companion species:										
Epilobium minutum	II	.	2	+	III	.	III	V	IV	.
Lotus wrangelianus	IV	V	3	II	I	.	I	.	II	.
Hemizonia luzulifolia	IV	V	2	+	.	.	.	.	.	.
Plantago erecta	IV	V	.	+	.	.	.	.	.	.
Calycadenia multiglandulosa	II	II	.	I	.	.	.	.	.	.
Micropus californicus	II	II	.	II	.	.	.	.	.	.
Layia platyglossa	II	II	.	+	.	.	.	.	.	.
Lessingia nemaclada	+	.	.	IV	I	.	.	.	.	.
Madia exigua	+	.	2	.	I	.	.	.	.	.
Lotus unifoliolatus	.	.	.	.	II	5	.	.	.	III
Madia elegans	.	.	.	.	.	5	.	.	.	II
Agoseris heterophylla	I	II	.	.	.	.	.	.	.	.
Astragalus gambelianus	I	I	.	.	.	.	.	.	.	.
Linanthus micranthus	+	III	.	.	.	.	.	.	.	.
Calandrinia ciliata	+	II	.	.	.	.	.	.	.	.
Rigiopappus leptocladus	I	.	.	.	.	.	.	.	V	.
Castilleja densiflora	.	IV	.	.	.	.	.	.	.	.
Trifolium depauperatum	.	II	.	.	.	.	.	.	.	.
Trifolium microcephalum	.	II	.	.	.	.	.	.	.	.
Hemizonia fitchii	.	.	.	.		.	II	.	.	.
Mimulus mephiticus	.	.	.	.	.	.	.	II	.	.
Mimulus layneae	.	.	.	.	.	.	.	.	II	.
Daucus pusillus	I	.	.	.	.	.	.	.	.	.
Filago californica	.	.	.	.	I	.	.	.	.	.

Relevés source: Table 3, pg. 695, Rodríguez-Rojo & *al*. 2001. 1a: *Hesperevacetum sparsiflorae typicum*, 1b: *Hesperevacetum sparsiflorae lasthenietosum californicae*, 2: *Hesperolinon drymarioides* community, 3: *Hesperolinetum clevelandii*, 4: *Hesperolino micranthi-Navarretietum filicaulis*, 5: *Madia elegans-Hesperolinon micranthum* community, 6: *Streptanthetum polygaloidis*, 7: *Mimulus mephiticus-Streptanthus polygaloides* community, 8: *Lagophylla minor-Polygonum spergulariiforme* community, 9: *Helianthus bolanderi* communities.

pool of serpentine endemics with a clear floristic and biogeographical distinction such as *Acanthomintha lanceolata*, *Benitoa occidentalis*, *Camissonia benitensis*, *Caulanthus barbarae*, *Chorizanthe breweri*, *C. palmeri*, *C. ventricosa*, *Emmenanthe rosea*, *Eriogonum argillosum*, *Githopsis candida*, *Layia discoidea*, *L. jonesii*, *Microseris decipiens*, *Navarretia jaredii*, *Streptanthus albidus*, *Systenotheca vortriedei*, etc. Thus, these serpentine annual communities from the territories of the Southern Californian Province may constitute an equivalent new order that requires further studies.

We propose the name *Vulpio microstachyos-Hesperolinetea micranthi* for this new class according to the autoecology of the two taxa involved: *Vulpia microstachys* is a frequent annual grass in all the studied serpentine grasslands, mainly growing on crumbled ultramafic rocks and substrata, and *Hesperolinum micranthum* is the most widespread species of this endemic genus restricted to ultramafic soils throughout the Californian biogeographical region.

ERIOGONO LUTEOLI-HESPEROLINETALIA MICRANTHI ordo novus

Typus nominis: ***Hesperevaco sparsiflorae-Hemizonion congestae*** *alliancia nova*.

Within this order we include the serpentine annual communities whose biogeographical distribution comprises the Northern Californian Province (Figure 1). The dynamics are related with the mesomediterranean series of serpentine chaparrals framed into the *Quercion duratae* Sánchez-Mata, Barbour, Rodríguez-Rojo in Rivas-Martínez 1997 alliance (*Heteromelo arbutifoliae-Quercetea agrifoliae* Rivas-Martínez 1997) and, in the supramediterranean areas, with the open conifer mesoforests of *Querco vaccinifoliae-Pinion jeffreyi* Rivas-Martínez & Sánchez-Mata 1997 alliance (*Calocedro decurrentis-Pinetea jeffreyi* Rivas-Martínez & Sánchez-Mata 1997). According to our data these plant communities colonize a wide spectrum of habitats, even in very unstable or low-hydromorphic substrates and are characterized by several taxa listed in Table 1.

HESPEREVACO SPARSIFLORAE-HEMIZONION CONGESTAE alliancia nova

Typus nominis: ***Hesperevacetum sparsiflorae typicum*** Rodríguez-Rojo & Sánchez-Mata *in* Rodríguez-Rojo, Sánchez-Mata, Gavilán, Rivas-Martínez & Barbour 2001 *in* J. Veg. Sci. 12(5): 690.

Holotypus: RODRÍGUEZ-ROJO & *al*., *op. cit*.: 692, table 2a, rel. 16 (*typicum*):
California: Alameda Co., Oakland, Redwood Road & Samara Street, edges of *Nassella pulchra* perennial grasslands, 240 m, 1 m^2, 80% cover, 10% slope, W, 10SEM7384. Characteristic species: *Hesperevax sparsiflora* 1, *Vulpia microstachys* 4, *Lepidium nitidum* 2, *Microseris douglasii* +. Companion species: *Plantago erecta* 3, *Hemizonia luzulifolia* 2, *Astragalus gambelianus* 1, *Lotus wrangelianus* +, *Layia platyglossa* +, *Lolium multiflorum* 1, *Funaria* sp. 3, *Bromus rubens* 1.
Characteristic species: see Table 1.

Serpentine annual grasslands developed in open areas and sunny places. They occur throughout pluviseasonal oceanic areas with hyperoceanic character, with meso- and supramediterranean thermotypes. The distribution comprises the territories included in the Northern Californian Coastal and Great Valley biogeographical sectors along the Bay Area and North Coast Ranges.

We include in this new alliance only one formal association so far: *Hesperevacetum sparsiflorae* with two recognized subassociations: *typicum* and *lasthenietosum californicae* Rodríguez-Rojo & Sánchez-Mata *in* Rodríguez-Rojo & *al*. 2001 (*op. cit*.: 693) developed in serpentine vernal pool areas. Also we include in this alliance the provisional unit called *Hesperolinon drymarioides* community in our prior work (cf. Rodríguez-Rojo & *al*., *op. cit*.: 694) (Tab. 2). This last community grows on very shallow soils as sparse grass on the edges of chamise chaparrals (*Adenostomion fasciculatae* Rivas-Martínez 1997) along the North Coast Ranges serpentine areas.

HESPEROLINION CLEVELANDII alliancia nova

Typus nominis: ***Hesperolinetum clevelandii*** Rodríguez-Rojo & Sánchez-Mata 2001 *in* Rodríguez-Rojo, Sánchez-Mata, Gavilán, Rivas-Martínez & Barbour *in* J. Veg. Sci. 12(5): 691.

Holotypus: RODRÍGUEZ-ROJO & *al*., *op. cit*.: 692, table 2a, rel. 43:
California: Lake Co., Morgan Valley, Berryessa-Knoxville Road, Hunting Creek, under *Cupressus macnabiana* and *Adenostoma fasciculatum* shrubs, 640 m, 0.5 m^2, 30% cover, 10% slope, W, 10SEP5101. Characteristic species: *Hesperolinon clevelandii* 4, *Vulpia microstachys* +. Companion species: *Lessingia nemaclada* +.
Characteristic species: see Table 1.

Hesperolinon clevelandii is a Californian serpentine endemic closely related to the Franciscan Jurassic formation of metamorphic serpentines and other ferromagnesian rocks that also occur in the North Coast Range; there we describe a sciophilous association *Hesperolinetum clevelandii* Rodríguez-Rojo & Sánchez-Mata *in* Rodríguez-Rojo & *al*. 2001 (*op. cit*.: 691; Tab. 2).

The newly proposed alliance (*Hesperolinion clevelandii*) would comprise those most oceanic sciophilous communities which have a very narrow distribution generally in Californian North Coast territories. These communities are associated with serpentine chaparrals (*Ceanotho albiflori-Quercetum duratae* Sánchez-Mata, Barbour & Rodríguez-Rojo *in* Rivas-Martínez 1997) in the Northern Californian biogeographical province.

HESPEROLINO MICRANTHI-NAVARRETION FILICAULIS alliancia nova
Typus nominis: ***Hesperolino micranthi-Navarretietum filicaulis*** Rodríguez-Rojo & Sánchez-Mata *in* Rodríguez-Rojo, Sánchez-Mata, Gavilán, Rivas-Martínez & Barbour 2001 *in* J. Veg. Sci. 12(5): 691.

Holotypus: RODRÍGUEZ-ROJO & *al*., *op. cit*.: 692, table 2b, rel. 63.
California: Butte Co., Magalia, Magalia Reservoir, shadow places under *Cupressus macnabiana* and *Pinus sabiniana*, 675 m, 1 m^2, 40% cover, 10SFQ2109. Characteristic species: *Hesperolinon micranthum* 4, *Vulpia microstachys* 2, *Navarretia filicaulis* +. Companion species: *Epilobium minutum* 2, *Eriophyllum croceum* +, *Melica torreyana* +.
Characteristic species: see Table 1.

Pluviseasonal oceanic, meso- and supramediterranean communities dominated by sciophytes, mainly *Hesperolinon micranthum*, the only widespread species in the *Hesperolinon* genus that occurs throughout the Coast Ranges and the Sierra Nevada foothills. In contrast with *Hesperolinion clevelandii* alliance, *Hesperolino micranthi-Navarretion filicaulis* would comprise sciophilous communities with a more continental tendency. Thus, in the Sierra Nevada foothills we proposed a mesomediterranean association dominated by *Hesperolinon micranthum* with a distribution restricted to Cascade Ranges and northern and central Sierra Nevada foothills: *Hesperolino micranthi-Navarretietum filicaulis* Rodríguez-Rojo & Sánchez-Mata 2001 *in* Rodríguez-Rojo & *al*. (*op. cit*.: 691). This association is related to serpentine chaparrals (*Quercion duratae* Sánchez-Mata, Barbour & Rodríguez-Rojo *in* Rivas-Martínez 1997).

The *Madia elegans-Hesperolinon micranthum* community we described in our prior work (cf. RODRÍGUEZ-ROJO & *al*., *loc. cit*.) should also be included in this alliance (Tab. 2). It is related to supramediterranean thermotype areas in open Jeffrey pine mesoforests growing on ultramafic soils (*Querco vaccinifoliae-Pinion jeffreyi* Rivas-Martínez & Sánchez-Mata 1997).

STREPTANTHION POLYGALOIDIS alliancia nova
Typus nominis: ***Streptanthetum polygaloidis*** Rodríguez-Rojo & Sánchez-Mata *in* Rodríguez-Rojo, Sánchez-Mata, Gavilán, Rivas-Martínez & Barbour 2001 *in* J. Veg. Sci. 12(5): 690.

Holotypus: RODRÍGUEZ-ROJO & *al*., *op. cit*.: 693, table 2b, rel. 87:
California: El Dorado Co., Placerville-Georgetown, Bear Creek Road-Meadow Brook Road. Head of Traverse Creek, 620 m, 0.5 m^2, 80% cover, 5% slope, 10SFN8905. Characteristic species: *Streptanthus polygaloides* 3, *Vulpia microstachys* 2, *Eriogonum luteolum* 1, *Minuartia californica* 1, *Lagophylla minor* +. Companion species: *Epilobium minutum* +.
Characteristic species: see Table 1.

Pluviseasonal oceanic, meso- and supramediterranean communities that grow in open serpentine barrens with an oceanic influence. The altitudinal gradient determines the differentation of two communities characterized by *Streptanthus polygaloides* along the west side of Sierra Nevada and recently described in our prior work: *Streptanthetum polygaloidis* Rodríguez-Rojo & Sánchez-Mata *in* Rodríguez-Rojo & *al*. 2001 (*op. cit*.: 690) from the meso-

mediterranean areas of Sierra Nevada foothills and the *Mimulus mephiticus-Streptanthus polygaloides* community from the supramediterranean thermotype territories of Sierra Nevada and related to the open conifer forests with subhumid and humid ombrotype character (*Calocedro decurrentis-Pinetea jeffreyi* Rivas-Martínez & Sánchez-Mata 1997).

When soils become more developed and stable the area covered by *Streptanthus polygaloides* decreases and other species such as *Lagophylla minor* and *Polygonum douglasii* subsp. *spergulariiforme* enter, thus constituting another community (cf. RODRÍGUEZ-ROJO & *al*., 2001: 691; Tab. 2).

Finally we still do not frame the complex of communities related to *Helianthus bolanderi* and provisionally described before (cf. RODRÍGUEZ-ROJO & *al*., *op. cit*.: 693) in any high phytosociological units published in this paper (Tab. 2). These community-types require further studies throughout the territories of the Californian biogeographical region.

SYNTAXONOMICAL SCHEME

VULPIO MICROSTACHYOS-HESPEROLINETEA MICRANTHI classis nova

Eriogono luteoli-Hesperolinetalia micranthi ordo novus
Hesperevaco sparsiflorae-Hemizonion congestae alliancia nova

1. *Hesperevacetum sparsiflorae* Rodríguez-Rojo & Sánchez-Mata *in* Rodríguez-Rojo, Sánchez-Mata, Gavilán, Rivas-Martínez & Barbour 2001
   typicum
   lasthenietosum californicae Rodríguez-Rojo & Sánchez-Mata *in* Rodríguez-Rojo, Sánchez-Mata, Gavilán, Rivas-Martínez & Barbour 2001

Hesperolinion clevelandii alliancia nova

2. *Hesperolinetum clevelandii* Rodríguez-Rojo & Sánchez-Mata *in* Rodríguez-Rojo, Sánchez-Mata, Gavilán, Rivas-Martínez & Barbour 2001

Hesperolino micranthi-Navarretion filicaulis alliancia nova

3. *Hesperolino micranthi-Navarretietum filicaulis* Rodríguez-Rojo & Sánchez-Mata *in* Rodríguez-Rojo, Sánchez-Mata, Gavilán, Rivas-Martínez & Barbour 2001

Streptanthion polygaloidis alliancia nova

4. *Streptanthetum polygaloidis* Rodríguez-Rojo & Sánchez-Mata *in* Rodríguez-Rojo, Sánchez-Mata, Gavilán, Rivas-Martínez & Barbour 2001

FLORISTIC APPENDIX

We have listed below in alphabetical order all the taxa mentioned in the text and tables (including abbreviated citations) with indication of their recognized taxonomic ranks, authors and families (cf. KARSTEZ, *op. cit*.; ANON., *op. cit*.).

Acanthomintha duttonii (Abrams) Jokerst (Labiatae)
Acanthomintha lanceolata Curran (Labiatae)
Agoseris heterophylla (Nutt.) Greene (Asteraceae)
Agrostis microphylla Steud. (Gramineae)
Astragalus breweri A.Gray (Leguminosae)
Astragalus gambelianus E.Sheld (Leguminosae)
Astragalus jepsonianus: see *A. rattanii* var. *jepsonianus*
Astragalus rattanii var. *jepsonianus* Barneby (Leguminosae)
Benitoa occidentalis (H.M.Hall) D.D.Keck (Asteraceae)
Bromus rubens L. (Gramineae)
Calandrinia ciliata (Ruiz & Pav.) DC. (Portulacaceae)
Calycadenia multiglandulosa DC. (Asteraceae)
Calycadenia oppositifolia (Greene) Greene (Asteraceae)
Calycadenia pauciflora A.Gray (Asteraceae)
Camissonia benitensis P.H.Raven (Onagraceae)
Camissonia lacustris P.H.Raven (Onagraceae)
Campanula angustifolia Eastw. (Campanulaceae)
Campanula exigua Rattan (Campanulaceae)
Campanula griffinii Morin (Campanulaceae)
Castilleja densiflora (Benth.) T.I.Chuang & Heckard (Scrophulariaceae)
Castilleja lacera (Benth.) T.I.Chuang & Heckard (Scrophulariaceae)
Caulanthus amplexicaulis var. *barbarae* (J.T.Howel) Munz (Cruciferae)
Caulanthus barbarae: see *C. amplexicaulis* var. *barbarae*
Caulanthus flavescens (Hook.) Payson (Cruciferae)
Centaurium muehlenbergii (Griseb.) W.Wight ex Piper (Gentianaceae)
Centaurium trichanthum (Griseb.) B.L.Rob. (Gentianaceae)
Chaenactis glabriuscula var. *heterocarpha* (Torr. & A.Gray ex A.Gray) H.M.Hall (Asteraceae)
Chaenactis heterocarpha: see *C. glabriuscula* var. *heterocarpha*
Chorizanthe breweri S.Watson (Polygonaceae)
Chorizanthe palmeri S.Watson (Polygonaceae)
Chorizanthe ventricosa Goodman (Polygonaceae)
Cistanthe quadripetala (S.Watson) Hershkovitz (Portulacaceae)
Clarkia biloba (Durand) A.Nelson & J.F.Macbr. (Onagraceae)
Clarkia franciscana F.H.Lewis & P.H.Raven (Onagraceae)
Clarkia gracilis subsp. *tracyi* (Jeps.) Abdel-Hameed & R.Snow (Onagraceae)
Clarkia tracyi: see *C. gracilis* subsp. *tracyi*
Claytonia gypsophiloides Fisch. & C.A.Mey. (Portulacaceae)
Claytonia rosulata: see *C. spathulata* var. *rosulata*
Claytonia saxosa Brandegee (Portulacaceae)
Claytonia spathulata var. *rosulata* (Eastw.) McNeill (Portulacaceae)

Collinsia greenei A.Gray (Scrophulariaceae)
Collomia diversifolia Greene (Polemoniaceae)
Cordylanthus brunneus: see *C. tenuis* subsp. *brunneus*
Cordylanthus capillaris: see *C. tenuis* subsp. *capillaris*
Cordylanthus nidularis J.T.Howell (Scrophulariaceae)
Cordylanthus hansenii: see *C. pilosus* subsp. *hansenii*
Cordylanthus pilosus: see *C. pilosus* subsp. *pilosus*
Cordylanthus pilosus subsp. *hansenii* (Ferris) T.I.Chuang & Heckard (Scrophulariaceae)
Cordylanthus pilosus A.Gray subsp. *pilosus* (Scrophulariaceae)
Cordylanthus pilosus subsp. *trifidus* (B.L. Rob. & Greenm.) T.I. Chuang & Heckard (Scrophulariaceae)
Cordylanthus pringlei A.Gray (Scrophulariaceae)
Cordylanthus tenuis subsp. *brunneus* (Jeps.) Munz (Scrophulariaceae)
Cordylanthus tenuis subsp. *capillaris* (Pennell) T.I.Chuang & Heckard (Scrophulariaceae)
Cordylanthus tenuis subsp. *viscidus* (Howell) T.I.Chuang & Heckard (Scrophulariaceae)
Cordylanthus trifidus: see *C. pilosus* subsp. *trifidus*
Cordylanthus viscidus: see *C. tenuis* subsp. *viscidus*
Coreopsis stillmanii (A.Gray) S.F.Blake (Asteraceae)
Cryptantha clevelandii var. *dissita* (I.M.Johnst.) Jeps. & Hoover (Boraginaceae)
Cryptantha dissita: see C. *clevelandii* var. *dissita*
Cryptantha hispidula Greene ex Brand (Boraginaceae)
Cryptantha mariposae I.M. Johnst. (Boraginaceae)
Daucus pusillus Michx. (Umbelliferae)
Emmenanthe rosea (Brand) Constance (Hydrophyllaceae)
Epilobium minutum Lindl. ex Lehm (Onagraceae)
Eriastrum brandegeae H.Mason (Polemoniaceae)
Eriogonum argillosum J.T.Howell (Polygonaceae)
Eriogonum caninum: see *E. luteolum* var. *caninum*
Eriogonum luteolum: see *E. luteolum* var. *luteolum*
Eriogonum luteolum var. *caninum* (Greene) Reveal (Polygonaceae)
Eriogonum luteolum Greene var. *luteolum* (Polygonaceae)
Eriophyllum croceum: see *E. lanatum* var. *croceum*
Eriophyllum lanatum var. *croceum* (Greene) Jeps. (Asteraceae)
Filago californica Nutt. (Asteraceae)
Gilia pinnatisecta: see *G. sinistra* subsp. *pinnatisecta*
Gilia sinistra: see *G. sinistra* subsp. *sinistra*
Gilia sinistra subsp. *pinnatisecta* (H.Mason & A.D.Grant) A.Gray (Polemoniaceae)
Gilia sinistra M.E.Jones subsp. *sinistra* (Polemoniaceae)
Githopsis candida: see *G. diffusa* subsp. *candida*
Githopsis diffusa subsp. *candida* (Ewan) Morin (Campanulaceae)
Githopsis glabra: see *G. pulchella* subsp. *pulchella* var. *glabra*
Githopsis pulchella subsp. *pulchella* var. *glabra* (Jeps.) Morin (Campanulaceae)
Helianthus bolanderi A.Gray (Asteraceae)
Hemizonia congesta: see *H. congesta* subsp. *congesta*
Hemizonia congesta DC. subsp. *congesta* (Asteraceae)
Hemizonia congesta subsp. *vernalis* (D.D.Keck) Tanowitz (Asteraceae)
Hemizonia fitchii A.Gray (Asteraceae)
Hemizonia luzulifolia DC. (Asteraceae)
Hemizonia vernalis: see *H. congesta* subsp. *vernalis*
Hesperevax sparsiflora (A.Gray) Greene (Asteraceae)
Hesperolinon adenophyllum (A.Gray) Small (Linaceae)
Hesperolinon bicarpellatum (H.Sharsm.) H. Sharsm. (Linaceae)
Hesperolinon breweri (A.Gray) Small (Linaceae)
Hesperolinon californicum (Benth.) Small (Linaceae)
Hesperolinon clevelandii Small (Linaceae)
Hesperolinon congestum (A.Gray) Small (Linaceae)
Hesperolinon didymocarpum H.Sharsm. (Linaceae)
Hesperolinon disjunctum H.Sharsm. (Linaceae)
Hesperolinon drymarioides (Curran) Small (Linaceae)
Hesperolinon micranthum (A.Gray) Small (Linaceae)
Hesperolinon serpentinum N.McCarten (Linaceae)
Hesperolinon spergulinum (A.Gray) Small (Linaceae)
Hesperolinon tehamense H.Sharsm. (Linaceae)
Lagophylla minor (D.D.Keck) D.D.Keck (Asteraceae)
Lasthenia californica DC. ex Lindl. (Asteraceae)
Layia discoidea (D.D.Keck) D.D.Keck (Asteraceae)
Layia jonesii A.Gray (Asteraceae)
Layia platyglossa (Fisch. & C.A.Mey.) A.Gray (Asteraceae)
Layia septentrionalis D.D.Keck (Asteraceae)
Lepidium nitidum Nutt. (Cruciferae)
Lessingia arachnoidea: see *L. hololeuca* var. *arachnoidea*
Lessingia glabrata: see *L. micradenia* var. *glabrata*
Lessingia hololeuca var. *arachnoidea* (Greene) J.T.Howell (Asteraceae)
Lessingia micradenia: see *L. micradenia* var. *micradenia*
Lessingia micradenia var. *glabrata* (D.D.Keck) Ferris (Asteraceae)
Lessingia micradenia Greene var. *micradenia* (Asteraceae)
Lessingia nemaclada Greene (Asteraceae)
Linanthus ambiguus: see *L. ambiguus* subsp. *ambiguus*
Linanthus ambiguus (Rattan) Greene subsp. *ambiguus* (Polemoniaceae)
Linanthus ambiguus subsp. *micranthus* (Steud. ex Benth.) H.Mason (Polemoniaceae)
Linanthus dichotomus: see *L. dichotomus* subsp. *dichotomus*
Linanthus dichotomus Benth. subsp. *dichotomus* (Polemoniaceae)
Linanthus dichotomus subsp. *meridianus* (Eastw.) H.Mason (Polemoniaceae)
Linanthus liniflorus: see *L. liniflorus* subsp. *liniflorus*
Linanthus liniflorus (Benth.) Greene subsp. *liniflorus* (Polemoniaceae)
Linanthus liniflorus subsp. *pharnaceoides* (Benth.) H.Mason (Polemoniaceae)
Linanthus meridianus: see *L. dichotomus* subsp. *meridianus*
Linanthus micranthus: see *L. ambiguus* subsp. *micranthus*
Linanthus pharnaceoides: see *L. liniflorus* subsp. *pharnaceoides*
Lolium multiflorum: see *L. perenne* subsp. *multiflorum*
Lolium perenne subsp. *multiflorum* (Lam.) Husn. (Gramineae)
Lotus unifoliolatus (Hook.) Benth. (Leguminosae)
Lotus wrangelianus Fisch. & C.A.Mey. (Leguminosae)
Lupinus spectabilis Hoover (Leguminosae)
Madia doris-nilesiae T.W.Nelson & J.P.Nelson (Asteraceae)

Madia elegans D. Don ex Lindl. (Asteraceae)
Madia exigua (Sm.) A.Gray (Asteraceae)
Madia hallii D.D.Keck (Asteraceae)
Madia stebbinsii T.W.Nelson & J.P.Nelson (Asteraceae)
Melica torreyana Scribn. (Gramineae)
Micropus amphibolus A.Gray (Asteraceae)
Micropus californicus Fisch. & C.A.Mey (Asteraceae)
Microseris decipiens K.L.Chambers (Asteraceae)
Microseris douglasii (D.C.) Sch.Bip. (Asteraceae)
Mimulus brachiatus Pennell (Scrophulariaceae)
Mimulus douglasii (Benth.) A.Gray (Scrophulariaceae)
Mimulus layneae (Greene) Jeps. (Scrophulariaceae)
Mimulus mephiticus Greene (Scrophulariaceae)
Mimulus nudatus Curran ex Greene (Scrophulariaceae)
Minuartia californica (A.Gray) Mattf. (Caryophyllaceae)
Minuartia douglasii (Fenzl ex Torr. & A.Gray) Mattf. (Caryophyllaceae)
Minuartia howellii (S.Watson) Mattf. (Caryophyllaceae)
Monardella douglasii: see *M. douglasii* subsp. *douglasii*
Monardella douglasii Benth. subsp. *douglasii* (Labiatae)
Monardella douglasii subsp. *venosa* (Torr.) Jokerst (Labiatae)
Monardella venosa: see *M. douglasii* subsp. *venosa*
Monolopia gracilens A.Gray (Asteraceae)
Navarretia filicaulis (Torr. ex A.Gray) Greene (Polemoniaceae)
Navarretia heterodoxa (Greene) Greene (Polemoniaceae)
Navarretia jaredii Eastw. (Polemoniaceae)
Navarretia jepsonii V.L.Bailey ex Jeps. (Polemoniaceae)
Navarretia pubescens (Benth.) Hook & Arn. (Polemoniaceae)
Navarretia rosulata Brand (Polemoniaceae)
Nemacladus montanus Greene (Campanulaceae)
Phacelia congdonii Greene (Hydrophyllaceae)
Phacelia greenei J.T.Howell (Hydrophyllaceae)
Plagiobothrys infectivus I.M.Johnst. (Boraginaceae)
Plagiobothrys shastensis Greene ex A.Gray (Boraginaceae)
Plantago erecta E.Morris (Plantaginaceae)
Polygonum douglasii subsp. *spergulariiforme* (Meisn. ex Small) J.C.Hickman (Polygonaceae)
Polygonum spergulariiforme: see *P. douglasii* subsp. *spergulariiforme*
Rigiopappus leptocladus A.Gray (Asteraceae)
Sairocarpus breweri (A.Gray) D.A.Sutton (Scrophulariaceae)
Sairocarpus cornutus (Benth.) D.A.Sutton (Scrophulariaceae)
Sairocarpus subcordatus (A.Gray) D.A.Sutton (Scrophulariaceae)
Sairocarpus vexillocalyculatus (Kellog.) D.A.Sutton (Scrophulariaceae)
Sairocarpus virga (A.Gray) D.A.Sutton (Scrophulariaceae)
Sedella pentandra H.Sharsm. (Crassulaceae)
Sidalcea diploscypha (Torr. & A.Gray) A.Gray (Malvaceae)
Sidalcea hartwegii A.Gray ex Benth. (Malvaceae)
Sidalcea hickmanii subsp. *viridis* C.L.Hitchc. (Malvaceae)
Sidalcea viridis: see *S. hickmanii* subsp. *viridis*
Silene campanulata S.Watson (Caryophyllaceae)
Streptanthus albidus Greene (Cruciferae)
Streptanthus barbiger Greene(Cruciferae)
Streptanthus batrachopus J.L.Morrison (Cruciferae)
Streptanthus brachiatus: see *S. brachiatus* subsp. *brachiatus*
Streptanthus brachiatus F.W.Hoffm. subsp. *brachiatus* (Cruciferae)
Streptanthus brachiatus subsp. *hoffmanii* R.W.Dolan & LaPre (Cruciferae)
Streptanthus breweri A.Gray (Cruciferae)
Streptanthus drepanoides Kruckeb. & J.L.Morrison (Cruciferae)
Streptanthus elatus: see *S. morrisonii* subsp. *elatus*
Streptanthus glandulosus: see *S. glandulosus* subsp. *glandulosus*
Streptanthus glandulosus Hook. subsp. *glandulosus* (Cruciferae)
Streptanthus glandulosus subsp. *pulchellus* (Greene) Kruckeb. (Cruciferae)
Streptanthus glandulosus subsp. *secundus* var. *hoffmanii* Kruckeb. (Cruciferae)
Streptanthus glandulosus subsp. *secundus* (Greene) Kruckeb. var. *secundus* (Cruciferae)
Streptanthus glandulosus subsp. *secundus* var. *sonomensis* Kruckeb. (Cruciferae)
Streptanthus hesperidis Jeps. (Cruciferae)
Streptanthus hirtiflorus: see *S. morrisonii* subsp. *hirtiflorus*
Streptanthus hoffmanii (1): see *S. brachiatus* subsp. *hoffmanii*
Streptanthus hoffmanii (2): see *S. glandulosus* subsp. *secundus* var. *hoffmanii*
Streptanthus kruckebergii: see *S. morrisonii* subsp. *kruckebergii*
Streptanthus morrisonii subsp. *elatus* F.W.Hoffm. (Cruciferae)
Streptanthus morrisonii subsp. *hirtiflorus* F.W.Hoffm. (Cruciferae)
Streptanthus morrisonii subsp. *kruckebergii* R.W.Dolan & LaPre (Cruciferae)
Streptanthus morrisonii F.W.Hoffm. subsp. *morrisonii* (Cruciferae)
Streptanthus morrisonii: see *S. morrisonii* subsp. *morrisonii*
Streptanthus niger Greene (Cruciferae)
Streptanthus pulchellus: see *S. glandulosus* subsp. *pulchellus*
Streptanthus secundus: see *S. glandulosus* subsp. *secundus* var. *secundus*
Streptanthus sonomensis: see *S. glandulosus* subsp. *secundus* var. *sonomensis*
Streptanthus polygaloides A.Gray (Cruciferae)
Systenotheca vortriedei (Brandegee) Reveal & Hardham (Polygonaceae)
Trichostema laxum A.Gray (Labiatae)
Trichostema rubisepalum Elmer (Labiatae)
Trifolium depauperatum Desv. (Leguminosae)
Trifolium microcephalum Pursh (Leguminosae)
Triphysaria floribunda (Benth.) T.I.Chuang & Heckard (Scrophulariaceae)
Vulpia microstachys (Nutt.) Munro (Gramineae)

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