To La Serena

What severe and brown earth, sun-soaked, barren, poor, and torn by a thousand stone needles. Softened by pastures where the bells lend their voice to the sheep. Earth watched over by castles already void, of dry battlements, lichen and wild-fig covered, silent witness of the passage of time. Naked earth of trees and undergrowth, of mountain crags, dark and ashen, of a dying greyish green cut out against the sky like a Chinese shadow.

And however, so beautiful. In spring the breeze carries the scent of labdanum and heath to the plain, and the rosemary prays to its god, the Sun, giving to the air a magic aura of sanctity, as if bathing it in incense. Winter sows the earth with torrents, ponds, streams leaping and sparkling, their banks carpeted with the tiniest flowers whose names only botanists know. Spring dries the soul of La Serena and shrouds it with flowers, crowning it with beauty, then to clothe it in fields of golden hay combed by the east wind in summer.

Everything in La Serena is ephemeral, as a lily petal left on the altar, as the winged soul of a butterfly, as the tears of a child. Only the holm oak, brown like earth, remain in time, year after year, standing, silent, with their gray trunks, their hardy leaves, their gnarled strong and haggard branches.

Generalities

1. INTRODUCTION

Following the 1996 Cork (Ireland) Declaration "*A Living Rural Environment*", rural development has become a key cross-sectoral goal of a major part of European Community policies. The intention is to attempt to maintain rural societies by diversifying their job possibilities, thereby enabling them to attain a quality of life that will avoid the exodus of the population. Amongst other things, this implies the use of the territory's natural resources with a view to sustainability, the preservation of autochthonous cultures and landscapes, endogenous development, and the education and training of local inhabitants in the skills required for the new methods of exploiting nature.

In Extremadura, knowledge of the natural environment had been the basis of a culture spanning millenia -basically of agriculture and sheep farming- but which today has practically disappeared save in the memory of the older generations. However, certain age-old uses of the territory have formed a rich regional tradition, assisted by a historical trajectory which has permitted a state of conservation of nature which in itself is a valuable heritage, worthy of being enjoyed and preserved by all.

The interest in our land, however, has not been confined to aspects that are characteristic of a traditional agricultural, woodland, and sheep farming culture. The territory has also been the field of study in various sciences. Botanists, zoologists, geologists, geographers, etc., have found motives for especial attention to the region of Extremadura in many areas of research. Considering only the extreme north-east of the province of Badajoz, the territory covered in this book, and scientific contributions of the 20th century, we might cite F. Bernis or J.A. Valverde in the field of ornithology, S. Rivas Goday, J. Borja, or E. Laguna in botany, A. Guerra or F. Monturiol in soil science, and E. Hernández Pacheco in physiography, as examples of this interest in La Serena and the bordering territories.

In Pérez Chiscano's personal Herbarium (PCH) as well as in the library of his pharmacy in Villanueva de la Serena (Badajoz), there are conserved herbarium sheets and numerous written documents (correspondence, field inventories, notebooks filled with observations) of a good part of the censuses, itineraries, and expeditions made in La Serena both by the authors cited above and by later ones. There serve by way of examples the bequeathals of M. Ladero, J. Fernández Casas, C. Valle Gutiérrez, A. Amor, P. Montserrat Recoder, S. Rivas Martínez, E. Valdés, B. Valdés, S. Castroviejo, C. Kreutz, H. Ch. Keitel, B. Smythies, D. Costich in botany, and M. Fernández Cruz, E. de Juana, N. de Borbón, C. Barros, A. Aguilar, and E. Carp in ornithology.

A little more than a century has passed since the French botanist Auguste Henri Cornu de la Fontaine de Coincy published in his *Egloga Plantarum Hispanicarum* two species new for science that he had collected in this region - more specifically, near the railway station of La Sierra de Almorchón: *Scrophularia oxyrhyncha* and *Dianthus serenaeus*. Since then, different botanists have travelled through La Serena and surrounding districts, providing more or less fragmented information. P. Escobar's study (2003) is the systematic compilation of the catalogue of the territory's flora, with an enumeration of the existing vegetation. Also worth mentioning from this perspective is the information in the Habitats Directive 92/43/CEE cartography of the Spanish

Ministry of the Environment. This does not mean that there are no longer gaps in the botanical knowledge of this part of Extremadura: the biodiversity of fungi, algae, and bryophytes needs to be analyzed. Aquatic plants represent, in many cases, a field yet to be explored. And in the area of aerobiology or floral biology, there is still a notable lack of data.

This work is basically addressed to the naturalist (Spanish or non-Spanish, amateur or professional) who visits La Serena or the surrounding sierras as a tourist or for reasons of work; to the local development agent whose professional activity is carried out in these territories; to the secondary education, pre-university, or primary education teachers of the zone who wish to prepare their own didactic material from the everyday reality of the children and youngsters in the schools of the area; to those working on fostering cultural activities who need new ideas related to the rural context; to the university students of Biology, Environmental Sciences, and Agricultural or Forestry Engineers with imagination who want to make the rural environment an option; to Forestry Agents wishing to increase their knowledge; to the Farming and Livestock Technician with a desire for improvement; to the tourist, the world citizen...

The aim is to give the reader a general idea about the territory's flora and vegetation in a straightforward and scientifical way. The central chapters are dedicated to describing the different habitats and plant communities that make up the landscape of this region. Before going into this question, the aspects most directly related to the causes of the existence of these communities - climate, substrate, and history - will be considered. The final chapters deal briefly with the value of the vegetation as elements of the landscape, and the relationships that arise within those elements. An annex includes a systematic description of the species constituting the Flora contributing details of their environmental importance, distribution, time of flowering, biotype, ecology, toxicology, and their possibilities of use for medicine, farming, cultivation, as ornamentals, timber, fodder, or in folk crafts.

We are convinced that a scientific knowledge of the botany of this zone will help those who love nature to respect it more, and those who do not yet know it to begin to love it. A not purely aesthetic or emotional but also naturalist vision can give us greater reason for interest and admiration. After all, as the Catalan botanist Vigo i Bonada used to say: "*The things in this world are valued more, the better they are understood*."

2. THE PHYSICAL ENVIRONMENT

2.1. DEFINITION OF THE TERRITORY

The territory covered in our study consists of a broad strip in the north-east of the province of Badajoz. It has traditionally been represented as part of the Extremaduran districts ("comarcas" in Spanish) of La Serena and La Siberia. Biogeographically, it belongs to the Mariánico-Monchiquense sector of the Luso-Extremadurensian chorological subprovince (Fig. 2.1.1).

It is a vast undulating peneplain, at about 400m altitude, constituting a step-by-step transit between the Campo de Calatrava, the Valle de Alcudia, Los Pedroches, and the Extremaduran Vegas del Guadiana and Tierra de Barros. The limits are represented in Fig. 2.1.2. It is a heterogeneous region. In the south, it begins with the Sierra del Oro of Monterrubio de La Serena (895m a.s.l.). This range delimits, together with the sierras of Castuera, Tiros, and La Rinconada located more to the north, a valley whose waters flow towards the River Zújar in the east. The waters of this valley converge in the streams of Ballesteros and El Venero, that flow into the Zújar by means of the stream of Benquerencia, of which they are tributaries. In the western end of the territory, there also flow the rivers Ortiga, tributary of the Guadiana, and Arroyo del Molar, tributary of the Zújar.

Important mountain ranges are the Sierra de Castuera, Sierra de Tiros (with the highest peak in the district, 961 m a.s.l.), Sierra de La Rinconada, and Sierra de la Osa. These form a wide arc that extends towards the north-east, only interrupted by the tail of the La Serena reservoir in the Zújar. Behind it, more towards the north-east, rises the Sierra de La Motilla, the second highest in the territory, (940m a.s.l.). From this range to the north emerge chains of western-facing scarpements, aligned NW-SE. This is the beginning of the district of La Siberia. In this area the streams of Montabanejo, Siruela, and Guadalemar, and the Guadalmez and Esteras rivers flow into the Zújar. The Sierra de Los Villares' waters flow into the northern tail of the La Serena reservoir as the streams of Sanjuanilla, Los Majadales, and Los Carneros.

The arc of mountains mentioned above delimits in the south and east a broad, undulating plain, whose many streams and brooks flow into the Zújar, a river which after passing through the sierras changes in direction by more than 270°, passing from SW-NE to distinctly westwards. Among these tributaries there stand out, from west to east, the river Guadalefra, the streams of Lavandero, Venta, Lirio, Pilar, Melijo, Mejoral, Miravete, Cuervo, Campo, Almorchón, Horcajo, Cevallos, and Dos Hermanas because of their importance. The territory between the Rivers Zújar and Guadiana - the latter detained in the reservoirs of Orellana and Puerto Peña (= García Sola) will serve as the north-west limit. Here the streams flow into the Guadiana, the most notable being the Bodeguillas, Malos, Arroyo Grande, Casas, Valsecas, Santa Bárbara, Horcados, and San Ramón.

2.2. THE BIOCLIMATIC CHARACTERISTICS OF THE ZONE

In these latitudes, and especially in the territory of Extremadura, the climatic characteristics correspond to a very marked seasonal climate characterized by winters that are rainy (more than 60% of the annual rainfall) and more or less cold, and high-pressure system summers that are dry and hot. If Rivas Martínez's classification (Table 2.2.1) is followed, the bioclimatic zone is Mediterranean pluviseasonal-oceanic, within which different variants can be recognized. On the plains, there exists the lower Mesomediterranean of lower dry ombrotype. At higher altitudes, this changes to the upper dry ombrotype, and then to lower subhumid. In the zones of greater continentality (e.g., Zalamea de la Serena), this is reflected bioclimatically in that the Mesomediterranean becomes Supramediterranean, although the ombrotype is maintained as in the rest of the peneplain (lower).

With respect to the temperature variables, since these are the factors that completely determine plant life, the bioclimatological literature suggests the use of various indices that are found to be useful in relating these factors with the distribution of species and communities. The mean monthly, seasonal, and, above all, annual temperatures give a general idea of the goodness of a certain climate for the plants' vital activity. They have very evident correlations with the latitude and altitude, although they are insufficient to reflect the effect of continentality. This is only considered if specific indices - the Itc (compensated thermicity index), for example - are calculated.

In our case, the mean registered annual temperatures vary between 14.3°C and 17.4°C. In spring the mean seasonal temperature is 14.1°C, in summer 24.5°C, in autumn 16.7°C, and in winter 7.4°C. The length of the cold period varies between 3 and 7 months a year, and the hottest period between 2 and 4 months. The hottest month is in most cases July, with a mean temperature of 25.8°C. The absolute maximum temperatures in this month are close to 40° (39.8°C - 41.4°C).

December is the coldest month with a mean temperature of 7.2°C, exceptionally in January with a mean of 4.7°C in the area of Zalamea de la Serena which also has the absolute minimum temperature (-6.8°C) and the shortest frost-free length of time (6 months) in contrast with the 10 months in other parts of the district.

Making a comparison between the mean temperatures of the hottest and the coldest months, one finds an annual temperature range of 16-19°C. This corresponds to a moderate continentality. Taking into account the values of Itc (thermicity index) which integrates the temperature variables and the continentality, one finds the highest index to correspond to Villanueva de la Serena (347.45), and the lowest to Zalamea (244.5) which is the coldest and most continental zone of the territory.

As regards the rainfall variables, here, as in all the west of the Peninsula, precipitation occurs due to the activity of cloud masses originating from the west, principally in autumn and winter. But rainfall is quite scant generally, and the hydric balances are negative. The wettest zones are those of the surrounding mountainous regions, especially their highest areas: Garbayuela receives the most rainfall (724 mm). The driest are also the hottest: Villanueva de La Serena (444 mm) being the most xeric. The mean registered seasonal rainfall is: in winter 208.8 mm, spring 158.5 mm, summer 59.25 mm, and autumn 155.18 mm. The rainiest months are December and January (exceptionally March or November), and the driest are July and August. The dry period lasts between 3.5 and 4.5 months a year.

But a more realistic approach to the availability of moisture for the vegetation - a decisive factor in their distribution - requires the consideration of thermopluviometric index, i.e., the combination of rainfall data with temperature variables, or when it is possible to calculate it, with the potential evapotranspiration (Etp). In this sense, the ombrothermic index ($Io = 10(Pp/Tp)$) provides interesting information, since the higher its value the greater the availability of water for the plants. The index takes its lowest values when the values of Tp are very high and of Pp are low. This is the case for the meteorological observatories in the La Serena plains, where the values vary between 20 and 25. However in the mountainous regions, the Io rise considerably (35-37). In the River Esteras basin, the Io values are somewhat lower given that there are high temperatures together with high rainfall (e.g., in Zarza Capilla it is 31.13). The redundant information represented by the Ios2 (the ombrothermic index of the year's hottest two-month period) and Iod2 (the ombrothermic index of the driest two-month period of the year's hottest four-month period), which coincide in our case, merely lend support to what was said above: localities in mountainous regions present a value of 0.3, while in the peneplain the values are of the order of 0.05-0.09.

The ombroevapotranspiration index (Ioe) indicates the relationship between Pp and PET (evapotranspiration) calculated following Thornthwaite, so it is a better approximation to the real moisture availability for the plants. The highest Ioe values (near 0.7) are recorded at the observatories in the mountainous regions (Capilla, Talarrubias, Tamurejo), while the lowest (near 0.4) are found in Villanueva, Castuera, etc, this zone being the most xerothermic in the territory. In some places on the peneplain (e.g., Magacela) the values rise somewhat (to about 0.5) due to the soil-type factor which indirectly conditions the influence of evapotranspiration.

Table 2.2.1. Climatics parameters of the meteorological stations studied, from the data of National Institute of Meteorology, Cabezas & Escudero (1989) and Forteza (1986).

LOCALIDAD	Altitud m.s.m	T	Tp	m	M	T'	m'	Itc	Ic	P	Ps	Pw	ETP	Io	Ios2	Iod2	Ioe	termotipo	ombrotipo
Benquerencia de la Serena	714	16,1	1808						18,8	502	42,4	176,7	810,5	27,70	0,102	0,102	0,50	mesomediterráneo superior	seco inferior
Cabeza del Buey	550	16,7	1878						18,0	529	45,8	199,4	840,3	28,10	0,207	0,207	0,54	mesomediterráneo inferior	seco superior
Campanario	308	16,2	1031						18,4	477	20,8	178,0	877	24,72	0,132	0,132	0,47	mesomediterráneo inferior	seco inferior
Capilla	658	16,0	1872						18,0	671	42,3	207,2	840,8	30,83	0,210	0,210	0,77	mesomediterráneo inferior	seco superior
Castuera	612	16,8	1802						18,6	402	33,6	173,6	864,8	24,42	0,158	0,158	0,48	mesomediterráneo inferior	seco inferior
Esparragosa de la Serena	445	16	1020						18,5	409	42,1	180,0	860,2	25,05	0,223	0,223	0,54	mesomediterráneo inferior	seco inferior
Esparragosa de Lares	473	15,9	1008						18,5	509	37,4	237,7	861,0	31,04	0,107	0,107	0,54	mesomediterráneo inferior	seco superior
Garbayuela	487	15,7	1881	2,1	0,9	41,1	-2	298	21,4	742	57,8	308,4	844,5	30,43	0,308	0,298	0,70	mesomediterráneo inferior	subhúmedo inferior
Garlitos	554	15,8	1874						18,0	846	45,8	239,7	847,8	34,42	0,252	0,252	0,38	mesomediterráneo inferior	seco superior
Helechal	608	15,4	1830						18,7	536	37,8	288,0	868,5	30,47	0,000	0,098	0,39	mesomediterráneo inferior	seco inferior
La Coronada	355	16,3	1057						18,3	502	34,8	163,1	864,4	25,67	0,230	0,233	0,32	mesomediterráneo inferior	seco inferior
Magacela	562	15,8	1870						18,0	480	30,8	180,1	845,2	25,61	0,200	0,208	0,30	mesomediterráneo inferior	seco inferior
Malpartida de La Serena	470	15,9	1009						18,6	611	45,0	185,7	841,4	23,79	0,234	0,234	0,54	mesomediterráneo inferior	seco inferior
Monterrubio de La Serena	557	15,6	1871						19,0	620	43,6	116,6	843,2	33,30	0,180	0,186	0,30	mesomediterráneo inferior	seco superior
Pantano Orellana	325	16,6	1000	3,8	11,0	30,8	-1,3	323,5	18,8	610	42,3	227,0	873	30,79	0,158	0,158	0,32	mesomediterráneo inferior	seco superior
Peñalsordo	456	16	1017						18,4	570	30,1	219,0	863,5	30,72	0,228	0,228	0,30	mesomediterráneo inferior	seco superior
Puerto Hurraco	600	15,5	1857						18,7	594	41,5	222,4	840,3	31,42	0,250	0,255	0,32	mesomediterráneo inferior	seco superior
Quintana de La Serena	400	16,1	1030						18,4	403	35,9	168,0	874,0	23,03	0,183	0,183	0,40	mesomediterráneo inferior	seco inferior
Risco	457	15,8	1001						18,0	574	37,9	198,0	850,5	30,10	0,170	0,170	0,39	mesomediterráneo inferior	seco superior
Siruela	610	15,8	1800						18,0	600	42,4	264,0	864,4	34,53	0,242	0,242	0,39	mesomediterráneo inferior	seco superior
Talarrubias	435	16	1044						18,6	608	37,0	249,9	870	34,37	0,102	0,102	0,39	mesomediterráneo inferior	seco superior
Tamurejo	647	16,7	1870						18,7	700	40,0	262,7	860,6	37,41	0,360	0,260	0,73	mesomediterráneo inferior	subhúmedo inferior
Vva. Serena	204	17,4	2002	4,1	12,8	41,1	-0,7	347,5	18,9	444	30,1	177,9	1007	21,24	0,149	0,149	0,47	mesomediterráneo inferior	seco inferior
Zalamea de la Serena	485	14,3	1080	-2,4	11,7	41,4	-0,8	244,5	19,7	444	10,6	147,1	873,2	20,33	0,060	0,053	0,40	mesomediterráneo superior	seco inferior
Zarza Capilla	410	16,6	1005	4,3	10,9	40,8	0	288	19,0	821	37,5	229,3	871,0	31,13	0,182	0,182	0,37	mesomediterráneo inferior	seco superior

Parameters and Indexes have been calculated according with the Rivas Martínez method (Rívas Martínez et al. 2002). Temperatures are expressed in centigrade degrees (Celsius) and precipitations and evapotranspiration in mm. T, yearly average temperature; Tp, yearly positive temperature; m, average minimum temperature of the coldest month of the year; M, average maximum temperature of the coldest month of the year; T', maximum absolute temperature of the month of July; m', minimum absolute temperature of the month of December; Itc, compensated thermicity index; Ic, continentality index (yearly thermic interval). P, yearly average precipitation; Ps, summer precipitation; Pw, winter precipitation; ETP, yearly average evapotranspiration; Io, ombrothermic index; Ios2, ombrothermic index of the warmest bimonth of the summer quarter. Iod2, ombrothermic index of dryest bimonth within the dryest quarter of the year; Ioe, ombro-evapotranspiration index.

2.3. GEOLOGICAL SYNTHESIS*

To analyze the geological evolution and structural dynamics of La Serena, we shall use the stratigraphic-techtonic divisions in zones of the Iberian Massif established by Lotze in 1945. In this context, its materials are included in the Central Iberian Zone (CIZ) and in the northern sector of the Ossa-Morena Zone (OMZ) that constitutes the Obejo Valsequillo Domain. This domain is characterized by including Neoproterozoic and Ossa-Morena type Cambrian materials, and post-Cambrian Palæozoic materials that include series which share the characteristics of the CIZ. According to some investigators, an opinion that we share, this domain has the rank of structural-Zone. The fundamental difference with the rest of the OMZ, apart from those already mentioned, is the presence of much shallower Palæozoic environments which would indicate that this domain acted as a threshold until at least the early Devonian.

CENTRO-IBERIAN ZONE
Neoproterozoic

The oldest materials belong to the Ediacaran period and occupy the greatest extensions in the area under study, which are located in the central and north-west sector. These materials have been assigned to the Dome Extremeño group, which includes the oldest stratigraphic unit of the CIZ. The sedimentary materials of which it consists are mainly turbidites, and according to the various studies on the theme were deposited in environments corresponding to slopes, canyons, and submarine fans. These materials have been synsedimentarily deformed, and have a flyschoid character, so that they have been related to the last phases of the Cadomian Orogeny.

Lithologically, it consists of lutites, graywackes, and conglomerates with an abundant matrix. The latter contain soft clasts originating from the same basin (graywackes and phosphates), and well-rounded quartz and black quartzite exotics (cherts), possiby originating from the erosion of the Proterozoic successions of the OMZ (Serie Negra) that was partially emergent.

Its lithological composition and the great abundance of organic and sulfide materials that the sediments contain make them easily erodable, occupying the areas of the deepest depressions where the great Zújar, La Serena, and Orellana reservoirs are now situated.

Palæontologically, it includes the oldest fossils that are known in the Iberian Peninsula. These are represented by:

a) bacterial microfossils (related to possible planktonic cyanobacteria of the Order Chroococcales) and represented by the species *Sphaerocongregus variabilis* and *Palaeogomphosphaeria cauriensis*;
b) megascopic carbonaceous fossils ("beltanelloides" and vendotaenids); and

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* Authors: T. Palacios Medrano, L. Eguiluz Alarcón and O. Apalategui Isasa. Palaeontology Area. Uex.

c) ichnofossils such as *Phycodes* aff. *P. pedum*, that represent the remains of the oldest metazoa in the Iberian Peninsula (Palacios 1987, Vidal et al. 1994).

In the northernmost sectors, there occurs the gradual transition from the deep-water environments of the previous group to the Ibor group, which includes shallow water mixed shelf environments. The materials contained in this group include limestones, dolomite, marls, lutites, graywackes, and conglomerates. This group is very little represented and the presence of carbonates is quite sporadic, although in some sectors such as Sierra de la Zarzuela and the north of Talarrubias (Cerro de la Calera) it can become important. In the areas outside the zone under study (Castañar de Ibor and Villarta de los Montes), these carbonates are seen to be authentic bioconstructions formed by tubular fossils belonging to *Cloudina hartmannae*. These were the first metazoa in the world to secrete a mineralized exoskeleton that permitted them to build the first metazoic bioconstructions generally associated with structures formed from microbial carpets (stromatolites). The *Cloudina* age is known with fair precision on the basis of the geochronological data of the levels containing this fossil in Oman and Namibia, and that indicate a range (548.8±1 - 543.3±1 millions of years) very close to the Ediacaran-Cambrian boundary (Vidal et al. 1999).

Ordovician and Silurian

The Sardie phase of the end of the Cambrian or the final episodes of the Cadomian Orogeny, which determined the folding and the emergence of the Ediacaran and Cambrian materials situated in the Centro-Iberian Zone, gave rise to a new palæogeographic configuration. We find an emergent area which is to be invaded by the seas. The first sediments deposited in the Ordovician (Capas Intermedias) are represented by a range of sandstones and conglomerates of a reddish colour (from 0 to 350 m thick) which take a discordant position on the Ediacaran substrate, filling the existing palæorelief. On the previous deposits or, if they are missing, directly on the substrate there is a thick succession of sandstone (Armorican Quartzite). These are easily identified in the field for their resistance to erosion, giving rise to the elevated rugged relief of the ranges which limit the Ediacaran (Sierra de Castuera, Sierra de Rinconada, Sierra del Torozo, Sierra de La Moraleja, and Sierra de Los Villares, to mention the most important). The Armorican Quartzite gradually gives way to a group of quartzite and lutite alternations known as Capas de Pochico, in the upper part of which there appear trilobites. These three units together represent a transgressive period, initiated with fluvial deposits that evolve to marine deposits. Abundant ichnofossils, algal structures, inarticulated brachiopods, and trilobites have been found. Their age is considered to be Tremadoc-Arenig.

The lower Ordovician sandstone materials give way to a group principally constituted by Llarvirniense (Middle Ordovician) age lutites, commonly known as Capas de Tristani, which reach their maximum thickness towards the north. This group begins with a thick lutite series (Pizarras del Río) that represents the maximum of the transgression. The rest of the group is represented by sandstone, lutite, and quartzite alternations that reflect shallow periods in the basin, and a general regressive tendency. The environment in which they were deposited corresponded to a gently sloping terrigenous shelf which contained a great biotic diversity (San José et al. 1992). More than 250 fossil taxa have been determined, including trilobites, graptolites, brachiopods, molluscs (bivalves, gasteropods, cephalopods, rostroconchs, monoplacophoan and hyolites), conulard, bryozoa, scolecodonts, chitinozoan, and acritarchs. Over the previous materials, there are lutite and occasionally limestone levels (Urbana Limestone). These levels are very fossiliferous, and contain trilobites, ostracods, brachiopods, briozoa, echinoderms, rugore corals, molluscs, conodonts, and graptolites. The top of the Ordovician is represented by the Chavera Shales, also known as Pelites with fragments. Its base represents a stratigraphic discordance that has been related to the glacio-eustatic erosive event that is located near the Ordovician-Silurian boundary. The lithofacies correspond to graywackes and lutites with fragments of irregular outline. This unit has been compared to others that are similar of a clastic type (diamictites) that appear in SW Europe and N Africa, and have a glacio-marine origin, related to the upper Ordovician polar icecap situated in Gondwana.

Over the previous materials, the Silurian is deposited in a transgressive sequence, whose base corresponds to a quartzite section (Criadero Quartzites), after which there follows a unit formed by sapropelic lutites with abundant graptolites that are evidence of a relatively distal marine environment. The fossils that appear are planktonic or nectonic, indicating open marine environments. This unit gradually gives way to very monotonous alternations of highly micaceous black limolites, lutites, and sandstones (the Corchada Alternations) that reach the lower Devonian (Gediniense) in a regressive-type sequence.

Devonian

The principal Devonian outcrops occur in the core of three synclines - Herrera del Duque (which lies outside the study area), the Garlitos syncline to the north-west of the Sierra de la Minerva, and Cabeza del Buey which is situated to the south of that locality in the proximity of the River Zújar. The principal geological and biostratigraphic studies that are the basis of the analysis of their historical evolution were conducted on the outcrops of Cabeza del Buey and Herrera del Duque (Pardo Alonso et al. 1996). The observed stratigraphic succession is the following.

On top of the Corchada Alternations and following a regressive trend, there is a quartzite unit (Doradillo Formation) which at its top includes lower Devonian trilobites and poorly preserved rhynchonellid brachiopods. This unit gives way to the Valdenmedio Formation, a thick, fundamentally pelitic series of which there are no palæontological data and a general deficiency of knowledge. The next unit is the Risquillo Formation which includes approximately 20 metres of intensely biodisturbed ferruginous sandstones and quartzites at whose upper part there already appear Pragian-Emsian brachiopods and Praguiense conodonts. Over these materials lies the Herrera Formation, consisting of lutite materials, with a calcareous unit intercalated in its middle section (Molino de la Dehesa Member) containing stromatolites (Pardo Alonso and De Renci 1993). This unit contains abundant Emsian age brachiopods, corals, and tentaculitoids.

One of the principal characteristics of the Devonian in the CIZ is the presence of a stratigraphic gap (absence of geological record) that covers all the Middle Devonian. At the top of the Herrera Formation there appear lutites and some sandstones and intensely bioturbbated strata (vertical burrows), with frequent floating plant remains which have been interpreted as indications of emergence at the end of the Lower Devonian, possibly linked to the first phases of the Hercynian Orogeny.

The first materials dated as Upper Devonian belong to the Abulagar Formation which includes at its base levels of conglomerates and coarse grain sandstones, with cross statification and erosive bases, interpreted as belonging to transition environments (river channels and tidal flats). On top of these lie in ascending order: the Valmayor Formation, fundamentally lutitic with some sandstone insertions; the Tres Mojones Formation consisting of sandstones with some levels of calcareous sandstones; and the Valdegregorio Formation which includes lutites with powerful levels of sandstone in its middle section. These three units indicate shelf environments with frequent sea level variations and higher energy events that could correspond to regressive pulses or to strong storm events, which would stir up the bottom sediments with the formation of shell beds, which include abundant brachiopods, bivalves, very disarticulated crinoids, briozoa, trilobites, ostracods, corals, tentaculitoids, cephalopods, gasteropods, serpulids and conodonts. The biostratigraphic data at the upper part of Abulagar Formation indicate an age that runs from the Givetiense to the Frasniense. The Devonian series culminate with the Guadalmez Formation deposit which contains nodulous shales and pelagic limestones with abundant Famennian age ammonoids and some remains of floating plants. This unit marks a clearly transgressive event, and its facies with a high organic matter content is similar to other anoxic facies in the rest of the world linked to the Frasnian-Famenian boundary. This is the interval in which occurred the great mass extinction at the end of the Devonian.

Carboniferous

The Carboniferous outcrops, given their lithology (fundamentally lutites and graywacke sandstones), occupy extensive areas of low relief that are mainly located in the core of two syncline structures separated by a central anticline which runs along the ranges of La Lapa, Sierra del Arrozao, and Sierra del Oro. These ranges include quartzite and sandstone material assigned to the Ordovician because of their lithological characteristics, although it is possible that they also include Silurian and Devonian materials. The structures contain intrusions of granitic materials from the Los Pedroches batholith that metamorphose the surrounding rocks.

Igneous rocks

The outcropping igneous rocks are from the Hercynian age (Upper Carboniferous-Permian). They are constituted by the Campanario batholith (monzogranites, in the core of which there appear granites of two micas and aplitic granites) and the Quintana batholith (fundamentally, granodiorites). There are also some small granite intrusions in the Garlitos area.

OSSA-MORENA ZONE (Obejo-Valsequillo Domain)

To the south of the Peraleda Fault, which constitutes the border between the CIZ and the OMZ, and within the Obejo-Valsequillo Domain, there are materials that have been assigned to the Neoproterozoic, Cambrian, Ordovician, Devonian, and Lower Carboniferous.

Neoproterozoic

The Neoproterozoic outcrops are limited to a small remnant in the proximity of Peraleda del Zaucejo which includes material assigned to the Serie Negra, consisting of metapelites, metavulcanites, and black quartzites (lidites).

Cambrian-Ordovician

Assigned to a Cambrian age are thick series that fundamentally include arcosic sandstones and reddish lutites, that culminate in quartzite bars assigned to the Lower Ordovician.

Lower Devonian

Although the greatest expanses of this domain are occupied by Lower Devonian materials, knowledge about them is quite incomplete due to their being tectonized and affected by many faults, an aspect that makes it difficult to elaborate complete stratigraphic series. It consists of ferruginous and carbonate sandstones, sandy limestones, bioclastic limestones, and shales that contain abundant remains of brachiopods, bivalves, trilobites, tentaculitoids, and tabulate and rugose corals which have made it possible to date it to the Lochkovian and Praguiense. The Emsian includes similar facies, and has been dated from its content of brachiopods. This unit is known as **La Manchuela**.

Upper Devonian-Carboniferous

These materials are scantly represented in the area under study, and their characteristics are similar to those of CIZ.

Igneous Cadomian rocks

The main outcrops of igneous Cadomian rocks in the area under study are located to the south of Higuera de la Serena, and hence lie outside the study area. They consist of basic and ultrabasic rocks in the core of a sigmoidal structure, and are granitoid at the margins. These rocks present a very intense deformation, and their age is Ediacaran (573 Ma).

Cenozoic

Miocene series:

Cenozoic sediments crop out extensively in the area under study. These materials are discordantly arranged on the top of materials that are less resistant to erosion and weathering - the Ediacaran and Carboniferous (Culm Facies) which are very similar lithologically. The lithological characteristics of the Cenozoic are strongly controlled by the materials of the source area. The filling sediments fundamentally correspond to continental lacustrine deposits (polygenic conglomerates, sands, and clays), with the main features being that the marginal facies are represented by mud flows, scree, and fluvial sediments of the filling of anastomosed channels, and the central facies correspond to fine floodplain sediments with the possibility of there also being levels of lacustrine deposits.

Pliocene-Pleistocene series:

Raña levels. The rañas are made up of 1 to 2 metres of red clays that includes quartzite cobbles and other resistant elements of variable sizes (5 to 20 cm). They are alluvial glacis which are arranged around the border of the palæozoic reliefs which feed them. Rañas are a type of deposit that originate in wet climatic conditions with seasonal rains of great intensity that cause mass mud flows that include heterometric cobbles. These great flows produce an erosive scar in the pediment that is manifest in a surface eroded down to 320 metres. The age of these materials has been established as Pliocene-Pleistocene by correlation with other areas in the Peninsula.

Pleistocene-Holocene

This cycle has a fundamentally erosive character. The opening of the Miocene endorrheic basin culminated by the rañas, which constituted what now is occupied by the Guadiana basin towards the Atlantic, marks the beginning of important erosive processes - processes which continue today - that affect by far the most distinctly the unconsolidated Miocene sediments. The sedimentation that develops under these conditions is fundamentally alluvium and colluvium, with the most important deposits being the fluvial terraces of the important rivers such as the Guadiana and the Zújar.

Unlike other rivers in the peninsula, usually no complete system of terraces is present, with at least the oldest missing. The composition is conglomerates with abundant rounded, fundamentally quartzite, pebbles (1 to 25 cm diameter) and a clayey-sand matrix. The sedimentary structures are characteristic of fluvial environments.

The colluvial and alluvial deposits are those which are being formed now. The former include the slope deposits and the soils developed on the different rock types. The present-day alluvial deposits are formed by fine detrital materials (clays and sands) that fill today's river networks. In general, the most recent materials in Extremadura, despite presenting little complexity, are still great unknowns given the lack of detailed geological studies or palæontological data.

2.4. THE SOILS*

In the territory studied, five soil units can be established. They are represented in Fig. 2.4.1 by yellow, beige, white, grey, and red coloured polygons. Each unit may consist of a single group of soils or of a collection of groups. In the latter case, one speaks of an association where the most abundant soil is known as the dominant and the rest associates. These associates are usually variations of the principal type which become included because of changes in the vegetation, relief, or original material, or of a process of degradation. The order of the units is as follows from the least developed to those of more complex evolution, with the appearance of horizons indicative of a high degree of transformation. One thus distinguishes relatively poorly evolved and undifferentiated soils, soils with a cambic B horizon, and soils with an argic B horizon. For the soil nomenclature, we use the WRB classification (1998), proposed by the United Nations Food and Agricultural Organization (FAO), the International Society of Soil Science (ISSS-AISS-IBG), and the International Soil Reference and Information Centre (ISRIC).

Soils with scant development: leptosols and regosols

These are soils that present a uniform profile with little diversity of horizons. They sometimes are of considerable depth. One distinguishes between soils with little development because of the scant activity of the pedogenic process or because the nature of the original material makes the effects of the pedogenic processes very slow, and undifferentiated soils, i.e., those that do not show any clear distinction between the horizons which form the profile. The lack of evolution may be determined by the youthfulness of the soil, sometimes established by erosion as in the cases of leptosols and regosols. At other times, it is the continual contribution of material that prevents differentiation, as in the case of fluvisols. Associated with particular original materials are the arenosols (on very sandy sediments).

Leptosols

The leptosols are incipient soils that are still in the first stages of development due to the slowness of the formative process. This slowness is marked by either the

* Author: L. Fernández Pozo. Area of Soil Science and Agricultural Chemistry. Uex.

hardness of the original material or the weakness of the weathering process because of climatic or biological factors, for example in those cases where the vegetation consists of species whose remains degrade with difficulty. It may be that they derive from developed soils and that a degradation process, generally erosion, has led to the disappearance of the more evolved soil.

They are characterized by a sequence of AR or ACR type horizons, lacking the B horizon, or if it appears it is of little thickness. The high resistance of the original material to weathering impedes the formation processes developing fast enough to overcome the erosive processes provoked by the lack of vegetation. Indeed, this is the prime cause of the phenomenon because very often these soils are located in gently undulating zones. It is possible to observe their presence in areas with a highly varied original material, relief, or vegetation. They are thus located on granite, quartzite, and shale materials. As is observed in Fig. 2.4.1, these soils occupy the central portion of the peneplains in La Serena, and zones of greater relief in the sierras of Siruela and Monterrubio.

On opening the type profile, one finds a horizon where the soil is mixed with coarse elements which come from weathering of the original material on which the soil lies. This is the A horizon. Beneath, is another horizon exclusively made up of material from the bedrock. If it is easy to dig, it is known as the C horizon. It has hardly any organic matter and does not have the structure of soil. The minerals which are present in it are the same as make up the bedrock, and the only formation process that is taking place is that of physical disaggregation into smaller materials. If the material can not be dug when moist, this is the R layer.

The leptosols are usually slightly acid. This is also a reason for their slow development towards more evolved stages. They have little organic matter content, a light brown colour, light texture, low cation content, and low water retention capacity. In zones of developed vegetation, they appear as regosol inclusions.

Most leptosols are soils that have undergone intense erosion. The initial soil could have been very developed, even having reached the category of luvisol. In the areas where the destructive process was most marked, the current soils are classified as leptosols, and in those where it was less intense as regosols or cambisols, or even luvisols if they were left unaffected. The proportions of regosols, cambisols, and luvisols which appear are more or less the same - about 10% each - while the leptosols represent more than 60%. This gives an idea of the great intensity and extension of the erosive process. In small zones where holm oak woodland are conserved, the soil has developed a mollic A horizon of remarkable thickness, with the appearance of a chernozem (or cambisols). Leptosols are found in some zones on shale materials intercalated with limestones. These are richer in organic matter, with a pH close to neutral, and are saturated to a greater or lesser extent depending on the original material.

Regosols

These are soils that have developed on unconsolidated materials of a balanced or fine texture. They present an AC profile with an ochric or umbric A horizon. In general the surface is a light brown colour, with little organic matter, and fairly shallow. Their texture depends to a great extent on the type of original material, the cation exchange capacity, the degree of saturation, and the pH. The regosols which present a degree of saturation of less than 50% predominate, having developed on sandy-type alluvial sediments with a variable clay content, and little water retention capacity. They tend to be acid with a pH between 5.5 and 6, a low cation exchange capacity, and a low degree of saturation which accentuates the poor quality of these soils. In the zone, they appear as associates of the leptosols. They also characteristically accompany soils which have developed on old, sandy-type, fluvial sediments, and are often close to rivers but far from their direct influence.

Soils with cambic B horizon: cambisols

The principle characteristic of these soils is the presence of a cambic B horizon. They are young soils but with a sufficient level of evolution for the said horizon to appear. This is a subsurface alteration horizon typical of Mediterranean environments. The degree of alteration is shown by the more intense or redder colour of the starting material, by a higher clay content, or by the structure of its aggregates - usually in subangular blocks - being sufficiently developed to be differentiated from the original material.

Its name comes from the Latin *cambiare*, which means to change, to indicate the changes in colour, structure, and consistency that occur in this horizon. Only the cambisol type is included in this group. The cambisols are soils with an incipient development - and hence their identification as young soils - which may be because the process of alteration of the original material is very slow or because they are the relicts of more evolved soils that underwent a process of degradation, generally of water erosion. The cambisols which are present have in common the existence of an ABCR type profile. Their diversity, however, is immense.

Cambisols

On granites, in flat or gently ondulating zones, the cambisols possess a medium to high thickness, a more or less light brown colour, a low organic matter content, and a slightly acid pH.

On shales, the cambisols also present an ochric A horizon, with a higher than 50% saturation, a medium exchange capacity, and a red colour in the cambic B horizon. The presence of sandstones intercalated with the shales provides the soil with good aeration, which favours oxidation and dehydration in summer. This process is known as rubefaction, and is responsible for the reddish colour of the cambic B horizon. The A horizon is more or less brown depending on the organic matter content, which depends in turn on the existing vegetation type. In soils under holm oak woodland, pasture, or crops, the organic matter content is higher. The cation exchange capacity is medium or low, resulting in base-poor soils. When the erosive processes are intense or the original material presents higher quartz contents, they are associated to leptosols. When the shales correspond more to clays than to silts, illuviation of the clay occurs, generating argic B horizons with the consequent transformation of the soil into an acrisol.

In small zones, and developed from shales, there appear cambisols whose A horizon is ochric. They are generally found forming islands in zones dominated by leptosols. They are differentiated from the latter by the slightly higher pH and degree of saturation.

Soils with an argic B horizon: luvisols, alisols, and acrisols

The argic B horizon is subsurface. Its origin is due to the accumulation of clay from higher horizons - a process known as illuviation. For this to happen requires a climate with alternating wet and dry seasons. During the wet periods, the clay particles are in suspension, and in the dry period they flocculate. The Mediterranean climate is very well-suited to this process. The clay accumulation takes place as the pore sizes shrink, so that it is deposited within the finer pores, and when the water evaporates it remains adhered to their walls. The laminar character of clay particles and their small size creates a patina giving brilliant surfaces known as clay-skins. The distinctive characteristic of an argic B horizon is an increased clay content in comparison with the horizons above it, and the presence of clay-skins which guarantee its illuvial origin.

The presence of an argic B horizon gives the soil greater water retention and cation exchange capacity. While both of these conditions have a positive influence on fertility, the permeability is less and may lead to difficulties in the aeration of the root zone. These are very evolved soils, and require lengthy periods of formation. They therefore only appear on old surfaces, and the presence of this type of horizon together with the eluvial horizons that give rise to it is an indication of low risk of erosion. Their presence near the surface of the soil is evidence of the contrary.

The sequence of horizons is ABCR type, and in the better conserved areas AEBCR in which there appears the eluvial E horizon. They are deep soils, with more than 150 cm useful depth in which there stands out an A horizon with a colour between yellowish brown and dark brown and a subpolyhedral structure. In the cases where the E eluvial horizon exists, this is characterized by an impoverishment in clay and other components, and the presence of light colours. Following this is the argic B horizon with a polyhedral structure, and a red colour with tendencies to yellowish.

Luvisols

The characteristic of the luvisols is the presence of an ochric A horizon with low organic matter content, medium texture, and polyhedral structure of intermediate size and good development. Between this and the argic B horizon there may exist an E horizon impoverished in clay but not discoloured. The argic B horizon is usually a reddish brown colour, with a fine texture, and very well developed structure, and which lies on a C or R layer. These soils are deep, neutral or slightly acid, rich in bases, with good water retention, and moderate subsurface permeability. They develop from shales, igneous rocks, limestones, and Tertiary materials such as arcoses and marls.

From shales, luvisols can develop with a brown A horizon and sandy-loam texture, beneath which there appears the argic B horizon with a notable clay enrichment, polyhedral structure, and dark brown colour. Between the B horizon and the bedrock there is usually a zone of alteration of the latter. These are deep soils, with a good content of bases but generally poor in organic matter, that present a neutral or even slightly basic pH. They possess good physical properties with a balanced texture on the surface that becomes firmer at depth, thus allowing them to retain water without any serious problems of permeability arising. They were probably very abundant soils before the processes of erosion led to the present situation.

Alisols

This type of soil is very similar to the luvisols. Its main difference being that they are more acid, so that the degree of saturation is under 50%. The other characteristics are very similar. They appear developed principally from rañas. The surface horizon is usually an ochric A horizon of a fairly light colour.

Acrisols

This type of soil is very similar to the luvisols and alisols, from which it is only differentiated by the characteristics of the complex of changes in the argic B horizon and the acidity. Principally because they are very old, the acrisols are acid soils with little cation exchange capacity, and hence very poor. Normally they develop from shales.

Other less represented soils

Arenosols

These are soils that are rich in sand with very little clay content. They develop on coarse alluvial materials. They are very light, poor in bases and organic matter, with little cation exchange capacity, and are very permeable.

Gleysols

These are soils that show evident signs of iron reduction processes in the top metre, as a consequence of being waterlogged for at least one part of the year.

3. ORIGIN AND DYNAMICS OF THE VEGETATION

The territory which is being described has environmental characteristics that correspond perfectly with the vegetation type which the authors have termed durilisilva, sclerophyllous woodland or Mediterranean woodland. This name refers to the great physiognomic-ecological formation dominated by trees and shrubs which are evergreen, sclerophyllous, with xeromorphic adaptations and spring flowering, that are typical of those places in the world where there is a *summer drought*, i.e., zones with a *Mediterranean climate* (the countries of the Mediterranean basin, and small areas in California, Chile, South Africa, and SW Australia).

In our region, this Mediterranean climate - which is at the origin of the resulting flora and vegetation with the same name - took place at the end of the Tertiary. Before, the climate in the zone had been closer to that which now exists in the tropics or subtropics, and the vegetation consequently consisted of lauroid subtropical broad- and hard-leaved forests, similar to those which are conserved today in the Canary Islands. These laurisilvas contrasted with the coniferous and deciduous forests typical of N Europe.

The appearance of the Mediterranean climate caused the migration or disappearance of these earlier vegetation types, and the natural selection of plants with mechanisms of adaptation to the heat and drought of the summer, and to the availability of spring pollinators. This favoured such adaptive strategies as limiting transpiration from the vegetative organs (reducing leaf surface area, generating spines, increasing sclerenchyma or pilosity, situating the stomata in crypts or on the abaxial surface, forming essential oils), the frequent existence of short-cycle species, spring phenology, the formation of bulbs and tubercles to get through the unfavourable period, etc.

After the Tertiary, this Mediterranean vegetation was subjected to a succession of major glacial and interglacial periods throughout the Quaternary. With the resulting migratory movements of species there appeared processes of hybridization and polyploidy that led to speciation, above all in geographic zones with isolating orographic or pedological barriers (high mountains, peculiar soils...).

The preceding climatic and palæobiogeographic factors were decisive in determining the primitive vegetation which existed in the area before there occurred any type of anthropic intervention. This primitive vegetation corresponded in the flattest plains to a dense holm oak forest with wild pears (*Quercus ilex* subsp. *ballota*, *Pyrus bourgaeana*), and the canopy projected deep shade on the understorey throughout the year. The holm oak was accompanied by sclerophyllous and lauroid elements such as spurge flax (*Daphne gnidium*), mock privets (*Phillyrea angustifolia*), butcher's-broom (*Ruscus aculeatus*), mastic (*Pistacia lentiscus*), laurustinus (*Viburnum tinus*), strawberry tree (*Arbutus unedo*), asparagus (*Asparagus acutifolius*), a powerful lianoid stratum with honeysuckle (*Lonicera implexa*, *L. etrusca*), madders (*Rubia peregrina*), ivies (*Hedera*), sarsaparilla (*Smilax aspera*), and a sparse herbaceous stratum of geophytes and hemicryptophytes (*Anemone palmata, Tulipa sylvestris*) with comelinidae (*Carex distachya*), various monocotyledons (e.g., *Fritillaria lusitanica*), and ferns (*Selaginella denticulata, Asplenium onopteris...*).

In the mountains (the Sierras de Oro, de Castuera, de Tiros, de la Rinconada, de la Osa, de la Motilla, and de los Villares), this forest would be dominated by cork oak (*Quercus suber*), with some gall oak (*Quercus faginea* subsp. *broteroi*), occasionally Montpellier maple (*Acer monspessulanum*), and even certain conifers such as *Juniperus oxycedrus* subsp. *oxycedrus*. In the herbaceous stratum there would appear orchids (*Epipactis helleborine, Orchis langei, Neotinea maculata*) and other geophytes of less xerophilous character, such as *Allium massaessylum*, *Conopodium majus, Ornithogalum pyrenaicum*, and various hemicryptophytes (*Ponentilla recta, Leucanthemum ircutianum* subsp. *pseudosylvaticum*...). These last would certainly not be present on slopes exposed at midday where, on the contrary, myrtle (*Myrtus communis*), kermes oak (*Quercus coccifera*), white asparagus (*Asparagus albus*), and other thermophilous elements (*Osyris alba*, *Pistacia terebinthus, Rhamnus oleoides*) would flourish.

Near to watercourses of sufficient size, the soil moisture would compensate for the aridity of the climate to such an extent as to reduce the characteristic Mediterranean summer drought to the point where the natural vegetation would not correspond to a durisilva of sclerophyllous plants adapted to xeric conditions, but would be a different kind of vegetation, belonging in this case to the group of aestisilvas. This is the deciduous vegetation belonging to the Atlantic climes prevailing in the temperate zones of Europe, part of Asia, and North America. Within the Mediterranean world, this physiognomic-ecological formation can only appear in favoured habitats, such as the courses of rivers or mountains high enough for there to be a considerable increase in rainfall which makes the Mediterranean character milder.

The river banks would originally have consisted of a dense alder (*Alnus glutinosa*), willow (*Salix atrocinerea, Salix viminalis*), and ash (*Fraxinus angustifolia*) forest, where one or the other element is dominant depending on the local soil moisture. This riparian forest would have on its edges figworts (*Scrophularia scorodonia*), lords-and-ladies (*Arum italicum*), birthworts (*Aristolochia paucinervis*), diverse geophytes and hemicryptophytes (*Ranunculus ficaria, Viola riviniana, Brachypodium sylvaticum*), or deciduous shrubby elements constituting brambles and thorn-breaks where species of roses and brambles (*Rosa, Rubus*) would be abundant, accompanied by climbing vines (*Clematis campaniflora, Tamus communis*).

4. VEGETATION AND MAN: LAND USE AND THE HISTORICAL TRANSFORMATION OF THE VEGETATION*

The history of mankind is linked to the evolution of the vegetation and the landscape. If during the first millennia of the development and evolution of humans, they were incapable of modifying and changing the environment, the passage from a predator to a producer economy had its first effects on the landscape. These grew in importance as humans developed much more complex ways of life. Until then, the changes recorded in the vegetation had been related to climate fluctuations - periods that were colder, damper, etc. - which indeed made their mark on the different species.

However, from the moment man achieved the cultivation of his first agricultural products and domesticated his animals, many of these variations were caused by human activity: fires, uncontrolled felling, excessive grazing. In other words, most of the modifications were provoked by the uses man made of the territory, creating in this way what is known as a "cultural landscape".

Knowledge of the vegetation and land use is relatively straightforward to obtain if there are written sources available. But to define and establish the original vegetation and the first impacts of man on the environment it is necessary to have recourse to the so-called palæobotanical sciences, such as palæopalynology (the study of fossil pollen), anthracology (carbon), and carpology (seeds and fruits), whose data are collected either from peat deposits or at archæological sites. In the specific case of La Serena, even though the information is fairly scant we can make an approximation as to what the historical development of the vegetation would have been on the basis of the data which is known from other places in Extremadura and Spain, at least for the most general aspects.

The oldest archæological remains, those belonging to the vast Palæolithic period, are generally of little importance in Extremadura. The geomorphological characteristics of the Extremaduran river network restricts the settlement of human groups in the first stages of Extremadura's history, although there are some infrequent elements that allow to posit the existence of human presence from the beginning of the Pleistocene. Judging from the discoveries, these first human groups were concentrated around the Guadiana and its tributary the Zújar river. Worth mentioning are the remains recovered at the site in Alía close to Mérida and Alange, and also in the proximities of the Tiétar-Tajo, in Navalmoral de La Mata, and in the valley of Alagón where a voluminous group of a stone tool industry was collected at the El Sartalejo site in Galisteo. The occupation was above all of sites on the plains close to a river, but also well protected and with a visual control of the river. To a later period, the Upper Palæolithic, correspond the enigmatic cave paintings in the Maltravieso cave in Cáceres.

In recent years, archæological investigations of rock shelters located in what is known as the Cáceres Calerizo are bringing to light interesting human fossil remains, as well as implements that formed part of their material culture. These studies are shedding some light on one of the darkest stages of Extremadura's prehistory, with levels ranging from the Lower to the Upper Palæolithic. In the Santa Ana cave, in the strata belonging to the oldest phases, specifically the Lower Pleistocene - around 1 Ma BP - palynological analyses have identified Mediterranean taxa, including a high percentage of *Olea europaea*, which reveals a warm period. The palynological analyses, as well as those of the seeds and carbon which have been recovered at these shelters will permit the prevailing vegetation to be determined. Among the bone remains from the digs, there are examples of *Sus* sp. (wild boar), *Dama clactoniana* (fallow deer), *Ursus* cf., *Bos primigenius* (aurochs), *Equus* cf. *caballus* (horse), *Lynx pardina* (lynx), and *Crocuta crocuta* (hyena).

No archæological studies of Palæolithic times exist for La Serena, although it is evident that in its extensive territory some artefacts and stone tools have been found which could be ascribed to this broad period. During the first stages of human history, man was not yet able to modify the vegetation of his environment. Small groups of humans - from 10 to 15 people at most - moved about intermittently dependent on and subordinate to the resources offered by the environment, hunting, fishing, gathering wild fruits, etc. Of course, this economy, based on predatory activities, would neither change the environment nor modify the landscape.

Up to the present date, and awaiting the publication of the palæo-environmental studies of the Calerizo of Cáceres, we have no data available on either the prevailing vegetation or the climate in these first stages of humanization. However we can refer to those of other points in the Iberian Peninsula. At a climatological level, the Palæolithic is fundamentally noted for the phenomenon of the glacial and interglacial periods, which did not have the same consequences in the Iberian Peninsula as in the rest of Europe. The overall assessment of the data (palaeobotanical, faunistic, pedological, etc.) shows the existence of a relatively mild climate in contrast with that of Europe. With the exception of certain moments of the last glacial period - the Würm - only the northernmost zone of Spain suffered the effects of glaciation. The further south, the less noticeable were the effects. In-deed, because of its latitude, the region of Extremadura would have avoided the severe effects of the glacial periods, with the exception of the Central System where their rigours did have an impact.

In the last stages of the Würm ice age - some 15 000 BP - the climate began to recover with a series of brief warm fluctuations separated by short cold phases - the Old and Recent Dryas, or Dryas I,II, and III.

The Old Dryas corresponds to a short very cold period, which especially made itself felt in the mountains. The dominant vegetation seems to have been steppe, characterized by the abundance of Chenopodiaceae, *Ephedra, Artemisia, Juniperus,* and abundant *Pinus*. Between 13 000 and 10 000 BP the climate underwent a relative improvement, which coincided with the Alleröd interstage - a period in which there took place the rapid expansion of *Quercus*.

The next stage, the Recent Dryas (10 000 years), was characterized by extreme, but not cold aridity, that provoked a regression of the *Quercus* woods and an increase in the heliophilous steppic taxa.

During the last 10 000 years, the results from the Padul (Granada) peat deposits and from Atapuerca (León) show the recovery of the temperate woodland related to a rise in rainfall. In the Baetic zones, there is a predominance of *Quercus suber* (cork oak), and the constant presence of *Olea* (wild olive), although in low percentages, while in Atapuerca the forest consisted of birch, hazel and ash, likewise the result of the improved climate.

Once the glacial and interglacial phenomenon had ended, approximately 8800 BP, there began the new period known as the Holocene. This new period in the Quaternary was characterized by the recovery of the temperate woodland, and then by the development of a new stage in human history - the Neolithic - and the changes and transformations that immediately followed both in human history and in the landscape and vegetation.

From the Boreal (8800 to 7500 BP) and Atlantic (7500 to 4500 BP) stages, woodlands underwent a steady evolution in parallel with the improvement in temperatures and the increased rainfall. During the Subboreal stage (4500 to 2700 BP), there were some fluctuations in the vegetation. A case is the regression of the woodland and the development of *Artemisia* (Mugworts) and Chenopodiaceae, which may have been in response to the slight climatic worsening of the Subboreal, although it is also possible that it was a result of anthropo-zoogenic activity.

The beginning of the Neolithic marked the passage from predator activity to one of production based on agriculture and the domestication of the first animals. It evidently had enormous impact on the vegetation which was intensified with the incipient process in which the groups of humans became sedentary.

The archæological references for this stage are now more numerous. The occupation of caves and natural shelters was generalized, but also some more or less stable open-air habitats have been confirmed. Fortunately, palæopalynological analyses are available for this period in Extremadura, although not for the La Serena zone where no archæological investigations have been done for this period. The palæopalynological studies correspond to Los Barruecos in Malpartida de Cáceres (López Sáez et al. 2005) where an open-air habitat occupied from the earliest Neolithic - transit from the VI to the V millennium BC - was excavated, and the Cerro de la Horca in Plasenzuela. The palæopalynological data of both sites correspond to the Early Neolithic (chronology ca. 5200- 4800 BC) reflect a vegetation adapted to high temperatures and wet conditions, characterized by dense holm oak forest although already tending towards the more open anthropic parkland of today known as “dehesa”. This holm oak forest was accompanied by a pre-climax arborescent community of *Olea europaea* (wild olive) and *Pistacia lentiscus* (mastic) that would even have been predominant on south-facing and rocky slopes. The riparian forest was represented by the alder (*Alnus*).

There is also evidence of agricultural and husbandry activities in both cases, with the identification of some scarce palynomorphs of cereals and other herbaceous plants. The types *Plantago lanceolata, Urtica dioica*, and Chenopodiaceae/Amaranthaceae form the basis of these claims. However, the low percentages presented by the nitrophilous flora show that these practices still had little importance in the economic basis of the human groups that were settled here.

From the Middle Neolithic (3600-3300 BC), the effects of agricultural and husbandry activities were already making themselves felt in the natural environment. Palæopalynological studies reflect a retreat of both the holm oak woods and the Bia of wild olive, whilst there were increases in the percentages corresponding to nitrophilous and grassland pasture taxa. During the following stage, the Late Neolithic, deforestation worsens, the wild olive practically disappears as a consequence of the reiterated burning and clearing to make the land suitable for crops and grazing, and the holm oak also underwent a regression.

For the province of Badajoz, we do not have available either archæological remains as interesting as those of Cáceres, nor of course any palæo-environmental studies. As of the present date, the La Charneca cave in Mérida is the only site of stable occupation which has been subject to scientific scrutiny.

The beginning of the Chalcolithic, and with it the Age of Metals, again involved major transformations for human life, and consequently for the landscape and vegetation. On the one hand, although it would not reach its zenith until the Middle Chalcolithic, there began the development of an authentic agricultural occupation of the entire middle Guadiana valley, and there took place what one could call the first colonization of these fertile lands to use for crops and livestock. And on the other, there is evidence of copper metallurgy, a factor stimulating advances in agriculture, changes in the social organization of groups of humans, etc. It has to be stressed, however, that these technological, economic, and social changes occurred neither suddenly nor rapidly. Instead, they corresponded to a slow but steady process of evolution.

The archæological references are much more numerous now. Stable settlements have been documented where huts were built on a stone base, and were covered with branches. They were small settlements situated on the plain or on gentle hillocks close to permanent river courses and environments of obvious agricultural use. Neither for this stage do we have any palæo-environmental studies to confirm agricultural activity. It is inferred, however, not only from the characteristics of the spaces occupied, but also from finds in these habitats of sickle teeth with a cereal glaze, back-and-forth grindstones, and polished stone axes - the tools and implements needed in an agricultural economy. The sedentary process tells of an economy that is more advanced, more stable, and less subject to such secondary activities as hunting and gathering which, while still practised, had lost the importance of previous times.

Recent prospection and research in the middle Guadiana basin have identified numerous, diverse types of settlements. This diversity echoes a complex organization of the territory, from which one infers that there must have been some social complexity, too. But this occupation and organization of the territory also doubtless had major consequences for the natural vegetation. For these early dates, there are only available the palæopalynological analyses of the Chalcolithic levels excavated in the settlement of Hornachuelos, Ribera del Fresno. These studies have revealed the existence of a thinned-out holm oak wood of the dehesa type, accompanied by thermophiles such as the mastic and the wild olive which would have populated the unshaded locations. The wetter spaces were populated by elm and hygrophilous pasture of Cyperaceae, but there principally stand out the high percentages that the nitrophilous-anthropic flora (Aster type, Cichorioideae, etc.) already presented - clear signs of a marked humanization of the natural landscape.

This vegetation type also tells us about the prevailing climate for the Middle Chalcolithic, characterized by warm temperatures - presence of wild olive and mastic - and a certain degree of wetness - perseverance of hygrophilous pastures.

For the La Serena-Siberia zone, there are no archæological excavations of settlements available for a palæo-environmental analysis. Remains and structures assigned to this stage have been recovered, such as the Magacela dolmen, numerous wall paintings in shelters, as well as other objects and tools, reflecting an intense occupation in this zone also which likewise altered the vegetation.

The consequences of the process of humanization of the landscape began in the Neolithic, and speeded up throughout the III millennium in the Chalcolithic, reaching higher proportions during the following stage - the Bronze Age. For this period, which developed throughout the II and part of the I which developed throughout the II millennium and part of the I millennia BC, there are already more numerous and systematic palæo-environmental studies. In the Cerro del Castillo in Alange, one of the most emblematic and significant settlements for our knowledge of this extensive cultural stage has been excavated. In the corresponding research project, a fundamental section was devoted to palæo-environmental and palæo-economic information about the settlement and its environment, based on the analysis of pollen, seeds, and carbon.

These studies reveal the existence of a *Pyro-Quercetum rotundifoliae* forest, whose most characteristic taxon is represented by *Quercus ilex* t., but where the serial elements of this association - *Olea europaea, Myrtus, Rhamnus, Ericaceae*, and *Cistus* t. - reach high values. The percentages of *Quercus* correspond to a dehesa type woodland, very thinned out and probably degraded as can be deduced by the presence of the shrubby flora typical of degradational stages of holm oak woodland.

Elms, alders, ashes, and poplars formed the riparian woods that grow along the Matachel and Palomillas rivers, but this vegetation also shows the signs of deforestation. The fertility of these lands favoured their intense agricultural use with the consequent degradation of these forests which were reduced to simple riparian fringes. Also, their retreat favoured the development and increase of other species, as is the case of the taxa corresponding to anthropic pastures.

Associated with these wet environments is the example of *Juglans* (walnut) identified in these analyses. Traditionally, its natural habitat was established in south-eastern Europe and western Asia, but there are numerous palæo-botanical studies which have located examples in the Iberian Peninsula - the Cueva del Nacimiento, Pontones, Jaén; in the Cueva del Calor, Murcia; in the Cerro de la Virgen, Granada; in the site of El Recuento, Cervera del Llano, Cuenca; in the settlement of Les Jovades; and in the Cabecico del Tesoro.

The index of humanization and deforestation detected is the consequence of the farming and husbandry activities in the surroundings of the settlement. The practice of agriculture is not only corroborated by the identification of cereal pollens and the recovery of naked wheat seeds, barley, and beans, but also from the floristic retinue that grows in these nitrophilous environments. Also, the documentation of some non-spore-pollen microfossils such as the Type 7A are associated with felling and burning processes, while the Type 55 is a coprophile fungus spore that indicates the presence of livestock. The fauna studies reveal numerous livestock principally consisting of sheep/goats and cattle.

Determining the prevailing palæo-climate on the basis of the changes observed in the vegetation of an archæological settlement is an arduous task. Indeed, the alteration of the vegetation as a consequence of human action makes it practically impossible. Nevertheless, during the Late Bronze Age (around 1200 to 1000/900 BC) there is a documented retreat of the riparian taxa accompanied by a rise in such thermophilous species as Ericaceae and *Olea europaea*, as well as *Pinus*. These variations could have been the consequence of a stage of greater thermal xericity rather than a process caused by human activity, as the values of other species equally affine to anthropic effects remain unperturbed.

In the final moments of the Bronze Age, settlements with Chalcolithic horizons were reoccupied. Examples are the settlement of Medellín, situated under the walls of the present castle, or the Cerro de la Muela in the Alcazaba of Badajoz. Unfortunately there are no palæo-environmental studies available for these archæological levels in either of the two settlements. The only references for these dates are centred in the middle Tajo basin, specifically in the settlements of the Sierra del Aljibe, Aliseda, and in El Risco, Sierra de Fuentes, with environments that are different from the valley of the Guadiana. In both settlements there is documented a still well conserved dense holm oak forest, although also evident are the typical elements of serial stages such as labdanum, wild olive, etc.

In the last years the excavation, of a series of archaeological drills in the Magacela Hill, documented its occupation already during the transit from the second to the first millenium, this is The Final Bronze. The paleopolinic and charpological studies revealed the dominance of *Quercus* t. perennifolious over the rest of taxa, indicating a dense and well conserved forest. This dominant element is accompanied by a floristic fringe of shrubs as *Olea* sp., Ericaceae, Rosaceae, etc.

Settlements such as Medellín, the Alcazaba of Badajoz, possibly Magacela, etc., which were already occupied during the end of the Bronze Age, maintained this occupation along the Iron Age. This new cultural phase, meaned the arrival to the Iberian Peninsula, firstly of transpirenaical people and then of colonizing mediterranean ones. As a consequence a lot of social and cultural changes were introduced. Together with them, there arose another type of settlement spread out not only over La Serena, but also over the fertile lands of the Guadiana valley. To this type belong the architectonic complex of Cancho Roano (Zalamea de la Serena), La Mata (Campanario), and La Barca (Villanueva de la Serena). The first two have undergone systematic archæological excavations, and palæo-environmental studies are available.

The oldest archæological levels of Cancho Roano analyzed belong to the mid VI century BC, although the site's occupation goes back to the end of the VII century BC. In the corresponding diagram (Figs. 4.1, 4.2, and 4.3), the low percentages that the arboreal strata presents are evident, reflecting a highly cleared and deforested holm oak forest, where open spaces predominate in which the nitrophilous taxa such as *Aster* t., Cichoiroideae, Cardueae, etc., grow.

The identification among the herbaceous flora of cereal pollen, although isolated, of other palynomorphs of ruderal or arvense character such as Fabaceae, Brassicaceae, and *Rumex t.*, and of some non-spore-pollen microfossils such as *Glomus* associated with erosive processes caused by ploughing the land, are sufficient to prove agricultural activity. But, apart from agriculture, the economic life of these settlements must have been based on livestock farming as is shown by the presence of a high index of grasses, Chenopodiaceae/Amaranthaceae, *Plantago lanceolata t.*, and spores of species of coprophile fungi such as Type 55 which reflects the existence of cattle in the nearby environment. The two activities, agriculture and livestock farming, must have been the fundamental causes of the deforestation processes of the environment.

The analyses of the seed remains also reveal this activity. The cereal farming is confirmed, with a preponderance of barley over wheat, and of the broadbean among the legumes. Another of the crops documented is the grapevine. The wild variety was already recorded in the settlement of the Cerro del Castillo in Alange for the period of the Late Bronze Age but, to date, the endocarps recovered in Cancho Roano are the oldest evidence of its cultivation in Extremadura. This variety, together with the olive, was introduced into the Iberian Peninsula by the Mediterranean colonizers.

In the arboreal stratum, apart from *Quercus* t., other elements associated with the serial stage of Mediterranean forest have been identified - wild olive, labdanum, spurge flax, and pine, the last with very low values despite its good pollen dispersion. Anthracological and carpological studies have also identified examples of pine, specifically the species *Pinus pinaster*.

Elms, willows, alders, poplars, some honeysuckles, etc., formed the scant riparian fringe of the Cigancha stream, which, with a permanent flow all year round, runs a few metres to the east of the site. The hygrophilous pastures which inhabit these wetter zones are formed by *Ranunculus*, Cyperaceae, and rushes, as well as different monolet and trilet spores.

The deforestation of Cancho Roano contrasts with the landscape of La Mata, also belonging to the Early Iron Age. The first archæological studies spoke of a building similar to that in Cancho Roano. Later work in the two complexes have highlighted certain differences which we shall not mention here, although it needs to be left clear that these differences are also perceived in the type of landscape surrounding the two settlements and in the palæo-environmental findings (Celestino 2000; Rodríguez & Ortiz, 1998; Rodríguez & Enríquez, 2001). While Cancho Roano is located in a space with good quality land, the soils of La Mata correspond to a sandy type, poorly suited to crop farming.

The pollen analyses (Fig. 4.4) reflect the existence of a dense forest, very well conserved, and superior to the dehesa type (with values that reach 43.4%), mainly consisting of *Quercus* t. *perennifolio* (this alone represents 37.2%) and to a lesser extent of *Olea europaea*, Cistaceae, and Ericaceae. The anthracological studies confirm the presence of a well conserved forest, where the holm oak - the prevailing species - is accompanied by labdanum, aleppo pines, strawberry trees, etc. (Grau et al. 2004; Duque, 2004).

Associated with the wetter zones, both the palynological and anthracological analyses have identified some examples of riparian taxa: *Ulmus, Alnus, Populus*, etc. (Pérez, 2004).

The carpological analyses document barley and hard wheat seeds which reveal agricultural practices, activities that favour the development of nitrophilous flora as well as cultivation of the grape, fig, almond and olive trees. (Pérez, 2004).

The economic life of these settlements was based on agriculture and livestock, but secondary activities such as gathering wild products and hunting must have constituted important additional resources. Indeed, this aspect is deducible from the results of the analyses of the micro-remains left on a hand mill which revealed the milling of acorns (Rodríguez & Ortíz, 1998). The recovery of acorn remains in the archæological sites is frequent. This making use of wild as well as domestic resources indicates an agricultural-woodland economic model (Pereira & García, 2004). Diversification of the resources sought security of supply throughout the year. Thus, while acorns would be at their best in autumn, the cereals and legumes would not develop until spring. This practice continued during Roman times. Pliny, in his *Naturalis Historia* (XVI.15) notes that the acorn constitutes wealth for many peoples even in times of peace - when there was a lack of cereals, they dried the acorns, ground them, and kneaded the flour into the form of bread.

During the II Iron Age - IV century BC till the Roman stage - important changes took place in economic patterns related to the arrival in Extremadura of peoples from the interior of the meseta. The economic model of these populations was based on the exploitation of the rich iron mines and the control and exploitation of the pastures by sheep/goat livestock. Settlements such as the Tabla de las Cañas (Capilla) and La Barca (Herrera del Duque) controlled the natural droveways for the livestock and mining exploitation.

Agriculture and livestock farming are the causes which have been considered to explain the deforestation processes. But one must not ignore the significance of the mining and metallurgy which have been confirmed to have existed in the district region since the Late Bronze Age. The La Serena zone is known for the richness of its argentiferous galena, copper, iron, and tin, which were intensely exploited from the Bronze Age onwards, and especially following the Roman stage.

The arrival of the Romans meant the maintenance of already established settlements, as well as the creation of new cities such as *Iulipa* (Zalamea de la Serena), *Metellium* (Medellín), *Lacimurga* situated on the hill of Cogolludo (between Navalvillar de Pela and Puebla de Alcocer). Together with these, there were other types of settlements which gave rise to a complex pattern of populating and reorganizing the territory which would obviously have repercussions on the vegetation, and would mould a cultural landscape different from that of the previous stages. These newly founded settlements were located either where the lands were more fertile with a view to their use for agriculture, or in places from where the exploitation of the mining and metallurgical wealth of the district could be controlled. The former were based around a group of villas such as La Sevillana in Esparragosa de Lares, or the one situated in the Dehesa de Santa María, where various rooms have been excavated related to the transformation and storage of agricultural products. In the latter case, in order to secure this control, there exists a personalized group of massive constructions which are located along the length of La Serena and Los Pedroches (in the neighbouring province of Córdoba).

The description given by some authors of the Roman works in the argentiferous galena mines allow one to assess the consequences they would have had on the vegetation: "*The labours were intense, open cast, removing the surface to bare the veins of ore, seeking galena and silver while scorning other metals.*" There are remains of old iron exploitations in Zalamea de la Serena and Cabeza de Buey, and of silver in Castuera. Without doubt, this type of activity and the process of smelting and metallurgical work must have been a hard blow to the holm oak forest, which gradually retreated to be replaced by open spaces. These works plus those deriving from the crop and livestock farming led to an intense deforestation. This is reflected in the palæopalynological analysis done in one of the aforementioned massive constructions - specifically in the tower-enclosure of Hijovejo, in Quintana de la Serena. The natural vegetation corresponded to the *Pyro-Quercetum rotundifoliae* association, but was highly altered. The holm oak forest was accompanied by shrubs characteristic of the serial stages - labdanum and numerous representatives of the Labiatae and Fabaceae families - although the nitrophilous flora was principally predominant overall - *Rumex*, Cichoriadae, *Aster*. t., Anthemideae - together with the graminoid pastures as well as anthropic palynomorphs such as Chenopodiaceae/Amaranthaceae, Plantaginaceae, etc.

In the wetter zones, there are still conserved some isolated examples of elms and alders, although the most frequent are nitrophilous species such as Ranunculaceae, *Plantago major*, etc., that grow in nitrogen-enriched riparian meadows.

So the landscape the Romans found on their arrival in Extremadura is far from the description that Livy gave in recounting the struggle between the Carthaginians and Romans in the year 207 BC where he refers to the forest richness of the Iberian Peninsula, remarking that *the very thick woods, as are general in Hispania*, hindered the march of the army (Livy XXVIII, 1, in Blázquez, 1973). in fact, other authors such as Plato in his work Critias had already lamented the deforestation of the Peninsula. More specific references to Extremadura are found in the Estrabon's *Geography* (Book III) and in Pliny's *Naturalis Historia*. Estrabon mentions the harsh aspect of Beturia, bordering the course of the Anas (River Guadiana), whose dry plains are rich in mineral ores. Pliny also comments on this same deforestation. Both authors too, as well as describing its mining wealth which could explain the deforestation of the zone due to the constant felling of timber for firewood, charcoal, mine supports, and fuel for metallurgical activities, tell about the crops of the zone - abundant amounts of wheat which was exported to Rome, barley, vineyards, olive trees, etc. In other words, there was an intense agricultural production which would doubtless have accentuated the processes of deforestation.

Data for the Visigoth period are very sparse. Most of the Roman villas remained occupied throughout this period, fully devoted to agriculture. Bauer (1980) notes that during those centuries forest ownership and the forest itself were strongly protected as an economic unit, and that the extensive rural estates inherited from the Roman times were also maintained.

The arrival of the Muslims in the Iberian Peninsula, guided by the appealing vision of wealth and the bounties of war, accelerated the deforestation process begun in previous stages. This was firstly because of the intensification in farming practices, and secondly because of the continual fighting and looting on all sides that derived from the struggle for control of the Peninsula between Muslim and Christian leaders known in Spain as the Reconquista. Under the Muslim dominion, the district of La Serena kept its importance of previous times. Localities such as Medellín, Zalamea de la Serena, Magacela were still important centres of population. Together with these, other strategic points were occupied - Capilla, or the still unknown Berber city of Miknasa, which researchers locate at some point between Zalamea de la Serena and Cerro Cogollado. Muslim geographers such as Al-Razi and Al-Idrisi praised the importance of the zone's holm oak woodland, the sweetness of its acorns, and the greatness of its mining, whose continuous exploitation would have affected the vegetation even more.

The conquest of La Serena by Christian troops was finished during the reign of Fernando III in the XIII century. From then onwards, the territories of La Serena were given by the monarch to the Order of Alcántara, while the bordering territories - those of La Siberia - were given to the Templars, although they later also passed into the hands of Alcantara after the dissolution of the Templar order. This concession of territories to the military orders was not only a show of thanks for their armed support during the military campaigns, but also a way of ensuring that the defence would remain in the hands of prepared warriers. This fact would mark an important milestone in the history and evolution of La Serena's landscape. The Reconquista led to a major increase in the population. In the territories won from the Muslim troops, settlers were brought from the north of the Peninsula who sought to develop land for farming, but, above all, pastures for their numerous livestock.

The Order of Alcántara exploited the Royal Dehesa of La Serena by renting its pastures and acorn wealth to the great droving farmers of the "Honourable Council of La Mesta". Founded by Alfonso X in 1273, this organization enjoyed every privilege as against other sectors of the Spanish economy. But, as has already been mentioned, this decision was to severely mark not only the Peninsula's landscape, but also its historical fate. The favouritism enjoyed by these drovers and their livestock prevented both the development of autochthonous livestock because of the inaccessibility of grazing and the complementarity of crop production. Furthermore, the over-exploitation speeded up deforestation, a process which must have reached such a magnitude that already during these times laws were passed against the felling of holm oaks. A clear example is present in the ordinances of Los Santos de Maimona, which states:

"...that all who cut, pull up, or burn any albarrena oak in any of our dehesas the width of a man, or take timbers out of it having branches and the oak standing..." (In: Guerra, A., 1952:500).

The herds reached La Serena along the Burgos and Segovia droveways. They spent most of the winter in the zone's dehesas, although not only were the winter pastures rented, but also the summer pastures and the acorn resources. The grazing herds were very numerous. With Philip II, in 1585, the 46 dehesas of the Order of Alcántara of 22 000 000 mrs. were rented, with about 70 000 sheep allowed to graze in the Partido de La Serena alone. Other references mention even 110 000 head in the year 1424. Contrasting these data with those obtained in the Livestock Census for 1999 where the number of head of sheep in the entire district of La Serena and Siberia reached a total of 85 644, one clearly observes the abusive grazing load that these lands were subjected to. Indeed, the deforestation led to the practical disappearance of the trees in some zones.

But references to deforestation are much more numerous. Sometimes, they are not only provoked by the dire effects of droving, but also derive from other abuses. Chapter 23 of the Regulations of La Serena, in which the uses of the zone were regulated juridically, for 5 September 1755 states: *"...that because the justice of the villages had allowed the inhabitants to set fires in the zones and stubble bordering the lands of the Royal Dehesa continuous fires had resulted causing the loss of a large part of the holm oaks. To avoid such damage the Marquess of Los Llanos forbade the inhabitants to burn scrub and* *fallow before Michaelmas."* (In: Serrano González de Murillo, 1990).

These same abuses are considered in the administrative municipal district of Alcántara (belonging, as did La Serena, to that same military order), whose forests were already found to be in a precarious situation in the XVI century. Thus, a conflict between this municipality and La Mesta in 1523 confirms the existence of a wooded area that was not only sparse, but also low in height due to abusive felling which did not permit the regeneration of the stands. In 1501, in the municipality of Brozas, it is mentioned that the existing vegetation is sparse and principally consists of evergreen oak scrub. This change in the vegetation landscape affected the fauna, above all those species most sensitive to habitat alterations, such as bear, deer, wild boar, etc., which, according to the Book of the Hunt of Alfonso XI, populated these lands.

Such is the magnitude that the loss of woodlands and vegetation must have reached that some monarchs became concerned about the topic, and laid down laws for their protection and conservation. In 1558, Philip II, to remedy the harm caused by fires in Andalusia, Extremadura, and Toledo, ordered that the burnt lands were not to be used for grazing without an order from his Council.

However, despite these attempts at regulation, the problems became yet more pressing when, midway through the XVIII century, with the aim of freeing the Royal Treasury from a difficult situation, Philip V decided to transfer the ownership of the Royal Dehesa of La Serena to lay nobility and religious institutions. The new owners were guaranteed the exclusivity of these lands for the exploitation of droving livestock, thereby likewise preventing the economic development of the autochthonous populations. These actions were highly criticized:

"If the fertile Serena,when it began to be sold by the thousand, had been given by His Majesty to the people of Extremadura, Catalonia, and Galicia for grazing and for ploughing … with time, what is today a sad desert, would have been a pleasant state." (In: Fernández Nieva, 1982).

The survey of the territories of the Spanish state at the end of the XVIII century during the reign of Charles V, known as the Interrogatorio de la Audiencia Real, provides an excellent report on the vegetation and land use in La Serena. It mentions the existence of dehesas with holm oak stands, the growth of wild olive in the mountains, and, among the crops, notes wheat, barley, oats, rye, and legumes such as broadbeans and chickpeas. But, above these commentaries, the survey reflects the same concerns that we noted above - deforestation, and the exclusive use of the land for the drovers:*"It is clear that the greater part of the grass continues to be dedicated to migratory livestock, and therefore leaving insufficient either for the livestock of the townspeople or for sowing."*

Antonio Ponz, in his work "*Travels through Extremadura*" of 1784, repeatedly mentions these same problems of deforestation. In Letter IX (p. 228 and ff.) he deals with the law made by Philip II on 22nd February 1567 forbidding indiscriminate felling in forests and other wooded lands. Two centuries later, not only had the felling not been stopped, but no new plantations had been made on river banks or in the common lands of the municipalities. The reason again was the need to maintain grazing zones for livestock. Specifically, for the region between Miajadas and Medellín he describes *"flat* *land with few trees, but covered with merino sheep"*. In the more fertile lands, in the Guadiana floodplains, the riparian vegetation had also disappeared in favour of agricultural crops. Dillon in 1778 alludes to the richness and fertility of the lands near the Guadiana, where cereals, grapevines, pears, and figs are cultivated. A. Ponz notes for the locality of Miajadas (Letter VII, 182.58): *"It has a good portion of land sown with grain and flax which is spun and woven in the village by the women…"*.

The decadence of the Honourable Council of La Mesta from the times of Charles III favoured enormously the small towns of La Serena, which were steadily gaining ground in the use of the pasture lands. Another hard blow to the Mesta livestock was the Report on the Agrarian Law issued by Jovellanos in 1795. The abolition of La Mesta in 1836 and the processes of disentailment in 1855 and 1866 meant the transfer of ownership of all the lands of La Serena, including the common lands. However neither action favoured the economic development of the district, but only reinforced a bourgeois-style large landowner structure to add to that of the nobility of before. Moreover, it was already too late to avoid the deterioration caused by the over-grazing of these dehesas.

The work carried out by the Corps of Land and Forestry Engineers created in 1848 permitted much of the wooded public land to be saved throughout the Peninsula. In spite of this, as a result of the political instability of Spain, many of the protectionist laws were repealed, leading to an intense destruction of the woodlands. Evidently, in an area like La Serena, already greatly deforested, and traditionally subjected to over-grazing, these protectionist laws had hardly any impact. Neither the Law of Montes (wooded lands) of 1863 nor the Replantation Law of 1877 of Alfonso XI and his prime minister, Cánovas del Castillo, could slow this intense deforestation. Even in the XX century, Alvarado Corrales (1983) stressed the shameful loss of woodland in the region of Extremadura, pointing out that in the province of Badajoz alone in the period between 1969 and 1978 a total of 1 800 000 holm oak were felled.

This stage of alarming deforestation throughout the XX century was motivated by two principal factors. The first of these was the low profitability of the traditional grassland system, especially in relation to the major economic and social changes that went with the policy of "development at any cost" and the "Plan of Stabilization" of 1959. The result was the implementation of what was called the "Changes in Crops" program, first by the Office of Plant Production, and later by ICONA. In the end, this consisted of nothing more than a massive and indiscriminate felling of holm oak stands in order to use the land for herbaceous, fundamentally dry-land, crops cereals and legumes. Some specific data for the study area is presented in Table 4.1, taken from Alvarado Corrales (1983).

This policy only accentuated the by-now centuries old processes of deforestation, but the situation became even more serious. The second of the factors which accelerated deforestation was brought about by the replantation campaigns which were carried out throughout Spain after the Spanish Civil War.

With the passage of the State Forestry Heritage Regulations in 1941, there began a stage of intense replanting. This forestry policy was continued by ICONA when it replaced the National Heritage in 1972. While it was intended to alleviate the grave problems of soil erosion in the Peninsula as a consequence of the continuous deforestation of its woodlands, it is evident, as is very much reflected in the landscape, that the end result was far from this romantic idea. The principal cause of the failure was replanting with species for the timber industry rather than with autochthonous species. Plantations of pine and eucalyptus not only spread over barren deforested hills, but an immense task of destruction of existing woods was performed in order to instal enormous areas of foreign species. Most of this replanting was carried out in the mountainous zones of the regulatory dams - one finds clear examples in the headwaters of the Cijara - which ICONA justified as aimed at reducing the risk of silting up of the reservoirs and at creating new sources of wealth in the most depressed areas of the province, whose possibilities were exclusively in reafforestation. However, everything happened to the contrary. The species used for the reafforestation - *Pinus pinaster, Pinus pinea, Eucalyptus botryoides, E. camaldulensis, Eucalyptus globulus,* and *Eucalyptus rostrata* - impoverished the soil to such an extent that they did not permit the growth of herbs to the prejudice of the economy of these zones that is based on pasture uses.

The replantations were excessive. In Talarrubias, Puebla de Alcocer, and Garbayuela alone, for 1954 the reafforestation of 21 168.80 ha was approved. Furthermore, in Fuenlabrada de los Montes the 1400 ha property of Valdemoro was acquired for the same reasons. It is calculated that for the Los Montes area alone, the reafforested area is around 44 000 ha. An essential complement to the work of reafforestation was the construction of broad forest tracks - between 3 and 5.40 metres in width - needed for the removal of the timber products, but which also have more negative consequences environmentally. As well as these tracks, one must add forestry houses, garages, stables etc., which needed equally important movements of the soil and provoked their corresponding impact.

Reafforesting with allochthonous species was extensive around the great reservoirs of Extremadura. But also the construction of these great dams and reservoirs such as those of Cíjara (with 1670 cubic hectometres), Puerto Peña (=García Sola) (555 cubic hectometres), Orellana (842 cubic hectometres), Zújar (723 cubic hectometres), and Serena (3232 cubic hectometres) on both the Guadiana and its principal tributary, the Zújar, has had the consequence of a major reduction of the riverside forest which populated their banks.

The land use map, elaborated from the data of the agricultural census of 1999, reflects the importance attained by pastures in the area of study - 44.7% (Fig. 4.6) of the land is used for pasture while only 28.8% is devoted to crops (herbaceous plants, olive groves, vineyards, orchards, etc.). The percentage of woodland is very low, and the greater part corresponds to reafforestation.

The greater part of the pasture is exclusively for sheep. These represent 79.1% of the livestock (Fig. 4.7), followed at a great distance by swine - 16.9% - which make use of the scarce holm oak dehesas which can still be found in some areas. These pastures are principally located on shale soils, and to a lesser extent on basic substrates. They are known as “majadales”, and principally comprise *Poa bulbosa* and *Trifolium subterraneum* which arise from therophyte pastures subjected to the intense and continuous action of sheep.

The Forestry Map (pag. 61), also elaborated from the data of the agricultural census of 1999, shows that most of the 15.6% of woodland corresponds to the intense reafforestation carried out in the Extremaduran Siberia, in particular, at the heads of the Cíjara and Puerto Peña (= García Sola) reservoirs, although there are some areas in the mountains of Siruela. The patches coinciding with sclerophyllous woods are situated in the rocky areas and in the zones of greatest slope. There, where the Guadiana penetrates into Extremadura, the lack of accessibility made the work of reafforestation difficult and make unproductive. At these points, there grow holm and cork oak, and with them, in the shady areas, gall oak, and even the occasional Pyrenean oak. Their density permits the development of an important natural ecosystem typical of woody Mediterranean vegetation.

Fortunately some holm oak dehesas are conserved. They are dedicated either to the use of their pastures for sheep grazing and for free-ranging pigs, or, in areas with deeper and more fertile soils, to growing dry-land herbaceous plants. On the south-facing slopes, the wild olive trees of past times have been grafted, and today there extend olive groves which have in recent years begun to produce a high quality oil of great market acceptance.

5. FLORISTIC ANALYSIS OF THE TERRITORIAL BIODIVERSITY IN VASCULAR PLANTS

The Iberian Peninsula, due to its geographical position between the Mediterranean and the Atlantic, its proximity to the African continent, its variety of climate and soil types, and its eventful geological history, is one of the floristically richest European territories. Of the nearly 10 000 species which constitute the Peninsula's flora, almost a fifth are represented in Extremadura. Catalogued in La Serena are more than a thousand taxa (991 species, 1026 taxa considering species and subspecies, and 1061 considering also the rank of variety).

The flora of La Serena consists of more than a hundred families. Those with the greatest representation are the grasses (132 taxa), the legumes (115 taxa), and the composites (113 taxa) (Fig. 5.1). These are taxa that mostly correspond to sward therophytes, favoured by the dedication of a great part of the zone to extensive livestock farming. The ecological dominance of the first two families has important livestock farming consequences, as these are the main source of nutrients for the animals, contributing the greatest part of carbohydrates and proteins. In terms of genera, there are 460, half of which (241) are represented by only one taxon. Those which stand out because of their diversity are the genera of *Trifolium* (28 taxa), *Ranunculus* (18 taxa), and *Silene* (13 taxa) (Fig. 5.2). The humanized environments contribute to maintaining the degree of diversity of the flora in the zone because, as can be seen in Fig. 5.3, 53% of the taxa are nitrophilous are pasture elements. The aquatic (7%) and rupicolous (5%) communities in the territories must not be forgotten since, although their percentages are not high, they and usually associated with species of interest for conservation. With respect to ethological forms, more than half the wild species of La Serena are therophytes, i.e., plants that avoid the yearly unfavourable period in the form of a seed. This is very frequent in Mediterranean environments, above all in open mixed agricultural, sylvicultural, grazing ecosystems such as the dehesas. On the contrary, the helophytes and hydrophytes are very scarce, given the obvious lack of permanent open waters in the zone.

In the floristic analysis, as important as the number of species in a territory is the endemism rate - a measure of the originality and singularity of the flora. Endemics are taxa restricted to a certain area, which have formed during the process of evolution due to the existence of geographical, pedological, or reproductive barriers. In a global context, the Mediterranean basin, with a climate and geographical history of its own, is the territory of distribution of a large number of plant species: the Mediterranean elements. Of the taxa that are found in La Serena, 76% present a certain Mediterranean character. Of these, 53% are really Mediterranean elements (of which 7% are Iberian endemics, 9% Iberian-North African, 1% Iberian-Gallic, 5% Mediterranean-western, and 7% Mediterranean-Macaronesian), and the remaining 23% are taxa that are distributed over the palæo-temperate zones - zones which are very close to the Mediterranean region (Fig. 5.4).

Amongst the endemic plants of the Peninsula, there are found some of a marianic character: *Dianthus crassipes, Erysimum lagascae, Verbascum barnadesii, Scrophularia oxyrhyncha, Digitalis mariana* subsp. *mariana*, *Jasione crispa* subsp. *mariana*, *Centaurea cordubensis, Avenula sulcata* subsp. *occidentalis*. Others of a central Peninsular character reach La Serena and La Siberia through the mountain connection represented by the Montes Oretanos and Sierra de Siruela: *Leucanthemum ircutianum* subsp. *pseudosylvaticum*, *Linaria saxatilis, Antirrhinum graniticum* subsp. *graniticum*, *Genista cinerascens*, etc. There is even a species of Ibero-Levantine distribution which irradiates into the limestone outcrops of the western Peninsula: *Agrostis nebulosa*. Finally, one must mention the existence of a few genera of Mediterranean and Central-South African distribution such as *Gynandriris, Gladiolus, Olea*, and *Erica*.

The rest are plants belonging to other chorological groups, among which stand out the cosmopolitan and subcosmopolitan (7%) and the aloctonous (5%). The former are either species of very broad ecological valence, species characteristic of particular environments with representation in all the Earth's floristic kingdoms, or plants that accompany man and his crops in different parts of the world. The latter are non-native elements which have managed to a greater or lesser degree to integrate into the landscape. Most of them are from tropical America, and a very few are of Asian or Australian origin.

In relation to the protected flora, the Council Directive 92/43/CEE of 21 May 1992, dealing with the conservation of natural habitats and wild fauna and flora, catalogues *Marsilea batardae* as "of priority Community interest", for whose conservation it is necessary to designate special conservation zones (D.O.C.E. Nº L 206, of 22-VII-1992). The same can be said of *Marsilea strigosa*, whose presence in the zone it has not been possible to certify, although it is possible that it might appear. This directive, also catalogues the species *Narcissus bulbocodium* subsp. *bulbocodium* and *Ruscus aculeatus* as of "Community interest", whose collection in nature and exploitation may be the object of management measures. The application of these European directives in the case of Spain was put into effect with later legislative measures (Real Decreto 1997/1995).

The Law 37/2001 of 6 March regulating the Regional Catalogue of Threatened Species in Extremadura (D.O.E. 30, 13-III-2001), catalogues *Marsilea batardae* and *Serapias perez-chiscanoi* in the category of "sensitive to changes in their habitat" and 5 taxa present in the studied zone in the category of "vulnerable" - *Acer monspessulanum, Erodium mouretii, Juniperus oxycedrus* subsp. *badia*, *Juniperus oxycedrus* subsp. *oxycedrus*, and *Scrophularia oxyrhyncha*. There are a total of 14 taxa of La Serena and the peripheral sierras catalogued in the category "of special interest" according to the said law. They are: *Armeria genesiana* subsp. *genesiana*, *Carduncellus cuatrecasasii, Digitalis mariana* subsp. *mariana* (sub *D. mariana*), *Digitalis purpurea* subsp. *toletana*, *Flueggea tinctoria*, *Genista cinerascens*, *Narcissus bulbocodium* subsp. *bulbocodium*, *Ononis viscosa* subsp. *crotalarioides*, *Ophrys dyris, Orchis italica, Orchis langei, Orchis papilionacea, Ruscus aculeatus*, and *Scrophularia sublyrata* (sub *Scrophularia schousboei*). The Red List of Spanish Vascular Flora (2000) includes as "vulnerable" *Erodium mouretii, Scrophularia oxyrhyncha,* and *Serapias perez-chiscanoi,* and as "critically threatened" *Marsilea batardae*.

6. THE VEGETATION UNITS

To describe the vegetation tapestry of a territory, the concepts of vegetation unit, plant community, or association are frequently used. These terms, which in the context of academic botany are not exactly the same, from a wider perspective can be considered as synonymous. They express the group of plants that live together in a certain type of habitat or ecological environment.

If floristic analysis studies the list (catalogue) of plant species of a territory, and evaluates botanically the richness and singularity of the flora, the study of the vegetation units describes firstly the diversity of plant communities of the zone (types of pasture, scrub, woodland,...), and secondly contrasts the biological meaning of the presence of one or another community within the ecosystems or biomes to which they belong.

The description which we shall present in this study is based on phytosociological criteria. This means that it gives priority to the floristic composition of the community over other characters, taking also into account its physiognomy, dynamics, phenology, ecology, and the chronology of its components, without neglecting the importance that human activity or palæo-geographic factors have often had on the present composition and structure of the communities and landscapes.

The Diversity of the Plant Communities

7. PASTURES AND OTHER GRASSLANDS

Plant communities dominated by non-woody plants belonging to different botanical families. When the biomass is used for the everyday nourishment of livestock, one speaks specifically of pastures. In general, in that situation the plants which are considered are plants which complete their biological cycle in one year, i.e., they are annuals. This is very frequent in zones of the world with a Mediterranean climate. If the plants are perennials, generally because they possess a strong radicular apparatus, often rhizomatose, one speaks of meadows. These normally appear in places with a certain degree of moisture, because they are the type of herbaceous vegetation which dominates all of Atlantic Europe.

7.1. DRYLAND PASTURES[1]

7.1.1. Open grassland pastures

Ephemeral pioneering vegetation dominated by grasses and small non-nitrophilous therophytes, appearing on dry soils from the beginning to the end of spring. They constitute one of the most characteristic examples in the world of the Mediterranean plants (**Tuberarietea**) known locally known as "hunger pastures". They are communities that contribute scant biomass from the point of view of farming, and go unnoticed due to their frailty and size. They nevertheless reach an extraordinary degree of floristic diversity, and hence have an appreciable botanic value. Among their most important components are found many Caryophyllaceae (*Cerastium brachypetalum* subsp. *brachypetalum*, *Chaetonychia cymosa*, *Herniaria cinerea*, *Moenchia erecta* subsp. *erecta*, *Paronychia echinulata*, *Silene conica*, *Silene portensis* subsp. *portensis*), legumes (*Ornithopus pinnatus*, *Lotus conimbricensis*), composites (*Crupina vulgaris*, *Filago pyramidata*, *Filago lutescens*, *Hypochaeris glabra*, *Leontodon taraxacoides* subsp. *longirrostris*, *Logfia gallica*), and grasses (*Aira caryophyllea* subsp. *caryophy-llea*, *Micropyrum tenellum*, *Vulpia myuros* subsp. *myuros*). There is a notable abundance of typical Mediterranean plants, such as *Aira cupaniana*, *Anthoxanthum ovatum*, *Arenaria leptoclados*, *Asterolinon linum-stellatum*, *Astragalus pelecinus*, *Corrigiola telephiifolia* subsp. *telephiifolia*, *Euphorbia exigua*, *Helianthemum aegyptiacum*, *Jasione montana* subsp. *montana*, *Lathyrus angulatus*, *Linaria spartea*, *Linum trigynum*, *Mibora minima*, *Molineriella minuta* subsp. *minuta*, *Ornithopus compressus*, *Petrorhagia dubia*, *Psilurus incurvus*, *Rumex bucephalophorus* subsp. *gallicus*, *Silene colorata* var. *colorata*, *Teesdalia coronopifolia*, *Tolpis barbata*, *Tolpis umbellata*, *Xolantha guttata*, *Xolantha plantaginea* var. *plantaginea*. Some have a more specific distribution area, being restricted strictly to the Iberian Peninsula (*Linaria saxatilis*, *Prolongoa hispanica*), occasionally reaching the North of Africa

1 Priority natural habitat of Community interest: code 6220 (Directive 92/343/CEE). Pseudo-steppe with grasses and annuals (*Thero-Brachypodietea*).

(*Campanula lusitanica*, *Coronilla repanda* subsp. *dura*, *Eryngium tenue*, *Hymenocarpos hispanicus*, *Molineriella laevis*, *Linaria spartea*, *Linum trigynum*, *Molineriella minuta* subsp. *australis*, *Silene scabriflora* subsp. *scabriflora*).

From February or March, in the clearings of holm oak woodland and scrub of all the low zones of the studied territory, in small patches of terrain with scant depth of soil, where there exist no very high levels of agricultural or livestock farming activity, and the habitat is dominated by shale and quartzite outcrops, it is common to find pastures with these elements. Depending fundamentally on the acidity and texture of the substrate, different variants of this type of pasture can be recognized. Here plants such as *Trifolium cherleri*, *Plantago bellardii*, and diverse fescues (*Vulpia*) are characteristic.

On shelves among granitic rocks, on undeveloped soils preferentially of sandy texture, appears a community characterized by two Iberian grasses very typical of continental Spain: *Micropyrum patens* and *Ctenopsis delicatula*. It is much rarer in this part of Extremadura than in the cold zones of Castilla, where it abounds at the end of spring.

Without doubt, the most striking community linked to the outcrops of granite is that which covers the slabs of rock with reddish and pink colour as winter is coming to an end. It is dominated by different species of the genus *Sedum*, belonging to the family of the Crassulaceae, which receives that name because of its crass or fleshy leaves. Some, such as *Sedum andegavense* or *Sesamoides purpurascens*, are Mediterranean plants, while others such as *Sedum arenarium* are Iberian or Iberian-North African (*Sedum mucizonia*) endemics. Physiologically, these plants have a special metabolism (C.A.M.), which allows them to live in these habitats practically devoid of soil.

If one observes in detail what is the case in the proximities of these outcrops, where there already exists soil strictly speaking although it is not very deep (a lithic soil), one sees that there enter to form part of the community other Crassulaceae that are also seen on the compact sandy soils of tracks and paths. Examples are *Crassula tillaea* and *Sedum caespitosum*.

In the clearings in hill-side scrub, protected by labdanum and heather, and often at the base of rock formations and slightly in the shade, we can find small pastures dominated by grasses such as *Holcus annuus* or *Anthoxanthum aristatum* subsp. *aristatum*. On occasions, they have floristic elements which give them a peculiar character, as for example is the case with *Pterocephalidium diandrum*, a Spanish endemic Dipsacaceae.

In the municipality of Magacela, as well as in La Guarda and Campanario, there exist porphydic granites that have given rise to the existence of soils with a very sandy texture which are related to the presence of psammophilous (=linked to sands) plants. Of these, especifically significant are some Iberian-North African endemics, *Corynephorus divaricatus* subsp. *macrantherus*, *Loeflingia baetica* var. *micrantha*, and *Evax pygmaea* subsp. *ramosissima*.

In Las Caleras and Las Solanas de Magacela, where there exist, inserted between the granites and shales, limestone outcrops. In earlier times they were exploited for the sale of quicklime in the district. Today, one can observe a plant community of pioneering character and sparse cover, that usually goes unnoticed at the beginning of spring. It constitutes an excellent indicator of even the smallest basic rock insertions in the siliceous territorial domain, and forms typically Luso-Extremadurense pastures. It is characterized by *Brachypodium distachyon*, and in its floristic composition there are abundant basophilous plants such as *Atractylis cancellata*, *Lomelosia stellata*, *Polygala monspeliaca*, *Valerianella discoidea*, *Valerianella microcarpa*, *Ononis pendula* subsp. *boissieri*, *Linum strictum*, or *Euphorbia falcata* var. *acuminata*. The Mediterranean elements are very characteristic (*Asteriscus aquaticus*, *Echinaria capitata*, *Euphorbia sulcata*, *Helianthemum ledifolium*, *Helianthemum salicifolium*, *Lagoecia cuminoides*, *Ononis reclinata* subsp. *mollis*), and there are some Iberian-North African plants such as *Platycapnos tenuiloba*, *Helianthemum angustatum* or *Ononis laxiflora*.

7.1.2. Sheepfolds

Small perennial swards of bluegrasses, clovers, plantains, and other small chamephytes and prostrated hemicryptophytes (**Poetea bulbosae**) which are produced by sheepfolds. This is a typical husbandry practice of the extensive livestock farming of the western Mediterranean. It consists of a form of shepherding in which the sheep are kept on a section of pasture land so that they fertilize it with their excrement. In La Serena, the tradition has been to corral the sheep during the night in pens, which are then moved to the next section of land until the whole available area of the farm has been covered.

The effects are multiple. Firstly, the nibbling on the plants stimulates their growth, favours within a given plant species the trailing individuals over those of upright growth, and influences the species composition. Many have seeds whose germination capacity is reduced by the passage through the gut of the ruminants, while others need the gastric acids of the animals to break their dormancy and be able to germinate. Secondly, the trampling by the livestock intensifies the cohesion of the surface soil horizons, especially if they contain a sufficient percentage of clays, which depends on the mineralogy of the bedrock. This will influence the soil's water retention capacity and available moisture, as well as its susceptibility to erosion. With regard to nutrients, the animals extract them from the pastures and then deposit them in the pen in the excrement. This type of beneficial effect makes sheepfolding a model of sustainable management as long as the grazing load is suitable. Overgrazing would have as primary consequences the deterioration of the vegetation's regenerative capacity, the substitution of sheepfold species by typically ruderal ones, and increased exposure of the soils to water and wind erosion.

As does all typical Mediterranean vegetation, the sheepfolds bloom in spring and wither in summer. What differentiates these "sheep-tooth pastures" is that they have a second spurt of vegetative growth after the autumn rains. The most significant plant here is *Poa bulbosa*, a very palatable perennial grass which grows very rapidly in the autumn when the rest of the annual species have not started to germinate, and forms swards that stay green and productive during the winter. This facilitates the growth of adapted therophytes the following spring. Very significant plants here are fundamentally Mediterranean species that give these swards their character, such as *Trifolium tomentosum*, *Erodium botrys*, *Parentucellia latifolia*, *Ranunculus paludosus*, *Paronychia argentea* var. *argentea*, *Bellis annua* subsp. *annua*, or *Bellis sylvestris* var. *sylvestris*. There may be geophytes (*Romulea ramiflora* subsp. *ramiflora*), but these are very palatable for the livestock and are reduced to the underground organ - the bulb - unless the grazing is very controlled.

The majority of the sheepfold swards of the territory are located on pre-Cambrian shales where acid soils have developed. They are characterized floristically by clovers such as *Trifolium subterraneum*, *Trifolium glomeratum*, *Trifolium bocconei*, or *Trifolium gemellum*, bulbous geophytes such as *Narcissus bulbocodium* subsp. *bulbocodium*,[2] *Ornithogalum ortophyllum* subsp. *baeticum*, *Ornithogalum umbellatum*, *Gagea elliptica*, *Scilla autumnalis*, Iberian-North African legumes such as *Astragalus cymbaecarpos*, or endemic buttercups of the Iberian Peninsula such as *Ranunculus ollissiponensis* or *Ranunculus pseudomillefoliatus*. When the soils have little depth, in places that encircle the emerging shale rocks (locally named “dog teeth”), the community is characterized by the presence of *Onobrychis humilis*. In the neighbouring sites, on soils with greater depth, there appears the typical sheepfold sward of varied clovers, whose overgrazing causes the formation of communities of nitrophilous, ruderal plants.

Occasionally, the mineralogy of the shales has given rise to the formation of very clay enriched soils, which often have neutral or basic pH. When these soils have been subjected to sheepfolding, the resulting pastures have bioindicators such as *Ranunculus bullatus* or *Erodium primulaceum*. It is not frequent to find sheepfold swards of this type because the soils which have these characteristics are usually already dedicated to agriculture, unless their shallowness impedes ploughing and other mechanized farming procedures.

In extreme cases, linked to the Devonian limestone outcrops in the district of Magacela, one finds basophilous sheepfold swards. The characteristic floristic elements here are *Astragalus glaux*, *Astragalus stella*, *Linaria micrantha, Plantago loeflingii*, *Trifolium scabrum*, or *Scorpiurus vermiculatus*.

7.1.3. Pseudosteppes of thatching-grasses and needle-grasses

Communities dominated by Mediterranean plants adapted to the xeric conditions and large tuft-forming grasses such as “cerrillos” or “barrones” (thatching grasses) belonging to the genus Hyparrhenia (**Lygeo-Stipetea**). Except in the earliest stages of growth, they are barely palatable for livestock and form the coarsest of pastures.

2 Species of Community interest whose collection in nature and exploitation may be the object of management measures (D.O.C.E. No. L 206 of 22.VII.92; Directive 92/43/CEE). Included in R.D. 1997/1995. Included in the category “of special interest” according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Threatened Species of Extremadura.

They can be found in spring, in rocky sites, clayey screes, the cleared areas at the sides of tracks, and even on old cropland, on shallow soils. Their interest is in their contribution to stopping soil erosion, and botanically in their floristic composition because of the presence of some Iberian-North African endemics such as *Daucus crinitus* or *Andryala laxiflora* which prefer roadway habitats. Also present in these communities are Mediterranean plants such as *Arrhenatherum album*, and others whose presence is rather due to the existence of clays, as in the case of some mallow bindweeds (*Convolvulus althaeoides* subsp. *althaeoides*) and various garlics and wild orchids (*Allium stearnii*, *Ophrys lutea*, *Ophrys tenthredinifera*, *Orchis lactea*, *Orchis papilionacea*[3]). Other plants which sometimes appear in these environments (*Ornithogalum narbonense, Phlomis lychnitis*) are of broader distribution.

In the granitic basement between Castuera, Campanario, and Quintana de la Serena, on cambisols with no hydromorphic horizon, there appear occasional communities of perennial grasses of great size dominated by *Stipa gigantea*. This is an Iberian-North African needle-grass endemic known locally as “berceo” or “lastón”. There may appear as forming part of these tatching grasslands some Iberian (*Armeria genesiana* subsp. *genesiana*[4], *Conopodium majus* subsp. *ramosum*) or Mediterranean plants, such as *Melica magnolii* or *Sedum tenuifolium*.

7.2. RUDERAL AND WEED PASTURES

Communities of herbs colonizing habitats that have been nitrified by the action of man and animals (anthropozoogenic action). Ruderals inhabit strongly disturbed environments such as waste ground, or places associated with human dwellings and farming. Many ruderals are weeds, which is the term used both popularly and technically to refer to species that form part of the plant communities of gardens, sown crops, ploughed fields, etc.

These nitrophilous plants are usually endowed with great genetic or physiological plasticity. They are very competitive species, with a high photosynthetic efficiency (C4 metabolism), high rate of germination and vigour, very fast growth, and a considerable production of allelopathic substances. They usually have seeds of easy dispersion by the wind or animals, and possess a great capacity for persistence. In some cases this is because they produce a great number of seeds (opportunistic or r-strategy species), and in others because the seeds remain viable for long periods of time or germinate in a staggered fashion (persistent or k-strategy species). With regard to their reproductive biology, a noticeably large proportion of these plants present phenomena of apomixis and of autogamy.

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3 Included in the category “of special interest” according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species in Extremadura.

4 Included in the category “of special interest” according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species in Extremadura.

Environmentally, these communities contribute to increasing the biodiversity of a territory's flora, and constitute part of the local population's phytogenetic heritage.

7.2.1. Crop farming and weed communities

Agricultural activity constitutes a common practice in the general context of the zone, especially in the central and southern zone where, because of the characteristics of the soils, there has since ancient times been less vocation for husbandry.

The practice of agriculture causes different types of modifications to the environment, particularly to the substrate. Thus, fertilization produces a higher level of nitrites, nitrates, or ammonium salts, and tilling leads to increased aeration of the surface horizon and a loss of its structure. Moreover, the incorporation of fertilizers, insecticides, fungicides, and herbicides modifies the soil's chemical element content.

These alterations condition the presence of native wild plant species in these habitats. Their biological, flowering and growth cycle is usually coupled to the characteristics of the crops where they appear, and chorologically they commonly have a vast distribution area worldwide, except for the tropics.

7.2.1.1. The weeds of cereal fields in spring

Dryland cereals have been a traditional crop in the zone, covering great extensions of land with low productivity (extensive farming). The cultivation system most used has been to allow the croplands to lie fallow for a time ("barbecho"). During this period, the soil is tilled two or three times to increase its fertility with the influence of the rains and the air. The crops are rotated, alternating plants with roots at different depths to absorb the nutrients by zones. At other times, improving plants are cultivated, such as legumes to fix nitrogen.

In most of the territory, on acid soils of a sandy-loam texture, the cereals that are cultivated are oats, barley, and to a lesser degree wheat. The "weeds" which prosper in these crops (**Aperetalia spicae/venti**), are in general nitrophilous plants (*Capsella bursa-pastoris, Stellaria media, Silene gallica, Lamium amplexicaule, Bromus hordeaceus...*), together with others that seem to have a more harvest-loving character (the Spanish adjective "meseguero" means associated with reaping) and a Mediterranean distribution such as *Aphanes microcarpa, Papaver argemone* var. *argemone*, *Papaver hybridum, Spergula pentandra, Veronica arvensis*, and *Viola kitaibeliana*, or Iberian-North African such as *Linaria amethystea* subsp. *amethystea*. They are typically spring flowering plants which have completed their biological cycle before harvesting time arrives. It is in the fields left fallow where perhaps these communities are best observed.

In the "tierras de barros" (lands of clay) that exist in the district of La Haba, on basic pH substrates and, because they are fairly clayey, with a high water retention capacity, the community of harvest loving plants (**Roemerion hybridae**) is enriched with basophiles and calcicoles, a good portion of them Mediterranean. It is an interesting vegetation where the species can be regarded as true bio-indicators of soil basicity. In that sense, it is worth mentioning legumes such as *Coronilla scorpioides, Ononis biflora, Melilotus infestus, Medicago doliata, Medicago italica*, and *Medicago truncatula* var. *truncatula*; Rubiaceae such as *Galium verrucosum* and *Galium tricornutum*; Valerianaceae such as *Valerianella muricata* and *Valerianella coronata*; Papaveraceae such as *Papaver dubium*, *Papaver pinnatifidum*, and *Hypecoum imberbe*; and a significant group of species among which *Vaccaria hispanica*, *Linaria hirta, Convolvulus siculus, Euphorbia serrata,* and *Lolium temulentum* stand out.

7.2.1.2. The summer weeds of olive groves and dryland agriculture-fields

The cultivation of olive trees is most typical in the zone of Monterrubio de La Serena, where the olive tradition has given rise to the existence of an oil milling industry. The oils produced have their own official denomination of origin. There are also scattered olive groves in different parts of the territory, especially in situations where the soil's depth and nutrient richness makes their implantation profitable. During spring, the weeds to be found in the groves are similar to those mentioned in the previous section. They are usually eliminated by tilling, however.

During the summer, it is not rare to find in these biotopes a weed community (**Diplotaxion erucoidis**) that also inhabits areas of other dryland crops such as vineyards, almond, fig, or different market garden vegetables and fruits which do not have excessive water needs.

Very significant plants here are the pigweeds (*Amaranthus blitum* subsp. *emarginatus*, *Amaranthus hybridus, Amaranthus deflexus*), mignonettes (*Reseda phyteuma*), beets (*Beta maritima*), purslanes (*Portulaca oleracea* subsp. *granulato-stellulata*), and caltrops (*Tribulus terrestris*), and the black nightshade (*Solanum nigrum*), most being cosmopolites or subcosmopolites. Of a fundamentally Mediterranean character are worth pointing out such elements as *Reseda luteola*, *Heliotropium europaeum*, *Platycapnos spicata, Dittrichia viscosa*, or *Chrysanthemum segetum*. Also here there live plants of interest for their origin and distribution. Two cases are *Cucumis myriocarpus* subsp. *myriocarpus*, an African Cucurbitaceae, and *Cleome violacea,* a relatively rare Iberian-North African endemic which usually prefers sandy terrain.

7.2.1.3. The weeds of market gardens, water channels, and irrigated crops

In family market gardens, where plants for household use are cultivated which need to be watered (tomato, cucumber, beet), as well as on the nitrified borders of pools, ponds, or streams that collect waste from human use, it is common to find in the autumn weed communities with many adventitious plants, i.e., native of other places in the world but which have incorporated themselves into our flora, and are reproducing and spreading fairly strongly (**Polygono-Chenopodion polyspermi, Bidentetea**), as is the case with *Ammannia coccinea*, a loosestrife of rice crops that is extremely resistant to herbicides, which lives in the irrigated areas of the zone of Don Benito. Those of American origin are abundant, such as the bur-marigold (*Bidens aurea*), the thorn-apples (*Datura innoxia, Datura stramonium*), and grasses such as *Eragrostis virescens* or *Panicum dichotomiflorum*, the latter only occasionally.

In general they are communities dominated by cosmopolitan or subcosmopolitan plants (*Xanthium strumarium* subsp. *cavanillesii*, *Sorghum halepense* var. *halepense*, *Euphorbia peplus*, *Digitaria sanguinalis, Setaria pumila, Cyperus difformis*), with especial implantation in areas of warm and humid climate, for which they often have a specially adapted internal metabolism (C4 photosynthesis of *Echinochloa crus-galli* or *Echinochloa colonum*). On the muddy banks of reservoirs and canals, on water-logged soils, the existence of characteristic Polygonaceae (*Polygonum hydropiper, Polygonum lapathifolium* subsp. *lapathifolium*, *Polygonum minus*, and *Atriplex prostrata*) is frequent.

7.2.1.4. The subnitrophilous pastures of fallow ground and dehesas

The traditional cropping system in the territory is to sow arable fields in alternation, rotating a year of cereal with bare fallow of twelve to fourteen months duration. This is known in Spain as "año y vez" (year and turn) farming. The second year, the field left fallow the first year is sown, and the field that carried cereal the year before is left fallow. The cropping intensity is thus 1/2. Fallowing "by the third" is also used.

The fallow field is not tilled until the spring, when the soil moisture facilitates tilling. Until then, it is made use of by the sheep livestock which consume the crop stubble and any spontaneous vegetation that grows. With this type of alternation, there are no serious problems of nitrate leaching. Also, the stubble left on the field limits the risk of erosion that might otherwise have occurred if there was a storm with heavy rainfall following tillage or harvesting. In effect, fallowing is done to fertilize the land in a natural way.

Another widespread type of exploitation is making use of the pastures under scattered tree cover. These systems are practised in small areas in north-east Hungary, south-east Poland, central Italy, Morocco and above all the south-west quadrant of the Iberian Peninsula, where sheep, pigs, and cattle graze in the shade of the cork and holm oaks (exceptionally muricated oak or Pyrenean oak). These are the Spanish "dehesas" and Portuguese "montados". Their traditional management creates and maintains a characteristic landscape which includes woodland, cropland, and fallow area elements, as well as grasslands and scrub of high biological diversity. This mixture harbours a singular abundance and variety of wild life, and is especially important for the reproduction of birds. Here in La Serena, it is relatively frequent that cereals are cultivated in rotation with fallow and pastures to provide extra forage for the sheep.

In this context, the spring subnitrophilous vegetation (**Brometalia**) is dominated by floristically highly varied herbaceous plants. There are abundant grasses (*Avena sterilis, Briza maxima* var. *pubescens*, *Bromus diandrus, Bromus matritensis* var. *matritensis*, *Bromus tectorum, Cynosurus echinatus, Desmazeria rigida, Lolium multiflorum, Lolium rigidum, Phalaris minor, Phalaris brachystachys, Phalaris coerulescens, Stipa capensis, Vulpia ciliata*), legumes (*Medicago orbicularis, Medicago sativa, Melilotus sulcatus, Trigonella monspeliaca, Trifolium campestre, Trifolium hirtum, Trifolium stellatum*), composites (*Calendula arvensis, Centaurea melitensis, Centaurea pullata* subsp. *baetica*, *Urospermum* *picroides, Scorzonera laciniata, Sonchus asper*), and examples of such diverse families as the Caryophyllaceae (*Silene gallica*), Scrophulariaceae (*Bellardia trixago, Misopates orontium*), Boraginaceae (*Nonea vesicaria*), and Venus'-comb (*Scandix pecten-veneris*). Many of these species usually show preference for clayey substrates and the roadway habitats.

It is very interesting to note here the presence of Mediterranean species, amongst which can be mentioned *Astragalus hamosus, Avena barbata* subsp. *barbata*, *Bromus rubens* var. *rubens*, *Echium plantagineum, Erodium cicutarium* s.l., *Lamarckia aurea, Trisetaria panicea, Plantago afra, Neslia paniculata* subsp. *thracica*, or *Lupinus luteus*. And even more significantly, Franco-Iberian species such as *Omphalodes linifolia*, or Iberian-North African species such as *Malva hispanica, Leontodon salzmannii*, or *Althaea longiflora*.

Different subtypes of these pastures can be distinguished. The first are those known as "seas of grass" (**Echio-Galactition**) - a dense sward dominated by fescues (*Vulpia geniculata* var. *geniculata*, *Vulpia membranacea*), and linked to soils with clayey horizons. This presence of clays increases the water retention capacity, as is indicated by a spiny Mediterranean macrotherophyte that is very typical in these situations -*Galactites tomentosa*-, whose name comes from the characteristic white tomentose (with a thick covering of short hairs) nature of its abaxial surface. Occasionally, hedge mustard (*Sisymbrium officinale*) may appear in cool environments.

On the contrary, on soils of a coarser, sandy texture, typical of siliceous terrain, the community is usually rich in members of the mustard family (**Alysso-Brassicion barrelieri**) such as *Alyssum granatense, Alyssum simplex, Brassica barrelieri,* although on occasions the community's physiognomy is dominated by composites such as *Chamaemelum mixtum*, above all in fields left fallow for two or three years.

Fairly often, on siliceous soils with a sandy-loam or loamy texture, on abandoned arable land, or even wasteland, the dominant community (**Thaeniathero-Aegilopion**) is characterized by Iberian species (*Herniaria lusitanica* subsp. *lusitanica*), Mediterranean grasses of the *Taeniatherum caput-medusae* type, or various legumes (*Trifolium cherleri, Trifolium arvense, Trifolium angustifolium, Vicia vicioides*).

At other times, the outstanding plant at the beginning of spring is *Stipa capensis*. This grass is quite aggressive, often colonizing even sheepfolds. It is indifferent pedologically, being able to prosper on granites, but also being widespread on shales and even on the limestones of La Haba and Magacela.

In late spring, close to summer, on the Palæozoic limestones of Magacela, in almost ruderal environments, there grow the goatgrasses communities (*Aegilops geniculata, Aegilops neglecta, Aegilops triuncialis*), and medicks (*Medicago rigidula, Medicago minima*) of a calcicolous character or that are simply clay-seeking such as the grape-hyacinths (*Muscari comosum*) and caterpillar-plants (*Scorpiurus muricatus, Scorpiurus sulcatus*).

7.2.2. Thistle fields

Thistle fields are plant communities of a summer optimum dominated by thistles. They constitute a vegetation type (**Onopordenea**) which is usually associated with the sides of paths and roadway environments where they grow with ease. They are plant communities of more or less nitrified and disturbed soils, where not only those spiny plants appear but also other unarmed, generally of great size and bright colouring such as mulleins (*Verbascum pulverulentum, Verbascum barnadesii, Verbascum virgatum, Verbascum sinuatum, Verbascum rotundifolium* subsp. *haenseleri*), chicories (*Cichorium intybus, Cichorium pumilum*), donkey mint (*Marrubium vulgare*), and other biennials or perennials, such as *Daucus carota, Ammi majus, Chondrilla juncea, Centaurea cordubensis, Convolvulus arvensis, Lactuca serriola, Picris echioides, Cynoglossum cheirifolium, Foeniculum vulgare* subsp. *piperitum*, *Lactuca viminea, Scrophularia canina, Hypericum perforatum, Mantisalca salmantica*, etc. They are entomophilous plants with showy corollas, very attractive for insects.

In the Mediterranean world, thistle communities are a vegetation type that is strongly associated with the summer, when most bloom and their pollinators are active, although a small minority bloom in spring.

The spines are an adaptive mechanism for the summer drought. They are transformed leaves which have reduced their surface area so as also to reduce water losses from evaporation through the stomata. From another point of view, they are a typical defensive strategy against attack by herbivores, especially vertebrates. One thus deduces that these are communities with interesting plants from both the biological and the eco-physiological point of view.

The biodiversity of the thistle fields varies according to the characteristics of the climate and soil. Here, in this zone, at the beginning of spring, it is typical to find thistle fields of the milk thistle (*Silybum marianum*), a characteristic Mediterranean plant known popularly from ancient times, and used nowadays by the pharmaceutical industry. It usually appears living together with the common thistle (*Carduus tenuiflorus*). Its most typical environments are garbage dumps, rubble tips, and urban drains. It also appears on the edges of paths near towns and villages, above all on disturbed soils, both acid and basic. It is especially frequent if the soils have a certain water retention capacity. This community may be replaced in summer by thistle groups of Onopodum macranthum.

Later in spring, another slightly different thistle community appears in the basic outcrops of La Haba. These are the ones dominated by *Onopordum micropterum, Scolymus maculatus*, or *Picnomon acarna*, accompanied by basophiles that are Iberian (*Carduncellus cuatrecasii*[5]), Iberian-North African (such as *Carduus bourgeanus*), Franco-Iberian (such as *Mercurialis tomentosa*), or of a wider area such as *Salvia argentea* and

5 Included in the category "of special interest" according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species in Extremadura.

Cachrys sicula which are Mediterranean plants. Another Mediterranean sage, *Salvia verbenaca*, prospers in these environments, but can also live on more acid soils. When autumn arrives, the garter thistle (*Chamaeleon gummifer*) and the mandrake (*Mandragora autumnalis*) bloom here.

When all the herb communities in dry locations have withered with the arrival of summer, very visible on the "posíos", village commons, and uncultivated or overgrazed fields, especially in neutro-basic clayey soils on shale formations, are the thistle fields of *Cynara humilis*, the "yerbacuajo" in spanish common name. This is a very well-known species locally because of its use as vegetable rennet in the traditional fabrication of sheep and goat cheeses.

In the same period of the year, when the dominate substrate has an acid character - as is the case for example if the soils are developed on granites - the uncultivated lands, droveways, and sheep tracks have a thistle community dominated by *Carlina corymbosa, Carthamus lanatus, Centaurea calcitrapa, Eryngium campestre, Scolymus hispanicus*, and other spiny plants. This is the case of the spiny restharrow, *Ononis spinosa* subsp. *australis*, an Iberian-North African legume that also lives in other ruderal environments, or the sweet scabious, *Scabiosa atropurpurea*, a Mediterranean Dipsacaceae which shares the same situation.

7.2.3. Urban and eunitrophilous vegetation

The nitrophilous vegetation associated with towns and villages has a stronger anthropic character than that which generally is associated with agriculture. This is because it unites the action of man, of his associated domestic animals, and the generation of organic and inorganic waste by industry, commerce, and similar activities. The soils have a higher proportion of nitrogen in their horizons, and the plants are species that are called eunitrophilous as being adapted to exclusively living in these environments of high nitrophily. They need soluble nitrates to be able to grow fast, with organic nitrogen being of no use to them. They reproduce with high rates of growth, and are independent of symbiont fungi.

The soils of these habitats are altered in their structure, degree of compaction, and hardness. This affects the growth of roots and seedlings and the germination of the seeds, since it in some way modifies the degree of water infiltration as well as the fluidity of the movement of liquids and gases inside the soil. It also affects the soil's biological activity, microflora, microfauna, the presence or absence of important organisms (fungi, bacteria, nematodes, arthropods), and in the last instance the quantity and type of nutrients available.

7.2.3.1. Ruderal vegetation

The term ruderal (from the Latin, *rudus*: rubble) was coined by Linnaeus in 1751 who defined as *ruderata* the habitat typical of disturbed locations, abandoned lots, and buildings in ruins. The vegetation of these places is rich in annual anthropophytes of diverse botanical origins, but with representatives of the Chenopodiaceae and Amaranthaceae (**Chenopodion muralis**) families being of some importance.

The most typical community of this group is of early phenology, blooming at the beginning of spring. It lives in rural environments frequented by man and animals. It is common in the urban centres of the territory's villages and towns, in rubbish tips and courtyards, on all types of substrate. Floristically, it is dominated by mustards (*Sisymbrium irio, Sinapis alba, Diplotaxis catholica*) and Mediterranean mallows belonging to different species that are often mistaken for each other (*Malva nicaeensis, Malva neglecta, Malva parviflora, Lavatera cretica*). Here also are very frequent the nettle-leaved goosefoot (*Chenopodium murale*), the garden anchusa (*Anchusa azurea*), some stork's-bills (*Erodium moschatum*), and diverse Asteraceae (*Senecio lividus, Chamaemelum fuscatum, Coleostephus myconis, Crepis vesicaria* subsp. *haenseleri*, *Taraxacum erythrospermum*). Soils with a good proportion of clays (Monterrubio, Magacela, etc.) are differentiated by the blessed thistle (*Cnicus benedictus*), a infrequent Mediterranean plant in the district. In other clayey situations there abounds a sub-Mediterranean grass as *Piptatherum miliaceum*.

Occasionally, colonizing highly impacted escarpments and screes, as well as rubbish tips, rubble, and alleyways, the community is characterized by certain species that are thermophilous, or at least sensitive to the cold and continental climate of the more interior areas of Spain, such as the Cordillera Carpetana and the Castilian Meseta. Examples of these species are *Hyoscyamus albus* and *Urtica membranacea*. At other times, the community has Iberian-North African endemics such as *Ballota hirsuta* subsp. *hirsuta*.

On the contrary, the community may also appear enriched in plants such as *Urtica urens* growing in environments strongly nitrified by livestock, subject to a certain degree of trampling, and sometimes waterlogged. This type proliferates at the drinking ponds and resting sites of livestock, in folds, pens, stables, village streets used as the usual passage for the animals, or biotopes where the accumulation of animals' excrement is abundant. Significant elements here are the borage (*Borago officinalis*) and the squirting cucumber (*Ecballium elaterium* s.l.). This community flowers later, almost in the summer, and may reach autumn by way of some allochthonous species, some of a thermophilous character, that take refuge in these environments (*Chenopodium album, Chenopodium ambrosioides, Conyza canadensis, Conyza bonariensis, Amaranthus albus, Amaranthus blitoides, Amaranthus muricatus, Xanthium spinosum*).

7.2.3.2. The ditches and borders of roadways and tracks

The vegetation of roadway habitats (**Hordeion leporini**) in the territory consists of thick weed pastures dominated by plants of the Mediterranean area (e.g., *Anacyclus clavatus, Chrysanthemum coronarium, Plantago lagopus, Silene nocturna, Vicia angustifolia, Vicia benghalensis, Vicia cordata, Vicia sativa*) and spring phenology. They are plant associations with a high floristic diversity. The determining elements of the community's physiognomy are some grasses (*Hordeum leporinum, Rostraria cristata, Avena barbata* subsp. *barbata*), legumes (*Medicago polymorpha, Lathyrus cicera, Lupinus angustifo-*

lius, Vicia lutea subsp. *lutea*), members of the mustard family (*Hirschfeldia incana, Raphanus raphanistrum,...*), Euphorbiaceae such as *Euphorbia helioscopia*, and plants as frequent as the fumitories (*Fumaria agraria, Fumaria parviflora, Fumaria faurei, Fumaria officinalis*), poppies (*Papaver rhoeas* var. *rhoeas*), crane's-bills (*Geranium molle*), toadflaxes (*Linaria viscosa*), cleavers (*Galium aparine* subsp. *aparine*), or the common mallow (*Malva sylvestris*). These environments occasionally harbour populations of an endemic lupin of Extremadura and the bordering regions (sector Toledano-Tagano) - *Lupinus hispanicus*.

On the clayey soils of a basic character in the areas of La Haba and Magacela, the communities are enriched with typical plants of basophilous environments. Significant examples are *Diplotaxis virgata* subsp. *virgata*, *Hedypnois cretica, Ononis viscosa* subsp. *crotalarioides*[6], *Pallenis spinosa, Lathyrus ochrus, Lathyrus clymenum, Bromus scoparius, Bromus lanceolatus, Anacyclus radiatus, Bupleurum lancifolium, Fumaria faurei, Nigella papillosa* subsp. *papillosa*, *Phalaris paradoxa, Stipa bromoides, Ridolfia segetum, Tragopogon porrifolius*, and even *Nepeta tuberosa* subsp. *tuberosa*. In the case of ancient tracks that have been little altered and old ditches, the passage of time makes it possible for bulbous monocotyledons such as *Asphodelus fistulosus, Allium ampeloprasum, Allium neapolitanum, Allium paniculatum, Allium roseum* or *Gladiolus illyricus* to establish themselves in these enclaves. In the better conserved environments there are some endemic orchids: *Ophrys dyris* or *Orchis italica*[7].

With greater soil moisture, a poisonous plant enters the community - the hemlock (*Conium maculatum*).

7.2.3.3. Paved, cobbled, and heavily trampled habitats

On the droveways and other livestock tracks of the district, on the heavily trampled ground of rural and urban paths and tracks, as well as in the cracks in the paving and in old cobbled roadways, it is curious to observe the existence of a vegetation type of strong anthropo-zoogenic character consisting of small annuals, and exceptionally perennials (**Polygono-Poetea annuae**).

Here, very characteristic plants are *Plantago coronopus, Poa annua, Poa infirma, Polygonum aviculare, Polygonum arenastrum, Sagina apetala*, and *Spergularia rubra*.

When the substrate has hardly any clay, as is the case in the quarztites and granites, on paths and tracks at the end of winter it is very frequent to find rounded patches of vegetation with abundant *Trifolium suffocatum, Crassula tillaea, Polycarpon tetraphyllum* subsp. *tetraphyllum*, *Sagina apetala*, or *Spergularia purpurea*. This community can also be found in the skeletal, trampled soils around bare rocks and boulders. In farmyards, and heavily trampled dry places there sometimes prospers as a characteristic element *Gynandriris sisyrinchium*.

6 Included in the category "of special interest" according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species in Extremadura.

7 The two species are included in the category "of special interest" according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species in Extremadura.

On the other hand, on clayey soils originating from the breakdown of shales, habitats with a clearly greater water retention capacity and degree of compaction, the characteristic community is dominated by the mayweed *Matricaria aurea*, a Mediterranean species of important practical interest. It is a type of vegetation in expansion, given the notable overgrazing to which many farms of the district are subject.

In the streets of villages and towns that conserve cobbled pavements and roadways, during spring one may observe in the spaces between the cobbles a community of this group in which the most characteristic plant is *Gymnostyles stolonifera*, an American Asteracea perfectly adapted to life in our territory.

Another American neophyte of these environments is a small creeping spurge (*Chamaesyce canescens* subsp. *canescens*). This is still infrequent in the zone, but it is beginning to colonize well-trodden gardens, market gardens, and areas under irrigation at the end of summer, together with lovegrasses such as *Eragrostis pilosa* or *Eragrostis minor*.

8. VEGETATION OF OPEN WATER AND WETLANDS

Aquatic plants and the plant formations that inhabit wet zones, constitute an interesting example of adaptation to special characteristics of the habitat resulting from the constant presence of water. This decisive ecological factor is directly related to the topography, the drainage capacity of the soils, and the climate. Not all ponds and wet zones are the same: some are deep and permanent, others small, seasonal, and shallow. In the Mediterranean climate, there exist wetlands which are annual (that flood every year), occasional, or habitual. The first are found above all on the banks of rivers in the northern zone of the territory. In this type of community, another influential factor is the physico-chemical constitution of the water, which in turn depends on the geology of the substrate. In more than a few cases, the presence or absence of certain types of minerals or ions determines the species distribution. Hence, knowledge of the plants that constitute the vegetation allows many aspects referring to the biological significance, value, and state of conservation of these environments to be deduced.

This section includes not only the aquatic vegetation, but all those types of vegetation that are linked to soils which have moisture during a certain period of the year, being dry in the remainder. They may be found in the outermost parts of river, stream, lake, or pond banks, as well as in arroyos (normally dry stream-beds) and depressions within the dehesa, wherever the topography and the substrate allow water to occasionally accumulate.

8.1. AQUATIC AND PALUSTRINE VEGETATION

Aquatic plants, also called hydrophytes or aquatic macrophytes, are in a strict sense those which complete their biological cycle when all their parts are submerged or floating on the water surface. However, in nature it is easy to find elements that, while able to remain in the water, are also capable of giving rise to terrestrial forms that inhabit very wet soils. This vegetation of constant pedological hygrophily is termed palustrine or helophytic. These terms derive from the respective words for marsh in Latin and Greek: *palus* and *helos*. The plants that live in such water-fringing environments are called hygrophytes or helophytes.

Within the aquatic vegetation, different types can also be identified depending on the ethological characteristics of their components - whether or not they are rooted, submerged, etc. In the palustrine vegetation too, where all the roots of the plants are always wet, there is a variation according to the time that the habitat remains flooded, the depth of the water, and the nature of the substrate.

8.1.1. Duckweed communities

The duckweeds are a group of small plants that float on the surface of the water, for which they are called acropleustophytes. They lack leaves, but have a small modified stem which is often divided into several parts, and whose upper face is adapted to aerial life while the lower face is adapted to aquatic life. Their roots, short and filiform, do not reach the bottom of the ponds where they live. In La Serena, they constitute a natural habitat of Community interest[8] (**Lemnetea**) consisting of communities that colonize ponds and streams which are more or less subjected to livestock farming pressure. Floristically, the constituent elements are the duckweeds *Lemna gibba* and *Lemna minor*, the former more tolerant to eutrophication than the latter. In both cases, these are plants with a great capacity for growth, and a high protein content, the reason for which they are still being used as food in some parts of the world. Also, their capacity to absorb the nutrients that are liberated in the decomposition of organic matter present in the water makes them interesting as bioremediators. Somewhat similar is the case of a small aquatic pteridophyte, *Azolla filiculoides*, which is present in the territory at a few scattered points in nearly stagnant stretches of streams with a high purine content in the granitic zone of Castuera. It has possibly been spread by ducks, moorhens, and other water birds.

8 Natural habitat of Community interest: code 3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation (Directive 92/43/CEE).

8.1.2. Submerged vegetation

Vegetation consisting of mesopleustophytes, i.e., rooted plants, which float between the bottom and the surface of the water (**Potametea**). The principal fact to consider in these communities is the adaptation to the aquatic medium that their components must have undergone throughout evolutionary history. As is well known, the least developed plants (algae, procormophytes) left the water to colonize land areas. But it is also known that the presence of flowering plants in aquatic media is due to a later process adaptation and recolonization of water habitats.

The roots of these plants only serve as anchors, having hardly any nutritional function. Internally they lack supporting tissues, as in the water they have no need to maintain themselves upright. Outwardly, they do not possess land plants' coverings and protective tissues to avoid water losses. On the contrary, all of their outermost cell layers are in direct contact with the aquatic medium to favour the absorption of water, gases, and nutrients. The leaves are often of two types: floating and submerged. The latter are usually divided into fine laciniae, which increases the absorption surface. There are no stomata. When the flowers emerge from the surface of the water, cross pollination is assisted by the wind (anemophily) or by insects (entomophily). The submerged flowers are frequently hydrophilous.

Most plants which live in these habitats have a very extensive area of distribution (subcosmopolitan, boreal...), and belong to just a few genera. While these genera are very different from each other, the species are very difficult to identify taxonomically. In La Serena the most frequent are the batrachids, so called for their tendency to develop terrestrial forms. They belong to the genera *Ranunculus* and *Callitriche*, and which form floating and submerged leaves.

Other genera, always with filiform or laciniate leaves, are *Ceratophyllum, Myriophyllum*, and *Zannichellia*.

Also found here are species of *Potamogeton*, characterized by their generously stalked floating leaves.

At the end of winter, in small streams or other small watercourses with a very slow flow or no flow at all, on sloping banks and fast-drying ponds, in oligotrophic water habitats, one can find without difficulty in La Serena a natural vegetation type of Community interest[9]. Rich in batrachids such as *Callitriche brutia, Callitriche stagnalis, Callitriche truncata* subsp. *occidentalis*, *Ranunculus peltatus* subsp. *peltatus*, and *Ranunculus tripartitus*. In enclaves where the flow is stronger and faster, species such as *Potamogeton fluitans* or *Ranunculus penicillatus*, which are usually in full flower at the height of spring, enter to form part of the vegetation.

During the summer, in the clear, clean water of reservoirs and in some natural ponds with sufficient depth to accommodate water even in this period, communities develop with *Myriophyllum alterniflorum, Myriophyllum spicatum* (water milfoils), *Pota-*

9 Natural habitat of Community interest: code 3260 (Directive 92/43/CEE). Floating vegetation of Ranunculus of plain, submountainous rivers.

mogeton crispus, Potamogeton panormitanus, Zannichellia peltata, and *Ceratophyllum demersum*.

Although the present work deals exclusively with the higher plants, we cannot fail to mention here a group of communities of great importance in these environments - those comprised of muskgrasses or stoneworts (**Charetea**). These are evolved green algae which live submerged and supported by rhizoids in the beds of the reservoirs. This vegetation type is included in the Habitat Directive[10] as being of enormous biological interest. They tolerate neither contamination or eutrophication of the water, and their presence is highly beneficial to aquatic ecosystems, as they contribute to oxygenating the water and keeping it transparent. Furthermore, they are very nutritious for the water-fringing fauna, from invertebrates to birds.

8.1.3. Blinks and buttercup communities

Early spring communities, very visible over the entire peneplain of La Serena, on moist soils fringing the small streams which cut through the territory, and carry water only in this first part of the season. They are readily recognized by the presence of a carpet of white flowers of ivy-leaved crowfoot (*Ranunculus hederaceus*), which live side-by-side with a dense lawn of blinks (*Montia fontana* subsp. *amporitana*) (**Montio-Cardaminetea**). These habitats, of Community interest[11], are also the refuge of different species of forget-me-not - *Myosotis discolor* subsp. *dubia*, *Myosotis laxa* subsp. *caespitosa*, *Myosotis sicula*.

8.1.4. Watercress and marshwort communities

The watercress (*Rorippa nasturtium-aquaticum*) and the fool's-watercress marshwort (*Apium nodiflorum*) coexist during spring in the same ecological media, forming communities which prosper in more or less slow-flowing running water rich in nitrogen-containing nutrients (**Rorippion nasturtii aquatici**). They are common in the wet phase of temporary watercourses throughout the territory when these are situated close to rural dwellings, farms, animal enclosures, or sheepfolds.

8.1.5. Water-dropwort communities

These are frequent associations on the edges of watercourses, occasionally developing to fringe large seasonal ponds, particularly when the substrate is granitic.

10 Natural habitat of Community interest: code 3140 (Directive 92/43/CEE). Hard oligo-mesotrophic waters with benthic vegetation of *Chara* formations.

11 Natural habitat of Community interest: code 3260 Floating vegetation of Ranunculus of plain, submountainous rivers (Directive 92/43/CEE).

Physiognomically, they are dominated by a poisonous apiaceae of Mediterranean distribution (*Oenanthe crocata*), the hemlock water-dropwort, which finds its optimal environment in the siliceous substrates of the west-central Peninsula.

This plant contains strongly convulsive alkaloids which produce serious intoxication in livestock that ingest it, as occurs sporadically in years of prolonged drought.

In situations of greater water permanence, other interesting Mediterranean plants such as *Scrophularia auriculata* may appear.

8.1.6. Flooded meadows with spikerush

In seasonal ponds throughout the territory, and stagnant sections of discontinuous watercourses and rock pools, throughout spring it is easy to see a medium-height plant community which grows at the edge of the water, and where plants of a grass-like aspect dominate, some with floating leaves (**Glycerio-Sparganion**). Floristically, the characteristic elements are the spikerush (*Eleocharis palustris*) and the manna grass (*Glyceria declinata*), although some upright or decumbent water-fringing plants are also frequent, such as *Ranunculus ophioglossifolius, Oenanthe fistulosa, Veronica anagallis-aquatica*, or *Alisma lanceolatum*.

8.1.7. Cane, reed, and reedmace beds

In the lowest section of the Zújar, in streams with a high flow, and on the banks of the River Guadiana, there occasionally appears vegetation of a grass-like aspect comprised of extremely tall plants in which the Provence cane (*Arundo donax*), reeds (*Phragmites*), reedmace (*Typha*), and other perennial plants dominate. They usually possess thick rhizomes, such as water irises (*Iris pseudacorus*), purple loosestrife (*Lythrum salicaria*), gipsywort (*Lycopus europaeus*), or willowherbs (*Epilobium hirsutum, Epilobium parviflorum*) (**Phragmition australis**).

These are communities typical of permanently flooded boggy or swampy soils, where the cosmopolitan species of a boreal optimum dominate. They appear, above all, near irrigated land or land that has been turned over. Some of the plants are indifferent to contamination, and may be used in purifying wastewaters because their roots, stems, and leaves have the capacity to fix nitrogen, phosphorus, and heavy metals. Such is the case of *Phragmites australis* subsp. *australis*, *Typha dominguensis, Typha latifolia, Typha angustifolia,* and *Scirpus lacustris* subsp. *tabernaemontani* which have an irregular presence in the territory. Of these, the reedmaces are the most competitive, and their distribution area is in continual expansion, especially in the case of *Typha dominguensis*, which appears to be the most nitrophilous.

8.2. MOIST RUSH MEADOWS

In this section we include perennial vegetation dominated by medium height plants of grass-like aspect which grow on soils that are moist during a certain period of the year, which may be more or less prolonged according to each case. Excluded are bogs dominated by small, ephemeral annuals.

8.2.1. Hay meadows

Dense meadows dominated by grasses, perennial plants of medium size, great biomass producers, and usable in livestock farming for grazing or mowing. They constitute a vegetation type that is habitual in the temperate zones of Europe, where the summer drought, typical of the Mediterranean , does not exist (**Juncion acutiflori**). In Mediterranean climate environments, their presence is reduced to the borders of rivers, reservoirs, and watercourses, where the soil remains moist all the summer due to the proximity of the phreatic layer.

They are very sparsely represented in our district since deep moist soils are very scarce, and where they do appear they are very small in area. Flowering is in late spring, in considerable contrast with the context of the rest of the vegetation landscape, which is already totally yellowed and parched at this time of the year.

Fragments of these communities can be found on oligotrophic substrates with a sandy or sandy-loam texture, especially in the zone of granitic boulders, adopting the physiognomy of a dense sward of rushes (*Juncus acutiflorus, Juncus effussus* var. *subglomeratus*, *Juncus articulatus*), sedges (*Cyperus longus, Carex distans, Carex flacca*), and numerous grasses (*Poa pratensis, Poa trivialis, Arrhenatherum elatius* subsp. *bulbosum*, *Arrhenatherum elatius* subsp. *elatius*, *Dactylis glomerata* subsp. *hispanica*, *Holcus lanatus, Phleum bertolonii*), together with some perennials (*Plantago lanceolata, Hypericum undulatum, Scutellaria galericulata, Silene laeta*).

The sward often includes scattered plants from wet sites and eye-catching flowers such as is the case of some daisies (*Senecio jacobaea, Crepis capillaris, Bellis perennis*) and various clovers (*Trifolium dubium, Trifolium repens*). Among the taxa outstanding for their chorological value is an orchid of Mediterranean distribution - *Orchis laxiflora* - a plant that is never found except on gleyed soils. A protected plant, *Serapias perez-chiscanoi*[12], also inhabits these media. It has been considered endemic to Extremadura, although recent data on its area of distribution reveal that it may reach Portuguese Estremadura.

Some of these meadows have been subject to a certain degree of anthropic impact directly or through livestock. In these cases, some hygronitrophilous plants have become part of the community (*Plantago major, Medicago arabica, Ranunculus tri-*

12 Included in the category "in danger of extinction" according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species of Extremadura, and the category "vulnerable" according to the Red List of Spanish Vascular Flora (2000).

lobus, Epilobium tetragonum, subsp. *tournefortii*, *Mentha suaveolens, Mentha pulegium, Polypogon viridis, Chamaemelum nobile, Hordeum geniculatum, Festuca arundinacea, Juncus inflexus* var. *inflexus*). In certain particulary wet places, there appear dense populations of *Equisetum ramosissimum*. Also allochthonous grasses such as *Paspalum dilatatum* or *Paspalum paspalodes*, which have been introduced into La Serena through irrigation in the Guadiana floodplains, are not infrequent in this environment.

Plants indicative of enclaves with these characteristics, commonly known as subsaline lands, frequently appear on the nutrient-rich clayey soils that developed on the endorrheic marls of Magacela and La Haba. Typical of them are some grasses with a Mediterranean optimum such as *Hainardia cylindrica*, *Hordeum marinum* var. *marinum*, *Hordeum bulbosum*, or *Polypogon maritimus* subsp. *maritimus*. Other excellent bioindicators of these habitats are the sea clover (*Trifolium squamosum*) and the sharp rush (*Juncus acutus*). The presence of *Agrostis nebulosa*, endemic of the south and east of the Iberian Peninsula merits especial mention since their populations in the zone mark the northern limit of their area.

8.2.2. Round-headed club-rush beds

In all the centre and west of the Iberian Mediterranean, on siliceous substrates, on moist clayey-sand soils, the most typical rush meadows are the beds of round-headed club-rush, *Scirpus holoschoenus* (**Molinio-Holoschoenion**)[13]. This is a vegetation type that needs less moisture than the meadows of the previous section, being better adapted to the summer drought, and therefore of a more Mediterranean character.

They are meadows of great economic value in the zone, as they remain green during the summer, so that they are natural summer pastures at this critical time of the year. We can find them in dried-up ponds, arroyos, depressions, and places where the soils have a great water retention capacity. Their value in livestock farming is considerable since they contain a good proportion of grasses (*Alopecurus arundinaceus, Phalaris aquatica, Agrostis reuteri, Briza minor*) and legumes (*Melilotus indicus, Trifolium squamosum*). Some of them usually inhabit the wettest parts of the rush bed.

Plants from other families also appear in these meadows. Some of them have an appreciable chorological value, as is the case of some genuinely Mediterranean taxa such as *Euphorbia hirsuta* var. *subglabra*, *Hypericum tomentosum, Ranunculus bulbosus* subsp. *aleae*, *Ranunculus muricatus*, or *Linum tenue*, this last only in areas very rich in clays. A rare orchid in the territory - *Serapias vomeracea* - Mediterranean and argilophilous, merits especial mention. Its presence has been confirmed in Higuera de la Serena and in La Haba.

13 Natural habitat of Community interest: code 6420 Mediterranean tall-herb and rush meadows (Molinio-Holoschoenion) (Directive 92/43/CEE).

8.2.3. Bermuda-grass meadows

In the Mediterranean world, when rush meadows are heavily grazed and much visited and trodden by livestock, this intensive action determines a nitrophilous medium which leads to the invasion and final dominance of specialist plants. The combined action of trampling and grazing establishes the "gramadales" or Bermuda-grass meadows (**Trifolio-Cynodontion**).

These meadows of moist livestock tracks, very typical and widely extended around the villages and in the vicinity of ponds which serve as summer watering places, have as dominant species the *Bermuda grass, Cynodon dactylon* var. *dactylon*, and other perennial grasses such as *Elymus repens* subsp. *repens* or *Lolium perenne*. These elements are accompanied by hygronitrophilous plants such as *Rumex pulcher, Rumex conglomeratus, Rumex crispus*, or *Verbena officinalis*.

When the soils are acid, on oligotrophic substrates over shales and granites, the gramadal is characterized by *Trifolium resupinatum* and *Carex divisa*. In the limestone outcrops of La Haba-Magacela, another perennial clover forms part of the gramadal: *Trifolium fragiferum*.

8.2.4. Perennial summer pastures (vallicares)

The vallicares are dense grass-like swards, consisting principally of *Agrostis castellana* var. *castellana*, and where annual elements of moderately hygrophilous character, such as *Holcus annuus*, are in abundance. In this territory, they are restricted to deep soils with a certain degree of hydromorphy, to deep arroyos and depressions within dehesas, and to ponds which have dried up by the end of spring. They constitute the least hygrophilic of all those associated with moist soil, and function as summer pastures at the beginning of summer when all the surrounding vegetation is dry.

Independently of their livestock farming value, the perennial vallicares (**Agrostietalia**)[14] constitute a vegetation type of remarkable botanical value due to the Mediterranean character of their components. The plants involved have areas of distribution completely restricted to the Mediterranean basin such as (*Hypochoeris radicata*) *Asphodelus aestivus, Leontodon tuberosus*, or *Serapias lingua*, to its western zone, such as *Festuca ampla* subsp. *ampla*, *Rumex acetosella* subsp. *angiocarpus*, or *Thapsia garganica*, and even to the Iberian Peninsula, as in the case of *Narcissus jonquilla*. Occasionally they represent the habitat of curious hemiparasite plants such as the yellow bartsia (*Parentucellia viscosa*).

14 Priority natural habitat of Community interest: code 3170 Mediterranean temporary ponds (Directive 92/43/CEE).

8.3. BOGS

The bog communities in the territory are small swards of pioneering annuals, characteristic of arroyos, depressions, and temporarily waterlogged places which dry up and reappear each year. It is a type of holarctic vegetation that is well represented in the Mediterranean world, and constitutes a priority natural habitat of Community interest[15], with different variants according to the season.

The winter bogs (**Isoetion**) have a pre-spring phenology. They are formed by low-growing therophytes of little coverage, which colonize quickly-drying pools in roadways and cattle tracks on shale and granite formations. Plants which are very characteristic here are *Crassula vaillantii*, some dwarf rushes (*Juncus pygmaeus, Juncus bufonius, Juncus tenageia, Juncus capitatus, Juncus hybridus*) and various species of purple-loosestrifes (*Lythrum thymifolia, Lythrum hyssopifolia, Lythrum borysthenicum, Lythrum portula*).

Also typical in this season, in arroyos and depressions where water accumulates, both on shales and granites, are swards of Mediterranean quillworts (*Isoetes histrix, Isoetes setaceum, Isoetes velatum* subsp. *velatum*) or adder's-tongues (*Ophioglossum lusitanicum*), although the latter may also flourish in heavily grazed pastures (sheepfolds). In both cases, these are biologically very interesting pteridophytes which lack the conventional morphology of ferns.

The spring bogs (**Cicendion**) are found in those enclaves within the dehesas where water has remained throughout autumn and winter, in zones where the topology favours the formation of large pools, or the edges of natural ponds. In such situations, there may appear a vegetation rich in small hygrophilous plants (*Cicendia filiformis, Centaurium pulchellum, Centaurium maritimum, Centaurium erythraea, Elatine macropoda*), and where species of Mediterranean distribution are frequent (*Illecebrum verticillatum, Exaculum pusillum, Radiola linoides*).

These small and ephemeral communities are occasionally dominated by grasses that are endemic to the western Mediterranean (*Agrostis pourretii*), or to the Iberian Peninsula such as *Antinoria agrostidea* subsp. *annua* which lives in the wettest parts, or *Chaetopogon fasciculatus* which appears in the driest parts of the bog. The first of these is the most frequent, and constitutes a group of ephemeral pastures known as annual vallicares (**Agrostion salmanticae**), which often appear on siliceous soils with a sandy or sandy-loam texture, and are a very typical Mediterranean vegetation type. At times they are even found in the furrows of fallow fields when the soil is of a type which easily retains water. Among the outstanding floristic elements are some Mediterranean clovers and flax (*Trifolium cernuum, Trifolium micranthum, Linum bienne*), two Iberian-North African endemics (*Pulicaria paludosa, Carlina racemosa*, this latter of a somewhat more basophile-argilophile character), and two Iberian Peninsula eryngos: *Eryngium galioides*, and *Eryngium corniculatum*. With respect to these vegetation groups, they have a noteworthy abundance on certain granites, particularly those in which erosion has led to weathering, and consequent sealing, of the plagioclases, giving rise to the

15 Priority natural habitat of Community interest: code 3170 Mediterranean temporary ponds (Directive 92/43/CEE).

formation of phreatic layers. This is the cause of a curious phenomenon known by the local shepherds in the area from Campanario to Quintana ("El Censo") in which the ponds are fed by upwelling springs.

Of especial importance for these habitats is the presence of the water-clover *Marsilea batardae*, as it is a protected species[16]. It is a hygrophilous and heliophilous terrestrial pteridophyte, frequent in the zone, colonizing the banks of seasonal streams whose courses run through the shale formations. It is also frequent in temporary ponds which are scattered over La Serena during the rainy season. It also copiously colonizes the bare shale banks of the district's reservoirs. It is a highly polymorphic plant in response to the ecological challenges posed by the aquatic habitat: in the dry stream beds of summer, there are very small, coriaceous, 4-foliate individuals which are abundantly tomentose. During the rainy spring, small-leaved non-pilose forms predominate in the streams, while in the pools and ponds there appear individuals with larger, floating leaves, with long petioles of even more than 20 cm in length. In the reservoirs, one may observe a succession of different forms, occasionally at the ends of the same stem. First, Individuals with filiform leaves appear permanently submerged. As the season advances and the water level drops, these individuals, on being exposed to the air, produce leaves that are 2-foliate and filiform, bifoliate and non-filiform, and finally 4-foliate forming great swathes around the shores. It is difficult to find fertile individuals, so that it is often complicated to determine which species of water-clover is colonizing a given site.

The summer bogs (**Menthion cervinae**) are the vegetation of large therophytes of ponds persisting until summer and dry river beds. In these environments, at times in the Zújar, one may find scattered communities of *Sisymbrella aspera* subsp. *aspera* or *Mentha cervina* belonging to this vegetation type. Much more frequent, and often occurring later, are the bogs dominated by autumn plants (**Nanocyperetalia**), which appear in the drying tails of reservoirs and marshes. In these environments, there are very often species whose origin is tropical Africa (*Cyperus michelianus, Glinus lotoides, Heliotropium supinum, Crypsis schoenoides, Polypogon monspeliensis*), or America (*Eclipta prostrata*), which do not belong to our native flora but have adapted to living and reproducing in these habitats. There are also many species of widespread distribution, Euroasiatic, cosmopolitan, or subcosmopolitan (*Gnaphalium luteo-album, Cyperus fuscus, Cyperus flavescens, Cyperus eragrostis, Filaginella uliginosa, Scirpus setaceus, Chenopodium botrys, Ludwigia palustris*). Distinguishing species of the territory are *Crypsis alopecuroides* and *Verbena supina*, two Mediterranean plants typical of siliceous substrates.

16 Priority species of Community interest, for which it is necessary to designate special conservation areas (D.O.C.E. No. L 206 of 22.VII.92; Directive 92/43/CEE). Included in the category "of special interest" according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species in Extremadura. Species "in critical state" according to the Red List of Spanish Vascular Flora (2000).

9. THE VEGETATION OF WALLS, ROCKS, AND STONY GROUND

An important component of the territory's landscape are the rocky habitats. Their richness and variety are due not only to the lithological diversity, but also to the tectonic differences which condition the various forms of relief. In the study area one can find outcrops of granites, shales, quartzites, and conglomerates. The general term "rupicolous" is used for any plant associated with these environments.

The distribution of rupicolous plants is not random, but conditioned by diverse variables. The mineralogy of the substrate, its capacity to store water, the amount of light, and the exposure to winds of the site are fundamental in determining whether one or another species forms part of the plant community, although all have to face a common problem - thermal oscillation by reverberations.

A great deal of specialization is needed to support a rupicolous habitat. For this reason the species in this environment do not leave easily, and competitors are rare. Nonetheless, rocky outcrops are a fairly frequent type of ecological environment. Sometimes they are places that have lost soil by erosion, but generally they have never had a normal layer of soil. The high zones of the sierras, screes, escarpments... are places which at first sight give the impression of having no vegetation. Closer observation will, however, quickly allow one to differentiate plant communities consisting of diverse species.

Only lichens can survive directly on the rock. These are the pioneering colonizers on the surface. The disintegration of the surface layers of the rock caused by their fixation systems, the organic matter left by their bodies as they die, the masses of hairs which become attached to their structure, etc., form a substrate on which other simple vegetation, such as mosses, ferns, or small vascular plants can establish themselves. A consequence of the repetition of this process over geological time scales has been the elementary process of soil formation in places where an accumulation of horizons has been possible.

The harsh environmental conditions in these media have led the plants to evolve remarkable adaptations. Substrate suitable for establishment (soil) can build up relatively easily within crevices in the rock, especially if they are deep, if not destroyed first by wind and rain. The plant's radicular apparatus, including the stems (often long and twisted), is solidly anchored so that one may find casmophytic plants of great height in spite of the steepness of the substrate. Moreover, rock crevices are the last bastion from which moisture evaporates, so that plants capable of living there are the last to dessicate. Plants which sink their roots deep into the crevices in the rocks are called casmophytes. Those which do not colonize bare rock, but need there to be at least some earth in the cracks, are denominated comophytic (casmocomophytic).

On bare rock pavements, bearing no more than a few millimetres of litterfall or incipient soil, the situation is very different. The purely surface fixation is difficult and insecure. Hence, no large plants can grow. Instead the plants are discreet in size, with a modest root system, and often a tendency to a certain degree of succulence since water is scarce. Here there abound mosses, ferns, and herbs which we generally call exocomophytes.

On screes and stony slopes, the principle problem is the mobility of the substrate. A certain proportion of moisture usually collects in the lowest part of the stony ground. Certain aspects reproduce the conditions in rock crevices. They have to possess a ductile radical system (as do the casmophytes), and the aerial part has to be discreet and accommodating so as not to dislodge and succumb to the fall of the loose stones above them. The plants living in this medium are termed saxicolous, and in the study territory studied are found in the mountains of Tiros, Siruela and Castuera.

9.1. QUARTZITE OUTCROPS

On the north-facing aspects (the ubacs) of the outstanding quartzite crests of the territory's mountain ranges, such as in the sierras of La Chimenea and Puerto Peña (Talarrubias), La Buitrera and El Puerto Mejoral (Benquerencia), or Las Vacas, La Rinconada, and El Calvario (Cabeza del Buey), the narrowest rock crevices harbour a community of casmophytes which are mainly silicicolous and typically Mediterranean (**Cheilanthion hispanicae**)[17]. Such is the case of *Asplenium billotii, Asplenium trichomanes* subsp. *quadrivalens*, *Cheilanthes hispanica*, or *Cheilanthes tinaei*. Other elements also present (e.g. *Cheilanthes maderensis*) have a broader ecology and distribution. Some of these mountain zones have small areas of scree and stony slopes which bear saxicolous plants such as *Silene inaperta* (which also lives among the rounded cobbles of river beds) or *Lactuca viminea*. Nevertheless, this type of plant is very infrequent in the area. Without doubt, the most curious of them is *Linaria nivea*, a species of Carpetanian distribution and higher altitudes which appears here in Puerto Peña, Peloche, and the sierra of La Chimenea, in zones where water has accumulated.

In the wider, earthier crevices, there enter to form part of the community perennial heliophilous hemicryptophytes belonging to different botanical families, and with a distribution restricted to the Peninsula or the Mediterranean (**Rumici-Dianthion lusitani**). At the beginning of spring, the most common are *Phagnalon saxatile* and *Rumex induratus*. As the season advances, the dominant flowering elements are *Dianthus lusitanus* and *Digitalis thapsi*. The latter is sometimes parasited by *Orobanche amethystea*.

The greatest interest in these communities lies in the sporadic presence of taxa which are significant for their chorological or taxonomic importance. In this sense, one can mention some plants restricted to certain central or south-western regions of the Peninsula such as *Erysimum lagascae* or *Avenula sulcata* subsp. *occidentalis*, the endemic foxgloves, *Digitalis mariana* subsp. *mariana* and *Digitalis purpurea* subsp. *toletana*[18], and various Campanulaceae (e.g., *Jasione crispa* subsp. *mariana*, *Jasione crispa* subsp. *tomentosa*). A plant which the French botanist Coincy first described for science at the end of the XIX century also belongs to this group. It is a French figwort gathered by

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17 Natural habitat of Community interest: code 8220 Vegetated silicicolous inland cliffs with casmophytic vegetation (Directive 92/43/CEE).

18 Both included in the category "of special interest" according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species of Extremadura.

this botanist in the rock crevices of the Almorchón mountain range - *Scrophularia oxyrhyncha* - now a protected species[19]. Another extremely interesting plant of these regions and also protected legally is *Erodium mouretii*[20]. This is an Ibero-Moroccan endemic that is very rare in the Peninsula, occasionally present on the quartzite pavements of Quintana de La Serena.

9.2. GRANITE OUTCROPS

The granite outcrops give way to rupicolous habitats with their own peculiarities. The facility with which the minerals comprising these rocks disintegrate produces a more varied content in ions than in the case of the quartzites, although the resulting pH is also acidic.

In the narrowest rock crevices, we find a community that is similar to that we described for the homologous quartzite environment (Sec. 9.1): casmocomophytes belonging to different fern species, constituting a natural habitat of Community interest[21]. When the crevice is wider, it is frequent to find communities with *Digitalis thapsi*, as was also the quartzite case, and where other frequent elements are *Dianthus lusitanus* or *Antirrhinum graniticum* subsp. *graniticum*, rugged plants such as *Sedum hirsutum* subsp. *hirsutum*, or grasses adapted to this medium such as *Arrhenatherum elatius* subsp. *sardoum*. On occasions there appears *Digitalis mariana* subsp. *heywoodii*[22], an Iberian endemic.

In broad shady recesses - a habitat which is only found in this type of rock, never in quartzite crags or shale or slate formations - one can find at the beginning of spring a scionitrophilous community, highly characteristic of the Luso-Extremadurense province, dominated by small annual plants (*Anogramma leptophylla, Parietaria lusitanica* subsp. *lusitanica*, *Parietaria mauritanica*) that are very faithful to these media. In the larger recesses, or when there is a wider crevice in the rock, but always in the shade, it may be find *Scrophularia sublyrata*, a species protected by legislation[23].

On the large slabs of granite, it is frequent to find the pioneering swards described in Sec. 7.1.1, dominated by exocomophytes, fundamentally Crassulaceae.

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19 Included in the category "vulnerable" according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species of Extremadura, and with this same category in the Red List of Spanish Vascular Flora (2000).

20 Included in the category "vulnerable" according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species of Extremadura, and with this same category in the Red List of Spanish Vascular Flora (2000).

21 Natural habitat of Community interest: code 8220 Vegetated silicicolous inland cliffs with casmophytic vegetation (Directive 92/43/CEE).

22 Included in the category "of special interest" according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species of Extremadura, and "vulnerable" according to the Red List of Spanish Vascular Flora (2000).

23 Included in the category "of special interest" according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species of Extremadura, under the name of Scrophularia schousboei.

9.3. SHALE AND SLATE OUTCROPS

Shale or slate outcrops constitute a type of rupicolous medium which is differentiated from the two previous types by their greater availability of nutrients in the substrate due to the facility with which this type of geological material disintegrates. They also constitute an ecological environment that is included in the Habitat Directive[24].

In general terms, the casmophytic communities which can be found here are not very different from those described in the two previous sections. However, there are some peculiarities to be pointed out. The most significant is the presence of *Bufonia macropetala* subsp. *willkommiana*, a plant endemic to the Luso-Extremadurense province. Also belonging to this group is the rock pink *Dianthus crassipes*, a Caryophyllacea whose morphological variability in La Serena has peculiar characteristics which led Coincy in 1897 to give a new description of the "carnation of La Serena", *Dianthus serenaeus*. In La Serena, except in Cabeza del Buey and Campanario (Piedraescrita), it is quite scarce. It is found in greater profusion in the neighbouring district of Las Villuercas.

Another frequent species in shale outcrops is the mousetail-plant *Arisarum simorrhinum*, although it also can be found on granite or quartzite substrates.

9.4. THE VEGETATION OF WALLS AND EARTHY SCREE SLOPES

Communities with a somewhat nitrophilous character, dominated by plants of wide distribution - cosmopolites or subcosmopolites.

On walls in the villages and towns, in places where animals shelter, and on the ruins of walls and historic buildings such as watch-towers and castles, or unwhitewashed churches, we can find plants which are quite faithful to this medium, although they are not very abundant. Significant examples are *Umbilicus rupestris, Cymbalaria muralis, Asplenium ceterach, Sedum album*, with a more markedly rupicolous character, and *Sonchus tenerrimus* or *Hyoscyamus albus* which have greater requirements of nitrogen-containing soil, and therefore grow at the bases of walls.

On earthy, hygrophilous, and shaded scree slopes, and in cool protected places in the wettest mountain ranges of the territory such as La Chimenea and Puerto Peña, it is not unusual to find communities dominated by small, often rhizomatose ferns, and perennial vascular plants such as *Selaginella denticulata* and *Saxifraga granulata* subsp. *granulata*, species of Mediterranean distribution, and *Polypodium cambricum* subsp. *serrulatum* and *Polypodium interjectum* whose area of distribution is broader.

24 Natural habitat of Community interest: code 8220 Vegetated silicicolous inland cliffs with casmophytic vegetation (Directive 92/43/CEE).

10. SCRUB AND WOODLAND

In this section we shall consider generically those vegetation units where trees and shrubs are determining elements in the physiognomy of the landscape. From a dynamic (=successional) point of view these are more evolved communities, closer to the climax vegetation, i.e., the greatest level of organization compatible with the environmental conditions of the biotope.

This time-dependent perspective is indispensable in interpreting plant communities. Any observations made about a vegetation type must carry an implicit reference to the type of landscape that would be found at the end of the successional process, because this represents the natural trend observed in the changing ecosystem with the passage of time. And it is related to what would have been the primitive vegetation, i.e., that which existed before there was any kind of human intervention.

Another no less important consideration has to do with the ecological conditions - fundamentally the climate. In the case of the territory of this study, the dominant shrub and tree vegetation is that typical of a Mediterranean climate. This consists of Mediterranean durisilva woodland and its substitution stages (labdanum brush, Spanish broom fields, stands of wild olive...), all of which are sclerophyllous and evergreen. On the contrary, the deciduous forest and pre-forest vegetation (riparian woods, bramble thickets, *Flueggea* scrub,...) are associated with riverine environments, where the soils maintain a certain phreatic moisture in summer, thereby mitigating the harshness of what is most typical of Mediterranean systems - the summer drought. The case is somewhat similar in the highest peaks of some of the mountain ranges, where with altitude there is greater rainfall, and the climate slightly loses some of the genuine Mediterranean character.

10.1. EVERGREEN SCRUB AND WOODLAND: WOODY SCLEROPHYLLOUS VEGETATION

10.1.1. Labdanum brush (jarales)

This shrubby, xeric vegetation (**Ulici-Cistion ladaniferi**) grows at the foot of the mountains, on clay soils containing many angular quartzite stones. It constitutes the substitution stage of silicicolous Mediterranean forests.

It is dominated by the gum rock-rose or labdanum (*Cistus ladanifer* subsp. *ladanifer*), but includes other Mediterranean or Iberian plants such as *Cistus crispus, Cistus salviifolius, Genista hirsuta* subsp. *hirsuta*, *Lavandula stoechas* subsp. *luisieri*, *Lavandula stoechas* subsp. *sampaiana*, *Rosmarinus officinalis, Thymus mastichina* subsp. *mastichina*, *Helichrysum stoechas, Thapsia villosa*, and Ibero-North African species (e.g., *Halimium umbellatum* subsp. *viscosum*, *Erophaca baetica* subsp. *baetica*). Occasionally, between Castuera and Benquerencia, there appear in these habitats localized populations of *Genista hystrix*, a Peninsular endemic.

Geophytes may grow in the clearings: spring blossoming (*Narcissus triandrus* subsp. *pallidulus*, *Narcissus serotinus, Asphodelus ramosus*), summer blossoming (*Urginea maritima*), autumn blossoming (*Leucojum autumnale*), and sometimes parasitic (*Cytinus hypocistis*).

On the south-facing aspects (the adrets) of certain particularly warm mountain ranges (Sierra del Oro, Monterrubio de la Serena), or in places with carbonate outcrops such as Puerto Peña (Talarrubias) and Cabeza del Buey, the jarales become enriched in characteristic thermophilous plants - white rock-rose (*Cistus albidus*) and Montpellier rock-rose (*Cistus monspeliensis*) - which often are found side-by-side with Mediterranean and Iberian basophiles (*Ajuga iva, Thymus zygis* subsp. *sylvestris*, *Helianthemum apenninum* subsp. *stoechadifolium*, *Phlomis herba-venti, Plantago albicans, Sideritis hirsuta, Teucrium capitatum, Crucianella angustifolia*).

However the most common vegetation type on steep mountain adrets that have not been planted with olive trees, and that are in a good state of conservation, consists of wild olive, kermes oak, and mastic shrub thickets (**Asparago-Rhamnion**)[25]. It is dominated by elements of Mediterranean chorology: *Quercus coccifera, Pistacia lentiscus, Olea europaea* var. *sylvestris*, *Asparagus albus, Rhamnus oleoides, Myrtus communis, Osyris alba, Phlomis purpurea*.

On the contrary, in the cool ubacs of the peripheral ranges, the labdanum (*Cistus ladanifer* subsp. *ladanifer*) appears intermixed with elements that are more characteristic of a mild oceanic climate and very acid, gleyed soils, as is the case of various heaths (*Erica australis, Erica scoparia* subsp. *scoparia*, *Calluna vulgaris*), rock-roses (*Cistus populifolius* subsp. *populifolius*, *Halimium ocymoides, Xolantha tuberaria*), or legumes (*Pterospartum tridentatum, Genista triacanthos*) (**Ericion umbellatae**)[26]. Most of these plants are of Ibero-North African distribution, and some of them cluster together forming small "nano-jaral" heaths inhabiting leached soils that are highly acid on the surface. These communities harbour species of great interest, such as *Thymelaea villosa*. In the streams of the Puerto Peña mountain range, this scrub includes *Erica lusitanica*.

10.1.2. Fields of Spanish broom (retamares)

These are communities of shrubs dominated by species of broom - legumes with long, slender, flexible, and photosynthetic branches. They constitute a type of scrub characteristic of the warm western Mediterranean (**Cytisetalia striati**)[27], and dynamically they represent substitution stages of the durisilva on both clay and granitic soils.

25 Natural habitat of Community interest: code 5333 Thermophilous brush - subtype of thermo-Mediterranean brush, broom fields, and scrub (Directive 92/43/CEE).

26 If they become enriched in Genista, they may be included in the natural habitat of Community interest: code 4090 Endemic oro-Mediterranean heaths with gorse (Directive 92/43/CEE).

27 Natural habitat of Community interest: code 5335 Thermo-Mediterranean broom fields (retamares) - subtype of thermo-Mediterranean brush, broom fields, and scrub (Directive 92/43/CEE).

In La Serena, they form great masses of vegetation, replacing the jarales on the mountainsides when the soils are not stony, and are particularly dominant in all the peneplains of the Cambrian shale formations, with Spanish broom, *Retama sphaerocarpa* - an Ibero-North African plant - being clearly the element configuring the landscape in these environments. Spanish broom possesses various reproductive strategies, and, since it grows faster than trees, it is patently beneficial in the short term in protecting and retaining the soil. Its presence induces the almost immediate establishment of other plant species around it, among other reasons because these legumes have nodules on their roots containing nitrogen-fixing bacteria which enrich the soil. Indeed, there is a popular local saying that "under every retama a lamb is reared".

It also appears on granites. In these cases, there is a major presence of Mediterranean broom such as *Cytisus scoparius*. During the spring, certain elements of interest can be observed in these environments, such as *Orobanche rapum-genistae* which parasites the roots of these shrubs, and occasionally *Narcissus cantabricus*, with its characteristic white flowers. This narcissus can also be found on quartzite ledges.

The retamares existing between Zalamea and Quintana now harbour occasional populations of *Genista polyanthos*, a SW Iberian endemic typical of stony alluvium, and which today can be observed growing on the sides of roads due to the use of river gravel in their construction. Although it must before have been frequent in the lower Zújar and in the Guadiana, the over-exploitation and destruction of its habitat by uncontrolled gravel extraction is steadily eliminating the populations of the species.

10.1.3. Mountain brushwood and juniper formations

On the crests of the sierras, on quartzites, there is frequently dense, well conserved brushwood in which one of the most significant elements is an Ibero-North African gymnosperm - the juniper, *Juniperus oxycedrus* subsp. *badia*. Its presence is witness to the characteristics of the vegetation of other geological times[28], and it is a protected species[29]. Here there also appear numerous examples of chaparro oak (*Quercus ilex* subsp. *ballota*). These thickets of juniper and squat holm oak, subrupicolous or casmophytic in character, in some way bring to mind the holm oak and juniper forests which constitute the natural optimal vegetation of many continental zones of the Castilian Meseta. In the vulture colony crags of Puerto Peña, and the mountains of Peñal-

28 In the late glacial period (14 000 to 11 000 years B.P.), the Mediterranean landscape of the Peninsula was dominated by steppe with trees, principally Pinus, with some gall oak and birch, and xerophilous grasslands of Artemisia, Poaceae, and Chenopodiaceae. During this period the genus Pinus began to recede due to the drying of the climate, and Juniperus became more extended.

29 Included in the category "vulnerable" according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species of Extremadura. Included in natural habitats of Community interest: code 5210 Mediterranean arborescent matorral: Juniper formations; and code 5211 Juniperus oxycedrus arborescent matorral (Directive 92/43/CEE).

30 Included in the category "of special interest" according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species of Extremadura. The scrub may be included in the natural habitat of Community interest: code 4090 Endemic oro-Mediterranean heaths with gorse (Directive 92/43/CEE).

sordo and Cabeza del Buey, the two taxa co-exist with another protected species - *Genista cinerascens*[30]. This is a Carpetanian plant coming from the Central System. Similar ecological preferences in the Sierra de Siruela are shown by *Genista florida*, a western Mediterranean species infrequent in this territory. With the same ecology and area of distribution as the foregoing, but rather more abundant, are *Adenocarpus complicatus* and *Adenocarpus telonensis*, and the hairy-fruited broom (*Cytisus striatus* subsp. *eriocarpus*). The presence of *Teline linifolia*, rare and of isolated occurrence in the Garbayuela mountains, is worthy of particular mention.

10.1.4. Sclerophyllous woodland: holm and cork oak communities (encinares and alcornocales)

The woodland consisting of sclerophyllous evergreen holm oak (encinares) and cork oak (alcornocales), typical of the Mediterranean climate (**Quercion broteroi**), have been the object of exploitation by man since prehistory. The causes and consequences of man's management have been described in a previous chapter of this book. Today, these woods are quite thinned out. Most have a dehesa parkland structure, with a considerable proportion of shrubby plants. They are only conserved intact in rugged places with a steep topography and of difficult access.

In general terms, the encinares in this zone occupy lower altitudes than the alcornocales, as the latter are more demanding in their water requirements. The alcornocales therefore appear in the territory's mountains: the Sierra del Oro, S. de Castuera, S. de Tiros, S. de La Rinconada, S. de La Osa, S. de La Motilla, and S. de Los Villares. The dominant tree of these communities is the cork oak (*Quercus suber*), although there are sometimes gall oak (*Quercus faginea* subsp. *broteroi*) and occasionally Montpellier maple (*Acer monspessulanum*)[31]. In some places mostly on granites (Dehesas de Quintana) cork-oaks can be found.

This natural vegetation, which has an important environmental interest[32], occupies favoured enclaves in the high altitude ubacs of the territory. There frequently also exist there dense pre-climax arborescent communities (**Ericion arboreae**) known as maquis, a name which was also given to the members of the guerrilla resistance to the Fascist regimes in Spain during the post-war period following the Spanish civil war and in France in World War II who took refuge in these environments. The maquis are extensive, dense scrublands, abounding in plants with fruit adapted to dissemination by birds (berries and drupes) whose colours (black, purple, reddish) lie within the visual spectrum of birds, especially of the Turdidae. They comprise old strawberry trees (*Arbutus unedo*), laurustinus (*Viburnum tinus*), mock privet (*Phillyrea angustifolia, Phillyrea latifolia*), cornicabras (*Pistacia terebinthus*), and tree heath (*Erica arborea*). In more

31 Included in the category "vulnerable" according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species of Extremadura.

32 Natural habitats of Community interest: code 9330 *Quercus suber* forests; code 9240 *Quercus faginea* woods (Directive 92/43/CEE).

open spots, one can usually find butcherbroom (*Ruscus aculeatus*)[33] or honeysuckle (*Lonicera etrusca*), and a non-spiny fringe (**Origanietalia**) where labiates typical of the western Mediterranean abound, as in the case of *Clinopodium vulgare* subsp. *arundanum*, *Teucrium fruticans, Origanum virens*, or *Satureja ascendens*. Other plants typical of these media but not always abundant are *Paeonia broteri, Sanguisorba hybrida, Silene mellifera, Pimpinella villosa, Carex divulsa, Carex distachya, Conopodium majus subsp. ramosum, Conopodium capillifolium, Vicia tenuifolia, Vicia disperma, Lathyrus latifolius, Leucanthemum ircutianum* subsp. *pseudosylvaticum*, *Silene latifolia*, or *Campanula rapunculus*. When the alcornocal is situated on soils which are especially cool and moist, plants of a more hygrophilous character enter to form part of the community. These are generally herbs, such as *Asphodelus albus* subsp. *albus*, *Lapsana communis, Smyrnium perfoliatum, Smyrnium olusatrum*, or *Magydaris panacifolia*. Occasionally, as is the case along the streams of Puerto Peña, one can find a prospering heathland communities. And in the deeper soils there also prosper such geophytes as *Biarum arundanum, Limodorum abortivum, Neotinea maculata, Orchis langei*[34], *Orchis champagneuxii, Epipactis helleborine, Ornithogalum pyrenaicum*, or *Allium massaessylum*.

Within the cork oak scrub, it is not difficult to find scree ubacs that harbour a characteristic nitrophilous vegetation type (**Geranio-Anthriscion**) which is also typical of the borders of woods and shrublands. It consists of plants of wide distribution, fundamentally subcosmopolitan or palæotemperate. Outstanding in this sense are *Geranium robertianum* subsp. *purpureum*, *Geranium rotundifolium, Rhagadiolus edulis, Rhagadiolus stellatus, Geranium dissectum, Anthriscus caucalis, Cardamine hirsuta, Centranthus calcitrapae* subsp. *calcitrapae*, *Draba muralis, Fumaria capreolata, Geranium lucidum, Lamium bifidum, Myosotis ramosissima* subsp. *ramosissima*, *Torilis nodosa*, and, in the warmer south-western zones of La Serena and the Esteras river valley, *Urtica membranacea*.

The natural succession of the cork oak is heath and jaral-heath scrubland whose floral composition and characteristics were described in previous sections.

The encinares, on the contrary, are almost always found transformed into dehesas, a sustainable type of management of remarkable environmental value[35]. The dominant tree is the holm oak (*Quercus ilex* subsp. *ballota*) which can be seen accompanied by the pear *Pyrus bourgaeana*, an Ibero-North African species whose Peninsular distribution is restricted to the south-western quadrant, and is not very common. More common here are the spurge flax (*Daphne gnidium*), asparagus (*Asparagus acutifolius*), jasmine (*Jasminum fruticans*), and wood sage (*Teucrium scorodonia* subsp. *baeticum*).

33 Species of Community interest whose collection in nature and exploitation may be the object of management measures (D.O.C.E. No. L 206 of 22.VII.92; Directive 92/43/CEE). Included in R.D. 1997/1995. Included in the category "of special interest" according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Threatened Species of Extremadura.

34 Included in the category "of special interest" according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species of Extremadura.

35 Natural habitats of Community interest: code 9340 *Quercus ilex* forests; and code 6310 Sclerophyllous grazed forests (dehesas) with *Quercus suber* and/or *Quercus ilex* (Directive 92/43/CEE).

On untilled and better conserved areas, some plants are indicators of the fringes of the encinares (**Origanietalia**). This is the case with the geophytes (*Hyacinthoides hispanica* and *Fritillaria lusitanica* - Peninsula endemics - or *Tulipa sylvestris* subsp. *australis*, *Anemone palmata*, and *Iris xiphium* - Mediterranean plants). Another Mediterranean geophyte found in these habitats which also often lives sheltered in the chinks of shale outcrops is the mousetail-plant, *Arisarum simorrhinum*. In the shrubby fringes of the natural encinar one finds honeysuckle (*Lonicera implexa*) together with climbing plants such as *Rubia peregrina* or *Smilax aspera* var. *altissima*, and hemicryptophytes such as the larkspurs (*Delphinium gracile, Delphinium pentagynum*) or the Tournefort mallow (*Malva tournefortiana*) - an endemic, very typical of these environments.

The natural succession of the encinar is jaral and then retamar, an *Cytisus communities*, types of scrubland which have been described in previous sections.

10.2. DECIDUOUS SCRUB AND WOODLAND: THE WOODY VEGETATION OF RIVERS AND STREAMS

In the vicinity of watercourses of sufficient importance, the soil moisture compensates for the aridity of the climate to such a degree that the summer drought, which characterizes Mediterranean environments, is mitigated to the point at which the natural vegetation corresponds not to a durisilva of sclerophyllous xerophytes, but to a different vegetation type, belonging in this case to the aestisilvas. This is the deciduous vegetation characteristic of the Atlantic climes prevailing in the temperate zones of Europe, and part of Asia and North America. Within the Mediterranean world, this physiognomic-ecological formation can only appear in favoured habitats, such as riverine environments or mountains high enough for there to be an increase in rainfall sufficient to assuage the rigours of the Mediterranean summer.

10.2.1. Bramble thickets

Thorny deciduous scrub which grows on soils rich in humus and nutrients, in deep arroyos, and the banks of watercourses, especially on clayey substrates (**Pruno-Rubion ulmifolii**). They constitute the substitution stage of the territory's elm stands and riparian forest, which are today very scarce. They fundamentally consist of blackberry (*Rubus ulmifolius*) and wild roses (*Rosa canina, Rosa pouzinii, Crataegus monogyna*), accompanied by climbing plants such as the black bryony (*Tamus communis*) and the wild grape-vine (*Vitis vinifera* subsp. *sylvestris*), and poisonous plants such as the bitter nightshade (*Solanum dulcamara*) or the white bryony (*Bryonia dioica*). In these shady and hygrophilous environments, it is not unusual to find bracken *Pteridium aquilinum*, a species of extensive worldwide distribution, as also are a good many of the plants previously mentioned.

10.2.2. Securinega scrub (tamujares)

Scrub typical of the watercourses of streams and rivers with a strong summer decline in flow in the south-western quadrant of the Iberian Peninsula, dominated by a species endemic to that area - the "tamujo", *Flueggea tinctoria* - and included in the Habitat Directive (**Securinegion**)[36]. It is an optimal vegetation type for these ecological environments. In winter, it has a characteristic purple tone from the branches and stems of this plant which only bears leaves in spring and summer. In times past, household brooms, street-sweeper's brushes, and pens for livestock were made from this plant.

In this environment, the tamujares include both oleander (*Nerium oleander*) and tamarisk (*Tamarix africana*). These are Mediterranean species with a strongly thermophilous character, which grow profusely along the waterways of the warmest parts of the Iberian Peninsula - Andalucía and Levante - reaching westwards to the Guadiana basin. In Extremadura, as one proceeds northwards, the tamujar gradually loses the thermophilous shrubs to finally consist of monospecific populations of *Flueggea tinctoria*[37].

10.2.3. Gallery woods

The riverbanks today are highly altered, so that one can not speak of the existence of a well-structured gallery forest (**Populetalia**)[38], but only of the more or less occasional presence of elements which would be part of the primitive forest. This is the case of stands of ash (*Fraxinus angustifolia* subsp. *angustifolia*), elm (*Ulmus minor*), willow (*Salix atrocinerea, Salix viminalis, Salix salviifolia*), white poplar (*Populus alba*), and even black poplar (*Populus nigra*), although the origin of the latter is surely due to the interference of man. The soils in which they flourish are fluvisols with the phreatic layer near the surface.

Plants strongly linked to these environments are some geophytes and hemicryptophytes of different botanical origins, such as *Viola riviniana, Vinca major, Aristolochia paucinervis, Arum italicum*, and *Ranunculus ficaria* - most with a palæotemperate distribution. Others are neophytes, well adapted to their present life in these cool, shady habitats, as in the case of the bear's-breech (*Acanthus mollis*). Less frequent are the exclusively Mediterranean or Iberian plants, such as *Scrophularia scorodonia* and *Clematis campaniflora*, respectively.

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36 Natural habitat of Community interest: code 92D0 Thermo-Mediterranean riparian galleries (Nerio-Tamariceteae) and south-west Iberian Peninsula riparian galleries (Securinegion tinctoriae) (Directive 92/43/CEE).

37 Included in the category "of special interest" according to Decree 37/2001 of 6th March which regulates the Regional Catalogue of Endangered Species of Extremadura.

38 Natural habitat of Community interest: code 92AO *Salix alba* and *Populus alba* galleries (Directive 92/43/CEE).

Assessing the plant communities' value

11. IMPORTANCE AND GEOBOTANICAL VALUE OF THE VEGETATION UNITS

According to the data contained in the Geographic Information System of the University of Extremadura Conservation Research Group, the area of the territory of the present study is 396 627 hectares, of which 40% (176 680 hectares) accommodate vegetation units protected by the environmental legislation of the European Community Directive 92/43/CEE on the conservation of natural habitats and wild flora and fauna.

This Directive is the legislative instrument by which the member states of the European Union are urged to develop a coherent ecological network comprising Sites of Community Importance (LICs) which make up the NATURA2000 network, together with the Special Protection Areas (SPAs) for Birds designated under the Birds Directive 79/409/CEE. The selection of the PCIs is based on the presence of species and habitats of community interest included in the Directive's annexes. Annex I enumerates the types of habitat - vegetation units defined according to geobotanical criteria with a strong phytosociological component, both of asigmatist (the term given to the Braun-Blanquist or Zurich-Montpellier methodological approach to classification) stamp and of other European schools. The concept of each type of habitat, and its international identification code is defined in the Interpretation Manual of European Habitats (European Commission's Directorate General for the Environment, 1999), on which we have based the equivalences which appear in Secs. 7-10 of the present book.

The most abundant habitats of the Directive in this zone (see page 285) are the dryland pastures described in Sec. 7.1 (Directive code 6220). They are important not only for their extension, but also because they are catalogued as "of priority interest", as are the perennial summer pastures (vallicares) and bogs (Secs. 8.2.4 and 8.3; Directive code 3170). Their value is based on the extraordinary diversity of the species they harbour - most of which are exclusively Mediterranean or Iberian - and because they constitute the natural habitat of other communities of notable biological importance, as is the case of birds of the steppe. Insectivores predominate in the grasslands, followed by granivores and some birds which eat the green parts of plants. There are no frugivores, as plants with fleshy fruit are either scarce or non-existent. Carnivorous predators are also scarce.

Amongst the birds which nest in the pastures are: Montagu's harrier, common kestrel, red-legged partridge, little bustard, great bustard, stone curlew, collared pratincole, black-bellied sandgrouse, pin-tailed sandgrouse, little owl, roller, hoopoe, short-toed lark, calandra lark, crested lark, thekla lark, stonechat, and black-eared wheatear. And as species in passage or accidental: hen harrier, griffon vulture, cinereous vulture, golden eagle, lesser kestrel, common crane, lapwing, gull-billed tern, european bee-eater, skylark, swallow, red-rumped swallow, tawny pipit, meadow pipit, woodchat shrike, whinchat, northern wheatear, black redstart, goldfinch, house sparrow, spanish sparrow, starling, spotless starling, magpie, jackdaw and raven.

Also particularly noteworthy for their presence in the zone are all the habitats related to Mediterranean sclerophyllous forest in its two facets - the mature stages (encinares, Directive code 9330; alcornocales, Directive code 9340) and the far more frequent parkland dehesas (Directive code 6310). Their characteristics were described in Sec. 10.1.4. The reasons for their inclusion in the Directive are also the Mediterranean character of their component plants and the fact that they harbour a great number of endemic or threatened species, principally birds. These are normally insectivores and, to a lesser degree, diurnal and nocturnal raptors preying on mammals and reptiles. Outstanding amongst the principal nesting birds are: the white stork, black-shouldered kite, black kite, common buzzard, booted eagle, short-toed eagle, woodpigeon, turtle-dove, collared-dove, cuckoo, great spotted cuckoo, green woodpecker, tree pipit, woodchat shrike, great grey shrike, sardinian warbler, subalpine warbler, spotted flycatcher, rufous scrub-robin, blackbird, mistle thrush, long-tailed tit, blue tit, great tit, chaffinch, serin, goldfinch, spanish sparrow, jay, azure-winged magpie, spotless starling, magpie. And as species in passage or accidental: the common crane, blackcap, greater whitethroat, pied flycatcher, robin, song thrush, jackdaw and common raven.

Another vegetation unit that is closely associated with those above - with which it often shares physical space is that of the retamares or broom fields (Directive code 5335), which we define in Sec. 10.1.2. Their geobotanical importance and their inclusion in the Directive is again due to the Mediterranean character of their components, and the ecological niche that they constitute not only for animals but also for plants and beneficial bacteria.

All the aforementioned types of vegetation occupy considerable proportions of the zone of study. At the opposite extreme, there is vegetation which is extremely interesting botanically, but has a far more reduced spatial presence, forming scattered localized communities. This is the case of all the vegetation associated with the rocky heights of the peripheral mountain ranges and of the sierras of La Siberia in general.

We would first highlight in this group (see Sec. 10.1.3.) the juniper formations (Directive codes 5210, 5211) and the scrub of the crests of the sierras (Directive code 4090), often with genistas that are interesting for their exclusive area of distribution in the centre of the Iberian Peninsula. In this mountain scrubland, many species of birds (passeriforms) consume fruits that are in season in autumn-winter, coinciding with the passage of trans-Saharian migrants and the arrival of overwintering species.

Also noteworthy here is the silicicolous casmophytic vegetation (Directive code 8220) whose composition and characteristics are set out in Sec. 9. In this case, although there is little floristic variety, the value resides in that most of the plants are either endemics or of very narrow distribution. These are essentially nesting habitats for birds (which have to go to other biotopes to feed).

This environments harbour an interesting avifauna. They are habitats for such species as: the black stork, white stork, golden eagle, common buzzard, Bonelli's eagle, griffon vulture, egyptian vulture, peregrine falcon, common kestrel, stock dove, rock dove, eagle owl, alpine swift, ptyonoprogne rupestris, red-rumped swallow, house-martin, wren, black wheatear, blue rock-thrush, mistle thrush, rock bunting, chough and raven.

Other vegetation types that occupy only small areas in the territory are all those associated with the margins of river, but in this case - unlike in the previous cases - the reason is not natural but anthropic. The riverine vegetation has been much affected by human intervention, and therefore gallery woods of *Salix alba* and *Populus alba* (Directive code 92A0) and ash groves (Directive code 91B0) are infrequent (see Sec. 10.2.3). These fragile ecosystems have a low level of conservation in the zone, and require environmental restoration measures.

On the contrary, the typically Mediterranean Shrubby gallery vegetation has an acceptable state of conservation and representation in the zone, where it appears in the form of tamujares (Sec. 10.2.2, Directive code 92D0). These riparian *Flueggea* scrub formations consist of very few species - often only one. But they are included in the Directive because of the peculiarity of the soils on which they grow and the endemic character of the dominant species, and because they constitute an ecological niche for fauna of great interest.

Also associated with aquatic or marshy media are various vegetation types included in the Directive and present in our territory (see Secs. 8.1.1, 8.1.2, 8.1.3; Directive codes 3150, 3140, 3260), although they require a more in-depth study to determine in detail their location and characteristics in the different pools, ponds, and estates of the zone. In contrast to all the previous plant communities, those of this group comprise plants which are often not exclusively of the Mediterranean area, but have a broad worldwide distribution. Their inclusion in the Directive is due to the peculiarities of the ecological media they inhabit (small streams, ponds, and wetlands that dry up every year), and also because they constitute the first links in the trophic chain of the aquatic environment, and are intimately associated with the existence of a varied and interesting entomofauna. In this sense, the case of the stonewort communities (Directive codes 3140), which are well represented in the Orellana reservoir for example, merits special mention.

A related vegetation type is that of the wet meadows of round-headed club-rush (Directive code 6420, Sec. 8.2.2). These are included in the Habitat Directive due to their Mediterranean character, which gives them some quite singular floristic and ecological characteristics. Included in the vegetation associated with the large wetlands, such as those that have arisen in the areas influenced by the territory's reservoirs, there is a good representation of reed and reedmace beds, and hay meadows which are not included in the Habitat Directive, but which play an important role in maintaining biological diversity.

The waterbirds that abound in these aquatic environments usually feed on insects, aquatic invertebrates, and poikilothermic vertebrates (fish, reptiles, and amphibians). The most interesting species to be found in these habitats are, as nesting species: the little grebe, great crested grebe, little bittern, night-heron, cattle egret, little egret, purple heron, white stork, mallard, red-crested pochard, black kite, common buzzard, moorhen, coot, little ringed plover, black-winged stilt, stone curlew, collared pratincole, little tern, turtle-dove, great spotted cuckoo, scops owl, red-necked nightjars, common kingfisher, European bee-eater, roller, hoopoe, great spotted woodpecker, sand martin, red-rumped swallow, pied wagtail, Cetti's warbler, reed-warbler, great reed-warbler, melodious warbler, sardinian warbler, fan-tailed warbler, stonechat, rufous scrub-robin, common nightingale, great tit, blue tit, corn bunting, serin, goldfinch, spanish sparrow, golden oriole, azure-winged magpie and magpie. And as species in passage or accidental: the cormorant, grey heron, black stork, spoonbill, glossy ibis, greater flamingo, greylag goose, shelduck, teal, gadwall, wigeon, pintail, garganey, shoveler, pochard, tufted duck, osprey, dunlin, ruff, common redshank, spotted redshank, greenshank, green sandpiper, common sandpiper, black-tailed godwit, curlew, common snipe, avocet, black-headed gull, lesser black-backed gull, black tern, gull-billed tern, caspian tern, common tern, black-bellied sandgrouse, pin-tailed sandgrouse, yellow wagtail, grey wagtail, garden warbler, blackcap, chiffchaff, pied flycatcher, spotted flycatcher, bluethroat, bearded tit, long-tailed tit, penduline-tit, reed bunting, siskin and hawfinch.

Finally, we would mention those birds which nest in village and hamlet buildings, but - as do those inhabiting the rock outcrops - feed in a different biotope. Examples are: the white stork, lesser kestrel, common barn owl, scops owl, collared-dove, common swift, roller, hoopoe, swallow, house martin, black-eared wheatear, house sparrow, tree sparrow, spotless starling, and jackdaw.

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