

## Chapter 3

# THE SYSTEMS OF GRASSLAND MANAGEMENT IN SPAIN

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## INTRODUCTION

Spain is a very old country, with diversified landscape and rich history. The present features of its counties and fields are the result of a very long evolution, with interactions of climate, animals and human cultures.

As a normal country of the temperate zone, Spain was largely forested, mainly with evergreen oaks; also the mountains and the western side were covered by deciduous oaks, beech, pine and mixed forests. Only at the top of the mountains and in the endorheic basins were there natural grasslands. The wild animals and natural fires extended the grassland into forests and, later, the farmers and shepherds produced a big expansion of open land.

The Iberian Peninsula is the biggest and the most mountainous region in southwestern Europe and is characterized by a continental climate and strong contrasts from Atlantic to Mediterranean or sub-desertic environments. Cultural influences from the Near East arrived quickly by maritime routes and more slowly through North Africa or Europe. Thus, diversified influences in space and time are at the origin of the present mosaic in grasslands, flocks and human uses.

In this paper we intend to introduce the main grazing systems of Spain now; they are classified and named by Spanish words taken from names of plants (*zulla*), landscapes (*boalar*, *dehesa*, *borreguil*, *majada*), types of herds (*manchega*, *segureña*) or cultural traditions (*minifundus*, *pasiego*, *borda*, *Mesta*). Of course, geographic or ecological descriptions are used in each case.

Basic information is drawn mainly from our own experience; the specialized literature has been cited and listed synthetically, and for the statistical

data we use recom compilations: Climatology (Instituto Nacional de Meteorología, 1983), Agriculture (Ministerio de Agricultura, Pesca y Alimentación, 1980), History (Vicens Vives, 1954; Ubieta, 1970).

Knowledge of historical development and present-day diversification make it possible to predict how to utilize the existing ecological diversity of the country in order to exploit the geographical, phytosociological and cultural possibilities. Spain is mountainous, with many poor soils well adapted to extensive husbandry.

## GENERAL ASPECTS

In a map taken from the work of Hernández Pacheco (1932) (Fig. 3.1), we have outlined the main features of the "Three Spains": the siliceous area on the west, the calcareous lands on the east, and the clay areas making up the main river valleys of Spain (Duero, Ebro, Guadalquivir), with the limestone mountain ranges in the east (the Levante), the Cordillera Iberica and the Cantabrian-Pyrenean Mountains. The evaporites<sup>1</sup> of La Mancha and those of the Duero and Ebro Rivers are also shown in the map.

The dotted areas indicate mountains and mountain chains over 1000 m above sea-level; on the islands only the Sierra de Mallorca rises above 1000 m, while the Sierras of the other islands hardly reach a height of 300 to 400 m.

The complex orography, with an average height of c. 800 m, gives rise to a great variety of

<sup>1</sup>Evaporites: Rocks formed by the evaporation of brackish water.

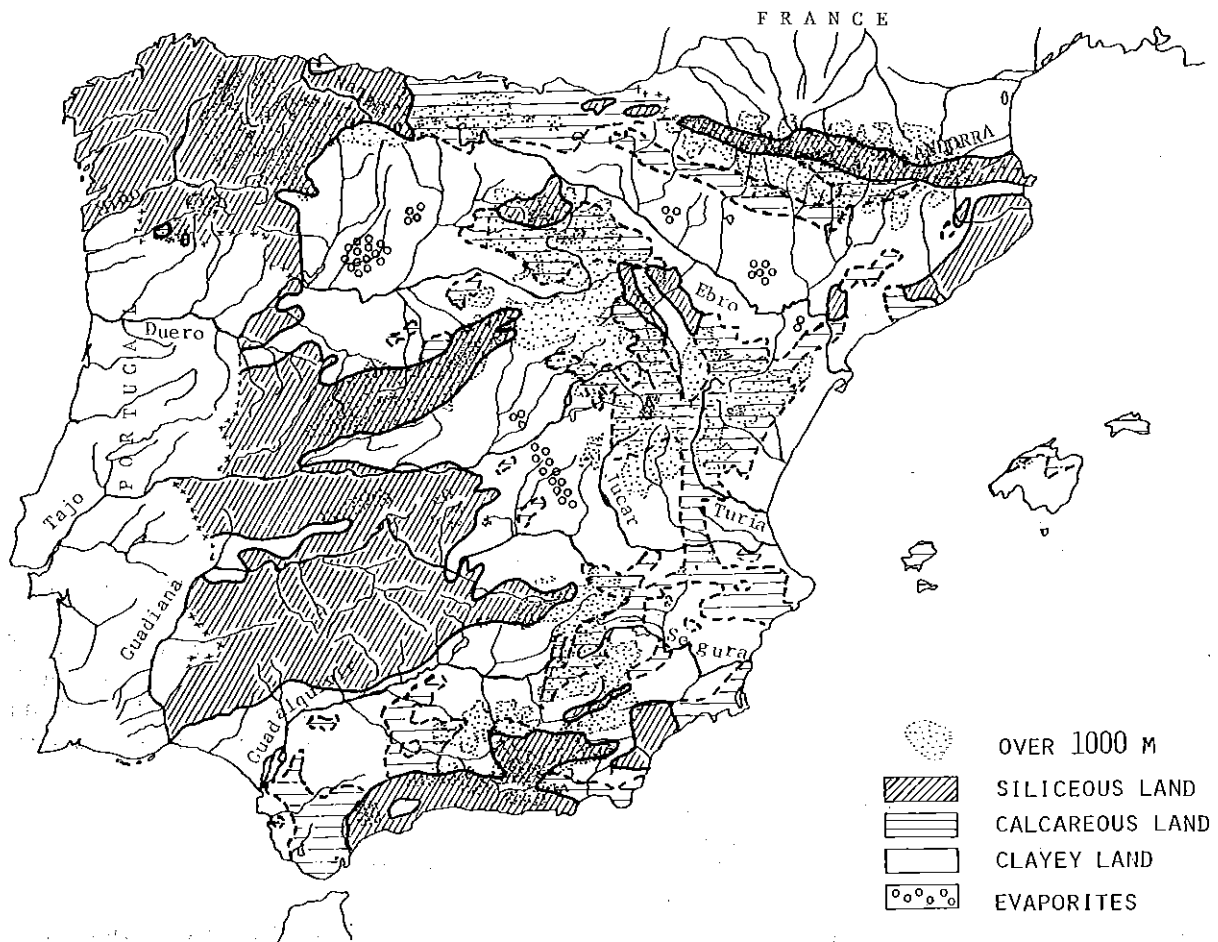


Fig. 3.1: The lithology of Spain and Balearic Isles (based on Hernández Pacheco, 1932).

environments with valleys and eroded slopes, and to lithosoils in which geological features predominate. The rainfall is moderate, while vegetation is sparse, and dense woodland is rare. Soils are inappropriate for sustained agricultural exploitation, and advantage can be taken of rough pastureland only by a specialized and diversified animal husbandry. [See also Aguilar (1961) and Selecciones (1962) with maps on these topics.]

#### General characteristics of bioclimate

A description of the bioclimatic conditions of Spain is based on 30 years' measurements (1931–1960) by the Servicio Meteorológico Nacional. In the pluviometric map (Fig. 3.2A) it is possible to see the main ranges of rainfall climate:

(a) Very humid in Galicia and the Cordillera

Cantábrica with isolated points in central and southern Spain (Sierras de Gredos, Guadarrama and Grazalema, and the Serranía de Ronda).

(b) Humid with dry periods and 800 to 1400 mm of precipitation in mountains of northern and central Spain, with isolated areas in the Sierra de Guadalupe, Montes de Toledo, Sierra Aracena, Sierra Madrona, La Sagra, Sierra Nevada, Sierra Mariola in Alicante and the Sierra de Montseny and Guillerías near Barcelona.

(c) Dry climates in the Duero and Ebro Valleys, La Alcarria and the valleys of the Jálón and Jiloca; the drought is extreme in the southeastern sub-desertic climate of the Almería Region.

Temperatures are related to altitude and latitude. In Fig. 3.2B we have shown the general meteorological features with the distribution of the minimum temperatures of a typical anticyclone

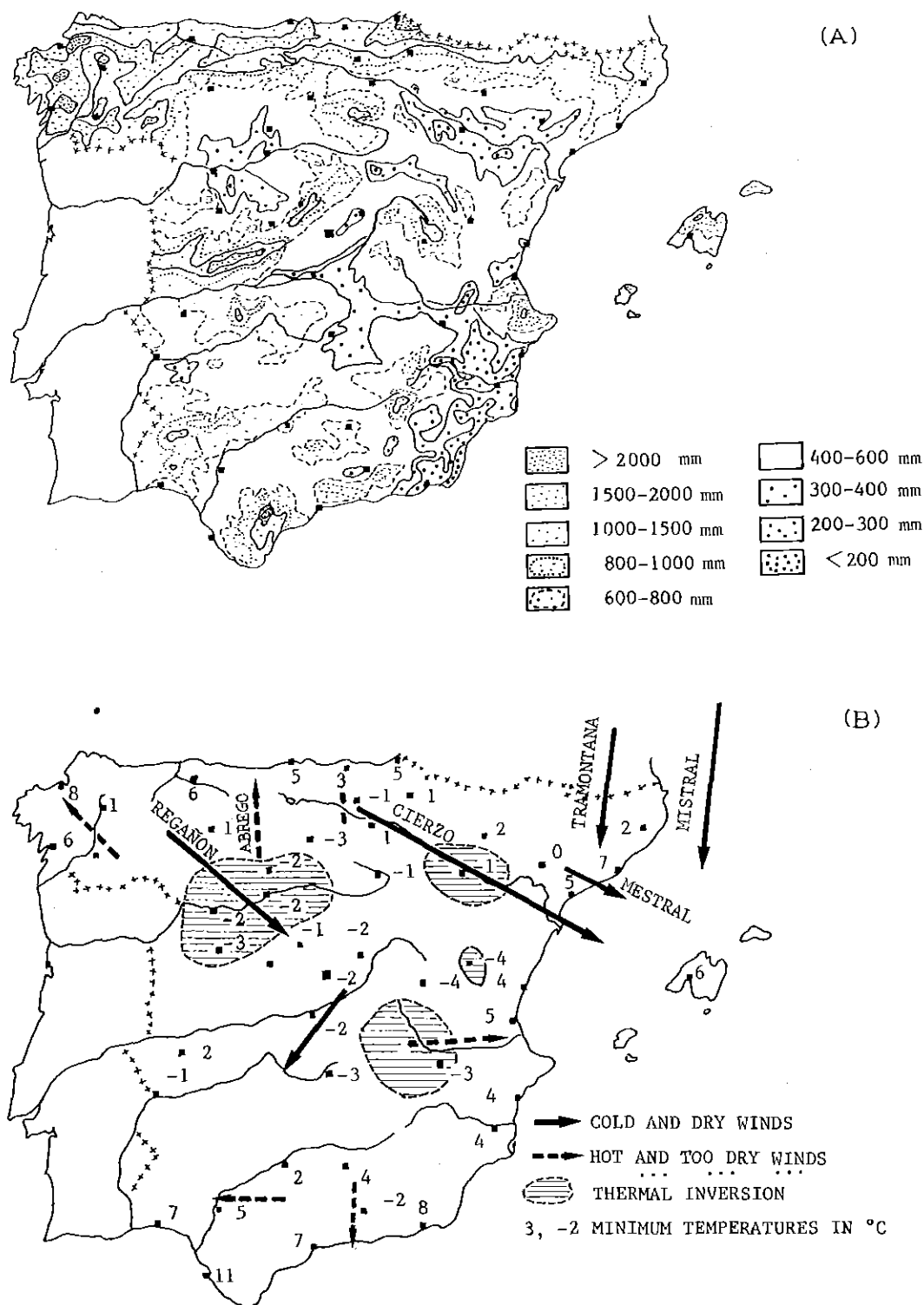


Fig. 3.2. Pluviometry, temperatures and winds in Spain. A. Annual precipitation (Servicio Meteorológico Nacional, 1965).

B. Winds and temperatures. Minimum temperatures on 4 February 1983 (from Servicio Meteorológico Nacional, 1972 and Instituto Nacional de Meteorología, 1983). Small squares are the main towns.

day<sup>1</sup> when the areas of important thermal inversion are localized in the Duero and Ebro Valleys and in La Mancha. In areas close to the ocean (Galicia and Cantabrian coasts), the high atmospheric humidity tempers extreme changes of temperature, so the summers are reasonably cool, favouring the growth of meadow without necessity of irrigation. In the northeast, especially around Gerona, humidity from the Mediterranean Sea acts as a thermal regulator preventing extreme desiccation. In the south and the Balearic Islands, summer droughts are more extreme, due to the excessive loss of moisture caused by long hours of strong sunshine heating the soil. Andalucía is under a joint influence of the Atlantic and the Mediterranean Sea with a maritime climate in the Strait of Gibraltar, cool and wet except at the height of summer.

Wind plays an important part in mountain areas, such as the leeward foehn typical of the great mountain ranges. Moist maritime air is drawn up over the crest and mists are frequent. The descending currents of air are hot and dry. We have endeavoured to show (Fig. 3.2B) those winds that are best known and intense in action such as the aptly-named *Tramontana* (the *Mistral* of Ampurdán) the *Cierzo* and *Mestral* of the Ebro Valley and Tarragona, and the *Abrego*, a hot dry wind which blows down from the Meseta towards the Cantábrico. The *Regañon* blows from Galicia towards the Duero Valley.

Finally, to give an idea of the seasonal fluctuations of rainfall in different parts of Spain we have drawn a map (Fig. 3.3) showing the predominance of rainfall in any given season. The typical winter rains of the Atlantic zone do not penetrate very far inland due to the action of the Iberian anticyclone; located in the centre of the Peninsula in this season. However, these heavy winter and autumn rains do prevail in some valleys, like that of the Guadalquivir and especially the Tajo.

Moving inland from the Atlantic-Cantabrian Region and because of the altitude it can be seen that the maximum amount of rain falls in winter and spring ("winter-spring-autumn-summer" on the map). In the east, the rains are characterized by Mediterranean influence and the autumn is the typical season (Balearic Islands, Valencia); in the Ebro Valley the spring rains are more important ("autumn-spring-winter-summer" on the map).

The dotted areas on the map indicate the closed interior valleys of the Peninsula where little rain falls, and it is irregularly dispersed tending to fall in the hotter months as a result of convectional storms. In these valleys there is a predominance of spring rains ("spring-autumn-winter-summer"). Only in a few places such as the basins of the Jiloca and Alfambra (Teruel), La Cerdaña, the eastern Pirineos and Cadí, there are frequent summer storms and this season is the rainiest ("summer-spring-autumn-winter").

The areas which have been left blank are those where climate is very changeable, oscillating between the types already mentioned.

Logically, the regions with autumn and winter rains are those affected by the above-mentioned maritime air-masses during the colder months and where, therefore, the humidity is acting as a thermic regulator. The summers are usually dry and, since vegetation is scarce, this general characteristic of Spain has contributed to the traditional importance of sheep, which must be moved to the wetter and cooler mountain areas. The autumn and spring rains characteristic of the Mediterranean climate facilitate the growth of trees such as the evergreen oak and the pine, especially *Pinus halepensis*. As one moves further inland the weather becomes variable with sudden changes of temperature, and the vegetation becomes steppe-like, dry, with scrubby grazings and very rough grasses.

The climatological studies of Spain are numerous and we select only some papers like: Fillat (1983) for seasonality of rains, and a simplification by Icona and González Rebollar (1974). Maps are based also on those of the Servicio Meteorológico Nacional (1965, 1972) and the Instituto Nacional de Meteorología (1983). Regional studies include those on Galicia by Díaz Fierros (1971); on Cataluña, by Febrer (1930); on Aragón by Liso and Ascaso (1969); and central Spain by Sánchez Egea (1975).

<sup>1</sup>Friday 4 February 1983, minimum temperatures. High pressure centre of 1043 mbar in 43°N, 17°W; anticyclone curves on the Iberian Peninsula.

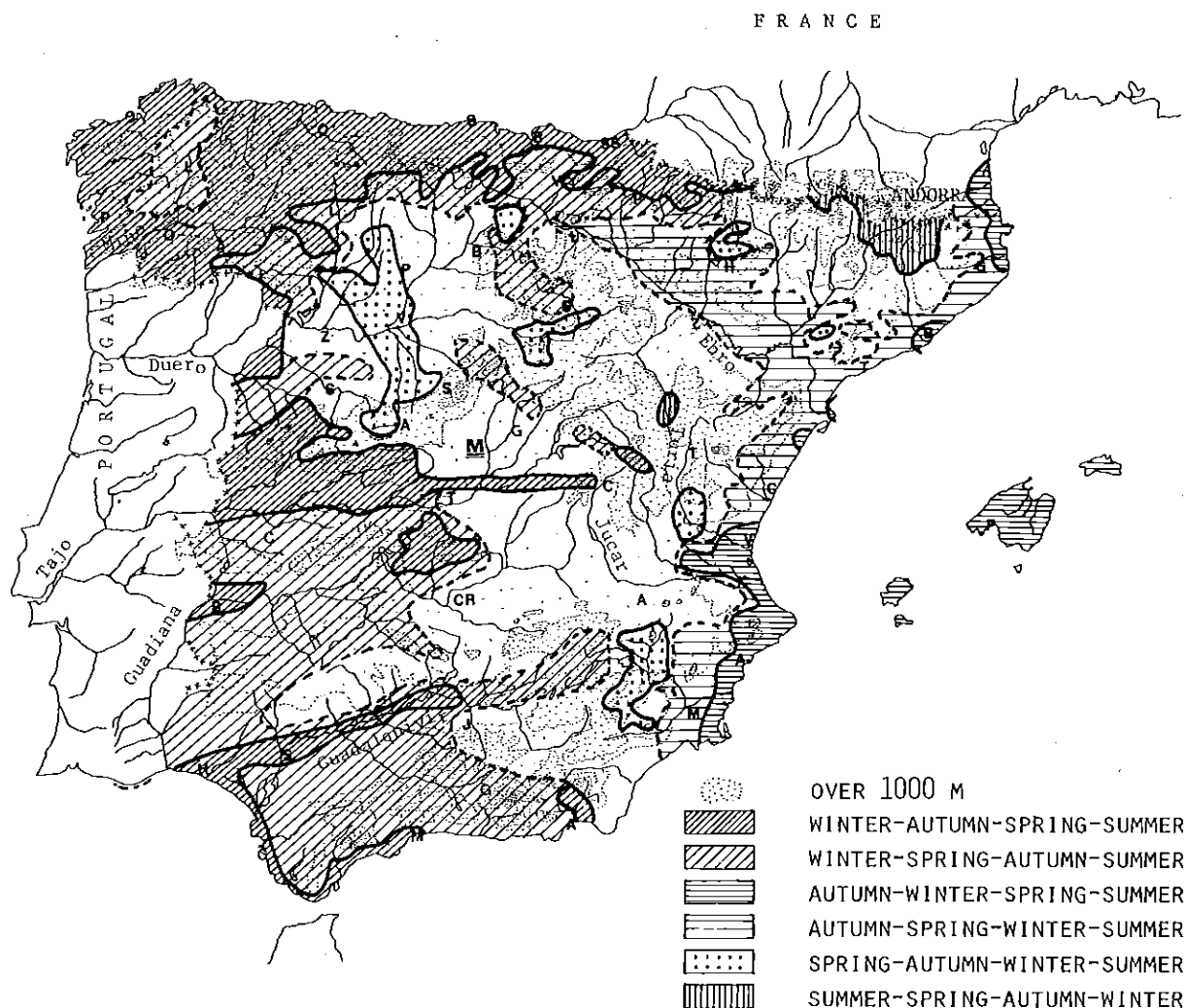


Fig. 3.3. Seasonal distribution of precipitation. The seasons are ordered from the rainiest to the driest.

### Dynamics of vegetation related to soil and topography

There is a tendency of plant communities to change until the optimum vegetation for the soil conditions establishes itself, that is until a *climax* is reached. Where there is a gentler topography and erosion is minimal, a balance can be reached for given climatic conditions, if this is not prevented by the action of animals or man. Exploitation by animals together with acute erosion on mountain slopes results in a simplification of local plant communities, until autogenic succession balances the losses. Every permanent community is an

expression of this balance.

The formation of the soil layer is slow and the natural plant communities tend to preserve it. Compact shoots, stolons and rhizomes, interweaving of roots at the surface and deeper down, prevent the soil being carried away and contribute to the formation of a glaxis. Herbs covering a soil which is basically unstable provide a dynamic and efficient protection.

### The main topographical features of the Peninsula (Fig. 3.4A)

The Pyrenees were formed by a very fragmented

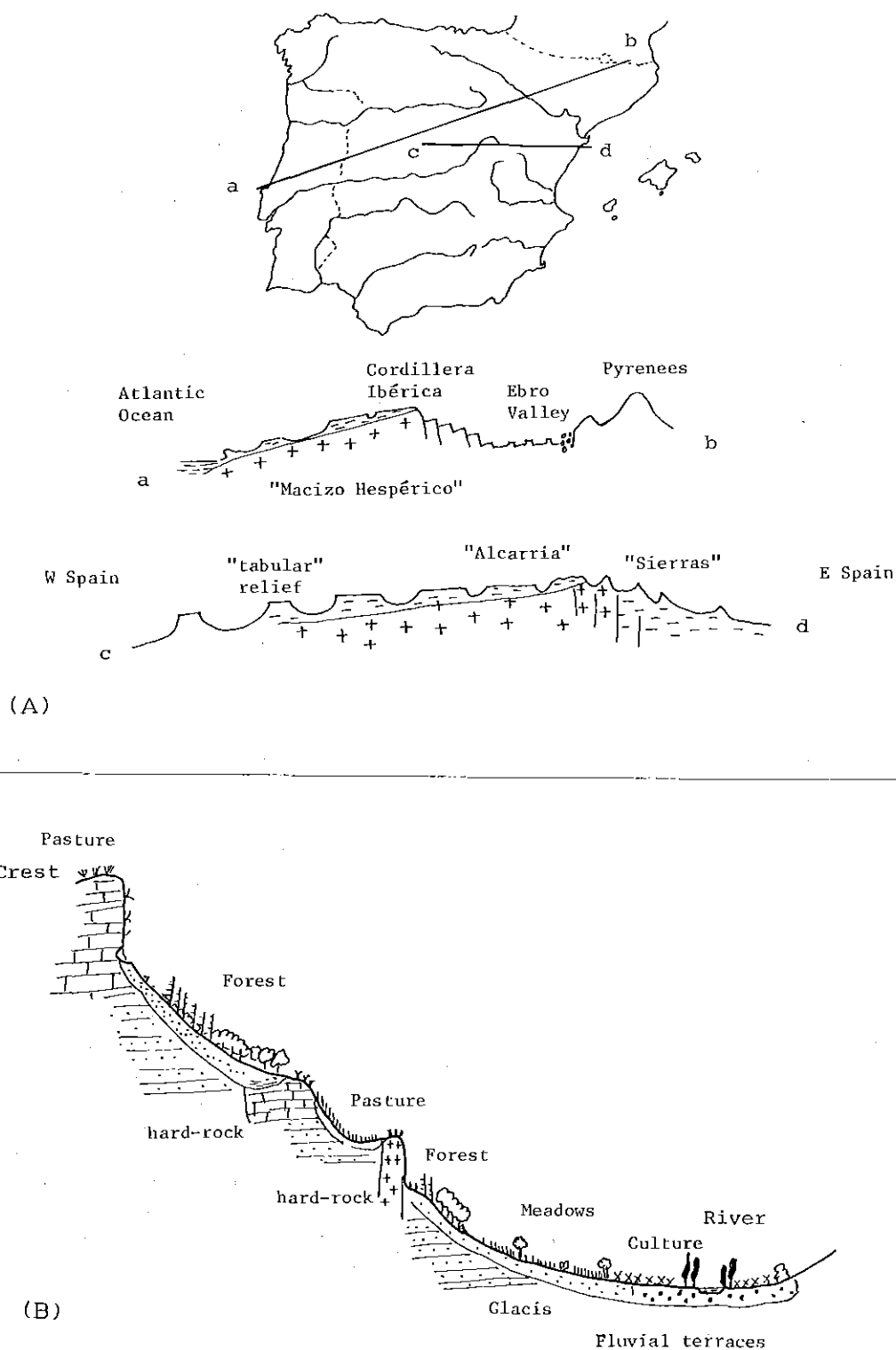


Fig. 3.4. A. The main topographical features of the Peninsula. a-b is a cross-section from Portugal to the Pyrenees, c-d is a cross-section from the Meseta to the Mediterranean Sea; the geomorphological names in Spanish are put on the drawing. B. Typical slope with topographical sequences.

ancient socle<sup>1</sup> and its recent Oligocene orogeny is very rich in lime and flysch.

The great "Macizo Hespérico"<sup>2</sup> of Caledonian-Hercynian orogeny presents an overall homogeneity except at the extreme edges where Mesozoic mountains are found (Montes Cantábricos, Montes Ibéricos, Sierras Béticas). It is a horst limited by a system of faults to the northeast (the Ebro Basin) and south (the Guadalquivir Basin).

During the Miocene, the Pliocene and at the present time, evaporites have been laid down in the Ebro Valley (dry with strong W-NW winds), in Castilla and La Mancha. The endorheic basins were of less importance in the Guadalquivir Basin but they are still to be found in the great mountain ranges of the southeast. The tilting of the Meseta, combined with partial subsidence on the Atlantic side (*Rías gallegas*), drained Castilla and La Mancha, reducing endorheism but re-activating erosion along the Iberian edge, with the consequent renewal of soils and the expansion of gypsophilic communities.

### Topographical microclimates

On mountain slopes microclimate varies according to the degree of exposure to sunshine and the type of prevailing winds. They can be ascending winds, with the formation of mist or descending foehn winds. When there is a channelling of wind (Venturi effect) it causes drought in certain localized spots (this is often caused by descending winds). Each type of microclimate favours a different kind of plant growth, and as a result the flora of the Iberian Peninsula is very rich. Because of the mountain-valley sequences already mentioned, drought conditions can be found even in environments with a wet oceanic type of climate. This is a source of diversity, with preservation of very particular plants, and also causing great specialization in pasture management (see also Montserrat, 1980, 1981, 1983).

### The dynamics of water

As mentioned above, the presence of water influences temperature due to its high specific and latent heat. Water also causes erosion through freezing-thawing, imbibing-drying out and run-off. On the other hand, in its role as transport agent, it contributes to fertilization and facilitates plant recuperation. The topography, frequency of

mists, water-vapour condensation under ground, etc., all influence the dynamism of pasture-lands, as do both erosion and rapid soil recovery.

Erosion is a process which liberates soil-enriching nutrients, the loss of which is prevented by soil bacteria and the intense root activity of certain plants. This activity is greatest in luxuriant areas bordering forest, in meadows, and especially where there is a productive grassland. Watercourses have been changed to irrigate pasture-land, fodder crops are grown where they are appropriate to the surrounding environment, with an eye to choosing species that resist unpredictable periods of dryness, and the herds are moved to places where the topographical microclimate is optimal. Plants, animals and human activities are a reflexion of climate.

### Watercourses and associated phenomena

(Fig. 3.4B)

Topographical sequences on slopes are linked mainly to geophysical characteristics like rock hardness, or to protection of the soil by plants against erosion. Deeper soils are found mainly on fluvial terraces and glacia, but also on slopes, *cuestas*, protected by hard rocks (polycyclic relief) as in our scheme, obviously favouring accumulation of soil, and the establishment of grasses and trees, and causing great diversity in a restricted space.

The relationship between the animals and environment is reciprocal; for example, mountain tops are fertilized by animals in their search for cool windy areas where they will not be plagued by flies. Although high mountain crests are often unproductive and stony, they are nevertheless a source of the water needed for lower mountain pastures.

The development of the vegetation, transhumance of animals and human activities have been shaped by the variation of these environments, forming repetitive patterns which can be studied. Since such diversity exists in Spanish valleys it might be helpful to study some examples which will enable us to understand the general trends of

<sup>1</sup>The Axial Pyrenees formed during Hercynian orogeny.

<sup>2</sup>The oldest part of the Iberian Peninsula.

animal husbandry in the past and also its future possibilities.

### Soil evolution in different habitats

It seems necessary to consider not only the climatic and topographical frames within which soil develops but also the type of rock which forms the parent material.

In siliceous zones of Spain, and also in a part of Portugal, the so-called "Escudo Hespérico" with Palaeozoic mountains is formed mainly of siliceous rocks (Galicia, Montes de León, Sierras de Gredos and Guadarrama, Oretana or Montes de Toledo, and Sierra Morena), and this is most evident on the Cambrian slates or in the granitic regions. Mountain crests where quartz is present in quantity have resisted erosion, but the soil is very poor. The Spanish oak (*Quercus pyrenaica*) in these areas effectively mobilizes and retains mineral cations which would otherwise be lost to the pastureland, and thus helps to form the grazed *bardal*, a very typical kind of Spanish western grasslands.

Hard limestone rocks, which form cliffs and stony mountain crests, provide a suitable base for the deep-rooted legumes so sought by sheep. Mixed woods evolve at the base of these cliffs. They are rich in a variety of species and readily lend themselves to pastoral exploitation. The frequency of alternating areas of marl, sandstone and conglomerates favours diversity of soil types and the different kind of pastures which may be found in valleys dedicated to grazing.

Finally, the geological deposition of evaporites in the wide valleys of Aragón, La Rioja and La Mancha has helped to preserve a very specialized flora, adapted to the presence of both gypsum and salt. The large quantity of gypsum prevents the formation of black alkali (sodium carbonate), which has had such a devastating effect on similar environments in other countries.

### Diversification of pasture-land

Taking a broad view of the dynamics of the natural vegetation and its development, especially that which has been subjected to erosion, recovery and diversification, the extreme importance of such diversification can readily be understood.

By observing the behaviour of gregarious animals man learnt how best to make use of these diversities. Gregarious ethology, and knowledge of

the traditional methods of the past, both contributed to the development of grazing land and also to the integration of the farmer with his surroundings. For this reason it is necessary to describe the interplay between the animals and their habitat, whether in terms of plants and animals found there or geophysical conditions. Any given breed is the consequence of its evolution in a specific environment. The group adapts by a process of selection and the resulting genetical evolution. This means, within any given mountain habitat, that it is possible to preserve those breeds that are not only well adapted but can be maintained at a minimum cost.

### An historical perspective of animal husbandry in Spain (Fig. 3.5)

The shepherd of the Neolithic revolution (Moore, 1981) learnt from the wild flocks. Nomadism and also flock movements in the morning, resting at noon and sheepfolding, have evolved from the behaviour of wild animals. Similarly, gregariousness and group life pass directly from animals to men.

We present by maps (Fig. 3.5) the cultural influences in Spain from Neolithic times to the Middle Ages. Megalithism and "Campaniforme" culture came from Egypt to the Balearic Islands and southern Spain. In Fig. 3.5A we show a range of these influences from 4000 years ago. Megalithism was very rare in central Spain.

From 2000 B.C until the beginning of Roman influence (200 B.C.) there was a continuous flow of influences from the Near East (Phoenicians, Greeks) to eastern and southern Spain (Fig. 3.5B) and also from the northwest of Africa (Argar culture). Before the Romans came to Spain (900–650 B.C.), the Celts influenced Spain, mainly in the northwest. In our map we outline approximately the zones of influence and their limits.

Romanization was intense in eastern Spain and Andalucía (Fig. 3.5C), developing the agricultural techniques founded in the *villa* organization of the country (this is found typically in the *mas* of the northeast and the *cortijo* in southern Spain). Roman penetration to the west of the Peninsula (Evora and Mérida) was slow and only very scattered, limited to mines or thermal waters in central or northern Spain. Wine and cereals were



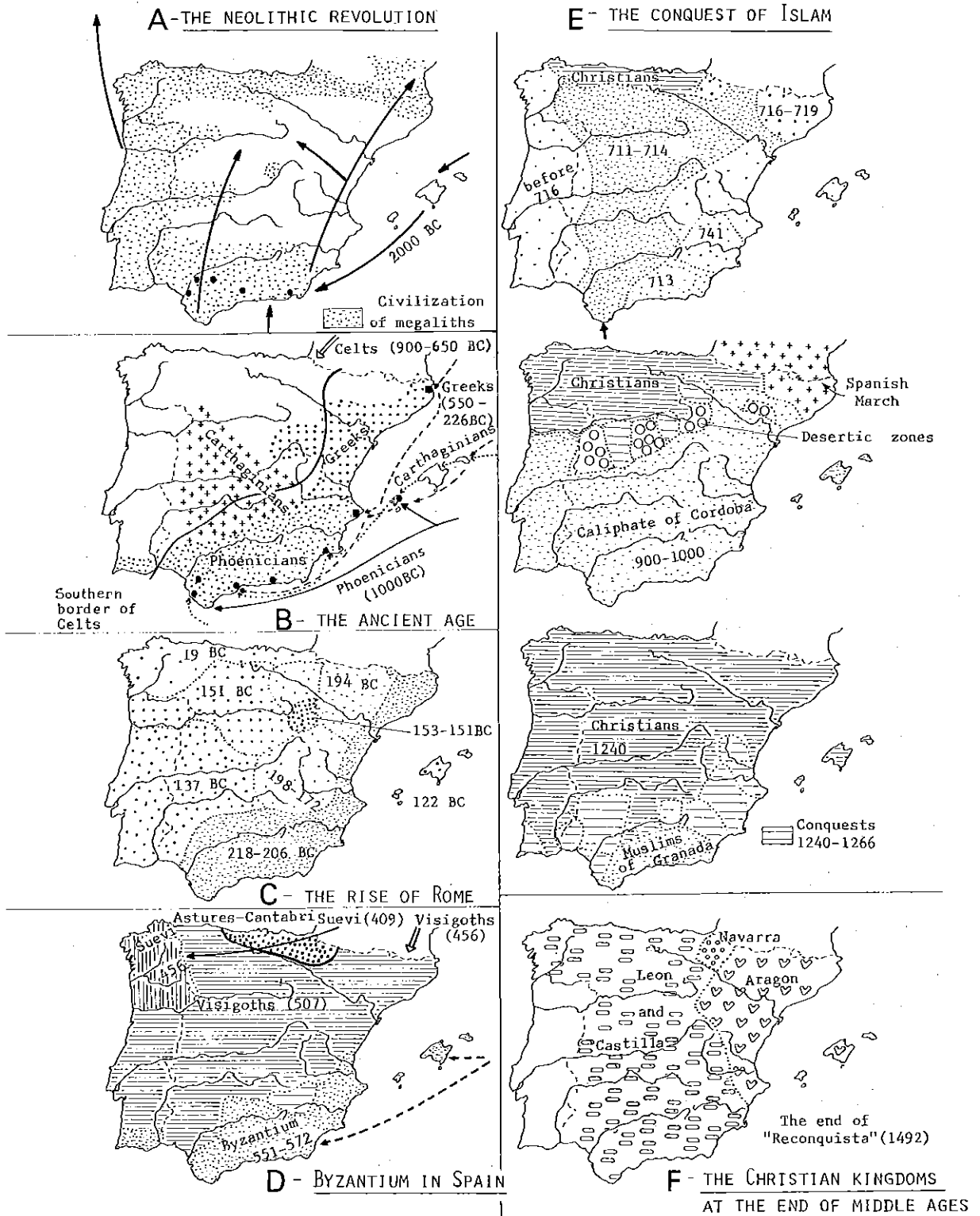


Fig. 3.5. Historical events. A and B: The little dots and black squares are historical towns. The dates explain the expansion of every event (from Vicens Vives, 1954, 1974 and Ubieta, 1970).

the main products of Roman *villa* development, and rearing animals in the north was influenced by the Celts.

This old division of Spain into Celtic and Mediterranean influences has persisted till now. Many cultural features are linked to this historical fact. Byzantium (Fig. 3.5D) was also important, influencing mainly the Balearic Islands and the southeast of the Peninsula; the Visigoths influenced all Spain and the fierce tribes of the Asturian and Cantabrian Mountains remained isolated in the north.

Islam came to Spain in 714 A.D. but some parts in the north [the Spanish March (Catalonia), Navarra and the Asturias] (Fig. 3.5E) remained outside this influence. Islamic influence was intense in southern and central Spain (Córdoba and Toledo) but minimal in the west, north and northeast of the country.

For centuries the Christian frontier was stabilized at the rivers Duero (León–Castilla) and Ebro (Aragón–Cataluña). In Fig. 3.5E a large part of Castilla, from Duero to Sierra de Guadarrama, was devastated by incursions from the Córdoba Emirate or by Christians. Open grazed lands without any trees and with many castles were characteristic of this time, and this history is essential to the understanding of grassland and husbandry evolution in Spain. The muslims of Granada (Figs. 3.5E and 3.5F) stayed till 1492 in southern Spain, and this enables one to understand some *moriscos* influences in villages and farming.

In more recent times, from the 16th century, the Spanish kingdoms were united by a very diversified administration persisting till the centralized system of the Bourbons (rise to power of this royal family in 1700). The powerful herdsmen's organizations in Aragón and León–Castilla influenced farm management and grassland composition.

Communal exploitation is typical of the country under Celtic influence in northwestern Spain (Navarra, Vizcaya, Castilla and Asturias), and family holdings (*villa*, *mas*, *pardina* and *cortijo*) which have persisted in eastern and southern Spain from Mediterranean–Roman influence. Medieval influence caused only superficial changes in herds, grassland and men. More striking changes and political influence came from the modern (16th to 18th century) organizations of herdsmen in Castilla–León (Mesta) and Aragón (Mesta de Albarrac-

ín and Casa de Ganaderos de Zaragoza).

Recent centralism (Napoleonic administration) destroyed in part the communal organizations. Intelligent men were migrating to the town, and only old people remained in the mountains. It is necessary to change this mentality because the city men coming back to the country are not able to make a success of shepherding.

### Traditional breeds of farm animals in Spain

The maps in Fig. 3.6 show the geographical distribution of different types of farm animals. Figure 3.6A shows the four main groups of sheep breeds as classified by Sánchez Belda and Sánchez Trujillano (1979): 1–Merino, 2–Churra, 3–Ibérica and 4–Entrefina.

The Merino group came originally from ancient Tarsus; they are gregarious, and well adapted to the conditions of southwestern Iberia and to transhumance from the summer grazing area to the winter one. The Churro stock is native to the north of Spain with a coat of rough and long wool; these sheep move about less than the Merino. The Iberian group is well suited to mountain ranges, and the three areas where they still remain are shown. Lastly the Entrefina breeds are selected now in order to increase lamb production.

Figure 3.6B shows the distribution of the pig population, which is divided into two main groups: the Ibérico, adapted to roaming free on mountains and in marginal regions; and the Celta, used in intensive pig farming.

With reference to the equine population (Fig. 3.6C) we have singled out the pony found in northern mountains, and the Andaluz horse. The donkey comes from northerly regions (Zamora and Cataluña) and has been used in crossing to produce the much appreciated mule.

The distribution of cattle (see Fig. 3.6D) has its roots in prehistoric time (Sánchez Belda, 1976). The peripheral zones where Red and Blond animals are found coincide with areas where megalithic cultures existed. The Iberian Black, found in the interior of Spain, is concentrated in the wooded grassland and mountains. Other breeds are found in specific localities like the Cantabrian coast or some parts of the Iberian Mountains. The White of Cáceres (*Blanca cacereña*) has practically disappeared.

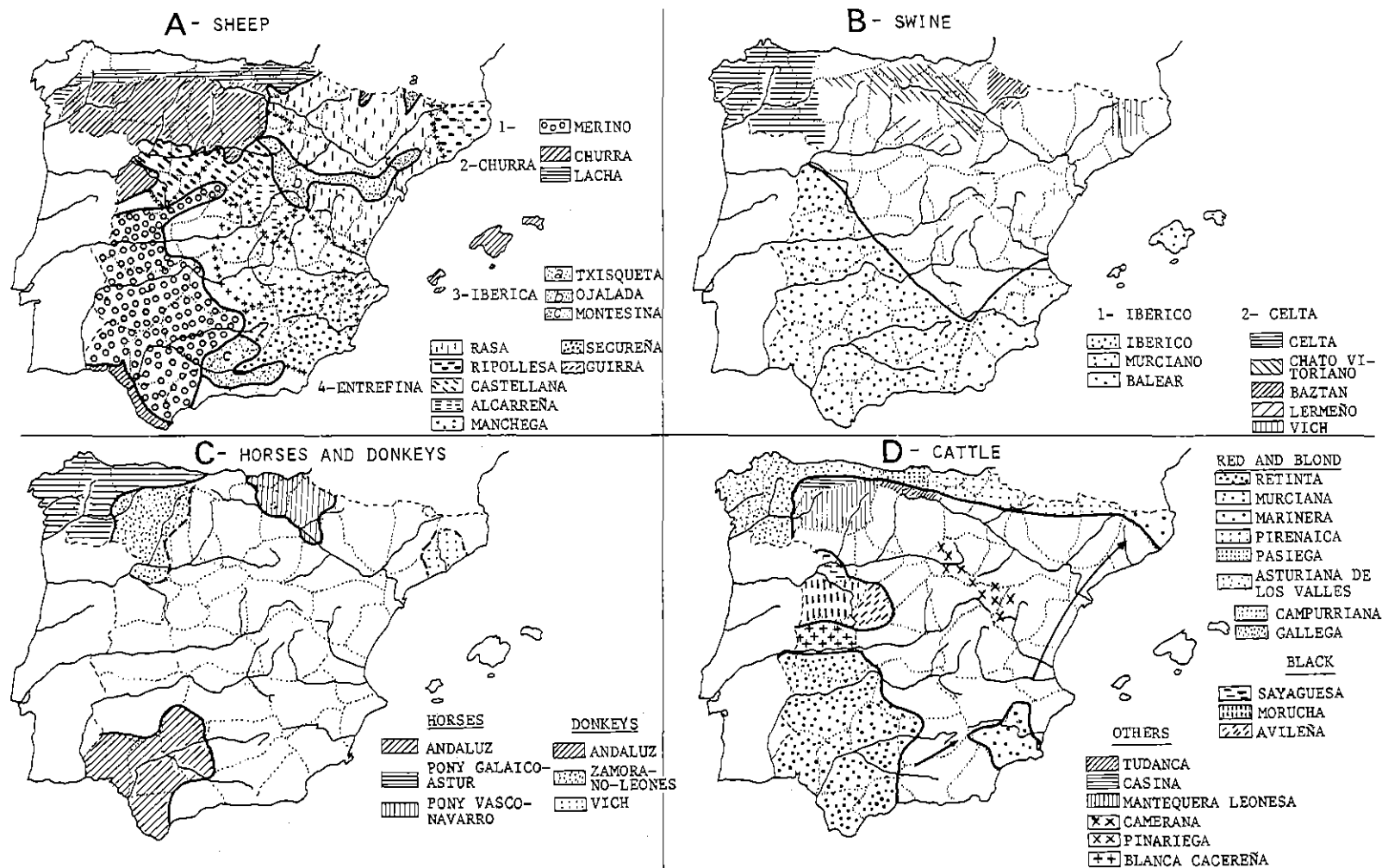


Fig. 3.6. Geographical distribution of farm animals. A. Breeds of sheep (from Sánchez Belda and Sanchez Trujillano, 1979). B. Swine breeds (from de Juana and Zuzuarregui, 1966). C. Horses and donkeys (from Saraza Ortiz et al., 1975). D. Cattle (from Sánchez Belda, 1976 and Saraza, 1975).

Information on the distribution of traditional herds in Spain can be found in general books, for instance, Sarazá et al. (1975) or in regional monographs: Rodríguez (1955); Echevarria Belzunegui (1975); Francia (1978); de Miguel (1978); Sánchez (1978).

## THE MAIN GRAZING SYSTEMS IN SPAIN AT THE PRESENT TIME

### Introduction

The maps in Fig. 3.7 summarize the uses of agricultural and forested land. They are based on the most recent statistics supplied by the Ministerio de Agricultura (1980). Our main aim has been to show, quantitatively, the relationship of different provinces to one another.

The relative importance of different types of land usage is summarized in the central diagram, that is, agricultural, forested, meadow and pasture-land and other miscellaneous uses. More than 70% of the land is taken up by cultivation and forestry.

The great plains of the Duero, the Tajo, La Mancha, La Campiña in Andalucía and a big part of the southeast (Murcia–Alicante) have been ploughed for centuries. Permanent grasslands are found in the northern region or in mountains, and also in the western region (Salamanca–Extremadura and western Andalucía) where the *dehesa* organization of pasture-land is typical. Extensive reforestation has taken place in Galicia, the Basque country, and the provinces of Barcelona, Gerona and Huelva.

Figure 3.8 shows further details of land use with special reference to grazing land. In the north and west the distribution of grassland is dependent on humidity and edaphic factors and it is generally privately owned, while the rough pastures are communal. In areas such as the *dehesa* (a type of natural evergreen oak forest, managed under extensive farming), the timber production is unimportant. Lastly (Fig. 3.8D) there is the southeastern region with "Esparto" (*Stipa tenacissima*) rough grassland.

To complete the picture, we have also shown (Fig. 3.9) the areas where trees are cultivated for their fruit (olives, almonds, etc.) and the *dehesa* region.

### Some types of grazing systems

Figure 3.10 shows sixteen different types of pasture-land found in Spain and the main routes of transhumance traditionally followed by flocks to reach areas of winter grazing.

#### European–Atlantic sector

**Cantabrian meadows.** General characteristics (Montes Cantábricos and Galicia Regions, No. 1a, 1b and 1c in Fig. 3.10). In a wet climate it is easy to maintain the meadows in good condition by periodic cutting. Maritime air and also frequent mists provide the necessary humidity to pastures surrounded by woodland. Grazed lands are found in the more rocky rugged slopes (*brañas* in the Cantabrian Mountains) and meadows in more accessible regions for cutting and storing (hay or silage). The grass was formerly scythed up to a slope of 30–40°, although nowadays, because most of this grassland has been abandoned, bracken and natural woods have replaced meadows while the warmer, lower slopes have been reafforested with pine (*Pinus radiata*) or *Eucalyptus*.

Near the more densely populated coastal regions, where there are scattered factories, one finds the so-called *prado-jardín* or grasslands dedicated to dairy cattle. This dual activity (industry and cattle) is typical of Cantabria, Asturias and Galicia, with well-managed meadows interspersed with small allotments. Most of these grasslands are dominated by *Festuca arundinacea*, a spontaneous grass standing up well to frequent cutting, and characteristic of good soils near the Cantabrian coast (Sociedad Nestlé, 1980).

Further inland, winter production decreases together with cutting frequency. Away from the villages there are stables near the cut grass and the production is stored as hay for feeding to stock in winter; generally, pastures are more important than in the coastal region. There are plant communities of *Arrhenatherion elatioris* or *Cynosurion* (Tüxen and Oberdorfer, 1958) and *Nardetalia* in the wetter depressions. The practice of burning winter grassland has given rise to communities of heathlands (mainly *Ulex europaeus* or *U. gallii*). *Erica vagans* abounds in dry limestone mountain regions, as against *E. cinerea* and *Calluna vulgaris* where the substrate is siliceous. The big *Erica*

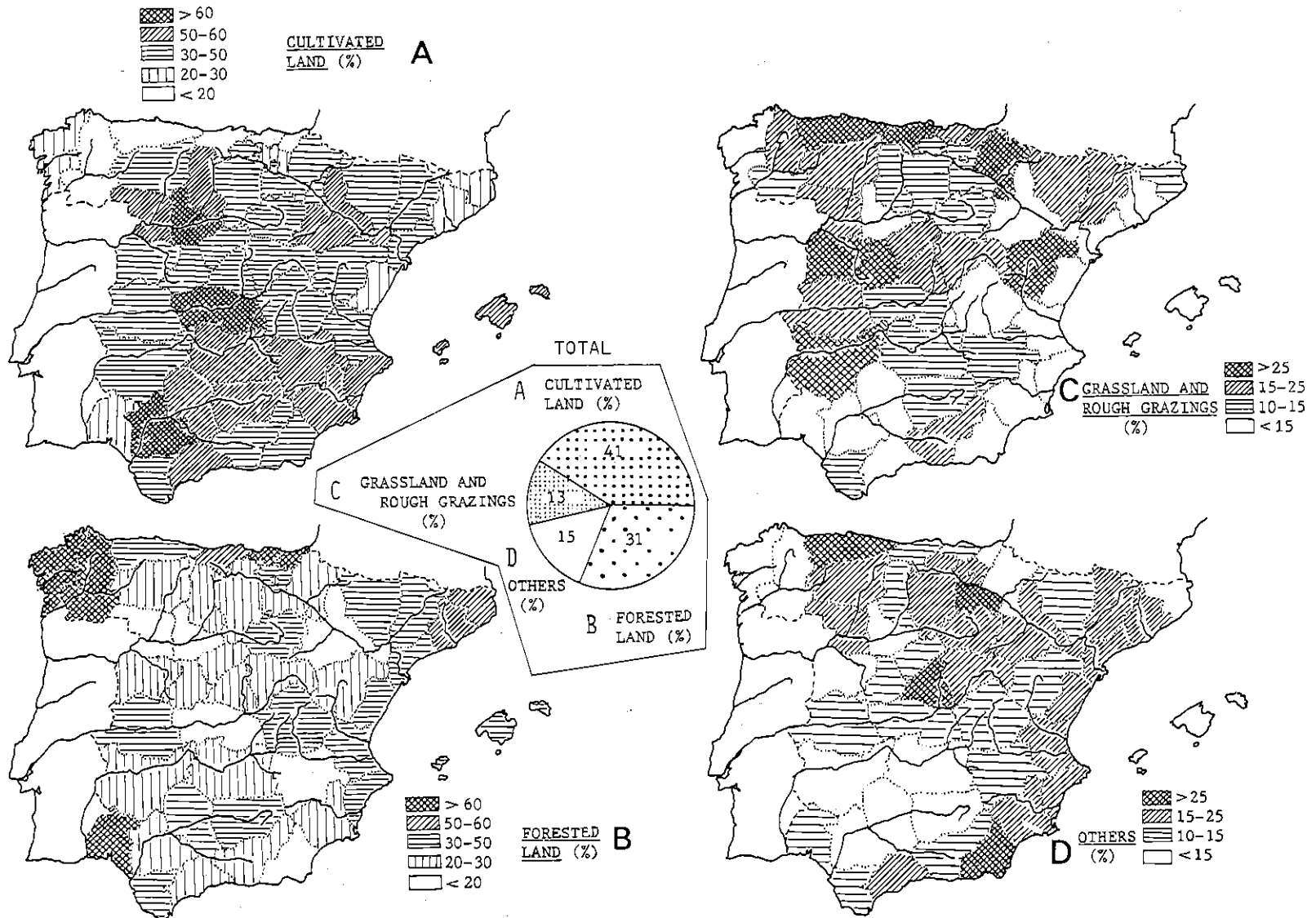


Fig. 3.7. Usage of land in Spain. Four main statistical categories (from Ministerio de Agricultura, 1980).

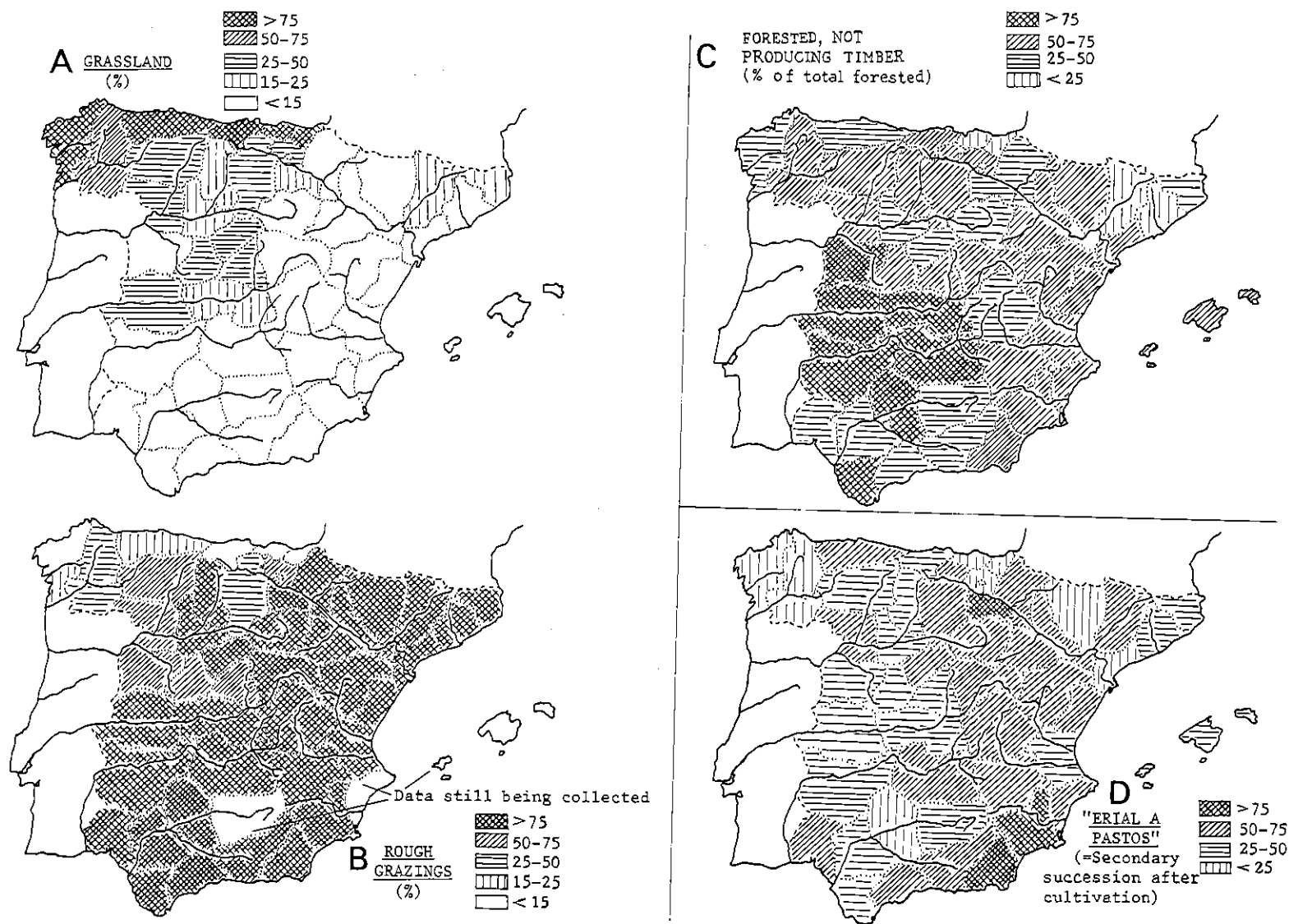


Fig. 3.8. Usage of land. Some subdivisions. A and B are two subclasses of Fig. 3.7C. C The "over 75%" category represents the *dehesa* zone; the figures are for the proportion of forest land (Fig. 3.7B) not producing timber. D. Grazed agricultural land; the *Erial a pastos* class is typical of the driest part of Spain (% of the "Others" category in Fig. 3.7D).

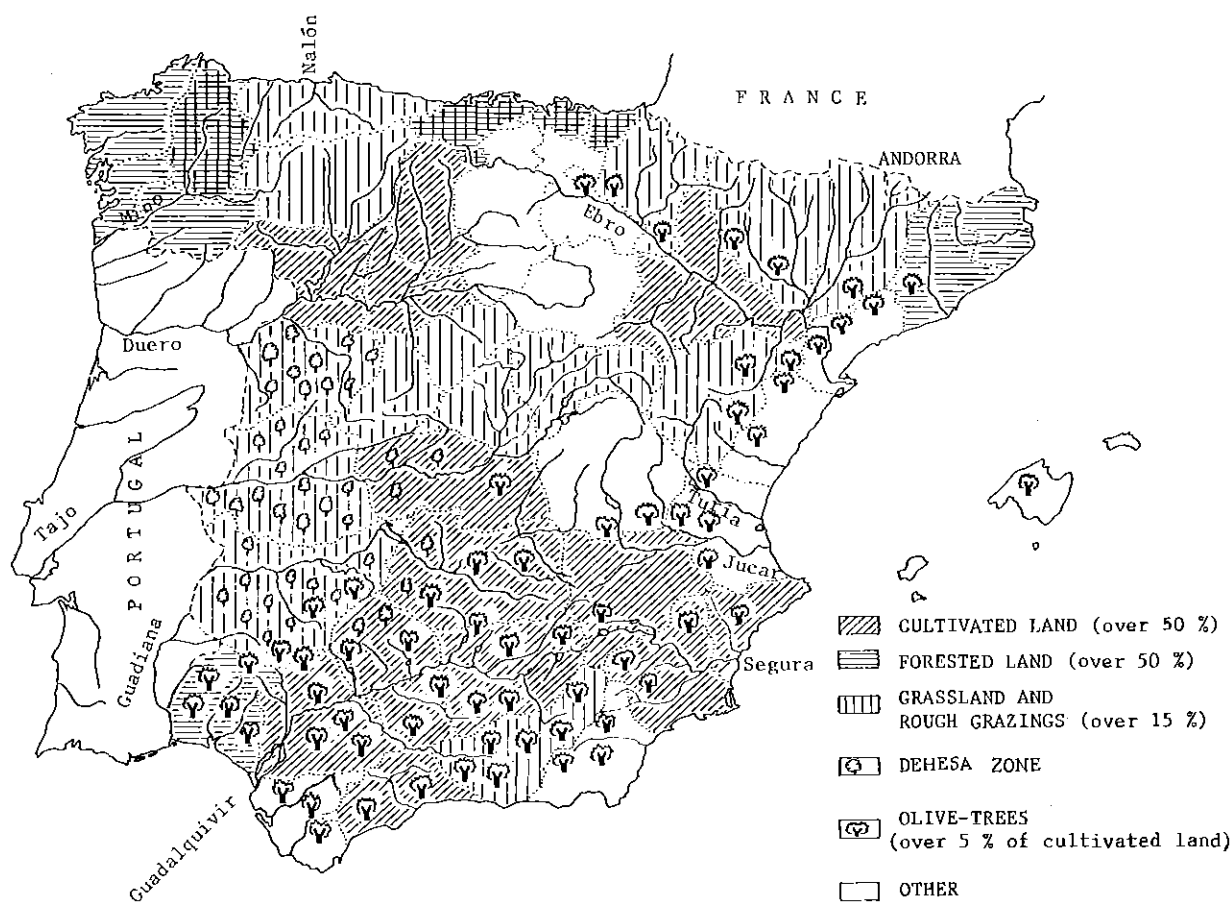


Fig. 3.9. Usage of land in Spain. Summary.

*arborea* is typical of good woodlands with deep soils, sometimes associated with *Genista florida*. Bracken (*Pteridium aquilinum*) quickly colonizes derelict grasslands in the hills, but occurs only on the southern slopes of the highest mountains; everywhere the prevalence of bracken is reduced by heavy cattle grazing or early cutting in spring.

**The Galician minifundus** (1a in Fig. 3.10). Even nowadays the population of Galicia is widely dispersed (there are here 32 700 hamlets, a similar number to the total of all villages in the rest of Spain) covering an area where the resources for cultivation are few (less than 20% of total surface). This means that the farms are small (5.5 ha average) consisting of a great number of plots (average 22) at some distance one from other (10–15 km) (Otero Díaz, 1977). Given these cir-

cumstances it is not surprising to find that the Galician farmer is very attached to his small-holding, especially as the whole family is usually involved in its management. In spite of this, the land has been abandoned in certain mountain regions and is now overgrown with scrub (*Ulex europaeus*) and heather (*Erica* species or *Calluna*), which may cover up to 34% of the nominally forested areas.

It is thought, historically, that the practice of splitting up land into plots originated with the Suevi (Sánchez, 1978), when they divided up the land. During the *Reconquista* (9th, 10th and 11th centuries) stock-farming in Galicia was under the control of the feudal lords and the monastic orders. The autochthonous cattle breed (*rubia gallega*) increased after the potato and maize were introduced from America (after 1541 when Perú

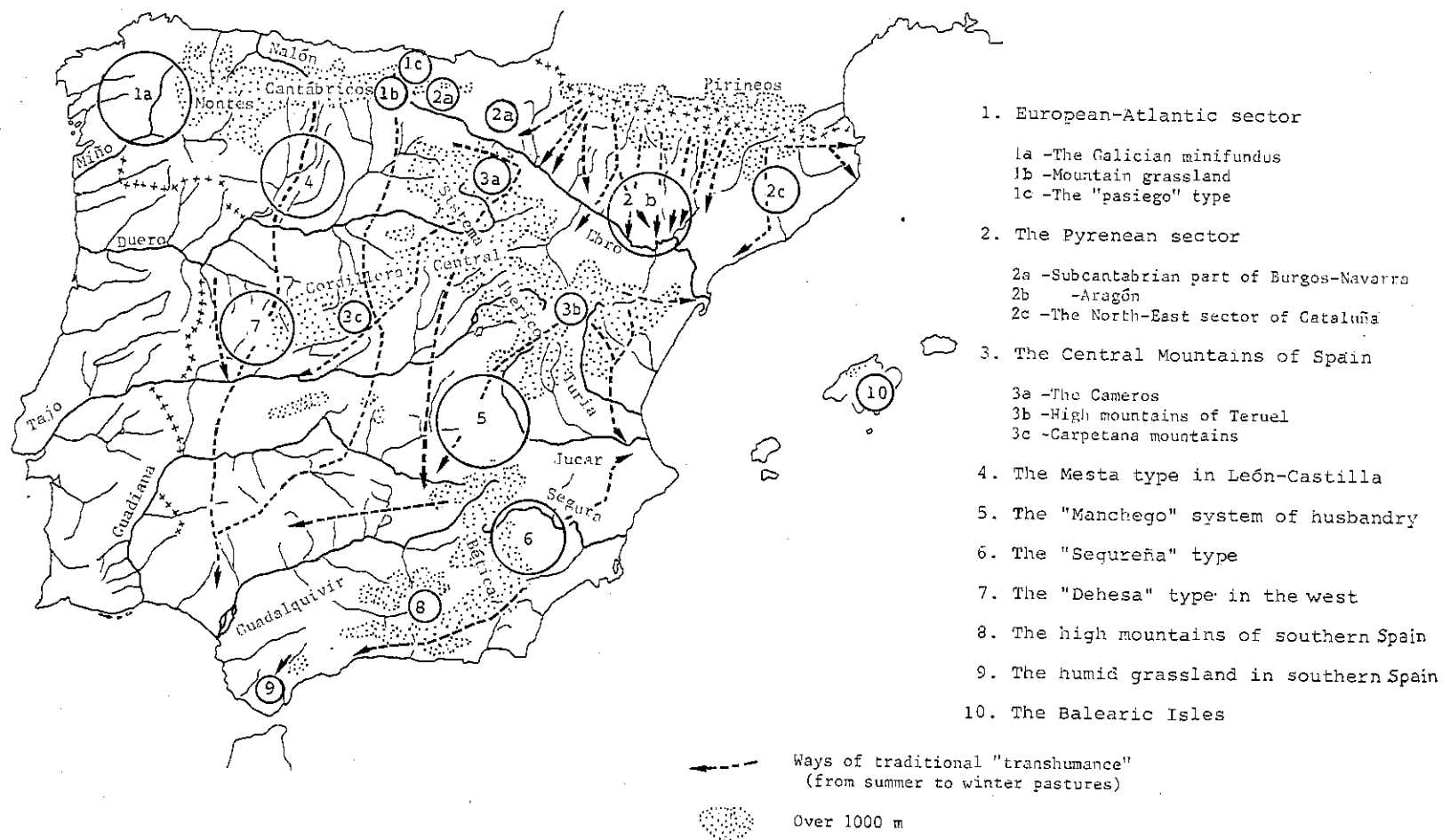


Fig. 3.10. The main grazing systems in Spain at present.



was finally conquered), thus enriching the traditional range of foodstuffs, such as rye, turnips, linseed, acorns and chestnuts.

At the end of the 18th century, as the result of Spain's ties with the United Kingdom and the growth in demand from urban centres of industrialized England, a new market for the export of meat was created. This brought about the specialization of the *rubia gallega* as beef cattle, which later found a new market in the industrial centres of Spain (Rodríguez et al., 1979).

Generally speaking, Friesian cows are found on the richer grazing land of the Atlantic coastal areas while the *rubia gallega* breed has spread further inland. Two important varieties of this breed have gradually evolved, the dairy cattle of the valleys and the mountain beef-cattle. Nowadays, in spite of the small scale of farming in Galicia (96% of farms support less than 6 cows) and difficulties with feeding because of the intricate system of very small plots, Galicia produces something more than 23% of the calves raised in Spain. These are later fattened in areas situated closer to the main marketing centres.

**Mountain grassland (1b in Fig. 3.10).** The Cantabrian Mountains act as a filter for the moist sea air with frequent mists on the north-facing slopes and to the northwest. On the leeward side, the combination of drier descending currents of air and a southerly orientation is associated with a change in the type of pastures and woodland found there. Meadow-lands are restricted here to the deeper soils in the valley bottoms or irrigated gentle slopes. Looking at the map one can appreciate the importance of these mountains and their role as a screen against moisture-carrying winds.

The watershed is complicated especially round the Picos de Europa which form a giant barrier. In the southern part of the mountains the dry limestone supports good pastures which, together with eroded slopes on slate rock making ploughing difficult, have facilitated the development of the nomadic movements of sheep flocks (*trashumancia*). The basic major routes are shown in Fig. 3.10; they are called the "Zamorano-leonesa" and the "Segoviana" one.

Figure 3.11 shows a transection from Cabuér-

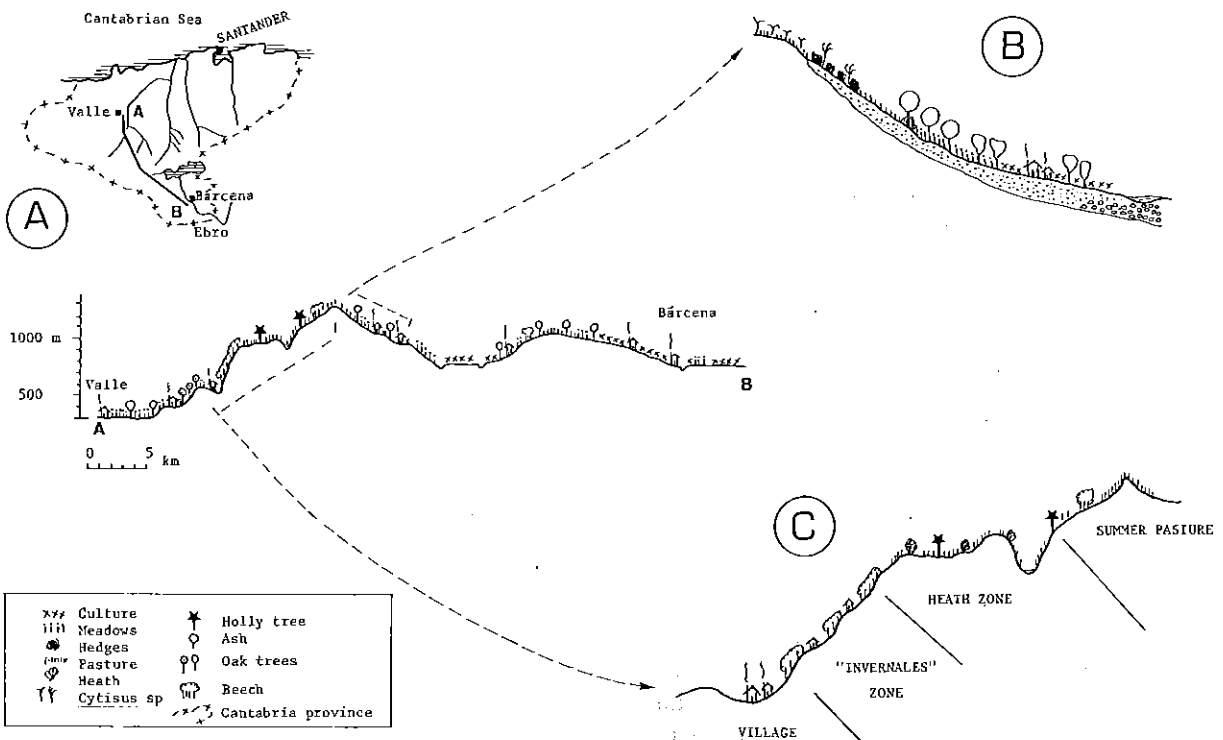


Fig. 3.11. Mountain grasslands in Cantabria province (from Montserrat and Fillat, 1978).

niga (Valle de Cabuérniga), on the north side of the Cantabrian Mountains, to the river Ebro near Reinosa (Bárcena). This is typical of many mountains of northern Spain, with humid cloudy slopes changing to the sunny climate of the Ebro Valley.

The gentle slopes not very far from the Mar Cantábrico are cultivated, and very good meadows are dominant, grazed or heavily cut near the houses. Hedges are common with relics of climax oak (*Quercus robur*) and ash (*Fraxinus excelsior*). The cloudy slopes (ascending maritime winds) have dense forests of beech (*Fagus sylvatica*), meadows, grazed pastures, and bracken (*Pteridium aquilinum*) in some cases. The cross-section C is a more detailed representation of this part.

As one moves towards the 1000 m contour grazing becomes more intensive and beech disappears, giving way to holly (*Ilex aquifolium*), hawthorns (*Crataegus monogyna*) and gorse (*Ulex gallii*) with heath (*Erica vagans*). This is the *Monte tojo*, the home ground of very wild cattle, the *Tudanca* breed. Fires and grazing acting through centuries have impoverished the highest parts of the communal pastures.

The maritime winds, with frequent rain, pass across the mountains and drop down towards the river Ebro, so that fine weather is dominant throughout the year in this part. The dry air with sunny south-facing slopes, means dry-pasture dominantes together with the characteristic *pior-nales* (*Genista obtusiramea* and *Cytisus purgans*), a "retamoid" type of shrubs very typical of Spain. In the upper Ebro Valley very deep soils are found in the bottom of the glacis on gentle slopes; only near the top part is the *piornal* dominant, together with hard grasses like *Festuca indigesta* and *Agrostis delicatula*. Shrubs like *Erica arborea* and *Genista florida* are found in hedges on the best soils, but near the villages ashes and oaks also help to create a very typical landscape (see Fig. 3.11B).

The climax forest of this region is formed of *Quercus* (*Q. pyrenaica*, *Q. faginea*), and grasslands are good because the soil is deep and rich in limestone; but it is dry in summer, and irrigation is essential in order to have good meadows. The *Tudanca* breed is well adapted to these grasslands but now it is necessary to change its utilization from oxen for throughing and ploughing to meat production by crossing (heterosis) with other breeds (see also Fillat and Montserrat, 1978; López, 1978).

**The Pasiego in the mountains of Burgos-Cantabria** (1c in Fig. 3.10 and Fig. 3.12). While more extensive grazing systems are dominant in the west-northwest of Reinosa, intensive systems producing milk from grass are found in the northeastern mountains. The *pasiego* people have many special cultural characteristics studied by de Terán (1947), Madariaga (1970), Tax de Freeman (1970), Ortega Valcarcel (1974, 1975) and Leal (1976).

Figure 3.12B is a detailed map showing the scattered "habitat" of the three municipalities which make up the *pasiego* region of the Cantabria. The farm buildings (*cabañas*) are located in places where grass is most easily grown. Each family owns several houses in different places, living first in one and then another depending on the needs of their cattle and the condition of the pastures in any given area (these moves can take place as often as once a week). The hay is harvested in summer and then stored, together with lucerne which is purchased. The farmer of this region has perfected the method of converting heathland or areas of bracken into meadows. The land to be used as meadow is covered with a certain quantity of manure enough to buffer the pH and ensure a rapid enrichment of the soil. Each year a little more meadow can thus be reclaimed depending on the need of the cattle owned by each family.

In Machorras (a little village in the north of Burgos Province), the meadows closed by walls of stone and their concomitant farmhouses are characteristic of the area, which extends from an altitude of 800 to 1300–1400 m. Here, the grazings are periodically burnt off, and are dominated by *Ulex gallii* and *Erica vagans*. The latter are grazed by horses and donkeys, cows and sheep (the Churro breed). The farmers burn the rough pasture in February–March while the ground is still frozen and winds are not likely to be strong. The origin of the *pasiego* system reaches a long way back and is historically interesting.

**Future perspectives.** Within a relatively small area of the great mountains and the associated valleys there is a gamut of habitats, different vegetation communities, different types of woods, meadows and pasture-land with the accompanying variation of animal breeds. Associated with the animals which have adapted to their particular environment, human groups have grown up with a

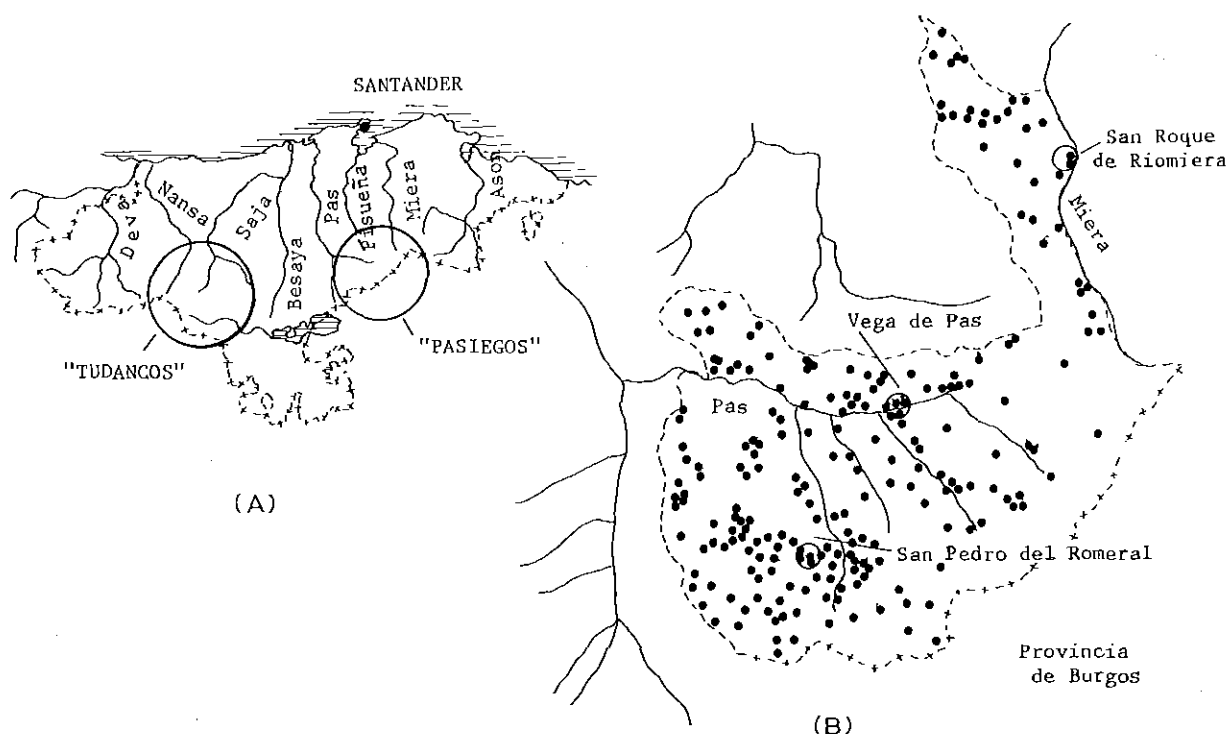


Fig. 3.12. The *pasiego* people in the mountains of Burgos-Cantabria. A. *Tudancos* region with rough grazings described in the text. B. The scattered habitat type of the *pasiego* people in Cantabria province. Every dot is a house, making three municipalities named in this figure.

specialized knowledge of animal husbandry. If one takes into consideration the great natural diversity, which is nevertheless unified by a long common evolution, one can see that there are many possibilities for improved organization in the foreseeable future.

To the south of Campoó, in the province of Palencia, the land opens out to form the great plains of Tierra de Campos. The transition is gradual, and near the Cantabrian Mountains we find habitats where all types of meadows and forage crops can be cultivated, the most important being lucerne. This latter is grown either with or without the help of irrigation. This is an area where the old cattle markets and fairs were held; here nowadays there are experiments in the crossing of different breeds to produce hybrids showing heterosis. It is also an area where sheep density increases, the Churra breed being mainly utilized for the production of milk. There has been an increase in both cattle and sheep production in this zone. Cow husbandry has created areas of short pasture which, in turn, the sheep resident here

graze with facility. Since this expansion has developed to different stages in different places, it is now possible to study directly the progress which has been made.

#### The Pyrenean sector

**Grazed forests in the subcantabrian part of Burgos-Navarra (2a in Fig. 3.10).** This is a mountainous part of Spain drained by the Ebro Valley. The climate is a transition from the humid Cantabrian to the continental Mediterranean type. Erosion becomes strong on these steep slopes, and accordingly the traditional agriculture evolved by using only restricted ploughing and by saving natural forest subject to limited grazing.

The dominant trees are semideciduous oaks (*Quercus faginea* ssp. *navarrana*, *Q. pubescens*, and *Q. pyrenaica*) and *Q. robur* remains rare on the more humid soils. Box (*Buxus sempervirens*) and *Q. ilex* make a dense canopy on the driest slopes. Naturally this landscape is the "home" of pigs (of the types *chato alavés*, *lermeño* and *baztanés*).

However, nowadays the autumn grazing of acorns by pigs (*montanera*) has disappeared and the *lacha* sheep are grazing all the year in forest and scrubs, together with an increasing number of horses. The pony (*jaca navarra*) is also typical of this landscape.

At the present time, the more intensified agriculture is limited to the deep valley soils, but the fields are always surrounded by hedges, shrubs and trees, mainly relicts from the ancient forests. Permanent grasslands are dominant on slopes, situated below the grazed forests.

Pastures with *Brachypodium pinnatum* dominant, together with *Erica vagans* or bracken (*Pteridium aquilinum*) show bad grazing techniques in this landscape, promoted by the abandonment of marginal lands. Ecological diversity is favouring grazing husbandry in this attractive part of Spain. The communal organization and other historical influences, together with an improved road system, will be helpful in improving a new animal husbandry.

#### Aragón (2b in Fig. 3.10)

**The *boalares*.** The villages of the Huesca Pyrenees, like many other agricultural provinces of Spain, retained some plots of forest from the communal property. Traditionally these plots were grazed by traction animals (oxen, horses, mules and donkeys). They are called *dehesa boyal*, *boveral* or *boalar*, meaning a surface reserved for oxen. The dominant tree is a local oak or *quejigo* (many strains of *Q. faginea*) or in the more Mediterranean part the evergreen oak (*Q. ilex* subsp. *rotundifolia*). Until recent times (1940–1960) shrubs were very sparse under the trees, and were eliminated by heavy grazing, but since the use of mechanical tractors has become frequent, this special grassland has evolved towards a natural forest.

Every hamlet in this part of the Pyrenees has its own *boalar* with an area of 2 to 10 ha according to the exigences of ploughing. Under this very sunny climate, good grassland can be protected by a canopy screen of pruned trees. Animal dung and urine create good conditions for grass under heavy grazing pressure. This special sod and very productive turf should be used in the future to diversify the grassland in every mountain village, mainly because it is accessible and well adapted to grazing.

**Development of meadows from fields of sainfoin and lucerne.** Some characteristics of mountain meadows are summarized in Fig. 3.13. The graph (Fig. 3.13c) explains two important effects on quality of meadows. The ordinate axis is a quality index for the first cut [DNDF = Digestibility of the cell-wall material (neutro-detergent fibre — Goering and Van Soest, 1970-)] and the abscissa the cutting date. The oceanic type of climate of the more westerly sites (Hecho and Siresa) with a milder spring facilitate an early cut as compared with Anciles and Cerler. The hay quality is better at lower (Hecho, 833 m) than at higher altitude (Siresa, 1050 m), and the same is true in the comparison between Anciles (1200 m) and Cerler (1500 m) in the eastern Alto Aragón.

Table 3.1 shows the location of eight sampling sites on present-day grassland: some of them are coming from old fields (2, 3 and 5), others from lucerne fields (1 and 4) and finally one comes directly from a cleared forest (8). In the last years some fields were sown with selected grassland seed (6 and 7). In general, we can see the height of grasses and the stabilization of legumes at low levels.

Table 3.2 summarizes the total production (cutting and grazing) of a typical meadow of this region.

Table 3.1 emphasizes the effect of manuring on the first cut (June 1977) under diversified conditions of mountains. Lucerne remains many years together with new-coming spontaneous species, and maintains fertility in the topsoil. In the same way, sainfoin improved soil fertility on dry slopes on limestone. In order to establish new meadows, it will be essential to use adapted legumes and grasses like cocksfoot (*Dactylis glomerata*) or other selected seeds, always with heavy manuring.

**The *borda* for hay and animals.** In the Spanish Pyrenees, *bordas* are not very frequent except in the central region where the big valleys are suitable for important hay production. Figure 3.14C shows the big dissimilarity between the eastern and western sides of the Monte Perdido, in the centre of this section. The Ancient Pyrenees (of Primary or Palaeozoic age) are more important to the east, while the Sierras Interiores (more recent, of Oligocene age) are predominant in the west; consequently, the big valleys are frequent in the east. The altitudinal distribution of *bordas* is

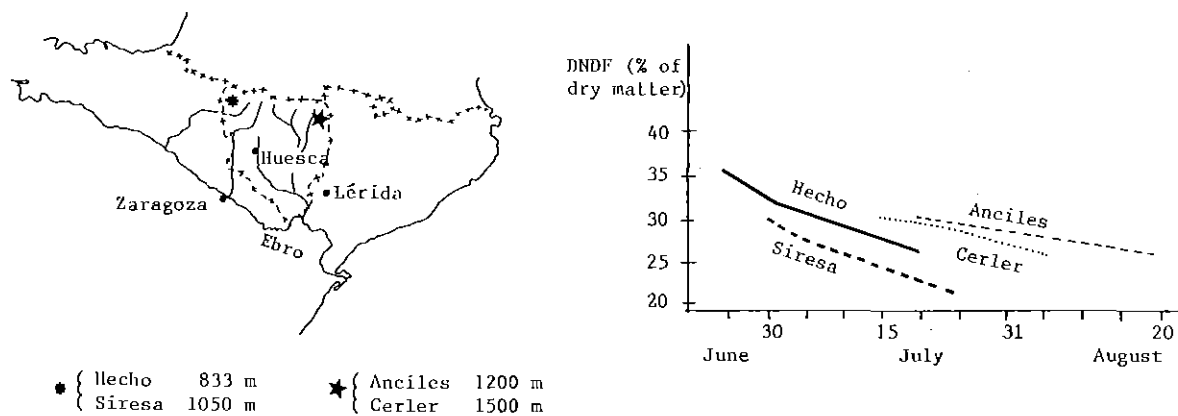
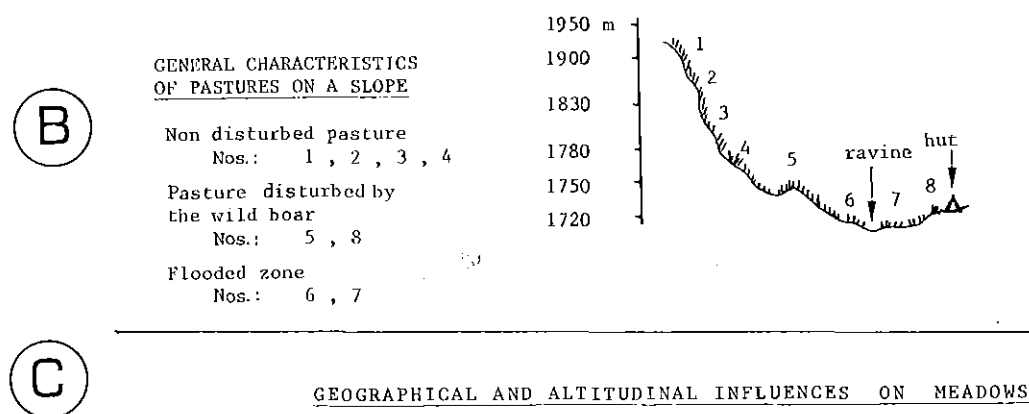
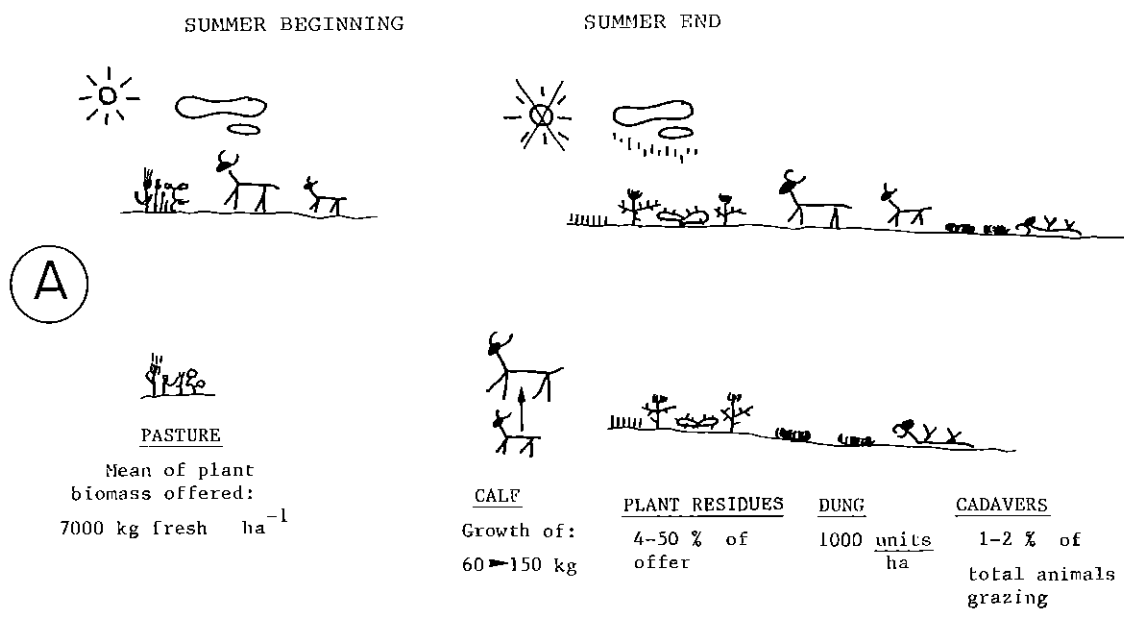


Fig. 3.13. Some characteristics of Pyrenean pastures and meadows. A. A typical seasonal sequence for cows in a Pyrenean grassland. B. A topographical sequence in the western Pyrenees from 1720 to 1950 m. The diversified production is specified in Table 3.3. C. The figure explains the production of meadows situated in the Western and Central Pyrenees. Production is indicated (Tables 3.1 and 3.2).

TABLE 3.1

Some characteristics of Pyrenean meadows

Sites	Height of plants (cm)		Fresh weight g m <sup>-2</sup>	Composition % of DM				DM %
				grasses	legumes	composites	others	
	panicles	foliage						
1	60	40	1592	76	21	0	3	27
2	70	45	2365	80	10	6	4	20
3	60	30	1632	90	8	0	2	22
4	45		1482	22	59	14	5	24
5	70	35	1715	81	18	0	1	25
6	95	45	1865	86	11	2	1	30
7	105	70	2415	51	43	0	6	21
8	105	70	2165	65	17	0	18	19

1. Siresa (960 m). Secondary succession after five years of cultivated lucerne.

2. Siresa (1000 m). Secondary succession after cultivated manured cereal.

3. The same origin as 2, but less manured.

4. Hecho (900 m). Lucerne field four years old without manure.

5. Hecho (900 m). "Natural" meadow ten years old. Secondary succession after cultivated cereal.

6. Hecho (800 m). Meadow five years old sown with selected seed.

7. Anciles (1130 m). Meadow three years old sown with selected seed and manured.

8. Anciles (1130 m). "Natural" meadow 20 years old.

Date of sampling: June 1977.

TABLE 3.2

Total production of a typical Pyrenean meadow

	kg DM ha <sup>-1</sup>
First cut	3200
Second cut	1920
Spring and autumn grazing	594
Total	5714

shown in Fig. 3.14D. In the eastern Alto Aragón (Sobrarbe and Ribagorza), one finds this type of farm building called *borda* where hay is stored on the first floor, while the lower part is devoted to animals. That is the essential construction, but in some villages a small hut may be included, in which

the herdsman and his family can stay for some days during the hay harvest.

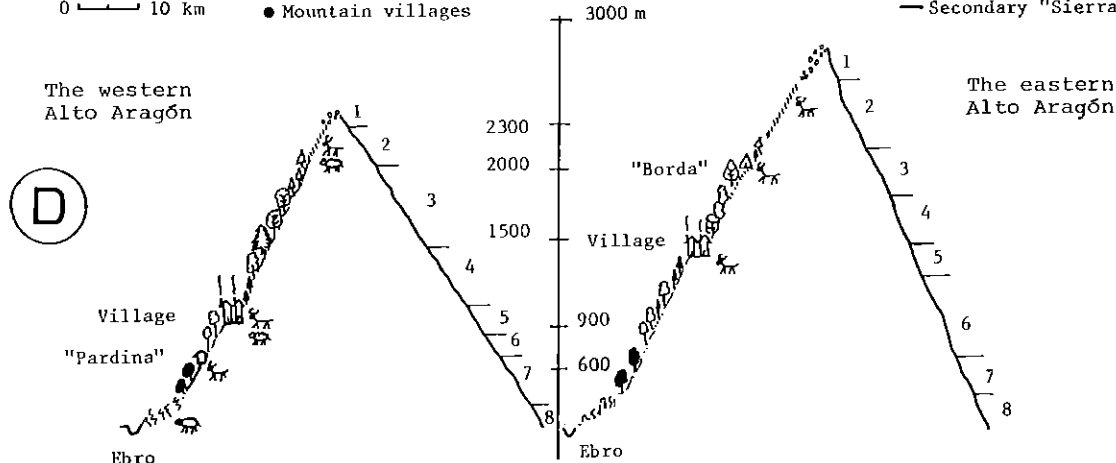
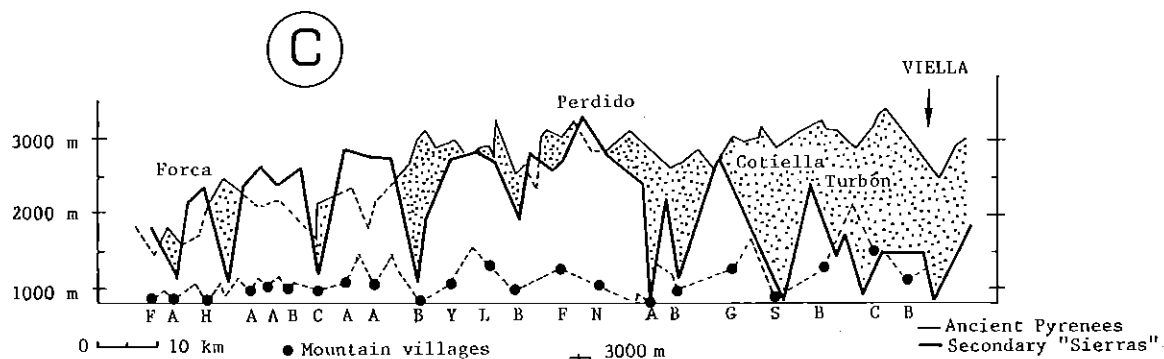
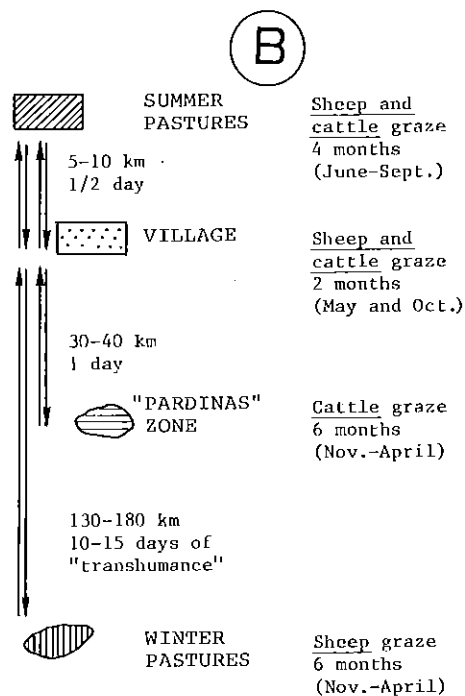
The cows are stabled only for some months — a sufficient time for them to eat the stored hay cut from the neighbouring meadows. During the spring, these meadows receive all the manure produced in the *borda*. Thus, the building acts as a collector of fertilizers coming from pastures, in its turn favouring hay-making. These plots are private properties mixed among the communal pastures, and they need protection by hedges.

Traditional utilization of *bordas* was in cereal culture, and they were not formerly as big as at the present time. Isolation and demographic pressure forced cereal cultivation up to 1950 m on some favourable sites (*panares*), with a very long growing period (13 months, from August to September of the next year). Nevertheless, in recent

Fig. 3.14. Pasture management in the central part of the Pyrenees. A and B. Schemes showing the transhumance of flocks of sheep and cattle in Aragón. C and D. The situation of the villages and temporary houses (*borda* or *pardina*) in connexion with altitude in the Axial Pyrenees and in the youngest Sierras Interiores. The mountain villages are indicated by their initial letter: F=Fago; A=Ansó; H=Hecho; A=Aragués; A=Aisa; B=Borau; C=Canfranc; A=Acín; A=Acumuer; B=Biescas; Y=Yesero; L=Linás; B=Broto; F=Fanlo; N=Nerín; A=Ainsa; B=Bielsa; G=Gistain; S=Seira; B=Benasque; C=Castanosa; B=Bono. In D, the numbers indicate: 1=crest rocks; 2=alpine pasture; 3=subalpine pasture and shrubs; 4=forest; 5=cultivated land; 6=shrubs and dry forests; 7=evergreen oaks; and 8=steppe vegetation.



- Summer pastures  
 Spring and autumn p.  
 Winter pastures of cattle  
 Winter pastures of sheep  
 Property land  
 Land on hire



times potatoes and lucerne have become more convenient for this purpose; the present-day area of grassland on these mountains is a consequence of the abandonment of cereals.

**Wintering problems. Complementarity of the high mountains and the steppe grassland in the Ebro Valley. The high mountain grassland modalities.** The very big possibilities of summer grazing on mountains like the Pyrenees are always limited by wintering needs. Every mountain county has its corresponding lowland for wintering. The prehistoric shepherds imitated the behaviour of wild large herbivores, descending from the Pyrenees to the Ebro Valley. Nowadays the trails for flocks (*cañadas*) persist and are protected by specific regulations.

From early ages we have evidence of these flock movements, not only for sheep but also for donkeys, horses and cows. The grazing value of steppe bushes (*Atriplex halimus*, *Artemisia herba-alba*, *Salsola vermiculata*, *Suaeda fruticosa*) and grasses (*Brachypodium*, *Koeleria vallesiana*, *Lygeum spartum*, *Stipa lagascae*, *S. parviflora*, etc.) is maximal in autumn when pregnant sheep come down from the mountains. Until the 20th century ploughing and irrigation were not very important, and flock movements were easier than now. Figure 3.14 represents this system. Figure 3.14A shows four areas of pastures: summer pastures in communal properties, spring and autumn pastures in private plots near the village, winter pastures of cattle in rented land in the *pardinas* zone and winter pastures of sheep in rented land in the region of *La Ribera*. Figure 3.14B explains the movements between these areas and the times of residence; the arrows indicate the direction of travel.

Figure 3.14D shows the *pardina* site in western Alto Aragón. The *pardina* is the residue of the *Reconquista* big properties, scattered on the poor Pyrenean dry slopes, not very cold in winter. This pasture zone has been managed by shepherds of the high valleys since 1950–1955, when the former owners emigrated to Zaragoza or Barcelona and rented their properties. These grasslands are very poor (7–10 ha per cow) as a result of the abandonment of ancient cereal fields without any improvement.

Obviously, mountain grasslands are closely related to geophysical conditions, mainly to soil

depth. For climbing to dry limestone crests and slopes, sheep are preferred; the “Mancomunidad de Ansó-Fago” in western Aragón supported more than 60 000 animals in 1940. On the other hand, the Permo-Triassic sandy soils and siliceous rocks with tall grasses are better for grazing cows and horses.

Figure 3.13A summarizes the activity of grazing cows in summer on mountain pastures. Arriving to nutritive young grass after snow-melt (May–June), the animals graze all summer; when the autumn comes only thistles and poisonous plants remain, together with dung and dead carcasses.

Figure 3.13B and Table 3.3 show the composition of grass before grazing on a north-facing slope at Plandániz (Hecho Valley), from the crest to the bottom of the valley. On site 1 legumes are important (*Trifolium alpinum*), and on site 2 *Lotus alpinus* abounds; sites 5 and 8 have *Trifolium repens* and *T. pratense* over ground disturbed by wild boar or by the presence of a hut respectively. Of course, grasses are dominant everywhere (*Agrostis*, *Festuca*, *Nardus*, *Poa*, etc.) but in flooded soil (site 6) the genus *Carex* is dominant. Other genera such as *Phleum* and particularly *Dactylis* are only found on disturbed soils (sites 5 and 8) where the wild boar dig for little tubers (*Conopodium majus* principally).

The quality of this grassland is very high, but the plant biomass is small and develops late. The southern slopes provide an earlier pasture. Altogether, the area was put to use by skilful shepherds until recent times. Moreover, the chamois (*sarrio* or *rebeco*) — a wild ruminant of the Pyrenees — is also grazing here.

**The future of saline soils.** Throughout the geological ages, low rainfall and heavy evaporation due to strong winds (*Cierzo*, from the west-northwest, but dry because it loses humidity in the mountains before reaching the Ebro Valley) caused accumulation of salt in the central Ebro Valley. This endorheism persists constantly in some sectors such as Bardenas (Navarra), Cinco Villas (Zaragoza) and Monegros (Huesca–Zaragoza), on the north of the Ebro River.

These soils with gypsum and soluble salts have been irrigated on a large scale, and the process results in a brackish contamination of normal soils. Without doubt, it is a very big problem that is overcome by establishing new meadows well



TABLE 3.3

Some characteristics of Pyrenean pastures

Sites	Height of plants (cm)		Fresh weight g m <sup>-2</sup>	Composition (% of DM)				DM (%)
	panicles	foliage		grasses	legumes	<i>Carex</i> spp.	others	
1	25	5	100	45	39	7	9	36
2	35	5	240	84	15	0	1	40
3	50	12	530	81	8	7	4	29
4	60	15	780	72	5	0	23	31
5	50	12	400	81	19	0	0	38
6	30	5	120	2	3	95	0	37
7	50	10	400	53	4	34	9	36
8	55	15	1020	60	19	0	21	31

Date of sampling: 5 August 1974.

adapted to the brackish water and soil. Among the Chenopodiaceae there are some genera pre-adapted to these soil and climate conditions, mainly species of *Atriplex* and *Salsola*; *Salsola vermiculata* (sisallo) produces its fruit in autumn, and the sheep enjoy it. The C<sub>4</sub> plants (especially those with grey and glaucous colouring) are resistant to losses by photorespiration, and are very promising for this environment. The production of *Chenopodium* and *Amaranthus* seeds for irrigated brackish soils should also be investigated.

**The northeastern sector of Cataluña** (2c in Fig. 3.10). The humid Mediterranean climate of this part of Spain favours a farming dispersed over hills and valleys. Such a dispersion is typical of oceanic climates and regions under a long political stability from the Middle Ages till recent times. Effectively, this sector formed the boundary of the empire of Charlemagne ("Marca Hispanica").

The Roman institution of inheritance linked to the farmhouse (family unit) was also a new factor for stability. So, diversity of geophysical conditions and continuity in management allowed a very good protection against historical changes, preserving the more essential structures. In every farm one can find the following elements: forested part, permanent grassland, Mediterranean cultivation of winter cereals, maize, potatoes and typical forage crops like *Trifolium incarnatum*, *T. pratense*, turnips, cabbages, Italian ryegrass, lucerne, many horticultural plants and the poplar (*Populus* spp.) or plane tree (*Platanus hybrida*) on fluvial terraces.

Nowadays, intensified exploitation is being directed to the famous calves, milk, or selected fruit production.

Near the Gulf of Rosas, on fluvial recent soils, one finds the *closes*, fields fenced by stone walls or hedges. On these fields, bordering the wetter meadows, is also found the *Emporda* type of lucerne. Transhumance from the eastern Pyrenees to this sector (see Fig. 3.10) was very important, and explains the development of lucerne and sainfoin forage.

There are books on Pyrenees like Sorre (1943), Solé Sabaris (1951), Viers (1973) and Taillefer (1974), with good descriptions of Pyrenean life and also those of Violant (1949), Montserrat (1966, 1978) and Balcells (1971). A very good picture of the Atlantic part was given by Lefevre (1933); and the eastern part of Navarra, Roncal, was described by Puigdefábregas and Balcells (1970). The central part of the Pyrenees, the Aragón sector, was studied by Daumas (1967 and 1976), Ocaña (1978) and Fillat (1980) and Cataluña by Vilá Valenti (1950, 1963) and Generalitat de Catalunya (1981).

#### The central mountains of Spain

The Cantabrian foothills facing into the Castilian Meseta sometimes form a vast glaciis with well-washed soil. Here one is dealing with ancient *marojales* (forest of *Quercus pyrenaica*) and *quejigales* (*Q. faginea*), reduced to the present state by fires which have got out of control. The vegetation of the dry grassland and heathland (*páramos*) is

made up of hard-leaved grasses (*Avenula mirandana*, *Festuca hystris*, *F. indigesta*, *Koeleria vallesiana*, etc.) together with Cistaceae and Fabaceae (*Cistus*, *Halimium*, *Helianthemum*, *Tuberaria*, *Astragalus*, *Genista occidentalis*, *G. pumila*, *Medicago*, *Trifolium*, etc.). Dry air and contrasting temperatures are characteristic of this environment which is epitomized by the juniper tree (*Juniperus thurifera*) so typical of this region, as are *J. nana* and *J. sabina*.

Although the above vegetation is typical of the Cordillera Ibérica, Montañas de León, Sanabria and the Carpetana between Somosierra and Gredos, oak woods are also widespread, and to a lesser degree pine forests (Sierra de Guadarrama, Pinar de Lillo of León province, Sierra de la Demanda, Cameros, Sierra del Moncayo and Montes Universales): there are a few beech woods on slopes facing north-west with their characteristic frequent mists caused by the cooling of the ascending air currents. There are also extensive moorlands, where the dominant plant is *Calluna vulgaris* associated with *Erica australis* and at times *Vaccinium myrtillus* and *V. uliginosum*. The presence of *Erica arborea* and *Genista florida* are indicative of a habitat where there is deep soil and underground water.

**The Cameros** (3a in Fig. 3.10). The environment of the Cameros between Logroño and Soria (Calvo, 1977) can be taken as generally representative for the central mountains of Spain. When the cows leave their winter stable, pregnant, they reach Cameros rough pastures where they give birth, and they descend to the village when they sense the approach of the first heavy snowfall. The *Camarana* cow or *Pinariega*, was perfectly adapted to the poor quality of the grazings, scattered between small woods and heathland, where each cow has its haunt, gives birth and returns home with its calf. Sheep graze on the drier slopes, and transhumants are frequent in this part of Cameros.

The phytosociology of the Cameros Mountains with grasslands has been described by Mendiola (1983).

Those meadows which need cutting only once a year are located near centres of habitation; here the *pasiego* and the *borda* of the Pyrenees and the Cantabrian Mountains are virtually non-existent. Instead there are meadows of *Arrhenatheretalia*

characterized by an abundance of *Malva moschata*.

Near the *páramo*, where the heathland is driest, are found oak woods of *Quercus pyrenaica*, an excellent oak for forage. It provides scrub for grazing, with shoots c. 10 to 25 cm in length, and abounds in Zamora, Avila-Segovia, Sierra de Guadalupe, etc.

**Meadows in the high mountains of Teruel** (3b in Fig. 3.10). In the high mountains of Teruel (1500–2000 m) pine forests predominate (*Pinus sylvestris*) intercalated with small woods of *Quercus pyrenaica* and hazel (*Corylus avellana*) in the Sierra de Gúdar-Valdelinares, where the soil is cooler and richer. The meadow-lands of this eastern zone have been famous since ancient times (Asso, 1779) with pastures where Fabaceae are dominant (*Astragalus danicus*, *Medicago suffruticosa*, *Onobrychis hispanica*, *Ononis cristata*, etc.). The pastures of the Montes Universales are scattered between abundant pine forests and are of a poorer quality than those mentioned above. Methods used for cattle farming were once very similar to those found in the Cameros, but nowadays exploitation for timber takes precedence. Some of the villages in the Sierra de Albarracín keep flocks of transhumant merino sheep which winter in La Mancha (Mesta de Albarracín). In the mountains where soil is gravelly or sandy, *Calluna vulgaris*, *Cistus laurifolius* and *Halimium viscosum* have invaded those pastures which have been burnt off. In these zones goats are the chief grazing animal. A monograph on these grasslands has been published by Gómez (1982).

**Meadows and grassland in the Carpetana Mountains of Central Spain** (3c in Fig. 3.10). The Carpetana mountain chain (Sierra Ministra, 1200 m; Somosierra, 2000 m; Guadarrama, 2400 m) presents a picture of various extensive glaciales sloping gently down towards the Castilian Meseta. The relatively fertile deep soils (*bardal* soils) are most suitable for establishment of meadows and green pasture-land during the summer. Where it is drier, as in Segovia, there are woods of evergreen oak (*Quercus rotundifolia*) and pastures dotted with *Juniperus thurifera*. Towards Somosierra there are grazings on deep soil which are now overgrown with the bracken fern, an index of both their abandonment and the decrease in livestock activity.

In the Escorial and Guadarrama the meadows on deep soil are cut in spring and intensively grazed; the ash (*Fraxinus angustifolia*) borders these meadows. Where *Quercus pyrenaica* grows it is an indication of permeable soil, while evergreen oak and *Juniperus oxycedrus* grow in the drier enclaves at higher altitudes close to 800–1000 m (Rivas Martínez, 1982).

The Avileña cattle are characteristic of these mountains, and are well represented in the Sierra de Gredos and its foothills. *Festuca elegans* growing on the convexities is the dominant summer plant of the upland pastures, while Campanulo-Nardion communities grow in the damper hollows (Rivas Martínez, 1963). Moving southwards the change of level is extremely abrupt, and this contrasted landscape was advantageous to the Avileña breed, which make a short transhumance to the Mediterranean type of pastures of Arenas de San Pedro and the Tiétar Valley; in these wintering zones, *Poa bulbosa* and *Trifolium subterraneum* are abundant.

#### **The Mesta type of animal husbandry in León and Castilla**

This is a sheep system which has been influential from mediaeval times to the present day, and it is characteristic of the northern Meseta. This zone was uninhabited for several centuries during the *Reconquista* (Fig. 3.5E), thus favouring the movement of enormous flocks.

In the part which was reconquered before the 10th century and colonized by freemen, the dominant breed of sheep is the Churra, useful for milk and with rough wool. The landscape is one of heathlands and criss-crossed by wide valleys of deep soil favouring the establishment of meadows. Flocks of 100 to 140 sheep also graze on the stubble of the crops sown in the area, and on other forage crops sown traditionally for work animals. The resident flocks of milk sheep have originated here.

The dominant breed of sheep on the rest of the Meseta is the Entrefina Castellana, used for both their meat and milk. Flocks of about 200 sheep graze in the area all the year round. Here one must distinguish between two principal patterns: that in the west associated with extensive wooded pasture-land, and the eastern pattern, where moorland on limy soil is suitable for the cultivation of sainfoin.

The winters are long, and, while grazing still continues in some of the meadows bordering watercourses, feeding is supplemented by hay made from sainfoin and lucerne. The moorland sheep graze also on the stubble which remains after harvesting sainfoin and lucerne, and this ensures that the meadows lying along the watercourse continue to be productive.

When the severe winter conditions of the *páramo* prevail, one finds in this zone (Sierra Ministra, Molina de Aragón, etc.) the hardy Ojalada Soriana breed of sheep, a branch of the Ibérico stock. To the southwest, in La Alcarria, yet another hardier breed of sheep is found, the Alcarreña, a branch of the Entrefina especially adapted to mountain areas (see Fig. 3.6A).

The lack of emphasis on wool production in sheep farming is due to the running down of the wool industry and the collapse of the Mesta organization. The "Honrado Concejo de la Mesta" was originally created and supported by the King in 1273 (Klein, 1964) in order to take advantage of the production of enormous quantities of wool obtained from the merino. This association concerned with sheep farming created wealth for the Royal Treasury, and was thus encouraged to the detriment of a more general agricultural policy (cultivation of arable land). However, the increase in population during the 18th century and the collapse of the foreign market caused the loss of these privileges and their legal abolition in 1836 (García, 1978).

Figure 3.10 shows the great sheep trails of the central-western area where the Castilian Mesta was important. To the east there were the Mesta de Albarracín and the Casa de Ganaderos de Zaragoza organizing the Montes Ibéricos and Ebro Valley transhumances. The short grazing provided by *Poa bulbosa* and *Trifolium subterraneum* (Rivas Goday and Rivas Martínez, 1963) is good for the merino sheep. This type of pasture-land is principally confined to the west (end of the arrows in Fig. 3.10) and has a high winter production as indicated by the rainfall maps (Fig. 3.3). The long journey involved in transhumance enables the sheep to take advantage of the short tough pastures of the *páramos* and of the limestone subcantabrian mountains of León, Palencia and Soria. This is why the wide sheep trails, with areas set aside for resting, have persisted in all their complexity until the present day.

As wool has become a less important commodity and the importance of producing prime lamb and cheese has taken over, the need for transhumance is no longer paramount, the result being that more and more flocks of merino stay all the year in their original province. From the above breeds and crossbreeds enough lamb is produced to be industrially exploited. Merino is now exploited for its wool in Australia, where population density is low and there are similar Mediterranean conditions to those found in the west of the Iberian Peninsula.

#### **The Manchego system of husbandry (5 in Fig. 3.10)**

To the south of Madrid, the Meseta is at a lower altitude than to the north (average altitude 600 m as opposed to 800 m), the summer is hotter and drier, and thus the grazings are rougher and poor in quality. Less arable land is dedicated to pasture or scrub, most of it being under cultivation, with grapes as the main crop. Frequently olive groves alternate with the vineyards, and occasionally olives, vines and almond trees all grow in the same field.

The combination of a temperate winter, deep soil and the diversity of crops, (including fodder barley, oats and legumes grazed in the field), opens out the possibilities of a much greater variety in diet for the sheep during the lactation period. The milking of sheep for the manufacture of cheese is a very old industry. Vines and trees supply a source of food in autumn, and modern irrigation has meant that the small flocks of 40 to 60 sheep can be kept near the centres of habitation in La Mancha. However, the larger flocks (200–250 sheep) need more extensive areas of uncultivated land where there are wide sheep trails. Usually they are kept on large provincial estates which were previously associated with the mediaeval Ordenes Militares (Calatrava, Alcántara) on the southern frontiers of the Christian Kingdoms.

As with other breeds of sheep, the Manchega graze on the stubble in summer and on the uncultivated land around in winter. The number of forage crops grown (such as cereal-legume mixtures for grazing by sheep) have increased but there is not sufficient humidity to produce summer forage, like some of the legumes sown in the northern part of the Castilian Meseta. The deep

soil permits the dry farming of lucerne and also, where there is irrigation, a variety of forage crops plus lucerne. Pastures are dominated by rough grasses as *Aegylops*, *Bromus* and *Taeniatherum*, together with *Medicago* and other annual legumes.

To sum up, we find a great diversity within this environment, a variety of different products even in autumn lacking pasture in Mediterranean climate and a breed of sheep resistant to both heat and drought. Given the possibilities for the further expansion of forage crops, using underground water for irrigation, the Manchega sheep could have a promising future.

A greater diversity in diet can be provided by use of vine shoots and the leaves of trees in autumn, thereby avoiding the destruction of annuals in a season which is critical for their establishment. As mentioned above, the sheep of this region stand up well to the extreme summer heat and continue to produce milk, which is why they have been selected to populate this Mediterranean type habitat.

#### **The Segureña type of grassland system (6 in Fig. 3.10)**

To the southeast of the Peninsula the climate becomes drier and the vegetation woodier. Because of these conditions there are more goats and fewer sheep. As well as the sheep indigenous to the coastal regions (*Guirra* in Valencia and Alicante), a hardy animal which resists heat and drought, there is a second breed of sheep, the Segureña, scattered throughout the region. The latter is similar to the Manchega sheep but produces less milk and is of a hardier stock.

The vegetation covering the area inhabited by the Segureña sheep is mainly rosemary (*Rosmarinus officinalis*) and rush (*Lygeum spartum*) with tough grasses (*Agropyron*, *Brachypodium*, *Helictotrichon filifolium*, *Stipa*, etc.) and scrubby pastures, thus producing conditions for grazing which would not be tolerated by the more productive breeds of sheep. Traditionally, the land is used for the production of rushes and in the valleys, interspersed between the arid mountains, some cereals are cultivated. Given these circumstances it would seem sensible to encourage the expansion of the Segureña breed, thus increasing the production of lambs which are much in demand.

**The *Dehesa* type of grassland in the west of the Iberian Peninsula (7 in Fig. 3.10)**

In the west, due to the extreme summer drought and the poorness of the soil, the cultivation of cereals is not profitable, and instead there are large areas of wooded pasture-land supporting a large range of livestock, such as swine, sheep, cattle, horses and donkeys. In some areas there are also flocks of domestic fowl of various types. The density of trees increases as one goes further south, thus protecting the land surface from the intense heat and insolation. There is also an increase in the number of swine.

The tradition of use of forest clearings for the grazing of animals is left over from earlier epochs. At one time, when demographic pressure was not so great, other mountain areas were grazed in the same way; but nowadays it is a custom which persists mainly in the west. Here the original evergreen oak has been preserved; and, where this is not so, a more productive oak with a large sweet acorn has been planted in woodland pastures.

Historically speaking (Balcells, 1978–1982), from the time of the *Reconquista* the land was divided into large estates (100–500 ha). There has been little change in this respect due to the low fertility of the soil, a fact which has precluded intensive cultivation in the area. Only in Tierra de Barros (Extremadura Region), and along narrow river valleys, properties are smaller and intensive cultivation takes place.

If one considers a typical or average *dehesa*, 10 to 30% of the land may be under cultivation while the rest is employed in different ways which vary from Salamanca to Huelva. In the western sector of Salamanca there are two main methods of using the land, one so-called *al tercio* and a second named *a cuatro hojas*. *Al tercio* means that 2/3 of the land is used for cultivation of cereals while a third lies fallow. In the second, 30% of the land is dedicated to growing cereal which then provides stubble for grazing (Gómez Gutiérrez, 1982 in Balcells, 1978–1982). Where there is a greater density of trees, grazing continues until it is invaded by scrub or toxic plants and a system of rotation must be applied in order to clean the area. The dense evergreen oaks are intensively pruned, before ploughing the soil, and cereal is sown the year after. This process continues until the soil becomes impoverished and has to be abandoned.

The abandoned fields of stubble are given over to grazing, and vegetation becomes progressively denser.

The watercourses and hollows found between areas of cultivation provide productive pastures which are cut sometimes, especially where fertilizer has been applied; it helps to keep the pasture clear of undergrowth. The principal plants found here are *Trifolium striatum* with *T. subterraneum* and *Agrostis castellana*.

The Morucha cow is typical of *dehesas* of Salamanca, and it keeps the pasture both clean and short for subsequent grazing by the Entrefina Castellana sheep. This is the limit of the zone where the Iberian pig occurs, the production of acorns being scarce and variable from year to year. Even so, the herdsmen have been responsible for planting acorns from which many of the evergreen Salamanca oaks grow. By rooting in the soil, the Iberian pig causes a series of microchanges in the pastures, thus creating a diversity used efficiently by the ruminants. Finally, the common Spanish turkey (*Pavo mexicano*) feeds on acorns, and at the same time controls the populations of some insects and molluscs.

In Extremadura, acorn production is greater and there are many more pigs, with a consequent decrease in cattle density. The Blanca Cacereña cow is now practically non-existent, and various breeds of cow can be seen locally. The environment is optimal for merino sheep, and there are some flocks resident all the year round while others still practice transhumance to the Cantabrian Mountains, protected from wolves by the *mastín extremeño*. This big shepherd dog carries a collar with nails and fights with wolves, but when animals such as horses and Cantabrian autochthonous cows graze without shepherd or dog the wolves kill some — between 1974 and 1979 236 animals, predominantly colts, were killed in Asturias (Brana et al., 1982; see also López et al., 1981).

Approaching the west side of the Sierra Morena (Sierra de Tudia and Aracena) one finds an increase in the number of herds of Retinta cows, which maintain the pastures clean without the need to resort to cultivation. In these *dehesas* there is a great number of evergreen oaks, even along the edges of waterways. The increase in tree density protects against insolation and feeds the great number of pigs. This is the centre of the region of

There are more difficulties in the Ebro Valley, where ploughing and recent extension of irrigated fields are making it more and more difficult to winter in the steppe area. Moreover, one cannot forget the poor possibilities of marriage for young shepherds. In fact, this is a very big social problem which can ruin a traditional transhumance.

The two models of transhumance described above, one linked to the Mesta and the other to the Casa de Ganaderos, clearly typify the situation in many cases. Although diversity of grassland production is still persisting, unfortunately the shepherd's organization has disappeared without being replaced by any modern equivalent.

Faced with such a high diversity of grass production in space and time, the first problem will be always to put grazing animals on each pasture at the best time. Traditionally, the family used to be divided for half of the year, shepherds wintering very far from home. Nevertheless, there are many unpublished possibilities for overcoming this problem. The typical *Mancomunidades Ganaderas* might be evolved and find legal solutions to facilitate these flock movements.

On the other hand, animal selection is mainly directed to indoor production; we think it would be more important to select for correct behaviour, and look for a good guiding animal. As gregarious behaviour is normal for these animals, it should be possible to exploit it.

The next step could be a selection for making better use of the hard grasses and sometimes of the bushes or shrubs dominant in every province. For this reason, our grassland descriptions were based on characteristic animal breeds. Among these traditional specializations it should be possible to select the most efficient for every situation, and particularly for mobility.

The recent techniques of animal production involve heterosis by crossing some breeds. In our opinion it would be easier to maintain every breed in its own environment. As we have emphasized, such a genetic and ecological bank could be full of possibilities for animal husbandry and grassland management in Spain.

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#### REFERENCES

- Aguilar, S.A., 1961. *Nuevo Atlas de España*. Aguilar, Madrid, 455 pp.
- Aljama, P., 1982. *La Raza Retinta*. Monte de Piedad y Caja de Ahorros de Córdoba, 200 pp.
- Asso, I., 1779. *Synopsis stirpium indigenarum Aragoniae Praefatio*. Massiliae, p. XIV.
- Balcells, E., 1971. *El ambiente y el hombre en la montaña*. Conferencia pronunciada en el Patronato Alonso de Herrera del C.S.I.C. el 4 de febrero de 1971, Madrid.
- Balcells, E. (Editor), 1978-1982. *Estudio integrado y multidisciplinario de la Dehesa Salmantina*. 1 Estudio Fisiográfico-descriptivo, 2 fasc. 243 pp., 3 fasc. 343 pp., 4 fasc. 83 pp. UNESCO MaB Project No 506. Salamanca-Jaca.
- Brana, F., Del Campo, J.C. and Palomero, G., 1982. Le loup au versant nord de la cordillère Cantabrique. *Acta Biol. Montana*, 1: 33-52.
- Calvo, J.L., 1977. *Los Cameros*. Instituto de Estudios Riojanos, Logroño, Vol. I: 298 pp. Vol. II: 18 mapas.
- Cavaillès, H., 1931. *la Vie Pastorale et Agricole dans les Pyrénées des Gaves, de l'Adour et des Nestes*. Armand Colin, Paris, 403 pp.
- Daumas, M., 1967. "Pardinas" et "masías" dans le Haut Aragon oriental. *Pirineos*, 83-86: 105-118.
- Daumas, M., 1976. *La vie rurale dans le Haute Aragon oriental*. C.S.I.C. Patronato "José María Quadrado" y "Alonso de Herrera". Instituto de Estudios Oscenses y de Geografía Aplicada, Madrid, 774 pp.
- De Bolòs, O., Molinier, R. and Montserrat, P., 1970. Observations phytosociologiques dans l'île de Minorque (Com.-S.I.G.M. no. 191). *Acta Geob. Barcinonensis*, 5: 1-150.
- De Juana, A. and Zuzuarregui, J., 1966. *Ganado Porcino*. Ministerio de Agricultura, Madrid, 182 pp.
- De Miguel, A., 1978. Pasado y presente de las razas vacunas santanderinas de montaña. Selección de textos y comentarios. *An. Inst. Estud. Agropecuarios*, III: 9-63.
- De Terán, M., 1947. Vaqueros y cabañas en los Montes de Pas. *Estud. Geogr.*, 28: 7-57.
- Díaz Fierros, F., 1971. *Contribución a la Climatología Agrícola de Galicia*. Universidad de Santiago de Compostela.
- Echevarría Belzunegui, T., 1975. Raza vacuna pirenaica. Evolución, situación actual y perspectivas. *Imp. Diputación Foral de Navarra*, Pamplona, 197 pp.
- Febrer, J., 1930. Atlas pluviométrico de Catalunya. *Mem. Patxot*, 1: 523 pp.
- Fernández Casas, J., 1974. Vegetación y flora de Sierra Nevada. Los borreguiles. *Bol. Estac. Central Ecol.*, 3(5): 29-39.
- Fillat, F., 1980. *De la trashumancia a las nuevas formas de ganadería extensiva. Estudio de los valles de Ansó, Hecho y Benasque*. Memoria Doctoral.
- Fillat, F., 1983. Estacionalidad de las precipitaciones en España: clasificación de zonas homogéneas. *VIII Reun. Ponencia de Bioclimatología*. Zaragoza.

- Fillat, F. and Montserrat, P., 1978. Complementariedades en la regionalización agropecuaria. *Pastos* 8(1): 7-23.
- Francia, I., 1978. *La Raza Morucha*. Mataderos del Oeste, Salamanca, 154 pp.
- García, A., 1978. La agonía de la Mesta y el hundimiento de las exportaciones laneras: Un capítulo de la crisis económica del Antiguo Régimen en España. *Agricultura y Sociedad*, 6: 283-316.
- Generalitat de Catalunya, 1981. *Agricultura i Medi Rural al Pirineu Català*. Generalitat de Catalunya, Barcelona, 394 pp.
- Goring, H.K. and Van Soest, P.J., 1970. *Forage Fiber Analysis*. US Dep. Agric. Handb. 379.
- Gómez, A., 1982. *Estructura ecológica de los Pastos de Monte Turolenses*. Tesis Doctoral. Universidad Complutense de Madrid, 370 pp.
- Gómez Gutiérrez, J.M., 1982. In: E. Balcells (Editor), *Estudio Integrado y Multidisciplinario de la Dehesa Salmantina*. UNESCO MaB Project No 506. Salamanca-Jaca.
- Hernandez Pacheco, E., 1932. Síntesis fisiográfica y geológica de España. *Trab. Mus. Nac. Cienc. Nat., Geología* 38: 1-586.
- Icona, Montero de Burgos, J.L. and González Rebollar, J.L., 1974. *Diagramas Bioclimáticos*. Publicaciones Agrarias, Ministerio de Agricultura, Madrid, 379 pp.
- Instituto Nacional de Meteorología, 1983. *Bol. Meteorol. Diario*, 35: 4 pp.
- Klein, J., 1964. *The Mesta. A Study in Spanish Economic History: 1273-1836*. Kennikat Press, Port Washington, New York, 444 pp.
- Leal, A., 1976. El habla pasiega: Estudio del decurso en el ecosistema cantábrico. *Actas VII Congr. Int. Est. Pirenaicos*, 7(2): 39-52.
- Lefevre, Th., 1933. *Les Modes de Vie dans les Pyrénées Atlantiques Orientales*. Ed. Armand Colin, Paris, 777 pp., 152 figs., 34 pl.
- Liso, M. and Ascaso, A., 1969. Introducción al estudio de la evapotranspiración y clasificación climática de la cuenca del Ebro. *An. Estac. Exp. de Aula Dei*, 10(1-2): 505 pp.
- López, J., 1978. *Antropología de la Ferocidad Cotidiana: Supervivencia y Trabajo en una Comunidad Cantábrica*. Ministerio de Agricultura, Madrid, 282 pp.
- López, T., Espejo, M. and Jimenez, J., 1981. *Explotación de ganado ovino en Extremadura*. CRIDA 08. Badajoz, 16 pp.
- Madariaga, B., 1970. La ganadería en la provincia de Santander. *Publ. Inst. Etnografía y Folklore "Hoyos Sainz"*, 2: 173-210.
- Mendiola, M.A., 1983. *Estudios de flora y vegetación en la Rioja*. Instituto de Estudios Riojanos, Logroño, 311 pp.
- Ministerio de Agricultura, Pesca y Alimentación, 1980. *Anuario de Estadística Agraria 1980*. Madrid, 660 pp.
- Montserrat, P., 1966. La vegetación en la Cuenca del Ebro. *Publ. Cent. Pir. Biol. Exp.*, 1(5): 1-22 y mapa en negro a 1: 1.000.000.
- Montserrat, P., 1971. El clima subcantábrico en el Pirineo Occidental español. *Pirineos*, 102: 5-19.
- Montserrat, P., 1976. Clima y paisaje. *Publ. Cent. Pir. Biol. Exp.*, 7(2): 149-171.
- Montserrat, P., 1978. La ganadería pirenaica. *Munibe*, 4: 215-238; cf. *Pastos*, 6(2): 247-270.
- Montserrat, P., 1980. Continentalidades climáticas pirenaicas. *Publ. Cent. Pir. Biol. Exp.*, 12: 63-83.
- Montserrat, P., 1981. Rasgos de oceanidad en los fitoclimas topográficos pirenaicos. *Bol. Soc. Brot.*, 54(2ª Ser.): 405-409.
- Montserrat, P., 1983. Aspectos corológicos del dinamismo fitotopográfico. *Collect. Bot.*, Barcelona, 14: 441-452.
- Montserrat, P. and Fillat, F., 1978. La ganadería extensiva y las culturas rurales montañosas. *An. Inst. Estud. Agropecuarios*, III: 83-120.
- Moore, R.I., 1981. *Historical Atlas*. London, 176 pp.
- Muslera, R. and Ratera, C., 1984. *Praderas y Forrajes*. Ediciones Mundi Prensa, Madrid, 702 pp.
- Ocaña, M., 1978. *Ensayo de Planificación Ganadera en Aragón*. Institución Fernando el Católico (C.S.I.C.), Zaragoza, 435 pp.
- Ortega Valcárcel, J., 1974. *La transformación de un espacio rural. Las montañas de Burgos*. Univ. de Valladolid, Secretariado de Publicaciones, Valladolid, 531 pp.
- Ortega Valcárcel, J., 1975. Organización del espacio y evolución técnica en los Montes de Pas. *Estud. Geogr. Homenaje a D. Manuel de Terán*, II: 863-899.
- Otero Díaz, C., 1977. Caracteres esenciales de la agricultura gallega. *Agricultura y Sociedad*, 2: 185-208.
- Puigdefábregas, J. and Balcells, E., 1970. Relación entre la organización social y la explotación del territorio en el Valle del Roncal. *Pirineos*, 98: 53-59.
- Rivas Goday, S., 1964. *Vegetación y Flórua de la cuenca extremeña del Guadiana*. Diputación de Badajoz, 777 pp.
- Rivas Goday, S. and Rivas Martínez, S., 1963. *Estudio y Clasificación de los Pastizales Españoles*. Ministerio de Agricultura, Madrid, 269 pp.
- Rivas Martínez, S., 1963. Estudio de la vegetación y flora de las sierras de Guadarrama y Gredos. *An. Inst. Bot. A.J. Cavanilles*, 21(1): 1-325.
- Rivas Martínez, S., 1982. *Mapa de las Series de Vegetación de Madrid*. Escala 1: 200.000, Diputación de Madrid.
- Rodríguez, B., 1955. *Estudio de la Ganadería Leonesa*. Diputación Provincial, León, 150 pp.
- Rodríguez, M., Ruiz-Huerta, J. and Soria, R., 1979. El desarrollo ganadero español: El sector vacuno. *Monografías D.E.A.*, 8: Madrid, 147 pp.
- Sánchez Belda, A., 1976. *Contribución al Estudio de la raza Retinta*. Asociación Nacional de Criadores de Vacuno Selecto de Raza Retinta, Madrid, 32 pp.
- Sánchez Belda, A. and Sanchez Trujillano, M.C., 1979. *Razas ovinas españolas*. Ministerio de Agricultura, Madrid, 501 pp.
- Sánchez Egea, J., 1975. El clima. Los dominios climáticos y los pisos de vegetación de las provincias de Madrid, Avila y Segovia. *An. Inst. Bot. A.J. Cavanilles*, 32(2): 1039-1078.
- Sánchez L., 1978. *La Raza Vacuna Rubia Gallega*. Asociación Nacional de Criadores de Vacuno Selecto de Raza Rubia Gallega, Lugo, 319 pp.
- Sarazá Ortiz, R., Sotillo Ramos, J.L., Serrano Tome, V., Tejón Tejón, D., Pérez García, T. and Cuéllar Carrasco, L., 1975. *Ganadería española*. Madrid, 249 pp.
- S.E.E.P., 1982. *XXII Reunión Científica de la S.E.E.P. en Galicia*. Varios autores. Comunicaciones leídas en la Reunión.

- Selecciones del Reader's Digest, 1962. *El atlas de nuestro tiempo*. Madrid, 205 pp.
- Servicio Meteorológico Nacional, 1965. *Mapa pluviométrico anual 1931-1960*. Madrid, 1 hoja.
- Servicio Meteorológico Nacional, 1972. *Calendario meteorológico del año 1972*. Madrid, 161-171.
- Sociedad Nestlé, A.E.P.A., 1980. *El entorno del ganadero. Forrajes, vacas y leche*. Santander, 360 pp.
- Solé Sabaris, L., 1951. *Los Pirineos. El medio y el hombre*. Ed. Alberto Martín, Barcelona, 624 pp.
- Sorre, M., 1943. *Los Pirineos*. Editorial Juventud, Barcelona, 174 pp.
- Taillefer, F., 1974. *Les Pyrénées, de la montagne à l'homme*. E. Privat, Editeur, Toulouse.
- Tax de Freeman, S., 1970. Notas sobre la trashumancia pasiega. *Publ. Inst. Etnografía y Folklore "Hoyos Sainz"*, 2: 163-170.
- Treceño, J., 1983. *Informe de la Comisión Sierra Morena*. Agencia de Desarrollo Ganadero, Sevilla, 142 pp.
- Tüxen, R. and Oberdorfer, E., 1958. Eurosibirische Phanerogamen-Gesellschaften Spaniens. *Veroeff. Geobot. Inst. Eidg. Techn. Hochsch. Stift. Ruebel Zürich*, 32.
- Ubieta, A., 1970. *Atlas histórico. Como se formó España*. Ediciones Anubar, Valencia, 148 pp.
- Vicens Vives, J., 1954. *Atlas de historia universal*. Barcelona, 32 pp.
- Vicens Vives, J., 1974. *Historia social y económica de España y América*. Barcelona, 657 pp.
- Viers, G., 1973. *Los Pirineos. Colección ¿Qué sé? 100: 128 pp.*
- Vilá Valentí, J., 1950. Una encuesta sobre la trashumancia en Cataluña. *Pirineos*, 17-18: 405-445.
- Vilá Valentí, J., 1963. El "mas" catalán; una creación pirenaica. *Actas 3er. Congr. Int. Estud. Pirenaicos*, 4: 52-62.
- Violant, R., 1949. *El Pirineo español*. Editorial Plus-Ultra, Madrid, 675 pp.