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VEGETATION PROCESSES AS SUBJECT
OF GEOBOTANICAL MAP
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APPLICATION OF VEGETATION MAPS TO THE STUDY OF GRAZING UTILIZATION: A CASE IN THE WESTERN PYRENEES

Summary: Research was conducted in a summer grazing pasture located in the Western Spanish Pyrenees, between 1600 and 2650 m, at supraforestal level. Flora, with comprises about 500 taxa, are mainly composed of oromediterranean, alpine-pyrenean, eurosiberian and boreoalpinous species. Fifteen phytosociological alliances and twenty plant associations have been described in study area.

A 1:10 000 vegetation map has been elaborated taking into account those unities. In order to quantify the cover abundance of plant communities and their 200 m interval altitudinal distribution, a "line intercept" sampling was applied to this map. The main sintaxa according to occupied surface are: *Iberidion spathulatae* (21%), *Nardion strictae* (14%), *Mesobromion erecti* (13%) and *Saponarion caespitosae* (10%).

Records of aerial photographs of ungulate distribution allowed the elaboration of a grazing utilization map. The degree of grazing utilization of different plant communities was obtained by matching the information of both maps, and applying the same "line intercept method.

The use of plant communities by cattle, faithfully corresponds to the proportions at which these communities are found in the studied territory. Sheeps and chamois show a clear preference for communities with higher plant covering. Food utilization by herbivores is strongly related to some physical factors (altitude, degree of slope, snow duration) and biotic (plant cover, species richness, phenology, grass height, biomass) factors.

Key words: Plant communities distribution; Herbivorous mammals environment preference; Diet selection; Western Pyrenees.

I. INTRODUCTION

Supraforestal pastureland in the Pyrenees shows up a great structural complexity which is due to the high number of vegetable species and communities present in small areas which is, in turn, due to the environmental variety caused by the topography. Moreover, this complexity allows the pastoral use of summer passes by different types of herbivores on a spatial and temporal gradient.

The study of Pyrenean supraforestal pastures, their use by herbivores (domestic and wild) for seasonal grazing and the pasture — herbivore interaction which this use supposes, meets its first problem when quantifying the area occupied by different sintaxa. The relative importance of vegetable communities and their degree of use by herbivores present important aspects of feeding and possible patterns of food selection (SKOGLAND 1984).

The aim of this study is to find out the degree of use of various communities by the different herbivore species throughout the summer in area of Western Pyreneean supraforestal pastureland that coincides with one pastoral unit. To do this phytosociological characterization of the plant communities (REMON & GOMEZ 1990) was carried out on the above mentioned territory along with its cartography, to latter compare the information provided by the vegetation map and the map of herbivore occupation which were made on the same territory during the summer of 1986 (GARCIA-GONZALES et alii 1990).

II. METHODS

II.1. Study area

Research was conducted in a zone of alpine and subalpine pastures which has planimetric surface of about 1300 ha in the Western Spanish Pyrenees. Its limits are those of the watershed which gives rise

* *See also the annex map in portfolio*

to the headwaters of the Starrun river. The river basin, formed by two small converging valleys of glacial origin is perpendicular to the Pyrenean mountain range axis and it is southern-facing. The altitudinal range studied extends from 1600 to 2650 m (the top of Aspes mountains).

From the litologic point of view, there are three kinds of materials: Flysh (marls alternating with sandstone in fine layers), limestone and sandstone of Maerstrichiense. Therefore, the substratum is mainly basic although the soil is usually acidified on its surface by lixiviation. Carstic phenomena are frequent in this area.

Climatic conditions are in transition between atlantic and cqntinental climate (CREUS NOVAU 1983). Rainfall summarize about 1200-1500 mm per year related with altitude and orientation; monthly average temperature is 7.5°C. Snow and minimum temperatures reduce the productive period to four months or less. The climate is very different above 2000 m due to the higher snow duration and high relative humidity. Several days of storm, delay the withering away of plants living on scarce ground.

About 480 plant species have been catalogued. Species richness dwindless with the altitude and above 2400 m is reduced the number of plant species. *Gramineae* and *Compositae* form the most important groups. As far as vegetation is concerned, we found twenty plant associations assembled in fifteen phytosociological alliances which can be seen in the legend of vegetation map. Plants are called according to "Flora Europaea" (TUTIN et alii 1964-1980) and description of plant communities can be found in several authors (BRAUN-BLANQUET 1948, RIVAS-MARTINEZ 1969, 1974a, 1974b, REMON & GOMEZ 1990).

This teritory has been utilized since ancient times as a summer grazing range by sheep and cattle (2000 and 300 head respectively at present) and for some years by a small number of mares. Sheep are sheltered while cattle and horse are in free grazing. Furthermore, a wild population of about 300 chamois (*Rupicapra rupicapra)* share the grazing pastures.

II.2. Data gathering

A vegetation map to scale 1:10 000 (see map in annex) was drawn up from aerial photography and checks carried out on the land itself over three years. With this map we proceeded to quantify the area occupied by different vegetable communities by means of a line intercept (KNAPP 1984), using the 100 metre contour line as a cross-section. The 2500 and 2600 m contour lines were taken together because of their short lenght. This transversal sampling minimizes the deforming effect of aerial photography on sharp reliefs and allows us to obtain numerous sampling points if an adequate number of contour lines are considered.

The dat was grouped by 200 m intervals to show the wide oscilations in the relative abundance of vegetable communities with regard to altitude. From a physiographic and livestock management point of view, it is also useful to divide the study area into two altitudinal levels above and below 2000 m (REMON & GOMEZ 1990). Due to environmental heterogeneity, a number of plant communities of transition and mixed vegetation are shown up, which have been mapped as complexes of two or even three units: in these cases the sampling value has been divided among the different units in the complex.

The same line intercept has been applied to the herbivore use map (GARCIA-GONZALES et alii 1990) superimposed over vegetation map to evaluate the relative quantity of plant communities used by the cattle. For sheep and chamois only the plant communities which were present in the used territory were noted down in order of importance, as they had not mapped with the same precision.

III. RESULTS AND DISCUSSION

III.1. Altitudinal changes in plant communities distribution

For the whole territory, areas with no vegetation, screes of *Crepidetum pygmaeae, Mesobromion erecti* and *Alchemillo-Nardetum strictae* pastureland together with *Saponarion caespitosae* make up almost three quarters of the surface. 19 of the 20 existing associations have been represented by the methodology employed (Fig. 1).

Figure 2 shows percentages occupied by main plant communities and areas without vegetation at 200 m-intervals in the study area. *Mesobromion erecti* is only present below 2000 m, and between 1600 and 1800 m it occupies 60% of the area. *Nardion strictae* has here two associations: *Alchemillo-Nardetum strictae*, occupying 20% between 1800 and 2000 m and *Trifolio-Alopecuretum gerardii* that reaches above 2000 m in small percentages. Some remains of the original subalpine forest of *Pinus uncinata* are represented in the scrubland of *Juniperion nanae* with *Brachypodium pinnatum*. The nitrophilous communities related to trampling and fertilization of herbivores occupy small but numerous areas: these are *Rumicion alpini* at 3% of the surface in lowest altitudes. The few swampy areas (*Caricion nigrae*) in this territory are mainly to be found at this altitudinal level but only with 0.05% of this territory.

Primulion intricatae is represented by two associations: *Primulo-Horminetum pirenaicii* with its greatest presence between 1800 and 2200 m and

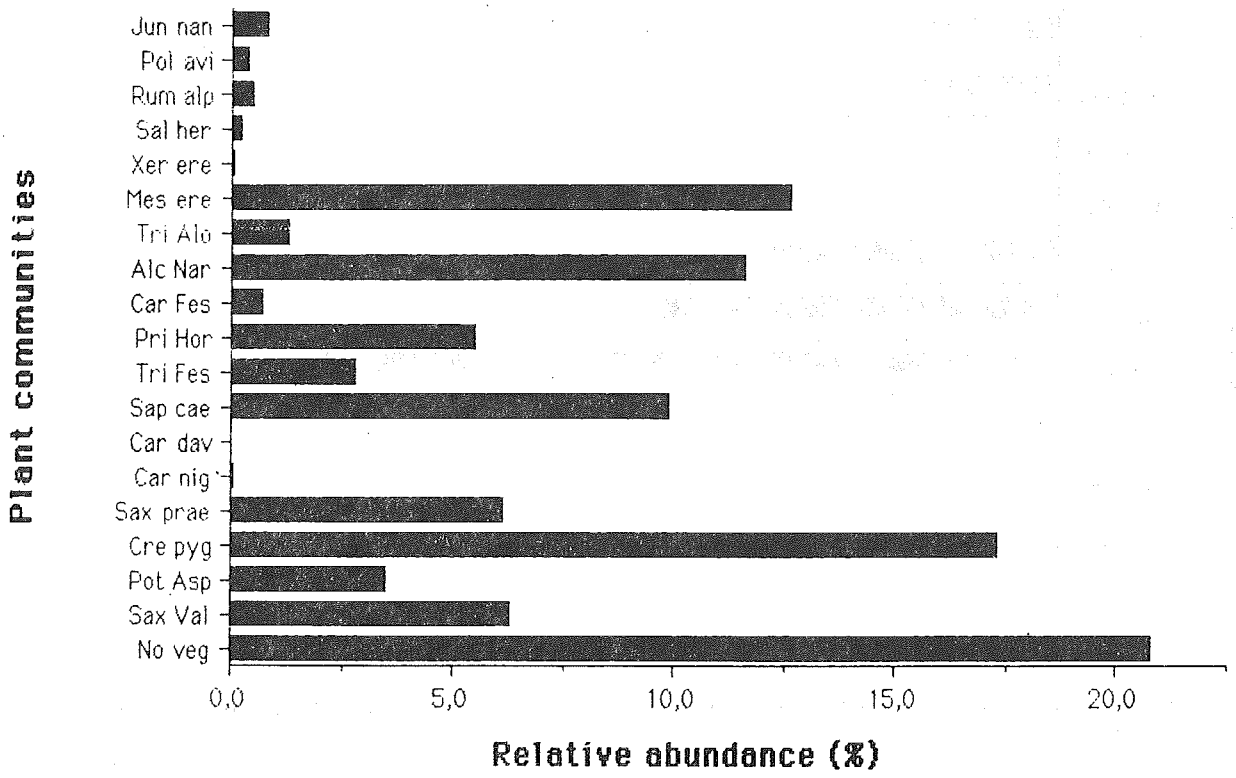

Fig. 1. Relative abundance of plant communities and no vegetation areas in study area determined by line-intercept method on a 1:10 000 scale vegetation map. Only *Hieracio-Festucetum paniculatae* and *Oxytropi-Elynion* not been included in this sampling due to their reduced occupation surface.

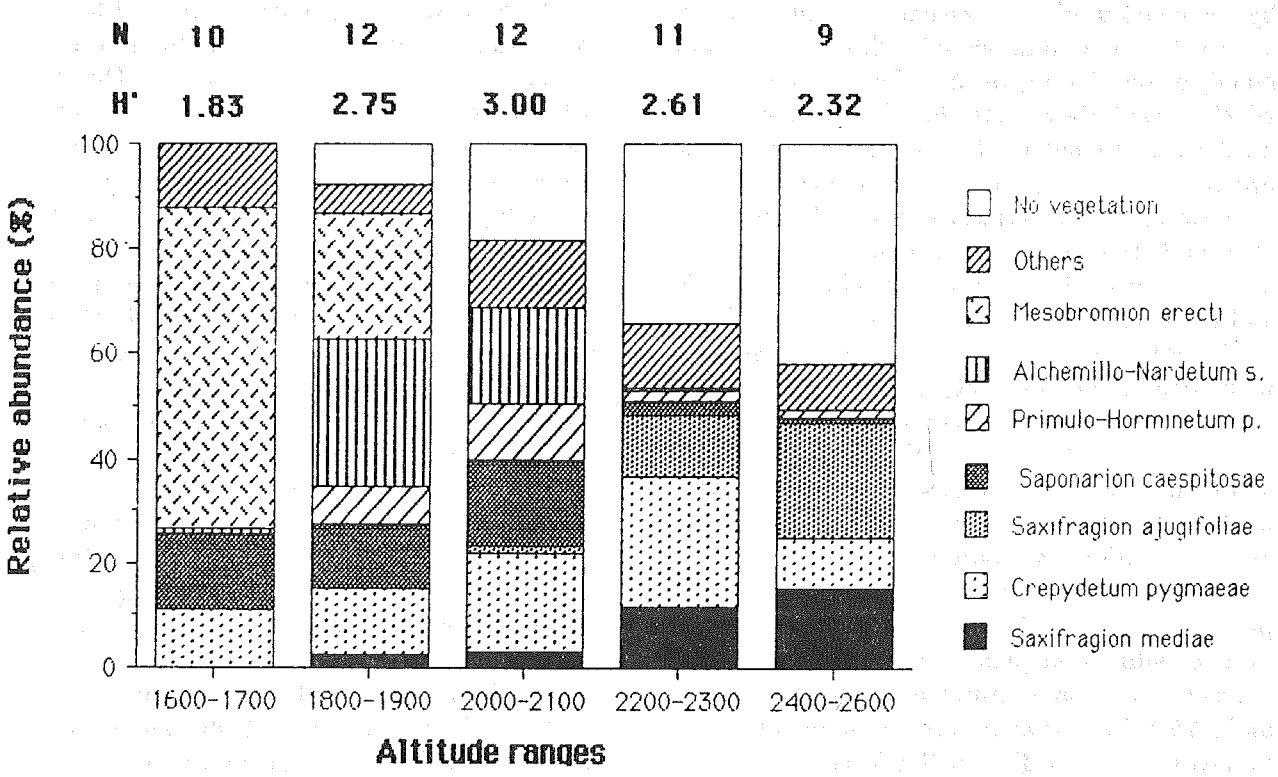

Fig. 2. Relative abundance of main plant communities and no vegetation areas at 200-m altitudinal intervals in the study area. Top values correspond to the Shannon-Weaver diversity index (*H'*) and community number (*N*) for each altitudinal interval.

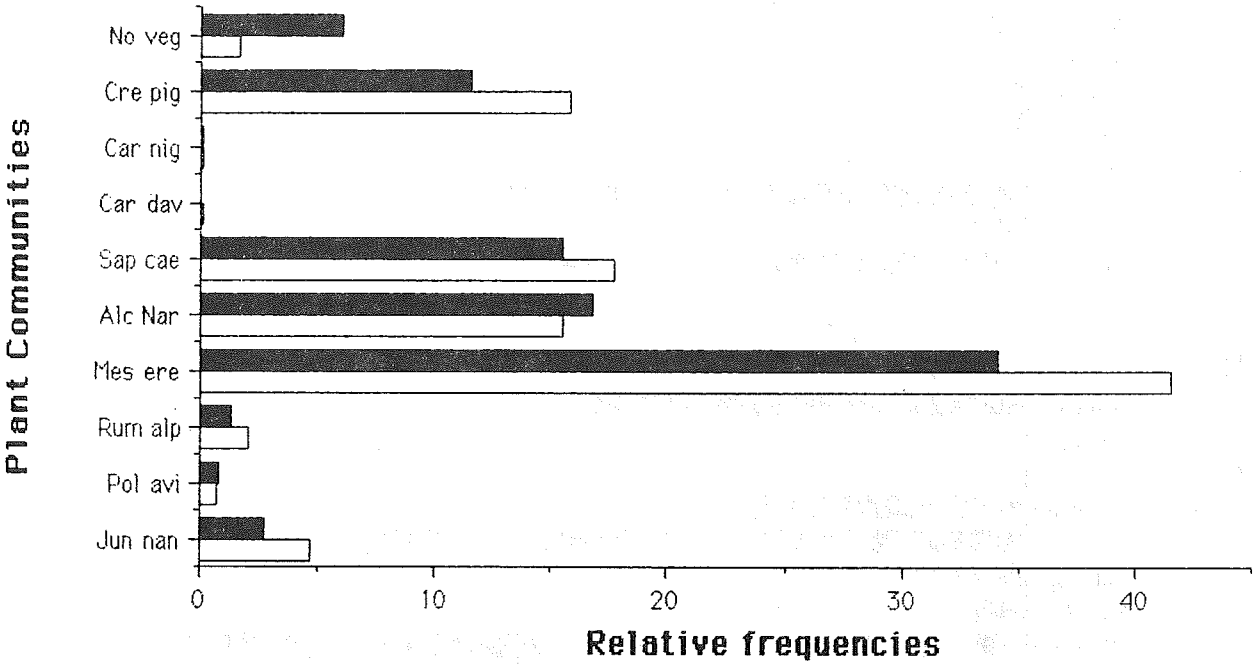

Fig. 3. Comparison between relative abundance of available plant communities below 2000 m of altitude (black) and those utilized by cattle (white).

Trifolio-Festucetum nigrescentis constituting the larger area of dense pastureland above 2200 m. *Saponarion caespitosae*, vicariant community of *Festucion gautieri* in the Western Pyrenees (MONTSERRAT & VILLAR 1975, 1987) is found on screes with little snow covering mainly below 2200 m.

High altitude screes, with abundant snow cover, are occupied by *Iberidion spathulatae*, represented by two communities: *Crepidetum pygmaeae* which is distributed among all altitudinal ranges but mainly below 2200 m, and *Saxifragetum ajugifoliae* which prevail above that altitude with a cover of 22% at the highest level. Cliff-face communities, *Saxifragion mediae*, increase in importance from the lowest levels and reach a cover of 10% between 2000 and 2200 m. Areas with no vegetation increase also with altitude as is shown in the Figure 2, and occupies over 40% in the highest altitudes.

Between 2000 and 2200 m we find the greatest plant community diversity (see Shanon-Weaver index in Fig. 2) with very similar number of plant communities (12) with. Similar percentages of abundance (near to 18%) for *Crepidetum pygmaeae*, *Saponarion caespitosae*, *Nardion strictae* and areas with no vegetation can be found. Between 2200 and 2400 m there are the same number of plant communities (11) but areas with no vegetation or with small plant cover have the highest percentages. Dense pastureland of *Nardion strictae* and *Primulion intricatae* are the main areas for herbivore concentration at this level.

Above 2400 m, the predominace of areas with no vegetation (42%), screes (32%) and rocky areas (15%) should be noted. *Primulion intricatae*, summer food base for chamois, represents 7%. Typical plant communities of alpine level, such as *Oxytropi-Elynion* and *Salicion herbaceae*, occupy small areas and the first is not represented in the sampling.

III.2. Herbivores distribution

The vegetation map includes general limits of areas used by different herbivores during the summer period (see attached map). Herbivores distribution shows that wild and domestic animals share the grazing space. Cattle are found mainly below 1800 m although some groups can occasionally climb to 2000 m. Chamois which during the winter, spring and the begining of the summer use the lower areas, in this season are to be found above 2200 m, while sheep are taken to medium altitude. It should be noted that above 2000 m, sheep stay only a few days per year (about 10 days between 2000 and 2200 m and five days above 2200 m) according to annual climate and vegetal availability at the lowest altitudes. This fact hinders the appearance of well developed nitrophilous communities, nevertheless some species as *Dactylis glomerata*, *Urtica dioica*, *Geranium sylvaticum*, *Taraxacum* gr. *pyrenaicum* appear on some surfaces.

Relative frequences of plant communities utilized by cattle (Fig. 3) show a high overlap with the percentages at which these communities are found in the area ($x = 8.623$; d.f. $= 9$; $p = 0.4728$). This supposes a low patch feeding selection for these herbivores. *Mesobromion erecti* (34%), *Alchemil-*

Tab. 1

Some biotic and physical parameters of main plant communities in Aisa valley. Values of slope, cover and species richness, was obtained from several relevés of different plant communities (unpublished data: ARBELLA & GOMEZ - in press; REMON & ALBERA 1989)

VEGETAL COMMUNITIES	ALTITUDINAL RANGE (m a.s.l.)	SLOPE (°)	pH	VEGETAL COVER (%)	SPECIES RICHNESS	BIOMASS (g/m2)
Mesobromion erecti	1600-2000	0-20	5.5-7	80-100	40	400
Mesobromion-Nardion mixture	1600-2000	0-20	5.5-6.5	80-100	29	400
Alchemillo-Nardetum strictae (Nardion strictae)	1700-2300	0-20	4.5-6	90-100	30	385
Trifolio-Alopecuretum gerardii (Nardion strictae)	2200-2600	0-10	4.5-6	90-100	25	250
Festucion eskiae	2000-2400	20-40	4.5-5	75-100	18	400-600
Trifolio-Festucetum nigrescentis (Primulion intricatae)	2000-2500	0-20	5-6	90-100	25	320
Saponarion caespitosae	1600-2400	20-40	6-7	5-20	23	50-80
Crepidetum pygmaeae (Iberidion spathulatae)	1600-2600	30-45	7-8	1-10	10	25
Saxifragion ajugifoliae	2200-2600	0-35	7-8	10-20	14	-

lo-Nardetum strictae and *Saponarion caespitosae*, are the mainly plant communities occupied by cattle. It is different for sheep and specially chamois, who show a clear preference for communities with higher plant cover, although main available plant communities have low values of plant cover. *Primulion intricatae, Trifolio-Alopecuretum gerardii* and *Saponarion caespitosae* are the preferred plant communities for sheep and chamois while more abundant plant communities above 1800 m are rocky and scree ones (*Saxifragion mediae* and *Iberidion spathulatae*) with cover lower than 10% (REMON & GOMEZ 1990).

In general terms, most of the communities used by the livestock feature a high vegetable covering (between 50% and 100%), a high oredominance of hemicryptophyte grasses (and some species of sedges) and high vegetable biomass (Tab. 1). As for the species richness, herbivores seem to prefer vegetable communities of wide diversity: however, they do not reject those scarce species if they can as well find high biomass (in the case of cattle and mares) or perhaps attractive species (for sheep and chamois).

III.3. Herbivores and plant community relationships

The comparison of vegetation and herbivore occupation maps shows very different degrees of plant community use. Below 2000 m grazing pressure particularly affects the pasture dynamic and favours the appearance and expansion of nitrophilous communities in the fallow areas. Above this altitude the influence of abiotic factors (specially snowfall and soil depth) on vegetation predominates, although plant communities with heavy covering also have a great influence of herbivore action.

The topographic position of the pasture plays an important role in limiting the plant range for the larger herbivores who have no access to the steepest slopes and cannot pass through screes, ledges and carstic areas. Sheep and chamois are better adapted to rugged terrain and have a wider choice of communities which in turn increase with the number of altitudinal levels which they frequent in summer (Fig. 2).

The concentration of animals in certain areas due to management factors (headcounts, herd separation, provision of sale, troughs) or to the search for attractive environments (thermic comfort, insect harassment reduction) provokes the use of communities which are unusual as grazing areas (DUNCAN 1983). These concentrations also cause high fertilization and the appearance of a number of clearings in the vegetation due to trampling which in turn causes the activity of digging animals (moles, wild boar). For all these reasons, the daily and periodic movement of herds should taken well into account when explaining certain plant community distribution, their floristic composition and productivity (MCNAUGHTON 1984).

The existence of different kinds of domestic livestock facilitates the exploitation of mountain pastures without excluding the presence of wild ungulates. Herbivores present particular morphophysiological characteristics that allow they to profit food resources differentially, reducing animal competition (GARCIA-GONZALES & MONTSERRAT 1986). On the other hand and from an applied point of view, the superimposition of vegetation and use maps can be a very useful tool in finding out the livestock load which a certain mountain area can bear while at the same time suggesting management patterns.

This study has been carried out in a research project entitled "Plant-Herbivore interaction in the Cantabrian Mountains and Pyrenees" suported by the "National Plan" with the number: ID88JA053

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SUPRAFORESTAL VEGETATION MAP OF AISA VALLEY (WESTERN PYRENEES)

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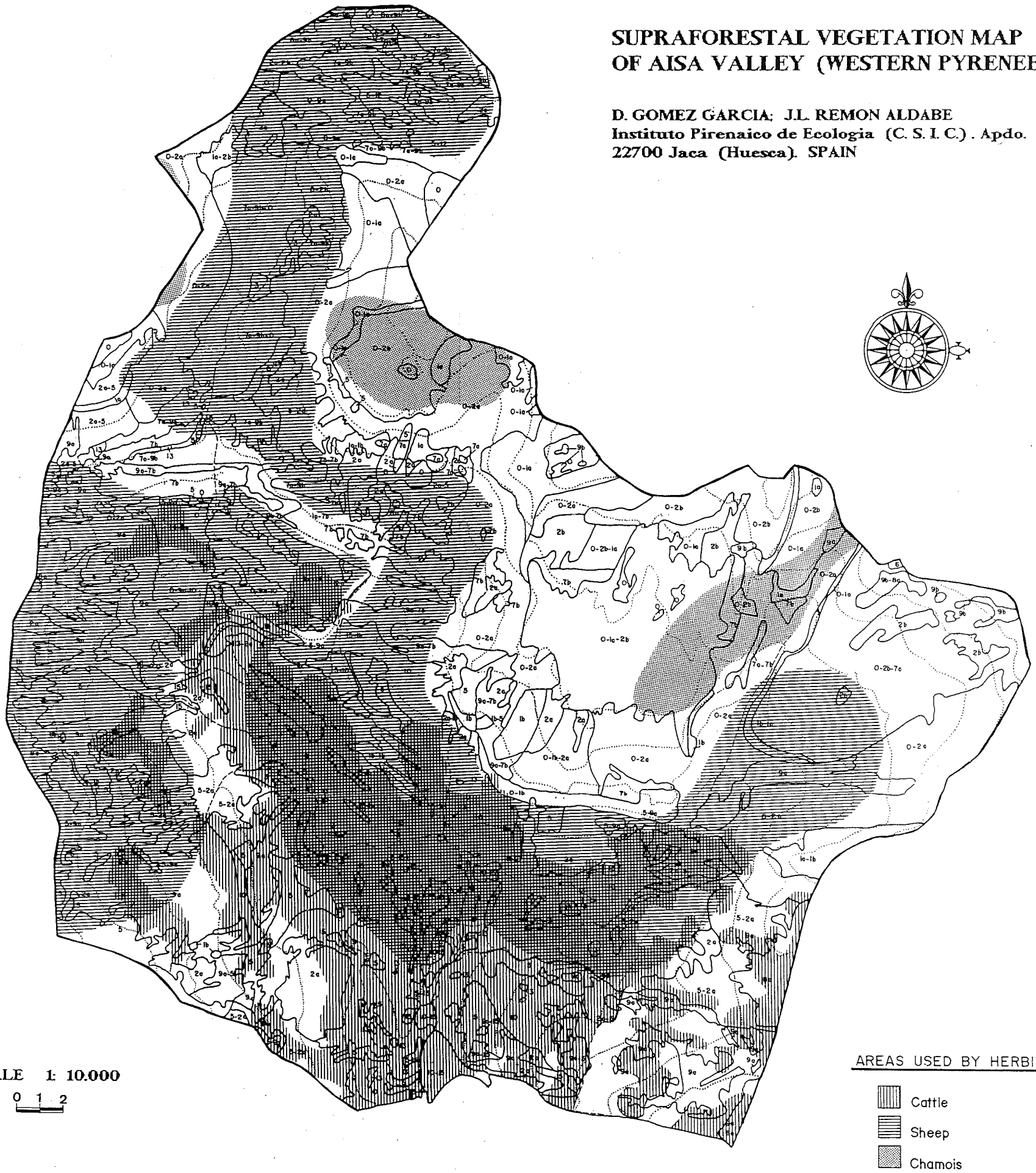

SCALE 1: 10.000

0 1 2

AREAS USED BY HERBIVORES

- Cattle
- Sheep
- Chamois

LEGEND

0.- AREAS WITH NO VEGETATION

1. - SAXIFRAGION MEDIAE
   - a) SAXIFRAGO - VALERIANETUM GLOBULARIFOLII
   - b) POTENTILLO - ASPERULETUM HIRTAE

2. - IBERIDION SPATHULATAE
   - a) CREPIDETUM PYGMAEAE
   - b) SAXIFRAGETUM PRAETERMISSAE

3. - CARICION NIGRAE
   - CARICETUM NIGRAE + PRIMULO - SCIRPETUM CAESPITOSII

4. - CARICION DAVALLIANAE
   - CARICETUM DAVALLIANAE

5. - SAPONARION CAESPITOSAE
   - SERRATULO - ASPERULETUM HIRTAE

6. - OXYTROPI - ELYNION
   - OXYTROPI - ELYNETUM

7. - PRIMULION INTRICATAE
   - a) TRIFOLIO - FESTUCETUM NIGRESCENTIS
   - b) PRIMULO - HORMINETUM PYRENAICI

8. - FESTUCION ESKIAE
   - a) CARICI - FESTUCETUM ESKIAE
   - b) HIERACIO - FESTUCETUM PANICULATAE

9. - NARDION STRICTAE
   - a) ALCHEMILLO - NARDETUM STRICTAE
   - b) TRIFOLIO - ALOPECURETUM GERARDII

10.- MESOBROMION ERECTI
   - ERYNGIO - PLANTAGINETUM MEDIAE

11. - XEROBROMION ERECTI
   - TEUCRIUM - FESTUCETUM SPADICEAE

12.- SALICION HERBACEAE
   - CARDAMINO - GNAPHALIETUM SUPINAE

13.- RUMICION ALPINI
   - RUMICI - CHENOPODIETUM BONI - HENRICI

14.- POLYGONION AVICULARIS
   - TARAXACO - POETUM SUPINAE

15.- JUNIPERION NANAE
   - ARCTOSTAPHYLO - PINETUM UNCINATAE

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Fig. 4. Herbivore utilization areas overlaped to the supraforestal vegetation map of Aisa valley (Western Pyrenees).