Pirineos, 129: 5 a 33. JACA, 1987

MEADOWS OF CENTRAL PYRENEES: FLORISTICAL COMPOSITION AND QUALITY[1]

POR
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SUMARY.—In the summer of 1985, 45 plots were sampled in the meadows of San Juan de Plan (Huesca), by cutting off surfaces of 1m². Three samples were taken for: determination of dry matter; manual separation of species and chemical fractioning of organic components. The results obtained have been studied trough an analysis of the principal components; a system of automatic classification and a method of global quality evaluation. On the whole, these meadows keep their original characteristics (whether we are dealing with low productive graminea or low quality species from the wood edgings or from the uncontrolled streams). The improvement of management: a better timing of cutting, irrigation and fertilization will produce inmediately some increase in production, without altering the traditional habits of exploitation.

RESUMEN.—Prados de los Pirineos Centrales. Composición florística y calidad. En el verano de 1985 se muestrearon un total de 45 parcelas en la pradería de San Juan de Plan (Huesca) mediante corte de superficies de 1m². Se tomaron tres muestras destinadas a: determinación de materia seca, separación manual de especies y fraccionamiento químico de los componentes orgánicos. Los resultados obtenidos han sido estudiados mediante un análisis de componentes principales, un sistema de clasificación automática y un método de valoración global de la calidad. En conjunto, estos prados conservan características de sus orígenes (ya se trate de gramíneas poco productivas o de especies de baja calidad procedentes de la orla del bosque o de los regatos incontrolados). La mejora de la gestión: corte en el momento oportuno, riegos y fertilización, producirá incrementos de producción inmediatos sin alterar los hábitos tradicionales de explotación.

Key-words: *Pyrenees, mountain meadows, indigenous species, traditional rural communities.*

1 Received september, 1987.
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I. Introduction

The present study deals with the meadows of San Juan de Plan (Gistain Valley) in the Pyrenees of Huesca. The three villages in the valley, Plan, San Juan de Plan and Gistain are at the head of the river Cinqueta, which is a tributary to the left of the river Cinca. They are nuclea inside the Axil Pyrenees with different autochthonous litological materials, and also with an important covering of glacial deposits. As a whole, concerning water circulation, we may speak of permeable and impermeable materials together with the existence of springs on the contact lines. Central Pyrenees, far from Cantabric and Mediterranean moisture shows important thermic contrasts and frequent freezing in Spring. The continentality of these inner zones is characterized by the tendency to have pluviometric maximums in Summer, and minimums in Winter. Plandescum Station, nearby Plan 1.060m, high, registered an average 1208mm annual precipitation in the period of 1952-77, with a seasonal distribution of 29% in Autumn, 27% in Summer, 25% in Spring and 19% in Winter.

The livestock of the Gistain Valley is formed by ovine and bovine herds. Bovine increase has reached values close to the limits of its capacity because the hay stored for Winter breeding, hardly allows them to reach the next spring budding season. The drop suffered by ovine livestock has become stable, and transhumant sheep and raisers (generally with more than 100 sheep heads) still coexist with those keeping small flocks in the village. The Pardo Alpina breed is dedicated to breeding, calves will be sold in Autumn to the industrial fatteners and the possible excess of milk production is self-consumed or directly sold in the village. Sheep of the Rasa Aragonesa breed are given over to meat and usually go through lambing three times every two years. The traditional sense of community exploitation is maintained for summer sheperding in mountain pastures but it is difficult to introduce it in plots of private property, where surely a better management could be obtained. Help among neighbours and village cohesion remains a necessity, as practically the same plots are exploited as at the beginning of the century, though with fewer labourers. Mechanization on the mountain is never satisfactory.

Our studies in the valley began in 1980 (GÓMEZ *et al,* 1982) and the degree of knowledge reached, has obliged us to use it as a test area, from which we hope to obtain generalizations about the Pyrenaic prairie. With regard to meadow classification, a first phytosociologic estimation (MONTSERRAT *et al,* 1984) was made that enabled us to characterize three wide groups: alfalfa fields, dry meadows and damp meadows. On the whole, irrigation is not very important, and so water canalization from ravines or springs is limited to the proximities of the irrigation outlet. As a result, the prairie is file-shaped consisting of

damp areas separated by dry convexities (fig. 1). The flora in the meadows preserves many of the indigenous species thanks to the traditional technique of sowing, which consists of using those seeds collected from haylofts. The crops have been reduced to potatoes for self consumption, cereals remaining the only agricultural alternative. The alfalfa fields are still important and they constitute an intermediate step, which by progressive ageing encourages the settling of a permanent meadow of increasing diversity. If the plot is near the village, it will usually suffer a more intensive exploitation, with greater use of manure, better control of irrigation and controlled harvesting. The present study relates characteristics of flora and the quality of stored hay, to ecological and livestock management factors.

2. Materials and methods

During the Spring-Summer season 1985, 31 plots were sampled on dates close to the time when cattle-raisers were going to start the first cutting (from the 6th of June to the 31st of July). The sampling was not made at random. We deliberately took samples from those plots that were outstanding for certain aspects known by previous studies (areas of *umbelliferae,* small rivulets, slopes of scarce and very dry soil, etc.). By doing this, we gathered a tottal of 45 samples which were these studied. The outline of the data taken and analysis performed, is sumarized in figure 2. Plots of $1 m^2$ were cut with scissors, leaving a stubble similar to that ramainig after motor scythe or scythe cutting.

Green weighing was taken with the help of a dynamometer of 5kg and a precision of 100gr. Grass height was measured with a flexible meter and the temperature of the soil with a digital thermometer (Crison T-637) whose probe went 20 cm into the ground. Fron the total plot, and after manual mixing, three sub-samples were obtained whose median weight was about 150gr, each one of them being kept in a cloth bag and destined to chemical analysis as hay, and the others, destined to manual separation of species and dry matter evaluation, were kept in plastic bags. This dry matter was determined in an air-heat cabinet and at 80 ºC during 48 h.; the bags for posterior separation of species were deep frozen (—30 ºC) and those chosen for the analysis were dried in the open air. These same bags were ground afterwards with a mill of hammers (Retsch-Muhle, AEG) being sieved to 0,5mm, and sent to a laboratory in Salamanca for the corresponding analysis. The organic components were determined according to the analytic routines of the center of Edafology an Applied Biology in Salamanca (GARCÍA, 1974). The samples prepared for the separation of species, after being thawed and separated were dried in the air-heat cabinet, obtaining the results, in percentages, of dry matter. As regards the statistical treatment, the

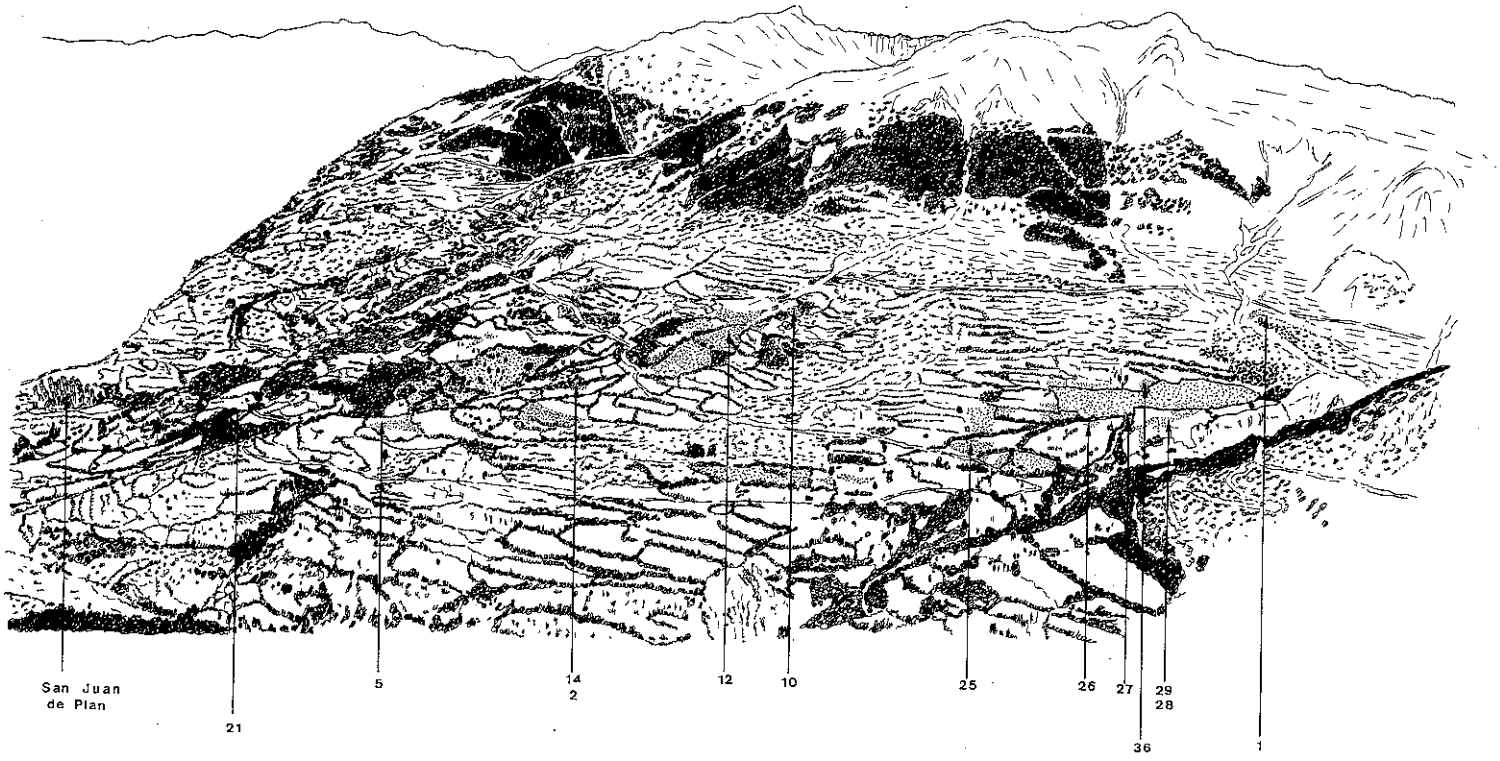
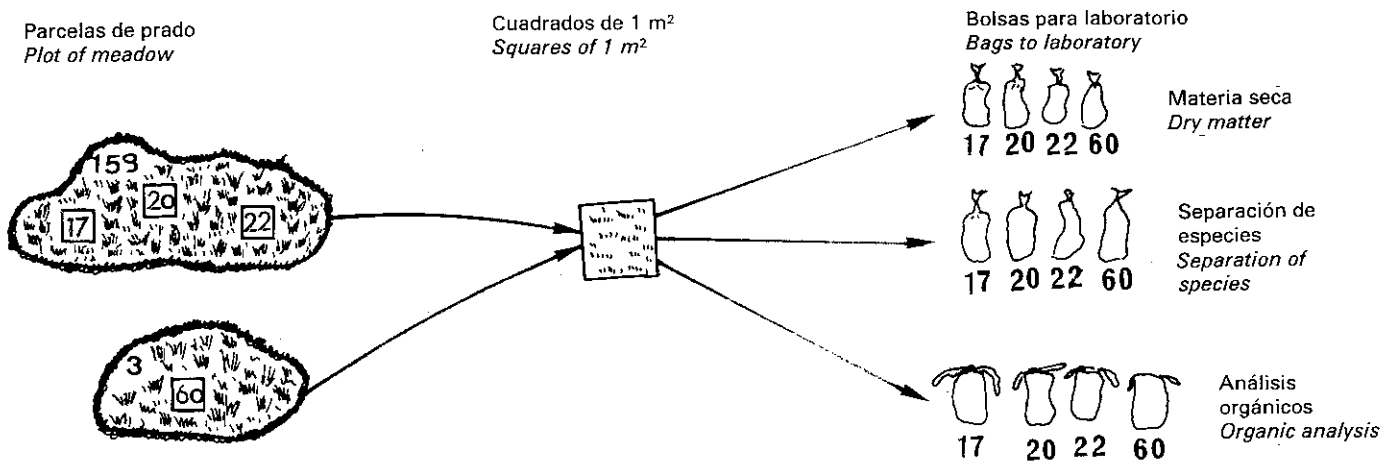


Fig. 1. Praderia de San Juan de Plan. (*Prairie of San Juan de Plan*).



Mediciones:
—Altitud
—Pendiente
—Exposición

Measurements:
—*Altitude above sea-level*
—*Gradient*
—*Exposition*

Mediciones:
—Altura de la hierba
—Peso verde
—Temperatura de suelo

Measurements:
—*Height of the herbage*
—*Fresh weight*
—*Soil temperature*

Fig. 2. Esquema de muestreo. (*Sketch of sampling*).

Analysis of Principal Components was utilized for data of digestibility analysis and, for the plots and their separation in species, an automatic classification which permits definition of the groups. The programs belong to the collection of the Pyrenaic Institute of Ecology and they have been treated in the intitute's computer (Alpha-Micro 1000 E). The samples have also been classified according to the "Complex" Method (SOSTARIC, 1974) and all the results obtained from the three methods have been discussed in a fourth paragraph in which some ecological variables are related.

3. Results and discussion

The complete data analyzed are summarized in table 1, in which the columns with the identification numbers appear and in each row: the field data, the green production in a $1 m^2$, percentages of dry matter (MS), the dry production extrapolated to the hectare (Qm/Ha), the floristic composition grouped together in three large groups (*Gramineae*, leguminous, and others), the number of identified species by manual separation, the diversity (Shannon's index), the equitability, the quality index of Complex method (in %), the production-quality of the same method (in Qm/Ha), the digestibility of dry matter calculated by a chemical method (DMD in %) and the product of such digestibility by dry matter production (in Qm/Ha).

3.1. *Organic parameters and principal components*

Study of parameters.

In figure 3A we summarize the mean data of the analysis. If we observe the values of NDF, and CC, we can classify this first cutting as an ageing material with very high values of NDF and very low of CC, owing to which the DMD is low. In 3B, we show the frequency histograms, all the parameters having a distribution very near the norm, only with the exception of the lignin which accumulates its values in the primary intervals.

Principal components.

The three former axes absorb 95% of the variance, being very important the contribution of the first axis (57%) and graded those of the other two (22% the II and 16% the III). The results are summarized in fig. 3C; in the upper part the layout of parameters is given and in the lower part, that of the plots. Axis 1, is characterized, on its negative side, by the important value of the cellular wall components (NDF, DNDF, cellulose, hemicellulose and ADF), and on the positive side, with a similar magnitude, by the cellular content and a digestible cellular

PARAMETRO parameter	MEDIA mean	D.E. E.D.	C.V. (%) V.C.	E.E. E.E.	MINIMO minimum	MAXIMO maximum	VARIACION variation
NDF	40.80	5.71	14.00	0.85	27.63	52.00	24.37
CC	59.20	5.71	9.65	0.85	48.00	72.38	24.38
ADF	32.90	3.90	11.85	0.58	26.05	41.78	15.73
Hemicelulosa	8.18	4.00	48.90	0.60	0.63	16.90	16.27
Lignina	5.88	1.97	33.50	0.29	3.93	17.15	13.22
Celulosa	27.02	3.61	13.36	0.54	17.20	34.20	17.00
DCC	45.12	5.59	12.39	0.83	34.14	58.03	21.42
DNDF	20.26	4.30	21.22	0.64	4.91	28.65	22.29
DMD	65.36	3.33	5.09	0.50	53.85	71.19	17.34
Proteina	10.38	2.13	20.52	0.32	6.38	15.31	8.93

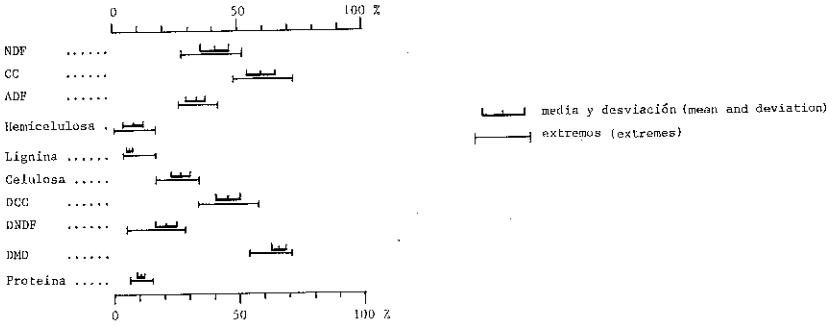


Fig. 3 A. *Datos medios del análisis orgánico. (The mean data of organic analysis).*

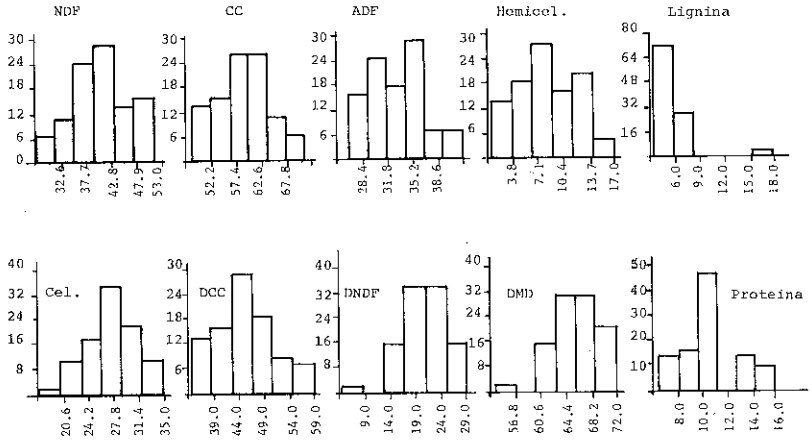


Fig. 3 B. *Histogramas de frecuencias. (Frequency histograms).*

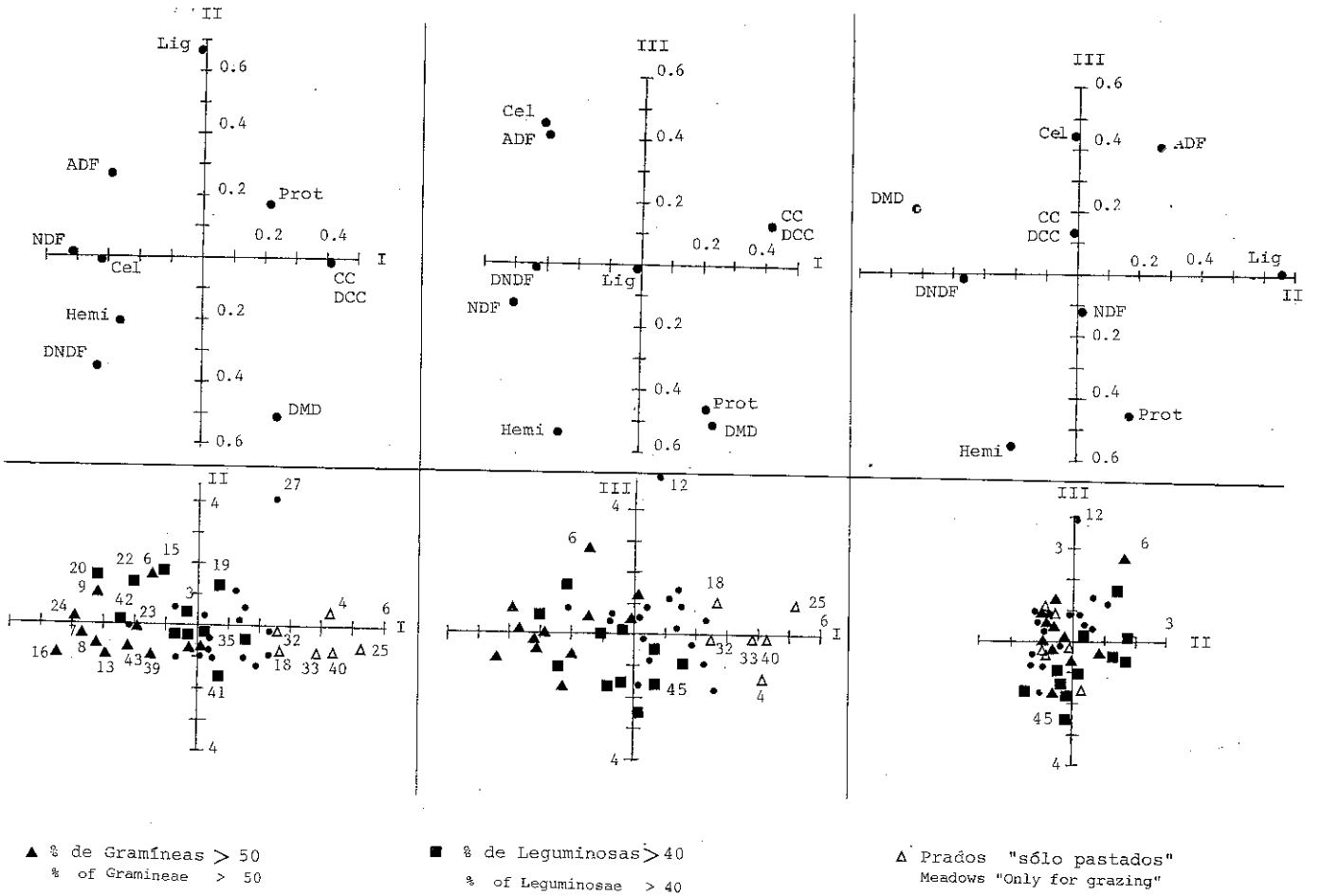


Fig. 3 C. *Componentes principales de los parámetros orgánicos.*
(Principal components of organic parameters).

content (CC and DCC). Protein is also placed in the positive semi-axis although with much less importance than the cellular content. Axis II is characterized on its positive side, by the great weight of lignin and on its negative, by the DMD. In plan I-III, a considerable space can be seen in relation to axis III, of the cellulose (positive side) and the hemicellulose (negative side). In the plan II-III, the above mentioned characteristics are repeated.

In the lower part of figure 3C, we give the samples' distribution in which three groups can easily be distinguished: in plan I-II, samples with more than a 50% *gramineae* in their composition and with not very high ordinates are grouped on the negative side of axis I. On the positive side and also with low ordinates, meadows "only for grazing" are grouped together. With a similar distribution to the gramineae but ranged towards the right side; samples with more than 40% of leguminosae are practically collected along the bisectrix of the second quadrant, and with most of the abscissas, negatives or low positive values. Considering the characteristics of axes I and II, we can define rich samples in gramineae, as material with a high value in DNDF (most over 23%) and also with high cellulose levels (most over 29%). In contrast to this, plots "only for grazing", situated on the positive side of axis I, have high values of CC and DCC (coincidents in these analysis) of over 65%. The group of leguminosae is characterized by the importance of protein; a parameter that lines them up along the bisectrix of the second and fourth quadrants; the protein values are, in most of the samples, over 12,5%. Sample 27 stands out on the positive side of axis I, due to its high content in lignin (17%). Axes I-III repeat the position of those meadows with a high content in gramineae and the ones "only for grazing" with respect to axis I, and they approach the rich meadows in leguminosae towards the fourth quadrant due to the protein situation in this range; cellulose, on the positive side of axis III, moves plot number 6 (34% of cellulose, the highest value) and number 12 (33% of cellulose, among the highest) towards higher ordinates. Finally, plan II-III reflects an aglomeration of values around the origin, only detaching samples numbers 6 and 12 according to the cellulose of axis III and the high degree in protein of numbers 45 on the negative side of axis III (an alfalfa plot with a 15% protein, as the highest values of all the samples).

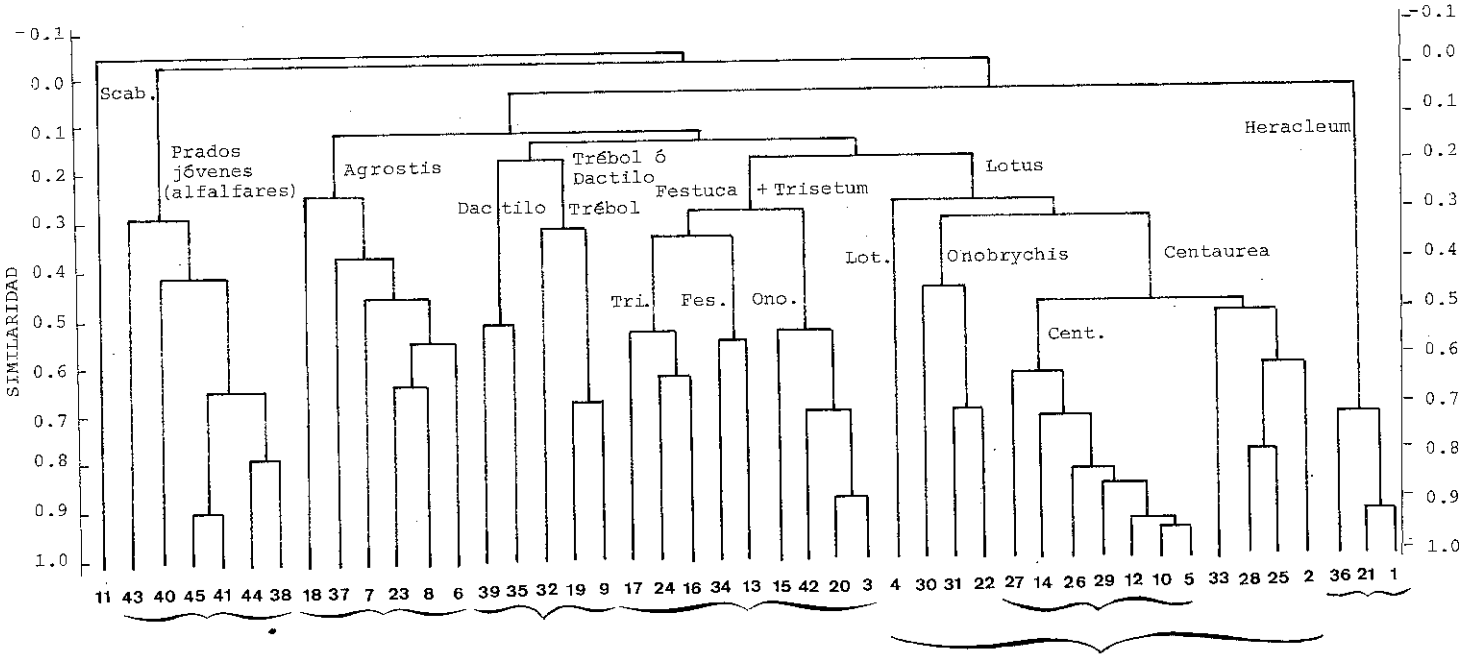
3.2. *Automatical classification: similarity dendrogram*

Data in percentages of dry matter from every specie, were utilized to try out a system of automatic classification. The matrix of entrance had 45 columns (corresponding to each plot) and 90 rows (corresponding to most of the species). With these data, a matrix of similarity (45 x 45)

was stablished based on the existence of correlations among every pair of plots. From this matrix, and through the corresponding programme (DAVIS, 1973) the level of similarity of every group was calculated and also the dendrogram of figure 4 was designed.

On the side of negative values, three groups remain clearly separated; the most original, only formed by sample 11, is characterized for its high content in *Scabiosa columbaria;* another incorporates the young meadows, with great alfalfa contribution (samples 38, 44, 41, 45, 40 and 43) and still another large group, where all the other meadows are included. Within the latter group, with low positive values, the group of three plots which are rich in *Heracleum sphondylium* (1,21 and 36) stands out. With levels of similarity a bit higher than 0,1, a numerous group formed by samples with great amounts of *Agrostis capillaris* (with more than 18%, numbers 6, 8, 23, 7, 27, and 18) can be seen. With values of similarity close to 0,15, a group with a high contribution of *Dactylis glomerata* (samples 39 and 35 with more than 17%) or of *Trifolium pratense* (32, 19 and 9 with more than 40%) stands out. A similarity close to 0,2 separates two groups: one, with a predominance of *Festuca gr. rubra* + *Trisetum flavescens* (17, 24, 16, 34, 13, 15, 42, 20 and 30) and another, numerous, with the presence of *Lotus corniculatus* as a common species. From this second group, when reaching values near to 0,3, plot number 4 has been separated due to its high level in *Lotus corniculatus* (36%). With a level of similarity a bit higher than 0,3 we can distinguish a dry variant, characterized by the common presence of *Onobrychis sennenii* (30, 31 and 32) and another damper one, with different proportions of *Centaurea debeauxii,* being the most characteristic group, separated by levels of similarity of 0,5 and formed by the plots 27, 14, 26, 29, 10 and 5.

In an already classical meadow classification, in Seo de Urgel (MONTSERRAT, 1957), it was performed, for the first time in Spain, a system of automatic classification based on the theory of information (GONZÁLEZ BERNÁLDEZ, 1968). Data of presence-absence from phytosociological inventories were utilized and groups were classified according to a statistic based on the concept of entropy. The corresponding dendrogram clearly separates three groups, two of which can be assimilated into our alfalfa fields and the *Heracleum sp. group*. In the third, we would join the typical meadows and separate two large groups in regard to fertility and, inside them, a gradient of moisture stands out. In our case fertility would be identified with a cocksfood or clover group and moistures with the *"Centaurea"*, remaining as intermediate characteristics, the two groups rich in *gramineae* (*"Agrostis"* and *"Festuca + Trisetum"*). The great abundance of *Agrostis capillaris* or *Festuca gr. rubra,* the practical absence of *Lolium perenne* and the very low contribution of *Arrhenatherum elatius,* in comparison to *Trisetum flavescens,* clearly separate for us the meadows of San Juan de Plan



Prados jóvenes (alfalfares) = young meadows (alfalfa fields)
Trébol o Dactilo = Clover or cocksfoot

Fig. . *Dendrograma de similitud: grupos y parcelas.*
(Similarity dendrogram: groups and plots).

(over 1000m) from those of Seo de Urgel (around 600-700m), with a much greater "farmer intervention".

3.3 *"Complex" Method to determine the quality and global value of meadows*

The Faculty of Agronomy in the University of Zagreb (Yugoslavia) published a work by the investigators K. Sostaric and J. Kovacevic in 1974, in which the "Complex" method was detailed in a combined publication of 4 languages (English, Russian, French and German) with an introduction and common parts in Serbian. Almost simultaneously, the same authors published a summary in French without the tables (SOSTARIC and KOVACEVIC, 1974). No work, using those theories, has been published in Spain. Essentially, this method consists of a quality value given for each specie of the sample according to some tables, dependent on the proportion in which it appears and attributing negative values for the species considered prejudicial. Grouping together the species which have been classified in regards to the same quality index, they are multiplied by the existing amount and the products done for every one of the qualities are added, the final quality of the sample is obtained. Thist quality index is multiplied by the yield to get a combined production-quality index.

We have applied the method to our samples and we summarized the obtained results, in table 1 (next to the last group of data). We have stablished the order from major to minor in table 2A. In the former positions, we can point out rich plots in leguminous (alfalfas, *T. pratense, Onobrychis sennenii*) where there are some high quality gramineae inserted (*Dactylis, Trisetum sp*). Plots with predominance of those species, including the group "Others", are placed in the latter positions, standing out, those which have a high proportion of *Centaurea debeauxii.* Finally, in an intermediate position between the two groups, we can find the plots constituted by the combinations of less defined species.

The comparison of our results and those summarized by SOSTARIC, (1974) permit us to observe that for the groups separated on the dendigram, our better group (without taking on account the alfalfa fields) is the "Clover or cocksfoot" (table 2) with a quality (52,6%) similar to the *Arrhenatheretum elatioris* (50,9%) and, the two groups with great amount of gramineae (*"Festura + Trisetum"* and *"Agrostis"*), would have values above and below the *Bromo-Cynosuretum cristati.* The *"Centaurea"* and *"Heracleum"* groups stay below, although they have superior qualities in relation to the more swamped communities summarized by Sostaric.

The great influence of manuring (table 2) in *Bromo-Cynosuretum cristati* (increase of 71% in the quality, 187% in the quantity and 491%

in a quality-quantity combination), clearly shows us that the improvement by fertilizing our rich groups in gramineae could have similar increases. If we assimilate our alfalfa fields to Sostaric's sowed and manured meadows, we will observe that the combined answer of quality-quantity could reach values of 650%.

It is quite clear that the improvement of the indigenous flora from wood clearings and streams may be achieved by means of a better control of water with an opportune utilization, and with a good manuring. For better plots, we must tend towards a sowing of very productive leguminous (case of alfalfa fields, which receive two cuttings more and can persist till 20 years) in association with good gramineae (*Dactylis*) and both adapted to the soft but continous Winter-Spring schepherding.

3.4. *Relations Between the three classification systems and other variables*

Diversity. In table 3A, we have compared the groups defined by the dendigram of similarity with the respective percentages presented by the three groups of gramineae, leguminosae and others. Paying special attention on the group "Others", we observe there is a clear drop from the *"Heracleum"* to the alfalfa fields passing through intermediate figures in the group of *"Agrostis"* and *"Festuca + Trisetum"*. The gramineae reach their highest values in these groups and the leguminosae in the alfalfa fields and "Clover or Cocksfoot". There is, therefore, a gradient of farmer intervention which goes from the most "wild" meadows (where the group "Others" predominates), to the most "domestic" ones (with predominance of leguminosae). The abundance of gramineae occurs in meadows of intermediate characteristics.

The samples, obtained by the same method, correspond aproximately to equal surfaces and can be compared to different perspectives by Shannon-Weaver's index. Data from every plot are summarized in table 1 and the order from major to minor diversity is given in table 3B. The estimations have been stabilished from the subsample destined to the species separation and it used to weigh, on the average, 40gr of DM corresponding to a 0,11 m^2 surface.

In table 3B, it is proved that the order of Shannon-Weaver's index coincides exactly with the specie number index and, in those cases in which with less number of species, a higher index is obtained, it is caused by a more homogeneous sharing of the specie weight; these differences are very well detected because the above-mentioned plots have a higher equitability.

In the ordering, the meadows previously denominated "domestic", present a low diversity, and as it has been seen, are characterized by a high percentage of leguminosae. It also appears low in those meadows

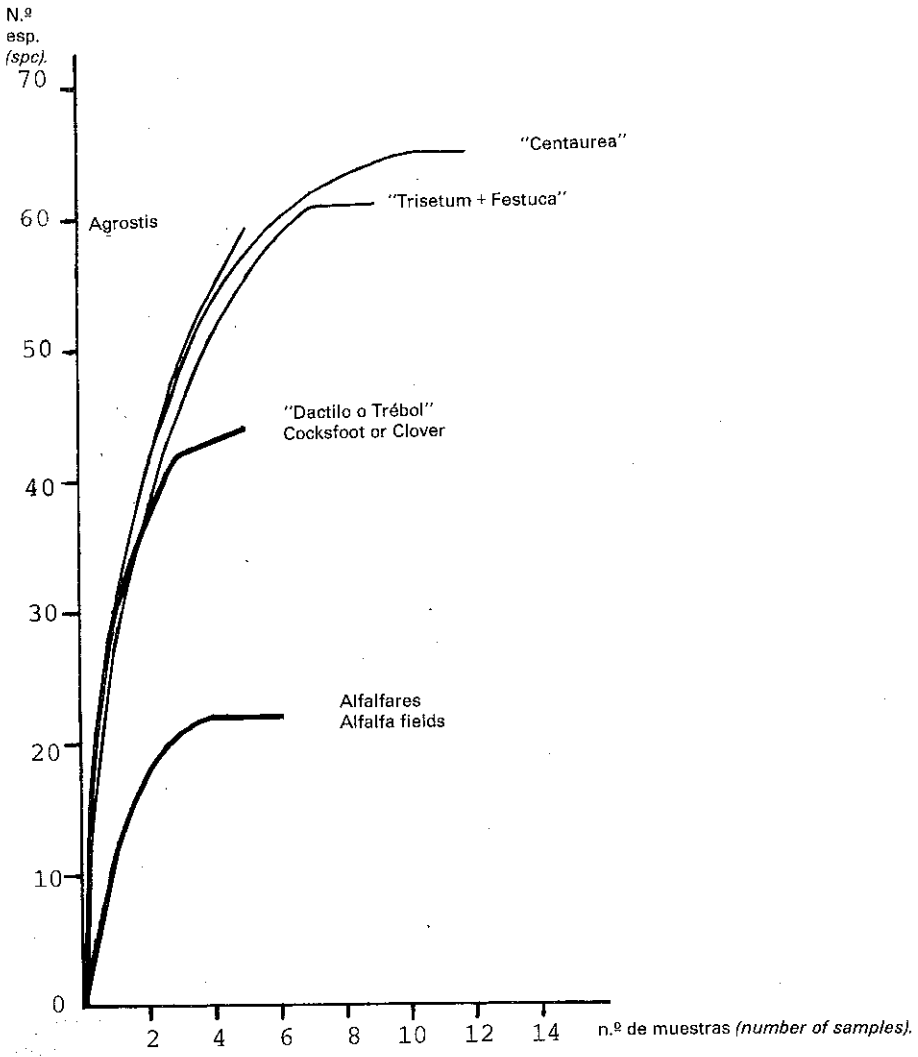


Fig. 5. *Number of species-number of the samples curveš.*

with a predominant specie (as the case of 5, 10, 12 from the "*Centaurea*" group and the 11 for its abundance in *Scabiosa sp.*). In the former positions, with a high index, (4,55 to 3,73) appear the plots which either belong to the wood edgings (1, 17, 35, 22, 23) or are used only for shepherding or they are grazed till very late in Spring (33, 27, 32). The others remain included among some values, as 3,67 and 2.70, which are middle values if we compare them to the ones obtained in the herbaceous stratums of the North American oak groves (MARGALEF, 1977) and even superior to the highest ones as in the case of the pastures in Salamanca (PUERTO, 1977). The plots we have classified as "wild" surpass widely those diversities with middle values of H = 4.

In fig. 5, the number of species found with respect to the number of necessary samples is related, drawing up the corresponding curves of every identified group by a similarity dendigram; a general aspect like that of an area-specie curve may also be observed. The groups, before having been defined as "domestic groups" (alfalfa fields, and "Clover or cocksfoot") present a maximum number of species lower than the less cultivated ones *("Agrostis", "Centaurea"* and *"Trisetum + Festuca".* The last group tends to stabilize its increase towards 60-65 species, got it with 6-8 samples, while the "domestic" ones only need 2-4 samples to get their maximums, always lower (20 or 45 species as the case may be).

In table 3C, we have put in order the most frequent species of the 45 plots studied, both referring to their presence as well as importance provided in weight. It is possible to point out that from the 106 species identified, 42 are the most frequent and, concerning the dry matter, 34 provide 92% of the total.

Production. In figure 6, we relate green production (Kg./m^2) and grass height (in cm.). For the latter one, the values that appear in table 1 have mot been directly taken; but the heights which correspond to the most frequent species. The regression curve results to be y=0,0832 x 1,23 (r=0,68).

In the plot distribution of the figure, we can register again three zones: one above 1,8kg/m^2 which includes the previously defined as "domestic" and those favoured by water (for example, plots 21 and 36 that belong to the "Heracleum" group). Another zone below 1kg/m^2 where we can gather those ones which are only grazed or are on poor and dry soils; and a third one, between 1 and 1,8kg/m^2 formed by the meadows of middle characteristics and with abundant gramineae ("Agrostis" and "Festuca + Trisetum").

If we connect the dry matter yield (Qm/Ha) with the altitudes, figure 7, we can observe that at different altitudes there is a gradient of management. Up to 1250m, management is directly carried out from the village and therefore, alfalfa yields abound. Above 1350m, management is tied to the existence of huts (stall + hayloft) being also abundant the meadows "only for grazing", which are used as support meadows (for example, for cows with a late parturition).

Soil temperatures. With the finality of picking up the gradient of moisture in the plots, soil temperatures were taken in each of them, being classified by days (table 4). In figure 1, there is a reproduction of a photograph taken in August 1980 after the first cutting, the places where coluvial water circulates by have been marked with dots. Comparing both pieces of information, we observe that the lowest everyday temperatures correspond to those plots represented on the photography as zones of phreatic circulation and there is a predominance

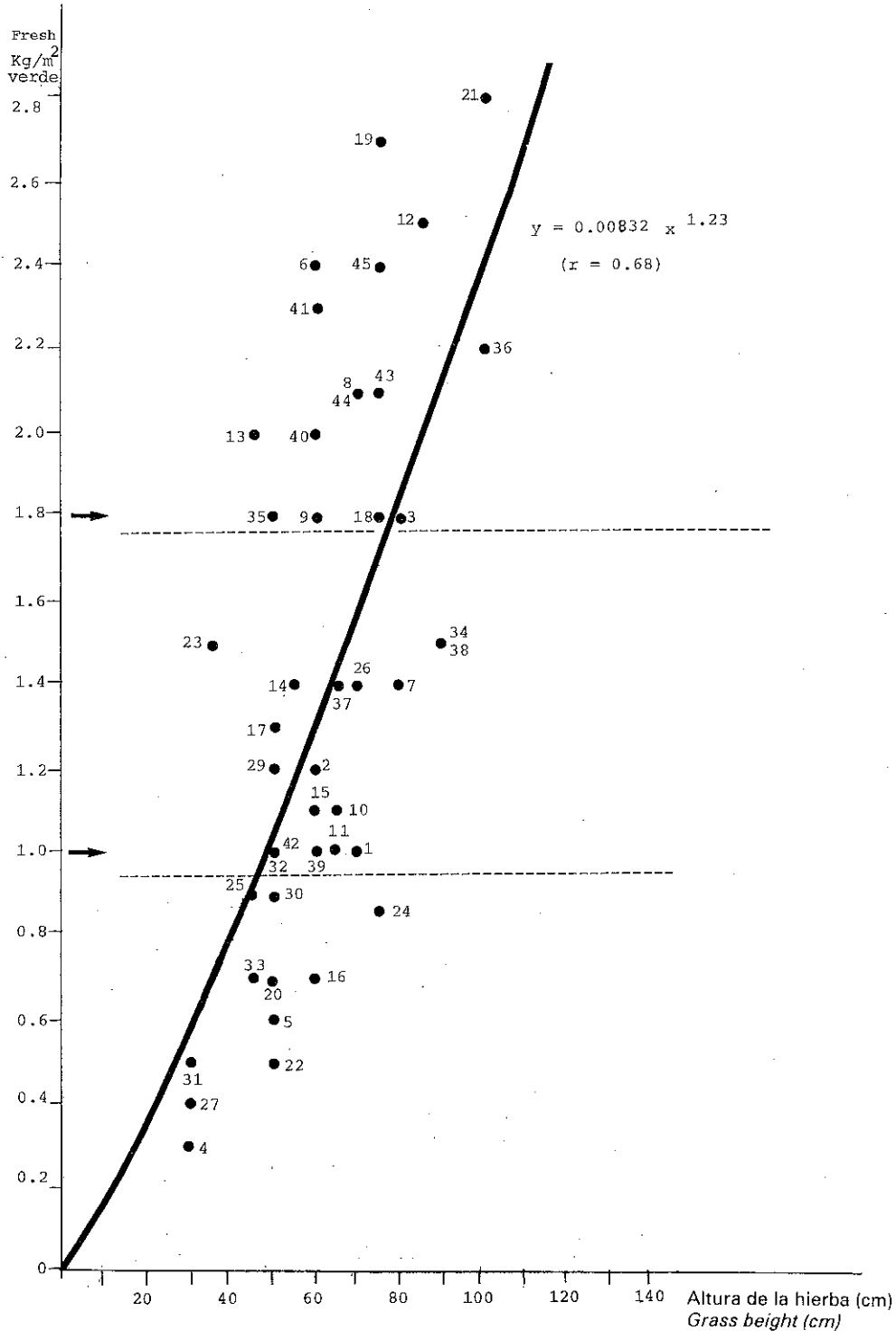


Fig. 6. Relación entre la producción verde y la altura de la hierba
(Relation between fresh production and grass height).

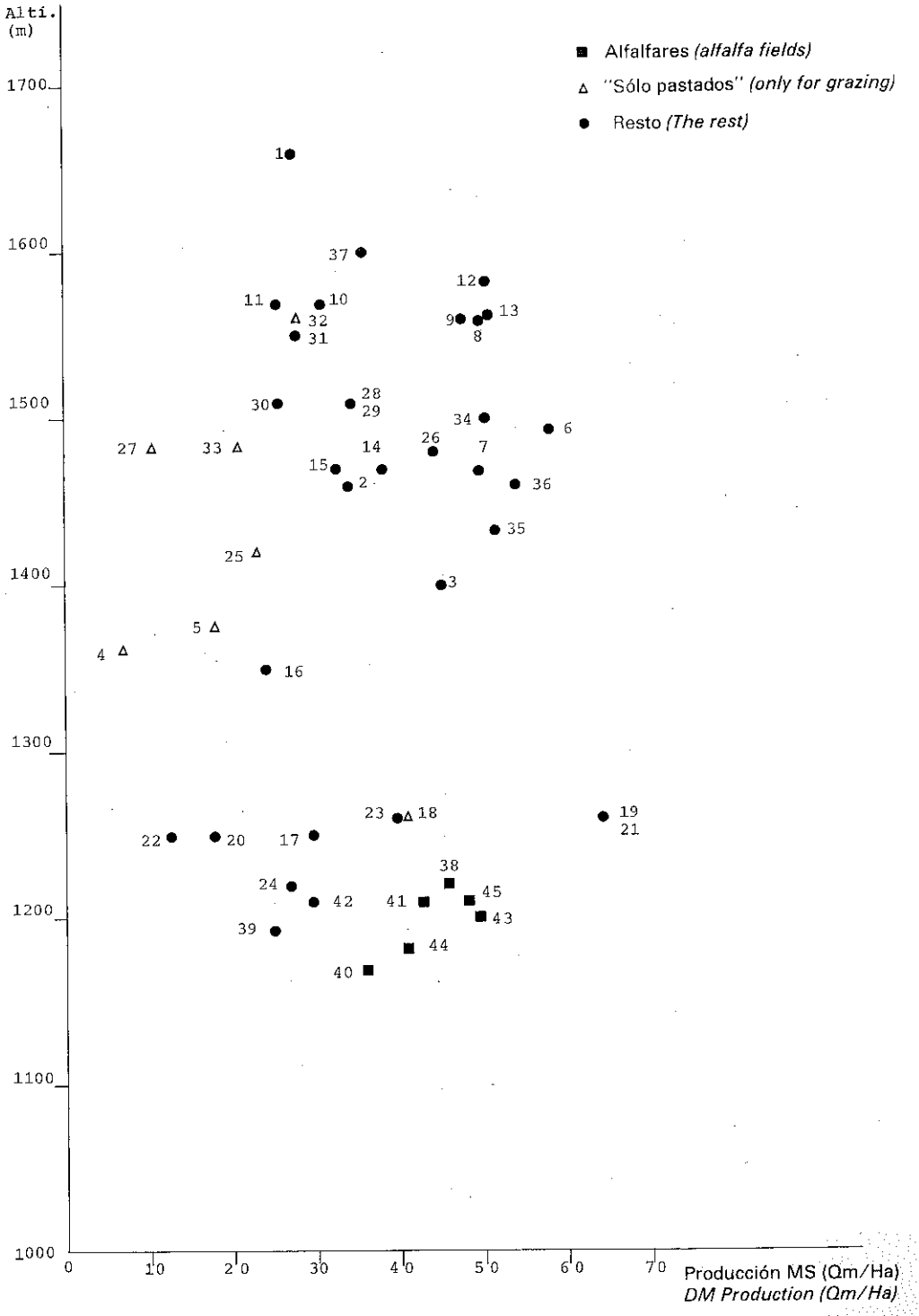


Fig. 7. *Relación entre la altitud y la producción de materia seca.*
(Relation between dry matter production and altitude (m. above sea level).

of *Centaurea debeauxii* (plots, 5, 2, ..., 29) and *Heracleum sphoudylium* (plots, 1, 2, 36). This same water has been circulating during the entire Spring, and its low temperatures can be the cause of maintaining them with quite a wild flora of little quality.

Comparison "Complex" — DMD. In table 5, we have put into order yield values of DM, DMD (quantity-quality DMD) and values obtained by the "Complex" method (combined index of production-quality). The three types of ordering have been compared by Spearman's index and they lave resulted to be: 0,98 for DM-DMD, 0,64 for DM-"Complex" and 0,60 for DMD-"Complex".

The strong correlation between DM ordering and that of the product DM DMD (in%) is evident, so that comparisons based on the DMD are not satisfactory for those types of wild meadows, with very different production wheter they were or not in a favourable zone. As we have seen in the study of Principal Components, axis I stablishes an order according to what may be called a characteristic of "ageing" since young tissues took priority, because of their abundance in CC an DCC. In the DMD ordering we can observe that plots with soft tissue are situated in good positions although they are of low quality (cases where *Centaurea debeauxii* is abundant, with less cellulose than the gramineae). This does not occur in the "Complex" method because quality is given to each specie and the result obtained does not permit one to classify as good, any plot that could have bad species; this is the case of sample 12 which was a third position according to DMD ordering and goes down to the thirty-first position in the "Complex' ordering. Therefore, plot classification by the DMD will be comparable to the Yugoslavian method (always referring to these indigenous meadows) when DMD qualities could be applied to each specie, the line of studies which is already being utilized in the Center of Salamanca. On the other hand, there is a group of plots in the three orders that always appear in the first positions and others that remain in the last.

Conclusions

The study of the organic parameters by a Principal Components Analysis shows a clear division between plots with ageing structures (gramineae with high presence of cellular wall) and plots "only for grazing" with softer renewal; and for that reason, with more cellular content. Plots with high contents in leguminosae are situated in an intermediate position with regard to the previous groups, caused partially by the presence of protein in those coordinates. Therefore, excepting the "only for grazing" meadows, it may be assured that all these meadows continue being scythed too late.

By means of the similarity dendrogram, plots have been grouped according to a resemblance criteria. Paying special attention on the proportions of gramineae, leguminosae and other species, obtained from every group, a primary classification can be made by means of the grade of farmer intervention: plots with *Heracleum* and *Centaurea* in abundance, and with circulation of coluvial water are the wildest. The second group is formed by meadows with high rate of gramineae, *"Agrostis"* and *"Festuca + Trisentum"* and it is very extensive in the vhole of the prairie, being these meadows a bit more cultivated than the previous ones. Finally the group formed by alfalfa fields and Clover or Coocksfoot plots where leguminosae are more abundant, is the nearest to the village and also the most cultivated. In these three groups diversity (Sannon's index in our case) decreases drastically with the grade of farmer intervention. As regards that which has already been exposed in the Complex Method and comparing our classification to the other studied in Yugoslavia, it can be estimated that the meadows of San Juan de Plan can be improved by means of a better control of water, an increase of their fertility and an advance on the period of cutting.

In these villages in the Central Pyrenees, with a terraced prairie in slopes, plot management has a gradient of intensification depending on the distance to the inhabited nucleus. The existence of stall-hayloft (hust) in indeterminate altitudes, reproduces in its surroundings the conditions of those plots near the village and they represent an essential support to extend the improvement from there onward. In each case, the model of improvement to put in practise would consist of very well controlled actions in the surroundings of the village (alfalfa field zones) and they would be continued towards meadows with intermediate characteristics to end with the furthest ("only for grazing" meadows and good edgings meadows) where the investments will only give a satisfactory answer after a long period of continuous improvements.

Acknowledgements. We would like to express our gratitude to J. Carlos Estévez for his collaboration in analytic works, to J. P. Martínez Rica and J. Puigdefábregas for their help in the statistic treatement, and to the cattle-raisers of San Juan de Plan for their enthusiasm.

—These estudies are inserted in the CAICYT project, number 2515. 83.

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Cuadro 2 A. Ordenamiento de muestras según el método "Complex".
(Samples ordering from "Complex" method).

	sample num.		Qm/Ha *
1 st	19	Trifolium pratense very important (40 % of DM)	45.01
2 nd	38	Alfalfa field (76 % of Medicago sativa)	40.29
3 rd	45	Alfalfa field (43 % of M. sativa)	36.77
4 th	41	Alfalfa field (47 % of M. sativa)	33.34
5 th	9	Trifolium pratense very important (45 % of DM)	30.18
6 th	35	A big importance of Leguminosae (47 %)	28.52
7 th	7	A big importance of good Gramineae (69 %)	26.61
8 th	8	Similar to the preceding (66 %)	25.08
9 th	13	Similar to the preceding (57 %)	22.69
10 th	3	A big importance of Onobrychis sennenii (38 %)	20.65
11 th	44	Alfalfa field (49 % of M. sativa)	20.28
12 th	6	A big importance of Gramineae (65 %)	19.83
13 th	24	Good Gramineae (Trisetum flavescens and Dactylis glomerata)	18.17
14 th	14	Leguminosae (35 %) and Centaurea debeauxii (30 %)	16.84
15 th	21	A big importance of Heracleum sphondylium (44 %)	16.22
16 th	40	Alfalfa field very old (25 % of M. sativa)	15.40
17 th	42	Leguminosae and T. flavescens (more than 60 %)	14.99
18 th	34	Gramineae (40 %), "Others" (44 %), Leguminosae (15 %)	14.97
19 th	36	A big importance of Heracleum sphondylium (35 %)	14.61
20 th	2	A big importance of the group "Others" (25 %)	14.27
21 st	17	Similar to number 34, Gramineae (41 %), "Others" (44 %) ..	14.21
22 nd	30	Similar to numbers 17 and 34, Gramineae (33 %)	11.46
23 rd	28	Leguminosae (23 %), "Others" (44 %), Astrantia major (23 %)	11.32
24 th	18	A big importance of the "Others" group (65 %)	11.29
25 th	32	Similar to the preceding (65 % of the "Others" group)	10.96
26 th	16	A big importance of the Gramineae (72 %)	10.75
27 th	20	Gramineae (21 %), Leguminosae (47 %), "Others" (32 %)	9.73
28 th	15	Gramineae (32 %), Leguminosae (26 %), "Others" (42 %)	9.30
29 th	29	A big importance of C. debeauxii	9.29
30 th	39	Gramineae (60 %), "Others" (40 %)	8.70
31 st	12	A big importance of C. debeauxii	8.12
32 nd	31	Gramineae (28 %), Leguminosae (27 %), "Others" (45 %)	7.64
33 rd	23	Gramineae (52 %), Legumonosae (13 %), "Others" (35 %)	7.33
34 th	37	A big importance of Holcus lanatus	6.75
35 th	43	Alfalfa field very old (M. sativa 24 %)	6.28
36 th	1	A big importance of H. sphondylium (47 %)	6.00
37 th	22	Importance of "Others" group (53 %)	5.19
38 th	25	A big importance of "Others" group (63 %)	5.07
39 th	4	Leguminosae (36 %), "Others" (43 %)	4.28
40 th	27	Importance of "Others" group (51 %)	3.92
41 st	33	Similar to the preceding (54 %)	2.92
42 nd	10	A big importance of C. debeauxii (74 %)	2.74
43 rd	5	Similar to the preceding (78 %)	2.33
44 th	11	A big importance of Scabiosa columbaria (85 %)	2.29
45 th	26	Importance of C. debeauxii (37 %)	0.93

(*) Qm/Ha of production-quality (= production x quality index)

Cuadro 2 B. Comparaciones con otros resultados. *(Comparison of other results).*

Datos de diversas asociaciones
Data of differents assotiations (Sostaric, 1974)

Asociación (Assotiation)	Calidad según "Complex" (en %) Quality accordig to "Complex" (%)
Bromo-Plantaginetum mediae	42.5
Arrhenatheretum elatioris	50.9
Bromo-Cynosuretum cristati	36.5
Deschampsietum caespitosae	-38.2
Caricetum tricostato-vulpinae	-97.3

Comparaciones entre una pradera permanente no fertilizada y fertilizada
Comparison between fertilized and non fertilized permanent meadows (Sostaric, 1974)

	Heno(Hay)		Quality		Qual-quantity	
	Qm/Ha	rela.	%	rela.	Qm/Ha	rela.
Bromo-Cynosuretum cristati non fertilized....	50.6	100.0	33.8	100.0	17.1	100.0
Bromo-Cynosuretum cristati fertilized	145.3	287.2	57.8	171.0	84.0	491.0
Sowed and fertilized meadow	144.7	286.0	76.8	227.2	111.2	650.0

Resultados de San Juan de Plan
The San Juan de Plan results

Alfalfares (1º corte) Alfalfa fields (1 st cut)	Heno(Hay)		Quality		Qual-quantity	
	Qm/Ha	rela.	%	rela.	Qm/Ha	rela.
Alfalfares. Alfalfa fields (1 st cutting)	43.6	-	67.0	-	29.2	-
Grupo "Trebol o Dactilo"."Clover or Cocksfoot"	47.0	-	52.6	-	24.7	-
"Festuca + Trisetum" group	17.4	-	48.3	-	8.4	-
"Agrostis" group	51.6	-	33.9	-	17.5	-
"Centaurea" group	24.1	-	29.5	-	7.1	-
"Heracleum" group	48.8	-	25.0	-	12.2	-

Cuadro 3 A. Contribución de tres grupos al tanto por ciento de MS.
(Contribution of three groups to percentage of DM).

	Gramineae	Leguminosae	Others
Total of the 45 samples	38	25	37
"Heracleum" group	30	8	62
"Centaurea" group	24	21	55
"Agrostis" group	55	10	35
"Festuca + Trisetum" group	47	23	30
"Clover + Cocksfoot" group	33	45	22
Alfalfa fields group	44	45	11

WILD meadows →	INTERMEDIATE →	DOMESTIC meadows
A big importance of "Others" Wood edgings zone Uncontrolled streams zone	A big importance of Gramineae More farmer intervention	A big importance of Leguminosae Near the village

Cuadro 3 B. Ordenamiento de parcelas según su diversidad.
(The order from major to minor diversity).

parcel numb.	H'	Equitability*	numb. of species	Characteristics
1	4.55	0.94	32	Wood edgings zone
17	4.22	0.90	30	Wood edgings zone
33	4.06	0.81	30	Grazing in the late Spring
27	4.03	0.85	29	Grazing in the late Spring
35	3.90	0.79	29	Wood edgings zone
22	3.81	0.78	28	Wood edgings zone
23	3.75	0.81	27	Wood edgings zone
32	3.73	0.86	27	Grazing in the late Spring
7	3.67	0.74	27	Good Gramineae
13	3.67	0.84	26	Good Gramineae
25	3.67	0.76	26	Others (63 %)
15	3.66	0.77	25	Others (42 %)
2	3.53	0.83	25	Others (25 % with 13 % of Cent. de.)
29	3.53	0.76	25	Importance of Centaurea debeauxii
30	3.53	0.74	23	Others (45 %)
26	3.50	0.81	22	Importance of C. debeauxii (37 %)
18	3.47	0.79	21	Others (65 %)
28	3.46	0.75	21	Others (44 %) with Astrantia major
34	3.45	0.83	21	Gramineae (40 %), Leguminosae (15 %)
31	3.43	0.76	21	Gramineae (28 %), Leguminosae (27 %)
21	3.17	0.72	20	Wood edgings zone
3	3.14	0.70	20	Importance of Onobrychis sennenii
20	3.12	0.66	20	Gramineae (21 %), Leguminosae (47 %)
8	3.12	0.75	19	Importance of Gramineae
16	3.09	0.70	18	Importance of Gramineae
6	3.06	0.76	18	Importance of Gramineae
14	2.94	0.68	18	Importance of C. debeauxii
24	2.87	0.80	16	Good Gramineae
19	2.80	0.67	16	Importance of T. pratense
36	2.70	0.68	16	Wood edgings zone
4	2.70	0.75	16	Leguminoseae (36 %), Others (43 %)
40	2.54	0.71	13	Alfalfa field
42	2.54	0.73	13	Leguminoseae (36 %)
39	2.50	0.79	13	Dactylis glomerata (44 %)
37	2.49	0.67	12	Gramineae (75 %)
9	2.14	0.54	12	Leguminoseae (49 %)
44	2.09	0.66	12	Alfalfa field
41	2.08	0.58	12	Alfalfa field
12	1.53	0.41	11	Importance of C. debeauxii
10	1.50	0.38	10	Importance of C. debeauxii
43	1.45	0.48	9	Alfalfa field
5	1.27	0.38	9	Importance of C. debeauxii
38	1.17	0.42	8	Alfalfa field
45	1.16	0.45	7	Alfalfa field
11	0.94	0.25	6	Importance of Scabiosa columbaria

Cuadro 3 C. N.º de especies más frecuentes y su importancia.
(The more frequent species and their importance).

	% de parcelas / % of plots		% de MS / % of DM
Dactylis glomerata	89	Centaurea debeauxii	10
Agrostis capillaris	78	Agrostis capillaris	8
Trisetum flavescens	71	Dactylis glomerata	8
Plantago lanceolata	71	Trisetum flavescens	7
Festuca gr. rubra	71	Onobrychis sennenii	6
Lotus corniculatus	71	Medicago sativa	6
Trifolium pratense	62	Trifolium pratense	5
Anthoxanthum odoratum	62	Lotus corniculatus	5
Taraxacum gr. officinale	51	Festuca gr. rubra	4
Ranunculus bulbosus	48	Heracleum sphondilium-m	4
Carex sp.	47	Rhinanthus mediterraneus	3
Onobrychis sennenii	47	Scabiosa columbaria	3
Cerastium fontanum	44	Bromus sterilis	2
Centaurea debeauxii	44	Sanguisorba minor	2
Sanguisorba minor	42	Taraxacum gr. officinale	2
Rhinanthus mediterraneus	42	Astrantia major	2
Holcus lanatus	37	Holcus lanatus	2
Arenaria serpyllifolia	37	Arrhenatherum elatius	1
Bromus erectus	36	Poa pratensis-angustifolia	1
Trifolium repens	31	Anthoxanthum odoratum	1
Achillea millefolium	31	Plantago lanceolata	1
Scabiosa columbaria	31	Holcus mollis	1
Poa pratensis-angustifolia	29	Bromus erectus	0.9
Arabis hirsuta	24	Carex sp	0.9
Phyteuma orbiculare	22	Chaerophyllum aureum	0.8
Arrhenatherum elatius	22	Knautia arvernensis	0.7
Cynosurus cristatus	22	Vicia gr. cracca	0.7
Astrantia major	20	Ranunculus bulbosus	0.6
Briza media	18	Picris hieracioides	0.6
Picris hieracioides	18	Achillea millefolium	0.6
Galium verum	18	Salvia pratensis	0.6
Viola sp	18	Ononis spinosa	0.6
Medicago sativa	16	Cerastium fontanum	0.5
Galium mollugo	16	Leontodon hispidus	0.5
Lolium perenne	16		
Leontodon hispidus	16	34 especies aportan el 92 % de MS	
Trifolium montanum	16	34 species provide the 92 % of DM	
Chaerophyllum aureum	13		
Veronica arvensis	13	Ms: Mhateria seca	
Vicia gr. cracca	13	DM: Dry matter	
Petrorhagia prolifera	13		
Phleum pratense	13		

Cuadro 4. Temperaturas del suelo. *(The soil temperatures).*

Días / Days		baja / low		intermedia / intermediate		alta / high	
		parc.	temp.	parc.	temp.	parc.	temp.
	6-6-85	41	15.4 °C			40	16 °C
		43	15.4			44	16
		45	15.4				
	4-7-85	17	14.1	20	15.3 °C	22	16.2
		18	13.8	38	15.4	23	16.5
		19	13.5	39	15.6	24	17.6
		21	14.6			42	16.1
	5-7-85	3	14.8			4	17.5
		5	14.5			16	16.4
	16-7-85	37	16.4	14	17.4	2	19.2
						15	20.9
	19-7-95	8	14.8			6	16.4
		9	14.5			10	17.4
		12	14.4			11	18.2
						13	17.0
	30-7-85	28	14.4	32	15.1	31	16.9
		29	14.1				
		36	13.8				
	31-7-85	1	15.4			7	17
		25	15.6				
		26	13.8				
		27	15.3				
		34	15.2				
		35	14.5				
		30	15.5				
		33	12.9				

Cuadro 5. Comparaciones entre "Complex" y DMD.
(Comparisons between "Complex" and DMD).

	The order from major to minor in DM production (Qm/Ha)			The order from major to minor in DMD x production (Qm/Ha)			The order from major to minor in "Complex" (Qm/Ha)	
*	19	64.01	*	21	42.45	*	19	45.01
*	21	63.60	*	19	40.36	*	38	40.29
*	6	58.00	*	12	37.98		45	36.77
*	12	54.54	*	6	37.03	*	41	33.34
*	36	53.90	*	36	36.12		9	30.18
*	35	51.66	*	35	34.81	*	35	28.52
*	13	50.60	*	13	33.11	*	7	26.61
	34	50.25		34	32.11	*	8	25.08
*	8	49.75	*	8	32.09	*	13	22.69
*	7	49.70		43	31.37		3	20.65
	43	49.58	*	7	30.91		44	20.28
	45	48.19	*	41	29.62	*	6	19.83
	9	47.83	*	38	29.45		24	18.17
*	38	45.33		3	29.06		14	16.84
	3	45.22		9	29.01	*	21	16.22
	26	44.17		26	28.66		40	15.40
*	41	42.96		18	28.56		42	14.99
	18	40.70		44	26.15		34	14.97
	44	40.67		40	25.29	*	36	14.61
	23	39.80		23	25.25		2	14.27
	14	38.18		14	24.74		17	14.21
	37	35.70		37	24.39		30	11.46
	40	35.70		45	23.70		28	11.32
	29	35.40		28	23.51		18	11.29
	2	34.14		29	23.33		32	10.96
	28	34.08		2	22.74		16	10.75
	15	32.70		10	21.27		20	9.73
	10	30.68		15	19.79		15	9.30
	17	29.51		17	18.94		29	9.29
	42	28.97		1	18.61		39	8.70
	32	27.60		32	18.47	*	12	8.12
	1	27.10		42	17.80		31	7.64
	24	26.66		30	16.97		23	7.33
	11	25.60		11	16.94		37	6.75
	30	25.38		39	16.68		43	6.28
	39	24.96		24	16.58		1	6.00
	16	24.02	*	25	16.40	*	22	5.19
*	25	23.04		16	15.08	*	25	5.07
*	33	20.86	*	33	14.42	*	4	4.28
*	5	17.84	*	5	12.00	*	27	3.92
	31	17.70		31	11.62	*	33	2.92
	20	17.42		20	10.49		10	2.74
*	22	12.45	*	22	7.76	*	5	2.33
*	27	10.40	*	27	5.60		11	2.29
*	4	7.96	*	4	5.33		26	0.93

	Spearman's index
Correlation between DM and DMD ordering	0.98
Correlation between DM and "Complex" ordering	0.64
Correlation between DMD and "Complex" ordering	0.60

Spearman's index : $r_s = 1 - \frac{6 \sum D^2}{n(n^2 - 1)}$ (Spearman 1904)

* The same situations in the three ordering