METHOD FOR THE STUDY OF THE STRUCTURE OF TROPICAL GRASSLANDS

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SUMMARY

Description of a method for studying tropical grasslands based on the structural analysis of vegetation. Analytical criteria : stratification, cover, biovolume, composition in terms of biological, morphological and biomorphological types. Definition and description of morphological types and biomorphological types of graminoid plants. Procedural formula for the surveying of the structure of vegetation. Symbiotic expression of structural data in the form of a " structural " card. Scope for the application of the method.

1. GENERAL PRINCIPLES

In the procedure we shall follow, an analysis of the structure of the vegetation is still the necessary foundation for the description and definition of grasslands. The basic reason for this choice is the fact that structural data relates to the intrinsic, and some of the most fundamental, characteristics of vegetation.

The analytical procedure we shall adopt derives from two basic statements :

— an herbaceous layer and ligneous layer may be distinguished in all grasslands as two well-differentiated types ; as a result it is necessary to analyse them separately, with regard to herbaceous cover. It is further possible to separate on the one hand graminoids (basically Graminaceae and Cyperaceae), always more or less the dominant if not the only species represented, and which should be analysed in detail, and on the other hand, other herbaceous plants (forbs) which are of little or no interest (1).

In conventional grassland (for example, Guinean Savanna) it is possible to distinguish at first glance two elements, an herbaceous layer and a ligneous layer ; their most immediately visible characteristics are clearly dissimilar.

Herbaceous layer is always present. By this we mean that the existence of herbaceous plant cover is the necessary prerequisite without which we cannot begin to consider the vegetation types which make up the grasslands. This is thus a necessary and sometimes sufficient condition, whereas the second element, the ligneous layer, is optional, although it normally occurs.

Usually, at the end of the dry season, after the plant life has been subjected to fire or has dried up, the ground is stripped of its herbaceous vegetation. However, only a few months later the herbaceous layer will be at the height of its growth. The cover of herbaceous vegetation on the ground thus follows a non-continuous cyclical pattern in time ; correlatively, its annual development is both considerable and very visible, since from ground surface level it may reach a height of between 3 and 4 metres ; and, also correlatively, its growth is very rapid, a few months being sufficient for the whole development process of the plants which make up the herbaceous layer. Conversely, the ligneous layer, where it exists, is present all the year round, its annual growth cycle being relatively very slight and little visible, and its growth seemingly slow.

The biological types most represented in herbaceous layer are therophytes, cryptophytes and hemicryptophytes ; plants of these types are in this case histologically herbaceous and their upward growth reaches a height of from 10 to 400 cm. With regard to the ligneous layer the biological types most represented are chamephytes and phanerophytes ; plants of these types are histologically ligneous (palm trees excluded) and their upward growth can be considerable, to as much as 20 - 25 m in height.

Another major phytosociological characteristic separates the two elements — the minimum phytosociological area required by the herbaceous layer may be as little as a few m² (from 4 to 25 m² on average), whereas for the ligneous layer the minimum may be as much as a hundred to several hundred square metres.

At the biological level, because of the physical imposition of one type of vegetation on the other, a certain effect is created by the ligneous layer which,

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(1) A good description of graminoids and forbs is given by Kuchler (1967).

by virtue of its density, shade and probably other secondary factors, somewhat modifies the nature and structure of the herbaceous layer which it dominates.

On the basis of these different points we may consequently make a clear distinction on the first level of structural analysis between the two elements which make up the grasslands. In consequence they should be analysed separately and according to slightly different standards.

It is possible to make a second distinction, within the herbaceous layer, which is less immediately obvious to the observer and which may, according to the season, be less justifiable, but which is nonetheless real and fundamental.

In the herbaceous cover, all observations, specially numbered (César 1971), show that it is the graminoid species which, by virtue of their height and the density of individuals, and the biovolume and the biomass they produce, impose their own particular appearance and structure on the herbaceous layer. In other words, in any given grassland an abnormal disappearance of forbs would cause no, or only little, modification in structural characteristics. This is the case in normal and general conditions, but of course for certain special groups (formations in transition towards non-grass vegetation, temporary stages in the evolutionary cycle of certain grasslands, etc.) this assessment may be amended.

One of the practical advantages which may be derived from this distinction is a decrease in the number of species or plants to be inventoried in the field, and also the amount of data to be gathered, in comparison with conventional phytosociological analysis. In addition, for the purposes of analysis it allows us to isolate homogeneous groups of plants at the level of structural characteristics, although their floristic, biological and ecological variation is also capable of providing a great deal of data at the structural level.

2. STRUCTURAL CHARACTERISTICS AND PARAMETERS

By structural characteristic we mean an essentially qualitative element of structure, only indirectly quantifiable. Stratification, composition according to biological types, morphological types, and biomorphological types are in this category. By structural parameter we understand an element of structure, basically quantitative, and thus directly quantifiable : size, cover, biovolume.

These descriptive criteria are for the most part conventional and widely used in phytosociological and phytoecological surveys. We will limit ourselves to a brief review of them in passing; reference for further information may be made to: "Code Ecologique" (Gordon *et al.* 1968) and Descoings (1971 a).

Stratification

Using vertical section, the mass of grassland is seen to exhibit a fairly clear-cut layering of plants in strata. Two of these are special and have already been noted in the distinction made between the herbaceous layer and the ligneous layer. Within these two basic strata there may be further strata, which may or may not be numerous, and may or may not be well defined.

Within each of these strata may be determined parameters (size, cover) and characteristics (composition in terms of biological types, morphological types and biomorphological types) which should be noted.

Cover

We are concerned here with cover as it is generally used in phytoecological study, that is to say, the ratio of the projection area for a given element on the horizontal level to the total area used in the analysis of the vegetation. We consider only the cover of crowns, represented by the above-ground mass of vegetative and flower-bearing plants, in respect of the different parts of the grasslands : strata, plants, individuals of the same species, or of the same biological, morphological or biomorphological type.

Biovolume

This is the product of size and cover. In fact it represents the amount of space occupied by a given vegetation mass. Because it cannot take into account the density of vegetation, this parameter has a certain relative value, which the use of the term biomass does not have. For dense grasslands of the temperate regions the relations between cover and biomass have been established in a precise way by several authors (Daget and Poissonet 1969; P. Poissonet and J. Poissonet, 1969). However with regard to tropical grassland, it seems that there is insufficient data to be able to determine the exact relationships between biovolume and biomass in the principal types of vegetation.

Composition in terms of biological types

The classic biological types of Raunkiaer (1905, 1934) form a very important structural element of grasslands. We will make use of the principal types only — phanerophytes, chamephytes, hemicryptophytes, cryptophytes, therophytes — without considering any further detail, although if the need arose nothing would impede further distinctions.

With regard to the ligneous layer, we will not go as far as noting the biological types, but data concerning stratification would in fact allow, if desired, the partial establishment of the corresponding spectrum.

With regard to herbaceous layer, its two elements are treated differently. Record of composition in terms of biological types is made in detail in respect of graminoid vegetation, and a spectrum is established with a percentage of the biovolume of each biological type. However, we shall not consider the biological types of forbs, for two reasons. Firstly, such consideration, which would provide information of some value, would still be of relatively little interest to our chosen purpose. And it would involve a certain increase in the work of vegetation sampling. Also, a definite obstacle would be that the optimum period of analysis for the forbs is often not the same as that for graminoids, and because of this, there is a risk that the record of the biological types of the forbs would be incomplete.

Composition in terms of morphological types

In parallel to the biological types, our analysis should take into consideration the composition of grassland in terms of morphological types (for a definition of these types, see paragraph 3 hereafter).

In the same way as for the biological types, the morphological types are recorded in a spectrum according to the relative value of their biovolume. Defined only in respect of graminoids, these morphological types are relevant only to the graminoid vegetation of the herbaceous layer, and forbs as well as plants constituting the ligneous layer are not taken into consideration in this record. The above reflects a work convention corresponding to the aspect of study chosen ; however there would be no difficulty in recording the composition of all the plants of grassland in terms of morphological types, after defining the new types required for forbs and for the ligneous plants.

Composition in terms of biomorphological types

All graminoid plants are of a biological type and a morphological type. The co-occurence of these two types enables us to define what we call "biomorphological types", the combination of a biological type with a morphological type.

Lists of the biological types and morphological types that we make use of enable us to establish immediately combinations, each of which result in a distinct biomorphological type. In fact, the combinations are not all of the same importance ; some of them are used more often, and it is noted that in practice the number of biomorphological types found in surveys of an area remains fairly limited.

The biomorphological types, defined in this way, make up part of the analysis of the grassland, benefiting, like the other two types, only the graminoid vegetation. They are expressed likewise as a percentage of their volume ; also, they are not recorded by means of a spectrum but by a diagram.

Lastly, biomorphological types derive directly from biological and morphological types, and the same conditions apply in that their number might be increased if a detailed study of the elements of which they are composed were made.

3. MORPHOLOGICAL AND BIOMORPHOLOGICAL TYPES

On the basis of certain morphological criteria — general plant morphology, modalities of ramification, etc. — and certain ideas of Jacques-Felix (1962), we have defined morphological types for graminoids which are clearly distinct from the classic biological types of Raunkiaer. In addition, by establishing combinations of biological and morphological types we have obtained a considerable number of biomorphological types, which for the graminoid plants represents a symbiosis of biological and morphological characteristics in general (Fig. 1).

These two types, morphological and biomorphological, are appropriate not only for graminaceae, but also for all plants that belong to the graminoids (cyperaceae, juncaceae, thyphaceae).

The morphological elements which comprise the definition of morphological types can be described by means of four principal characteristics : the number and arrangements of the axes, the manner of branching of these axes, the distribution of the foliage, and the manner of occupation of the surface area of the ground.

The multiple combinations of possible observable characteristics allow us to make a theoretical description of a large number of major morphological types, which are of interest for various reasons. We will limit ourselves to defining four basic morphological types : the caespitose type, gazonnant type, rhizomatous type, and uniculmaire type. Each of these types may be sub-divided into two subtypes : *basiphylle* and *cauliphylle*. Lastly, variants, of undefined number and kind give additional flexibility in use, by providing greater detail.

The following are the basic distinctive characteristics of morphological types :

— *caespitose type* (C) : caespitose plant, tufted, dense, erect ; base formed by a plateau of tillers at ground level, which are the result of dense basal branching ; very numerous closeknit erect above-ground axes, which result in dense ground cover ;

— *gazonnant type* (g) creeping, flattened plant, somewhat tufted, with fairly abundant branching ; with no plateau of tillers ; diffuse tufts, not tight-knit ; axes frequently spreading horizontally with radicating centers, often stolonate ; fairly numerous erect above-ground axes, which result in loose, light ground cover ;

— *rhizomatous type* (R) : underground axes fairly numerous, branched (rhizomes) ; they put out few erect, distantly spaced above-ground axes, which do not form tufts ; linear ground cover ;

— *uniculmaire type* (U) : few, or one single axis ; no or very reduced basal branching ; no shelf of tillers ; " dotted " distribution of ground cover.

Each of these types is comprised of two very distinct subtypes :

— *basiphylle subtype* (b) : foliage fairly erect, clustered at the base of the above-ground axes, to form tufts ; erect florific haulm, aphyllous or with very little foliage ; it is possible to distinguish in vegetation of this subtype, within the above-ground vegetative mass, a lower vegetative substratum composed of the total foliage and a florific upper substratum composed of the total of florific haulms ;

— *cauliphylle subtype* (c) : basal foliage sometimes present, sometimes forming basal tufts ; above-ground axes erect and florific axes with fairly dense foliage ; it is not possible to make a clear distinction between the vegetative and florific substrata, which was possible in the previous subtype.

The types and subtypes contain special, interesting morphological variations, which are considered as " variants ". In theory all the variants may be applied to all the types, except where there is, by definition, incompatibility.

Up to this point we have covered the following variants :

— *above-ground branching* (a) : presence of branching on erect above-ground axes or on inflorescences.

— *pauciculmaire* (p) : presence of a small number of axes ; this variant may be used for the more precise definition of the *uniculmaire* type.

In practice, these morphological types may be used with the same flexibility as Raunkiaer's biological types. The search for parallels between the two kinds of types has enabled us to define what we call " biomorphological types " (BMT). These biomorphological types are simply the result of the combining in pairs of a biological type and a morphological type. In theory the number of combinations might appear quite great, but in practice only a restricted number of BMT are found.

Within the biomorphological type are found data of various kinds, provided by the biological and morphological types of which it is composed. They define graminoid plants in detail, in biological and morphological terms, and also in ecological terms.

4. STRUCTURAL ANALYSIS OF GRASSLANDS

The study of the structure of grasslands must of necessity start with the initial analytical and descriptive phase. The analysis of the nature and the record of the values of the different characteristics and of the different parameters which are involved in grasslands provide a series of objective, qualitative, or quantitative data which together constitute the description of the grassland.

For obvious reasons of convenience and rationalisation, the descriptive structural survey would make use of pre-established formulae, composed of conditions which have only to be fulfilled on site. In this way, as for every phytosociological or phytoecological analysis, structural analysis has been rationalised. Also, the information gathered can be directly retrieved for use, by means of a data processing system.

Inspiration for this formula for the structural analysis of grassland has clearly come from the one used by CEPE L. Emberger, although of course some modification or innovation has been required for the consideration of tropical grassland.

The procedure and its utilisation have been described in detail in a previous article (Descoings, 1971 a) and will be the subject of a practical publication for use on site, in the near future.

The formulae for the structural analysis represented in three following pages (fig. 2a, 2b, 2c) suppose a certain knowledge of the application of conventional methods of phytoecological analysis, and also of the precautions to be taken in surveys of this nature.

In particular, the choice of the sampling site should satisfy the necessary conditions for a valid analysis (see " Code Ecologique ", Godron *et al.* 1968).

In order to decide on a surface area for the survey, it is necessary to return to the distinction between the two major elements of all grassland, the herbaceous layer and the ligneous layer. Each of these two elements possesses a basic area of its own, and it is vital that they be analysed in the region which suits each one.

Another precaution concerns the date of the structural survey. The description of grassland should be made at the time when it has reached an appropriate stage in its development. This stage extends from its earliest point, in the spring, to its best point, which is at the flowering or fructification stage of most of the graminoid plants. It is at this moment that the grassland has completed its development cycle. Any description made before this time runs the risk of being incomplete. This principle gives rise to certain reflections. In order to be valid, the comparison of the formations must be made at the corresponding stages of their development. Also, when the desired outcome is the definition and classification of grasslands, it becomes necessary to choose the stage at which the cycle of development is complete.

However, there are occasions where a structural survey is deliberately carried out at periods other than those stated above : for example with a very special aim in mind, when one wishes to describe the evolution of structure over a given period of time, or a given vegetative cycle or climatic year.

We should also mention the record of the floristic composition of the grassland. We stated, while considering general principles, that the proposed method does not include an account of the floristic composition within the description and definition of the grassland. This being so, there is of course nothing to prevent us from recording the species of which the grassland is composed.

In the framework of a regional study, from an ecological or chronological point of view, this data will always have some value. Sound knowledge (where it exists) of the flora, assists in the carrying out of a structural survey. Nevertheless, it still remains true that knowledge of the floristic composition of the vegetation described is not necessary in the definition of grasslands through vegetative structure. Correlatively, the lack of knowledge of flora in no way prevents the carrying out of structural surveys and an overall application of the method described.

In conclusion we note that the third page of the survey formula is concerned with ecological data. This is not necessary either for the description or the definition of grassland. But it may be helpful subsequently, for analysis, in identifying important ecological characteristics of certain types of grasslands. Moreover, it is obvious that in the case of a detailed phytoecological study, it would be necessary to carry out a more intensive survey of environmental conditions than would be necessary for any other kind of study.

5. STRUCTURAL CARD

The procedure for a structural survey of grassland involves the collection of analytical data, which when assembled provide the description of the vegetation. It is also necessary to make a synthesis of the data in concise form, which will constitute a definition of the grassland under study. It is this kind of descriptive card that we call a " structural card " (" fiche structurale ") (fig. 3).

It involves two distinct and complementary elements : firstly a graphic representation made up of several diagrams, and secondly a diagnosis established according to standardised terminology.

Details of the layout of the structural card and the way in which it should be filled in are set out elsewhere (Descoings, 1971a) (2). We will limit ourselves here to the principal characteristics of this structural card.

It is perfectly feasible to make a synthesis of structural data by means of figures or formulae or figurative drawings ; various authors have throught of such representations, particularly with regard to setting up general systems of classification for types of vegetation (Aureville 1965, Dansereau 1954, etc.). All the systems proposed contain both advantageous and inconvenient elements, and the one proposed here does not differ in this respect.

By concerning ourselves with a limited and fairly well-defined section of tropical vegetation we have sought to find a symbiotic means of representation of data, which, having taken into account the kind of subject and the declared aim, would include the qualities of clarity and simplicity without, in spite of this, diverging very far from conventional procedures or the realities of making inventories.

In examining a structural card for grassland (see

(2) Certain differences will be noted between the card described in 1971 and the one presented here, modifications and improvements having been carried out between the two. dates ; they are principally concerned with the more precise definition of morphological types.

attached model, fig. 3) we may see that it involves a series of 5 diagrams. The first three (the upper part of the card) are concerned with the grassland in terms of biological types, morphological types, and biomorphological types. They reflect the presence of these different types, and their relative value is expressed in terms of biovolume. The biological and morphological types are represented by means of spectra which are presented in a special way, in order that the kind of types found can be immediately distinguished. The biomorphological types are expressed by means of a simple diagram in which each type is represented by a square, and their value is recorded at the side of the square, expressed as a percentage in biovolume. This representation makes visual the proportions of the biomorphological types ; it involves some distortion because of a certain amount of over-estimation of the highest values and of under-estimation of the lowest values. This distortion should not provide any difficulties, because it corresponds to an actual biological fact — frequently occurring types exerting an influence and being relatively more important than types which only occasionally occur.

The expression of the absolute total of biovolume (ATBV) establishes the importance in volume and indirectly in biomass of the development of the graminoid layer within the grassland.

The purpose of the diagram in the lower part of the structural card is to express by means of a vertical section a symbiotic representation of the grassland. The ligneous vegetation and the herbaceous vegetation have been separated for reasons of convenience and because they are measured by distinctly different scales. In both cases, each stratum is described in terms of size, cover, and, in regard to graminoid layer, in terms of biomorphological type. The vertical structure and the horizontal structure of each element of the grassland are thus represented at the same time.

A certain amount of further information completes the stratification diagrams : in respect of the ligneous layer, absolute total cover (ATC) and density ; in respect of the graminoid layer, absolute total cover (ATC) ; finally, the cover of the forb part of the herbaceous layer.

In addition to the graphic representation provided by the diagrams, the structural card includes a short description which one might call a " diagnosis ". These diagnoses of grasslands follow a standard pattern, making use of precise restricted terms, each of which corresponds to the value or interval of value on a scale of structural characteristics and parameters. A code designed to allow the transcription and reading back of these diagnoses is presented in an attachment (table 1). The diagnosis can be made by listing in the order of the code, the terms corresponding to the values indicated in the diagrams of the structural card.

The purpose of the diagnosis is to express in words the information provided visually in the diagrams. It is possible for all useful purposes to substitute the diagnosis for the structural card, of which it is normally but one part. By virtue of its composition, the expression of the diagnosis is as rigorous, although less precise, than all the diagrams of the structural card together, which justifies its use in all comparisons. In addition, and most importantly, it enables us to describe comprehensively, in a few words only and without misunderstanding, every kind of grassland of every region.

6. SCOPE FOR THE APPLICATION OF THE METHOD

The method which has just been presented is applicable essentially to tropical grassland. It can assist two different functions at the same time : the description of vegetation by means of the analysis of structural data, using the procedural formula for survey ; and the definition of the same vegetation by means of a symbiotic presentation of structural data, using the structural card.

Its principal characteristics define, for practical purposes, its field of application and the scope of its use.

Most appropriate for the study of tropical grasslands, this method is in fact adaptable for analysis of all the types of grasslands of the world. However, the study of non-grassland types of herbaceous vegetation requires the remoulding of the procedural formula and of the structural card. Some of the basic principles would remain completely valid (structural analysis, separation of the ligneous layer from the herbaceous layer), but it would be necessary to redefine the morphological types for the forbs.

It has already been noted that this system by definition does not require any knowledge of the flora of the vegetation under study. This is a basic point and is worth insisting upon. All the work previously carried out which has dealt with regional or local studies of vegetation has based its description and its classification of vegetation on the analysis of flora. These methods, although indispensable, contain, from a phytoecological analysis, rely on the floristic analysis on the extent of surface area, and on a certain degree of subjectivity on the part of the person making the survey.

The structural analysis of vegetation, on the other hand, provides quantitative and objective data which makes it possible to compare all the types of grasslands of the world with each other.

With regard to data processing, standardisation of data of all kinds has become a necessity. The system presented here is designed to allow maximum use of the data gathered and the information synthesized, using the latest data processing techniques. In this respect its procedure remains close to that of the " Code Ecologique " of CEPE, and it represents in some ways a continuation of the code, adapted to a special type of tropical vegetation.

The first and best area of application of this method is obviously the inventory of grasslands, for which it was initially developed. Inventories at all levels, local, regional or general, are possible, and are as appropriate in respect of a simple inventory of vegetation as for the mapping of vegetation, or even for the purpose of a phytoecological study made in parallel with an analysis of the environment.

Some limited examples of the application of the method may be found in various studies of the savannahs of Gabon (Descoings, 1974 a, b, c ; 1975 a, b, c). A broader example, concerned with the overall grasslands of the Congo and Gabon, is soon to be published. In every case the grassland is considered from both the phytogeographical and rengeland points of view. IEMVT (Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicaux) has begun to use this method of analysis in completing descriptions of types of rangeland (Toutain, 1974).

The analysis of the structure of vegetation is also of interest when the course of an evolutionary biological cycle of grassland is to be studied. In effect, from the time of the revival of the vegetation to its drying up or its destruction by fire when its development cycle is complete, the structural characteristics and parameters of the different elements of the vegetation are seen to be modified to a sometimes considerable extent. Structural surveys, carried out at regular intervals on the same restricted area of land, make it possible to study this evolution in considerable detail. We may refer to an early example using the data of César, concerning the savannah of the Ivory Coast (Descoings 1972).

Finally, within the framework of a general inventory of rangeland and grassland, the structural analysis of vegetation provides an excellent tool with which to tackle the difficult problem of definition, denomination and classification of vegetation.

Table 1

Code for the diagnosis of grassland

Writing of diagnosis : write successively and in order of the sections just below the corresponding terms with the indicated values in the schemas of the structural card.

Example : grassland with pure (paragraph 11) unistratal (12) flat (13) very sparse (14) *graminoid layer,* and unistratal (21) scrubby (22) very sparse (23) scattered (24) *ligneous layer.*

N.B. Each interval of value includes its inferior limit and excludes its superior limit.

I. GRAMINOID LAYER

11. Composition in terms of biomorphological types (expressed as a % of total biovolume)

1 type only = 100 %	pure
1 type ⩾ 90 % + 1 or several other types	sub-pure
2 types (the lowest > 10 %)	mixed
2 types ⩾ 90 % (the lowest > 10 %) + 1 or several other types.	sub-mixed
other combinations	composite

12. Stratification (number of strata)

1 vegetative stratum	unistratal
2 vegetative strata	bistratal
3 vegetative strata or more	pluristratal

13. Height (highest vegetative stratum of more than 10 % of total cover)

from 0 to 25 cm	flat
from 25 to 50 cm	low
from 50 to 100 cm	moderate
from 100 to 200 cm	high
more than 200 cm	very high

14. Total cover (sum of the cover of individual strata)

from 0 to 25 %	very sparse
from 25 to 50 %	sparse
from 50 to 75 %	open
from 75 to 100 %	dense
more than 100 %	closed

II. LIGNEOUS LAYER

21. Stratification (number of strata)

1 stratum	unistratal
2 strata	bistratal
3 strata or more	pluristratal

22. Height (the highest stratum)

from 0 to 2 m	shrubby
from 2 to 4 m	low shrubby
from 4 to 8 m	high shrubby
from 8 to 16 m	low arboreous
more than 16 m	high arboreous

23. Total cover (sum of the cover of individual strata)

from 0 to 25 %	very sparse
from 25 to 50 %	sparse
from 50 to 75 %	open
from 75 to 100 %	dense
more than 100 %	closed

24. Density (number of stems of woody plants per 100 sq. m.)

less than 0.01	scattered
from 0.1 to 0.1	scarcely close
from 0.1 to 1	close enough
from 1 to 10	close
more than 10	very close

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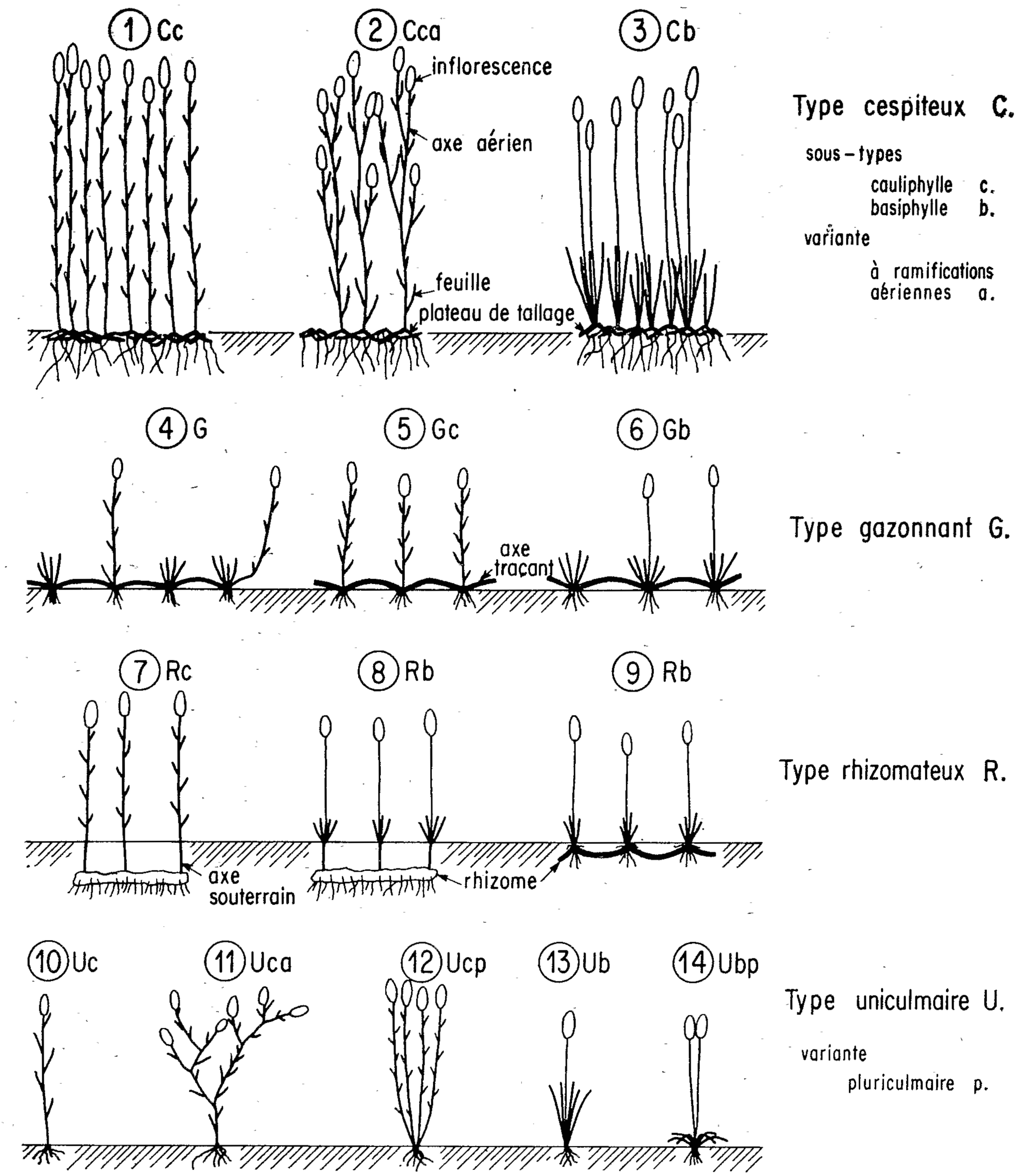


1. Cc, cespiteux cauliphylle – 2. Cca, cespiteux cauliphylle à ramifications aériennes 3. Cb, cespiteux basiphylle – 4. G, gazonnant – 5. Gc, gazonnant cauliphylle 6. Gb, gazonnant basiphylle – 7. Rc, rhizomateux cauliphylle – 8,9. Rb, rhizomateux basiphylle 10. Uc, uniculmaire cauliphylle – 11. Uca, uniculmaire cauliphylle à ramifications aériennes – 12. Ucp, uniculmaire cauliphylle pluriculmaire – 13. Ub, uniculmaire basiphylle – 14. Ubp, uniculmaire basiphylle pluriculmaire.

Types morphologiques des plantes graminoïdes. Représentation schématique

Figure 1

FORMATIONS HERBEUSES

Relevé de la structure de la végétation

Référence du relevé : Pays CONGO — Auteurs B. DESCOINGS — Numéro 722

Région LEFINI — Localité KINDAMBA — Altitude .... m

Latitude : degrés .... grades .... — Longitude : degrés .... grades ....

Jour 04 mois 05 année 1962 — Photos ....

Type de végétation Savane arbustive

I – STRATIFICATION DU PEUPLEMENT LIGNEUX

Superficie du relevé 200 m²

1 Strate		2 Taille en m.	3 Rec. %	4 Abond. numér.	5 Espèces dominantes
1	0 – 2 m	0,5-1	4	10	Annona senegalensis
2	2 – 4 m	2-4	20	12	Hymenocardia acida
3	4 – 8 m				
4	8 – 16 m				
5	> 16 m				

II – TAPIS HERBACÉ

Superficie du relevé 9 m²

Taille 0,8 / 1,8 m — Rec. peuplement graminoïde 60 %

Rec. total 60 % — Rec. autres espèces 2 %

III – STRATIFICATION DU PEUPLEMENT GRAMINOÏDE

6 Strate	7 Taille en m	8 Rec. %	9 Biov.	10 Nature vég.	fl.	11 Composition TB: T	H	C	Ch	P	TM: C	U	G	R
1	0,75	48		X			X				X			
-	2,00	3			X		X				X			
2	1,80	12		X	X		X				X			

Feuille 1

Figure 2a

Référence du relevé : Pays ......CONGO...... Auteurs ......B. DESCOINGS...... Numéro ......722......

IV _ ANALYSE DU PEUPLEMENT GRAMINOÏDE

Espèces dominantes ....

12 Nº	Nom de l'espèce	13 Strate	14 TB	15 TM	16 Taille en m	17 Rec. %	18 Biov.	19 Etat phénol.
	Loudetia demeusei	1	H	Cb	0,80	30	24	
	- -		-	-	2,00	3	6	4
	Loudetia arundinacea	1	H	Cb	0,60	10	6	
	- -		-	-	2,10	1	2,1	3
	Andropogon schirensis	1	H	Cb	0,60	8	4,8	
	- -		-	-	2,10	0,8	1,7	2
	Hyparrhenia diplandra	2	H	Cc	1,80	12	21,6	2
	Sporobolus dinklagei				0,25			4
	Digitaria brazzae				0,25			4
	Panicum brevifolium				0,20			3
	Bulbostylis laniceps				0,15			4
	Ochna arenaria							
	Landolphia thollonii							
	Aframomum stipulatum							
	Carpodinus lanceolata							

Feuille 2

Figure 2b

Référence du relevé : Pays CONGO Auteurs B. DESCOINGS Numéro 722

V _ RENSEIGNEMENTS ÉCOLOGIQUES

Exposition 1

0 . Terrain plat ou sans exposition définie
1 . N — 5 . S
2 . NE — 6 . SW
3 . E — 7 . W
4 . SE — 8 . NW

Situation topographique 7

0 . Terrain plat
1 . Sommet vif (pic, arête, éperon)
2 . Escarpement (corniche)
3 . Sommet arrondi (butte, mamelon, crête, croupe)
4 . Haut de versant (talus)
5 . Mi-versant
6 . Replat
7 . Bas de versant
8 . Dépression ouverte
9 . Dépression fermée

Pente *(noter en clair la valeur observée)* 3

0 . 0 à 0,9 % — 6 . 36 à 48 %
1 . 1 à 3,9 % — 7 . 49 à 63 %
2 . 4 à 8,9 % — 8 . 64 à 80 %
3 . 9 à 15 % — 9 . 81 à 99 %
4 . 16 à 24 % — 11 . 100 à 275 %
5 . 25 à 35 % — 12 . plus de 275 %

Nature de la roche ....

Surface du sol couverte par :

la roche dure et les blocs .... %
les pierrailles .... %
la terre fine .... % 90
la végétation (recouvrement basal) .... % 10
la litière .... %
l'eau libre .... %

Nature du sol ....
sableux, humifère

Humidité apparente de la station 4

0 . Cas particuliers
1 . Station très sèche
2 . Station sèche
3 . Station assez sèche
4 . Station moyenne
5 . Station assez humide
6 . Station humide
7 . Station très humide (sol saturé)
8 . Station extrêmement humide (sol sursaturé)

Submersion 1

1 . Station apparemment jamais inondée
2 . Station inondable accidentellement
3 . Station submergée périodiquement (moins de 6 mois)
4 . Station submergée périodiquement (plus de 6 mois)
5 . Station toujours submergée en eau peu profonde
6 . Station toujours submergée en eau profonde
11 . Eau circulante oxygénée
12 . Eau stagnante

Exploitation par les animaux sauvages

nature ....
intensité ....

Action humaine

Feux. nature pour la chasse
date annuel
intensité plutôt faible

Pâturage. nature ....
intensité ....

Divers. ....

VI _ BIOVOLUMES TB et TM DU PEUPLEMENT GRAMINOÏDE

Valeurs absolues

TM \ TB		T	H	C	Ch	P	Total
C	c		22				22
	b		44				44
U	c						
	b						
G	c						
	b						
R	c						
	b						
Total			66				66

Bv. A.T.

Valeurs relatives

TM \ TB		T	H	C	Ch	P	Total
C	c		33				33
	b		67				67
U	c						
	b						
G	c						
	b						
R	c						
	b						
Total			100				100

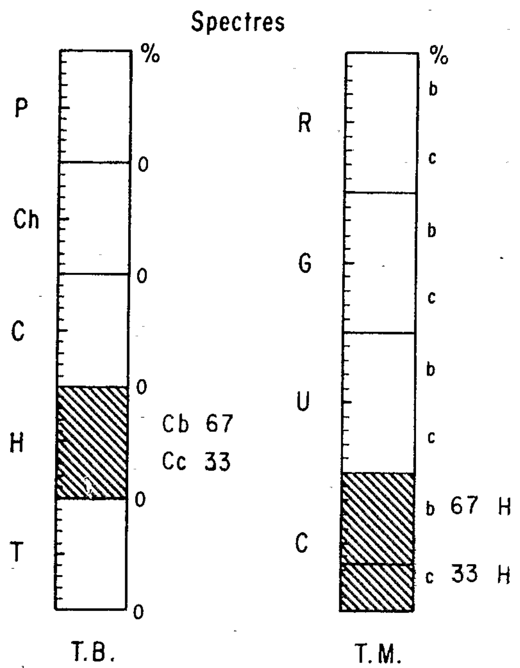
Feuille 3

Figure 2c

FICHE STRUCTURALE DE FORMATION HERBEUSE

Pays.........CONGO.................. Date 4-5-1962 Auteurs ....B. DESCOINGS.................. N° 722

Diagnose.....Formation herbeuse mixte (H/Cb + H/Cc) bistrate haute ouverte à peuplement ligneux bistrate arbustif bas très clair très serré



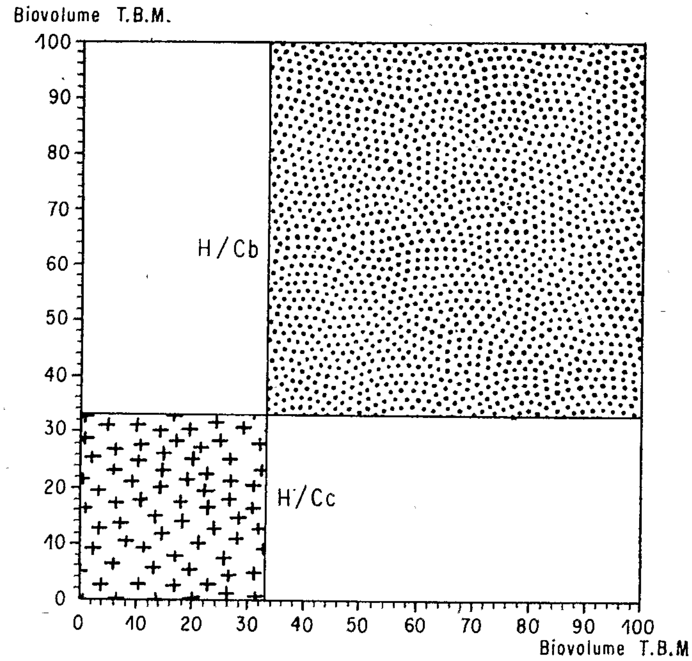


Diagramme biomorphologique

Bv. A.T. = ...66...... m³/are

Bm. = ... kg /are

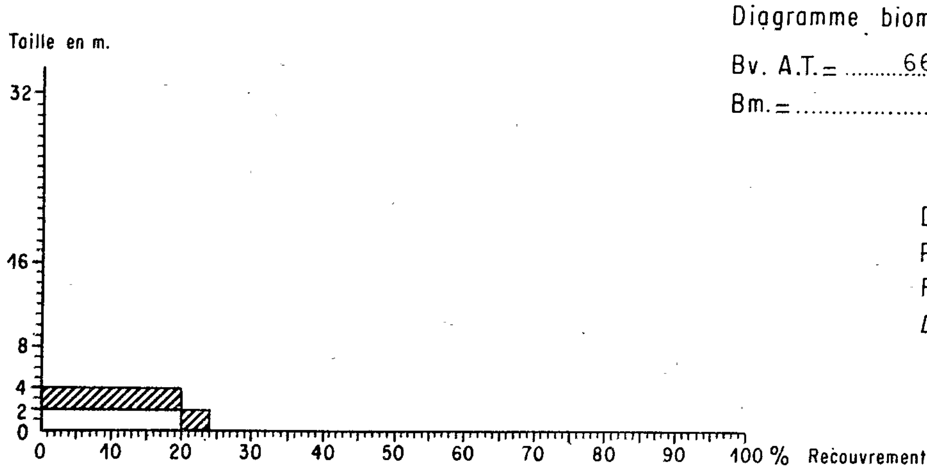


Diagramme de stratification
PEUPLEMENT LIGNEUX
R. A. T. = ... 24 ....%
Densité : .... 22 .... Pieds/are

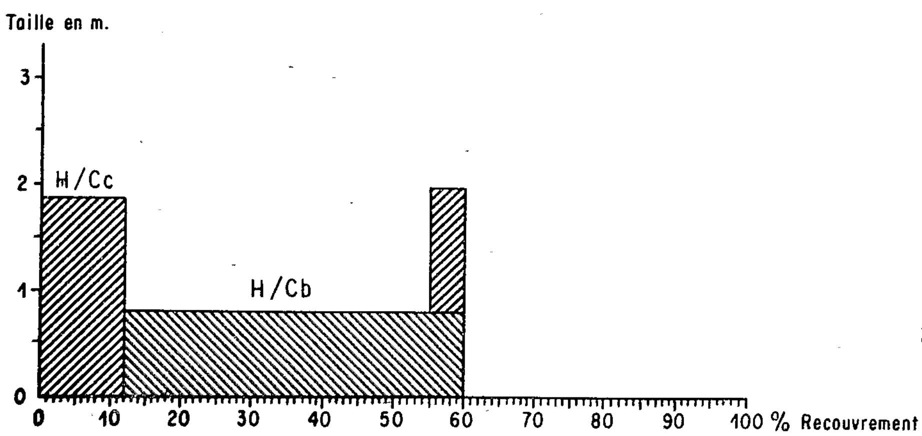


Diagramme de stratification
PEUPLEMENT GRAMINOÏDE
R.A.T. = ... 60 ....%

Herbacées ...... 3 ....%

Figure 3