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A comparison of vegetation classifications from wheel point and total floristic data sets from a South African grassland

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Abstract. Vegetation classes obtained from Two-way Indicator Species Analysis (TWINSPAN) and Braun-Blanquet Analysis of a semi-quantitative, total floristic data set and a quantitative wheel point data set on grass species only, from the same sample plots, are compared. The Braun-Blanquet classification of the total floristic data set is considered as the norm to which all other classifications are compared. The Braun-Blanquet classification of wheel point data corresponded 67.53% to the basic classification. The TWINSPAN classifications of the total floristic data set and the wheel point data set corresponded 79.22% and 54.55% respectively, to the basic classification. Chi-square tests indicate that all the classifications are significantly correlated to the basic Braun-Blanquet classification.

Key words: Braun-Blanquet technique; Classification; Comparison; Total floristic composition; TWINSPAN; Wheel point data.

Introduction

For many years agricultural researchers in South Africa have used wheel point data (Tidmarsh and Havenga, 1955) to classify and describe vegetation or to determine grazing potential (Danckwerts, 1982; Bosch and Janse van Rensburg, 1987; Fourie *et al.*, 1987). Many wheel point data sets are therefore available from many parts of the country, especially from the grassland biome area.

Recently a vegetation classification and mapping programme was initiated within the Southern African grassland biome (Mentis and Huntley, 1982; Bezuidenhout, 1988; Bredenkamp *et al.*, 1989). Accepting the necessity for classification in the grassland biome, Scheepers (1987) emphasized that the reconciliation of various approaches should be actively investigated to maximize the usefulness of the past work with the Braun-Blanquet technique presently used for vegetation classifications in South Africa. If wheel point data can be applied successfully in this classification exercise, the inclusion of this information in a Braun-Blanquet type data base, or classification system, could prevent wasting expensive manpower and time in duplicating field surveys where data already exist. It is expected that, in a particular data set, relevês lacking certain species, would be classified in different classes than those representing total floristic composition. This implies that wheel point data *per se* cannot be included in a Braun-Blanquet type data base. However, if classifications based on wheel point data could be reconciled with general classifications derived from total floristic composition, this information could be very useful in the classification, description and mapping of the grassland biome. To test this possible reconciliation, the results obtained from a Braun-Blanquet (Westhoff and

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Van der Maarel, 1978) and TWINSPAN (Hill, 1979) classification of quantitative wheel point data on grass species only, and semi-quantitative total floristic data from exactly the same sample plots, were compared. Taxa names and taxon author names used in this report conform to those of Gibbs-Russell (1984).

Study Area

The Faan Meintjes Reserve was chosen for this investigation. The reason for this was that two independent surveys were conducted simultaneously in the Reserve on the same sample plots. The wheel point survey formed part of an extensive investigation of the ecological status of grass species and benchmarks in the Highveld Region (Bosch *et al.*, 1987). A Braun-Blanquet type survey on exactly the same (and additional) sample plots was conducted to classify and describe the vegetation of the Reserve (Bredenkamp and Bezuidenhout, 1990).

The Reserve which covers an area of approximately 930 ha is situated 15 km northeast of the town Klerksdorp, in the western Transvaal, South Africa. According to the Acocks (1988) classification the vegetation of the Reserve represents *Cymbopogon-Themeda*-veld (Veld Type 48). However typical Bankenveld vegetation (Veld Type 61) may also be found on the Reserve (Bredenkamp and Bezuidenhout, 1990).

A description of the climate, geology, topography and soils of the study area is given in detail by Bosch (1985) and Bredenkamp and Bezuidenhout (1990).

Materials and Methods

Bredenkamp and Bezuidenhout (1990) used 108 stratified random, 900 m^2 (30×30 m), sample plots to classify and describe the vegetation of the Reserve by means of the Braun-Blanquet approach. The study area was stratified on 1 : 10 000 scale aerial photographs into relatively homogeneous physiographic-physiognomic units. Total floristic composition was noted, and the cover abundance of each species was estimated on basis of the Domin-Krajina scale (Mueller-Dombois and Ellenberg, 1974).

Table 1. *A list of the plant communities of the Faan Meintjes Nature Reserve (Bredenkamp and Bezuidenhout, 1990), with the communities referred to in this text*

No. in this text	Plant communities
	1. *Rhus magalismontanum-Aristida vestita* Shrubland
1	1.1. *Loudetia simplex-Aristida vestita* Shrubland
	1.2. *Dombeya rotundifolia-Aristida vestita* Shrubland
	2. *Protasparagus suaveolens-Grewia flava* Woodland
	2.1. *Grewia flava-Acacia caffra* Woodland
2	2.2. *Grewia flava-Acacia karroo* Woodland
	3. *Brachiaria serrata-Triraphis andropogonoides* Grassland
3	3.1. *Triraphis andropogonoides-Tristachya leucothrix* Grassland
4	3.2. *Triraphis andropogonoides-Schizachyrium sanguineum* Grassland
5	3.3. *Triraphis andropogonoides-Elionurus muticus* Grassland
	4. *Setaria flabellata-Cymbopogon plurinodis* Grassland
6	4.1. Typical Variant
7	4.2. *Pentzia globosa* Variant
	5. *Setaria sphacelata-Eragrostis plana* Bottomland
8	5.1. *Eragrostis plana-Andropogon appendiculatis* Bottomland
9	5.2. *Eragrostis plana-Eragrostis curvula* Bottomland

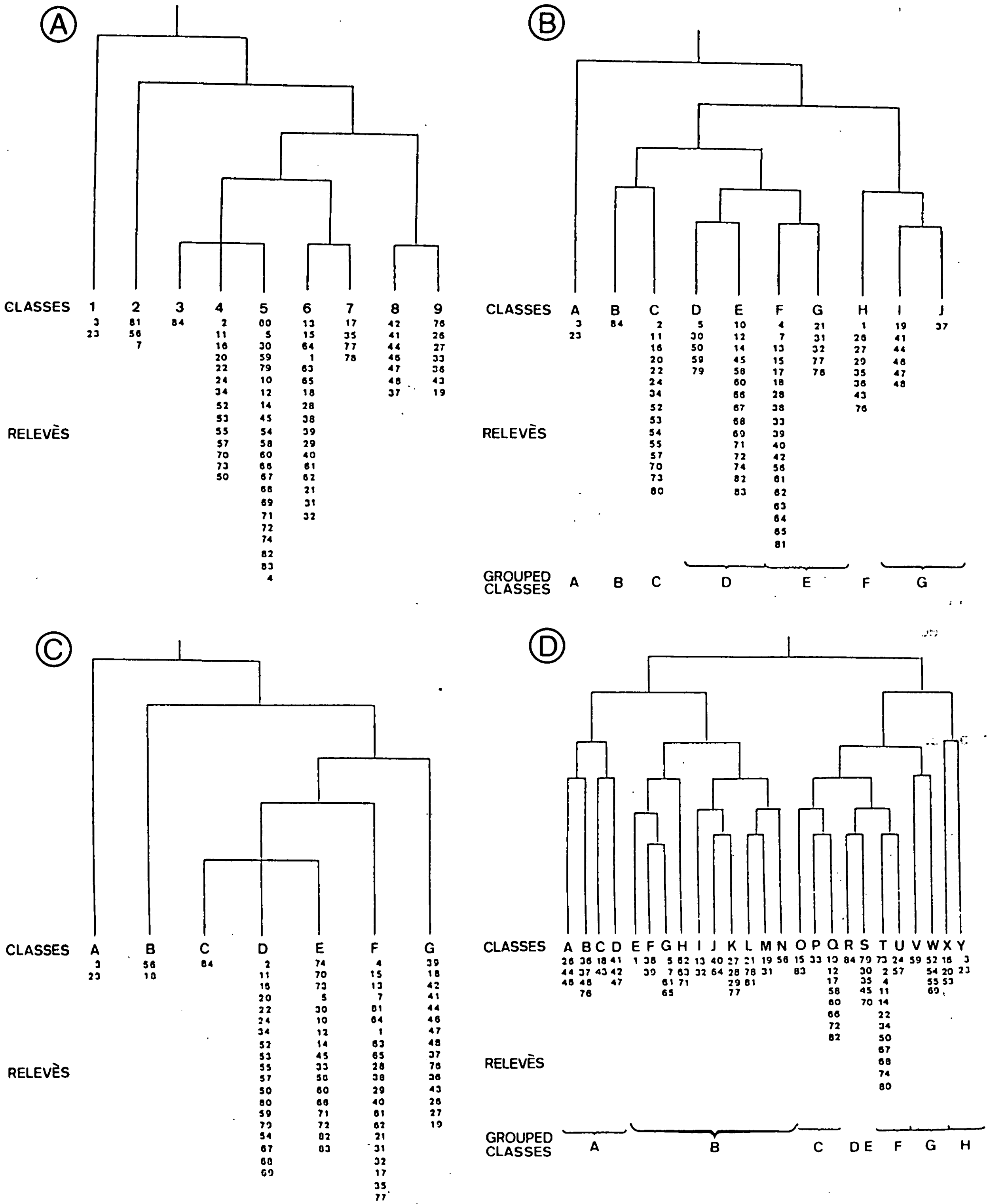

Fig. 1. Classification of 77 relevés by. A: Braun-Blanquet analysis of total floristic data; B: TWINSPAN of total floristic data; C: Braun-Blanquet analysis of wheel point data; D: TWINSPAN of wheel point data.

The wheel point apparatus has an axle with a spoked wheel, mostly about 1 m in diameter, that run on its spokes, that is a wheel without a rim. One of the spokes has a sharp point. The sharpened spoke is used as the point where the point-survey is being made. By pushing the wheel through vegetation sistematic point sampling is conducted. In South African grassland vegetation this method is used extensively to collect quantitative data of the grass species, mainly to determine the condition of the grass sward in relation to grazing potential, and to monitor change in the grass species composition.

In seventy seven of the 108 sample plots Bosch and Janse van Rensburg (1987) conducted 200 point nearest plant wheel point surveys to collect quantitative floristic data on the grass species only.

These 77 sample plots were used to compare classifications derived from quantitative wheel point data and semi-quantitative total floristic data.

The 77 sample plots represent nine of the plant communities identified by Bredenkamp and Bezuidenhout (1990). Conventional Braun-Blanquet procedures were followed, however table re-arrangements were done by computer. A dendrogram (Fig. 1A) was constructed from the hierarchical classification derived from the phytosociological table. A list of these communities is given in Table 1. As the Braun-Blanquet approach is presently the standardized technique for vegetation classification in South Africa (Bredenkamp, 1975), the Braun-Blanquet classification of the 77 sample plots was considered as the norm, to which all the other classifications were compared.

TWINSPAN (Hill, 1979) and standard Braun-Blanquet procedures (Braun-Blanquet, 1964; Werger, 1974; Westhoff and Van der Maarel, 1978), which both produce hierarchical classifications, were applied to both data sets. Tabular comparisons were made between the basic Braun-Blanquet classification of total floristic data and:

* the TWINSPAN classification of total floristic data,
* the Braun-Blanquet classification of wheel point data and
* the TWINSPAN classification of wheel point data.

Statistical correlation between classifications was calculated using the chi-square test as described by Bailey (1974) and applied by Morris (1973), Bredenkamp (1982) and Bezuidenhout (1988). Significance of the chi-square tests is according to the statistical tables of Fisher and Yates (1963).

Table 2. *A comparison between the Braun-Blanquet (BB) and TWINSPAN classifications of total floristic data*

		TWINSPAN A	B	C	D	E	F	G	Tot
BB	1	2							2
	2					3			3
	3		1						1
	4			13	1				14
	5			2	19	1			22
	6					15	2		17
	7					3	1		4
	8					1		6	7
	9					1	5	1	7
	Tot	2	1	15	20	24	8	7	77

X^2=360.92

X^2=84.037 at p=0.001 with 48 degrees of freedom

Results

TWINSPAN Classification of the Total Floristic Data Set

Application of the TWINSPAN algorithm to the total floristic data set resulted in 10 classes at the fifth and final division (Fig. 1B). The seven classes (A-G, Fig. 1B) obtained at the fourth division level correspond well to the basic Braun-Blanquet classification. A comparison between the two classifications (Table 2) shows:

* 61 of the relevês (79.22%) were classified in accordance with the Braun-Blanquet classification,
* the two classifications are significantly correlated at 48 degrees of freedom (X^2=360.92 X^2=84.037 at p=0.001) and
* if the obtained X^2 value is expressed as a percentage of the X^2 value of a perfect correlation, the two classifications correspond 58.59%.

Classes A, B, C, D, F and G coincide well with Communities 1, 3, 4, 5, 9 and 8 respectively. Communities 2, 6 and 7, are grouped in Class E, and not distinguished at the fifth division of the TWINSPAN classification.

Braun-Blanquet Analysis of Wheel Point Data

The Braun-Blanquet analyses of wheel point data resulted in identification of 7 final classes (A-G in Fig. 1C). Comparison between this classification and the basic classification indicates the following (Table 3):

* 52 of the 77 relevês (67.53%) were classified in accordance with the Braun-Blanquet classification.
* The chi-square test shows that the two classification are significantly correlated at 48 degrees of freedom (X^2=317.80 X^2=84.037 at p=0.001).
* If the obtained X^2 value is expressed as a percentage of X^2 value of a perfect correlation, the two classifications correspond 51.59%.

Communities 2, 6 and 7 of the basic classification are grouped in class F, and Communities 8 and 9 in class G. Class B cannot be assigned with confidence to any of the recognised communities, but probably represents Community 2.

TWINSPAN Classification of Wheel Point Data

The TWINSPAN of wheel point data resulted in 25 final classes. By grouping related classes on various levels in the hierarchical classification, the classes were reduced to 8 (Fig. 1D). This grouping was done subjectively with the ecological interpretability of the

Table 3. *A comparison between the Braun-Blanquet classifications of total floristic data (BB) and wheel point data (BBWP)*

		BBWP A	B	C	D	E	F	G	Tot
BB	1	2							2
	2		1				2		3
	3			1					1
	4				12	2			14
	5				7	14	1		22
	6						15	2	17
	7		1				3		4
	8							7	7
	9					1		6	7
	Tot	2	2	1	19	17	21	15	77

X^2=317.80

X^2=84.037 at p=0.001 with 48 degrees of freedom

Table 4. *A comparison between the Braun-Blanquet classification of total floristic composition (BB) and TWINSPAN of wheel point data*

BB \ TWINSPAN	A	B	C	D	E	F	G	H	T
1								2	2
2		3							
3				1					1
4					1	8	2	3	14
5		2	8		3	6	3		22
6	1	15	1						17
7		2	1		1				4
8	7								7
9	4	2	1						7
Tot	12	24	11	1	5	14	5	5	77

X^2=238.24
X^2=94.461 at p=0.001 with 56 degrees of freedom

groups as a guideline.

Comparison between this classification and the basic classification indicates the following (Table 4):

* 42 of the 77 relevês (54.55%) were classified in accordance with the Braun-Blanquet classification,
* The two classifications are significantly correlated at 56 degrees of freedom ($X^2=238.24$ $X^2=94.461$ at $p=0.001$) and
* If, however, the obtained X^2 value is expressed as a percentage of the X^2 value of a perfect correlation, the two classifications correspond 38.68%, which is relatively low.

In accordance with the Braun-Blanquet classification of wheel point data, the TWINSPAN algorithm also classified most relevês of Communities 2, 6 and 7 of the basic classification in a single class (Class B). Relevês from Communities 4 and 5 were classified into Classes E, F and G. Class H represents Communities 1 and 4 and Class A represents Communities 8 and 9.

Discussion

The Braun-Blanquet analysis of wheel point data and the TWINSPAN of total floristic composition as well as of wheel point data generally grouped most relevês of Communities 2, 6 and 7 in a single class. Community 7 however clearly represents a degraded phase of Community 6, and is presently floristically and ecologically so different from Community 6 that it should be identified and managed as a separate unit (Bredenkamp and Bezuidenhout, 1990). The differentiating species of the degraded community, *Pentzia globosa* and *Felicia muricata* were not included in the wheel point data set (grass species only), which explains why the two communities were not distinguished by the Braun-Blanquet analysis of wheel point data.

In spite of the quantitative nature of wheel point data, TWINSPAN did not clearly identify the degraded phase. Even if these two karroid species were included in the wheel point survey, their relatively low abundance and cover would probably not influence the TWINSPAN classification significantly.

The TWINSPAN of total floristic composition likewise did not distinguish between these two communities, probably due to the relative insignificance of the two diagnostic species within the total floristic data set. In this case ecologically significant species were therefore not adequately emphasized in the TWINSPAN algorithm.

Community 2 (the *Grewia flava-Acacia karroo* Woodland, Bredenkamp and Bezuidenhout, 1990) is an easy recognisable woodland, dominated by *Acacia karroo* and characterized by many diagnostic species. Floristically this woodland is distinguished from Communities 6 and 7 (grasslands), by the presence of the woody or semi-woody *Acacia karroo, Protasparagus suaveolens, P. laricinus, Grewia flava,* and *Teucrium trifidum* and also the grass species *Sporobolus fimbriatus*. Also of diagnostic importance is the absence of 13 grassland associated herbaceous species, including two grass species namely *Cymbopogon excavatus* and *Trichoneura grandiglumis.* Bredenkamp and Bezuidenhout (1990) distinguished two forms of the *Grewia flava-Acacia karroo* Woodland namely the typical form and a form representing *Acacia karroo* invasion into adjacent, previously overutilized, grassland communities (see also Bredenkamp *et al.*, 1989). Here the abovementioned grassland associated species are usually still present. Relevês representing this Woodland and which were included in the present comparative study, had all been compiled at sample plots in the *Acacia karroo* invaded grassland. TWINSPAN therefore classified these relevês together with relevês from the grassland communities, due to the presence of the many grassland associated species. Furthermore, as wheel point data lack the woody and not grassy herbaceous species, the inclusion of this Woodland in a single class together with grassland Communities 6 and 7 is not surprising.

Neither the Braun-Blanquet analysis nor the TWINSPAN of wheel point data distinguished between Communities 8 and 9, but grouped them into a single class. Application of both techniques to the total floristic data set however, resulted in the recognition of the two communities. Both hierarchical classifications also indicate that due to floristic relationships, the two communities may be grouped into a single higher vegetation unit.

The distribution of relevês from Communities 4 and 5 into classes E, F and G, and the grouping of relevês from Communities 1 and 4 into class H by the TWINSPAN of wheel point data (Table 4) cannot be explained ecologically.

Conclusion

It was repeatedly shown (cf. Bredenkamp, 1982) that in South African vegetation, the Braun-Blanquet analysis of total floristic composition mostly results in ecologically interpretable vegetation classes, which may be classified in an ecologically sound hierarchical system. This was also the case in the Faan Meintjes Nature Reserve (Bredenkamp and Bezuidenhout, 1990). Vegetation management classes may be selected on any appropriate level in the hierarchical system (see also Bredenkamp and Theron, 1976).

Due to the corresponding results obtained from TWINSPAN and Braun-Blanquet analyses on total floristic data sets, TWINSPAN may be useful as an extremely good first approximation to create basic classifications which may be refined by the application of Braun-Blanquet procedures. In this way a nearly final, objective classification can be obtained quickly, whilst the option to reclassify certain relevês on basis of the Braun-Blaquet criterion of diagnostic species, into ecologically more interpretable classes, remains open.

It is clear that wheel point data cannot be treated together with total floristic data in a single classification, as relevês containing only part of the total floristic composition may be classified in totally seperate classes. However wheel point data may be used for classification of vegetation and may be reconciliated with basic Braun-Blanquet classifications. Classes obtained from classifications based on wheel point data may often represent higher vegetation units in a hierarchical classification system.

It is concluded that Braun-Blanquet analysis of wheel point data produces ecologically more interpretable results, and its results correspond more closely to the basic Braun-Blanquet classification, than a TWINSPAN classification on similar data. The quantitative data obtained from wheel point surveys are however considered more useful for the determination of vegetation gradients, the study of vegetation dynamics and veld condition assessment, than for vegetation classification.

Careful analysis of classifications obtained from different types of data, by experienced vegetation scientists well acqainted with the vegetation and general ecology of the particular area, may lead to successful reconciliation of these classifications.

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以 wheel point 及植物組成種類之資料組比較南非某草地之植被分類

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本篇論文係針對相同的樣區，分別採用「雙相指標種分析」，以及半定量的植物組成種類的資料組和僅就禾本科植物的定量 wheel point 資料組做「Braun-Blanquet 分析」。根據該兩種方法比較植被的分類狀況。若將植物組成種類的資料組採「Braun-Blanquet 法」加以分析，並以所獲得的該項結果當做基準值，則 wheel point 資料組以「Braun-Blanquet 法」所得的數值爲該基準值的 67.53%；至於若是採用「雙相指標種分析」，則植物組成種類的資料組和 wheel point 資料組所獲的結果分別爲基準值的 79.22%及 54.55%。Chi-squane 測驗顯示上述所有的分類法皆與基準的「Braun-Blanquet」分類法有顯著的相關性。