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Progress with vegetation studies in South Africa

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ABSTRACT

Vegetation studies at various levels of detail and using various methods are briefly reviewed. The approach and procedures of the Zürich-Montpellier school of phytosociology as a standard methodology for regional studies has become increasingly recognized. Progress has been made in regional studies in the fynbos and woodland biomes, but grassland, forest and karoo vegetation have been much neglected. There have also been marked increases in activity over a wide range of additional vegetation studies including new fields of research, particularly ecosystem studies. However, there are still vast gaps in our knowledge of the basic vegetational resources of the country. A systematic regional-study programme is being launched to remedy these deficiencies in fundamental knowledge.

RÉSUMÉ

PROGRÈS DANS L'ÉTUDE DE LA VÉGÉTATION EN AFRIQUE DU SUD

Les études de la végétation, à divers niveaux de détail et ayant recours à différentes méthodes, sont brièvement passées en revue. La conception et la procédure de l'école phytosociologique de Zürich-Montpellier se sont de plus en plus imposés comme méthodologie classique pour les études régionales. Des progrès ont été réalisés dans les études régionales des biomes du fynbos et de la forêt claire, mais les formations herbeuses, la forêt dense et la végétation du Karoo ont été fortement négligées. Il y a aussi eu une nette augmentation d'activité dans toute une autre gamme d'études de la végétation comprenant de nouveaux champs de recherche, particulièrement des études d'écosystèmes. Cependant, il reste encore de grandes lacunes dans notre connaissance des ressources végétales fondamentales du pays. Un programme systématique d'études régionales est lancé pour remédier à ces déficiences.

Eight years have elapsed since progress with vegetation studies in South Africa was last reviewed at the 1974 AETFAT Congress (Werger & Edwards, 1976). Studies on the vegetation of South Africa have not only increased in number, they have diversified into a wider range of topics and a greater variety of approaches towards the range of topics. In this paper, groups of activities are dealt with in order of generally increasing detail, from general reconnaissance surveys, through reconnaissance and semi-detailed regional studies to larger-scale more-detailed studies, including research on ecosystem function and process, and to problem-orientated studies in the general field of applied ecology, including environmental planning and management. A review of this nature cannot be considered to be complete in that the range of work cannot be exhaustively treated nor can it be fully up to date. References are cited by way of example and do not purport to comprise all the relevant literature.

Reconnaissance and semi-detailed regional studies

The appearance of the second edition of Acocks's (1975) 'Veld types of South Africa' has again drawn attention to the need for revising some of the veld type concepts and of the vegetation map to accommodate resultant boundary changes. Preliminary indications of this need and of Acocks's contribution towards meeting this need were indicated by Acocks (1979). This work was unfortunately interrupted by the passing of Acocks in 1979. Work proceeds slowly on the revision of some 16 veld types of the western part of South Africa as information becomes available from regional studies. Several workers are contributing relevant information (cf. Boucher, 1974 *et seq.*; Gubb, 1981; Le Roux, 1982; Palmer, 1981; Taylor, 1976a & b *et seq.*).

Referring to the previous review, trends noted by Werger & Edwards (1976) have been confirmed. Notable among these is the consolidation of the position of the Zürich-Montpellier approach and methods as a standardized methodology in vegetation surveys. In some cases, the Braun-Blanquet approach and methodology have been used alone; in other cases, they have been used in combination with other methods to provide phytosociological insights that could not have been obtained by using single methods alone.

The programme of vegetation surveys of nature reserves on this basis continues. Other phytosociological studies have also been undertaken outside nature reserves. There is a large and rapidly growing literature which is impossible to review here (cf. Boucher, 1977 & 1978; Boucher & Le Roux, 1981; Campbell *et al.*, 1980; Campbell & Moll, 1976 & 1977; Coetzee, 1975 & 1982; Coetzee *et al.*, 1976; Gertenbach, 1978 & in prep.; Glyphis *et al.*, 1978; Laidler *et al.*, 1978; McKenzie *et al.*, 1977; Taylor, 1981; Taylor & Van der Meulen, 1981; Van der Meulen, 1978 & 1979; Van Rooyen *et al.*, 1981a & 1981b; Viljoen, 1979; Werger, 1980; Werger & Coetzee, 1977; Werger & Ellenbroek, 1980; Westfall, 1981).

Other approaches to regional studies and related vegetation studies at semi-detailed scales have continued along a number of lines that were already being explored prior to 1974 (cf. Werger & Edwards, 1976). A number of these studies may be conveniently grouped under the general heading of remote sensing. Interpretation of conventional air photography is standard procedure in a variety of

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different types of vegetation study and will be referred to again in connection with applied plant ecology in particular. Methodological studies on air-photo interpretation of vegetation cover (e.g. Jarman, 1977) are no longer appearing. This can be taken to indicate the air-photo interpretation is now well established as a tool in sampling strategy, for mapping and for monitoring vegetation change (cf. Drews, 1980a, b & c; Weisser, 1978a & b, 1979b, 1983; Weisser & Marques, 1979; Weisser & Howard-Williams, 1982; Weisser & Müller, 1983; Weisser & Parsons, 1981). The use of satellite imagery is still in the experimental stage and several investigations indicate that there is considerable potential for vegetation and land-use mapping and related studies, and perhaps more especially for monitoring change (e.g. Jarman *et al.*, 1981; Lane, 1980).

Quantitative plant ecology continues to enjoy attention, in that a variety of techniques are applied to a wide range of vegetation studies. Examples includes gradient analysis (e.g. Bond, 1981; Cowling & Campbell, 1981) and multivariate ordination procedures (e.g. Bosch, 1974 & 1978; Theron *et al.*, 1982; Venter, 1976; Westfall *et al.*, 1982) among the more popular quantitative approaches and techniques. Quantitative floristic and structural analyses of vegetation are still being done (e.g. Coetzee & Gertenbach, 1977; Lubke *et al.*, 1976; Moll, 1978a, b & c & 1980a; Rogers & Moll, 1975). In South Africa, the peak of multivariate classificatory methodology, especially experimentation with techniques, appears to have been reached in the seventies (e.g. Kruger, 1974; Morris, 1977; Scheepers, 1975; cf. Coetzee & Werger, 1975b; and Campbell & Moll, 1976). However, clustering procedures and computer manipulation are being used increasingly to speed up phytosociological and other tabulation, and other forms of presentation, while ordination and related techniques are also being used as aids to the interpretation of community/community and community/environment interrelationships (cf. Bredenkamp, 1982; Bredenkamp *et al.*, 1983; Musil *et al.*, 1976; Van der Meulen *et al.*, 1978; Westfall, 1981; Westfall *et al.*, 1982).

Other regional studies

Other more or less pragmatic approaches to vegetation study continue to be used wherever they can be usefully applied in practice as in pasture management and nature conservation for instance (cf. Bredenkamp, 1975 & 1977; Bredenkamp & Theron, 1976; Coetzee & Werger, 1975a; Taylor, 1979; Taylor & Van der Meulen, 1981; Weisser, 1980). Similarly, vegetation mapping continues (e.g. Van der Meulen & Westfall, 1979) where appropriate.

Detailed and specific vegetation studies

Apart from regional studies at semi-detailed scales, other vegetation studies have covered a wide range of activities. Among the more or less floristically based but not necessarily phytosociological studies, mention can be made of more detailed studies mostly of smaller areas, i.e. *not* regional studies. These range in scope from very restricted areas (e.g. Campbell *et al.*, 1980) through areas of intermediate size (e.g. Killick, 1978b) to fairly extensive areas up to the size of regions (e.g. Moll, 1980b; Rogers, 1980). These studies may have no formal phytosociological approach and methodology. Methods are adapted to the limitations of the aims, the size of the area and the scope of the study. There has been continued interest in the structural attributes of vegetation (cf. Edwards, 1983). A noteworthy example of work undertaken to meet a specific need is that of Campbell (Campbell *et al.*, 1981; Linder & Campbell, 1979) who had the task of setting up a structural-functional classification of fynbos to meet the needs of foresters and other land managers to be able to classify vegetation without any botanical training. This classification is particularly required for the management and monitoring of vegetation in mountain catchment areas. A variety of other work can only be referred to in passing here (e.g. Coetzee, 1982; Coetzee *et al.*, 1981; De Moor *et al.*, 1977; Lubke, 1983; Van der Meulen & Westfall, 1980; Van Rooyen, 1978; Werger, 1978). Efforts are being made by Edwards, 1983 (cf. also Campbell *et al.*, 1981) to provide a generally acceptable standardized classification system for South Africa, and possibly for the Southern Hemisphere. Convergence in structure between sclerophyll vegetation types of mediterranean-type climatic regions has continued to excite interest and stimulate work (Cowling & Campbell, 1980).

Recent developments

In recent years, there has been increased interest in diversity as an attribute of vegetation types and floras, much stimulated by the work of Whittaker (1972). Examples of such work are beginning to appear in print (Campbell & Van der Meulen, 1980; Kruger & Taylor, 1979; Whittaker *et al.*, in press). Other work on vegetation attributes includes investigations of pattern (Lubke *et al.*, 1976; Van der Meulen & Morris, 1979; *inter alia*).

Methods and techniques

Papers on methods and their application to South African vegetation have continued to appear intermittently. These range from the aftermath of earlier exploratory methodological investigations (e.g. Campbell & Moll, 1981; Werger, 1977c) to others of a more specialized nature (e.g. Coetzee & Gertenbach, 1977; Rutherford, 1980b; Rutherford & Carr, 1979; Rutherford & Curran, 1981).

Syntheses and theoretical studies

The past few years have seen a number of contributions of a theoretical and abstract nature (e.g. Campbell *et al.*, 1979; Moll *et al.*, 1980). Particularly in evidence have been the number of compilations and syntheses, some of them perhaps somewhat premature (Boucher & Moll, 1981; Brown & Jarman, 1978; Killick, 1978a & 1979; Kruger, 1979; Moll, 1978c; Moll & Werger, 1978; Rutherford, 1978a, 1979c & 1981a; Taylor, 1977b, 1978 & 1980; Walker, 1980 & in prep.; Werger & Coetzee, 1978; White, 1978). These works have

been and are being reviewed elsewhere in the open literature and it is not possible to do them justice in this paper. This trend appears to be continuing.

Ecosystem studies and experimental ecology

The most recent and innovative developments in vegetation studies have been in the fields of ecosystem studies and experimental ecology. In terms of extent, utilization and environmental problems, and inherent potential, the Savanna Biome has received priority for multidisciplinary ecosystems research centred on the Savanna Ecosystem Research Site at Nylsvley (Huntley & Morris, 1982; Walker *et al.*, 1978). For similar reasons, as well as for its uniqueness and intrinsic interest as part of the world's biological heritage, the Fynbos Biome Project has also received a high priority for a multidisciplinary approach to function, process and related aspects so as to gain the deeper understanding of fynbos ecosystems needed for their optimal management (Kruger, 1978). Multidisciplinary research programmes are similarly planned for Grassland, Karoo and Forest Biomes. Individual studies contributing to such multidisciplinary research programmes cover a wide range. Regarding the primary producer component, a number of papers have dealt with biomass and productivity (e.g. Cresswell *et al.*, 1982; Grossman *et al.*, 1980; Grunow, 1977; Grunow *et al.*, 1980; Kruger, 1977b; Low, 1981; Rutherford, 1978b, 1979a & b, 1980a, 1981a & b, 1982a, b & 1983; Rutherford & Carr, 1976 & 1979; Rutherford & Kelly, 1978; Rutherford *et al.*, 1978; Steinke & Charles, 1981). Several papers that are more ecophysiological in content are particularly concerned with nutrient relations and water relations (Bate *et al.*, 1982; Bate & Gunton, 1982; Du Preez & Bate, 1981; Furness & Breen, 1980; Henning & White, 1974; Pendle & Bate, 1981; Tew, 1981; Tinley, 1982; Weighill & Walker, 1981; Werger & Ellis, 1981). In some projects, the stage has been reached where there is sufficient information available to allow the commencement of syntheses, particularly the development of mathematical and other models of ecosystem processes. As models are improved, so will it become possible to simulate and predict the changes that will result from manipulating natural and semi-natural ecosystems in various ways (e.g. Morris *et al.*, 1978; Walker *et al.*, 1978; Walker & Noy-Meir, 1982; Walker *et al.*, in prep.; Weisser, 1978c).

Function and process in vegetation are, however, not only being studied at the ecosystem level but also at the species level (cf. Henning & White, 1974). There is increasing interest in phenology and periodicity in vegetation (e.g. Bond, 1980; Steinke & Charles, 1981; Van Rooyen *et al.*, 1979a & b). The interrelationships between form and function, interpreted not only in terms of the environment but also of chorology and population dynamics, are also being studied (e.g. Low, 1980; Mooney *et al.*, 1980; Rutherford, 1980c; Van Rooyen *et al.*, 1980; Werger & Ellenbroek, 1978). The dynamics of South African vegetation have enjoyed a great deal of attention for a number of years and continue to stimulate much research in both basic and applied ecology. Among the more fundamental studies, there are numerous examples of work on dynamics and the monitoring of vegetation change under various conditions and treatments (Downing, 1980; Granger, 1975; Le Roux & Morris, 1977; McLachlan *et al.*, 1980; Robinson *et al.*, 1979; Rutherford, 1981b; Trollope, 1982; Van Daalen, 1981; Walker, 1976; Weisser, 1978b & 1983; Weisser & Marques, 1979; Weisser & Parsons, 1981; Weisser & Müller, 1983; Werger & Leistner, 1975).

Applied vegetation studies

As is well-known, vegetation science has been applied in the fields of nature conservation, pasture science and sylviculture for many years. Recent developments relate to the application of plant-ecological knowledge to environmental planning and management, such as for multiple-use management and environmental impact assessment. The need for this type of work has increased, particularly over the past eight years. This development has been briefly sketched (Van der Meulen & Scheepers, 1978), and broad philosophical and methodological approaches towards meeting this need have been and are currently receiving much attention (e.g. Norton & Walker, 1982; Walker, 1977; Walker & Norton, 1982).

The familiar *ad hoc* or problem-orientated types of vegetation study applied to conservation and reclamation are numerous and only a few examples can be referred to here (Kruger, 1977a; Moll, 1977 & 1980b; Moll *et al.*, 1975; Taylor, 1976a, b & 1977a; Taylor & Morris, 1981; Tinley, 1976; Weisser, 1978a & 1983; Weisser & Ward, 1982). Recent trends in approaches to environmental planning and management, such as environmental impact assessments, can be traced in a growing literature (e.g. Drews, 1980a, b & c; Moll, 1981; Moll *et al.*, 1977 & 1978; Whateley & Porter, 1983; Taylor, 1981a & b; Van der Meulen & Scheepers, 1978; Weisser, 1979a, b & 1980; Weisser & Howard-Williams, 1982). To take one factor of environmental management as an example, the fire factor has continued to receive much attention and a few instances of such work can be cited here (e.g. Downing *et al.*, 1978; Kruger, 1977c; Trollope, 1980; Van Wilgen & Kruger, 1981).

Apart from a rapidly growing literature in the more specialized aspects of pasture science which are not relevant here, several contributions in the general field of applied plant ecology relate to pasture science (Downing, 1974; Fourie & Roberts, 1976; Moll, 1980c; Werger, 1977a, b & d). Similarly, vegetation science is widely applied to vegetation management for sylviculture and the broad field of environmental management (e.g. Taylor & Van der Meulen, 1981; Van Daalen, 1981; Van der Zel & Kruger, 1975). Other applications are assisting towards interpreting the palaeo-ecological environment in archaeological studies (e.g. Moffett & Deacon, 1977).

Summary

General trends that can be discerned include the consolidation of the position of the Braun-Blanquet approach and procedures, mostly in combination

with other methods amongst which quantitative methods have continued to figure prominently. Phytosociological and other studies have been pursued in fynbos and woodland (savanna) vegetation, but grassland, forest and karoo vegetation, in particular, have been much neglected. Other approaches and activities include remote sensing using aerial photography and satellite imagery, and vegetation mapping. Apart from floristic composition *per se*, other attributes studied include structure, diversity, pattern, phenology and dynamics. Conceptual analyses and syntheses, applied ecology, mathematical modelling and vegetation monitoring have also received attention. Standardized procedures for veld condition and trend assessment have become part of the stock-in-trade of the pasture scientist and are also being adopted by plant ecologists in basic as well as applied fields of research. Applied plant ecology is being pursued in modern environmental planning and management as well as in the traditional areas of nature conservation and management, pasture science and sylviculture.

These trends can readily be seen at work. Over wide areas, however, there is still an embarassing dearth of basic data about the vegetational resources of the country. To meet the requirement for such basic ecological information, a countrywide inventory of vegetational resources is being launched. This inventory of vegetational resources will be coordinated and integrated with the current survey of other basic natural resources of particular importance to agriculture (MacVicar *et al.*, 1974). To catalogue the resultant information systematically, a standardized system of plant-community nomenclature is required. While much work has been and is being done, there is still ample scope for much more work in the field of vegetation science in South Africa.

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