

Domestication of fynbos Proteaceae as a floricultural crop

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ABSTRACT

Domestication of a South African group of Proteaceae, the proteas, began with their cultivation as exotics in Europe. A growing local interest in their cultivation climaxed in the publication of a popular handbook in 1958. Commercial interest in cultivation and seed sources was stimulated and led to a botanical and horticultural survey of useful species throughout their distribution range in the fynbos. Information pamphlets on cultivation requirements and seed were eventually supplied to the public as an official service. Up to 1970 cut-flowers were harvested in limited quantities, mainly from the western Cape folded mountains, and sold on the European markets. During the last decade, the export trade in fresh Proteaceae flowers has become a significant factor in the national economy. However, the original system of harvesting from the natural habitat has caused serious marketing problems, for instance, poor cut-flower quality and an erratic supply of many species. Increased exploitation has also led to unprecedented disruptive pressure on the fynbos biome system, particularly on the Proteaceae-component. It is clear that the scientific cultivation of the protea family as a floricultural crop is necessary for its sustained growth as an economic factor, as well as for its natural conservation. The present paper gives an overview of the developments that led to the rise of the fynbos Proteaceae as a commercially cultivated crop in South Africa.

RÉSUMÉ

INTÉRÊT HORTICOLE DE L'ACCLIMATATION DES PROTEACÉES DU FYNBOS

L'acclimatation d'un groupe sud-africain de Protéacées les protéas débuta avec leur culture en tant que plantes exotiques en Europe. Un intérêt local croissant pour leur culture aboutit à la publication d'un manuel de vulgarisation en 1958. Un intérêt commercial dans la culture et les sources de semences fut stimulé et conduisit à un inventaire botanique et horticole des espèces utiles dans toute leur aire de répartition dans le fynbos. Des prospectus sur les exigences de leur culture et sur leur propagation furent finalement offerts au public à titre de service officiel. Jusqu'en 1970, les fleurs coupées furent récoltées en quantités limitées, surtout dans les montagnes plissées du Cap occidental, et vendues sur les marchés européens. Pendant la dernière décennie, le marché d'exportation de fleurs fraîches de Protéacées est devenu un facteur important dans l'économie nationale. Cependant le premier système de récolte, limité à l'habitat naturel, a causé de sérieux problèmes de commercialisation, par exemple la qualité médiocre des fleurs coupées et un approvisionnement irrégulier pour de nombreuses espèces. Une exploitation accrue a aussi amené une action perturbatrice sans précédent sur l'écosystème du fynbos, particulièrement sur sa composition en Protéacées. Il est clair qu'une exploration scientifique des Protéacées en horticulture est nécessaire tant pour maintenir le développement de ce facteur économique, que pour protéger la famille à l'état naturel. Le présent document donne un aperçu des développements qui ont conduit les Protéacées du fynbos à devenir une culture pratiquée à une échelle commerciale en Afrique du Sud.

INTRODUCTION

The domestication of plants begins with cultivation. This is, in due course, followed by improvement of techniques and plant material (Jacobs, 1970). In modern society these functions are usually assigned to scientific research. The domestication of fynbos Proteaceae for horticultural use has been profoundly influenced by research contributions in their country of origin, South Africa.

CULTIVATION

The fynbos Proteaceae were first cultivated in Europe. An interest in the exotic plants from the Cape led to the cultivation of a number of species, under highly artificial conditions, during the late 18th and early 19th centuries (Rourke, 1980). However, the 'art' was soon lost, due to the lack of systematic knowledge of the requirements of these 'strange' plants. For the next 150 years, the only significant cultivation of the family, popularly known as proteas, was at the Cape; of special

interest were the attempts, since 1913, by the National Botanic Gardens at Kirstenbosch (Vogts, 1962) and since about 1940, by two or three pioneering growers (Rourke, 1980). Their success was based partly on hit-or-miss methods and partly on study and observation of the natural habitat. However, all fynbos proteas cultivated with significant success were grown in the winter rainfall area, that is, in the region where they grow wild (Vogts, 1982).

RESEARCH

First phase

From approximately 1960, this limited scientific approach changed. The cultivation requirements of proteas were identified, classified and described in a popular handbook (Vogts, 1958). The information was drawn from the results of scientific experimentation, research and observation over a decade, of the behaviour of proteas cultivated outside their distribution range. This publication heralded the rapid establishment of protea cultivation and the intensification and expansion of research (Vogts, 1960; Letty, 1962; Rourke, 1980).

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The analysis of the basic cultural requirements of 52 species and 8 genera showed remarkable similarities within the family. Notwithstanding deviations in common needs, such as an alkaline soil required by some species instead of acid, it was generally accepted that all fynbos proteas could be considered for further investigation (Vogts, 1958).

The cultivation potential of proteas focused attention on their economic potential (Vogts, 1982). World-wide interest in the new and exotic in the cut-flower trade was indeed an impetus to bring these wild plants under human control.

At the same time, a breakthrough was achieved when South African proteas came on the European flower markets (Middelmann, 1981b). Most of these flowers were harvested directly from plants in the habitat. Hopes for the future of cultivation were, however, high and a 'South African Indigenous Flower Growers' Association' was formed in 1965 (Anonymous, 1965).

Conservation

The first serious problem which confronted the new phase of horticultural exploitation of proteas, was the protection of the natural sources of material. The exciting new interest in growing proteas for gain resulted in great numbers of prospective commercial growers harvesting plant material in the wild without the necessary know-how. Irreparable harm to rare plants, waste of seed collected at the wrong stage, and waste due to incorrect cultural methods soon led to a disastrous state of affairs. This was eventually brought under control, not so much by law enforcement, as by expert guidance (Vogts *et al.*, 1972) and by providing reproductive material (McCann, 1977; Anonymous, 1980). These official conservation actions were based on an awareness of the need to keep the natural resources intact (Vogts, 1982).

Reconnaissance survey of available resources: species, variants and ecotypes

It was realized by the authorities that, in order to cope with the growing interest in protea cultivation, an overall survey of the distribution area of the 300-odd species of Cape Proteaceae had to be undertaken (Nel, 1965). Localities in the south-western and southern Cape ranging from Clanwilliam to Grahamstown, were subsequently investigated systematically in different seasons from 1962 to 1972 (Vogts, 1972). All accessible and apparently suitable species were recorded as well as their habitats. Investigation of the latter included climatic data, elevation, aspect, soil analyses and associated plants (Vogts, 1972).

The most important contribution of this extensive survey project was the discovery of the variation of sub-populations within species. These were distinguishable from recognizable ecotypes with modified forms due to environmental conditions. These sub-populations were named commercial 'variants' (Vogts, 1980). A study of the variants of several species (up to the fourth generation) showed that

many characteristics including flowering time of different populations of a species remain stable (Vogts, 1971; Vogts, 1980; Vogts, 1977c). It can be accepted that the discontinuous topography of the distribution area has contributed to bringing these variants to the threshold of speciation (Vogts, 1971). However, variants of some species may lose their distinguishing features in cultivation and revert back to the average, their characters obviously dependent on changeable environmental conditions. An example is the brilliant red of *Leucadendron salignum* from the Cold Bokkeveld (Vogts, 1980).

Evaluation and selection for further research

Over 150 species in their wild state proved to have some economic potential, 86 to a very high degree (Vogts, 1972). For practical reasons, only a few could be considered for intensive research. Those with the highest score of combined favourable characteristics were chosen.

Economic and horticultural potential was assessed on a number of points, of which the following were the most important (Vogts, 1980):

- Attractive and arresting appearance, colour, shape and size of flowerhead; foliage attractive but not dominating,
- Flowerhead not hidden or pendulous,
- Erect growth providing good flowerstems,
- Good cultivation potential and availability of propagation material,
- Stability of characters,
- Desired flowering times,
- Postharvest quality,
- No obnoxious odour.

Finally, about 14 species and a number of variants of the genera *Protea*, *Leucospermum*, *Leucadendron* and *Serruria* were selected for commercial cultivation. Examples are the red, summer-flowering variant of *Protea repens* (Vogts, 1980) and ten variants of *Protea cynaroides*, chosen to allow year-round production of flowers of this species (Vogts, 1977c).

Second phase

The above-mentioned pioneering research and publicity were prerequisites to the cultivation of proteas on a commercial level in South Africa. They also led to limited attempts at cultivation and research in other countries, for example in New Zealand (Brits, 1978a; Thomas, 1974). These activities, however, lacked a strong financial incentive, such as that engendered by the South African export trade (Brits, 1978a).

The next stage in the domestication of proteas, spanning the last decade, has been characterized by rapid developments. These were, firstly the exponential growth of the protea cut-flower export trade by an annual average of 20%, to a value of about R3 million in 1979/80. This growth created an industry of national economic significance (Strydom, 1980). Secondly, a concomitant and vigorous programme of basic and applied production research developed. In this period, commercial protea activity was also initiated in at least five other countries (Brits, 1978a; Middelmann, 1981a).

In South Africa, research continues to precede the cultivation process in a curious way. An estimated 80% of all exported proteas are still being produced by the method of reaping directly from the habitat (veld-picking). This opportunistic practice is at variance with the principles of a sophisticated cut-flower marketing system and it may, in the long run, become counterproductive (Wood, 1980). The continuing disruption of the fynbos ecology, through selective commercial exploitation, also has serious ethical implications. The practice clearly conflicts with the growing concern in South Africa for conservation.

The considerable output of production research during the nineteen seventies has, therefore, been partly in anticipation of, and partly aimed at stimulating, cultivation (Strydom, 1978).

It is expected that the demands of increasing production costs, quality standards and competition will force ever-growing numbers of producers to resort to the cultivation of their product (Weiss, 1980; Strydom, 1980). It is believed that cultivated proteas may eventually replace the veld-picked product of the Western Cape to a large extent, if not completely.

The second research phase may be defined in terms of the problems which had to be overcome, in order to achieve the development of the protea family as a modern horticultural crop.

Seed dormancy in Leucospermum

Seed propagation of the genus *Leucospermum*, especially *L. cordifolium*, has always been difficult due to the severe dormancy exhibited by the seed (Brown & Van Staden, 1973; Brits, 1980d). Basic studies of the promotive effects of atmospheric oxygen in raising embryonic cytokinin levels (Van Staden & Brown, 1977), led to the development of a technique to break seed dormancy, consisting of imbibition in hydrogen peroxide (Brits & Van Niekerk, 1976).

Vegetative propagation

Until as recently as 1974, all proteaceous plants were commercially propagated by seed. Seed propagation had all the inherent disadvantages of a heterozygous species. Techniques have now been developed to root selected protea clones on a large scale yielding vigorous, true-to-type plants with apparently normal root systems (Admiraal, 1966; Rousseau, 1966; Rousseau, 1967a; Jacobs & Steenkamp, 1975; Vogts, Rousseau & Blommaert, 1976). Although species of *Protea* are often difficult to root, members of the other commercial genera are generally easy to root, with indole butyric acid, under mistbed conditions (Jacobs & Steenkamp, 1976).

The dependency of many Proteaceae on low soil pH-values, their sensitivity to higher levels of soil solutes and the poor rooting ability of some clones prompted grafting research (Brits, 1978c). Species and clones suitable as rootstocks were identified and screened (Rousseau, 1967b; Z. Welgemoed, 1979b). In the genus *Leucospermum*, for example, the arborescent species *L. conocarpodendron* subsp.

conocarpodendron and *L. patersonii*, proved to be the most suitable, as well as several vigorous hybrids which were tested as clonal rootstocks. A mass budding technique resulting in 95% success was developed, as well as an effective technique to graft onto the unrooted cuttings of a clonal rootstock, which are then rooted simultaneously with the process of graft wound healing (Z. Welgemoed, 1979b). These developments have placed the grafting of protea clones on a practical level comparable to the rooting of cuttings as a means of mass propagation.

Nutrition

The extreme sensitivity of the family to relatively moderate levels of phosphorus (Thomas, 1974; Claassens & Fölscher, 1978; Jones *et al.*, 1978) and the inability of most species to negotiate soil solutions in the higher pH-ranges (Vogts, 1958; Vogts, 1962) necessitated nutrition research. Some highly specific requirements have been identified, for example a preference of the family for nitrogen in the NH_4^+ -form and low levels of available potassium and phosphorus; proteas require nitrogen in relatively moderate amounts (Van Staden, 1968; Hanekom *et al.*, 1973; Claassens & Fölscher, 1978; Claassens, 1980).

Manipulation of growth habit

A study of the effects of ethephon and other growth regulators has revealed that it promoted lateral bud break of plants during vegetative flush. Tests on seedlings and rooted cuttings showed that early branching of both could be significantly increased by the application of ethephon as well as other feathering agents (Brits, 1977; Brits, 1980b). The same effect, though more costly, can be obtained by manual pruning (Vogts *et al.*, 1976a). This method is particularly useful in correcting the undesirable sprawling growth habit of many plants grown from terminal cuttings (Brits, 1980b).

Manipulation of flowering time in L. cordifolium

The main demand for imported cut-flowers on European markets falls within the South African midsummer. A basic problem of local *L. cordifolium* cut-flower production is the natural spring-flowering characteristic of the species (Brits, 1977).

The inflorescence of *Leucospermum* species is not borne terminally on a shoot, but in the axil of a leaf close to the shoot apex. Apart from this inflorescence referred to as the primary inflorescence, a number of axillary buds develop, situated immediately proximally to the primary inflorescence. These buds, referred to as secondary inflorescence buds, do not normally develop beyond the stage where they are 5 mm in diameter, due to correlative inhibition by the primary inflorescence. However, on removal of the primary inflorescence manually or chemically with ethephon sprays, one or sometimes more than one of the secondary inflorescence buds develop, giving rise to a secondary inflorescence which flowers later (Brits, 1977; Jacobs & Honeyborne, 1978). It has been shown that removal of the primary inflorescence of *Leucospermum* cv. 'Golden Star' on October 7 shifted the peak

flowering period from October to December (Jacobs & Honeyborne, 1978). Secondary inflorescence buds may, however, abscise if the primary inflorescence is removed too late (Brits, 1977; Jacobs & Honeyborne, 1978). Flower initiation in *Leucospermum* has also been studied (Jacobs & Honeyborne, 1979; Jacobs & Minnaar, 1980a; Jacobs, 1980b).

Blackening of *Protea* leaves

The leaf colour of *Protea* cut-flowers air-shipped from South Africa to Europe, often undergoes a degenerative blackening during transit (Anonymous, 1965). This is unsightly and extremely damaging from the marketing point of view. Oxidation of flavonoids has been identified as one cause of the blackening in *Protea* leaves (Whitehead, 1979; De Swardt & Pretorius, 1980). High temperatures, low light intensity, desiccation and packing flowers with free water on the leaves all enhance blackening of the leaves (Jacobs & Minnaar, 1977a; Jacobs & Minnaar, 1977b; Jacobs & Minnaar, 1980b). Techniques of proper precooling have been developed as an efficient method of controlling leaf-blackening (Vogts *et al.*, 1976c; Jacobs 1980a; Jacobs, 1981).

Breeding

The breeding of superior protea types for horticulture was attempted on a limited scale before 1973 (Horn, 1962a; Horn, 1962b; Brits, 1980e).

In 1973 a mass selection programme of Proteaceae cutflower types was launched involving the scrutiny of most natural and cultivated resources of commercial Proteaceae in the Western Cape Province. Individual selections were indexed, established as vegetative clones and evaluated. The primary breeding goals established were cut-flower quality, variety, yield, ease of rooting and lateness of flowering. An interspecific hybridization programme was launched using the established selections of these proteas as the main contributors. A genetic investigation of interspecies crossing compatibility was initiated (Brits, 1980b). Special techniques such as the polyploidization of proteas have been attempted (Van der Merwe, 1981).

Registration of protea cultivars

Prior to 1973, commercial resources were undescribed and were traded collectively under their old specific names, e.g. '*Leucospermum nutans*'. In 1973 a national cultivar registration programme for proteas was initiated (Brits, 1980c). In addition, authority was obtained from the ISHS (International Society for Horticultural Science) for South Africa to act as the International Registrar of all protea cultivars falling within the South African genera (Anonymous, 1975).

A first group of nine *Leucospermum*-selections and hybrids were registered as cut-flower cultivars and released, five in 1979 (Z. Welgemoed, 1979a; A. Welgemoed, 1979) and four in 1981 (Welgemoed, 1981; Anonymous 1981). *Protea repens*: Kouga variant, which was improved horticulturally by selection for deep red colour and early summer

flowering time, was also released in 1981 (Welgemoed, 1981; Anonymous, 1981).

Diseases and pests of Proteaceae

Several studies have shown the Proteaceae to be exceptionally susceptible to the root-rot fungus *Phytophthora cinnamomi* Rands (Van Wyk, 1973a; Van Wyk, 1973b; Von Broembsen, 1981). A survey was conducted to determine the extent of *Phytophthora cinnamomi* infestation in protea nurseries and cut-flower plantations in the Western Cape (Von Broembsen, 1981). A sanitary programme was initiated to control the spread of the disease in nurseries, plantations and in the natural habitat. This included the publication and distribution of information pamphlets to producers (Brits & Von Broembsen, 1978). These measures form the basis of a long-term project to control *Phytophthora cinnamomi* on proteas in the Western Cape.

The commercial insect pests of proteas constitute a major problem field (Myburgh *et al.*, 1973). The problem is illustrated by the vast number of pests, estimated at more than 200 species (Gess, 1968) and probably more than the total number of pests of all introduced horticultural crops in the Western Cape. This is because proteas are cultivated within the boundaries of their natural habitat. A wide range of destructive insects has been identified (Myburgh *et al.*, 1973; Myburgh *et al.*, 1974; Myburgh & Rust, 1975) and efficient control measures for some have been developed (Myburgh *et al.*, 1976; Myburgh, 1978; Starke, 1979).

Communication between research and industry

The scattered distribution pattern of protea production areas in South Africa (Vogts, 1980) presents a considerable problem of communication. A protea information pamphlet series was initiated (Vogts, 1980; Vogts, *et al.*, 1976b; Jacobs & Steenkamp, 1975; Vogts *et al.*, 1976a; Vogts *et al.*, 1976c; Myburgh *et al.*, 1976; Brits & Von Broembsen, 1978; Jacobs & Steenkamp, 1976; Vogts, 1977a; Vogts 1977b; Vogts, 1977c; Starke, 1979; Vogts, 1979; De Swardt & Pretorius, 1980; Claassens, 1980). In addition, a mailing list of cut-flower producers was compiled on a national basis (Brits, 1978b). New information is regularly distributed free-of-charge to producers in South Africa as an extension service to the Industry.

CONCLUSION

The above is a summary of important problems and research contributions relating to protea culture in South Africa. The solution of these problems represents a significant advance in the domestication of the fynbos Proteaceae as a commercial flower crop.

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