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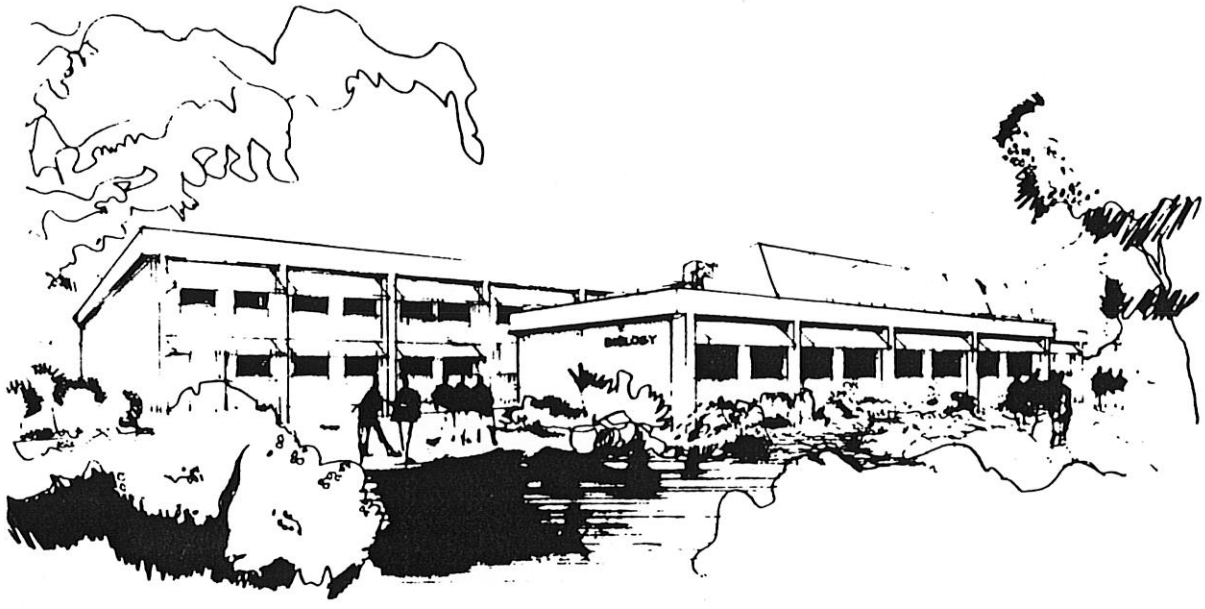
curtin
University of Technology
Perth Western Australia

School of Biology

PROGRESS REPORT

CONSERVATION REQUIREMENTS OF THE GAZETTED RARE SPECIES *BANKSIA CUNEATA*

B. LAMONT, S. BERGL AND S. CONNELL
SCHOOL OF BIOLOGY, CURTIN UNIVERSITY OF TECHNOLOGY



FOR THE ROADSIDE VEGETATION CONSERVATION COMMITTEE

DATED 18.03.88

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Progress report on the conservation requirements of the gazetted rare species *Banksia cuneata*.

By Byron Lamont, Stephen Bergl and Stephen Connell, School of Biology, Curtin University of Technology

for the Roadside Vegetation Conservation Committee, PO Box 104, Como 6152.

Dated 18.3.1988

Restatement of Initial Aim, Study Constraints and Techniques.

Aim

To explore ways of increasing population size of *B. cuneata* at Quairading by manipulation of the environment.

Constraints

1. The need to ensure that suitable methods for maintaining and establishing *Banksia cuneata* populations require limited effort and maintenance.

2. That the surrounding vegetation be considered in evaluating the success and utility of such methods.

Research Techniques

1. The demographic analysis of the existing population and the plant-stored seed crop [Status: complete],

2. Investigation of population regeneration following fire in control and experimental plots [Status: finalized for 1987, plans for 1988 given below],

3. Artificial expansion of the stand by transplanting seedlings grown in pots [Status: yet to commence].

Progress

The age structure of the road verge population was determined in early 1987. The population is dominated by 23 yr old plants which represent the one establishment event, presumably following a fire (Fig. 1). Plants with ages ranging from 20 to 25 can also be included in this one event, as these may represent errors in age determination. Other plants, of varying ages, are probably due to occasional plant death accompanied by seed release and seedling establishment. Both eventful and occasional recruitment show a general relationship to winter rainfall (Fig. 1). The pattern suggests that successful population regeneration requires above average rainfall in the year immediately after a fire.

In April 1987, five 23 yr old *B. cuneata* plants were harvested and returned to Curtin University for detailed analysis of the plant-stored seed crop. Results indicate an average viable seed store of >18 000 seeds per plant (Table 1). In 23 yr old plants the seed crop appears to be increasing still. *Banksia cuneata* thus has the largest canopy seed store recorded for *any Banksia* species; it is extremely serotinous, (Cowling *et al.* 1987, Cowling and Lamont, 1985). The size of the seed crop on a plant is exponentially related to age, with 40% being one year old.

Plants begin flowering when approximately 5 to 6 years old. It is evident that poor seed set and/or low seed viability (Table 1) are not the reasons for the current diminished state of the populations along the road verge (and probably at other sites). Results of these studies are currently being incorporated into a scientific paper.

Seedlings produced during our germination trials have been passed onto the CALM Narrogin nursery.

In May 1987 an experimental burn was placed over 18 plants (14 on the Northern side of the road, 4 on the southern side). All plants which burned, also died and released >90% of their seeds in the following 24 hours. Field monitoring of seed germination and seedling survivorship was commenced in August 1987. One large 45m^2 plot surrounding a dead 23 yr old plant and 25 random 4 m^2 plots were erected. Experimental studies in 1m^2 plots involving a) the provision of shelter (dead Turnip Weed and burnt branches), b) the application of pre-emergence herbicide (Ronstar) prior to sowing of *B. cuneata* seeds, c) combinations of the above, and d) controls, were commenced on the southern side of the road. A study of the effect of post-emergence weed control through application of Fusilade was initiated in September 1987 in a 20 m^2 plot showing good *B. cuneata* seedling regeneration. The regeneration of other native plant species was noted in the study plots and by casual observation.

Large numbers of seeds germinated during the winter (Table 2). Germination was greatest and seedlings survived longest in the drainage channels bordering the road. Seedling demography could not be monitored more frequently because of budgetry and time constraints. It is clear that *B. cuneata* is capable of regenerating naturally. However, the winter 1987 - summer 1987/88 rainfall, though not low by comparison with historical meteorological records, was clearly insufficient for seedling survivorship. No seedlings survived the summer (Table 2). Shrivelled dead seedlings indicated that drought was the major mortality factor. It is notable that of all species detected as seedlings, only *Banksia prionotes* seedlings continued to survive into late summer (Table 3). No *B. cuneata* seedlings were located during the most recent field trip (February 1988).

No seedlings of any native plant species were detected on the southern side of the road. A glasshouse trial found that this was not due to edaphic factors, such as toxic levels of superphosphate. Soil samples taken from burnt and unburnt areas on

both the northern and southern sides of the road supported healthy *B. cuneata* seedlings. The lack of seedlings may be related to the greater exposure of the southern road verge to wind erosion and scouring.

The implications of the above results are that in the past, mass seedling recruitment in stands of *B. cuneata* was restricted to those years when fire was followed by an exceptionally wet winter and above average rainfall over summer. In addition, the growth form of the species, with very mature plants splitting and shedding limbs, may have supplied sufficient seed for limited interfire plant replacement, stabilizing the populations over time. Examples of this type of replacement are to be found at the road verge site and at Badjaling Reserve.

The extreme drought-related seedling mortality masked any effect of the field experimental manipulations (shelter, herbicides).

Summary Points

1. *Banksia cuneata* plants retain their seeds in the plant canopy indefinitely and are killed by fire.

2. *B. cuneata* population sizes are not limited by the availability of viable seeds which are all released soon after fire.

3. Successful population regeneration is determined primarily by water availability.

Further Studies in 1988

1. A glasshouse experiment comparing the drought tolerance of *B. cuneata* and *B. prionotes* is planned. *Banksia prionotes* seedlings appear to be more drought tolerant. Comparison of water requirements will provide confirmation of the field observations and will be used to indicate the minimum watering intervals required for seedling survivorship on the road verge (Study 2). The water relations of adult plants in the field is being studied as well.

2. Further studies on the artificial expansion of the population will be made. These will be delayed pending the results of Dr. D. Coates, CALM, who is currently investigating the population genetics of the stand. These studies will require the cooperation of Quairading Shire Council in providing water for seedling trials.

Publications

Connell, S.W., B.B. Lamont and S.M. Bergl (1988) Matchstick Banksia. Australian Natural History Magazine Autumn issue. (Enclosed)

Connell, S.W., B.B. Lamont and S.M. Bergl. Seed bank dynamics of the gazetted rare species *Banksia cuneate*. (in preparation)

Newsletter Contributions on *B. cuneata* (Enclosed)

"Research into Rural Tree Decline Annual Newsletter" CSIRO, Canberra

"Fire Research Register", CSIRO, Canberra

References Cited

Cowling, R.M. and B.B. Lamont (1985) Serotiny in three Western Australian *Banksia* species along a climatic gradient. *Australian Journal of Ecology*, 10, 345-350

Cowling, R.M., B.B. Lamont & S.M. Pierce (1987) Seed bank dynamics of four co-occurring *Banksia* species. *Journal of Ecology*, 75, 289-302

Table 1. Reproductive attributes of *Banksia cuneata*. Results are x ± s.d. All parts of each of five plants counted unless otherwise indicated.

Attribute	Value
Age (years)	23
No. florets/head (N = 25)	69±7
No. heads/plant	1463±1793*
% cones fertile	53
No. follicles/head	1.8±1.0
No. follicles/plant	1686±1800
% follicles aborted	4
% follicles damaged	0
% follicles open	7**
% follicles mature	89*
% seeds aborted	13
% seeds nonviable	12
% seeds viable	75
No. viable seeds/plt	18374±2581

* exponentially related to cone/follicle age

** linearly related to follicle age

Table 2. Number of seedlings per adult of *Banksia cuneata* following fire.

Date	Births		Deaths		Net Population
	No.	Cum.	No.	Cum.	
8.08	414	414	0	0	414
27.08	256	670	68	68	662
21.09	78	748	281	349	379
25.10	28	776	324	673	103
8.12	2	778	99	772	6
6.01	0	778	6	778	0
21.02	0	778	0	778	0

Table 3 Regeneration of native plant species following fire at the study site.

Species	Family	Regeneration	
		Seed	Sprout
Banksia prionotes	Proteaceae	+	
B. cuneata	"	+	
Xylomelum angustifolium	"	+	
Grevillea integrifolia	"	+	
Dryandra conferta	"	+	+
Casuarina campestris	Casuarinaceae		+
Eremaea pauciflora	Myrtaceae		+
Leptospermum erubescens	"		+
Calothamnus sanguineus	"		+
Patersonia sp.	Iridaceae		+
Lepidosperma sp.	Cyperaceae		+
Mesomelaena stygia	"		+
Dianella revoluta	Liliaceae		+

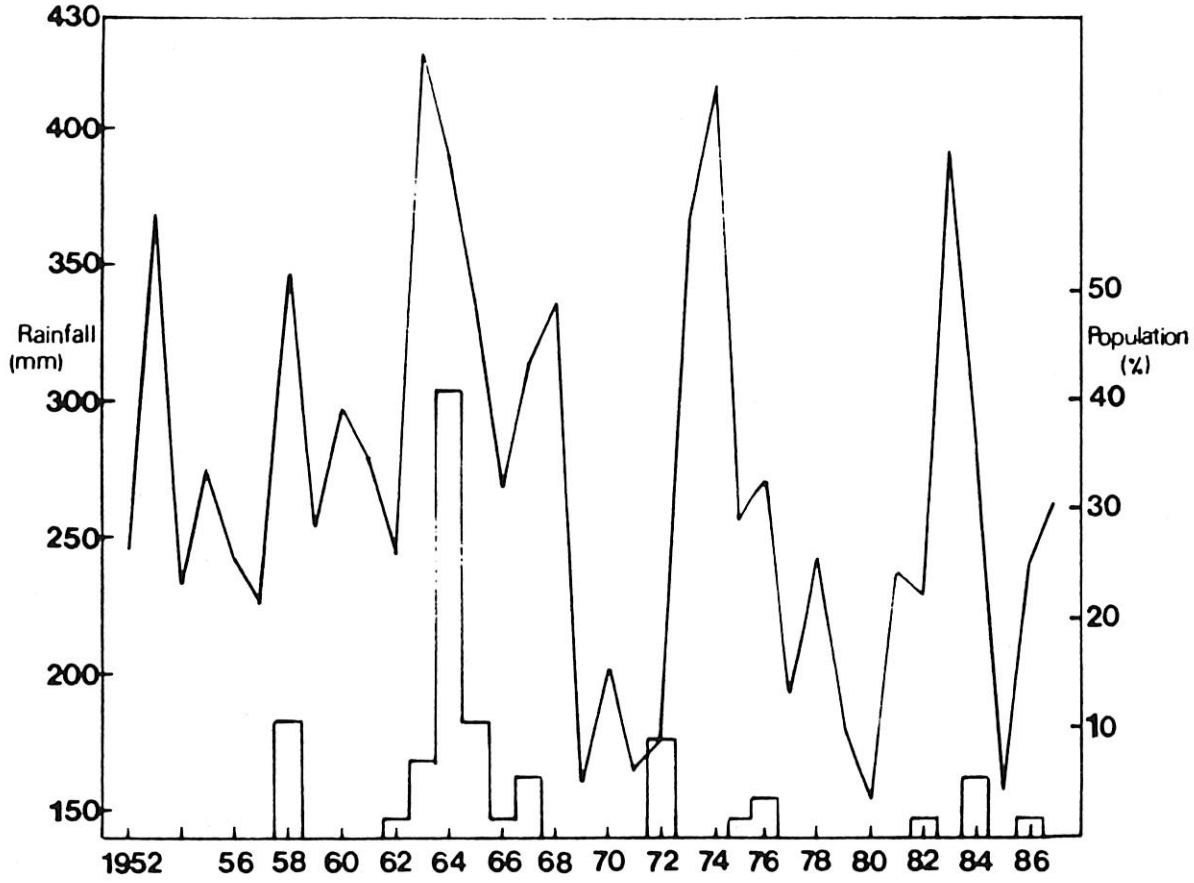


Figure 1. Population age structure of *B. cuneata* along the Quairading - Bruce Rock Road and winter rainfall (mm) at Quairading for the period 1952 - 1987.

Banksias are a group of plants familiar to most Australians. These shrubs and trees, with their conspicuous flowering cones, are found from the coast to the mountains, in forests, wetlands and heaths, along rivers, near the snow and in many people's gardens. All of the 74 species currently known to science are found in Australia, with one species extending to New Guinea and adjacent islands. By far the richest area for banksias is south-western Australia where 58 species occur. It is here that one of the rarest, the Matchstick Banksia (*Banksia cuneata*) is found.

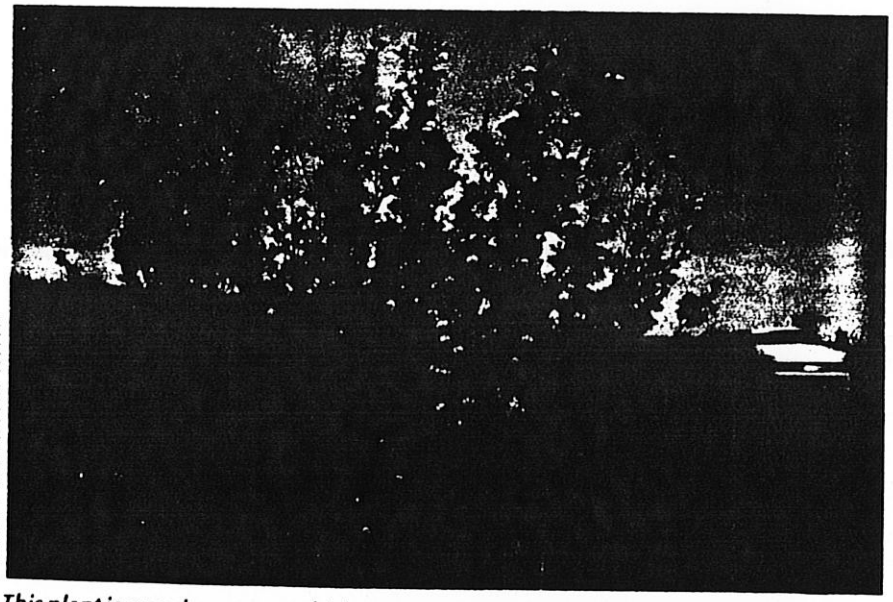
Identified as recently as 1981, the Matchstick Banksia is confined to remnant vegetation in the wheatbelt area of Western Australia, within a 50-kilometre radius of the town of Quairading. It is a gazetted rare species and has been accorded a conservation status of '2EC' ('2' meaning a species with a natural geographic range of less than 100 kilometres; 'E', an endangered species that may disappear from the wild within one or two decades if present land use and other causal factors continue; and 'C', a species known to occur within a national park or proclaimed reserve).

Four very restricted populations of the Matchstick Banksia are known: three on roadside verges and one in a small nature reserve. A recent survey found fewer than 300 plants in the wild, with individual populations ranging in size from one to 100 plants. The population in the nature reserve is the most perplexing. In 1982 its size was estimated at more than 300 plants; but a survey in April 1987 located fewer than 50 plants. The reasons for this startling decline are not clear; there is no evidence of recent disturbance such as fire, and no dead plants were found!

The Matchstick Banksia is a large shrub with smooth, grey bark and serrated, wedge-shaped leaves. Together with the Holly Leaf Banksia (*B. ilicifolia*), it is placed in a separate subgenus (*Isostylis*) from all the other species. The two species produce inflorescences, or flowering heads, which, unlike most banksias, are not elongated but are rather short and tufted. In the Matchstick Banksia these inflorescences are borne at the tops of the branches during spring and early summer.

Each inflorescence may contain up to 100 individual flowers. These are long and narrow, initially pink with a green apex, later becoming creamy yellow. Unfertilised flowers fall from the inflorescence axis, which then resembles a bright orange button. The two-centimetre-long fruits (follicles) are woody with soft downy hairs. They are bivalved with each valve containing a single winged seed. Follicles remain closed on the branches for a number of years until either the branch dies or a bush fire kills the entire plant. They are held closed by a resin that breaks down with time or can be melted during a fire.

This fire-related seed release is found in a number of *Banksia* species, many of them common, and in plants from other genera. It has possibly contributed to the decline of the Matchstick Banksia because of changes in fire regimes occurring in the wheatbelt since settlement. Fires that occur too frequently will prevent re-establishment of the populations, as the young plants will not have developed a large seed store (plants take four to five years to flower).



PHOTOS BARRY & BIKI WILLS

This plant is growing on a roadside verge near Quairading, Western Australia.

Conservation requirements of the gazetted rare species, Banksia cuneata A.S. George along the Quairading - Bruce Rock Road, Western Australia.

Byron Lamont, Stephen Bergl, Stephen Connell.
School of Biology,
Curtin University of Technology,
G.P.O. Box U1987,
Perth, W.A., 6001.

This project has been funded by the Department of Main Roads through the Roadside Vegetation Conservation Committee for a two year period which commenced in February 1987.

Background

Banksia cuneata, the Matchstick Banksia, is one of the rarest species of banksias. It is confined to remnant vegetation in the wheatbelt area of Western Australia; occurring within a 50km radius of the town of Quairading. Four populations are currently known; three occur on roadside verges and one is located in a small nature reserve. Fewer than 300 plants exist in the wild.

Project Aim and Constraints

The aim of this study is to explore ways of maintaining present populations and establishing new populations by manipulation of the environment. The project is constrained by:

1) the need to ensure that suitable methods require limited effort and maintenance; and

2) that the surrounding native vegetation be considered in evaluating the success and utility of such methods.

Project Status

Banksia cuneata is serotinous(retaining its seeds in woody follicles on the plant) and is killed by fire. It relies upon post-fire seedling establishment for population regeneration. The size and nature of the seed crop on plants of known ages was assessed in 1987.

In late Autumn 1987, a controlled fire was placed over a portion of one population. Seed release and seedling establishment in control and experimental plots within the burnt and unburnt areas is currently being examined. Experimental plots have been designed to examine the effects of microtopography, weed control, rabbit and insect exclusion, direct hand sowing and seedling transplanting on the success of seedling survivorship and growth.

Studies in 1988

Glasshouse investigations of the growth of B. cuneata seedlings on different soil types from the wheatbelt area will commence. Field monitoring will continue and a comprehensive census of all known populations will be undertaken. The census will determine population sizes, age structures, the nature of the surrounding native and weed vegetation, substrate relationships and possible threats.

Publications

Connell, S.W., Lamont, B.B., and Bergl, S.M. 1988. Matchstick Banksia. Australian Natural History Magazine (in press).

Lamont, B.B., Connell, S.W. and Bergl, S.M. Seed bank dynamics of Banksia cuneata (in preparation).

Fire Research Register

Project Name: Conservation Requirements of Banksia cuneata.

Location: Quairading Shire, Western Australia

Vegetation Type: Remnant roadside vegetation, undisturbed stands occur in tall shrubland - woodland.

Dominant Species Association: Banksia prionotes, Xylomelum angustifolium amongst others.

Commencement Date: February 1987

Completion Date: 1989

Description: The aim of this study is to explore methods of maintaining and establishing populations of Banksia cuneata, a gazetted rare species, by manipulation of the environment. The project is constrained by:

1. the need to ensure that suitable methods require limited effort and maintenance.; and
2. that the surrounding native vegetation be considered in evaluating the success and utility of such methods.

Progress; Population age structure, plant reproductive biology (phenology, inflorescence and infructescence characteristics, seed crop etc.) have been determined. A burn was placed over a portion of one population in Autumn 1987. Seed release and seedling establishment in control and experimental plots within the burnt and unburnt areas is currently being examined. Experimental plots have been designed to examine the effects of microtopography, weed control, rabbit and insect exclusion, direct hand sowing and seedling transplanting on the success of seedling survivorship and growth.

Project Leader: Dr. Byron Lamont. Telephone: (09) 350 7368

Contact Officer: Dr. Stephen Connell Telephone: (09) 350 7368

Contact Address: School of Biology,
Curtin University of Technology,
GPO Box U1987, Perth 6001.

No. Research Staff (part time): 2

No. Technical Staff (part time): 1

Publications:

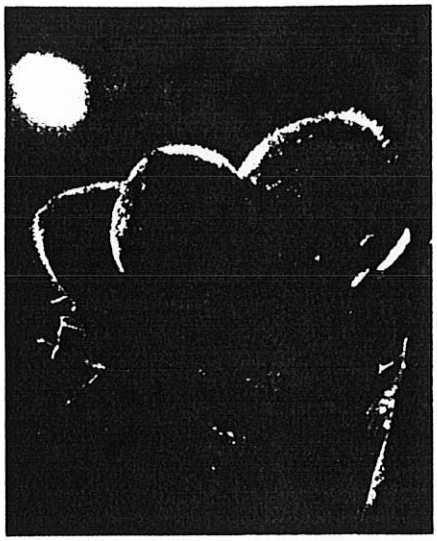
Connell. S.W., B.B. Lamont and S.M. Bergl (1988). Matchstick Banksia. Australian Natural History (in press)

Lamont, B.B., S.W. Connell and S.M. Bergl. Seed bank dynamics of Banksia cuneata.

Alternatively, long periods between successive fires result in plant death before seeds are released.

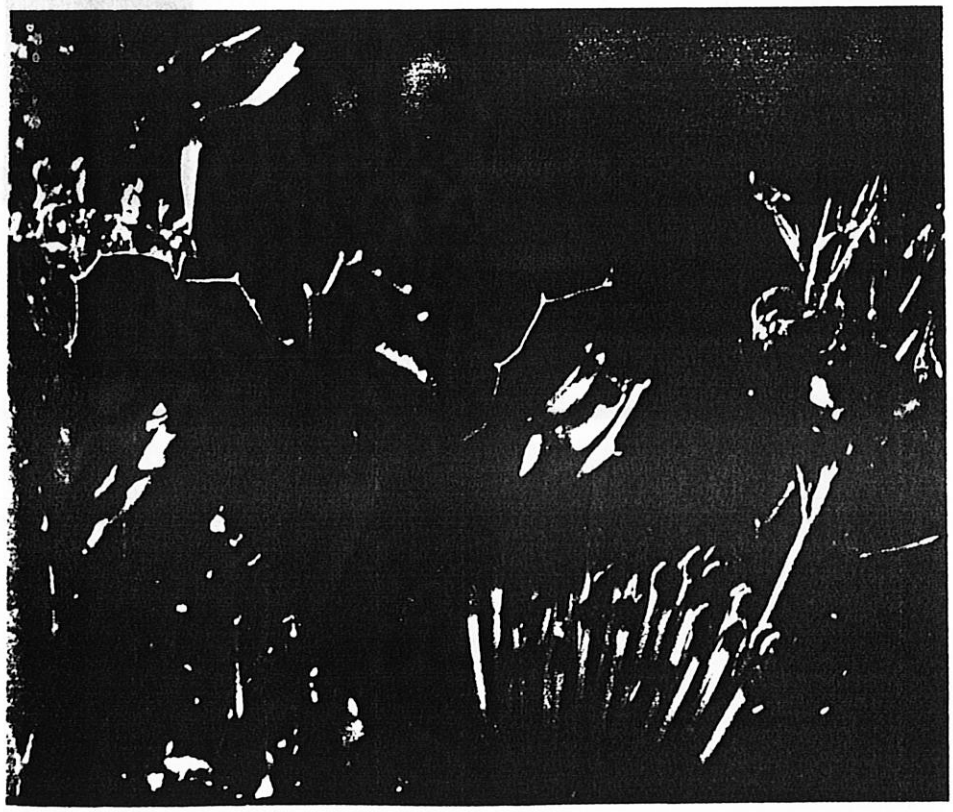
Since settlement, 90 per cent of what is now the wheatbelt area has been cleared. Native vegetation is now confined to rocky outcrops, roadside verges, small pockets on farms, and the occasional small nature reserve. Degradation of this remnant vegetation through land salinisation, rabbit infestation, weed invasion and altered fire regimes may have contributed to the current vulnerability of the Matchstick Banksia. Because the Matchstick Banksia has only recently been identified, little is known of its past distribution. One wonders how many other species are in a similar predicament and how many have disappeared or will soon go, perhaps before we are even aware of them.

We are currently studying the effects that fire, weed control, rabbit and insect exclusion, direct hand-sowing and seedling transplantation have on the Matchstick Banksia. The aim of the study is to explore ways of maintaining present populations and establishing new populations by manipulation of the environment. Realistically, however, the species may have no future in the wild; its only chance for survival being through its release as a horticultural plant. Such a decision may soon have to be made. ■



Each bivalved, woody fruit (follicle) encloses a single winged seed.

—Stephen Connell, Byron Lamont and Stephen Bergl
Curtin University of Technology, WA



The short, tufted flowering heads of the Matchstick Banksia.