

Preliminary Report on *Conospermum* (Proteaceae)

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SUMMARY

Ground and aerial reconnaissance has been conducted of the coastal areas of Western Australia from Perth north to Kalbarri to assess the available biomass of *Conospermum stoechadis*, *C. incurvum*, and closely related species; additionally, samples of these species have been obtained for quantitative analysis of conocurvone--an active chemical within the plant species that may have potential for treating AIDS. An estimated 1.1 million kg of root of *C. stoechadis* is available in the Kalbarri region and more than 2 million kg of root of *C. incurvum* occurs within 50 square km just north of Eneabba. Several other promising areas have been noted from aerial reconnaissance, but the plants have yet to be checked by ground survey. The southeastern part of Western Australia has not yet been surveyed where other closely-related species occur, particularly *C. distichum*, *C. floribundum*, *C. filifolium*. Thirty-three samples of *Conospermum* spp. have been obtained of *C. incurvum*, *C. stoechadis*, and also from variants of *C. triplinervium*.

DETAIL

Planning in Perth

The first week was spent obtaining photocopies of locality data on herbarium records from PERTH (herbarium name indicated in Index Herbariorum) and entering these data into a database. Species filed alphabetically in the herbarium from A-G were photographed before Neville Marchant, Acting Senior Botanist in charge for Jim Armstrong who has taken on another position under the Executive Director (Syd Shea), complained about taking proprietary information. Photographing was actually done with permission from other staff at the herbarium; however, this complaint and recognition of my visit led to further meetings with my partner, Ross Smith, Jim Armstrong and our (WBA) attorney to work out a satisfactory agreement between CALM and WBA. Currently, we are allowed to carry out our work as planned with the exception of not being able to ship the samples until an agreement has been actually signed.

With 75% of the information from the herbarium, we proceeded with the survey work. Jim Armstrong has indicated that he was going to send us a printout of all species of *Conospermum*, but we have yet to receive this information.

The A-G species of *Conospermum* photographed include: *C. acerosum*, *C. amoenum*, *C. brachyphyllum**, *C. bracteosum*, *C. brownii*, *C. caeruleum* spp. *caeruleum*, *C. caeruleum* spp. *debile*, *C. capitatum* ssp. *capitatum*, *C. capitatum* ssp. *spathulatum*, *C. capitatum* ssp. *velutinum*, *C. coerulescens* ssp. *coerulescens*, *C. coerulescens* ssp. *adpressum*, *C. coerulescens* ssp. *dorrienii*, *C.*

coerulescens ssp. *oblanceolatum*, *C. croniniae*, *C. densiflorum*, *C. eatonii*, *C. distichum*, *C. ephedroides*, *C. filifolium* ssp. *filifolium**, *C. filifolium* ssp. *glabratum**, *C. filifolium* ssp. *orientalis**, *C. flexuosum* ssp. *flexuosum*, *C. flexuosum* ssp. *laevigatum*, and *C. flexuosum* ssp. *marginatum*. Those marked by an asterisk (*) are considered to be most closely related to *C. incurvum* and *C. stoechadis*; however, there are four other closely-related taxa that were not photographed, *C. galeum* (possibly extinct), *C. microflorum* (unpublished name, Murchison River to Shark Bay), *C. multispicatum* (unpublished name, Toolibin, Boyerine, Wagin and Stirling Range), and *C. spectabilis* (unpublished name, Stirling Range), *C. floribundum**, and *C. glaucescens*.

Most specimens photographed in the PERTH herbarium were annotated by Eleanor Bennett and most of the ssp. names mentioned above are her names, or combinations, that have yet to be published, although some of the subspecies have validly published names at the species level. Also, Bennett's interpretation of some of the species related to *C. incurvum* and *C. stoechadis* differs from other published accounts (e.g., Blackall & Grieve 1988), and the problem here is reminiscent of some of the problems in the genus *Taxus*. Data on *C. incurvum* was obtained during a previous trip, February 1990. Latitude and longitude were determined for all locality data, and the database, which contains more than 350 records, was sorted by longitude and latitude. Species names were then marked on a road map of Western Australia.

An overpriced book was purchased on *Conospermum* and *Lambertia* (Sainsbury 1991) which shows color plates of all species as previously known, and four unnamed species of *Conospermum*; this book is helpful for its color plates. Although it includes notes on geographical distribution, frequency in success in seed germination and cuttings for each species, this information for the most part is not helpful to our survey work.

Ground and Aerial Surveys

Field work to date has focused mainly on *C. incurvum* and *C. stoechadis*, which primarily occur from Perth north to Kalbarri National Park. From ground reconnaissance of Perth to Kalbarri in a four-wheel drive land cruiser, notes were taken on the abundance of *Conospermum* spp. while travelling along main roads or tracks. These notes include visual estimates of spacing between plants in meters (m) and odometer readings in kilometers (km) at intervals when *Conospermum* appeared abundant (1-3 m apart), common (5-20 m apart, 10 m as an average), frequent (30-100 m apart, 100 m intervals used as an average), occasional (300 m apart as an average) and scarce (1000 or more meters apart). Areas that looked particularly promising were sampled and further checked by aerial reconnaissance to obtain a better estimate of the available biomass. Aerial reconnaissance of the coast from Perth to Eneabba, and of Kalbarri National Park, has also identified other areas on the ground that look promising and these remain to be investigated.

Aerial reconnaissance is best done by helicopter, but this is also very expensive, \$360.00/hr with 10 minutes charged for warming up and winding down. While we were at Kalbarri, only fixed-wing flights were available for charter (\$260.00/hr); however, the pilot of the plane that we chartered informed us that they were bringing up a helicopter from Perth next week and that we could probably get a ride part of the way at a reasonably reduced rate. We pursued this and met with the helicopter pilot in Perth. He charged us \$80/hr for the 2.5 hour flight from Perth to Eneabba and \$360/hr for 38 minutes to survey an area 16 km north of Eneabba; Ross Smith arranged to have someone, Elizabeth, to meet us at Eneabba with our field vehicle.

Table 1 shows the results of our ground and aerial reconnaissance. Our observations are documented by both photographs and voucher specimens. The color photography includes 190 prints and 30 slides, and also 55 minutes of video film; these and others photos will be edited and presented in a final report. The color photographs were taken at elevations of 500 feet over Kalbarri in a fixed-wing aircraft and from 1000-500 ft from Perth to Eneabba in a helicopter; a Nikon 4004 SLR camera loaded with either 1600 or 400 ASA film was used in automatic mode with the film-shutter speed at 1/250 or 1/500 and with a 35-70 mm lens (at 70 mm). The video camera was used only for the helicopter flight.

Observations on *Conospermum stoechadis*

This is a large shrub that is primarily a seral species occurring abundantly along roads where vegetation has been cleared or where vegetation has been burned; north of Perth there appears to be two centers of distribution, a southern-inland center near Cataby and a northern near-coastal center in Kalbarri National Park; however, since the range extends south and to the east of Perth, other population centers may be discovered. Furthermore, Bennett (unpublished) recognizes a subspecies of *C. stoechadis*, characterized by hairy leaves, in contrast to the typical form with glabrous leaves; the geographical occurrence of the hairy-leaved subspecies may correspond in part with the southern-inland center we recognize; she described the hairy subspecies as occurring between Dandaragan and road to Jurien Bay. Along Brand Highway, about 30 km north of Cataby, variants of *C. triplinervium* (*C. borealis* Bennett, *C. cinereum*, *C. wycherleyi* Bennett; unpublished), replace *C. stoechadis* as the dominant smokebush species until near the Hutt River where *C. stoechadis* reappears as the more dominant smokebush species. Further north (of the Murchison River) Bennett recognizes another closely related species, *C. microflorum* (unpublished) which extends to Shark Bay. The pilot of our chartered aircraft recalls seeing a large population of *Conospermum* about 100 km north of Kalbarri National Park which may belong to *C. microflorum*; we have yet to collect this one or explore north of the Murchison River on the ground. Another variant of *C. triplinervium* (*C. canaliculatum* Bennett, ms) occurs more abundantly than *C. stoechadis* at about the latitude of Yanchep (ca 31 degrees south), and from aerial reconnaissance it was noted to be particularly abundant in the southern half of Yanchep National Park; this was formerly regarded as a variety of *C. stoechadis* (Blackall & Grieve 1988). Our collections of *C. canaliculatum* were obtained just east of the Yanchep National Park on "Smokebush Hill."

Immediately following our chartered flight at Kalbarri, the pilot and my partner-Ross Smith were consulted to outline the occurrences of *Conospermum stoechadis* on a colored-vegetation map by Beard (1976) (1:1,000 000), i.e. the areas where we observed *Conospermum stoechadis* to occur in abundance in the Murchison Region. This information was soon redrawn by Ross Smith on a more detailed map of the Kalbarri National Park. Using the Kalbarri map, we have determined the area in square meters for each of the regions of *C. stoechadis* and then calculated the root biomass based on the frequencies indicated, which is usually 1 plant for every 10 meters, and an average weight of 500 g of root for each plant. In many regions, however, the frequency is closer to 1 plant for every m rather than 1 for every 10 m. The weight estimate may be adjusted as we obtain additional data on the yield in dry weight per plant; our samples are still drying. To further substantiate our observations, we will include selected aerial photographs showing the abundance of *C. stoechadis* and a photocopy of plate 35 in Beard (1976). Beard (1976) contrasted the occurrence

of *C. stoechadis* "in early stage after fire" with other "long unburned scrub"; this further supports our belief that *C. stoechadis* will do well in cultivation.

Observations on *Conospermum incurvum*

Conospermum incurvum is a much smaller shrub than *C. stoechadis*, 50-100 cm high, but it is ecologically similar to *C. stoechadis* by its preference for disturbed sandy soils, and as with *C. stoechadis*, there appears to be two distributional centers; however, we also recognize two morphological variants, a southern one with teretiform leaves and a northern one with flattened leaves. The northern (flat-leaved) variant is also slightly larger. The original sample (SPJ-7139) and subsequent 1990 WBA recollections of *C. incurvum* are of the northern, flat-leaved variant, and it is this variant for which we have identified the large biomass that is available north of Eneabba. *C. incurvum* is probably a short-lived shrub, perhaps not more than 15 years; it produces a long-simple taproot that extends straight down into the soil, 50-100 cm, and above the ground, it branches in distinct whorls at short internodes with the first whorl at about 10 cm above the base.

Additionally, a closely-related species, *C. brachyphyllum*, may occur with *C. incurvum*, and at a distance it may be difficult to distinguish from *C. incurvum*. *C. brachyphyllum* is recognized by Bennett (ms unpublished) as having leaves longer than 25 mm, in contrast to the leaves being less than 25 mm long in *C. incurvum*. We have yet to identify *C. brachyphyllum* in the field, thus, *C. brachyphyllum* appears to be uncommon as also evident by the paucity of its herbarium collections.

The amount of root biomass in *Conospermum incurvum* varies considerably from plant to plant with the northern variant producing notably larger roots. In random collections, 25-50 plants may be required to yield one kg whereas selecting sampling of large plants in more open, less competitive, areas, such on sand tracks, 1 kg of root may be obtained from only 1-2 plants. Our calculations of root biomass are based on 25 plants/kg, but in practice, a collector will selectively take the larger (older) plants. Also, in many of the high density areas of *C. incurvum*, which appear in our aerial photographs as "*C. incurvum* quasars," the plants are often not more than 10 cm apart.

Preliminary Assessment of Supply of *Conospermum*

Although other reports have indicated that *Conospermum incurvum* has not been grown from seed or cuttings, World Botanical Associates has first-hand experience in growing *C. incurvum* from seed. Ross Smith, in his revegetation projects, has been working with *C. incurvum* prior to NCI interest in this species. We feel that a crop could be produced in three years, and we have an understanding from one of our contacts that 600,000 cuttings or seedlings from tissue cultures can be supplied each year from closely-related species (*C. filifolium*, *C. floribundum*, *C. distichum*), and with 3-12 months research, similar tissue cultures could be developed for *C. incurvum* and *C. stoechadis*. We also believe that CALM would allow us to harvest up to 25% of the available root biomass with the understanding that species of *Conospermum* would be brought under cultivation to meet future needs of conocurvone. We provide this information because we recognize that the decision to advance conocurvone to preclinical and clinical trials depends on both the short term and long term supply.

Thus, this trip is already a success as sufficient quantities of the desired species have been located, and the expertise and organization to cultivate *C. incurvum* and *C. stoechadis* are now in place. Nonetheless, we will continue to sample species of *Conospermum* for evaluation of the seasonal variation and distribution of conocurvone in *C. incurvum*, *C. stoechadis*, and closely-related species. Also, *C. distichum*, a closely related species, will probably be found in abundance in the southeastern part of the state, perhaps in better quantities than *C. incurvum*.

Literature Cited

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Table 1. Preliminary Biomass Estimates on Selected *Conospermum* spp.

Region	Area (sq meters)	Abundance (m apart)	Plants (total)	Kg (2/kg)	
<i>C. stoechadis</i>					
Kalbarri					
A	282744	10	28274	14137	
Area B	4523904	10	452390	226195	
C & D	125664	10	12566	62832	
E	160000	10	16000	8000	
F	6000000	10	600000	300000	
G	1000000	10	100000	50000	
H*	28274400	?			
I	4000000	10	400000	200000	
J	1000000	30	33333	16666	
K	62500	10	6250	3125	
L	7000000	10	700000	350000	
Total Kalbarri.....				1174407 kg of rt	
S Brand Hwy					
22 km S	1060000	300	3533	1766	
of Moore	140000	100	1400	700	
River to	20000	1	20000	10000	
30 km N					
of Cataby					
Total South Brand Hwy.....				12466 kg of rt	
Guilderton TBD					
<i>C. incurvum</i>					
				25/kg	
Eneabba					
15-25 km North	50000000	1		2000000	
W Moore River			600	24	
E Moore River			10000	400	
Badgingarra			50000	2000	
Eneabba South			100000	4000	
TBD**	Namburg E	25000000	1	25000000	?
TBD	Cataby SW	30000000	1	30000000	?

* Area H in Kalbarri National Park was observed on the ground to have *Conospermum stoechadis* but from the air the plants could not be discerned from ashv color of the burnt soil and vegetation; therefore, the abundance of this

Notes on Observations on *Conospermum*

9-10 Sep 1992. Perth to Kalbarri.

--Pinjar Road, jct with Reaves Rd at Wanneroo, 52 km NW of Perth. *Conospermum* locally common here but no samples taken

Brand Hwy: Moore River Region

C. stoechadis

- extending for 22 km from S of Moore River Natl. Park to Moore River: *C. stoechadis* primarily along road verges.
- 12 km S of Cataby to Cataby (70 km N of Gingin) to Cataby, *C. stoechadis* fairly abundant along road verge.

Beginning 3 km N of Cataby

C. stoechadis:

- Scattered occurrences for 3 km, then rarely seen for 1 km; reappearing in 2 km as scattered more than 300 m.
- 7 km N of Cataby, common, less than 100 m apart, but only for about 1 km.
- 11 km N of Cataby, abundant for less than 1 km, plants 1 m or less apart, then becoming scattered.
- 15 km N of Perth, scattered small groups 100 m or more apart.
- 18 km N of Perth, good patches along E side of Hwy for about 1 km then becoming scarce for 3 km, then frequent for less than 1 km, reappearing in 2 km and then infrequent for 6 km becoming more frequent for the next four km.
- 30 km N of Cataby, Baadgingarra Natl Park. Common for about 5 km, plants often less than 1 m apart, becoming scarce for 2 km then good patches seen for the next 4 km; *C. incurvum* occasionally present.

C. incurvum, with *C. triplinervium* variants:

- 42 km N of Cataby, 12 km N of Badgingarra Natl Park, *C. borealis* (*C. triplinervium*) replaces *C. stoechadis*; good patches *C. incurvum*, 100 m or more.
- 46 km N of Cataby, town of Badgingarra. *C. incurvum* in patches around town and on hillsides, N of Badgingarra primarily along the highway for the next 12 km with occasional gaps, occurring with abundant *C. triplinervium*.
- 86 km N of Cataby, 1/2 km of *incurvum*; then samples of *C. incurvum* and also of *C. triplinervium*
- 22 km S of Eneabba, southern part of Eneabba Reserve, abundant for 100 m.
- 16 km S of Eneabba, good quantities for 5 km then becoming occasional for 3 km
- 10 km S Eneabba, abundant for 1 km then scarce for 2 km, then reappearing frequently for the next 7 km, Eneabba.
- 5 km N of Eneabba. *C. incurvum* on flats along highway for 1 km.
- 11 km N of Eneabba. 100 m patches.
- 14 km N of Eneabba. Recent burn with abundance of *C. triplinervium* variant.
- 15 km N of Eneabba. Very abundant for 1 km on W side of highway, then briefly thinning out, then abundant again for the next 4 km, extending as far as the eye can see.
- 20 km N of Eneabba. *C. triplinervium* variant very abundant.
- 31 km N of Eneabba, the last good patch of *C. incurvum* occurring for less

C. stoechadis:

- 210 km N of Eneabba, 8 km S of Hutt River, large variant of *C. stoechadis* becomes common. Sample here.
- Kalbarri Natl. Park. *C. stoechadis* appearing common at the park boundary and extending westwards for the next 70 km, terminating at the town of Kalbarri, which is near the ocean. Occasional gaps were seen but usually not more than 2 km. *C. stoechadis* occurs primarily where there has been fire within the last 4 or 5 years and occurring with *C. triplinervium*.