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PROJECT TITLE	**Collection of wild *Gossypium australe, G. bickii, G. nelsonii,* and *G. sturtianum* in the Australian eastern arid zone**	
FIELD OF RESEARCH	**New Cultivars**	
FIELD CODE	**3.1**	
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EXECUTIVE SUMMARY

Indigenous Australian *Gossypium* species possess a number of attributes that could be used to improve the profitability of cotton cultivation in Australia (see CSP47C & CSP85C). The Australian eastern arid zone was poorly represented in the current CSIRO Cotton Germplasm Collection. The collecting trip funded by this grant provided the accessions needed to rectify this gap in the collection and expanded our knowledge of the natural biology of *G. australe, G. bickii, G. nelsonii,* and *G. sturtianum*. The herbarium specimens represent important source materials for natural biologists and Flora writers. The germplasm samples will be used in future studies of levels and patterns of genetic and morphological diversity among the arid zone *Gossypium* species. This in turn will provide a base-line for documenting the existence and directionality of gene flow among these wild cotton relatives.

BACKGROUND

The importance of the 18 indigenous Australian *Gossypium* species to cotton cultivation in Australia has increased over the past years. They possess a number of characteristics that, if transferred to cultivated cottons, would increase pest resistance, improve cottonseed oil and protein meal quality, and possibly increase cold tolerance (CSP47C). Thus the indigenous Australian *Gossypium* species are directly relevant to the CRDC's key objective #3 (development of new or improved cultivars) as a source of new genetic potential. In both instances, the eastern Australian arid zone (south-western Queensland, north-western New South Wales, east-central Northern Territory), represents a vital area for new field studies.

Terpenoid aldehydes, which are often collectively referred to as 'gossypol', represent the most important component of cotton's natural disease and pest resistance. Unfortunately, the presence of 'gossypol' in the seeds renders the cottonseed oils and protein meals toxic to non-ruminant animals. The four *Gossypium* species that occur in the eastern Australian arid zone (*G. australe, G. bickii, G. nelsonii*, and *G. sturtianum*) do not initiate synthesis of 'gossypol' until germination, effectively rendering the seed free of these toxic chemicals. These species also appear to have terpenoid aldehyde profiles that may convey higher resistance levels than current cotton cultivars (CG Benson, personal communication). Transferring these characteristics to cultivated cotton cultivars has the potential to significantly increase the quality of cottonseed oils and protein meals without reducing current levels of disease and pest resistance. *Gossypium sturtianum* has higher levels of cold tolerance than existing cotton cultivars.

At the same time, new plant explorations in the eastern Australian arid zone would also expand our knowledge of the natural biology of these four species. Understanding the natural biology of *G. australe* and *G. sturtianum* is particularly relevant because both of these species occur naturally in the Australian cotton growing regions (CSP41C & CSP33C). In studying patterns of gene flow between *Gossypium* species, one important issue has received virtually no attention, namely the occurrence of natural interspecific hybrids among the indigenous Australian species. Only three known interspecific hybrids are known and field observations by CL Brubaker, LA Craven, JF Wendel, and JM Stewart suggest that *G. australe* and *G. nelsonii* may be hybridizing in sympatric areas in the Australian eastern arid zone. The co-occurrence of these four species in the eastern Australian arid zone, makes this region ideal for the identification of interspecific hybrids, if they exist.

OBJECTIVES & ACCOMPLISHMENTS

New Accessions of wild Australian *Gossypium* species: We located and collected seed from 123 populations of *Gossypium* species (Table 1.) Particularly notable are the number of *G. bickii*, *G. nelsonii*, and *G. sturtianum* accessions. In contrast to *G. australe*, these three species have smaller ranges (*G. bickii* and *G. nelsonii*) or are sporadically distributed over wide geographic regions (*G. sturtianum*). These new accessions represent significant step toward making the CSIRO Wild Cotton Germplasm collection a complete collection, encompassing the full range of morphological, genetic, and ecological diversity.

Table 1. Number of *Gossypium* accessions collected (by species).

G. australe	58
G. barbadense	1
G. bickii	19
G. nelsonii	20
G. sturtianum	18
G. australe x *G. bickii*	3
G. australe x *G. nelsonii*	4

Identification of sympatric populations and hybrids: One surprising and fascinating observation was that 21 populations contained more than one *Gossypium* species (Table 2). The widely distributed *G. australe* was the species most often found in mixed populations. In many cases these sympatric associations probably reflect range extensions that have occurred as a result of human road building activity. Hybrids between *G. australe* and *G. bickii* were observed at two sites. Hybrids between *G. australe* and *G. nelsonii* were seen at three sites. In the region around Mt. Isa in western Queensland, hybridization is occurring to the extent that the morphological distinction between *G. australe* and *G. nelsonii* is disappearing.

Table. 2. Number of sympatric populations located.

Species present	Number	Hybrids Observed?
australe/bickii	8	Yes
australe/nelsonii	3	Yes
australe/sturtianum	6	No
australe/nelsonii/sturtianum	3	No
bickii/nelsonii	1	No

Understanding the natural biology of the central arid zone *Gossypium* species: Because the *Gossypium* species native to the central arid zone have naturalized along roadsides, most field observations are based on populations that arose after the arrival of Europeans. During the course of this collecting trip, we tried to locate as many off-road populations as possible as these are more likely to be natural. Our observations suggest that these four *Gossypium* species mostly occur naturally along drainage lines running down from the local ranges (e.g., the Davenport, MacDonnell, and Harts Ranges) and rarely occur on upland areas where water availability is severely limiting. *Gossypium australe* occasionally violates this generalization. The ability of the four species to colonize roadsides probably reflects the extent to which table drains mimic the natural habitats of the four species rather than a strong propensity to weediness. *Gossypium sturtianum* is the least likely to colonize roadsides and all observed roadside populations occurred when the roads transected existing drainage lines. *Gossypium australe* is the species most commonly encountered along roadsides, and is clearly expanding its range locally along roadsides.

This difference is interesting because *G. australe* and *G. sturtianum* have equally extensive distributions: *G. australe* spans the continent in the northern and middle latitudes, while *G. sturtianum* spans the continent in the middle and southern latitudes. The greater likelihood of encountering *G. australe* on roadsides probably arises from its greater original density, wider ecological tolerances, and a more easily dispersed seed. The more consistent association with creeks suggests that water availability is more limiting for *G. sturtianum* than it is for *G. australe*. This would reduce the ability of *G. sturtianum* to exploit table drains. When the two species occur together, *G. sturtianum* is found at the edge or in the drainage line or creek, while *G. australe* is found must further up the bank. The difference in seed hairs probably also contributes to difference in colonizing ability between the two species. As the stiff spreading hairs covering light-weight *G. australe* seed expand, the seed is forced out of the widely flaring capsule where it can be caught by the wind. In contrast, the heavier seed of *G. sturtianum* is covered by tightly appressed hairs and the capsule does not flair as widely. This is referred to as a 'salt-shaker' capsule. The seeds are released only when the capsule is jarred with sufficient force.

The two remaining species, *G. bickii* and *G. nelsonii*, are also common along roadsides within their more restrictive ranges. *Gossypium bickii* is found in a triangle roughly defined by Tanami (northwest NT), Camooweal (central western QLD), and Alice Springs (central NT). *Gossypium nelsonii* occurs in a narrow band stretching from the western MacDonnell Ranges (west of Alice Springs NT) to Cloncurry. *Gossypium bickii* has a seed very similar to that of *G. sturtianum* which theoretically limit its colonizing ability. Whether the roadside populations of *G. bickii* represent new populations that arose along roadsides or represent pre-existing populations that were transected by roads remains an open question.

With a seed similar to that of *G. australe*, *G. nelsonii* also appears to be expanding its range along roadsides. This seems most pronounced in the eastern Northern Territory and western Queensland. One hypothesis to emerge from our field observations is that the *G. nelsonii* was originally found only in the Northern Territory and that the western Queensland populations

represent range extensions that occurred subsequent to European settlement and the construction of roads.

One consequence of this range expansion is that the genetic distinction between *G. australe* and *G. nelsonii* may be breaking down near Mt Isa. Around Alice Springs where the two species are presumably naturally sypatric, the two species occassionally occur in interdigitated populations but hybrids were not observed. At the eastern end of *G. nelsonii*'s range near Mt Isa, interdigitated populations are more common and hybridization is widespread. Our hypothesis suggests that around Alice Springs genetic or pheneological species isolating mechanisms limit gene flow between the two species. If *G. nelsonii* has spread eastward, it may have come into contact with an "unprotected" *G. australe* genotype (perhaps originating in the Selwyn Ranges north of Mt Isa) and extensive gene flow was the result. Of course this hypothesis can only validated with further research.

IMPLEMENTATION OF THE RESEARCH

The herbarium specimens and germplasm samples collected on this trip will be important components of future research projects of many kinds. The herbarium specimens collected will be housed at Australian National Herbarium, the Herbarium of the Northern Territory, The Queensland herbarium. These specimens represent a vital contribution of an understanding of Australian native flora and will be important source material for the botanists contributing to local and national Floras.

The germplasm collected provide represeutatives of populations from a region of Australia that was poorly represented in the CSIRO *Gossypium* germplasm collection. Although other gaps exist—most of Western Australia is poorly collected—we now have sufficient material to move ahead in two anticipated areas. The first is a study of morphological and genetic diversity across the full geographic range of *G. australe* and *G. nelsonii*. This will complement an existing study of the levels and patterns of morphological and genetic diversity within *G. sturtianum* throughout its continent-wide range. It will also provide a base-line for investigating the levels aud direct of gene flow between *G. australe* and *G. nelsonii* in the Mt Isa, a project for which we are currently seeking funding.