Genetic Resources Communication

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Abstract

Seventy-one accessions of *Centrosema pascuorum*, including cvv. Cavalcade and Bundey, were evaluated in replicated nursery rows at Katherine Research Station (14°28'S, 131°19'E) during the 1984-85 wet season. There was considerable variation in herbage and seed yield, flowering date, hard seed levels, seed size and morphological characters. In general, the most vigorous accessions were late-flowering lines collected in north-eastern Brazil. Brazilian accessions were the most diverse. Accessions from Central America were early flowering and had high levels of hard seed. Venezuelan accessions had small, mottled seeds, were early to mid-season in flowering date and had intermediate seed yields and intermediate hard seed levels. At least sixteen accessions warrant further evaluation in the semi-arid tropics in comparative trials with the commercial cultivars Cavalcade and Bundey.

Keywords

genetic resources, distribution, *Centrosema pascuorum*, tropical legumes, forage legumes

Introduction

Centrosema pascuorum is an annual, herbaceous, twining tropical pasture legume native to South and Central America. During 1967-1978, six accessions were evaluated at various times in plant introduction nurseries in northern Australia (Cameron and Mullaly 1969; O'Donnell and Smith 1975; Winter 1978; Burt and Williams 1979; Anning 1982). All six accessions were evaluated together at three sites from 1977-1980 (Clements *et al.* 1984). In that experiment, all accessions persisted (through seedling regeneration) for three years at Katherine, N.T., and several of them had higher herbage yields that *Stylosanthes hamata* cv. Verano. A breeding program using these six accessions commenced in 1976 with the aim of developing a cultivar suitable for dryland pastures in the higher rainfall areas of the Northern Territory (Clements *et al.* 1986). Additional plant collecting in tropical Latin America during 1978-83 provided many new accessions for evaluation (Schultze-Kraft 1985). This paper describes the characteristics and performance of all available accessions, including the new material and the best bred lines, in a nursery at Katherine in the 1984-85 growing season, classifies them into morphological/agronomic groups, and comments on their potential value to agriculture.

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Materials and methods

The experiment site was at Katherine Research Station (14°28'S, 131°19'E, average annual rainfall 950 mm). The soil was a Tippera clay loam (red earth) having a Northcote (1979) classification Gn 2.11. The site had been fertilised previously and used for nursery and pasture seed production activities, and no nutrient deficiencies were expected. However, an application of 50 kg superphosphate/ha was broadcast after the plants were established.

The 71 lines of *C. pascuorum* (Table 1) included 66 introduced accessions, one of which was the late-flowering cultivar Bundey (CPI 75115) released in late 1984. The other five accessions were bred lines, two of which (RJC1207 and RJC1208) had not been evaluated previously. The other three lines (RJC11/5, 12/4 and 2/2) were final selections in the program that led to the release of the cultivar Cavalcade (cross 2/2) in 1984 (Stockwell *et al.* 1986).

Seeds of all accessions were hand scarified and sown in peat pellets. Seedlings were inoculated with *Bradyrhizobium* strain CB1923 and transplanted to a cultivated seed bed in late December 1984. Each line was planted in a single row, containing 10 plants at 0.5 m intervals, in each of three replicates in a randomised block design. The rows were 4 m apart.

Weeds were controlled using chlorthal pre-emergence herbicide, applied at transplanting, interrow cultivation and hand weeding. Irrigation was used for establishment until early February, and two other irrigations, one in early March and one in late March, were necessary to avoid excessive plant moisture stress due to prolonged dry periods. Approximately 650 mm of rain fell during the four months after transplanting. This was very close to the long-term average for this period. The last effective rain (100 mm) fell between 14 and 18 April, resulting in an unusually favourable late wet season.

Measurements

Herbage yield

This was rated visually on six occasions. The first five ratings were made at approximately fortnightly intervals between 20th February and 17th April. The final yield rating was taken on 15th May. All ratings were made on a 1(low)-5(high) basis. On two occasions (19th March and 15th May) the ratings were calibrated against yield standards, by first rating and then cutting, drying and weighing twelve plots, which were planted within the experiment for this specific purpose and which covered the range of ratings.

Flowering and seed yield

Because *C. pascuorum* is an annual, particular attention was paid to the measurement of flowering behaviour, seed production and hardseededness.

The plots were observed for flowering every 1-3 days from 19th February when the first plants flowered, until 30th April. Flowering date was defined as the date on which the first flower was seen. Numbers of flowers per plot were rated in early, mid and late April with a final rating in mid-May. A scale of 1-5 was used (1 = 0 flowers, 2 = 1-50 flowers, 3 = 50-250 flowers, 4 = 250-1000 flowers, and 5 = >1000 flowers per plot). This information was complemented by measuring complete plot seed yield. To achieve this, all plant material was cut and removed in mid-July, and all seed was threshed. In late July, a vacuum cleaner was used to pick up the fallen seed from each plot. Sieving, winnowing and flotation techniques were used to clean the seed. Random samples of 100 seeds were taken to measure weight per 100 seeds. These samples were stored at room temperature and then used in mid-November to measure the percentage of hard seed. Seeds were placed on moist filter pads in petri dishes, in a constant 25°C environment for 6 days. Germinated seeds were counted and removed every two days and numbers of soft seeds (not germinated) and hard seeds were also counted on the final day. Numbers of seeds per row were calculated from seed yield and 100-seed weight.

General observations and morphological characteristics

Several other measurements were taken during the growing season to characterise the lines. Legume little leaf disease was rated in early March and mid-April. Again, a scale of 1-5 was used (1 = no disease present, 3 = 2 out of 10 plants affected and 5 = 5 or more out of 10 plants affected). Stolon rooting was observed in early April and was rated on a 1(nil)-5(profuse) scale. Leaflet length and width were measured in mid-February and mid-April, by selecting an average-sized leaf from each plot on each occasion and measuring the length and breadth of the terminal leaflet. Subsequently, data from the two sampling occasions were pooled. Thus the values presented below are means for six leaflets. The seed colour was also noted. A precise system of colour recording was not possible due to a general tendency of the seed to change to a browner colour with age. However, it was possible to classify the seed into three main groups, i.e. plain brown, plain green (often with one darkish spot) or mottled. A few accessions with darker coloration were noted.

An herbarium specimen of each accessions was prepared and deposited in the CSIRO Cunningham Laboratory Herbarium. The following characters were observed or measured on representative parts of these specimens: (a) ordered multistate characters: leaflet pubescence (upper and lower surfaces), 1-3 scale; bracteole pubescence, 1-3 scale; (b) numeric attributes, all in mm: leaflet length and width; stipule length; bracteole length and width; calyx length and width; and the lengths of the upper, middle and lower calyx teeth.

Data analysis

Agronomic data were subjected to analysis of variance and to correlation analysis. Pattern analysis of the morphological data and of some agronomic data was conducted using the TAXON package (Williams 1983). For this purpose, 22 characters were used. These were the disordered multistate character seed colour (two categories only, mottled *vs.* non-mottled seeds), the 13 characters derived from the herbarium specimens, 100 seed weights from other records and the following seven numeric characters from the field and laboratory measurements: herbage yield on 19th March and 15th May, stolen root score, flowering date, seed yield, number of seeds per row and percentage hardseededness.

Results and discussion

Herbage yield

There were significant positive correlations between visual ratings of herbage yield of accessions measured at six different times during the growing season (unpublished data), and also between yield estimates from calibrated ratings made in March and May (Figure 1). Even the earliest and latest visual ratings (February and May) were positively correlated ($r=0.43$; $P<0.001$). Although there were changes in the ranking of accessions with time, the estimates from the two calibrated ratings in March and May (Table 2) adequately describe the relative herbage yields of the accessions. In general, although correlations between herbage yield and flowering date were low, the highest-yielding lines were late-flowering accessions from Brazil. An exception was CPI 94279 which was the highest-yielding accession in March, and which flowered in late March but continued to grow vegetatively, perhaps because of its low seed production (Table 2). None of the late-flowering accessions outyielded 75115 (cv. Bundey) in May, whereas six accessions (all late-flowering except 94279) significantly outyielded cv. Cavalcade in March and ten accessions (all late-flowering except 94287) significantly outyielded Cavalcade in May.

Table 1. Identification, and details of the environment of origin of *Centrosema pascuorum* accessions.

CPI[1] or other Australian number	CIAT[2] number	Origin (Country, State)	Latitude	Longitude	Annual rainfall (mm)[3]	Number of dry months[4] per year
40060	5284, 5327	Brazil, Ceará	3°48'S	39°39'W	1300	6
40063	5285, 5373	Brazil, Ceará	3°45'S	39°47'W	1300	6
55697	5286, 5374	Brazil, Pernambuco	9°26'S	40°32'W	420	8
63454		Brazil, Ceará	5°06'S	38°25'W	740	7
65950	5287,5375	Ecuador, Guayas	2°38'S	80°25'W	350	8
74827	5288, 5320	Honduras	14°01'N	87°01'W	830	6
75115*	5289	Brazil, Paraiba (*cv. Bundey)	7°03'S	36°19'W	380	10
75116	5290	Brazil, Piaui	5°16'S	42°12'W	1370	5
83547	5196	Venezuala, Anzoategui	8°51'S	64°44'W	1220	5
83842	5176	Venezuala, Guarico	8°49'N	65°09'W	1210	5
83846	5293	Venezuala	-	-	-	-
84635	5288, 5320	Honduras	14°01'N	87°01'W	830	6
87893	5175	Venezuela, Guarico	8°41'N	65°29'W	1020	6
87894	5177	Venezuela, Anzoategui	9°04'N	64°19'W	1020	5
87895	5190	Venezuela, Guarico	9°06'N	67°28'W	1240	5
87896	5217	Venezuela, Anzoategui			-	-
87984	5171	Venezuela, Aragua	9°51'N	66°54'W	1120	5
87989	5187	Venezuela, Anzoategui	10°03'N	65°21'W	660	6
87990	5192	Venezuela, Guarico	8°34'N	67°35'W	1500	5
88459		El Salvador	13°50'N	88°50'W	880	6
91318		Mexico, Oaxaca	16°11'N	95°12'W	930	7
91349		Mexico, Oaxaca	16°32'N	95°10'W	930	7
92949		Brazil, Piauí	-	-	-	-
92960	5881	Brazil, Pernambuco	-	-	-	-
92961	5880	Braizl, Piauí	5°16'S	42°12'W	1370	5
93115		Brazil, Pernambuco	9°22'S	40°30'W	400	9
94271	468	Unknown	-	-	-	-
94272	5230	Brazil, Piauí	5°16'S	42°12'W	1370	5
97273	5385	Brazil, Ceará	3°28'S	39°49'W	840	7
94274	5386	Brazil, Ceará	3°46'S	40°18'W	800	7
94275	5387	Brazil, Ceará	3°45'S	39°58'W	650	8
94276	5504	Brazil, Sergipe	10°54'S	37°04'W	1550	5
94277	5506	Brazil, Sergipe	10°16'S	36°51'W	860	7
94278	5522	Brazil, Rio Grande do Norte	6°14'S	35°12'W	1160	5

94279	5524	Brazil, Rio Grande do Note	5°54'S	35°30'W	940	6
94280	5526	Brazil, Rio Grande do Note	6°06'S	35°44'W	500	8
94281	5528	Brazil, Rio Grande do Note	6°13'S	35°01'W	1200	4
94282	5532	Brazil, Paraíba	6°48'S	37°23'W	700	7
94283	5533	Brazil, Paraíba	6°58'S	37°09'W	710	8
94284	5536	Brazil, Paraíba	7°04'S	36°40'W	420	9
94285	5537	Brazil, Paraíba	7°06'S	36°17'W	370	10
94286	5540	Brazil, Paraíba	7°19'S	35°54'W	740	6
94287	5542	Brazil, Pernambuco	8°31'S	35°56'W	770	6
94288	5545	Brazil, Sergipe	11°06'S	37°22'W	1400	2
94289	5557	Brazil, Piauí	5°28'S	42°39'W	1370	6
94290	5643	Venezuela, Cojedes	9°40'N	68°32'W	1430	4
94291	5650	Venezuela, Cojedes	9°32'N	68°08'W	1310	4
94292	5651	Venezuela, Guarico	9°12'N	66°01'W	1020	6
94293	5653	Venezuela, Guarico	9°16'N	65°17'W	1150	5
94294	5655	Venezuela, Guarico	9°20'N	65°19'W	1190	5
94295	5659	Venezuela, Guarico	9°29'N	64°51'W	1210	6
94296	5660	Venezuela, Guarico	9°37'N	64°32'W	890	6
94297	5661	Venezuela, Anzoategui	9°49'N	64°33'W	970	6
94298	5687	Venezuela, Monagas	9°48'N	63°18'W	1220	4
94299	5708	Venezuela, Anzoategui	9°13'N	64°04'W	970	5
94300	5711	Venezuela, Anzoategui	9°16'N	54°22'W	900	5
95540		Brazil, Goias	-	-	-	-
95551		Brazil, Piauí	-	-	-	-
95557	5288, 5320, 5896	Honduras	14°01'N	87°01'W	830	6
95558		Brazil, Minas Gerais (?)	-	-	-	-
95559		Brazil, Piauí	-	-	-	-
99778	5831	Brazil, Goias	14°07'S	46°05'W	910	5
99779	5832	Brazil, Bahia	12°09'S	44°01'W	920	5
Q9855[5]	5291, 5376	Brazil, Pernambuco	7°23'S	37°11'W	460	9
Q10050[5]	5292	Brazil, Paraiba	7°22'S	36°30'W	390	9
CQ1576[6]		Brazil				
RX11/5[7]	5928	Q9855 x 55697(F_4)				
RX12/4[7]	5929	55697 x Q10050 (F_4)				
RJC 1207		75115 x Q9855 (F_2)				
RJC 1208		75115 x 55697 (F_2)				
Cavalcade[7]	5924	55697 x 40060				

[1] CPI = Commonwealth Plant Introduction
[2] CIAT = Centro Internacional deAGricultura Tropical
[3] Mean of the 4 nearest weather stations
[4] A dry month is one in which 60mm rainfall occurs
[5] Q = Queensland Department of Primary Industries
[6] CQ = CSIRO (Queensland)
[7] Clements, Winter and Thomson 1986

Stolon roots

Accessions which had high herbage yields also tended to have profuse stolon rooting (Table 2). All accessions had at least some stolon roots. With the exception of 87984 from Venezuela, the 12 lines with the best stolon root development (*i.e.* scores of 4.0 or higher) were all collected in north-eastern Brazil.

Resistance to legume little leaf disease

There were no significant differences between accessions in expression of legume little leaf disease (mean rating 1.6; data not presented).

There were significant differences in plot uniformity (data not presented) which were correlated with herbage yield (*i.e.* uniform plots tended to be high yielding). This variation presumably included an effect due to uneven establishment as well as an effect due to genetic variability within accessions.

Flowering and seeding

Flowering date ranged from 20th February to 5th May. The earliest accessions flowered 2-3 weeks earlier than any accession available previously (Clements *et al.* 1986). They also tended to have the highest percentages of hard seeds. The six accessions from Central America were all early flowering, and all of them except 88459 had high levels of hard seeds (69-94%). Accessions which flowered after the end of March (*e.g.* 75115 - cv. Bundey) had low seed yields (Figure 2), presumably due to drought stress, despite the rain which fell during 14-18 April. This led to a negative correlation ($r = -0.45$; $P < 0.001$) between flowering date and seed yield, as observed previously in a smaller set of accessions and crosses (Clements *et al.* 1986). Scores of flower production (data not presented) were virtually useless as a guide to seed yield, although the correlation between these characters was statistically significant ($r = 0.31$; $P < 0.01$). Flower production scores were more closely correlated with the number of seeds produced per row ($r = 0.48$; $P < 0.001$) although the relationship was still poor. These poor relationships may reflect the failure of many flowers to set seed due to moisture stress at critical times. The cultivar Cavalcade had the highest flower production score.

Although all seed was harvested in a similar manner, there was a range in hardseededness of 13-94%. Early flowering accessions would have set seed during hotter weather, and this may have influenced the percentage of hard seeds, but it is clear that genetic differences also occurred between accessions flowering on similar dates.

Seed number per row was quite closely correlated with seed yield ($r = 0.82$; $P < 0.001$), but, at the upper end of the scale, there were some notable discrepancies caused by variation in 100-seed weight. The relatively small-seeded lines 94292, 94300 and 94294 had high seed numbers relative to their seed yields, while for the heavy-seeded lines 65950 and 95559 (and to a lesser extent 94289) the situation was reversed.

There was no consistent relationship between seed yield and seed size (100-seed weight). For example 65950, the only accession from Ecuador, had very large seeds and a high seed yield, in agreement with previous results for this accession (Clements *et al.* 1984, 1986). One large-seeded accession from north-eastern Brazil (95559) was also high-yielding, one (95558) was rather low-yielding and the remainder (94273, 94274, 94275 and 95551) were intermediate. Most of the 21 accessions from Venezuela had small, mottled seeds, were early to mid-season with respect to flowering date and had intermediate seed yields (200-400 g/row) and intermediate hard seed levels (30-65%). Exceptions were 83846 (larger seeds), three accessions which flowered in early April and a few lines with lower or higher seeds yields or with hard seed outside the intermediate range.

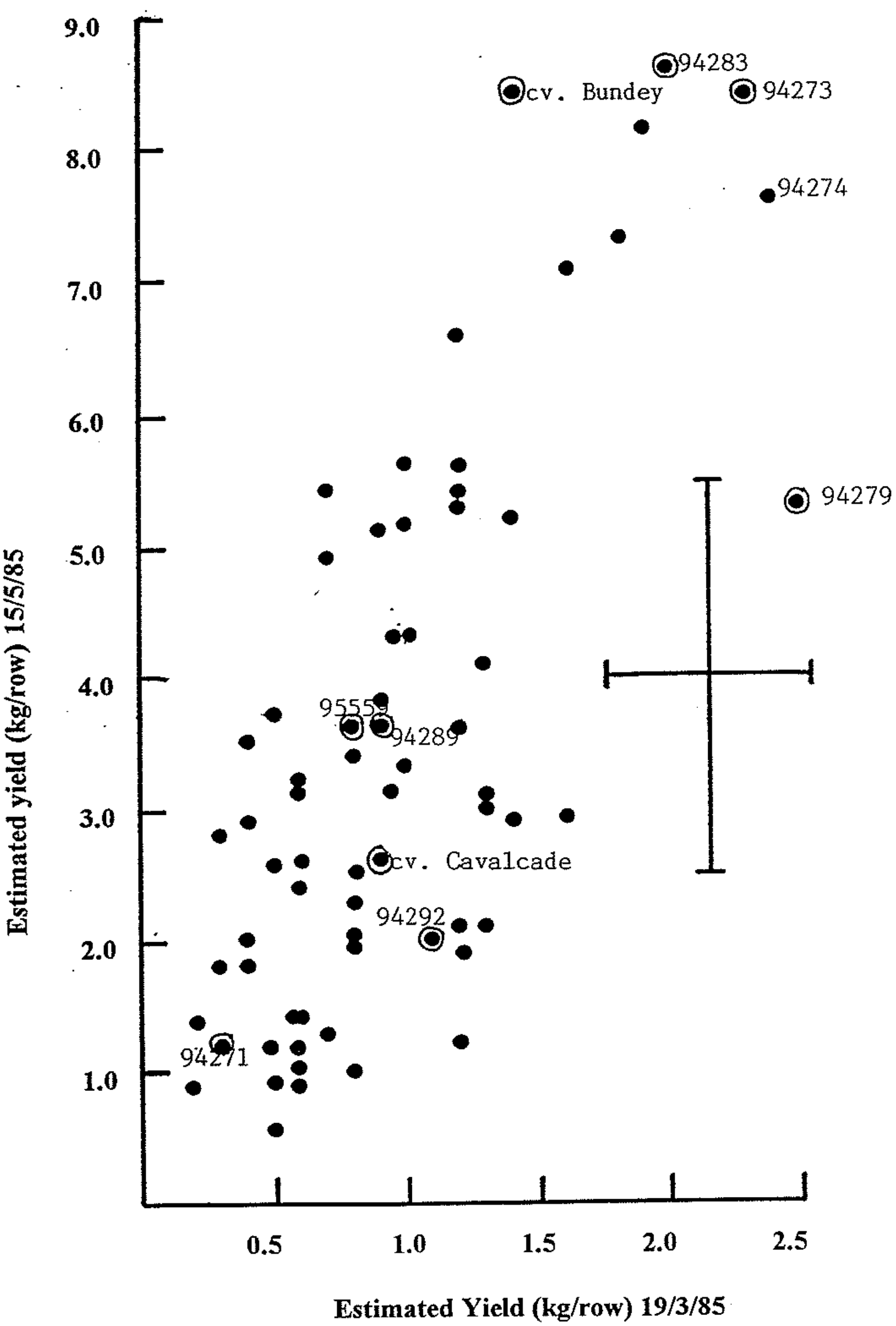

Figure 1. Relationship between estimated herbage yield of 71 accessions of *C. pascuorum* on two occasions during the 1984-85 growing season at Katherine, N.T. Some accessions mentioned in the text are identified. Correlations: $r=0.75$ ($P<0.001$); Spearman's rank correlation $r_s=0.64$ ($P<0.001$). Bars indicate least significant differences ($P=0.05$).

Table 2. Characteristics and performance of *Centrosema pascuorum* accessions grown at Katherine Research Station in 1984/85.

Accession	Herbage yield 19/3/85 (kg/row)	Herbage yield 15/5/85 (kg/row)	Stolon root score[1]	Flowering date (days after 31/12/84)	Seed yield (g/row)	Seed number ('000 row)	Soft viable seed (%)	Hard seed (%)	100-seed weight (g)	Seed colour[2]	Leaflet width (mm)	Leaflet length (mm)	M/A group
40060	0.8	2.5	3.2	104	113	8.4	26	52	1.35	G	12	106	B7
40063	1.2	1.9	4.8	91	368	27.3	14	81	1.35	G	27	78	B3
55697	0.6	3.2	2.5	87	53	2.9	45	34	1.78	B	15	121	B6
63454	0.4	3.5	3.2	96	278	24.0	19	48	1.16	B	8	117	B5
65950	1.3	2.1	2.7	67	708	28.5	8	89	2.48	G	27	130	B4
74827	0.6	0.9	2.3	66	376	47.0	16	81	0.80	DB	12	96	A5
75115*	1.4	8.4	4.3	105	6	0.4	17	64	1.70	B	16	136	B5
75116	0.4	1.8	2.3	97	168	9.9	20	57	1.70	G	10	114	B6
83547	0.6	2.6	2.7	83	272	34.0	23	49	0.80	M	10	96	A4
83842	0.6	1.4	2.7	80	206	24.8	20	63	0.83	M	10	115	A3
83846	0.8	1.0	3.0	74	218	13.1	28	54	1.66	M	11	111	A4
84635	0.2	0.9	2.0	67	301	19.9	15	80	1.51	DB	13	94	A5
87893	0.6	2.4	2.2	73	362	45.8	14	53	0.79	M	10	111	A2
87894	1.3	4.1	3.0	76	317	40.1	26	47	0.79	M	11	121	A4
87895	1.3	3.1	2.7	85	241	30.9	26	54	0.78	M	11	117	A4
87896	.04	2.0	1.7	98	51	7.7	13	28	0.66	M	10	91	A4
87984	1.2	5.3	4.0	84	179	25.6	14	16	0.70	M	32	73	A1
87989	1.6	2.9	2.3	75	318	40.8	32	51	0.78	M	12	91	A2
87990	0.3	1.8	2.3	95	154	17.3	16	60	0.89	M	10	90	A3
88459	0.5	1.2	2.3	69	413	21.5	27	47	1.92	M	10	118	A3
91318	0.6	1.0	3.3	67	329	23.3	4	94	1.41	M	12	98	A3
91349	0.5	0.6	1.8	63	193	17.5	21	74	1.10	M	11	96	A3
92949	1.2	2.1	3.3	68	526	37.6	14	64	1.40	B	12	116	A5
92960	0.9	3.1	3.7	98	272	17.4	26	42	1.56	G	11	112	B5
92961	0.9	4.3	3.7	95	254	17.0	34	33	1.49	G	10	120	B5
93115	1.2	3.6	3.0	70	320	28.3	13	63	1.13	B	11	111	B4
94271	0.3	1.2	2.0	51	218	22.2	4	88	0.98	B	6	96	A5
94272	0.5	1.2	2.8	97	89	6.4	20	58	1.39	G	10	109	B6
94273	2.3	8.4	4.8	95	202	7.0	40	21	2.88	B	15	135	B1
94274	2.4	7.6	4.7	96	376	14.3	42	39	2.63	G	22	132	B1
94275	1.3	4.1	4.3	92	340	11.8	44	23	2.89	B	37	90	B2

94276	1.8	7.3	3.8	92	36	3.4	24	26	1.05	B	8	117	B5
94277	1.2	1.2	3.7	70	7	0.7	28	42	0.96	B	12	112	B7
94278	1.9	8.1	4.3	105	13	1.1	23	17	1.20	B	12	119	B3
94279	2.5	5.3	4.7	80	30	3.1	24	23	0.98	B	11	100	B5
94280	1.6	7.1	4.3	98	18	1.6	24	51	1.16	B	24	75	B5
94281	0.8	3.6	4.0	107	100	8.5	15	56	1.17	B	21	103	B7
94282	0.7	1.3	2.5	96	34	2.3	35	40	1.47	B	12	129	B6
94283	2.0	8.6	4.2	100	205	13.8	38	36	1.49	B	19	134	B1
94284	0.9	3.8	3.0	97	65	6.3	25	55	1.04	B	11	101	B5
94285	0.5	3.7	3.0	106	2	0.2	30	44	1.32	B	16	116	B7
94286	0.3	2.8	3.2	101	21	1.7	25	26	1.21	B	11	98	B7
94287	1.2	6.6	3.3	87	17	1.7	18	20	0.98	B	13	121	B5
94288	1.0	5.6	3.2	125	2	0.1	26	64	1.76	B	10	137	B5
94289	0.9	3.6	2.7	90	760	45.5	17	70	1.67	G	8	120	B4
94290	0.6	3.1	2.4	95	235	30.9	15	32	0.76	M	9	106	A4
94291	0.8	3.6	2.6	86	123	18.6	25	34	0.66	M	13	86	A2
94292	1.1	2.0	2.8	73	598	66.4	20	68	0.90	M	18	83	A3
94293	0.8	2.0	2.5	73	212	29.9	23	49	0.71	DM	13	104	A3
94294	0.8	2.3	2.8	82	410	54.7	17	61	0.75	DM	13	96	A3
94295	0.2	1.4	1.8	87	42	7.1	19	44	0.59	M	12	107	A4
94296	1.4	5.2	3.4	78	232	29.0	37	33	0.80	M	27	74	A1
94297	1.3	3.0	3.4	78	228	30.4	26	32	0.75	M	27	70	A1
94298	1.0	4.3	2.8	80	207	26.2	29	28	0.79	M	13	81	A4
94299	0.8	2.0	2.3	75	164	21.9	25	54	0.75	DM	7	86	A2
94300	1.4	2.9	3.4	67	481	60.9	22	63	0.79	M	10	116	A2
95540	0.7	4.9	2.5	111	38	3.5	20	46	1.09	B	29	76	B3
95551	0.9	5.1	3.0	88	242	12.2	37	13	1.99	B	35	105	B2
95557	0.5	0.9	1.9	69	291	18.3	18	69	1.59	DB	13	106	B7
95558	0.7	5.4	2.8	83	86	3.7	43	24	2.33	B	36	98	B2
95559	0.8	3.6	2.8	93	685	34.3	30	57	2.00	G	9	119	B4
99778	0.6	1.2	2.2	78	68	3.7	31	50	1.84	G	9	112	B6
99779	1.2	5.4	3.6	84	500	29.8	37	39	1.68	B	10	129	A5
Q9855	1.2	5.6	3.4	102	8	0.6	25	39	1.33	DB	13	140	B5
Q10050	0.5	2.6	2.3	100	26	1.7	24	61	1.55	G	14	142	B7
CQ1576	0.6	1.4	2.1	80	23	2.1	43	27	1.11	B	10	109	B6
RJC11/5	1.0	3.3	3.3	89	225	13.7	30	53	1.64	G	12	133	B6
RJC12/4	0.4	2.9	2.1	79	82	5.0	30	38	1.65	DB	11	127	B6
RJC1207	1.0	5.1	3.1	105	22	1.2	26	53	1.85	B	13	133	B5
RJC1208	0.8	3.4	2.8	97	30	2.0	30	20	1.51	B	13	131	B6
Cavalcade	0.9	2.6	2.8	82	122	6.9	25	59	1.77	G	11	124	B6
LSD (P=0.05)	0.8	3.0	1.0	8	275		16	25	0.5				

*cv. Bundey [1]Stolon root development scored on 1 (nil) - 5 (profuse) basis [2]G = green, B = Brown, D = dark, M = mottled

Leaflet shape

The measurements on leaflet length and width allowed identification of two extreme groups of accessions, based mainly on the length:width ratio, as follows:

accessions with broad-leaflets (length:width ratio <5; leaflet width >18mm)	accessions with very narrow leaflets (length:width ratio >12; leaflet width usually <10mm)
40063	63454
65950	94271
87984	94276
94275	94289
94280	94299
94281	95559
94292	99778
94296	99779
94297	
95540	
95551	
95558	

The distribution of leaflet length:width ratio was bimodal, with the broad-leaflet group forming a distinct subset. The separation of the very narrow-leaflet group was more arbitrary. Two-thirds of the accessions had a leaflet length:width ratio in the range 7-12. The accession with the narrowest leaflets, 94271, was also the earliest flowering (see below) and was one of the lines which diverged most from the relationship between flowering date and seed yield (Figure 2). Leaves with four or five leaflets were observed commonly in 83547 and less commonly in 65950 (the species normally has leaves with three leaflets).

Morphological/agronomic (M/A) groups

The accessions were classified into 12 M/A groups as shown in Table 2, and the main features of the 12 groups are summarised in Figure 3. The dendrogram was truncated at this point because it was at this level at which the last of the M/A groups with broad leaflets, a striking morphological feature, was created.

The separation which gave by far the greatest information gain was the primary splitting of the accessions into two super-groups. One (super-group A) mainly contained the Venezuelan and Central/North American accessions and the other (B) containing most accessions from Brazil, the single accession from Ecuador and the five bred lines. Only two of the 37 Brazilian accessions (92949 and 99779) were placed in super-group A and nearest neighbour analysis showed that they resembled most closely the accessions from Honduras.

The attributes that contributed most strongly to the separation of the super-groups were: seed mottling (Venezuelan accessions had mottled seeds), number of seeds per row (super-group A had more seeds) and flowering date (super-group A flowered earliest on average). As noted previously, the Venezuelan and Central/North American accessions (super-group A) were generally lower yielding.

Within super-group B, separation of M/A groups B1 and B2 from the remaining accessions was due mainly to their larger leaflets, bracteoles and calyces (including calyx teeth), their bigger seeds and, particularly in the case of group B1, superior herbage yield.

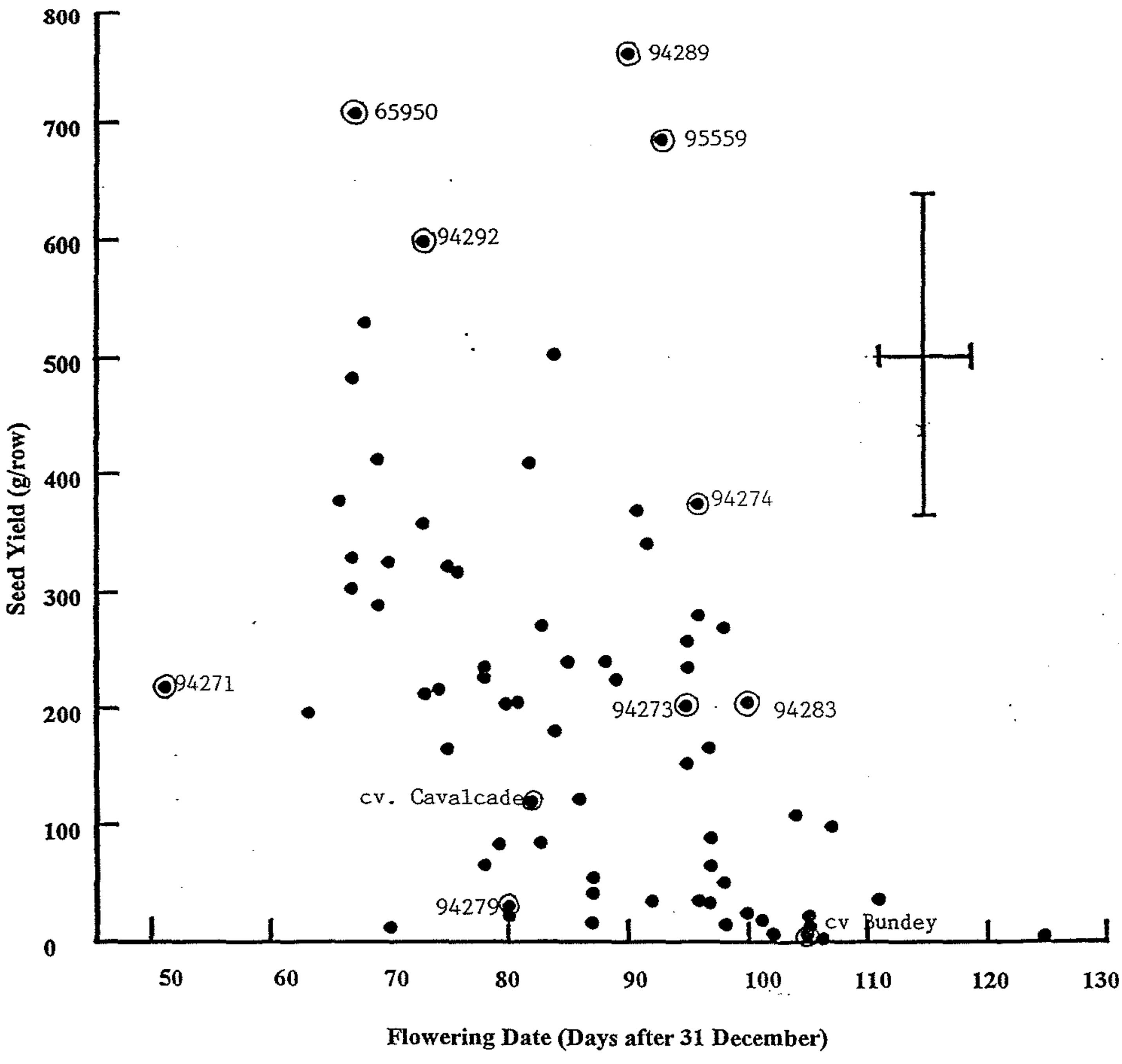

Figure 2. Relationship between seed yield and flowering date of 71 *C. pascuorum* accessions grown at Katherine, N.T., during the 1984-85 growing season. Some accessions mentioned in the text are identified. Correlation: r= -0.45 (P<0.001). Bars indicate least significant differences (P=0.05).

Agronomic implications

Because of the limited nature of this experiment (including the use of irrigation), caution is needed when one moves from broad generalisations to consider the detailed performance of individual accessions. However, the following accessions and M/A groups deserve special mention. M/A group A5 contained five accessions, four of which flowered 14-31 days earlier than cv. Cavalcade, and most of which had high levels of hardseededness but low herbage yields. CPI 94271 stood our as an exceptionally early-flowering accession with very high hard seed levels. Accession 94271 and the other seven lines (65950, 74827, 84635, 91318, 91349, 92949 and 94300) that flowered at least two weeks earlier than cv. Cavalcade should all be evaluated at a site south of Katherine to see if a new cultivar could be developed that would extend the range of adaptation of *C. pascuorum* to areas that have too short a wet season for cv. Cavalcade. Several accessions (Figure 1) produced high herbage yields, while others (Figure 2) gave high seed yields, but only 94274, 94273 and 94283 gave high yields of forage and relatively good yields of seed. However, these three lines flowered 13-18 days later than cv. Cavalcade and had lower hard seed levels, and these characteristics may limit their agricultural usefulness. They should be evaluated more widely in comparative trials with Cavalcade in the Top End of the Northern Territory and in other semi-arid tropical areas. Five accessions (94289, 94292, 94294, 94300 and 95559) with very high seed yields or seed numbers but only moderate herbage yields could be added to this list of promising material.

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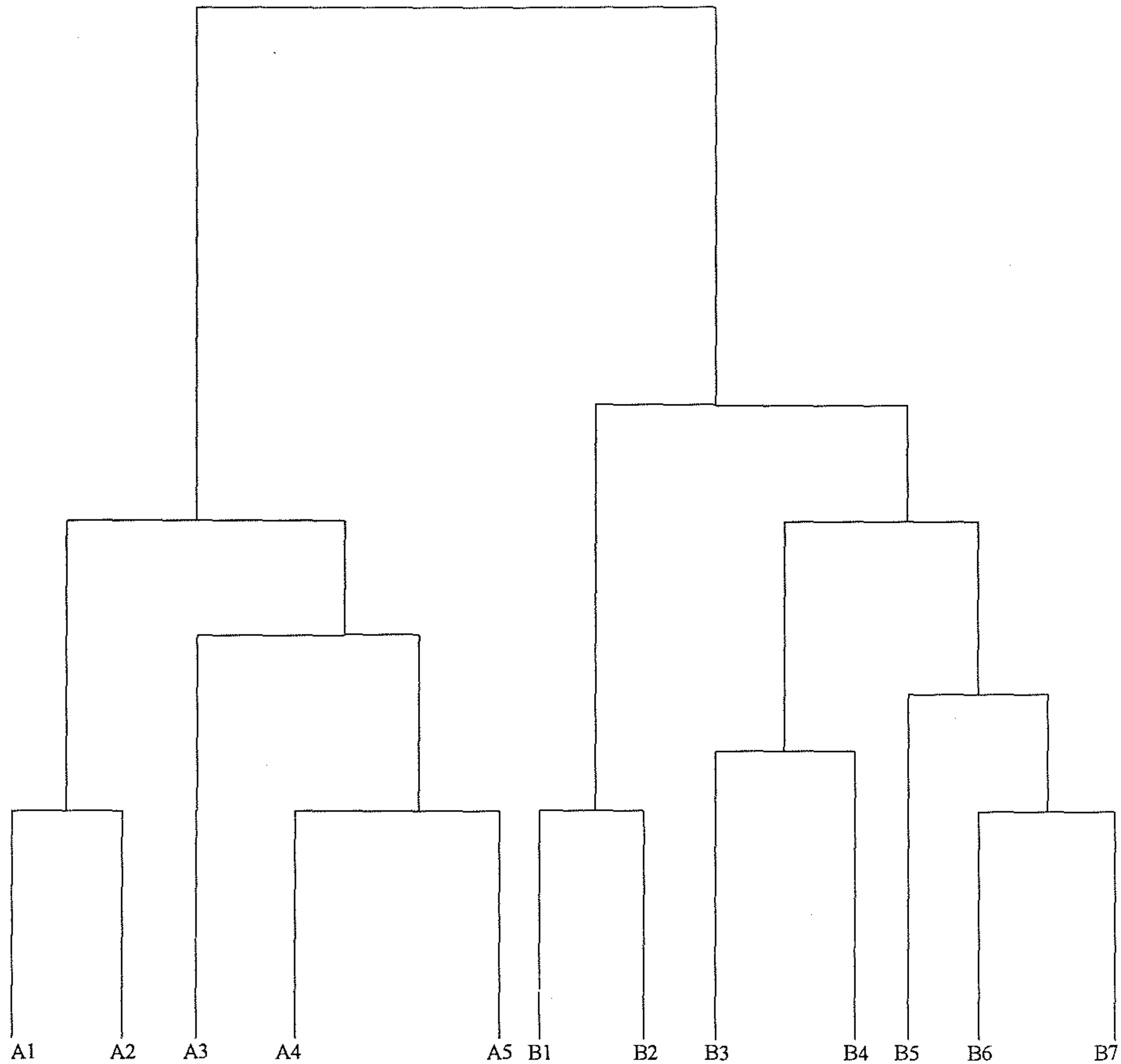

M/A Group	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7
No. of accessions	3	5	8	8	5	3	3	3	4	12	10	7
Seed colour1	M	M	M	M	P	P	P	P	P	P	P	P
100-seed weight	93	105	75	96	54	33	34	79	57	65	56	58
Leaflet width (mm)	19	7	7	9	7	11	27	11	9	9	9	7
Seed no 000/row	28	38	32	24	31	12	9	11	34	6	5	6
Herbage yield, May2	4.5	2.8	1.5	2.7	2.1	8.2	4.9	5.0	3.2	5.5	2.2	2.5
Flowering date 3	80	75	75	85	67	97	88	102	80	98	88	94
Hardseeded %	27	51	65	42	70	32	20	48	57	42	44	43

[1] M= mottled seed P=plain seed
[2] Yield as kg/row of DM
[3] Number of days after 31.12

Figure 3. Dendrogram and mean values for 8 attributes of 12 groups of *C. pascuorum*

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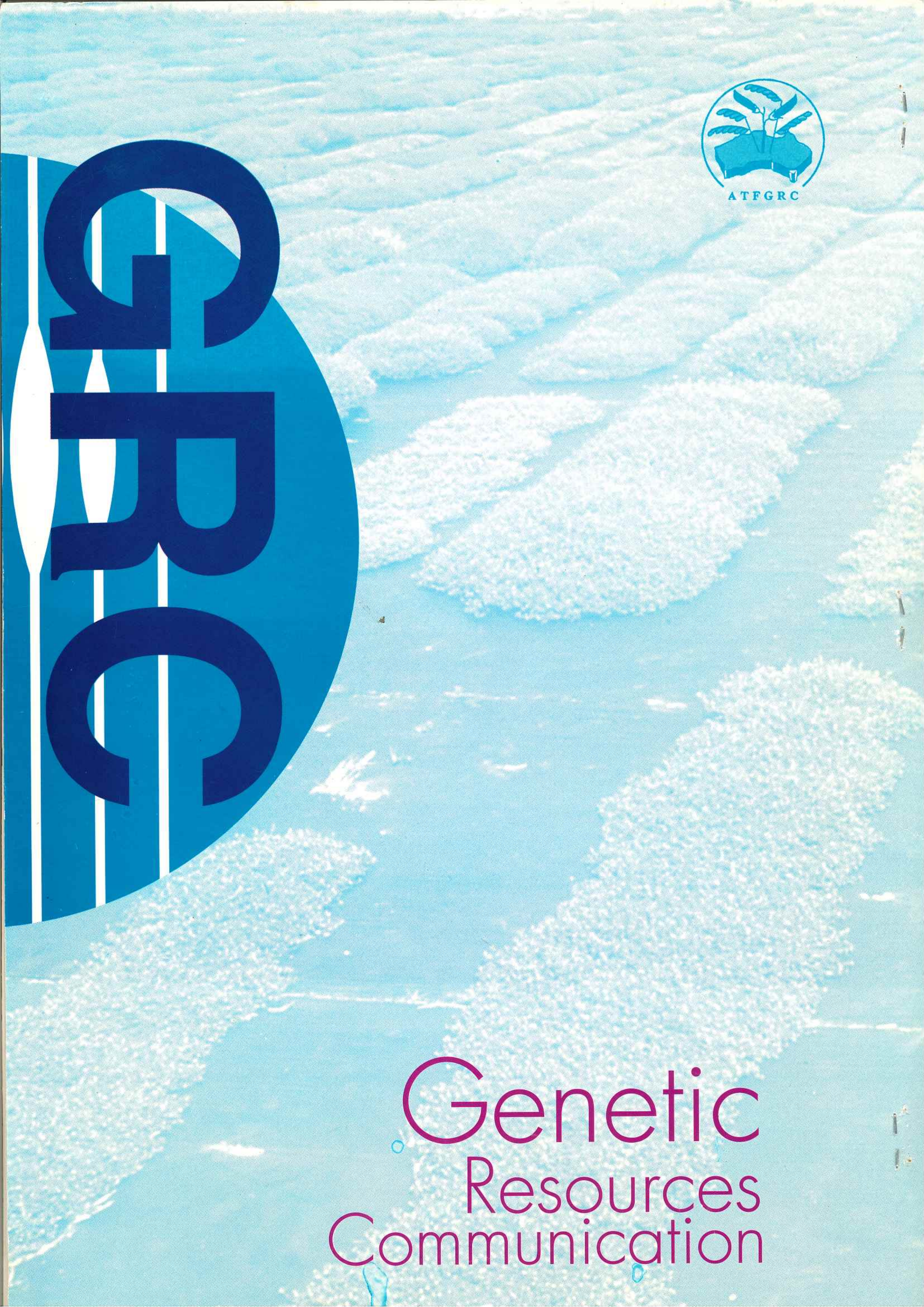

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