PRESIDENTIAL ADDRESS

A RECONNAISSANCE COLLECTION IN FOUR HOMOCLIMATES FOR HERBAGE PLANTS WITH POTENTIAL IN SEMI-ARID NORTH-EASTERN AUSTRALIA

J. P. EBERSOHN*

ABSTRACT

Four associations in western Queensland, comprising 120 million acres are considered to have potential for plant introduction. 1. Mulga (Acacia aneura) *scrub; 2. Eucalyptus open forest and* Triodia *formation; 3. the Ashy downs; and 4. the Channel formation on river and creek frontages.*

Seed of 175 plants was collected for trial from two areas in South America and two in Africa, which have similar homoclimates to midwestern Queensland. Of some seventy introduced pasture plants commercially available in Queensland only four broad-leaved species, viz. Phaseolus atropurpureus *cv. Siratro,* Medicago sativa *cv. Hunter River,* Medicago spp. (*annual medics and kapok bush*) (Aerva javanica) *and thirteen grasses, viz.* Cenchrus ciliaris (*seven cultivars*), *Cloncurry buffel grass* (C. pennisetiformis), *Birdwood grass* (C. setigerus), Panicum coloratum *var.* makarikariense, P. antidotale (*blue panic*), Urochloa mosambicensis *and* Sorghum almum *are suited to some habitats in semi-arid western Queensland.*

THE PRESENT SITUATION

Plant introduction and plant-breeding are recognised as perhaps the two most powerful means for agricultural and pastoral improvement. The semi-arid areas of Queensland are already benefiting greatly from herbage plants introduced primarily for the better watered areas in eastern Queensland. Cultivars of buffel grass (*Cenchrus ciliaris* and *C. pennisetiformis*) are widely grown, highly productive and persistent and the acreage under these versatile species is steadily increasing, both through deliberate sowings and by their ability to spread. Other grass species of promise are Makarikari grass (*Panicum coloratum* var. *makarikariense*) in less arid habits with fertile soil, *P. antidotale* (blue panic), *Urochloa mosambicensis*, *Cenchrus setigerus* (Birdwood grass) and *Sorghum almum*.

Oats, barley and forage and grain sorghums are grown in selected situations under dryland agriculture.

Among the broadleaved species, annual medics on heavy soils in the south where there is a fair winter component in the rainfall, kapok bush (*Aerva javanica*) on the skeletal soils of the Mt. Isa-Cloncurry mineral belt in the north-west and Siratro (*Phaseolus atropurpureus*) on water spreaders on nearly level land in the south-west have considerable potential. Hunter River lucerne (*Medicago sativa*) is commonly grown under irrigation. The impact of these introductions on the pastoral industries is however, small in relation to the vast semi-arid areas which now support native plant communities some of which have a potential for improvement through introduced species.

On the open downs indigenous grasses like Mitchell grass and other forbs will persist under grazing. In the case of scrubs and open forest many of the native grasses exist as understorey components and have a precarious hold after timber is cleared or after fire. Grasses such as *Neurachne*, *Danthonia* and *Digitaria* are poorly adapted to semi-intensive use, and decrease under grazing and during drought or floods. As a consequence such habitats are readily invaded by less useful and even harmful species like black spear grass (*Heteropogon contortus*), wire grasses (*Aristida spp.*), woody shrubs (*Eremophila*, *Dodonaea*), burrs (*Bassia spp.*), and other plants.

In eastern Queensland some seventy introduced temperate and tropical cultivars are available for pasture improvement. (See Table 1.) Animal production is already benefitting from pastures based in these new species, and can confidently be expected to increase greatly as these cultivars become more widely adopted.

* Department of Primary Industries, Brisbane, Queensland, 4000.

TABLE 1

Introduced Pasture Plants in Use in Eastern Queensland

Tribe	*Genus*	*Species*	*Cultivar**
PHASEOLEAE	*Dolichos*	*lablab*	Rongai
	Dolichos	*axillaris*	Archer
	Dolichos	*uniflorus*	Leichhardt
	Phaseolus	*lathyroides*	Murray
	Phaseolus	*atropurpureus*	Siratro
	Vigna	*marina*	Dalrymple
GLYCINEAE	*Glycine*	*javanica*	Tinaroo
			Cooper
			Clarence
	Centrosema	*pubescens*	"Centro"
	Clitoria	*ternatea*	"Pigeon Pea"
STYLOSANTHEAE	*Stylosanthes*	*humilis*	"Townsville lucerne"
	Stylosanthes	*guyanensis*	Schofield
	Stylosanthes	*guyanensis*	"Fine Stem Stylo"
TRIFOLIEAE	*Medicago*	*sativa*	Hunter River
			Siro Peruvian
	Medicago	*truncatula*	"Cyprus"
	Medicago	*littoralis*	Harbinger
	Trifolium	*repens*	Ladino
			Louisiana
			Greenleaf
DESMODIEAE	*Desmodium*	*intortum*	Silverleaf
	Desmodium	*uncinatum*	"Peuro"
DIODEAE	*Feuraria*	*phaseoloides*	Miles
LOTONONIDEAE	*Lotononis*	*bainesii*	"Peruvian"
MIMOSEAE	*Leucaena*	*leucocephala*	"Kapok bush"
ACANTHACEAE‡	*Aerva*	*javanica*	"Common Guinea"
PANICEAE	*Panicum*	*maximum*	Hamil
			"Sabi"
			Gatton
			"Coloniao"
	P.maximum var.	*trichoglume*	Petrie
	Panicum	*antidotale*	"Blue Panic"
	P.coloratum var.	*makarikariense*	Bambatsi
			Pollock
			Burnett

Tribe†	*Genus*	*Species*	*Cultivar**
PANICEAE (contd.)	*Cenchrus*	*ciliaris*	Gayndah
			American
			Biloela
			Molopo
			Lawes
			Boorara
			Tarewinnabar
			Nunbank
			West Australia
	Cenchrus	*pennisetiformis*	Cloncurry Buffel
	Cenchrus	*setigerus*	"Birdwood" grass
	Paspalum	*dilatatum*	"Common Paspalum"
	Paspalum	*notatum*	"Bahia grass"
	Paspalum	*plicatulum*	Rodd's Bay
	P.plicatulum var.	*glabrum*	Hartley
	Paspalum	*commersonii*	Paltridge
	Pennisetum	*clandestinum*	"Kikuyu"
	Pennisetum	*purpureum*	Capricorn
			Tamworth
			Ingrid, Pearl
	Setaria	*sphacelata*	Nandi
			Kazungula
	Brachiaria	*mutica*	"Para"
	Brachiaria	*decumbens*	
	Brachiaria	*ruziziensis*	
	Digitaria	*decumbens*	Pangola
	Urochloa	*mosambicensis*	
CHLORIDEAE	*Chloris*	*gayana*	Pioneer
			Katambora
			Callide
			Samford
	Melinis	*minutiflora*	Molasses
ANDROPOGONEAE	*Dichanthium*	*aristatum*	"Angleton grass"
	Sorghum	*almum*	Crooble
	S.halepense x *S.*	*roxburghii*	Krish
FESTUCEAE	*Festuca*	*arundinacea*	Kentucky, Demeter
	Lolium	*perenne*	Perennial rye grass
	Lolium	*multiflorum*	Italian rye grass
PHALARIDEAE	*Phalaris*	*tuberosa*	Phalaris

* Cultivar names according to Australian Herbage Plant Register, C.S.I.R.O. Division of Plant Industry, Canberra, A.C.T., 1967 et. seq.
† Tribes according to Hutchinson (1960).
‡ Family.

The question arises whether the few cultivars showing promise in some habitats of western Queensland exhaust the possibilities among introduced pasture plants for the semi-arid inland. The desirability of broadacre destruction of low-value shrubs in semi-arid areas and reseeding of grasses is questionable, since desiccation is severe and winds cut newly germinated plants at the surface. Marriott (1955) questions the permanence of plant introduction without compensating for the greater drain on plant nutrients removed from the soil by gregarious introduced cultivars.

Hartly (1960) cautioned against optimism on the future of introduced plants in the Australian arid zone. He maintained that ready establishment of overseas grasses within the existing vegetation would be difficult since the present grass flora is in equilibrium with the climate. Winkworth (1967) infers from recent studies in central Australia that the arid spinifex grassland is a stable edaphic climax.

On the other hand, Blake (1938) maintained that throughout Queensland the vegetation is of such unstable nature that it is frequently difficult to distinguish seral from climax communities. Davies *et al.* (1938) expressed the view that some components of the semi-arid Mitchell grassland community can and are migrating when the environment allows it in cyclic phases. Crocker and Wood (1947) claimed that the present plant communities in Australia are relatively young and that the potential environment of individual species overlap the actual environment.

A great measure of success has already been obtained with the introduction of pasture species into western Queensland (Wilson, 1961; Cull, 1964; Ebersohn and Lucas, 1965), in central-western Queensland (Edye, Humphreys, Henzell and Teakle, 1964; Purcell, 1964, 1965), and in north-western Queensland (Marriott, 1955). This demonstrates that gaps exist in different habitats, which can possibly be exploited through plant introduction. Such vacuums are regarded as a consequence of episodic climate crises and/or biotic agencies such as grazing, fire, timber clearing, cultivation, road construction, floods, and abandoned cultivations.

Plant introduction aimed at such "open" habitats in unstable communities could be highly rewarding. Species requirements will have to be met for soil type, drainage, soil fertility, radiation, temperature, length of growing season and moisture and for rhizobia in the case of legumes.

THE SEARCH FOR SPECIES

Homoclimates are areas with similar agricultural potential particularly with regards to the amount of rainfall, the season of precipitation and the temperatures of the coldest and warmest months (Meigs, 1951). The following symbols are used to classify arid homoclimates.

TABLE 2

Plant/Environmental Factors

Moisture	Season of Precipitation	Mean Monthly Temp. (°C)	(°F)
A = Arid (rainfall inadequate for crop production)	a = not defined	0 = 0	= 32
		1 = 0-10	= 32-50
S = Semi-arid (rainfall sufficient for certain types of crops)	b = summer	2 = 10-20	= 50-68
		3 = 20-30	= 68-86
	c = winter	4 = 30-40	= 86-104

In spite of his earlier caution against optimism, Hartley (1960) lists a number of world arid and semi-arid homoclimates from where useful plants may be introduced into Australia. These areas are situated in the following countries, with Meig's symbols given in brackets:—

(i) The southern United States and northern Mexico (Ab 24; Sb 23; Sb 33; Sb 24;
(ii) Chile, Peru and western Argentina (Sb 23; Sb 33);
(iii) The eastern extremity of Brazil (Aa 33; Sa 23; Sa 33; Sb 33);

(iv) West Africa through to Somaliland (Sb 33);
(v) Most of Arabia (As 23; Sb 33);
(vi) West Pakistan to central India (Ab 24; Sb 24);
(vii) South-west Africa through the Kalahari (Sb 23; Sb 24); and
(viii) South-western Madagascar (Sb 33).

Areas of similar homoclimates in arid and semi-arid Australia are shown in Figure 1.

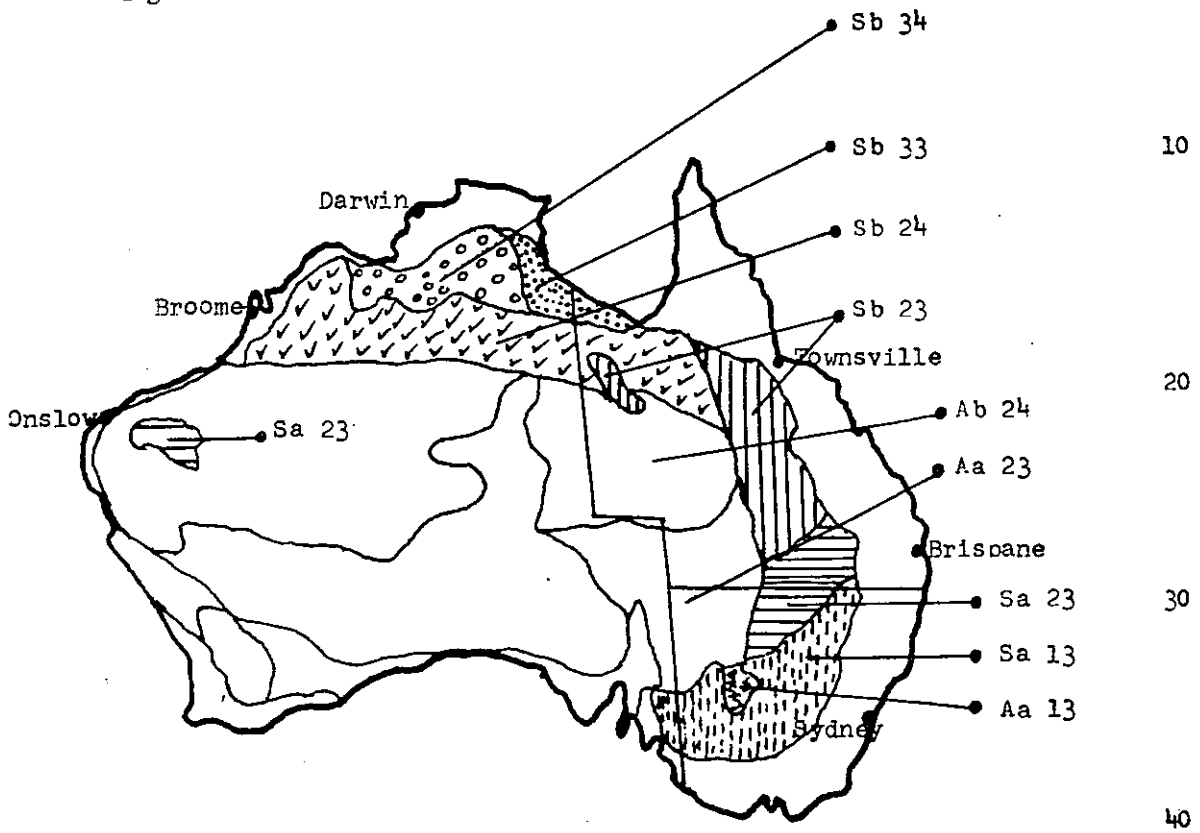

FIGURE 1

Distribution of Arid Homoclimates in Australia (after Peveril Meigs, 1951 UNESCO).

Arid Homoclimates

In north-eastern Australia, the symbol *As 23* is applied to the basin of the Cooper, Bulloo and Paroo rivers in south-west Queensland and adjoining areas in New South Wales and South Australia.

Ab 24 lies to the north of this and corresponds roughly with the basin of the Georgina, Hamilton and Diamantina rivers.

Semi-Arid Homoclimates

Sa 23 is the basin of the Warrego, Maranoa, Balonne, Moonie and Weir rivers in Queensland and the upper Darling in New South Wales.

Sb 23 comprises the Central and Mt. Isa Highlands approximately bounded by the towns of Tambo, Clermont, Charters Towers, Croydon, Cloncurry and Mt. Isa.

Sb 24 is the basin of the Norman, Saxby, Flinders, Cloncurry, Leichhardt and Gregory rivers, and continues on the Barkely Tableland and in the Northern Territory.

Sb 33 constitutes the delta of the rivers discharging into the Gulf of Carpentaria and continues into the Northern Territory as far as the Roper River.

Turning to Western Queensland, Figure 2 shows plant formations and major associations.

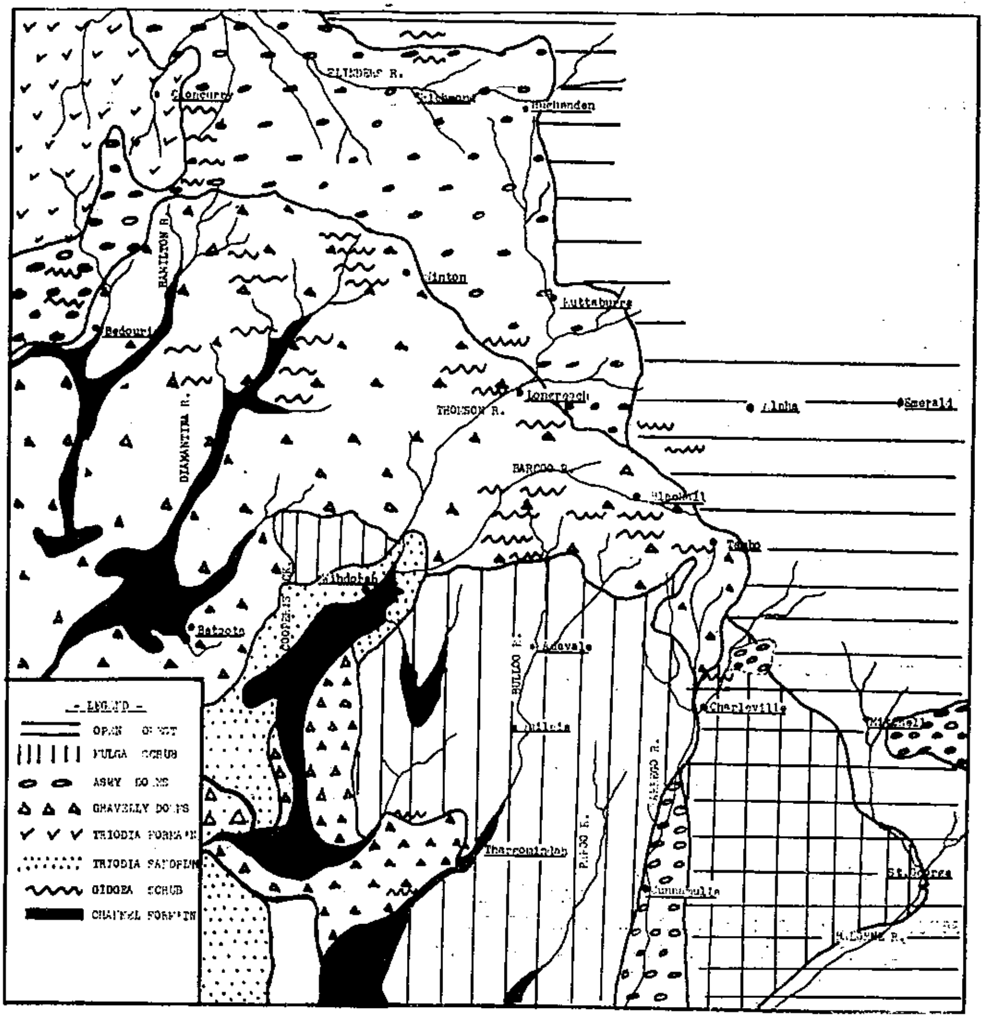

FIGURE 2

Western Queensland Plant Formations and Major Associations (after S. T. Blake (1938))

Four major soil-vegetation-land form types with a mean annual rainfall in excess of 10 inches and 120 million acres in Western Queensland were considered to have priority in plant introduction and evaluation. These are:

(i) Mulga (*Acacia aneura*) scrub (55 million acres) on light textured lateritic red earths with an abundance of fodder trees, adequate in protein but deficient in phosphorus and lacking in persistent, energy-rich grasses.

(ii) The ashy and to some extent the gravelly downs with grey brown soils of heavy texture where the Mitchell grass (*Astrebla spp.*) association (25 million acres) supports productive and persistent grasses with dry matter usually adequate but for extended periods deficient in protein-rich forage plants.

(iii) Open forest and *Triodia* formation on light soils overlying clays (35 million acres) with a dearth of both energy and protein-rich plants; and

(iv) River and creek frontage areas (5 million acres) on more fertile clay and clay-loam soil, where water relations are better as a result of run-on water. These are generally badly degraded and both grasses and protein and mineral-rich plants are required.

Due to the aridity of the reception area where long rainless periods are broken by infrequent rains, woody fodder shrubs which hold their leaves, and are not particularly sought after by stock are to be preferred.

Leguminous shrubs would be highly desirable. Among the herabceous plants, persistent perennial grasses with a medium to late flowering habit would be preferable. Big seeds are considered to bestow an advantage on emergence and establishment on self-sealing, rapid-drying soils with a dense surface crust common over large areas in western Queensland.

Annual grasses which establish rapidly are thought to have a place in initiating secondary succession in many bare and scalded areas and to provide forage from even light storms. Much attention has been given to and benefit obtained from annual legumes in eastern Australia. It is just possible that annual grasses may have a place in the semi-arid environment of western Queensland. Useful short-lived species could make a marked contribution to the feed situation during the infrequent periods when moisture and plant nutrients are in excess of the requirements of perennial species, where normally there would be bare ground or useless or even harmful plants.

During drier cycles of rainfall germination of plants will occur but due to the inevitable decrease in plant cover and insufficient and infrequent supporting rain, establishment and attainment of maturity and seed-setting seldom occurs. The seed supply in the soil thus becomes depleted. It would be advantageous to have an annual grass which establishes readily and which provides both a live plant cover, retards water run-off and at the same time reduces the erosive effect of raindrops on bare soil. By the next season such plants will bestow an additional benefit of providing dead plant material. This will assist to retard the flow of water and thus increase water penetration. As a consequence the habitat will be less arid. This in turn could assist the establishment of the annual grass and also that of the much slower perennial species. Such an annual grass should set large quantities of easily harvestable seed, possess a degree of hardseededness and seeds which could be easily sown from the air. Ideally it should be self-regenerating on both sandy and clay soils.

Habitats where annual grasses can be expected to initiate a sere and be a useful source of feed are the following:

(i) the south-western downs with both summer and winter rainfall where cool-season grasses are needed in addition to the native herbages.

(ii) the semi-arid central western downs where they could colonise the ground after drought-breaking rains and arrest aggregation of perennial grasses such as feathertop (*Aristida latifolia*) and white spear grass (*A. leptopoda*) which are harmful to sheep and whose seed causes "shive" in wool;

(iii) the upwind side of paddocks where sheep congregate, causing such areas to be devoid of plant cover, which gives rise to dust in the wool;

(iv) the interspace between spinifex (*Triodia spp.*) and other grasses like *Eragrostis* and *Aristida* in the open forest and *Triodia* formation;

(v) sandy levees and on degraded frontages which are either bare or which principally support poor grasses such as wiregrass (*Aristida browniana*) and Comet grass (*Perotis rara*) and ephemeral herbages like pigweed (*Portulaca oleracea*);

(vi) large tracts of mulga lands where scrub has been pulled for drought feeding and where the inherent seed supply of grasses is low or where it has been greatly reduced through drought; and

(vii) land formerly cropped, to initiate a sere to succeed to perennial, slower establishing grasses.

Since there are areas on other continents with similar plant environments to that of inland Queensland and the assumption is not without basis that vacuums already exist into which plants could be introduced, plant collection was undertaken in the early autumn and winter of 1966 in seven of Meigs's homoclimates. These were in northern Peru (As 33, Sb 33), and Chile (Aa 22), in north-eastern Brazil (Aa 33, Sa 23, Sa 33), in Ethiopia (Sb 33), and in Rhodesia (Sb 23, Sb 24).

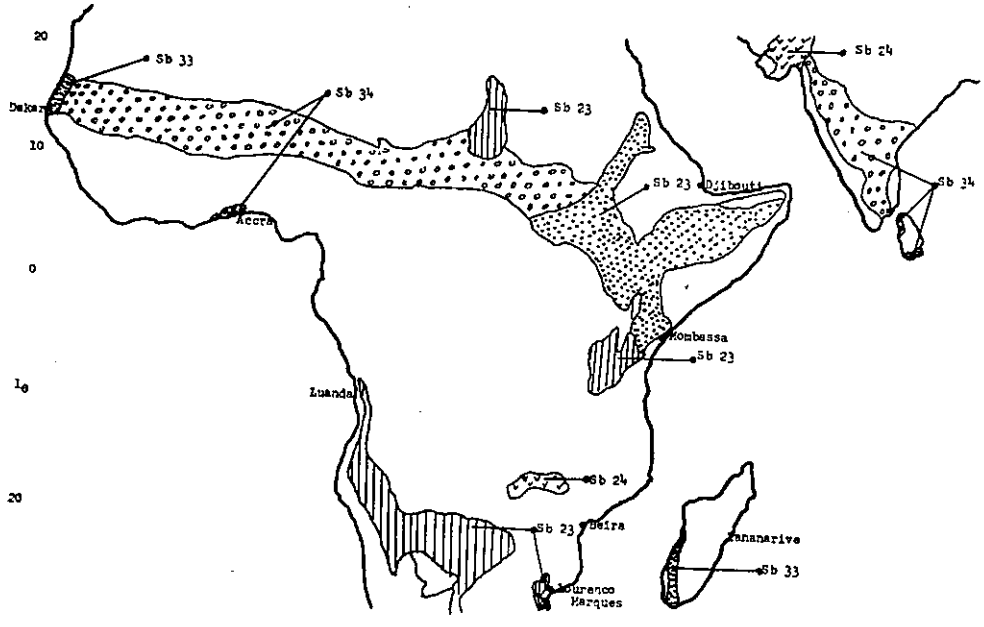

FIGURE 3

Distribution of Arid Homoclimates in Africa (after Pereeril Meigs, 1951 UNESCO).

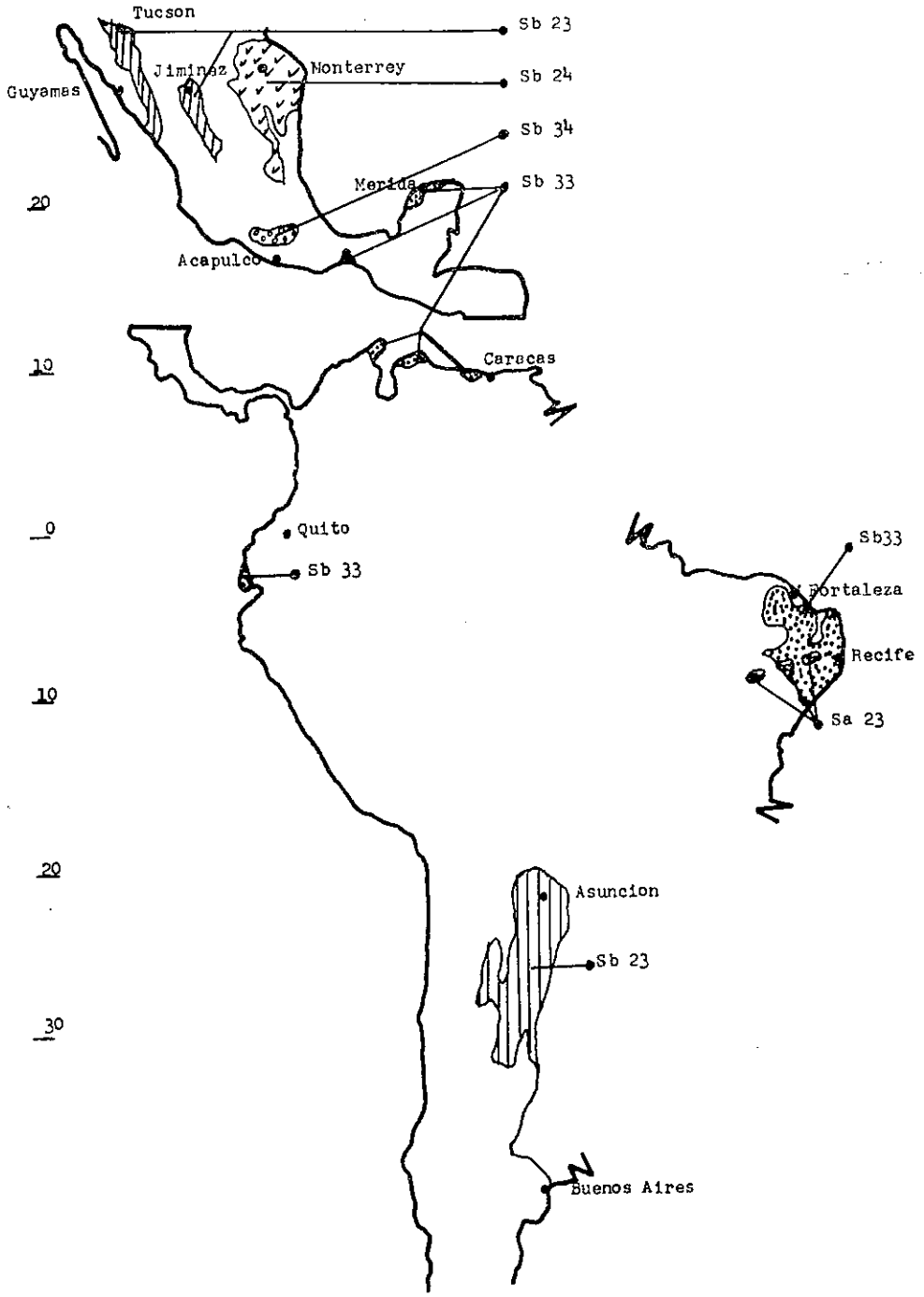

FIGURE 4
Distribution of Arid Homoclimates in Central & South America (after Peveril Meigs, 1951 UNESCO).

Three of the areas visited (see Figures 3 and 4) namely Ehtiopia, Peru and north-eastern Brazil are among the eight independent centres of origin of the world's most important cultivated plants (Vavilow 1949-50), or main centres of varietal polymorphism (Hartley and Williams, 1956).

TABLE 3

Tribal Affinities and Origin of Plants Introduced in 1966

		Peru & Chile	Brazil	Ethiopia	Rhodesia
DICOTYLEDONAE					
FABACEAE	Desmodieae	16	4	—	—
	Stylosantheae	1	11	—	—
	Phaseoleae	6	7	—	—
	Glycineae	3	4	—	—
	Galactieae	2	3	—	—
	Trifolieae	—	—	4	—
	Tephrosieae	1	0	1	1
	Aeschynomeneae	2	—	—	—
	Sesbanieae	1	—	—	—
	Indigofereae	1	—	—	—
	Loteae	—	1	—	—
	Coronilleae	—	—	—	1
CEASALPINIACEAE		1	12	—	1
MIMOSACEAE	Mimoseae	5	2	—	—
	Adenanthereae	1	—	—	—
CHENOPODIACEAE		6	—	1	—
MALVACEAE		1	1	—	—
RUBIACEAE		—	1	—	—
BORAGINACEAE		1	—	—	—
ANACARDIACEAE		1	—	—	—
CONVOLVULACEAE		1	—	—	—
No positive identification —		4	8	0	1
MONOCOTYLEDONAE					
	Paniceae	16	11	3	3
	Eragrosteae	2	4	3	6
	Poppophoreae	—	—	1	3
	Chlorideae	—	1	—	1
	Andropogoneae	—	2	—	—
TOTAL		72	72	13	18

The success of cultivars already introduced into Queensland influenced the selection of genera in the search for semi-arid species. Among the collected grasses, 33 belong to the tribe Paniceae (see Table 3). Hartley (1950) claims that the specific diversification (i.e. the percentage species in the total grass flora of a particular region) of the Paniceae is closely related to simple climatic factors such as winter temperature and summer rainfall.

Among the legumes of tropical origin, four are pre-eminently successful in eastern Queensland. They are the Glycineae, Desmodieae, Stylosantheae and Phaseloeae. In contradistinction to the grasses, Hartley (1950) did not think that climate influenced their distribution but rather that collections of legumes should be based on the distribution of agronomically important groups, i.e. further exploration within the regions of great species diversification. However, the four tribes already mentioned are represented by 53 specimens in the collection.

The collection made is not claimed to be either a homoclimatically or a genetically representative sample. It is in fact a cross-section of material available from a hurried and cursory reconnaissance survey, confined to a few sites in some readily accessible semi-arid regions. Since the collection was made principally in the low latitudes, and late in the growing season at that, the majority of plants can be expected to have a long growing season and to be late flowering. They will therefore be of limited use in areas where early frosts are likely to occur such as in the Darling basin (Sa 23).

Build-up of seed, initial evaluation and primary grouping of the material will be done at the Charleville Pastoral Laboratory. Duplicate plantings will be made elsewhere to insure against total loss or material from adverse climatic conditions or other hazards.

After nursery screening, regional testing will be undertaken for climatic and soil adaption, forage value, standover ability and other attributes at a number of field centres in south, central and north-western Queensland and the Cape York Peninsula.

Homoclimates in the southern United States and Mexico, western Argentina, Arabia, West Pakistan-India-Ceylon and Malagasy (Madagascar) still remain to be explored.

ACKNOWLEDGEMENTS

I am grateful to the Wool Production Research Committee of the Australian Wool Board, for generous travelling finance; the Director-General for Primary Industries, for the opportunity to make the collection; colleagues, who assisted in a number of ways; and to my numerous hosts, whose hospitality and patience is kindly remembered.

REFERENCES

BLAKE, S. T. (1938)—The plant communities of western Queensland and their relationships, with special reference to the grazing industry. *Proceedings of the Royal Society of Queensland.* **XIX**: 156.

CROCKER, R. L., and WOOD, J. G. (1947)—Some historical influences on the development of South Australian vegetation communities and their bearing on concepts and classification in ecology. *Transactions of the Royal Society of South Australia* **71**: 1.

CULL, J. K. (1964)—Tropical legumes in the south-west. *Queensland Agricultural Journal* **90**: 519.

DAVIES, J. G., SCOTT, D., and KENNEDY, J. F. (1938)—The yield and composition of a Mitchell grass pasture for a period of twelve months. *Journal of the Council for Scientific and Industrial Research*, Australia **11**: 127.

EBERSOHN, J. P., and LUCAS, P. (1965)—Trees and soil nutrients in western Queensland. *Queensland Journal of Agricultural and Animal Science* **22**: 431.

EDYE, L. A., HUMPHREYS, L. R., HENZELL, E., and TEAKLE, L. J. H. (1964)—Pasture investigations in the Yalleroi district of Central Queensland. *University of Queensland Department of Agriculture Papers* **1**: 153.

HARTLEY, W. (1960)—Plant introduction for the arid zone of Australia—its scope and limitations. *Proceedings Arid Zone Technical Conference* **1**: 1, C.S.I.R.O., Melbourne.

HARTLEY, W., and WILLIAMS, R. J. (1956)—Centres of distribution of cultivated pasture grasses and their significance for plant introduction. *Proceedings 7th International Grassland Congress* **190**.

HUTCHINSON, J. (1960)—The genera of flowering plants. 2nd Ed., Clarendon Press, Oxford.

MARRIOTT, S. (1955)—Buffel grass. *Journal of the Australian Institute of Agricultural Science* **21**: 277.

MEIGS, P. (1955)—World distribution of arid and semi-arid homoclimates in "Reviews of Research of Arid Zone Hydrology", pp. 203-210 (UNESCO/NS/AZ/37, 19 Avenue Kleber, Paris).

PURCELL, D. L. (1964)—Gidyea to grass in the central west. *Queensland Agricultural Journal* **90**: 548.

PURCELL, D. L. (1965)—Sowing pastures in Gidyea scrub. *Queensland Agricultural Journal* **91**: 338.

VAVILOV, N. I. (1951)—The origin, variation, immunity and breeding of cultivated plants. *Chronica Botanica* **13**: 1-364.

WILSON, R. G. (1961)—Sowing pastures in western Queensland. *Queensland Agricultural Journal* **87**: 214.

WINKWORTH, R. E. (1967)—The composition of several arid spinifex grasslands of central Australia in relation to rainfall, soil, water relations, and nutrients. *Australian Journal of Botany* **15**: 107.