PRESIDENTIAL ADDRESS

SELECTION OF CATTLE FOR TROPICAL ENVIRONMENTS

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Summary

Australia has a special obligation, in view of its large size and low human population density, to utilize its land resources fully. The main hope of widespread permanent settlement lies in the pastoral industry, and, for the climatically difficult areas of northern Australia, beef cattle production offers most promise.

Two types of tropical environment must be recognised — the hot humid and the hot dry — and selection of cattle having adaptational advantages appropriate to these, as well as to the intermediate climatic types, is necessary.

While research into characteristics of cattle most suitable for hot-humid climates has advanced significantly, progress has been slower in identifying the traits most desirable for very hot-dry regions. Walking ability and water economy as well as heat tolerance are obvious prerequisites for survival in such areas,. and an objective method of measuring these is discussed. Some behavioural patterns of Shorthorn cattle, observed during hot months on a shadeless tract of country on which cattle grazed five miles out from a single watering point, are also described.

The need is stressed for further, more intensive study where facilities for handling cattle are available. In pursuance of this, the establishment of a National Arid Zone Cattle Research Centre, available to visiting groups of scientists, is advocated.

I. INTRODUCTION

In the face of expansion in the world's human population, heavy responsibility rests with all countries to utilize their land resources fully and effectively. Production of food and clothing must keep pace with world population and this in itself is a continual challenge to agricultural scientists, as well as to those concerned with product distribution and the economies of world trade. But superimposed on this problem is the question of actual living space. Many parts of the world are overcrowded and, unless some curb is placed on their population increase, ideas of "spillover" of human population into other adjacent, less populated territories of other nations are always likely, however unsound agriculturally, or inappropriate nationally or sociologically.

The question of living space is particularly relevant for Australia, for not only has it one of the world's lowest population densities but it is close to countries in which the population pressure is among the world's highest.

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It is true that much of Australia is so difficult climatically that agricultural development of those regions seems well-nigh impossible. Nevertheless, the standard of living of Australians, generally, is high; and to avoid any suggestion of incomplete land utilization, it behoves us as a people not only to make every effort to intensify production in the favoured areas but, within the limits of sound ecological appraisal, to extend the area of permanent settlement into the marginal country bordering the deserts.

History has already shown that (aside from mining and secondary industry) cattle grazing offers the best hope for providing a core of permanent settlers throughout the climatically difficult, and especially the more remote, parts of northern Australia. Accordingly, the selection and adaptation of beef cattle for such areas is the main subject of this address.

As in other tropical climates, animal production in northern Australia is low. For meat production, the estimated efficiency probably falls within the range, quoted by McDowell (1966), of one-sixth to one-third of that which is acceptable in the cooler latitudes. Cox (quoted by McDowell 1966) has estimated that to produce a ton of beef, Latin America feeds four times as many cattle as the U.S.A. Those of our own cattle districts which are worst affected by parasites, heat or drought, probably rank about equal to Latin America.

But cost of production is also an important matter in such comparisons, and on the whole this is favourable to the Australian situation where large areas of land, little used for other forms of production, are available at low cost. Running expenses too are low, mainly due to the small labour force used in the Australian cattle industry.

Although Australia is the driest continent (37.6% of its land area is classified as arid and 30.5% semi-arid), it is also subjected to the problems of the hot-wet tropics in its coastal regions. Thus Griffith Taylor (1956) has likened the climate of Broome to that at the mouth of the Congo, Darwin to Bathurst in West Africa, and Townsville to Calcutta. With such a pronounced range of tropical climates, from the hot-wet tropical coast to the arid interior, corresponding differences are necessary in the adaptational characteristics of the cattle population. A detailed analysis of the North Australian cattle environments has already been made by the author (Yeates 1965), based on climographs of towns in the cattle areas for which long-term temperature and humidity records are available.

Simplifying the data previously presented, it is possible to define two extremes of climatic type, namely, the hot-humid and the hot-dry (Figure 1) with of course an intermediate zone of mixed type between them. Within each of these, climatic severity may be further characterised by the number of months each year in which mean monthly temperature exceeds 26.7°C (80°F), conditions that are certainly stressful to cattle. Interestingly, the limit of cattle tick *(Boophilus microplus)* infestation runs roughly mid-way between these two major climatic divisions (hot-humid and hot-dry) and this is another substantial reason for regarding the two zones as distinct.

II. THE HOT-HUMID AREAS

The picture in the hot-humid cattle regions up till a decade or' two ago, and still persisting to some degree, is one of poorly adapted Shorthorn herds suffering high annual losses of breeding females and calves; of live weight gains in the wet season followed by losses in the dry season, resulting in slow overall growth, and hence relatively old age at slaughter; anoestrus in lactating females which tend to calve only in alternate' years; debility from tick and buffalo fly infestations.

The solution of this problem of poorly adapted cattle in the hot-humid zone has received much attention in the last 20 years. Even before then, Brahmans were introduced to northern Queensland (Kelley 1943) and their improving influence on the factors listed above has been conclusively demonstrated ever since. Controlled hot-room tests (Yeates 1955) showed the desirability of cattle in hot-humid atmospheres having short coats. This supplemented the field findings of Bonsma (1949) in South Africa and has also been confirmed by field studies in Queensland (Dowling 1956; Turner and Schleger 1960). A better understanding of the physiology of coat shedding in Shorthorns, particularly in respect of photoperiod and nutrition, was obtained (Yeates 1955, 1958) while Riek (1962) showed the further advantage of short-coated individuals in regard to tick infestation.

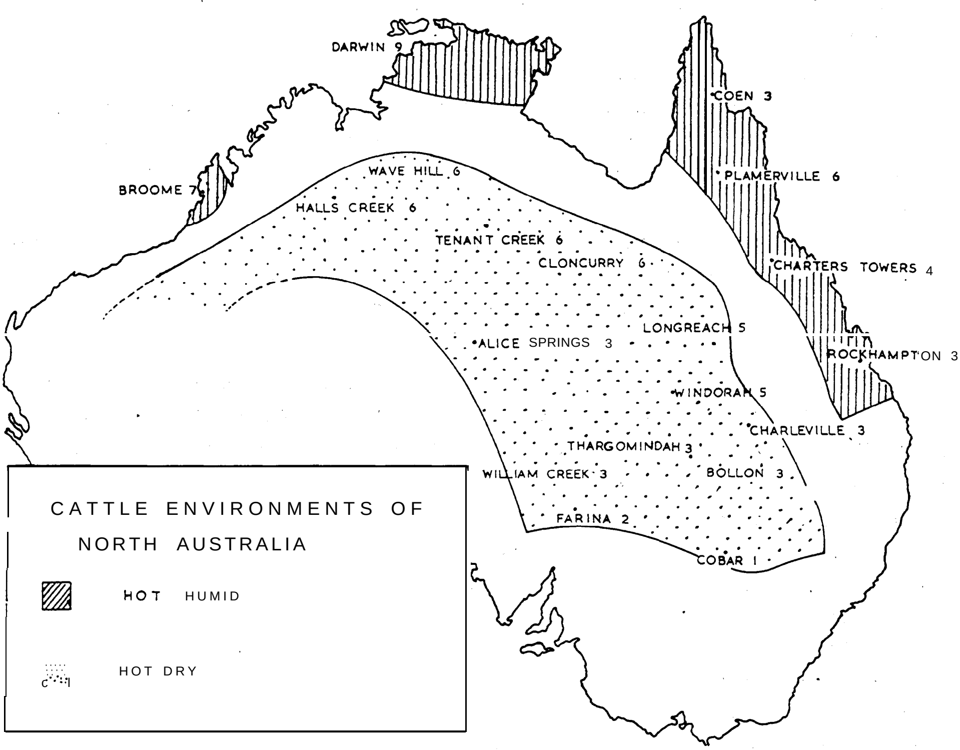

Fig. 1. — North Australian cattle areas classified according to whether all months of the year have a mean monthly relative humidity above (hot humid) or below (hot dry) 55%. The number of months with a mean monthly temperature above 26.7°C (80°F) is shown for each town. (Partly after Yeates 1965).

Turner and his colleagues at Rockhampton have shown that short-coated individuals also have growth advantages over and above those which can be explained purely by thermal insulation; that coat character has a high heritability estimate (0.63) and is a valuable aid to select (e.g. Turner 1962; Turner and Schleger 1960).

Skin thickness and characteristics of the hair fibres have also been studied (Dowling 1959, 1964), while Nay (1959) and his colleagues have provided information on sweat gland morphology which places Australian research well to the fore in this field. Finally, great advances are being made at the agronomic level, particularly with tropical legumes, while the Queensland Department of Primary Industries continues to pursue cattle breeding trials, and the Northern Territory Administration is exploring the possibilities of using other species of ***Bos*** (Banteng and Buffalo), e.g. on the sub-coastal plains near Darwin.

III. THE HOT-DRY AREAS

In the case of the more arid, hot-dry Australian tropics, research in cattle adaptation has been much less active. This may be a natural consequence of the low carrying capacity — costly research hardly seeming to be warranted; or it may" be due to the physical difficulties of inaccessibility and isolation. Alternatively, the relative inactivity may reflect an assumption, however erroneous, that the region needs no special study of cattle selection beyond that accorded "the tropics" generally.

It is argued here that the selection requirements of cattle for the two tropical climatic types are indeed different; and that increased expenditure on cattle research in the hot-dry interior can be justified (i) on socio-political grounds, (ii) in the interests of conservation of vegetation and soil, and (iii) on production potential.

The important bio-climatic consideratians relevant to arid zone cattle husbandry are the high dry-bulb temperature and low relative humidity, giving high evaporation; the intense solar radiation; the scarcity of shade; the infrequency of watering points; the sparseness of feed.

These points add up to a need for cattle which can walk long distances, withstand extreme fluctuations in hydration, possess an integument which is protective against both the long and the short wavelengths of solar radiation, and, of course, have a high overall heat tolerance.

Knowledge in many of these fields, as related specifically to cattle in hot-dry environments, is quite inadaquate. While important advances have been made in the comparative physiology of desert animals (Schmidt-Nielsen 1964) and in the water balance, kidney function (Macfarlane et *al.* 1961) and walking ability (Sharafeldin and Shafie 1965) of sheep. under conditions relevant to the present discussion, there are few critical studies indicating, least of all explaining, the superiority of particular breeds, strains or types of cattle under conditions of extreme aridity. For instance, the short-term benefits of evaporative cooling at a freely sweating skin surface or from moist surfaces of the upper respiratory tract, have not been reconciled with the animals' overall water economy in the longer term of, say, 48-72 h (a likely upper limit of water deprivation). Again though a short coat is desirable in the hot-wet environments, it cannot be said with certainty that the same character is necessary in the low humidity and high solar radiation of the arid tropics, where additional depth of coat might protect against direct radiation,, without unduly impeding evaporation. It is likely that a glossy coat (which is short) will also protect, by reflection; but the relative advantages of the two types have not been tested critically under severe conditions in the arid zone.

Many other questions, such as the relation between respiration rate and alkalosis, predisposing to renal calculi; salinity of drinking water; differences in heat production; water saving mechanisms; expression of oestrus; sperm quality; calving rate; lactation and calf survival, require study in the arid tropics.

IV. PROGRESS ACHIEVED

On the credit side, certain early work still stands. Light coloured hair reflects heat, and a dark pigmented skin protects against the erythema-producing u-v wavelengths (Riemerschmid and Elder 1945); hence, these two characters of the integument, most often present together in indigenous tropical cattle, should be selected. There is some evidence of superior performance, including walking ability, water economy, growth and reproduction of Africander (Bonsma 1949; Fourie, Grey and Louw 1964) and other Bos ***indicus*** type cattle (Wilson 1961) as compared with British breeds in Africa, but this work applies mostly to humid environments such as Messina, Transvaal, where the lowest mean monthly relative humidity exceeds 55 % (Joubert 1954) or Uganda which is also predominantly humid. In the rather more arid environment of Tanganyika, Payne (1965) and Payne and Hutchison (1963) have shown that water deprivation enhances nitrogen retention, and that water restriction is thus one way of "rationing" scarce forage on free range. They, and others, have also shown that ***Bos indicus*** cattle are more efficient than ***Bos taurus*** at reducing urine and faecal water output.

Our own studies have most recently been concentrated on objective field walking trials in moderately hot atmospheres and on observations of the walking and drinking behaviour of cattle on very hot dry shadeless plains with few and widely separated watering points.

In the measured walking trials, the technique involves walking cattle over known distances while tethered to a cross-bar mounted behind a vehicle which travels at constant speed of 4.3 k.p.h. ($2\frac{2}{3}$ m.p.h.). Pauses of approximately 10 minutes are made each hour to record rectal temperature, skin temperature and respiratory rate, while sweating rate is also estimated by the cobalt chloride technique (Schleger and Turner 1965) at the conclusion of each day's test. Up to nine animals, trained to lead in this way, have been used at one time.

So far, comparisons have been made between Santa Gertrudis and British breed cattle (Yeates and Murray 1966) and between steers, bulls, and heifers of a single breed (Murray and Yeates 1967). More recent trials just concluded (Yeates and Schmidt, unpublished data) have compared walking ability of groups of the same breed on different regimes of watering (twice daily v. once every second day) and on different planes of nutrition.

It is clear from this work that the method should be helpful in defining many of the characters required for difficult environments. Already we have found a distinct breed difference favouring Santa Gertrudis. Bulls appear to withstand exercise in the heat less well than steers and heifers of similar age. A tentative explanation is that bulls, having a higher percentage of muscle and a lower percentage of fat in their body composition, generate more heat during exercise. This is supported by the fact that bulls and steers reacted similarly during stationary exposure to heat.

Restriction of water to one drinking period every second day made little difference to walking ability (measured by rise in rectal temperature or in respiratory rate) compared with animals watered twice daily. This suggests that watering only once every second day might be sufficient for cattle in many hot environments, though the position is complicated by an interaction with food intake which was lowered in the water restricted group. In this connection, a clear-cut superiority was shown in another trial by poorly fed animals in average store condition over similar aged, better fed stock which were some 50-60 kg heavier. However, by change-over of diets it was found that the superiority in heat tolerance of "low plane" animals during exercise was at least partly an effect of reduced feed intake, this presumably being associated with a lower heat increment of feeding and so'lower total heat production.

Although the above findings indicate lines of progress in knowledge, the limitation is that the tests were conducted in an environment (Moree, N.S.W.) which, though quite hot in summer, falls far short of the climatic severity of the more arid tropics, to which this part of my address is directed and for which information is meagre.

Our work in the arid interior of Australia has so far been confined to observations on the grazing, walking, watering and associated habits of Shorthorn cattle on Alroy Downs, N.T. (P. J. Schmidt, unpublished data). Aerial photographs of this semi-arid area of the southern Barkly Tableland showed a number of relatively isolated bores (watering points), each surrounded in every direction by many miles of completely shadeless plains. This area was accordingly chosen for observations which have now been conducted over two summer periods of several weeks each, during which time heat stress was great.

Day-time temperatures (shade maxima) regularly reached 46°C and calves were often found dead or in a state of heat exhaustion,. abandoned by their mothers. Two patterns of behaviour were found among the cattle. One type which Schmidt has called the "walkers", and which included some calves, adhered to a characteristic pattern of walking directly out from water to their grazing about five miles (8 km) distant, each evening, as the temperature fell to about 35°C, not grazing or otherwise stopping on the way. There they grazed overnight and returned to water at about 9 o'clock each morning. Once back at water, they remained there in a group of some 700 or 800, all through the heat of the day. Each walking journey took about two hours, and well-defined tracks were made by their movement (Figure 2).

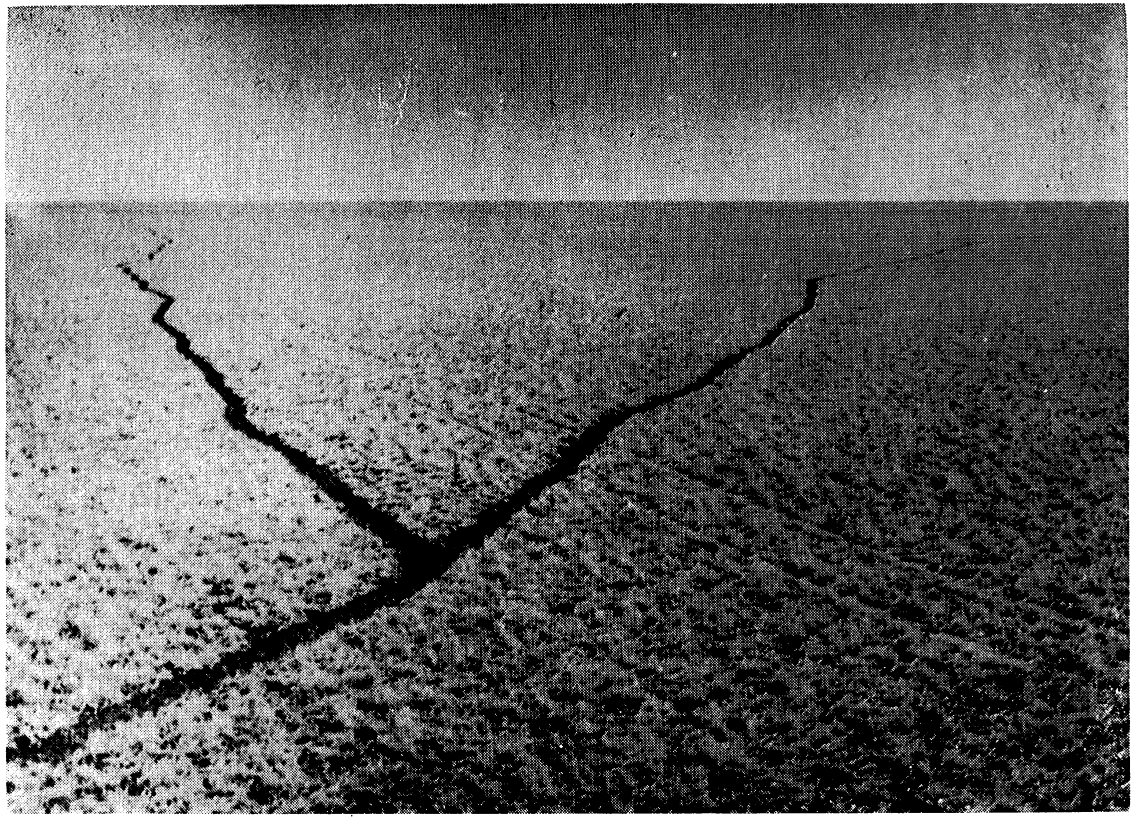

Fig. 2. — Cattle tracks radiating out to the less heavily grazed pastures four to five miles from a water point in the hot shadeless country on Alroy Downs, N.T. (Photo by courtesy of P. J. Schmidt).

The second type, the "non-walkers", seemed reluctant to go so far from water; instead, they fanned out in various directions, grazing and resting as they went, but always within about two miles of water. As the pastures nearer the water are the first to be eaten out, these cattle are probably the ones which lose condition first and die in the dry times. Though opportunity for individual identification was limited (e.g. distinctive colour pattern or horns) the indications were that membership 'of the two groups was constant-i.e. walkers remained walkers, and non-walkers were always non-walkers; however this requires verification. "Nursery" groups of calves were often observed, relatively near water, sometimes with one or two guard cows in attendance; but whether the calves belonged to "walker" or "non-walker" mothers, and whether the guard cows were the dams of calves present in the group, or indeed had any calves of their own, could not be determined.

Further work is needed to identify physiological characteristics associated with these particular behavioural patterns, and also to test the performance of other breeds. . In this latter connection, the Africander is a breed present in this country (albeit in small numbers), which is pre-eminent as a beef animal in the hot-dry regions of South Africa and which, therefore, deserves close attention.

V. CONCLUSION

The question of how and where this work should be followed up more intensively is a difficult one. The central point of Schmidt's observations on Alroy Downs was 27 miles (43 km) from the nearest cattle yards and 250 miles (400 km) from the nearest town of any Size (Mt. Isa). This emphasises the difficulty even of identifying and handling animals, let alone arranging transport of personnel, scientific equipment and stores.

As a solution, I suggest the, establishment of a National Arid Zone Cattle Research Centre., maintained with a view to investigating problems of the type mentioned in this address and to which visiting researchers from other centres could go periodically. Such a centre could also be of value for arid zone reseearch in general. . Certainly it should add to Australia's increasing prestige in research, particularly in a field — Arid Zone Ecology — in which other countries might look to this nation for leadership.

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