1976

Abydos - Woodstock Pastoral Research Station 1946 - 1976

Department of Agriculture and Food, Western Australia

ABYDOS — WOODSTOCK PASTORAL RESEARCH STATION

1946 — 1976

Western Australian Department of Agriculture

Abydos Homestead

SHORT HISTORY
ABYDOS-WOODSTOCK PASTORAL RESEARCH STATION

1946	Abydos and Woodstock leases were purchased from Dalgety and Co. Improvements were severely damaged by recent cyclones.
1947	Commercial rehabilitation commenced with repair of watering facilities and fences and purchase of cull sheep from Roy Hill and Sherlock stations.
1948	A committee consisting of members of C.S.I.R.O, Department of Agriculture and Institute of Agriculture did an 11 day inspection of the Pilbara region and reported on the suitability of Abydos-Woodstock for research purposes.
1951	Pasture experiments commenced following the appointment of H. Suijdendorp. A North West Pastoral Research Committee was formed in Perth at the same time.
1954	The first field day was held to show the effects of burning and deferred grazing.
1955 to 1960	Period of ecological studies on the euro by CSIRO Wildlife Division under leadership of E.H.M. Ealey leading to much improved control methods.
1956	First field day held at Mundabullangana Station
1957	Sheep fertility work commenced at Woodstock with an oestrus cycle trial.
1962	Time of lambing trial by H. Suijdendorp
1964	P.D. Morgan showed in large-scale comparisons the superior performance of offspring of locally selected rams.
1968	Wool Growth Measurements in the Pilbara by A.B. Williams and H. Suijdendorp.
1969	Cross breeding of sheep for meat production commenced using Dorset Horn and Border Leicester rams.
1972	Start of cattle diet selection observations.
1976	Closure of Abydos and Woodstock

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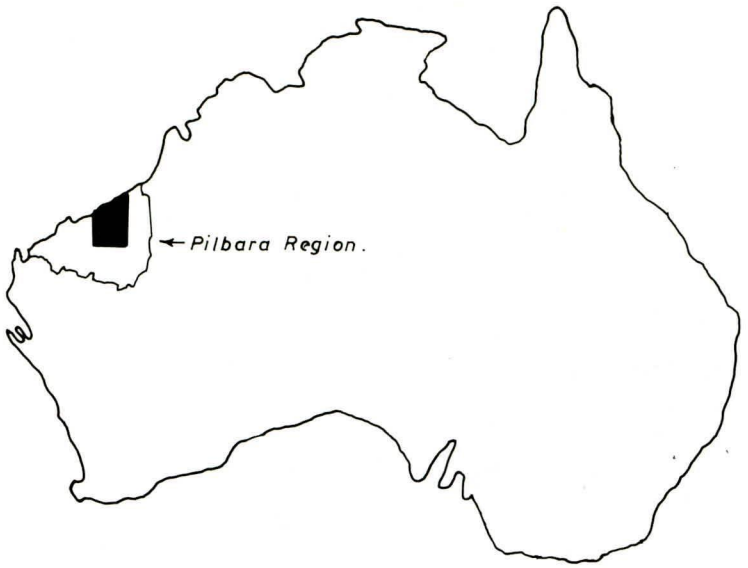
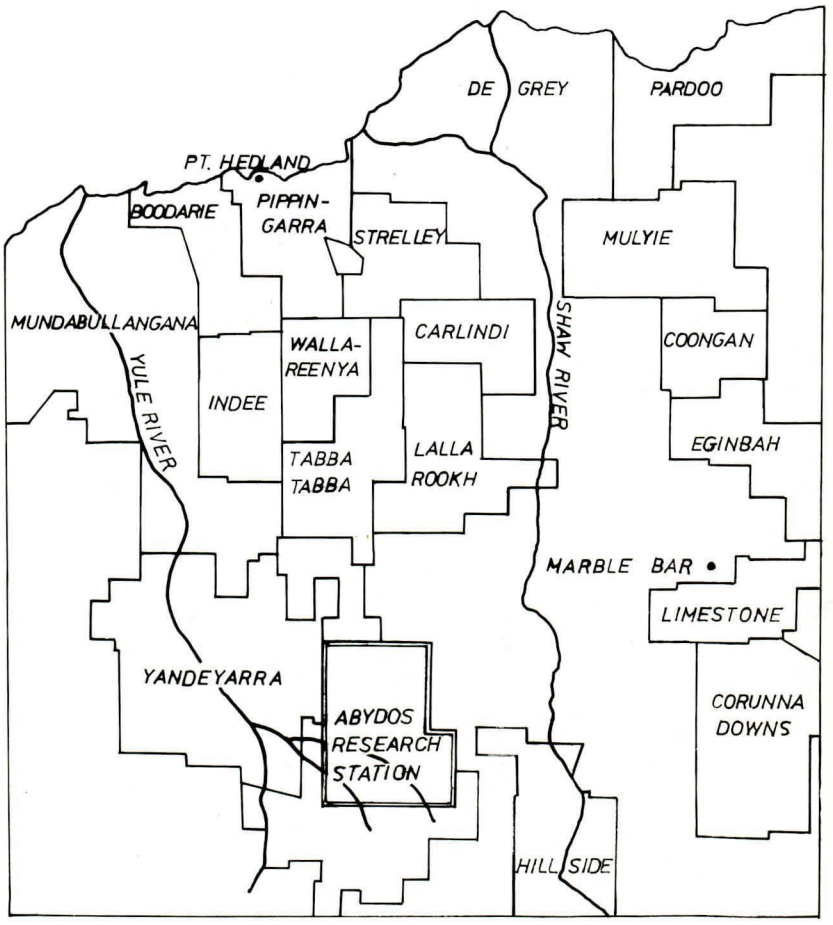
Fig. 1 *Location map of Abydos Research Station.*



Inset map



ABYDOS PASTORAL RESEARCH STATION - LOCATION AND DESCRIPTION

Abydos Pastoral Research Station was situated some 144km south-east from the town of Port Hedland in the Pilbara region of Western Australia. It consisted of the two old leases of Abydos and Woodstock stations of about 200 000 ha total.

The country is of granitic origin and much of it is rough and stony. Soils are mainly skeletal sands with some areas of deeper sandy soils. Vegetation is basically spinifex (mainly *Triodia pungens*) with small areas of better quality grasses associated with the deeper soils.

The area is semi-arid and typically has summer rainfall and dry winters. Total annual rainfall is only about 320mm of which nearly 75 per cent falls between the months of November and April. In some years total rainfall may be as low as 125mm.

Table 1 indicates the percentage chance of receiving specified amounts of rain (or more) in each month.

The average daily maximum temperature during summer is frequently 40 to 42°C and sometimes higher.

Table 1 - Percentage chance of receiving specified amounts of rain.

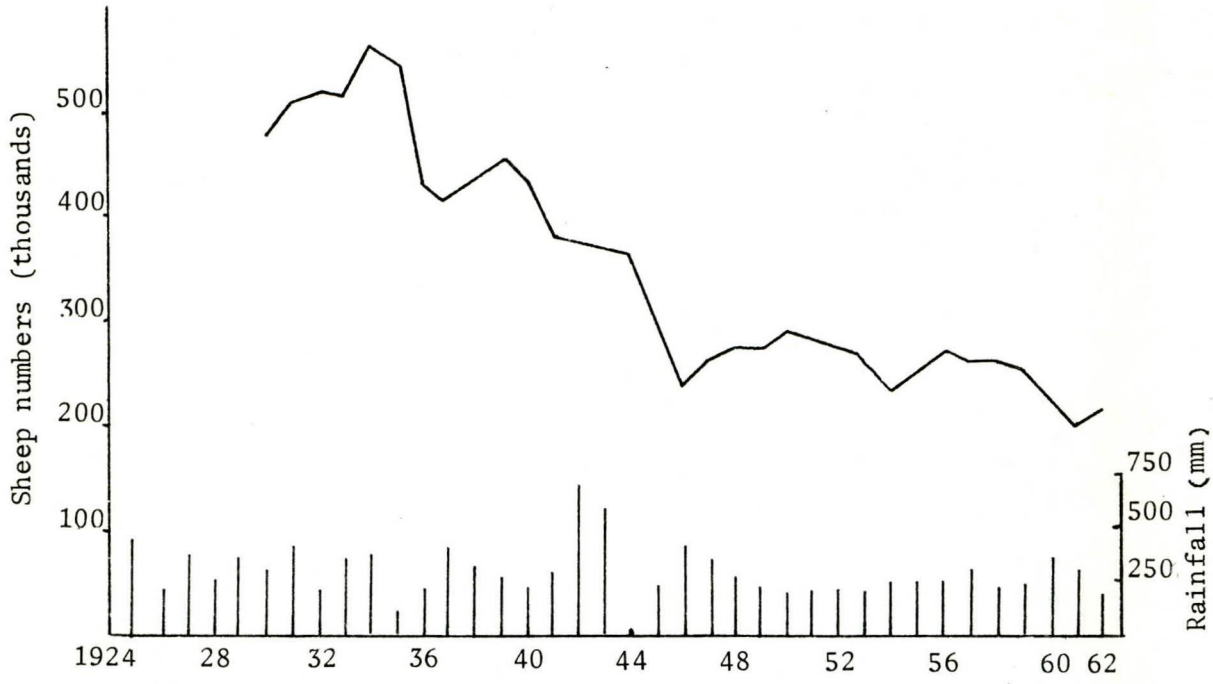
Monthly Rainfall Exceeding	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
25 mm	79	68	51	21	30	27	14	5	0	2	13	44
50 mm	54	46	46	14	17	16	5	2	0	2	0	25
75 mm	38	30	32	5	5	8	5	2	0	0	0	8
100 mm	22	19	22	2	2	5	0	2	0	0	0	4

Abydos and Woodstock Stations were purchased by the Western Australian Government in 1946 for research into the reasons for the failure of pastoral leases in the region to maintain sheep numbers by natural increase.

Figure 2 shows the decline in sheep numbers, especially from 1934 to 1946 when numbers in the Marble Bar and Port Hedland Shires dropped from 560 000 to 250 000. In most other pastoral districts of W.A. similar declines were accentuated by the prolonged and severe drought starting in 1936. This was not the case in the Pilbara region where rainfall during the 12 year decline was a little above normal.

Fig. 2

Trend of sheep numbers in the shires of Port Hedland and Marble Bar.



Commercial rehabilitation of the two stations was attempted in the first few years after acquisition but sheep losses remained high and lamb survival remained at a low level. Survival of wethers was reasonable.

In 1948 a joint committee consisting of members of CSIRO, Department of Agriculture and the Institute of Agriculture (University of W.A.) inspected the region and found that Abydos-Woodstock only represented one of the five major vegetation types of the area. Abydos was considered too stony for experimental work. Woodstock was a little better, but lacked most basic facilities.

Despite this report it was decided that an experimental programme to investigate pasture management and animal husbandry problems of the region should be commenced.

EARLY PASTURE EXPERIMENTS - H. SUIJDENDORP

Pasture experiments commenced in 1951 with

(a) Plant introduction work

(b) Experimental cultivation techniques to assist in buffel grass *(Cenchrus ciliaris)* establishment.

(c) Observations on the Plant succession sequences and regeneration of soft spinifex *(Triodia pungens)* country after fire.

(a) turned out to be a time consuming but non productive exercise with most species not germinating, (b) showed that any sort of cultivation would help in buffel establishment but that many soils in the spinifex region were too poor to support the grass, (c) was most successful and was expanded into a management system in subsequent years.

Further details of early pasture work, together with background information are outlined below. Much of this information was extracted from the M.Sc. (Agric.) thesis of H. Suijdendorp entitled *"A study of the influence of management practices on "Spinifex" (Triodia pungens) grazing (1967)"*.

Station practices and their effects

Pastoral leases are usually grazed on a system of continuous light grazing. Sometimes a paddock is unstocked from one shearing until the next, but apart from this, the permanence of the plant cover is taken for granted. After a few years, the spinifex cover is dense enough to prevent other species from getting established (Burbidge, 1944), and the time is ripe for a burn. The most convenient time for burning is during the general muster for shearing in April to June, when riders move through the paddocks in line abreast. Lighted matches are dropped in large contiguous patches of spinifex tussocks. The fires disturb the sheep and disclose the relative positions of the musterers. Usually soft gummy spinifex *(T. pungens)* is burned in preference to the harder types, as it is very resinous (35 per cent ether extract), and produces large volumes of black smoke. Usually soil and plant moisture levels are still fairly high at this time of the year and fires burn only small areas of a few hectares.

Near the coast, where humidity levels are higher and dews common, the underground parts of the spinifex often survive the burn and produce a green shoot almost immediately, but inland, where conditions are drier, tussocks are killed by the fire and regeneration is usually from seed only.

In the first season after a fire, production of dry matter is very low, and as sheep tend to concentrate their grazing on the small burned patches of country, these areas are severely overgrazed and often denuded.

Winter burning seems to be damaging for the following reasons:-

- Areas burned are usually too small to warrant subsequent special grazing treatment of the paddock and continuous grazing allows sheep to select palatable seedlings as soon as they emerge;

- Seed still on the plant or freshly dropped, is burned, as there has not been time for stock to trample it into the soil;

- The soil, after the burn, is subject to severe wind erosion for as long as nine months, or until the next rain comes. The equinoxial gales in September remove considerable quantities of seed and topsoil.

The common practice of continuous light grazing allows sheep to select the most palatable species at all times. As the number of really palatable plants is very small, they are more readily eaten out.

Forage production trends following fire

Typical forage production trends following summer and winter fires are shown in Figure 3.

Fig. 3

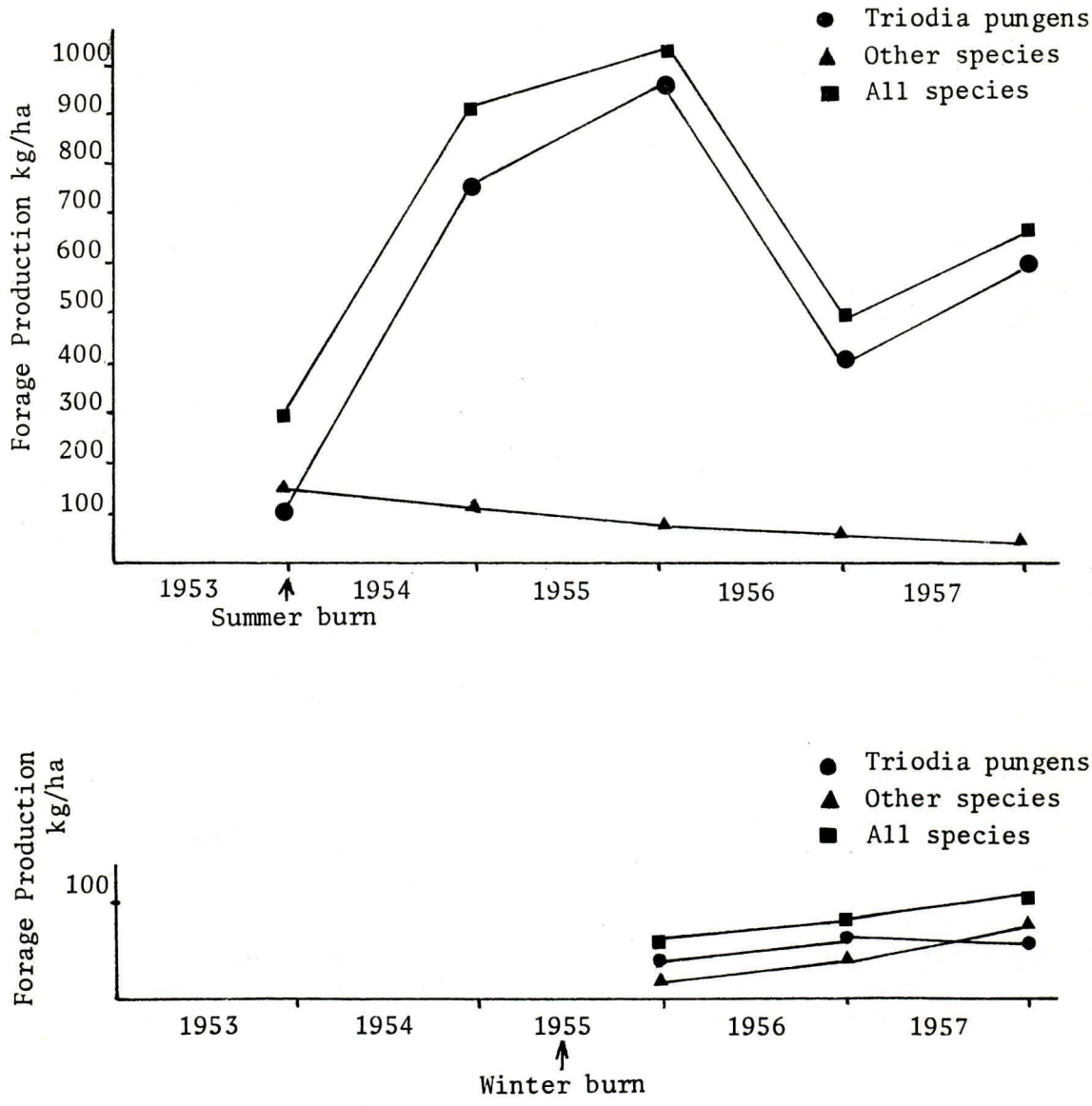


Plate 1 - Summer burn on old closed stand of spinifex

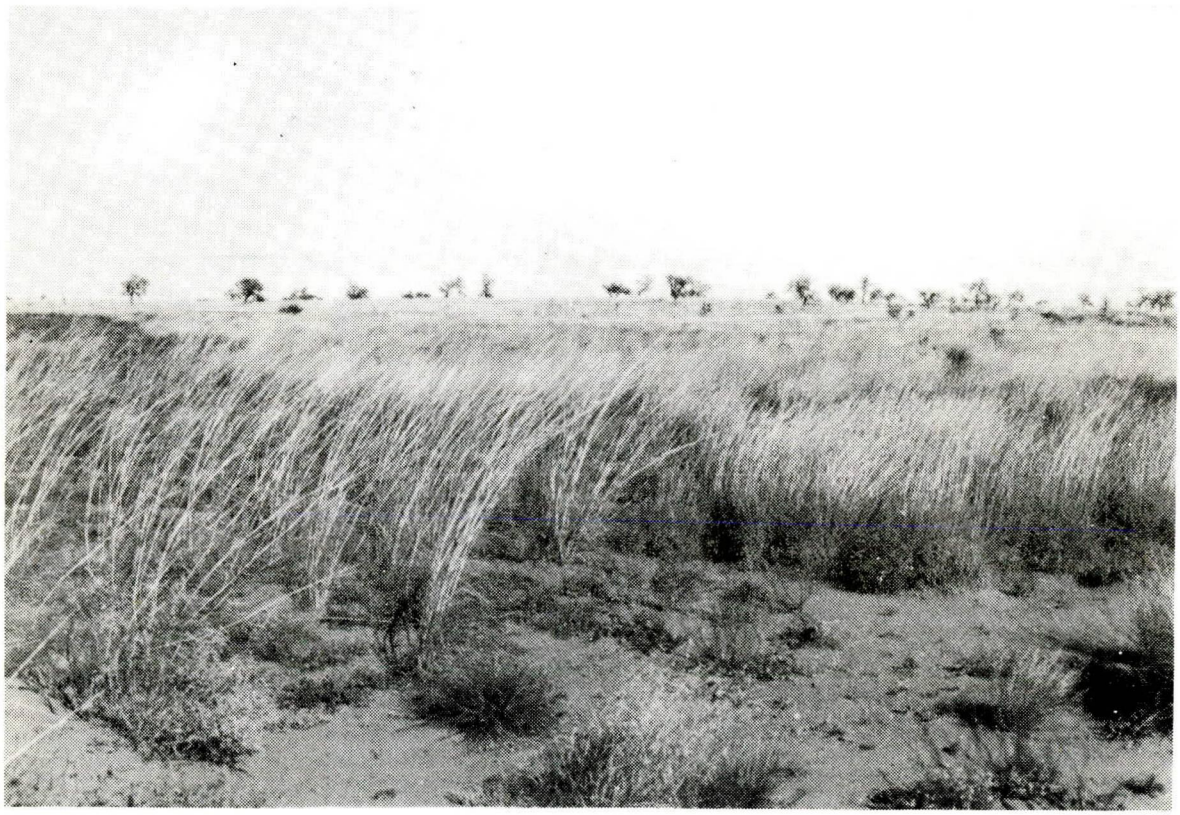


Plate 2 - Perennial weeping grass on left 12 months after a summer spinifex fire. Unburnt soft spinifex on right.

In the first season production of other species is in excess of the forage produced by *Trioda pungens* seedlings. This type of pasture is favoured by all grazing animals. Plot 3 was only grazed each November for a short period, equivalent to 1 sheep/1.6 ha.

Under these conditions production of other species gradually declined from the original level of 180 kg/ha to 45 kg/ha in the fifth year. Spinifex production increased to 956 kg/ha in the third year after which it varied with the seasons. Production in 1956 and 1957 was poor.

Results and conclusions from pasture trials

All plots in the trial tended to be dominated by *Triodia pungens*. Five years after the plots were established very little other vegetation remained, even when grazed during the dry season only or when completely protected.

As the nutritional value of the *Trioda pungens* climax is lower than that of the sub-climax species, the latter should be encouraged to persist for as long as possible. As most of them are perennials this should be possible. However, the growth habit of *Triodia pungens* is such that over a period of several years a seedling can grow into a tussock of ever increasing size by sending out adventitious roots. Other plants cannot compete with this crowding effect and die. The centre of the tussock eventually dies and seedlings can get established within such a tussock.

The community can be opened up again by the use of fire. *Time-of-burning trials made it obvious that burning shortly before summer rains is to be preferred to winter burning.* Also, grazing outside the growing season did not harm the sub-climax vegetation and seemed to be better than complete protection.

As the areas were too small to impose a continuous grazing treatment, a new experiment was laid out as described in the next section of this book.

Reference: Burbidge, N.T. (1944). Ecological succession observed during regeneration of *Triodia pungens* R. Br. after burning. Jour. Roy. Soc. W. Aust. 28:149-156.

EARLY GRAZING TRIALS - H. SUIJDENDORP

As it became apparent that the system of grazing management was a major factor influencing plant succession, a separate trial, to gather further information on this aspect, was started in November, 1953. An area of 9.6 ha of spinifex country was vermin proof fenced. Half of this area was subdivided into 12 x 0.4 ha paddocks, the other half was left as one 4.8 ha paddock. Four sheep were run on each half throughout the year. In the 4.8 ha paddock these sheep had access to all parts of the paddock at all times. On the other half all sheep were concentrated in one 0.4 ha paddock and moved at fortnightly intervals.

Burning treatments

Depending on the area of dense spinifex available, 0.8 to 1.2 ha was burnt every year in the subdivided section. An equivalent area was burnt in the continuously grazed area.

Burning was done in November each year and the burnt paddocks were then excluded from the rotation until seedlings, established with the summer rains, had themselves seeded (usually in March to May) after which these paddocks were once again included in the rotation. On the continuously grazed area sheep had access to burnt areas at all times.

Recordings

Line intercepts (Canfield, 1941) were used to record changes in vegetation. Liveweights of sheep and wool yields were also recorded.

Results and discussion

Originally, both 4.8 ha blocks were covered by a closed community of *Triodia pungens*, with dead plant material indicating the presence of other grasses at an earlier time. They had not been grazed, except by kangaroos, since 1945.

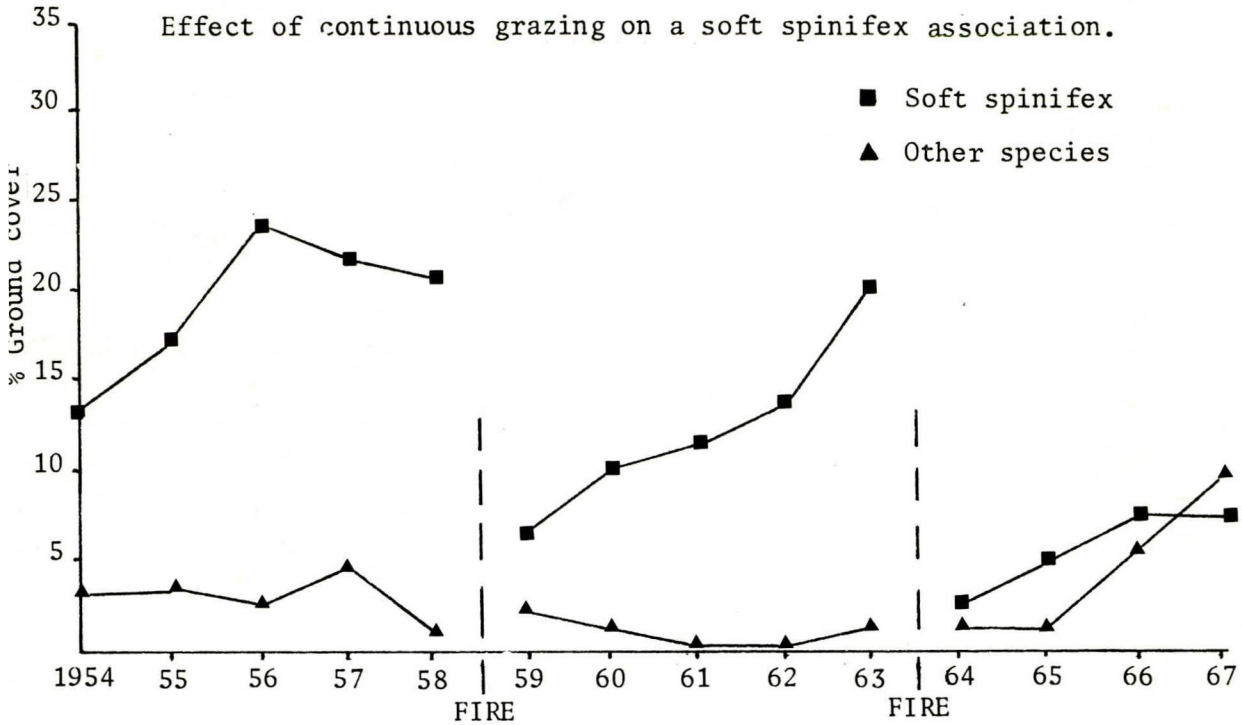
Revegetation after burns on the continuously grazed section, was negligible. Palatable perennials and annuals did not survive for long after germination, and were replaced by unpalatable species such as *Cassia notabilis*. This plant commonly comes up after burning but persists only in the absence of strong competition from other species.

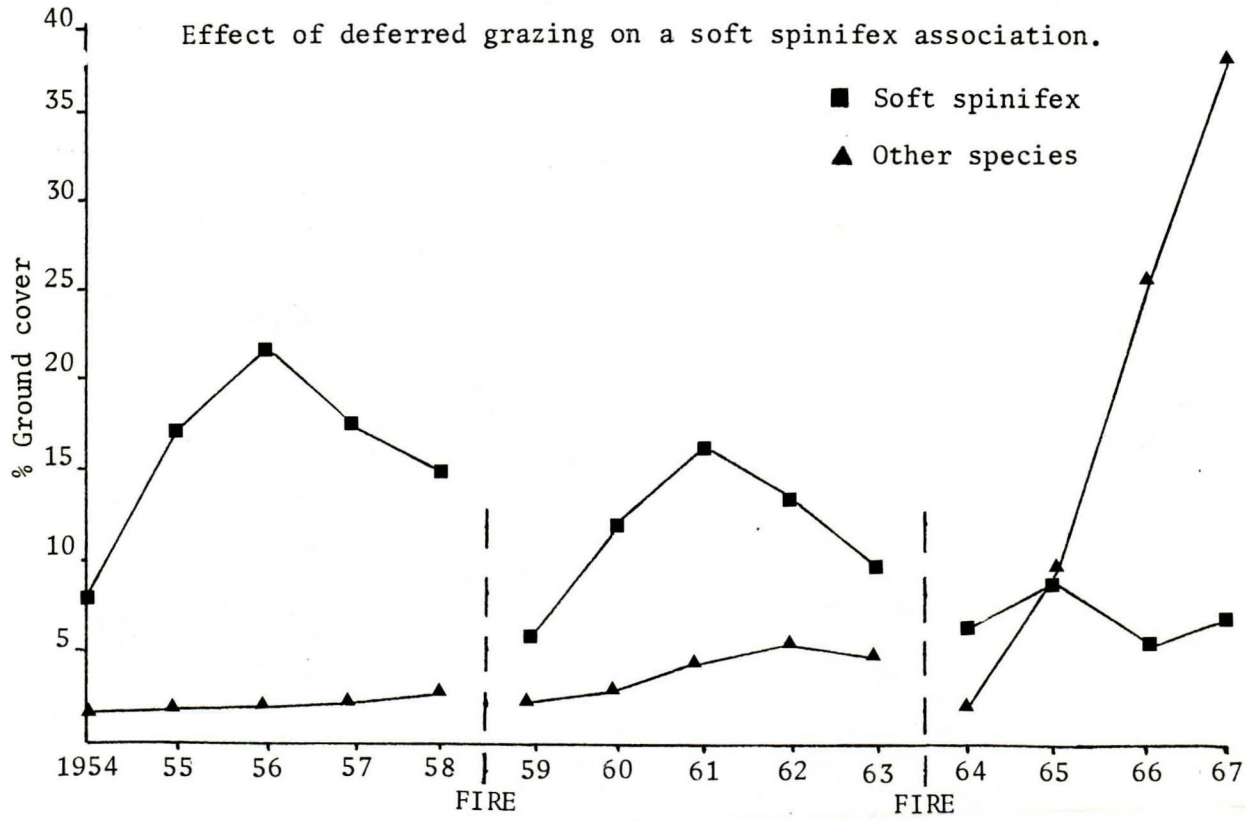
Annual burns on the continuous grazing plot caused the ground cover to diminish each year. In very good seasons a flush of annuals allowed the sheep to produce some wool, but in light seasons forage production was negligible. Judging from results in Plot 7, (see Fig.3 Page 8) winter burns would have been even more disastrous.

Stocking rates were maintained at 1 sheep to 1.2 ha until the end of 1956, thence 1 sheep to 1.6 ha.

In the first two cycles following fires, the grazing trial behaved very much like the management trials in that *T. pungens* became dominant in both continuous and deferred sections in the first few years after the fire. (Fig. 4).

Fig.4





In the deferred section the grasses other than *T. pungens* showed a gradual increase in successive burning cycles. Then unexpectedly, after the third fire, grasses such as *Eragrostis* and *Aristida* species increased rapidly to keep *T. pungens* at a relatively low level.

In the deferred section the total ground cover in 1967 was greater (47.8 per cent cover) than at any time during the experiment. It does not now seem likely that *T. pungens* will become dominant again under a deferred grazing system.

The change of composition towards grasses which produce a large quantity of forage during the wet season will create utilisation problems not previously encountered as this type of vegetation will not support sheep during the long dry periods when the animals normally rely on the previous season's spinifex growth.

Under continuous grazing conditions, the initial pattern of vegetation recovery after fire was very much as described in the management trial, *T. pungens* became dominant in a few years and other species gradually disappeared. In the second cycle, grazing pressure on the spinifex seedlings (being the most palatable component left of the perennial part of the pasture), slowed the spread of spinifex, leaving a considerable proportion of bare soil, which in good seasons was occupied by annuals.

Conclusion

The change of vegetation under deferred grazing techniques, where *T. pungens* was suppressed as the dominant species after the third fire has been achieved on some stations on deeper soils after the second fire (Boodarie Station in a 260 km^2 paddock), and it must be concluded that *T. pungens* is the climax community only on shallow soils associated with granitic outcrops and on granitic hills.

On deeper soils *T. pungens* must be regarded as an increaser. The common practice of continuous grazing at very high rates in the 1920s and 1930s would have encouraged this increase.

Once spinifex was present, burning became essential to maintain any volume of palatable pasture production at all. As a sub-climax the "other species" were only productive for about two out of five years and even then they had to compete with spinifex. Naturally the increase of spinifex occured more readily on stations where granite hills and ridges abound and the valleys only constituted a small proportion of the total area as was the case on stations that were abandoned in 1946.

To restore the region to full productivity the climax vegetation needs to be restored. It was shown that this may be a very long process. However, any station that is still a going concern can improve its vegetation at little or no extra costs, *by summer fires and by wet season deferment of grazing of their better paddocks.* This will have the immediate effect of strengthening the sub-climax which will improve the level of nutrition. In time the original climax vegetation will be restored.

Elsewhere in Australia no such effects have been observed from similar grazing techniques. Biddiscombe *et al*, 1956 reported no beneficial effects from either autumn or spring deferments on the *Stipa-Chloris* natural pasture at Trangie (N.S.W.). Williams (priv. comm.) found little effect from 17 years of protection of degraded *Danthonia* grasslands near Deniliquin. In neither of these cases could fire be used as a management tool for removing undesirable increasers.

References: Biddiscombe, E.F., *et al* (1956). Grazing management of natural pastures at Trangie, N.S.W. Aust. Jour. Agric. Res., Vol 7, No 4.

Burbidge, N.T. (1944). Ecological succession observed during regeneration of *Triodia pungens* R. Br. after burning. Jour. Roy. Soc. W. Aust. 28:149-156

Canfield, R.H. (1941). Application of line interception method in sampling range vegetation. J. of Forestry U.S.A. Vol 39 No 4.

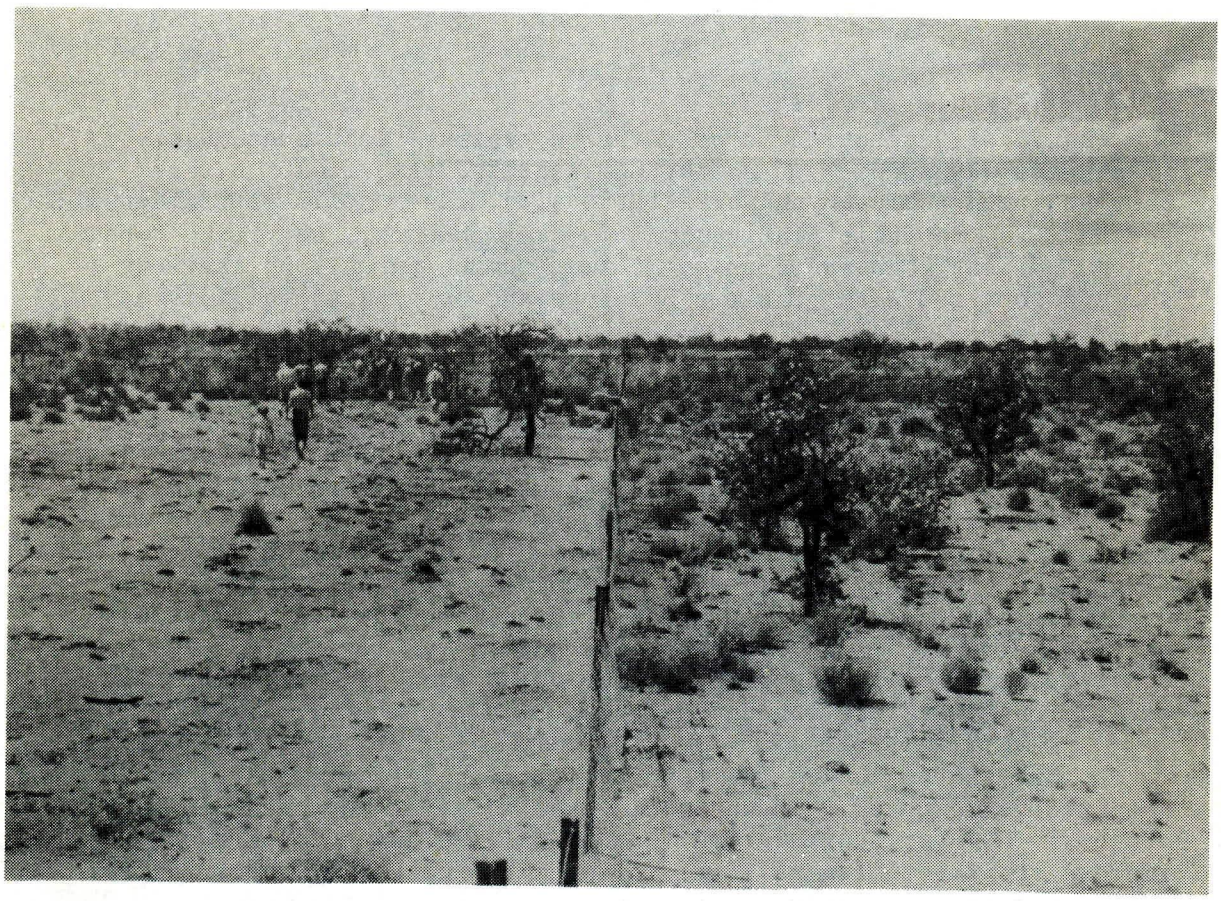


Plate 3 - Continuous grazing plot on left, rotational grazing on right - Abydos, September 1959.

Plate 4 - Adviser H. Suijdendorp addressing visitors at a field day at Abydos in 1955.

LAMBING TRIALS AT ABYDOS RESEARCH STATION - H. SUIJDENDORP

Burning and deferred grazing

It is common practice to burn spinifex when it is dense enough to carry a fire. If it is burnt shortly before the wet season and if grazing is deferred until about six weeks after good opening rains, seedlings of many native perennials will germinate and establish themselves. The resulting sub-climax vegetation will provide enough nutrition for lambing ewes for a limited period each year. The plant cover then reverts mainly to spinifex about four years after burning. This period of fair nutrition each year varies with the type of season, but generally ceases by August or September.

Naturally this basic pattern of available nutrition is the main limiting factor when selecting a suitable time for lambing.

Lambing trial

The results of a lambing trial conducted at Abydos in 1962/63 are shown in Table 2.

Grazing was deferred in all but one group. For the deferred treatments stock were removed from the experimental paddocks for six weeks from the break of the season, after which they were returned.

Table 2. Lambing Trial - 1961-62

Group	Mating time	Grazing system	Total ewes	Lambed %	Marked %	Weaned %	Late lambing %	Lamb daily weight gains kg/hd	Ewe wool (mid-Aug.) kg
A	Oct.	Deferred	41	83	56	51	14	0.19	2.7
B	Nov.	Burnt and deferred	36	95	89	81	-	0.13	2.3
C	Nov.	Deferred	48	92	90	88	4	0.15	2.3
D	Nov.	Continuous	40	98	80	78	-	0.11	1.9
E	Jan.	Deferred	38	92	74	63	-	0.15	2.3
F	Mar.	Deferred	39	80	74	54	2	0.10	2.6

The following comments are made for each group in the trial.

Group A

Group A was joined on October 1, but mating did not start until October 27. In the next ten days 86 per cent of the ewes were mated.

Severe losses of lambs immediately after birth (27 per cent) were due to dessication in high temperatures (43°C) maximum in April.

Nutrition during April was still good, as shown by the good daily weight gains (0.19 kg) of the surviving lambs. Weight gains were calculated between lambing and marking time about three weeks later.

Of the ewes mated 14 per cent. did not conceive during the two months long mating period. Most ewes conceived later in the summer. The reason for the delay is not known.

Group B

The groups of the November mating were joined in mid-November, and most of them were mated early in December. In this group an all spinifex paddock was burnt immediately before the summer rain and lambs were dropped on spinifex seedlings *(Triodia pungens)* and "tarbush," *(Cleome sp)*.

This type of vegetation was inferior to the spinifex associated with other perennial grasses in the other experimental paddocks. The lambs, however, were reared successfully on this plant cover and 81 per cent. were weaned.

This management opens up possibilities for stations with not much breeding country; they can make sure of higher lamb survival by reserving burnt soft spinifex country for lambing ewes.

Group C

Maximum temperatures usually fall by about $7^{o}C$ towards the end of April, allowing good lamb survival from a May drop. Weight gains were not so good in this group because of the dry vegetation. However, this offers the best compromise when selecting for good nutrition and reasonable temperatures.

Group D

Except for continuous grazing the conditions in Group D were the same as for Group C. The continuous grazing, however, adversely affected lamb survival (20 per cent. loss) and also the daily weight gains of the lambs and fleece weights of the ewes.

Group E

Some rain fell in May and June giving a useful boost to Group E. However, the effect did not last long and the vegetation dried off rapidly. This explains the high lambs losses (29 per cent) before weaning.

Group F

Conditions were even more severe at this time. Lower weaning percentages were recorded in Group F as well as the lowest weight gains in this series of experiments.

Stocking rates for all treatments were the same with 1 sheep to 2 ha. This was four to five times heavier than the usual rates for this region.

Conclusions

Clearly the time of lambing is the most important factor determining survival and growth of lambs in the spinifex region.

Lambing in May clashes with the present shearing season and may present some difficulties. However, it seems obvious that some effort should be made towards lambing at this time.

The experiment also showed that if recently burnt country is reserved for ewes lambing in May, the lambs can be reared on relatively low grade country.

Deferred grazing is essential to maintain production in this region. This is shown by the disastrous effects of continuous grazing for only one season on country that had been deferred grazed for four consecutive years.

Acknowledgements

All observations on lambing performance were made by Mr. R.H. Collett, Field technician.

Some sheep for this experiment were on loan from Mundabullangana and Warralong stations.

Finance for vermin-proofing of the experimental paddocks at Abydos was provided by the Australian Wool Corporation.

Plate 5 - Time of lambing trial, photo taken in September. Large lambs born in April, small ones in August - it is obvious which are going to survive the nutritional stress in November-December.

FACTORS AFFECTING SHEEP FERTILITY IN THE PILBARA -

Extract from thesis by P.D. Morgan

Ten locally bred (Abydos) rams were mated to 256 mixed age ewes and ten imported rams were mated to 256 similar ewes in four experiments. (See Table 3. page 18).

The locally bred rams were all bred at Abydos and were themselves sired by locally bred rams. The Abydos flock was based on approximately 90 per cent South Australian (non-Peppin) strong wool and 10 per cent strong wool Peppin "bloods." The imported rams, all of which spent one full summer in the area prior to their use in the experiments came from different origins in each year of the experiments.

In 1963/64 the imported rams came from a medium Peppin stud in Western Australia (latitude 31°S), in 1964/65 from a strong non-Peppin stud in South Australia (latitude 33°S) and in 1965/66 from a strong Peppin stud in Western Australia (latitude 34°S). The rams, all of which had received mating experience before being used in the experiments were 6 - tooths, except in 1965/66, when one fresh full mouth ram was used in each group.

All the rams were semen tested before use, and only rams classified as fertile were used. The semen samples were collected by electro ejaculation and examined for volume, colour, density, total sperm numbers, sperm motility and the percentage of dead sperms. One imported ram in 1965/66 collapsed and died in the yards on January 3, 1966 and was replaced by a similar ram.

All ewes were bred at Abydos and varied in age from 18 months (maidens) to 3.5 years in 1963/64, 4.5 years in 1964/65, and 5.5 years in 1965/66. In each experiment the ewes were evenly distributed within age brackets to the experimental groups. Except for the maidens, all ewes had received previous mating experience and were managed so as to have them as receptive as possible to the ram at least two months before joining and keeping them free from any contact (including visual) with the rams for a similar period. One ewe in Group II (1963/64) died before lambing and was eliminated from all results.

Observations

Mating activity was determined by fitting the rams with Sire-Sine raddling harnesses (Radford, Watson and Wood, 1960), and mustering three times a week to identify mated ewes.

At the end of the joining period the groups in each experiment were paired and run as one mob until weaning. Lambs were identified and weighed within 24 hours of birth. Marking was carried out when the average age was usually around six weeks, and weaning was carried out between mid-September and early October.

Results and discussion

Mating activity

In all trials except the January 1963/64 mating, the locally bred rams served their ewe flock at a faster rate than did the imported rams (Tables 3, 4, 5, 6 & 7).

This was because the locally bred rams commenced mating at an earlier date and had an earlier average date of first service than the imported rams (Table 3). The differences in average date of first service are statistically significant for the 1964/65 ($P < 0.005$) and 1965/66 ($P < 0.05$) trial, but not for the November 1963/64 trial. In the January 1963/64 trial there was no difference in the date of commencement of mating activity. In fact in this case the imported rams had an average date of service five days earlier than the locally bred rams. The possible reasons for this anomalous result are discussed at the end of this section.

Table 3. - Details of Commencement of Mating Activity

Group	Origin of rams	Date of joining	Date first ewe served	Average date of first service
1963/64				
I	Local	18.11.63	25.11.63	13.12.63
II	Imported	18.11.63	2.12.63	22.12.63
1963/64				
III	Imported	7. 1.64	10. 1.64	19. 1.64
IV	Local	7. 1.64	10. 1.64	24. 1.64
1964/65				***
III	Local	1.12.64	7.12.64	27.12.64
IV	Imported	1.12.64	24.12.64	17. 1.65
1965/66				
III	Local	2.12.65	8.12.65	27.12.65
IV	Imported	2.12.65	15.12.65	9. 1.66

* $P < 0.05$ *** $P < 0.005$

Table 4. - Distribution of mating activity November mating 1963/64

Forty two ewes joined to two local rams and 42 ewes joined to two imported rams. One ewe mated to the imported rams died and has been excluded from the results.

Days after joining	7	14	21	28	34	42	50	53	100
Ewes served by local rams	3	7	14	30	38	39	39	41	41
Ewes served by imported rams	0	1 *	2 ***	13 ***	23 ***	35	37	38	39
	3.04	4.82	10.80	13.11	11.76	1.95	1.84	1.10	0.37

* $P < 0.05$ *** $P < 0.005$

Table 5. - Distribution of mating activity January mating 1963/64

Forty two ewes mated to two local rams and 42 ewes mated to two imported rams. The mating dates of two ewes which were mated to local rams and five which were mated to imported rams were not noticed and have been excluded from the results.

Days after joining	7	14	22	27
Ewes served by local rams	8	17	33	40
Ewes served by imported rams	13	23	33	37
	2.22	2.98	0.70	0

Table 6. - Distribution of Mating Activity 1964/65

Seventy two ewes mated to two local rams and seventy four ewes mated to two imported rams. The mating date of three ewes which were mated to local rams were not noticed and have been excluded from the results.

Days after joining	7	14	21	28	35	42	49	57	64	72
Ewes served by local rams	1	7	23	45	61	64	66	66	66	66
Ewes served by imported rams	0	0 **	0 ***	2 ***	12 ***	24 ***	36 ***	55 ***	60 **	63 *
	1.08	7.89	29.39	63.25	74.46	54.92	38.58	12.47	7.24	4.47

* P $\leq$ 0.05 ** P $\leq$ 0.01 *** P $\leq$ 0.005

Table 7. - Distribution of mating 1965/66

One hundred ewes mated to four local rams and 98 ewes mated to four imported rams. The mating dates of three ewes which were mated to imported rams were not noticed and have been excluded from the results.

Days after joining	8	15	22	29	36	43	50	60
Ewes served by local rams	2	13	35	69	87	90	91	92
Ewes served by imported rams	0	2 ***	7 ***	15 ***	30 ***	63 ***	72 ***	78 *
	1.92	8.14	22.01	56.24	62.34	16.17	8.22	4.27

* P/ 0.05 *** P/ 0.005

Observations of the trial groups following joining suggest that the significant differences in mating activity observed in the November and December groups resulted from an initial lack of libido among the imported rams. The locally bred rams associated with ewes immediately following joining, whereas the imported rams segregated themselves until they commenced mating. Even when forcefully associated with the ewes during mustering to observe mating activity the imported rams displayed no interest in the ewes and again segregated themselves when returned to the paddock. Once they commenced mating the imported rams remained associated with the ewes except in 1964/65 when, following the mating of the first ewe on December 24, they again segregated themselves until mating activity recommenced five days later. Once the imported rams commenced mating they did so with an intensity similar to that of the locally bred rams.

The reason for the initial lack of libido among the imported rams is not clear. In Northern Queensland, Moule (1950b) observed imported rams to show a lack of libido from September to October until autumn, whereas rams bred there continued to exhibit libido during this period; he believed that a photo periodic effect may be involved. The worker was able to find good libido in three out of a group of four imported rams subjected to an artificially reduced light regime in September and observed a lack of libido among untreated controls.

In the Abydos experiments the imported rams had been in the area for approximately 18 months before the trials started and would possibly have adjusted to some extent to the different light regime. Also the delay was only relatively short - (7 or 17 days) - and was followed by normal libido. Further, the date of commencement of mating was different in each trial. It is therefore suggested that while a photoperiodic effect may be involved some other factor or factors were also operating.

While high environmental termperatures are believed to have no direct effect on libido, they may have an indirect effect. Macfarlane et al 1958, found that freshly imported rams had a higher respiration rate than local sheep in northern Queensland. By the following summer little difference between the two types was observed. Observations of imported rams in the Pilbara district of W.A. suggest that they were more distressed by heat than locally bred rams, even after a full summer in the north. They panted more readily if subjected to exercise and sought shade to a greater extent during summer. However, if imported rams suffer a lack of libido caused by heat induced discomfort they could be expected to experience improved libido during the cooler hours of the evening and night. As the diurnal distribution of mating was not studied in this trial it is not possible to say if this was the case. Nor can any explanation be advanced of how heat could suppress libido for a short period and then be followed by normal libido.

Hulet (1965) and Hulet et al (1964) observed a phenomenon which they described as a sexual inhibition in some rams. These workers found that when "sexually inhibited" rams were exposed to ewes in oestrus there was a delay in the commencement of mating activity when compared with "normal" rams. The libido of the "sexually inhibited" rams was similar to "normal" rams after they commenced mating. The authors were unable to explain the mechanisms involved in this inhibition. The pattern observed by these workers is similar to that observed in these experiments except that the initial delay in the commencement of mating activity was much greater than in their experiments. However, it was

Table 8

Details of Post Natal Loss Amongst the Offspring of Imported and Locally Bred Rams

Group	Origin of rams	Lambs born		Lambs marked		Lambs weaned		Loss birth to marking		Loss birth to weaning		Loss marking to weaning	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1963-64													
I	Local	37	88	31	74	31	74	6	16	6	16	0	0
II	Imported	27	66	24	59	24	59	3	11	3	11	0	0
1963-64													
IV	Local	40	95	37*	88	37*	88	3	8	3	8	0	0
III	Imported	35	83	29	69	28	67	6	17	7	20	1	3
1964-65													
III	Local	65*	90	58***	81	54***	75	7*	11	11***	17	4*	69
IV	Imported	57	77	42	57	32	43	15	26	25	44	10	24
1965-66													
III	Local	81	81	79***	79	75***	81	2***	2	6*	7	4	5
IV	Imported	68	69	57	58	54	55	11	16	14	21	3	5
Totals	Local	223***	82	205***	80	197***	77	18***	8	26***	12	8*	4
	Imported	187	73	152	60	138	54	35	19	49	26	14	10

* $P > 0.05$ *** $P > 0.005$

not known if a similar pattern would have taken place if mating had been carried out in cooler months.

Post natal losses

Significantly higher post natal loss occurred in the offspring of the imported rams than in those of locally bred rams (Table 8). There were a number of possible reasons for these differences.

It was suggested that time-of-lambing might be the major factor influencing lamb mortality, but other factors also appeared to be important.

Conclusions and recommendations

* In a November-early-December joining, locally bred rams commenced mating at an earlier date than imported rams, and the ewes mated to locally bred rams had an earlier average date of first service than those mated to imported rams. This difference was statistically significant in two out of three trials. In a January joining there was no significant difference in the commencement of mating activity, and the ewes mated to locally bred rams had a later average date of first service than those mated to imported rams.

* The ewes mated to locally bred rams had a significantly higher rate of lambing and rate of lambing to first service than those mated to imported rams.

* The offspring of the locally bred and imported rams had similar birth weights and post-natal rates of weight gain.

* The offspring of the locally bred rams had a significantly lower post natal mortality rate than the offspring of the imported rams. It is suggested that this important difference was due primarily to the lambing date of the ewes mated to locally bred rams being much earlier than that of the ewes mated to imported rams.

* These results are of considerable importance to the Pilbara sheep industry as they indicate that the reproductive rates of the flocks in that area might be raised by the use of locally bred rams. Since there are no studs present in the area and no indications of any being established in the northern areas, local ram breeding programmes must be developed within the existing station flocks.

Summary

* The factors most likely to contribute to the low reproductive rates in the Pilbara are; (i) failure of the ewe to exhibit oestrus during the summer mating period; (ii) failure of the ewe in oestrus to be mated; (iii) ram infertility and; (iv) post-natal lamb mortality.

* Locally bred rams are greater lamb producers than imported rams, and their use might be expected to improve reproductive rates in station flocks.

* As there are no studs present in the north of Western Australia, it is necessary to establish ram breeding programmes within the existing station flocks. The breeding programme likely to be most suitable on most stations involves keeping a number of the best lambs entire at marking time. This number should be approximately four times the number of 18 months old ram replacements required the following year. A selection programme based on fleece measurement at 18 months is then used to select the replacements for the working ram flock.

Reference: Morgan, P.D. A study of factors affecting the fertility of sheep in the Pilbara region, Western Australia. M.Sc.(Agric.) thesis, 1967.

WOOL GROWTH MEASUREMENTS IN THE PILBARA

by O.B. Williams and
H. Suijdendorp

Midside samples of wool were shorn every six weeks for two years from wethers at Mulga Downs Station (about 150 km south of Abydos) in the Mulga zone and at Abydos Station in the *Triodia* steppe. Wool growth was also compared between groups of sterile and fertile ewes at Abydos.

Wool production from the wethers at both sites was greatest soon after the summer wet season. At Abydos peak only lasted for six weeks and then faded to a low level for the rest of the year unless winter rain fell. At Mulga Downs, wool production remained at the higher level for a longer time, producing a somewhat bigger fleece.

The ewes at Abydos, suffered a 24 per cent drop in wool production during late pregnancy compared to the sterile ewes. Early lactation caused a drop of 44 per cent in wool production. Wool loss due to lactation averaged 26 per cent over the whole of the lactating period. It took almost a year after weaning for the wool production of the fertile ewes to catch up to that of the infertile ewes.

Reference: Williams, O.B., and Suijdendorp, H. (1968). Wool growth of wether grazing *Acacia aneura* - *Triodia pungens* Cummock grass steppe in Pilbara district, W.A. Aust. J. of Exp. Agric. Anim. Husb. 8 : 653 - 660.

SHEEP MEAT PRODUCTION IN THE PILBARA, ABYDOS RESEARCH STATION

by P.D. Morgan, B.R. Stone
and D.G. Burnside.

The specific aims of sheep meat production work at Abydos, first reported in the 1971 Arid Zone Newsletter, were to determine:-

* If the British breed mutton type sires would survive and reproduce in the harsh Pilbara environment.

* If the offspring from British breed x Merino crosses performed better than pure Merino animals.

* If the young animals produced were suitable for the local meat market.

Ram suitability

The sires used initially were Border Leicesters and Poll Dorsets and locally bred Merinos. Trials to determine the suitability of each ram breed were started. Body weight changes, body temperatures, heart rates and respiration rates were recorded.

Small and variable differences were observed in the last three measurements. However, Border Leicester rams suffered severe weight losses as shown in the table below.

	Average weight (kg)	
	18.1.71	21.2.72
5 Merino rams	44	51
5 Poll Dorset rams	56	59
5 Border Leicester rams	84	58

In contrast the other two breeds made small weight gains.

The Border Leicesters died after about two years in the area and were not replaced.

Mating ability

The Dorset and Border Leicester rams sired as many lambs as did the locally bred Merinos. The only difference occurred when the Dorsets and Merinos mated earlier than did the Border Leicesters. The imported British breed rams, by performing as well as did the locally bred Merinos, would perform better than imported Merino rams, as Morgan (1967) has demonstrated that locally bred Merinos are superior to imported Merinos as lamb producers.

Comparison of Offspring Performance

In all situations, it appeared that the offspring from the Dorset Horn-Poll Dorset rams performed slightly better than the pure bred Merinos. However, no significant differences were demonstrated. The results were highly variable because of the different mating times and different seasonal conditions. The September, 1972 mating produced the most

acceptable carcasses with Dorset Horn crosses reaching 29.5 kg (dressed weight 12.5 kg) at seven months of age. These animals were of good quality. However, the remaining animals which reached killing weight two months later were in poor condition. The low lambing percentage as a result of the summer lambing (less than 50 per cent) must be considered also.

The November, 1973 mating (the recommended mating time in the Pilbara) again showed the slight superiority of the Dorset Horn crosses. However, the animals required 15 months to reach slaughterable weight, and as a result of the poor 1975 summer season at Abydos they were in very poor condition at slaughter.

The results suggest that fat lamb production in the Pilbara would be an unreliable venture dependent on above average seasons. Once animals reach slaughterable condition they could not be maintained to allow for a continuity of supply.

From this aspect, Abydos Research Station was an unsuitable venue for this type of experiment. It is likely that better results could be obtained on coastal and tableland stations where nutrition remains at an adequate level for a longer period through the year.

Reference: Morgan, P.D. A study of factors affecting the fertility of sheep in the Pilbara Region, Western Australia. M. Sc. (Agric.) Thesis, 1967.

CATTLE GRAZING TRIAL AT ABYDOS RESEARCH STATION

by B.R. Stone

In 1971 a small-scale cattle grazing trial was started at Abydos. The object of the trial was to assess the effect of cattle grazing on mixed soft spinifex *triodia pungens* grass pastures and to measure animal performance. Ten steers were used and the stocking rate was one steer to 16 hectares.

Vegetation changes were monitored by sampling quadrats, both open and closed to grazing. Diet selection and body weight data were collected at two-monthly intervals.

Results

1. Grass dominant area.

   From July, 1971 to December, 1972, only 112 mm of rain was recorded at the Research Station. This drought greatly reduced plant and seedling numbers of desirable species. Between July, 1972 and June, 1973, there was a 55 per cent decrease in the desirable grasses (*Eragrostis eriopoda, Chrysopogon latifolius, Eriachne obtusa* and *Neurachne clementii*) in the closed quadrats.

   In the quadrats open to grazing, the reduction was 47 per cent for the same species.

   Seasonal conditions improved considerably in 1973 and 1974. Between June, 1973 and June, 1974, the following changes in desirable grasses were recorded:-

	Mature plants	Seedlings
Open to grazing	+ 130%	+ 64%
Closed to grazing	+ 92%	No change

   No significant changes of intermediate species (*Triodia pungens* and *Plectrachne shinzii)* or of undesirable species *(T. lanigera* and *T. longiceps)* occurred.

   The trend upwards in the density of desirable grasses, particularly in the quadrats open to grazing was encouraging.

2. Mixed soft spinifex - grass area.

   Similar trends to the above, although not as large, occurred on this particular vegetation type.

3. Soft spinifex - dominant area.

   Virtually no change in plant density or composition occurred during the trial period. This vegetation type was not as attractive to the cattle as the others and very little grazing took place on it.

Weight gains

Steers made poor gains between November, 1973 and January, 1974 (0.14 kg per head per day) and moderate gains (0.4 kg per head per day) from January to June, 1974.

Conclusions

This limited cattle work showed that, at the stocking rate tested, the animals had no detrimental effect on pasture. However, animal performance was poor indicating that the potential for beef production from these spinifex pastures is very low.

THE EURO OR HILL KANGAROO *(Macropus robustus)* IN NORTH WESTERN AUSTRALIA

by E.H.M. Ealey, CSIRO Wildlife Service Section.

In the Pilbara district of North Western Australia, numbers of sheep have dwindled to less than half the number 25 years ago. More than a dozen sheep stations totalling more than 3.2 million hectares have been abandoned. In contrast the hill kangaroos, *Macropus robustus*, or euros, have never been so numerous. For example, one of the smaller sheep stations, Mt Edgar (101 250 ha), on which we carried out some of our research was typical of much of the District. It had only 4 000 sheep and according to our census figures, approximately 30 000 euros. The pastures on this station were so degenerated that only low protein food plants could be found and sheep were unable to suckle the few lambs that were born. In contrast, the euros in this area were reproducting so successfully that they could maintain a high density despite considerable mortality which we showed occurred among them.

The sheep farmers blamed the euros for the degeneration of the pastures. The Agricultural Department of the Western Australian Government purchased two adjoining abandoned properties, Abydos and Woodstock. This Department carried out work on pastures and sheep (Suijdendorp, 1955) but called in the Wildlife Survey Section of the CSIRO to handle the euro problem. We set up our headquarters in the deserted homestead of Woodstock Station and lived and worked among the euros for nearly five years. An academic study of the euro was undertaken and the results compared with what was known about the sheep.

Environment

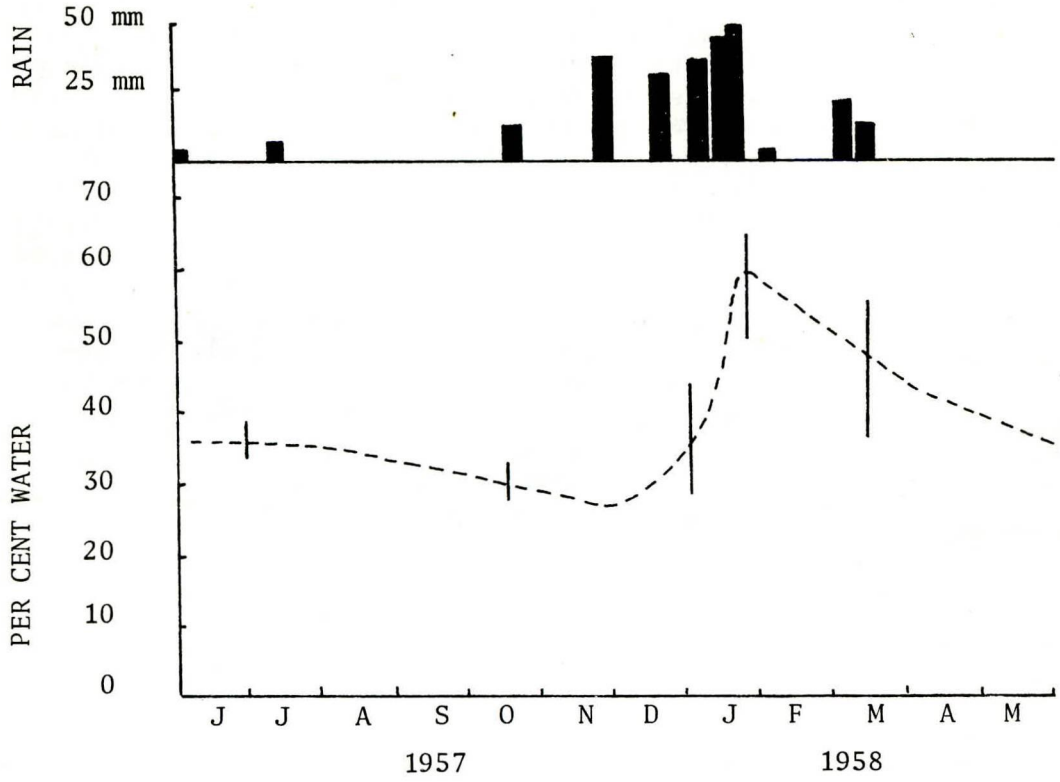
The study area was in the region of latitude 21° 30' south on longitude 119° 30' east. It was about (160 km) inland. Relative humidity in the District was low and usually below 30 per cent. The average daily maximum temperature during summer was sometimes as high as 42°C while the daily maximum occasionally reached 49°C.

Rainfall between November and April (summer) averages 230 mm. The average for the rest of the year being 90 mm. Geographically the locality falls in the transition from a climate D A'w to E A'd in the Thornthwaite classification (Keast, 1959, Trewartha, 1954) i.e. between semi arid, tropical steppe with rainfall deficient in winter and arid tropical desert with rainfall deficient in all seasons.

Macropus robustus is thus potentially subjected to great water loss. Natural waters are widely scattered pools in water courses. Windmills pump underground water to troughs for sheep and these may be frequented by euros.

The principal vegetation consists of *Triodia spp.* and low trees *Acacia spp.* The dominant food grass is *Triodia pungens* and the changes in the water content of this grass for the period July, 1957 to March, 1958, are set out in Fig. 5 and related to rainfall. The protein content (on dry weight basis) varied between five per cent during the rainless season to 12 per cent after rain had fallen.

Fig. 5 Seasonal Variation in the Water Content of *Triodia pungens*.



Macropus robustus is found over most of Australia, but in actual fact it is generally restricted to the hilly country. This was the case in the Pilbara District. Although there is much flat country suitable for sheep farming, this is transected by ranges of low, rocky hills. In many areas the countryside is dotted with great heaps of large granite boulders.

Nutrition

The sheep is a ruminant and required about 6.5 per cent (dry weight) of crude protein in its food to exist, much more for breeding. Protein analysis of hundreds of plant samples indicated that sheep could rarely find adequate forage for successful breeding. Yet the euro thrived in areas where sheep could not exist.

Studies on the digestion of the quokka, *Setonix brachyurus*, by Moir, Somers and Waring (1956) showed that this wallaby had a "ruminant like" digestive system. Tests for pH and analysis of stomach contents showed the euro also has a "ruminant like" digestion. Although it does not actually chew its cud, it may regurgitate food and chew it once or twice a day. The digestive system of the euro is more simple than that of the sheep and yet both have some strikingly similar features. For example, both have a region that produces a highly acid secretion.

The important part of protein is nitrogen. Herbivorous animals that depend on bacteria to digest the plant fibre for them, must obtain a certain amount of nitrogen each day. Much is wasted in the urine but sheep are able to retain a small proportion and recycle it via the saliva (Somers, 1957). Our suspicions that the euro could also do this were recently confirmed by a team working in the Zoology Department of the University of Western Australia, Main, (pers. comm.)

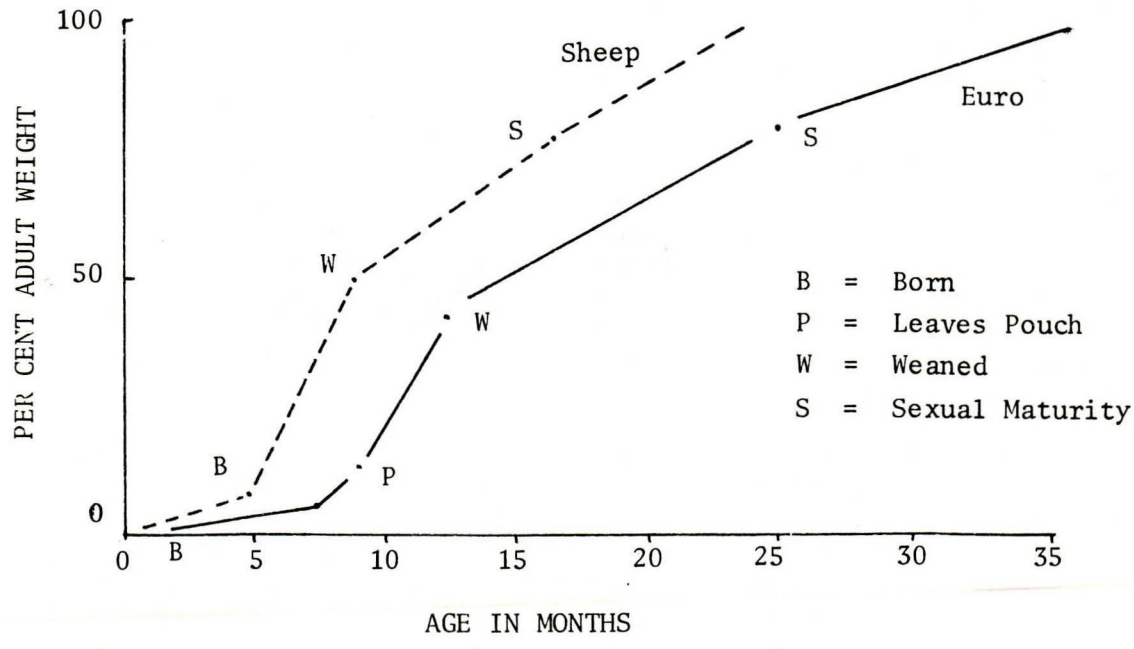
What euros ate was determined by noting which plants they grazed and by identifying parts of plants found in the mouths of shot animals. We used a technique, developed by Storr (1958), of identifying plants by cell structure so that we could find out what plants had been eaten by examining stomach contents and faeces. We found that they ate the same species of plants as did sheep. Therefore, where euros were dense they actively competed with sheep for the few high protein plants remaining in these degenerated pastures.

Analysis of hundreds of plant samples for protein content indicated that when summer rain fell in December and January, the protein level in the vegetation reached its peak in February. However, it can be seen that the nutritional status of the euro population (as judged by haemoglobin analysis) was highest in April. It can also be seen that during the dry part of summer the haemoglobin content of the blood fell significantly. The results given are for a mild summer. During harsh and extended dry periods widespread mortality occurs among euros and it can be presumed that it is due to nutritional stress.

Reproductive potential

The reproductive potential of sheep is really quite high. They may often have twins whereas only one euro in 500 has twins. They have a fairly short gestation period of five months. Lambs may be weaned eight months after conception and produce young themselves within two years of conception. In contrast the euro is not even sexually mature until two years after conception. Admittedly, the gestation period is only 38 days but during the eight months in the pouch, the young are mainly in a foetal condition. If the sheep has the potential to produce more young more quickly than the euro, why then is the sheep so unsuccessful at breeding in comparison? There are several reasons. Under conditions of low protein pasture the slower growth rate of the euro can be maintained by comparatively less energy output on the part of the mother (Fig. 6). Hence a higher survival rate.

Fig. 6 Comparison of growth rates of sheep and euros each expressed as a percentage of the adult female weight.



Euros display the phenomena of delayed implantation as also do some other marsuials and higher mammals. Shortly after the tiny foetus is born and crawls into the pouch, the mother again comes into oestrus and can be fertilised. However, the implantation and development of the newly fertilised ovum is delayed until the young in the pouch has gone. Whether it is removed immediately after birth, is lost by misadventure during development or naturally leaves the pouch after eight months, the quiescent blastocyst does not develop past the two day stage until the sucking stimulus of the pouch young is reduced or stops. Then, after 36 days (not 38) another young is born (Sadleir and Shield, 1960)

The phenomena of delayed implantation confers several advantages on the euro (Ealey, 1963). The principal advantage is the ability to produce another young quickly without waiting for oestrus to occur. This saving of time permits an overall faster breeding rate. It also means euros can take better advantage of a run of good seasons. If the sheep are mated at such a time so that lambs are born before rain has made the grass grow they die because the ewes cannot produce milk. It is months or more usually a year before more lambs are produced. Many baby euros die in the pouch from malnutrition during drought, but in contrast to the sheep, another is born within a few weeks and another ovum is fertilised and stored away. By that time rain may have fallen and if it has not the procedure can be repeated.

Breeding patterns

Nearly 2 000 female euros were shot between June, 1957 and February, 1960. Data from these samples is summarised in Fig. 6. It can be seen that, following good summer rain which fell in the period November, 1957 to January, 1958, most females had young in the pouch or were pregnant. Adequate winter rain maintained good breeding conditions so that as fast as young matured and left the pouch they were replaced by new born young. There were mainly from quiescent blastocysts. The following year, 1959, was a distinct contrast. Poor rain produced drought conditions and by the middle of the year 50 per cent of the adult females were anoestrous and only 20 per cent carried pouch young. However, while pasture conditions were extremely bad and before any rain had fallen, many of the anoestrous females began breeding. The first evidence of this reproductive surge was the appearance of many mitoses in the uteri of apparently anoestrous animals. Then, the percentage of anoestrous females fell and many females produced young before summer rain fell. These results suggest that there is a season of increased breeding but this is obscured when conditions are good. Pouch young born before the summer rain fell had a definite advantage. If rain falls at the usual time there is plenty of high protein food available for their mothers at the time when they require the most milk. This seasonal breeding would be particularly advantageous further inland where much less rain falls.

Mortality

Considerable mortality occurs among pouch young. During drought some are found dead in the pouch, presumably from malnutrition. Wild dogs or dingoes *Canis dingo* and wedge-tailed eagles *Aquila audax* have been known to chase females until they drop the young from their pouch. Remains of pouch young have been found in eagles' nests.

Data from our samples of shot animals indicated that about 40 per cent die before leaving the pouch or shortly afterwards. Life expectancy increases markedly after the first year by which time the first molar

tooth is fully erupted and the animal is properly equipped for grazing. As the other molars erupt the curve descends in an almost straight, diagonal line indicating a constant mortality up to the age of about seven years by which time the last molar has emerged. As the molars wear away the curve descends more steeply and life expectancy decreases rapidly. Very few animals attain the age of 20 years.

The above mortality pattern seems typical of populations on pastures devoid of high protein plants. In contrast where there is a mixture of high and low protein plants there is a general high survival rate. When the density becomes very high a sudden dramatic mortality occurs among all age groups. This mortality can usually be related to a period of drought. Such sudden mortality has never been known to occur in areas of low protein plants.

Water relations

The sheep, we know, is well adapted to withstand the hot arid climate. Its thick fleece is good insulation against heat as well as cold. It can withstand a high body temperature by panting like a dog (MacFarlane, 1956). It can keep cool far more efficiently than can Man and uses much less water to do so. If deprived of water, a sheep can withstand considerable dehydration, up to 25 per cent of its body weight. A man dies if he loses 7 per cent of his body weight due to dehydration (Adolph, 1947).

The euro has a thick pelage which acts an an insulation against heat and it is capable of panting as fast as 300 respirations a minute when it is very hot. When the ambient temperature reaches 32^{o}C euros lick their forepaws and hind legs. Experiments in our enclosures indicated that euros needed water equivalent to 5 per cent of their body weight each day in summer when on a dry diet. After five days without water they appeared healthy despite a weight loss of 25 per cent although this caused them to stop eating. Food plants contained 30 to 50 per cent water. However, euros that survived more than 70 days without free water but with abundant natural vegetation, still lost over 30 per cent body weight when kept in our enclosures. These animals were very dehydrated according to analyses of blood serum and urine undertaken by the University of Western Australia (Ealey, Bentley and Main, in M.S.). The same tests showed that the wild animals were not dehydrated during the same period. We decided to make detailed observations of euro drinking behaviour.

Drinking behaviour

Kangaroos are able to dig for water and make holes nearly one metre deep in the dry sandy creek beds. Locals call these holes "soaks". Many animals depend on these "soaks" for water. Pigeons, cockatoos, marsupial cats and even emus probably could not inhabit some regions if kangaroos did not dig down to water for them. We surveyed every creek in the study area marking each "soak" which was then checked each month for more than two years. We ascertained how much water could be obtained from food plants, throughout each year.

We knew exactly what natural water was available to the euros and we controlled the four wells that once supplied water to sheep in the area before the property had been abondoned. These watering places were fenced and devices installed so that each euro was automatically counted and sprayed with brightly coloured dye, as it passed through a gate

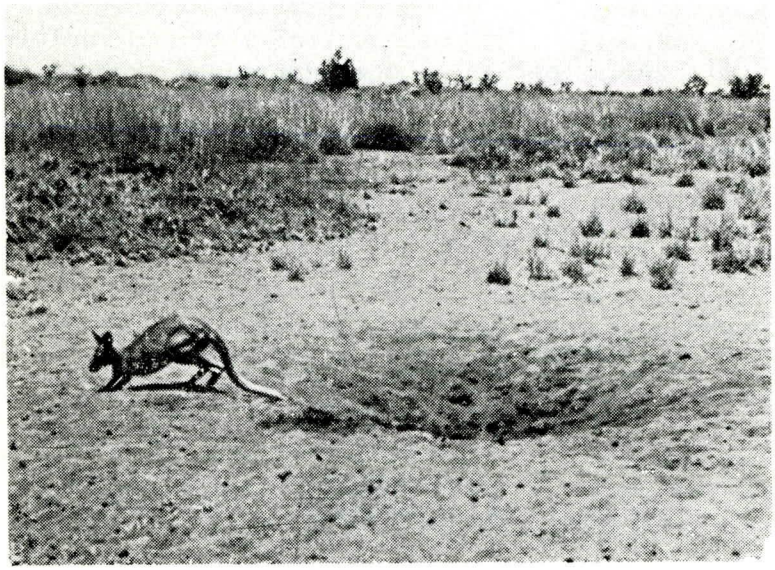


Plate 6 - A euro leaving a "soak" where water could be obtained two feet below the surface of the sand.

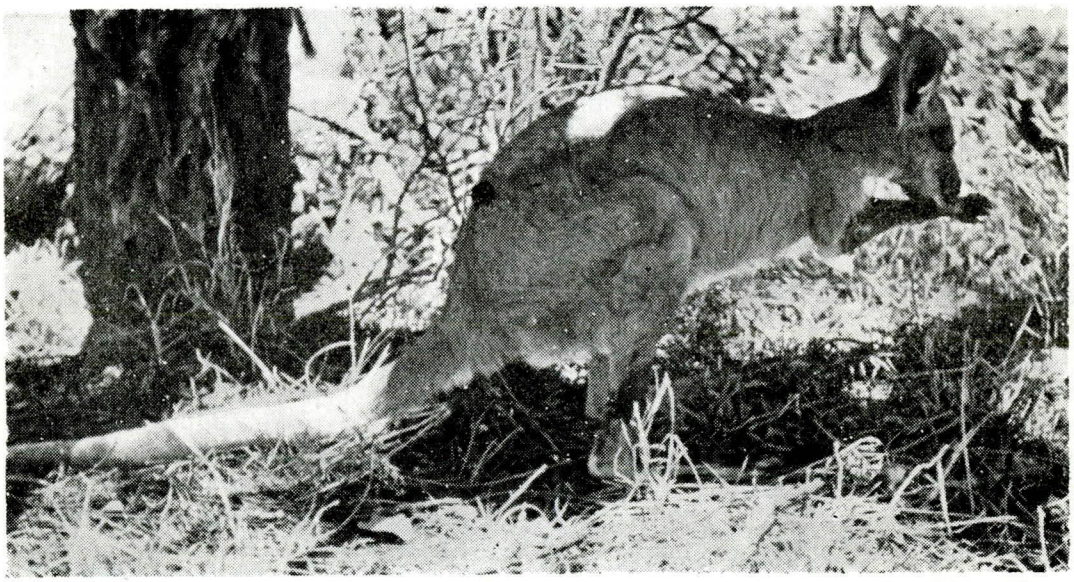


Plate 7 - Young female euro licking her fore-paws to cool herself.

on its way to drink. When the "soaks" dried up in a dry summer we knew that no euro could obtain a drink without getting marked and recorded. Our results showed many euros did not even drink once although shade temperatures exceeded 46°C.

Several hundred euros were trapped at the most central well and individually marked with a plastic collar bearing a combination of symbols (Ealey and Dunnet, 1956). These symbols were made from reflective tape so that at night by means of powerful spotlights and 15 x 20 binoculars, we could identify individual animals as far as 300 metres from a high observation tower near the central water point. We watched continuously for a fortnight at the height of summer in the years 1956 and 1957.

Very few animals used more than one well, judging by dye marks. Most marked animals seldom drank although a few drank as often as once every two days. Night transects with spotlights gave us information on home ranges of some marked animals; ranges which in some cases were only 500 metres across.

The interesting thing was that animals whose home ranges included a heap of granite boulders drank rarely while euros whose home ranges did not include a rocky outcrop drank more often. Recording instruments placed in caves in these rocky outcrops indicated that temperatures there never exceeded 32°C, despite ambient shade temperatures of 46°C outside. As euros do not commence licking themselves until the ambient temperature exceeds 32°C, they could obtain enough water for their bodily needs from vegetation if they remained in the caves while it was hot outside.

We knew how euros managed without water but why did they when abundant water was available at the wells? We knew our fences and gates did not deter them. It has recently been discovered in Africa (Livingstone, Payne and Friend, 1963) that stock can do well on pastures very low in nitrogen content, if water intake is restricted. This has recently been shown to be the case with the euro (Main and Brown pers. comm.) Analysis of urine from euros showed that animals that had recently drunk excreted very much more nitrogen than those which had not. As it appears to be an advantage to re-use this nitrogen rather than excrete it, it is therefore an advantage not to drink very often. The behaviour pattern of the euro in regard to drinking therefore ensures that it conserves nitrogen.

Nevertheless the hundreds of wells dug by Man in the Pilbara district make certain that in times of real necessity a euro can have an occasional drink and seldom die of thirst. This means that euros have increased in density in some areas and have also been able to extend into areas where there are no granite outcrops to provide them with heat refuges. They have also extended into areas where there were once thousands of red kangaroos. This is because red kangaroos dominate the pastures that contain the high protein plants. With the degeneration of pastures the red kangaroos have disappeared and the more hardy euros have invaded.

Summary and conclusions

This paper summarizes the results of a project designed to investigate the interrelationship between the euro and sheep in north-West Australia.

Both species have a ruminant type of digestion. Euros are able to live and reproduce successfully on pastures that are too poor for breeding sheep.

The gestation period for the euro is 38 days after which nearly eight months is spent in the pouch and then the young is suckled for a further five months from outside the pouch. Delayed implantation occurs in the euro.

Under favourable pasture conditions euros breed continuously. During drought at least a part of the population becomes anoestrous but may commence breeding again in early summer despite continuing bad conditions.

Reproductive success is high and dense populations can be maintained on poor pastures despite a rather high mortality rate among all age groups. Dramatic crashes of dense populations have been recorded.

The euro can withstand considerable dehydration and seeks shelter in cool caves during the day thus avoiding the use of water for body temperature control. Some populations exist in waterless regions.

In contrast to other Australian fauna the status of the euro has been improved by the activity of the white man. Everything the sheep farmers have done has made the situation worse for sheep and better for euros. There are approximately three hundred thousand sheep and two million euros in the Pilbara district. In some areas euros pose a problem where regeneration of pastures is attempted. Here they must be controlled but their efficient pattern of breeding and their ability to thrive on poor quality food and no water ensures their survival, as there are vast areas of good euro habitat that will never be used by man.

References

Adolph, E.F., (1947). Physiology of man in the desert. Interscience Publishers, New York.

Ealey, E.H.M., Bentley, P.J., and Main, A.R. (1965). Studies on the water metabolism of the hill kangaroo or euro. *Macropus robustus* in North West Australia. Ecology 46 : 473 - 479.

Ealey, E.H.M. and Dunnet, G.M., (1956). Plastic collars with patterns of reflective tape for marking nocturnal animals. CSIRO Wildl. Res. 1:(1) 56-62.

Ealey, E.H.M., (1963). The ecological significance of delayed implantation in a population of the hill kangaroos, *Macropus robustus*. Symposium on delayed implantation in mammals. Chicago Press.

Keast, A. (1959). The Australian environment. Biol. & Ecol. in Aust. 15:35

Livingstone, H.G., Payne, W.J.A. and Friend, M.T., (1963). Nitrogen metabolism of Cattle in East Africa. J. Agric. Sc. Cambr. (In press)

MacFarlane, W.V., (1956). Water economy and heat tolerance of tropical merino sheep. Aust. Acad. of Sciences. Symposium on man and animals in the tropics - May.

Moir, R.J., Somers, M. and Waring, H., (1956). Studies on marsupial nutrition. 1 - Ruminant-like digestion in a herbivorous marsupial. *Setonix brachyurus*. (Quoy and Gaimard). Aust. J. Biol. Sci. 9 2 : 293-304.

Sadleir, R.M. & Shield, J.W., (1960). Delayed birth in marsupial macropods - the euro, the tammar and the marloo. Nature 185:335.

Somers, M., (1957). Saliva secretion and its functions in ruminants. Aust. Vet. J. Nov: 297-301.

Storr, G., (1958). M. Sc. Thesis. Library, University of Western Aust.

Suijdendorp, H., (1955). Changes in pastoral vegetation can provide a guide to management. Bull. 2902. J. Agric. W.A. 4(6). (Series 4).

Trewartha, G.T., (1954). An introduction to climate. McGraw-Hill Book Co. Inc., New York.

SUMMARY AND POSTSCRIPT - H. SUIJDENDORP

The decline in stock numbers in the Pilbara was associated with a degradation of the natural pastures of the region. The valuable bluebush and saltbush pastures of the coastal fringe disappeared first and probably by the early 1900's had been replaced by a grass disclimax. It is unlikely that this shrubby climax vegetation will ever be rehabilitated. There are only traces left of the original plant cover.

This change in the coastal vegetation did not affect gross stock numbers in the Pilbara as the industry at this time was still expanding into the hinterland behind the coast. It was in this area of grassy plains that the most significant changes in carrying capacity, which were to affect the industry, were beginning to develop. The plains of tussock grasses were invaded by spinifex, reducing both the quantity and the quality of the forage. This led to a collapse in stock numbers, beginning in 1934 and ending in the abandonment of four pastoral leases and the amalgamation of others between1946 and 1960.

It has been demonstrated that the use of mustering fires in winter, followed by uncontrolled grazing encouraged soft spinifex dominance at the expense of the better grasses. The pastures which remained were of low nutrient quality and unsuitable for breeding purposes. These serious nutritional deficiencies were aggravated by the euro problem. The lower nutritional value of the spinifex disclimax did not disadvantage the euro as it can survive and reproduce on a poorer diet than can domestic animals (Ealey and Main 1967). In addition the many man-made watering points assisted in supporting euro populations and consequently numbers increased dramatically. Ealey estimated the euro population in 1965 at about seven times as high as sheep numbers. These increased grazing pressures further hastened the change in species composition and maintained the disclimax. Improved pasture management techniques were of no avail in this situation. A better understanding of the ecology of the euro following the C.S.I.R.O. wildlife study at Woodstock Station (Ealey 1962) made it possible to reduce euro numbers by a district wide poisoning campaign in the years 1960 to 1962 (Ealey and Richardson 1960).

The research work described in this booklet has shown how the transition from grass to spinifex can be reversed by improved burning and grazing management practices. Improved pastures and a reduction in euro numbers and some assistance from introduced grasses has made improved productivity possible. Because of comparative economics, the increasing carrying capacity was taken up by cattle (Fig. 7). It is suggested that stock numbers should stabilise at the present level with probably a further shift towards cattle.

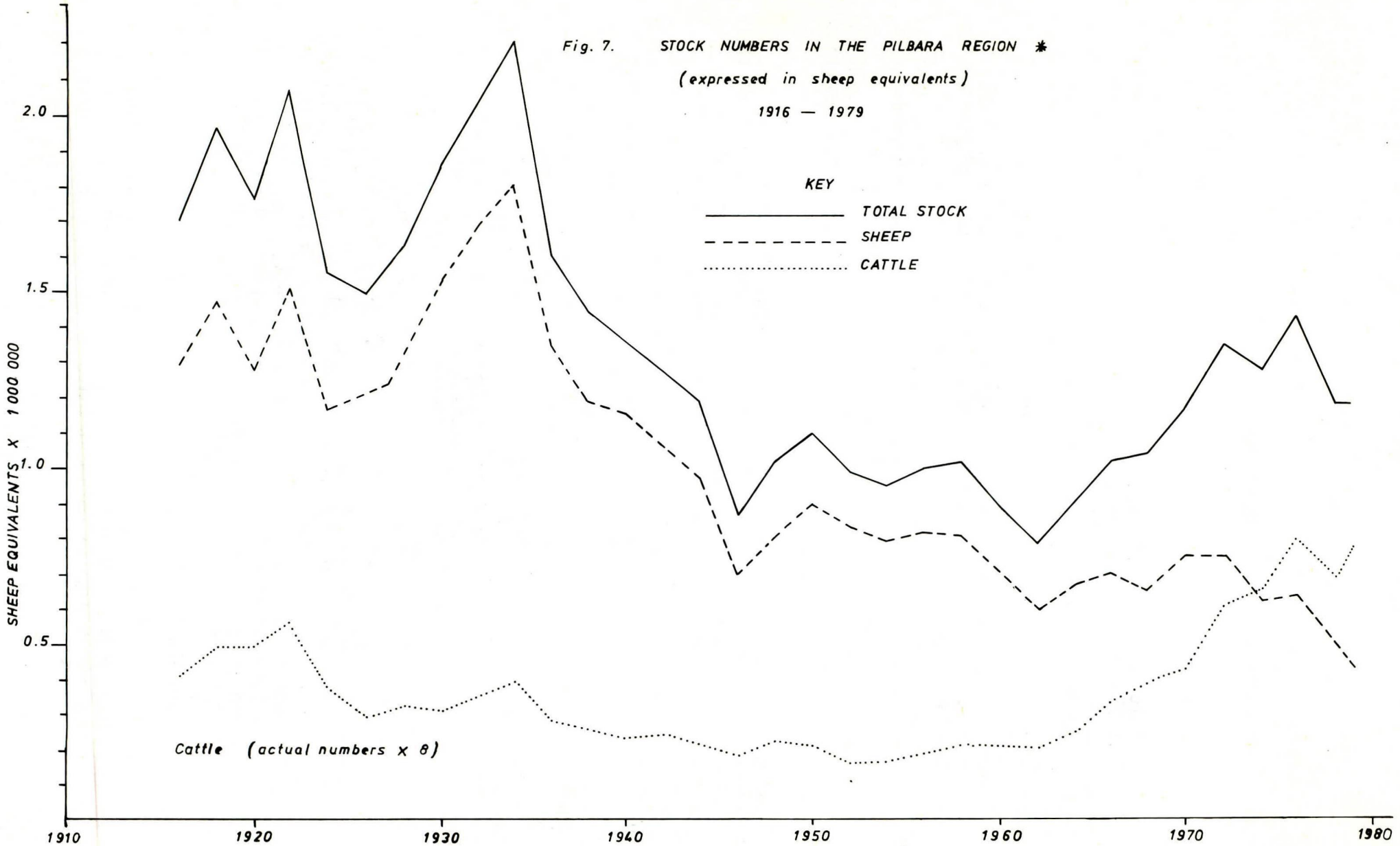
Further Observations

Since Abydos Pastoral Research Station was closed in 1976 the region experienced two exceptional seasons with frequent and plentiful rains. Some stations recorded up to 750 mm in a year. This is more than double

Fig. 7. STOCK NUMBERS IN THE PILBARA REGION *

(expressed in sheep equivalents)

1916 — 1979



* Shires of West Pilbara, Roebourne, Port Hedland, and East Pilbara.

the best year recorded in the 30 years of occupancy by the Department. As a result in paddocks which have been subject to summer burning and deferred grazing for 20 years, perennial weeping grass *(Chrysopogon latifolius)* became more widespread and occupied areas in which it had not been recorded since 1950. On pockets of cracking clay soils bundle-bundle *(Dichanthium* spp.) replaced the 'invader' buck spinifex *(Triodia longiceps)* following fire. These species must have been major components of the vegetation when these leases were first opened up.

References

Ealey, E.H.M., and Main, A.R. (1967). Ecology of the euro in N.W. Australia. III seasonal change in nutrition C.S.I.R.O. Wildl. Res. 12 : 53-65.

Ealey, E.H.M. (1962). Biology of the euro Ph. D. Thesis University of Western Australia.

Ealey, E.H.M., and Richardson, T.M. (1960). A successful campaign against the euro J. Agric. W. Aust. 4th series 1 : 757-769.