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"GROOTLAMSIEKTE", A SPECIFIC SYNDROME OF PROLONGED GESTATION IN SHEEP: FURTHER INVESTIGATIONS

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ABSTRACT

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By feeding both leaves and twigs of *Salsola tuberculata* var. *tomentosa* to pregnant ewes, it was established that the daily ingestion of 0,9 kg of this material for at least 10 to 50 days during any stage of gestation could result in postmaturity. The leaves mainly affected the terminal 50 days of pregnancy, whereas the twigs prolonged gestation even when fed during the initial 50 days. The longest gestation period after feeding twigs was 205 days and after leaves 214 days. Many of the lambs born between 150 and 165 days of gestation were either smaller than or equal in size to control lambs and enlarged ones were born mainly after longer periods. The heaviest experimental post-mature lamb mass-measured 9,46 kg. Normal post-natal development of multiple vesicular follicles was found in the ovaries of lambs born at normal term. This may at least partly explain the presence of ovarian polyfollicularity in post-maturity. *Partus* was frequently successfully induced by using stilboestrol and oxytocin, especially between 150 and 170 days of gestation. Many dystocias, however, occurred. The shrub is apparently most harmful when the dormant stages are ingested, especially during droughts. This phenomenon may be related either to an increased intake or to increased toxicity or to both factors.

INTRODUCTION

A specific syndrome of prolonged gestation in sheep in South West Africa was recently proved by Basson, Morgenthal, Bilbrough, Marais, Kruger & Van der Merwe (1969) to be due to the ingestion of a shrub, *Salsola tuberculata* (Fenzl ex Moq) Schinz var. *tomentosa* C. A. Smith ex Aellen.

The only vulnerable period was found to be during the last 50 days of gestation. Although the mean length of the gestation period in ewes fed on this shrub during the first 100 days of pregnancy was slightly longer than that of the control group, the increase was considered to be unimportant. The main objects of the present series of investigations were to determine the period of vulnerability more accurately, to establish the possible climatological factors responsible for the periodic and seasonal incidence of the syndrome and to obtain as much information as possible to assist in the control of the problem in the field. Induction of *partus* was also attempted.

EXPERIMENTAL STUDIES

Two camps covering 1 096 hectares in the enzootic area were used and stocked with 250 Karakul ewes and 11 rams. The two main camps were subdivided into smaller camps with sheds, pens and a water installation at a central point. These smaller camps were stocked at an average rate of 4 hectares per sheep. The ewes were flushed before mating by feeding 0,25 to 0,45 kg of lucerne hay daily for 3 weeks. Teaser rams were introduced each morning and evening for 4 to 5 days and subsequently removed for 10 days. Hand service was done with proven fertile rams. Each ewe was served 12 hours after the onset of oestrus and again at 12 hourly intervals until the termination of oestrus. The length of the gestation period was calculated from the first service in the last oestrous cycle. The ewes were kept on natural grazing except when feeding experiments were carried out. Natural grazing consisted of short grass and small shrubs, of which *S. tuberculata* (henceforth referred to as *Salsola*) was the dominant species.

Botulism, enterotoxaemia, *Pasteurella* and bluetongue vaccines were used in an annual vaccination programme. The sheep had access to a lick consisting of two parts of bone meal and one part of common salt (NaCl). Internal and external parasites caused no real problems, but the animals were treated occasionally with anthelmintics and insecticides. When a feeding experiment was carried out, the ewes were kept in one set of pens at night and in another by day. These pens were cleaned every morning.

Adaptation from natural grazing to crush-feeding (as described previously by Basson *et al.*, 1969) was at first accomplished in 8 days. In animals re-used in subsequent experiments, this period was eventually shortened to 2 days. The change from *Salsola* to lucerne meal was done in a day. This alteration was approximately at the same protein and carbohydrate level and caused no problems. The ewes took to natural grazing after feeding from the crushes without any apparent need for adaptation. Roughage consisting of lucerne hay, lucerne meal or teff hay was fed in the pens and each ewe received 0,9 kg daily. The basic ration consisted of 62 g whole maize, 62 g molasses plus 250 g lucerne meal. This ration was fed in the crushes in all experiments, but additions were made as indicated in each experiment. For the lucerne-fed control groups, 0,9 kg of lucerne meal was added daily to the ration of each sheep. The rations were divided into two portions and given twice daily in separate feeding crushes.

The rainfall was recorded regularly throughout the duration of the experiments. Specimens from a few lambs were collected in 10% formalin and processed in a routine way by embedding in paraffin wax and staining with haematoxylin and eosin.

The following aspects were investigated:-

A. Feeding *Salsola*
B. Feeding other shrubs
C. *Partus* induction
D. Post-natal ovarian development

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A. Feeding *SALSOLA*

Materials and methods

After service the ewes were kept on natural grazing and were only penned during the period that *Salsola* was fed. Feeding *Salsola* during the initial stages of pregnancy was always followed by a lucerne meal ration until *partus*. Either 0,9 kg *Salsola* leaves or *Salsola* twigs with leaves (henceforth referred to as twigs) were added to the basic daily ration of each ewe for various periods during the average normal length of gestation (150 days) as indicated in the various experiments. Post-term cases were retained on the same ration which they were receiving at normal term. Unless otherwise stated, the *Salsola* material was collected during the season in which each experiment was done. For the various seasonal experiments the ewes were separated as follows:

(i) *March to July 1968 (Table 1)*

This experiment was planned in order to determine more accurately the period of vulnerability (period of insult) during the last 50 days of pregnancy. Except where otherwise indicated the ewes were divided into seven groups of 16 to 18 animals each to which *Salsola* leaves were fed.

Group 1: Controls: Lucerne meal during last 50 days of gestation
Group 2: *Salsola* during last 50 days of gestation
Group 3: *Salsola* during last 40 days of gestation
Group 4: *Salsola* during last 30 days of gestation
Group 5: *Salsola* during last 20 days of gestation
Group 6: *Salsola* during last 10 days of gestation
Group 7: Natural grazing for the entire gestation period

(ii) *October 1968 to March 1969 (Table 2)*

Another experiment was conducted during a different season and *Salsola* twigs were fed as follows to groups of 13 to 15 ewes each.

Group 1: Last 50 days of gestation
Group 2: Last 35 days of gestation
Group 3: Last 20 days of gestation
Group 4: Last 10 days of gestation
Group 5: Controls. Lucerne meal during the last 50 days of gestation
Group 6: Natural grazing for the entire gestation period

(iii) *September 1969 to January 1970 (Table 3)*

Salsola-fed ewes were used mainly to determine whether the substitution of *Salsola* with lucerne meal for various periods could prevent post-maturity. The ewes were divided into seven groups of 10 to 14 animals each.

Group 1: These ewes were fed *Salsola* twigs during the first 100 days of pregnancy in order to verify the safety of this period.

The animals in the following groups received rations of *Salsola* leaves and lucerne meal during the last 50 days of pregnancy as indicated.

Group 2: For 50 days *Salsola* leaves only
Group 3: Initial 40 days *Salsola* leaves, last 10 days lucerne meal
Group 4: Initial 30 days *Salsola* leaves, last 20 days lucerne meal
Group 5: Initial 20 days *Salsola* leaves, last 30 days lucerne meal
Group 6: Initial 10 days *Salsola* leaves, last 40 days lucerne meal
Group 7: Natural grazing for the entire gestation period.

(iv) *May to September 1970 (Table 4)*

The ewes were kept in pens throughout the experiment because grazing conditions were poor. They were divided into four groups of 13 to 15 animals each and, during various stages of gestation, were fed *Salsola* material collected during January and February 1970. This was done in order to establish any possible toxic difference between leaves and twigs.

Group 1: *Salsola* leaves during first 50 days of gestation
Group 2: *Salsola* twigs during first 50 days of gestation
Group 3: *Salsola* leaves during 50 to 100 days of gestation
Group 4: *Salsola* twigs during 50 to 100 days of gestation

Results

The clinical syndrome of prolonged gestation conformed to the one described previously (Basson *et al.*, 1969). Some of the ewes were assisted manually and a small number were caesarianed. A few dead foetuses were delivered.

(i) *March to July 1968 (Table 1)*

Cases of post-maturity occurred in all the various groups that received *Salsola* leaves, particularly in Group 2, to which it was fed during the terminal 50 days of gestation. It was even evident in those ewes that only received *Salsola* leaves for the last 10 days of gestation. The maximum length of gestation was 214 days and the heaviest lamb (9,46 kg) was delivered from this ewe. The length of gestation in both the controls fed on lucerne and on natural grazing was within the normal range.

(ii) *October 1968 to March 1969 (Table 2)*

Post-maturity occurred in all groups that received *Salsola* twigs, the incidence being highest (100%) in Group 1, in which they were fed during the terminal 50 days of gestation. Feeding during the last 10 days resulted in 2 cases of post-maturity. The longest gestation period was 173 days. None of the controls fed on lucerne or on natural grazing had prolonged gestation periods.

(iii) *September 1969 to January 1970 (Table 3)*

Contrary to previous experience, many cases of post-maturity developed in Group 1, which was given twigs during the first 100 days of gestation. One of these ewes had a gestation period of 199 days. The main object of this trial, however, was to establish whether the substitution of *Salsola* leaves with lucerne meal in the feed for various periods during the last 50 days of gestation could prevent post-maturity (see Groups 2 to 6). In these groups only a few cases of mild post-maturity were encountered. Five cases were found in Group 7, which was kept on natural grazing.

(iv) *May to September 1970 (Table 4)*

The majority of ewes (85,7%) fed twigs for the first 50 days had prolonged gestation periods, whereas those which received leaves for the same period, had a normal mean gestation period with a maximum of 155 days in only one animal. In Group 4, which was given twigs during the second 50-day period, one case of post-maturity was found.

The data from all the corresponding experimental groups fed *Salsola* material since 1966 are compared in Table 5. The mean and maximum length of gestation

TABLE 1 Results of experiments with *Salsola* leaves during March to August 1968

Ewe No.	Group 1 (Controls)			Group 2 *Salsola* last 50 days of normal gestation			Group 3 *Salsola* last 40 days of normal gestation			Group 4 *Salsola* last 30 days of normal gestation			Group 5 *Salsola* last 20 days of normal gestation			Group 6 *Salsola* last 10 days of normal gestation			Group 7 Field controls		
	Gestation	Ewe mass (postpartum)	Lamb mass	Gestation	Ewe mass (postpartum)	Lamb mass	Gestation	Ewe mass (postpartum)	Lamb mass	Gestation	Ewe mass (postpartum)	Lamb mass	Gestation	Ewe mass (postpartum)	Lamb mass	Gestation	Ewe mass (postpartum)	Lamb mass	Gestation	Ewe mass (postpartum)	Lamb mass
	(days)	(kg)	(kg)	(days)	(kg)	(kg)	(days)	(kg)	(kg)	(days)	(kg)	(kg)	(days)	(kg)	(kg)	(days)	(kg)	(kg)	(days)	(kg)	(kg)
1	146	50,9	Twins	149	47,9	4,29	149	50,5	3,98	149	46,1	3,81	148	67,3	4,23	148	55,9	4,12	144	45,5	4,40
2	146	50,4	4,43	150	53,2	Twins	150	54,5	3,92	151	51,6	3,47	149	66,4	4,43	149	42,5	4,23	147	53,6	4,20
3	147	48,2	4,15	151	52,5	4,49	151	49,8	Twins	152	51,4	4,89	150	58,4	4,18	149	56,6	3,92	147	53,9	3,89
4	147	41,1	5,45	152	48,6	4,12	153	53,9	5,14	152	52,7	4,86	152	51,8	Twins	151	54,3	Twins	147	43,2	5,34
5	149	69,1	5,26	153	58,4	4,66	153	56,4	4,35	153	59,5	4,23	152	56,6	Twins	151	43,6	3,98	147	52,0	3,24
6	149	48,6	5,11	153	55,0	4,43	153	54,5	5,06	154	58,6	5,8	152	46,1	4,26	152	50,9	4,83	148	46,8	4,32
7	149	47,7	3,52	153	48,9	4,74	153	50,9	4,66	154	51,8	4,74	153	55,2	4,60	153	46,6	4,26	148	62,0	4,15
8	149	50,2	3,72	154	50,0	4,26	154	50,0	5,00	155	50,5	4,03	154	53,2	5,03	153	45,9	4,20	148	46,1	4,77
9	149	55,2	5,23	154	40,4	4,66	155	54,5	2,93	155	55,5	4,38	154	41,4	4,57	154	48,2	4,40	148	54,5	4,92
10	149	55,0	4,94	154	50,5	4,06	156	65,2	4,15	156	57,3	5,34	155	61,8	4,67	154	37,7	3,18	148	45,9	5,34
11	150	49,1	4,89	154	52,3	4,89	156	53,2	4,09	156	52,0	5,48	157	47,0	4,49	154	41,4	5,17	149	52,5	4,38
12	150	59,8	4,6	154	48,6	4,23	156	37,5	4,46	156	50,0	5,09	157	46,6	5,03	155	53,6	4,97	149	52,0	4,55
13	150	49,8	4,77	155	41,4	4,29	157	50,5	4,74	157	59,3	4,55	157	54,5	5,45	156	45,9	4,55	149	51,8	4,52
14	150	49,1	3,41	155	35,0	4,06	157	50,9	5,48	157	41,8	4,92	158	32,7	5,82	157	53,6	4,89	150	53,2	5,11
15	150	60,5	6,08	156	65,0	Twins	158	45,9	4,60	160	52,5	5,45	159	44,1	5,74	160	46,1	4,40	150	61,4	5,23
16	151	47,7	Twins	158	52,7	5,47	159	64,3	5,88	161	62,3	5,23	160	42,3	5,82	162	46,4	4,32	151	50,0	4,80
17	151	59,1	5,62	214†	52,3*	9,49	163	46,1	5,68	164	51,8	4,74	162	63,9	5,03				151	47,3	4,33
18	152	46,1	4,88				173	54,5	5,99				163	61,8	4,86				154	48,2	5,06
Mean	149,1		4,75	157,0		4,87	155,9		4,71	155,4		4,76	155,11		4,89	153,6		4,36	148,6		4,59

*Adjusted prepartum mass (Lamb mass + 0,9 kg subtracted)
†Caesarianed

TABLE 2 Results of experiments with *Salsola* twigs during October 1968 to March 1969

Ewe No.	Group 1 *Salsola* last 50 days of normal gestation			Group 2 *Salsola* last 35 days of normal gestation			Group 3 *Salsola* last 20 days of normal gestation			Group 4 *Salsola* last 10 days of normal gestation			Group 5 Controls			Group 6 Field controls		
	Gestation	Ewe mass (post-partum)	Lamb mass	Gestation	Ewe mass (post-partum)	Lamb mass	Gestation	Ewe mass (post-partum)	Lamb mass	Gestation	Ewe mass (post-partum)	Lamb mass	Gestation	Ewe mass (post-partum)	Lamb mass	Gestation	Ewe mass (post-partum)	Lamb mass
	(days)	(kg)	(kg)	(days)	(kg)	(kg)	(days)	(kg)	(kg)	(days)	(kg)	(kg)	(days)	(kg)	(kg)	(days)	(kg)	(kg)
1	155	53,2	4,15	150	41,4	3,92	145	46,8	3,15	148	40,9	4,09	147	51,8	4,60	147	52,5	3,72
2	159	50,9	5,09	151	51,4	3,49	150	42,3	3,61	149	51,1	3,49	148	52,3	4,26	148	63,6	4,80
3	159	50,5	4,63	152	44,5	4,29	150	52,7	4,35	150	52,3	4,77	148	55,3	4,46	150	50,0	3,78
4	159	62,7	5,23	153	58,0	4,40	151	50,9	4,55	151	53,6	4,92	149	53,2	5,34	150	55,2	4,77
5	159	61,1	4,69	154	48,9	4,72	152	58,6	4,89	151	53,2	4,92	150	53,6	4,15	150	55,5	5,65
6	160	45,5	5,06	154	43,6	3,69	152	41,1	4,62	151	53,4	4,55	150	60,9	4,89	150	47,3	5,43
7	162	59,1	4,97	155	45,7	4,32	152	47,5	4,06	151	48,7	3,61	150	58,4	4,69	151	52,0	4,55
8	164	53,6	4,72	156	52,5	5,17	154	54,5	5,09	152	65,9	5,82	150	57,7	4,57	152	60,7	4,40
9	165	52,5	5,71	156	58,6	5,16	157	46,1	5,57	152	60,7	4,43	151	49,1	5,06	152	45,5	5,80
10	165	45,9	4,94	157	58,0	5,40	159	51,6	6,65	152	44,5	4,25	151	53,9	4,49	153	49,5	5,57
11	168	48,9	6,25	157	58,9	4,77	159	38,6	4,94	153	59,1	4,77	152	47,7	4,69			
12	173	48,9	6,59	163	53,4	5,34	159	60,0	5,51	153	41,6	4,38	152	49,3	5,20			
13				164	50,5	4,89	159	50,0	6,34	154	65,7	4,64	153	57,5	5,31			
14				168	45,2	5,97	168	45,9	6,34	160	61,4	6,19						
15				168	56,4	6,14				160	52,7	2,44						
Mean	162,2		5,17	157,2		4,78	154,8		4,97	152,5		4,5	150,1		4,75	150,3		4,87

All the lamb masses are adjusted (stomach mass and contents subtracted)

TABLE 3 Results of the *Salsola* experiments during September 1969 to January 1970

Ewe No.	Group 1 First 100 days of gestation *Salsola* twigs. Last 50 days lucerne			Group 2 Last 50 days *Salsola* leaves			Group 3 Last 50 days: 40 days *Salsola* leaves, last 10 days lucerne			Group 4 Last 50 days: 30 days *Salsola* leaves, last 20 days lucerne			Group 5 Last 50 days: 20 days *Salsola* leaves, last 30 days lucerne			Group 6 Last 50 days: 10 days *Salsola* leaves, last 40 days lucerne			Group 7 Field controls		
	Gestation	Ewe mass (postpartum)	Lamb mass	Gestation	Ewe mass (postpartum)	Lamb mass	Gestation	Ewe mass (postpartum)	Lamb mass	Gestation	Ewe mass (postpartum)	Lamb mass	Gestation	Ewe mass (postpartum)	Lamb mass	Gestation	Ewe mass (postpartum)	Lamb mass	Gestation	Ewe mass (postpartum)	Lamb mass
	(days)	(kg)	(kg)	(days)	(kg)	(kg)	(days)	(kg)	(kg)	(days)	(kg)	(kg)	(days)	(kg)	(kg)	(days)	(kg)	(kg)	(days)	(kg)	(kg)
1	145	61,6	Twins	148	49,3	3,24	146	44,5	4,40	147	59,1	4,97	147	46,4	3,93	147	35,9	3,84	144	36,4	3,55
2	148	39,6	4,72	148	49,3	4,38	147	50,9	3,41	147	40,9	4,38	149	36,4	4,49	148	44,5	4,15	147	27,3	2,95
3	149	55,0	4,38	148	51,8	Twins	149	51,6	4,52	148	53,2	3,21	149	51,8	4,29	148	50,2	4,43	150	40,5	3,66
4	150	59,3	5,34	149	52,0	3,86	149	51,4	4,32	151	37,3	3,95	150	43,6	4,66	148	44,1	Twins	150	70,5	4,55
5	153	39,1	4,38	150	44,5	4,20	150	52,0	4,72	151	53,6	4,82	150	41,8	4,74	148	56,4	5,09	151	40,5	4,23
6	155	63,2	5,34	150	46,8	3,66	151	53,6*	5,34	151	53,6	4,38	150	40,9	4,60	148	39,6	3,98	155	48,7	3,55
7	155	60,9	4,26	152	47,7	5,09	151	50,0	4,77	152	55,0	5,23	151	48,9	4,49	149	60,0	4,94	155	38,6	3,55
8	156	56,4	5,43	152	58,6	5,28	152	46,8	4,82	152	50,9	5,26	151	51,8	5,43	149	63,6	5,14	155	33,2	4,55
9	157	52,3	4,89	153	54,3	4,00	154	52,5	4,55	152	46,8	6,25	151	53,4	4,32	149	42,3	4,20	157	43,2	4,60
10	169†	47,3	5,80	154	43,6	4,26	154	45,5	4,69	152	54,3	5,23	151	45,9	4,92	150	50,0	5,51	184	—	4,15
11	176	56,8	4,94	155	53,6	5,03	154	56,1	5,65	153	50,0	5,23	151	57,7	5,23	151	44,5	4,23			
12	186†	45,9	6,76	156	46,1	4,06	155	43,2	3,98	155	53,6	4,23	152	51,8	5,80						
13	192	45,5*	4,57	156	56,8	4,92	155	44,1	5,00				154	50,0	5,88						
14	199	53,6*	7,16	159	48,2	5,60	157	46,8	5,34												
Mean	163,6		5,23	152,1		4,43	151,7		4,66	150,9		4,67	150,5		4,83	148,6		4,55	154,8		3,93

All the lamb masses adjusted
*Prepartum mass adjusted
†Caesarianed

TABLE 4 Results of *Salsola* experiments during May to September 1970

Ewe No.	Group 1 *Salsola* leaves: first 50 days of normal gestation			Group 2 *Salsola* twigs: first 50 days of normal gestation			Group 3 *Salsola* leaves: 50 to 100 days of normal gestation			Group 4 *Salsola* twigs: 50 to 100 days of normal gestation		
	Gestation	Ewe mass (postpartum)	Lamb mass	Gestation	Ewe mass (postpartum)	Lamb mass	Gestation	Ewe mass (postpartum)	Lamb mass	Gestation	Ewe mass (postpartum)	Lamb mass
	(days)	(kg)	(kg)	(days)	(kg)	(kg)	(days)	(kg)	(kg)	(days)	(kg)	(kg)
1	147	50,2	3,64	151	41,8	3,64	147	48,2	—	145	37,9	—
2	147	48,2	3,93	153	48,2	4,15	148	46,6	3,69	148	48,7	4,15
3	148	35,5	3,20	155	38,9	Twins	148	55,7	—	148	50,7	4,45
4	149	51,4	4,60	155	55,0	3,93	150	44,5	3,32	149	44,5	3,75
5	149	50,0	3,47	159	46,4	3,52	150	59,8	4,60	149	43,2	Twins
6	149	51,4	4,20	162†	45,9	3,47	150	48,7	5,06	149	43,6	4,20
7	150	50,5	4,18	166	40,0	3,24	150	58,0	4,30	150	42,7	3,84
8	150	40,5	4,03	166	40,9	3,52	150	45,0	4,12	150	55,0	4,09
9	150	38,2	3,72	175	36,4	3,27	151	45,9	4,43	151	40,5	3,52
10	152	43,4	4,01	178†	49,5	Twins	151	43,2	4,63	151	43,4	4,23
11	152	37,7	3,86	184	52,3	Twins	151	44,5	4,38	152	43,6	Twins
12	153	49,5	2,84	184†	48,2	5,43	152	45,2	4,89	153	40,2	3,18
13	155	47,7	5,28	191†	50,0*	5,82	152	51,6	4,32	153	38,6	3,75
14				205†	39,6*	8,89				153	37,3	4,09
15										178†	—	4,01
Mean	150,0		3,92	170,3		4,44	150,0		4,44	151,9		3,94

All lamb masses adjusted
*Prepartum mass adjusted
†Caesarianed

TABLE 5 Summary of most important findings: 1966–1970

Feeding of *Salsola*		*Salsola* material		No. of ewes	Length of Gestation		
Period during gestation	Duration	Season collected	Type used		Mean	> 154 days	Maximum
(days)					(days)		(days)
1–50*	March - Sept. 1967	Oct. 1966 - Aug. 1967	Leaves	11	149,4	0%	152
1–50	May - Sept. 1970	Jan. - Feb. 1970	Leaves	13	150,0	7,0%	155
1–50	May - Sept. 1970	Jan. - Feb. 1970	Twigs	14	170,3	85,0%	205
50–100*	March - Sept. 1967	Oct. 1966 - Aug. 1967	Leaves	16	150,0	0%	153
50–100	May - Sept. 1970	Jan. - Feb. 1970	Leaves	13	150,0	0%	152
50–100	May - Sept. 1970	Jan. - Feb. 1970	Twigs	15	151,9	6,6%	178
100–150*	March - Sept. 1967	Oct. 1966 - Aug. 1967	Leaves	15	152,8	13,3%	163
100–150	March - Aug. 1968	March - Aug. 1968	Leaves	17	157,0	29,4%	214
100–150	Sept. 1969 - Jan. 1970	Sept. 1969 - Jan. 1970	Leaves	14	152,1	28,5%	159
100–150	Oct. 1968 - March 1969	Oct. 1968 - March 1969	Twigs	12	162,2	100,0%	173
1–100*	March - Sept. 1967	Jan. - Feb. 1970	Leaves	11	150,4	9,5%	155
1–100	Sept. 1969 - Jan. 1970	Sept. 1969 - Jan. 1970	Twigs	14	163,6	64,2%	199
1–150*	March - Sept. 1967	Oct. 1966 - Aug. 1967	Leaves	15	154,9	48,6%	166
1–150*	March - Oct. 1966	March - Oct. 1966	Twigs	29	161,9	68,5%	191
50–150*	March - Sept. 1967	Oct. 1966 - Aug. 1967	Leaves	14	154,2	42,8%	170
110–150	March - Aug. 1968	March - Aug. 1968	Leaves	18	155,9	55,6%	173
120–150	March - Aug. 1968	March - Aug. 1968	Leaves	17	155,4	58,8%	164
130–150	March - Aug. 1968	March - Aug. 1968	Leaves	18	155,1	44,4%	163
140–150	March - Aug. 1968	March - Aug. 1968	Leaves	16	153,6	31,3%	162
115–150	Oct. 1968 - March 1969	Oct. 1968 - March 1969	Twigs	15	157,2	60,0%	168
130–150	Oct. 1968 - March 1969	Oct. 1968 - March 1969	Twigs	14	154,8	42,8%	168
140–150	Oct. 1968 - March 1969	Oct. 1968 - March 1969	Twigs	15	152,5	13,3%	160
100–140	Sept. 1969 - Jan. 1970	Sept. 1969 - Jan. 1970	Leaves	14	151,7	21,4%	157
100–130	Sept. 1969 - Jan. 1970	Sept. 1969 - Jan. 1970	Leaves	12	150,9	12,5%	155
100–120	Sept. 1969 - Jan. 1970	Sept. 1969 - Jan. 1970	Leaves	13	150,5	0%	154
100–110	Sept. 1969 - Jan. 1970	Sept. 1969 - Jan. 1970	Leaves	11	148,6	0%	151

*Results of previous investigation (Basson *et al.*, 1969)

and the number of cases of post-maturity are given in relation to the *Salsola* material fed. It is apparent that the last 50-day period of gestation is markedly more vulnerable to the feeding of leaves whereas the entire period is affected by twigs, particularly the initial and terminal 50-day periods. Only two of the 64 ewes fed leaves during the first 100 days had prolonged gestation periods of 155 days. In general, therefore, indications were obtained that the initial and terminal 50-day periods of gestation are more vulnerable to the deleterious effects of the shrub than the middle period.

The monthly rainfall is summarized in Table 6. Natural cases of post-maturity occurred only during the 5-month period between September 1969 and January 1970 when 6 mm of rainfall was recorded. Some indications were also obtained in the feeding experiments that the shrub may be more toxic when it is dormant.

Analysis of all the experimental data since 1966 (Basson *et al.*, 1969) confirmed previous observations that the mass of the lambs during early postmaturity is somewhat subnormal and that a decline in mass gain follows before an ultimate increase is experienced (Fig. 1).

TABLE 6 Monthly rainfall during course of experiments

	Rainfall (mm)											
Year	January	February	March	April	May	June	July	August	September	October	November	December
1966	70	60,5	7	11	0	5	0	0	4	41	0	0
1967	48	75	37	15,5	40	0	0	0	0	0	11	0
1968	0	9	113	0	23	13	0	0	0	18	0	10
1969	84	25	8	20	0	0	0	0	0	0	0	0
1970	6	5	0	No more records: Ewes kept in pens								

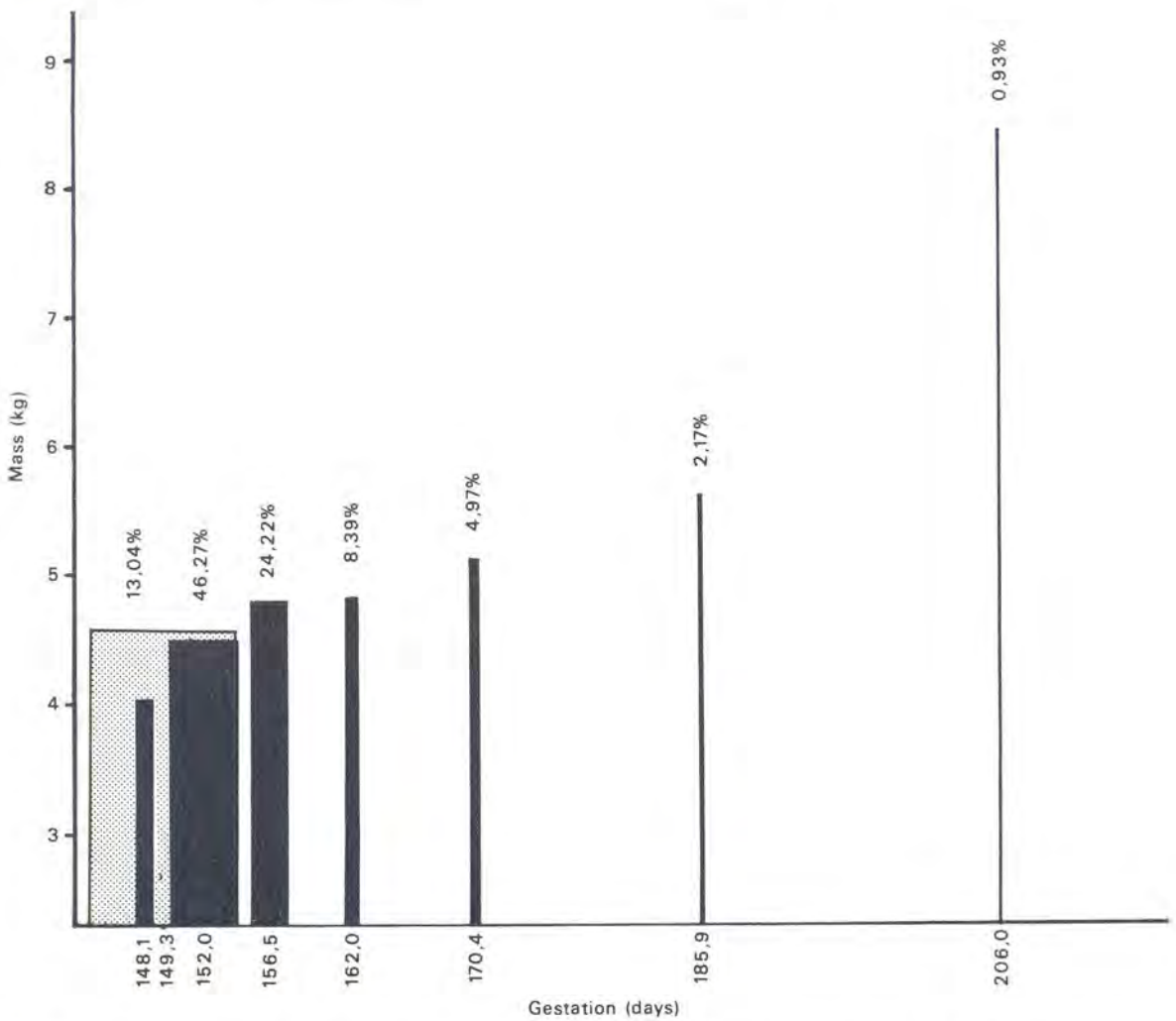

FIG. 1 Comparative frequency distribution of the body masses of all control (dotted histogram) and artificially produced post-mature lambs (black histograms) since 1966

B. Feeding other Shrubs

The shrubs mentioned below are found throughout the enzootic area, but they are not as frequently grazed during outbreaks of "grootlamsiekte" as *Salsola* is. They were fed to pregnant ewes in order to determine their effect on the length of gestation.

Materials and methods

The following shrubs were fed:

(1) *Leucosphaera bainesii* (Hook. f.) Gilg ("wolbos")
(2) *Monechma australe* P. G. Meyer ("perdebos")
(3) *Petalidium linifolium* T. Anders ("lusernbos")
(4) *Boscia foetida* Schinz ("noenieboom")

Four groups of ten ewes each were selected. Each ewe was fed 0,9 kg of a specific shrub daily except those that were fed *B. foetida,* of which each animal received 0,45 kg of berries daily. The ewes were given these rations in addition to the basic ration (*vide supra*) for the last 50 days of gestation.

Results

No increase in the length of gestation or any other ill effects were found when any of these shrubs were fed to pregnant ewes. The length of gestation in each group was as follows:

(1) *L. bainesii:* 148 to 153 days. Mean 150,1 days
(2) *M. australe:* 147 to 152 days. Mean 148,9 days
(3) *P. linifolium*: 147 to 151 days. Mean 148,6 days
(4) *B. foetida*: 147 to 154 days. Mean 149,5 days

C. *PARTUS* Induction

Materials and methods

The following drugs were injected intramuscularly:

(1) Stilboestrol dipropionate B vet C* (10 mg/ml): 2 to 4 ml/ewe
(2) E.C.P. Estradiol cypionate** (1 mg/ml): 3 ml/ewe
(3) Syntometrine***: 5 IU Synthetic oxytocin plus ergometrine maleate B.P. (500 mcg/c³): 1 to 3 ml/ewe
(4) Oxytocin V, synthetic oxytocin**** (10 IU/ml): 1 to 3 ml/ewe
(5) Rolitetracycline*****: 110 mg/ewe

Ten ewes that had received *Salsola* leaves during the last 50 days of pregnancy were selected and divided into two equal groups. Induction of *partus* was attempted at 147 to 150 days of pregnancy except in one ewe that was pregnant for 169 days. All the ewes were examined *per vaginam* and none revealed any degree of cervical dilatation prior to induction. The individual dosages used in Group 1 and Group 2 were 3 mg estradiol and 30 mg stilboestrol respectively. Syntometrine (3 ml/ewe) was given after complete dilatation

*May Baker
**Upjohn
***Sandoz
****Ciba
*****Hoechst

Table 7 Partus induction in natural post-term cases

Groups	No. of ewes	Stilboestrol dosage	Time lapse	Oxytocin dosage	Time taken up to partus	Second injection Oxytocin: (No. of ewes)	Gestation: Remarks	Dystocias
		(mg)	(hours)	(IU)	(hours)			%
1	14	30	13	30	3 to 33	6	*Advanced post-term cases	25,0
2	9	30	13	20	3 to 33	4	*Advanced post-term cases	25,0
3	25	30	14	20	4 to 36	11	*Advanced post-term cases	80,0
4	20	30	14	20	3 to 14	9	*Advanced post-term cases	80,0
5	5	30	14	10	3 to 14	5	*Advanced post-term cases	86,0
6	28	30	14	20	8 to 56	2	*Advanced post-term cases	86,0
7	9	30	14	10	8 to 56	9	*Advanced post-term cases	86,0
8	15	30	14	30	9 to 60		> 165 days gestation	80,0
9	22	30	12	30	6 to 50		> 170 days gestation	86,0
10	11	30	12	10	6 to 42		150–155 days gestation	2,5
11	70	30	24	10	3 to 24		150–155 days gestation	2,5

*No accurate mating records available

of the cervix. Four of the five ewes in the estradiol group received a second injection of 1 ml syntometrine 7 hours later.

A total of 228 natural post-term cases was also used for experimental induction of *partus* (Table 7). A dosage of 20 to 40 mg stilboestrol, which was sometimes subdivided into two equal doses, or of 3 to 4 mg estradiol was used for priming, followed by oxytocin (10 to 30 IU) after an interval of 9 to 24 h. When necessary a second injection of 10 IU oxytocin was given 5 to 7 h later. In order to combat secondary bacterial infections rolitetracycline was eventually administered simultaneously with oxytocin and repeated 24 h later. The number of ewes which developed dystocias was recorded and they were assisted either manually or by caesarian section.

Results

After priming with stilboestrol or estradiol, complete cervical dilatation followed within 9 to 14 h. The ewes were alert and ill at ease 10 min. after syntometrine administration. They twitched their tails, lay down and then rose again immediately and made frequent attempts to micturate. This phase lasted 15 to 30 min. After another 4 to 6 h they showed similar signs which led to contractions. Most of the 10 *Salsola*-fed ewes which were used developed dystocias and birth had to be assisted manually. The lambs were all found in an anterior presentation with cranio-pubic position and shoulder flexion of both front limbs. The chorio-allantioc sac was not ruptured and all these lambs were dead. The placenta was delivered with the lambs.

By using oxytocin instead of syntometrine in the natural cases with prolonged gestation, better results were obtained (Table 7). *Partus* was frequently normal and live lambs were delivered. Protracted *partus* and poor response was seen in ewes with unusually large foetuses. With gestation periods of up to 170 days most ewes reacted well to *partus* induction. Beyond this stage results were poor. This was mainly due to the large size of the lambs, the overgrown pelts, the small amount of foetal fluid and the fact that at this stage the ewes seemed to respond less favourably to the drugs.

After induced *partus*, up to 10% of the ewes died of bacterial metritis and from these lesions *Clostridium septicum, Pasteurella multocida* and *Streptococcus zooepidemicus* were isolated. Further mortalities were, however, prevented by the use of rolitetracycline.

D. Postnatal Ovarian Development

Materials and methods

Fifteen ewe lambs born from ewes on natural grazing and from *Salsola*-fed ewes with normal gestation periods, were reared with their mothers under natural conditions in the enzootic area. The lambs were divided into three groups which were slaughtered at 1, 2 and 3 months of age respectively. The ovaries of each lamb were collected in 10% formalin and, after fixation, their masses and the number of developing follicles were determined macroscopically.

Results

The normal post-natal development of multiple vesicular follicles seemed to reach a maximum at approximately 2 months of age. Both the maximum number of follicles and the maximum ovarian mass were still lower than the corresponding figures in post-mature lambs (Basson *et al.*, 1969), but the rate of post-natal body mass gain in normal lambs was considerably greater than the pre-natal mass gain in post-mature lambs.

No additional information was obtained from the histopathological studies and most of the previous observations were confirmed.

Discussion

As indicated earlier, one of the main objects of the present investigation was to obtain as much information as possible which could assist in the control of the problem in the field. Under natural conditions outbreaks of post-maturity are most severe during dry summers with very low rainfall. The present series of experiments, especially the field groups, indicated that *S. tuberculata* possibly contains more of the active toxic ingredient in its dormant stage, during dry periods, than at any other time. However, some cases of post-maturity (mostly mild) could also be produced during other seasons of the year, even when natural outbreaks are not experienced or recognized. The higher incidence of post-maturity in the field controls, however, could also be explained by increased intake of the shrub. Another very important finding was the effect of twigs as compared with that of leaves on the length of gestation period. With the latter, the period of insult proved to be mainly the last 50 days of gestation (Basson *et al.*, 1969), whereas the former affected even the

Table 8 Data of post-natal ovarian development in normal lambs

No.	Group 1 Age 1 month			Group 2 Age 2 months			Group 3 Age 3 months		
	Body mass	*Ovarian mass	*No. of follicles	Body mass	Ovarian mass	No. of follicles	Body mass	Ovarian mass	No. of follicles
	(kg)	(g)		(kg)	(g)		(kg)	(g)	
1	10,82	0,17	12	17,73	1,44	92	15,68	0,93	38
2	12,05	0,12	7	21,82	0,89	40	22,50	0,93	24
3	11,14	0,26	9	19,55	1,42	65	14,32	0,65	20
4	11,50	0,81	62	19,55	1,26	46	15,00	0,64	10
5	10,91	0,60	20	15,91	1,57	76	20,91	0,84	40
Mean	11,48	0,39	22	18,91	1,32	64	17,68	0,80	26

*Data of both ovaries are given

first 50 days very markedly. It is evident, therefore that a related active principle which has an earlier effect on gestation is present in the twigs. The object of one of the experiments designed to establish whether the feeding of lucerne as a substitute for *Salsola* for various periods during the last 50 days of pregnancy would be beneficial, was therefore nullified. It was also proved that the feeding of *Salsola* for only 10 days prior to normal term could result in mild prolongation of gestation. The daily ingestion of 0,9 kg of *Salsola* for at least 10 to 50 days during any stage of gestation can therefore result in post-maturity. However, there are some indications that the initial and terminal 50-day periods of gestation are more vulnerable than the middel period. The previous observations that many lambs during early post-maturity are either a little smaller than or more or less equal in size to those born at normal term and that a subsequent decline in mass gain follows before the ultimate upward leg of the peak is commenced, were confirmed. These observations show that the syndrome can occur unnoticed under natural conditions. Other factors, such as breeding and nutrition, might then be blamed for inferior or overgrown pelts. The estimated loss for the Karakul farmer due to post-maturity is consequently higher than is generally recognized. As expected, the rate of post-natal mass gain of normal lambs exceeded the rate of pre-natal mass gain of post-mature lambs.

It was proved that *partus* induction could alleviate the problem of post-maturity to some extent. Post-term stages up to 170 days gestation were treated successfully with stilboestrol, oxytocin and antibiotics. An interval of 24 hours between the administration of stilboestrol and oxytocin seemed to be more than adequate and fitted in well with the farm routine. Many dystocias and foetal deaths developed following the use of syntometrine. This was probably due to some uterine vasoconstriction.

Attempts to clarify the enigma of ovarian poly-follicularity in post-mature lambs revealed that some of it at least was due to a normal formation of multiple vesicular follicles which occurs post-natally before sexual maturity is reached. Although lambs from *Salsola*-fed ewes and ewes exposed to natural *Salsola* grazing were used, all of them were born at normal term. The post-natal development of multiple vesicular follicles is a well-known phenomenon in man and monkeys (Van Wagenen & Simpson, 1965) and seemingly also to a lesser extent in cattle (Erickson, 1966). However, the marked ovarian development and poly-follicularity encountered in some of the most advanced cases of post-maturity could possibly be due to the prolonged effect of placental hormones, as suggested by Basson *et al.*, (1969), but unless critical endocrinological experiments are undertaken this is still somewhat speculative. Feeding of pregnant ewes with various other shrubs from the enzootic area did not cause prolongation of the gestation period.

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