THE DAMARA SHEEP: AN APPRAISAL OF ITS REPRODUCTIVE
PERFORMANCE AND POTENTIAL

by

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Dissertation presented for the degree of

DOCTOR OF PHILOSOPHY

(AGRICULTURE)

in the

DEPARTMENT OF HUMAN AND ANIMAL PHYSIOLOGY

FACULTY OF AGRICULTURAL SCIENCES
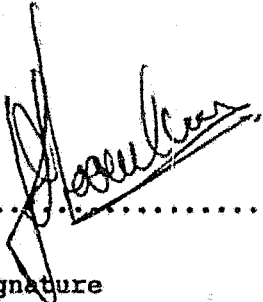
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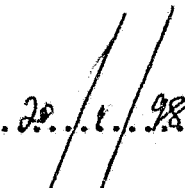
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MARCH 1998

DECLARATION

I the undersigned hereby declare that the work contained in
this dissertation is my own original work and has not
previously in its entirety or in part been submitted at any
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ABSTRACT

Investigations undertaken in this research program was
hampered by mainly two aspects viz. small numbers of animals
available for research purposes and that the work was
executed, due to circumstances, under intensive conditions,
taking into account that the breed is recognized for its
ability to survive under extensive and harsh conditions. The
results that came forth from this work should therefore
rather be regarded and treated as a springboard for further
research on aspects investigated and also on additional
topics of importance, rather than a set data base
representing the Damara breed.

Treatment of Damara ewes with different synchronisation
procedures gave rise to inconsistent results with regard the
interval from cessation of treatment to onset of oestrus.
Group A1 differed significantly from Groups A2, A3 and A4
($P < 0.05$). In most instances the interval under
discussion tended to be longer than findings quoted in the
literature. With regard duration of oestrus, all treatment
groups showed comparable oestrous durations except the PMSG
treated group which showed a markedly longer oestrous
period. The difference was however not significant
($P > 0.05$).

Breeding techniques (AI vs natural tupping) had no significant effect on reproductive performance with reference to the two experimental groups (P > 0.05). The average duration of the gestation period was 150 days which is in agreement with that recorded for other sheep breeds. The Damara ewe seems to have some resistence towards lower levels (5 mg) of PGF2a during pregnancy but is vulnerable towards higher concentrations (10 mg) during early pregnancy.

Plasma progesterone profiles indicated that the Damara ewe has a fairly extensive natural breeding season lasting from approximately February until August. From the results obtained, a fair assumption can be made that breeding is possible throughout the year with no significant difference between seasons (P > 0.05).

There is a certain degree of variation in the literature as to the age at which ewe lambs reach puberty. The Damara ewe fall well inside this range (290.43 days and 44.95 kg). Similar to other breeds, the Damara ram lamb attain puberty at a relatively early age (anatomical puberty at 16.15 ± 1.52 weeks; physiological puberty at 19.61 ± 2.06 weeks and 39.54 ± 3.50 kg bodyweight). Macroscopic investigations of the reproductive tract of the Damara ewe led to the same conclusion. No differentiation that distinguishes the Damara breed from any other sheep breed could be revealed.

An impression gained from the results which were obtained from specific tests executed during the program, is that the Damara sheep does not react according to expectations which normally result when certain treatments with an intensive nature are applied. The Damara breed is a member of the sheep family and as such does not differ exceptionally from any other breed of sheep with regard to many aspects investigated in the program. An outstanding feature of the study which relates to the statement made above, was the disappointing results obtained from experimental work done with regard to superovulation and embryo manipulation. Different aspects of environmental influences and combinations thereof could have been the reason for the results obtained. Since this was one of the primary objectives for the initiation of the investigation, this leaves a wide open and interesting field for research on the Damara sheep with regard to these topics.

UITTREKSEL

Ondersoeke wat gedurende die projek uitgevoer is, is
hoofsaaklik deur twee faktore beïnvloed nl. klein getalle
diere wat vir navorsingsdoeleindes beskikbaar is en die feit
dat 'n groot gedeelte van die werk vanweë omstandighede
onder intensiewe toestande uitgevoer is, in ag genome die
bekende gegewe dat die Damaraskaap erken word vir sy vermoë
om in moeilike en ekstensiewe toestande te oorleef. Die
resultate wat hieruit voortgespruit het, moet dus eerder
beskou word as 'n wegspringplek vir verdere navorsing
rakende aspekte wat ondersoek is asook bykomende onderwerpe
wat belangrik geag mag word, eerder as 'n vaste stel
gegewens wat verteenwoordigend is van die Damararas.

Onder optimale toestande gedy die Damaraskaap ten opsigte
van die neerlegging van energiereserwes, veral in die stert,
rug en liesareas soos vasgestel met behulp van karkasse van
geslagde proefdiere. Vanuit 'n ander oogpunt beskou, kan dit
eweneens een van die aanleidende oorsake wees van die
onverwagte swak resultate wat tydens superovulasie verkry
is. Dit vestig weereens die aandag op die moontlike
uitwerking wat verskillende aspekte van omgewingsinvloede
en/of kombinasies daarvan op navorsingsresultate kan hê.

Toepassing van verskillende sinchronisasie prosedures het
afwykende resultate opgelewer ten opsigte van die interval

vanaf einde van behandeling tot aanvang van oestrus by die Damara-ooi. Die tydsduur van Groep A1 was betekenisvol langer as die van Groepe A2, A3 en A4 ($P < 0.05$). Die duur van die periode onder bespreking was langer in vergelyking met beskikbare data uit die literatuur. Met verwysing na die duur van oestrus, het drie groepe oestrusperiodes van vergelykbare lengte vertoon terwyl die PMSG-behandelde groep se oestrusperiode opmerklik langer was as ooreenstemmende data uit die literatuur. Die verskil was egter nie betekenisvol nie ($P > 0.05$).

Teeltegniek (KI vs natuurlike dekking) het nie 'n betekenisvolle invloed op reproduksierespons tussen die twee eksperimentele groepe getoon nie ($P > 0.05$). Die gemiddelde duur van dragtigheid (150 dae) stem egter ooreen met die van ander skaaprasse. Die Damara-ooi het oënskynlik 'n mate van weerstandbiedendheid teen laer vlakke (5 mg) PGF2a gedurende dragtigheid, maar is gevoelig vir hoër konsentrasies (10 mg) veral gedurende vroeë dragtigheid.

Plasmaprogesteroonpeile het aangetoon dat die Damara-ooi oor 'n redelik uitgebreide natuurlike teelseisoen beskik wat van ongeveer Februarie tot Augustus duur. Eksperimentele data wat verkry is, dui egter daarop dat die Damaraskaap nie noodwendig 'n seisoensgebonde teler is nie. Siklisiteit het nie betekenisvol tussen seisoene verskil nie ($P > 0.05$).

Puberteitsondersoeke het getoon dat die gemiddelde ouderdom waarteen Damara-ooilammers geslagsrypheid bereik, 290.43 dae teen 44.95 kg is. Ramlammers bereik puberteit teen 'n relatiewa vroeë ouderdom wat 'n algemene verskynsel by skape blyk te wees. Die gemiddelde ouderdom vir Damararamlammers was 16.15 ± 1.52 weke (anatomiese puberteit) en 19.61 ± 2.06 weke (fisiologiese puberteit) teen 39.54 ± 3.50 kg liggaamsmassa. Makroskopiese ondersoeke van die geslagskanaal van jong Damara ooie het geen ooglopende verskille aan die lig gebring nie. In hierdie opsig verskil die Damaraskaap ook dus nie van ander skaaprasse nie.

Vanuit bepaalde resultate wat uit die ondersoek na vore gekom het, is die indruk gewek dat die Damaraskaap nie op spesifieke behandelings reageer soos algemeen verwag word wanneer sodanige behandelings toegepas word nie. Vanuit 'n breër perspektief beskou, verskil die Damaraskaap as lid van die skaapfamilie nie buitensporig van enige ander skaapras ten opsigte van meeste aspekte wat in die projek ondersoek is nie. Met verwysing na bostaande was veral opvallend die teleurstellende resultate wat verkry is van die eksperimentele werk wat gedoen is met betrekking tot superovulasie en embriomanipulasie. Die moontlike uitwerking wat verskillende aspekte van omgewingsinvloede en/of kombinasies daarvan op navorsingsresultate kan he, kom weer hier onder die soeklig. Aangesien dit een van die

motiverende oorsake vir die inisiëring van die ondersoek was, bied dit 'n wye en interessante veld vir verdere navorsing op die Damaraskaap.

ACKNOWLEDGEMENTS

Mr J Piek, Farm Manager, Kalahari Research Station. In Mem.

Mr B van Zyl, Meatboard of Namibia.

All the personnel who served in the National Agricultural Information Centre of the Ministry of Agriculture during the time of the investigation.

Each and everyone who contributed towards the final accomplishment of the project.

CONTENTS

CHAPTER 1

GENERAL INTRODUCTION

1.1 BREED DESCRIPTION

The Damara sheep breed, regarded as endemic to Namibia, has over time undergone an evolutionary development process which took place under natural conditions which can be described as severe and completely independent of any form of modern animal husbandry practices. Ultimately a breed of sheep, characterized by qualities which lends it a certain degree of uniqueness, exists today in the arid regions of North-Western Namibia.

The Damara sheep is able to cover great distances with ease, feeding on grass, shrub and bush. Surplus fat reserves are localized mainly in the tail which classifies it as a fat-tailed sheep. The Damara breed, adapted to harsh conditions, is a functional and efficient breed of sheep, a statement which is underlined by proven qualities such as high fertility, strong mother instincts and the capacity to grow fast which are inherent to this breed (Table 3.2.1).

Characteristics which describe the Damara sheep breed are set out by the Damara Sheep Breeders Association (1993) as follows:

- Long tail, broad at the base and gradually tapering down to a thin end below the hocks
- Short, comfortable gait
- Movable skin, ears and tail
- Agile appearance
- Strong, hard teeth
- Strongly developed herd instinct
- Long reproductive life
- Strong mother instincts and high fertility

Breed description:

a) Head: The nose is long and strong and inclined to be roman in males, more so than in females. The eyes are large and bright with well developed eyebrow ridges and movable eye-lids. The Damara sheep is predominantly horned although ewes are frequently polled. The rams have well developed, spiral horns which point away from the head. Behind the head is a typical thickening or cushion which is more prominent in the ram than in the ewe. The ears are relatively large and movable. A dewlap is present and wattles on the throat are permissible.

b) Conformation: Damara sheep have large and symmetrical shaped bodies which are long, oval and fairly deep. Beginning at the nose, the topline is concave over the head, slants down the neck with a slight rise over the shoulders, a gentle drop to the middle back from where it rises gradually over well

developed loins and ends in a goose-rump which slants gently down towards a straight tail. The inner and outer thighs should be well developed, the legs long and dry, but strong and well placed with strong and even shaped hooves. The Achilles tendons should be strong and slanting slightly forward. The knuckle joints must be long, springy and sloping towards the hooves. There should be no visible accumulations of fat on the body apart from the rump and tail.

c) Colour and hair covering: The colour of the Damara sheep ranges through various shades from white to brown or white to black while black and white or brown and white and dappled patterns are common. Dark pigmentation is a requirement. The hair is in general short and shiny, but develops a wool covering during winter. Rams often have longer and stronger hair on the neck and chest.

d) Tail: The tail is wedge shaped, tapering down from a broad base to the tip which ends below the hock. A slight kink or bend in the tail is permissible but a discrimination. A serious bend or twist is a disqualification.

e) Fertility: The Damara sheep is fertile and the ewes are good mothers. They reach puberty at a relatively early age and the ewes can lamb during any time of the year.

f) Reproductive organs: The males must have normal and well developed testes contained in a short scrotum. The udder of the ewe must also be normal and well developed with two teats.

Discriminations:

- Excessive fat accumulation around the base of the tail referred to as "cheeks".
- Long woolly hair in adult sheep.
- A poorly developed cushion behind the head.

Culling faults:

- Cylindrical shaped body
- Short tail
- Large, broad tail
- Mouse ears
- Cow hocks
- Weak and sagging pastern joints
- Underdeveloped sex organs and long scrotum
- Exaggerated goose-rump and small hind-quarters
- Hollow back
- Straight topline
- Ingrowing horns
- Uneven hoofs
- Undersized or oversized lower jaw
- Unmoving, drooping ears

- Runts

- Lack of pigment

- Woolliness

- Narrow and or short head

- Absence of cushion behind the head

(Damara Sheep Breeders Association, 1993)

1.2   ANCESTRY OF THE FAT-TAILED SHEEP OF NAMIBIA

The parent stock of the fat-tailed sheep has doubtless to be sought among the long- and thin-tailed domesticated breeds of Asia. Hence the ancestral wild stock of both the thin-tailed and fat-tailed sheep is identical. Duerst (Epstein, 1971) suggested that the recent fat-tailed Maimenè (Afghan) breed of Afghanistan and South-East Turkmenia had been evolved from the polled copper age sheep of Anau, and the latter in turn from the long-tailed turbary sheep originally domesticated by the ancient inhabitants of the Anau oasis from *Ovis orientalis arkal*. Duerst's theory of descent of the fat-tailed type of sheep from *Ovis orientalis arkal* has been elaborated by Adametz (Epstein, 1971) who included, in addition to the fat-tailed type, all domestic breeds with a tendency to fat tail formation.

The fat-tailed type, like every other basic type of sheep (and for that matter, every other domestic animal) is the product of its total history. This includes descent from a

particular wild race and may include outcrossing of one
domesticated stock to another or several other related wild
races, interbreeding of various domesticated types which
evolved from the originally domesticated stock in different
environments, and artificial and natural selection under
different circumstances.

It is probable that the various forms of domesticated sheep,
and this refers not only to the long-tailed varieties, are
ultimately derived from a single domesticated moufloniform race
of Western Asia. No knowledge exist of the species or
subspecies first brought under domestication. Whichever it was,
from this original parent stock the various types of sheep were
subsequently evolved through environmental influences and
directive selection of desirable variants in different
climatic, social and economic conditions. In the course of the
migrations of pastoral or agricultural peoples, or by
transmission, the earliest domesticated sheep reached regions
where different geographical races, subspecies or species of
wild sheep occurred, and through interbreeding with these, the
genetic pattern of the race first domesticated was further
disturbed and the range of variability widened. Most of our
domestic animals are not simple creatures but synthesized
beings, the issue of repeated crossings of domesticated stock
with wild races or species more or less related (Epstein,
1971). After thousands of years the range of racial variation
among sheep has become so extensive that it is now difficult to

establish the origin and causes of this great variety of characters, so that it has become nearly impossible to trace the wild race of moufloniform sheep originally domesticated or the various species and subspecies which subsequently influenced the domesticated type.

Until the end of the third millennium BC, the hairy thin-tailed sheep was the only type of sheep on the African continent. At the beginning of the second millennium, fat-tailed sheep made their appearance in Egypt where they are represented in frescoes from the XII th Dynasty. The fat-tailed sheep entered Africa by two ways: the Isthmus of Seuz and the straits of Bab el Mandeb. The northern stream did not extend far enough to the south to join the southern, although Libyan fat-tailed sheep have penetrated as far as Central Chad (Epstein, 1971). To this day the northern area of distribution of the African fat-tailed sheep is separated from the southern by a wide belt occupied by the thin-tailed breeds of the Sudan.

The southern group of fat-tailed sheep, which entered Africa by way of Bab el Mandeb, extends from the Red Sea littoral and Ethiopia into the lake districts of Uganda, Kenya and Tanzania. In Southern Africa the native flocks consist for the greater part of fat-tailed sheep. The original thin-tailed type of the southern Bantu is restricted to a relatively small area in Zimbabwe and Angola. The extensive replacement in Africa of hairy thin-tailed sheep by fat-tailed animals is mainly due to

one advantage of the latter namely the fat deposit on the tail. The importance of the fat-tailed type to the peoples of Africa is due to the fact that many of them are nomadic or semi-nomadic pastoralists who are in need of a fat producing animal. The fat-tailed type of sheep provides for this need.

From the early history of the Hottentot people it may be inferred that they acquired their fat-tailed sheep at their former home in the lake districts of East Africa where the fat-tailed type is bred to this day. After crossing the Zambezi river on their southward migration, the Hottentots probably introduced fat-tailed sheep into Zimbabwe. For before the invasion of the Southern African plateau by Black tribes, the Hottentot range extended much further north, perhaps even to the borders of Kenya (Epstein, 1971). However, the Hottentots were driven to the west and south by early Bantu invaders who are believed to have been in possession of hairy thin-tailed sheep. A faint record of these early times has been preserved in some of the Bushman paintings from Zimbabwe, depicting historic events.

The original sheep of the Bantu peoples of Southern Africa seems to have been of the hairy thin-tailed type in which the rams were frequently maned. This type of sheep is still encountered in Angola and Zambia. The Damara (Ovaherero) sheep of Namibia seem to have formerly been of the same type, although von Francois (Epstein, 1971) described the tail of

the Damara as a long narrow fat tail, extending to below the
hocks. As soon as the Bantu acquired fat-tailed animals from
the Hottentots, they commenced breeding these. Thin-tailed
sheep without fat deposits at the root of the tail have
therefore become exceedingly rare among the flocks of the
Herero and their neighbors. In the fat-tailed Damara sheep the
tail is still long and straight and without a great
accumulation of fat being much lighter than that of the Nama.
The original Damara sheep had a short, deep, heavy head,
markedly convex in profile, with a goitre-like deposit of fat
under the chin which resembled that of the Zunu of Angola. In
the ram the horns were strongly developed and of ammon-shape
(left-handed spiral) which distinguishes them from the Nguni-
type sheep while the ewes were commonly hornless. The body was
distinguished by high withers, long legs and a short drooping
rump. The indigenous sheep of Namibia has remained relatively
free from the influences of other breeds of sheep and are
confined to the Kaokoveld from where they extend into Southern
Angola, an area which is inhabited by the Himba and Sjimba
people of Herero descent (Epstein, 1971).

As Namibia became colonized by Europeans, commercial farming
practices came into operation, mainly in the form of livestock
farming. To prevent animal diseases spreading from the north, a
cordon line was drawn up, separating the far Northern parts of
the country from the central and southern parts. This
inevitably led to contraband trade across the line. During the

period 1940 onwards, white farmers traded horses and copperwire for sheep from the Himba people. The sheep were illegally brought across the line and sold as slaughter animals to speculators.

Since 1952, the then Department of Agriculture was looking for a well adapted breed of sheep that could be farmed with in the Northern parts of Namibia. Such a breed would be established at Omatjenne Research Station in the Otjiwarongo District. Efforts were made to establish Karakul sheep, Persians and German Merinos but they all proved to be unsuccessful. In 1954, two farmers from the Kamanjab region were caught with 50 smuggled sheep from the Kaokoland. The animals were confiscated and taken to Omatjenne where they were placed under quarantine. It was soon noticed that these animals were particularly well adapted and it was decided to start with a breeding program. The success of this exercise is illustrated by the number of 615 rams that were sold from Omatjenne to breeders in Namibia and South Africa by 1989 (Barnard, 1989).

Due to the, until recently, unexplored status of the Damara sheep, an investigation into certain general and reproductive aspects in particular, was launched with regard the mentioned breed. The sanctioning of such an investigation was further supported by the fact that the Damara breed is endemic to Namibia and one of only a few endemic smallstock breeds in Southern Africa of which a significant, unspoiled genetic pool

exists. During the recent past, the Damara breed gained
substantive popularity amongst the commercial farming sector
both in Namibia and South Africa, which can be measured against
prices gained on the open market for breeding material. This in
itself, can by implication indicate that the value or values
ascribed to the Damara breed are realized and exploited by
livestock breeders. This seems to be in particular so with
regard the hardiness and ability of the sheep to produce and
reproduce in areas and under conditions of stressful
proportions which are deemed to be generally inaccessible to
other breeds of small stock in terms of basic expectations as
mentioned.

CHAPTER 2

**STATUS OF THE DAMARA SHEEP IN COMMERCIAL FARMING: RESULTS FROM
A QUESTIONNAIRE**

2.1   INTRODUCTION

A questionnaire was compiled and dispatched to identified
Damara sheep breeders in an attempt to assess the extent to
which the Damara sheep has dispersed into the commercial
farming arena, both in Namibia and in the Republic of South
Africa, also endeavoring to formulate a perception of the
population dynamics and the economic significance of the Damara
sheep, if any, at the time of the investigation.

Due to the fact that the Damara sheep became an object of
interest to commercial farmers as recently as the last two or
three decades, information on the breed is scarce and
consequently the number of breeders and stock is still
relatively small. The character of the breed can also be
regarded as a contributing factor. In many instances Damara
sheep are kept in small numbers for the sole purpose of
personal consumption by the farmer and his workforce and not
for commercial reasons.

From this study the ubiquitous dilemma of the Agricultural
industry again manifested itself viz. inadequate record
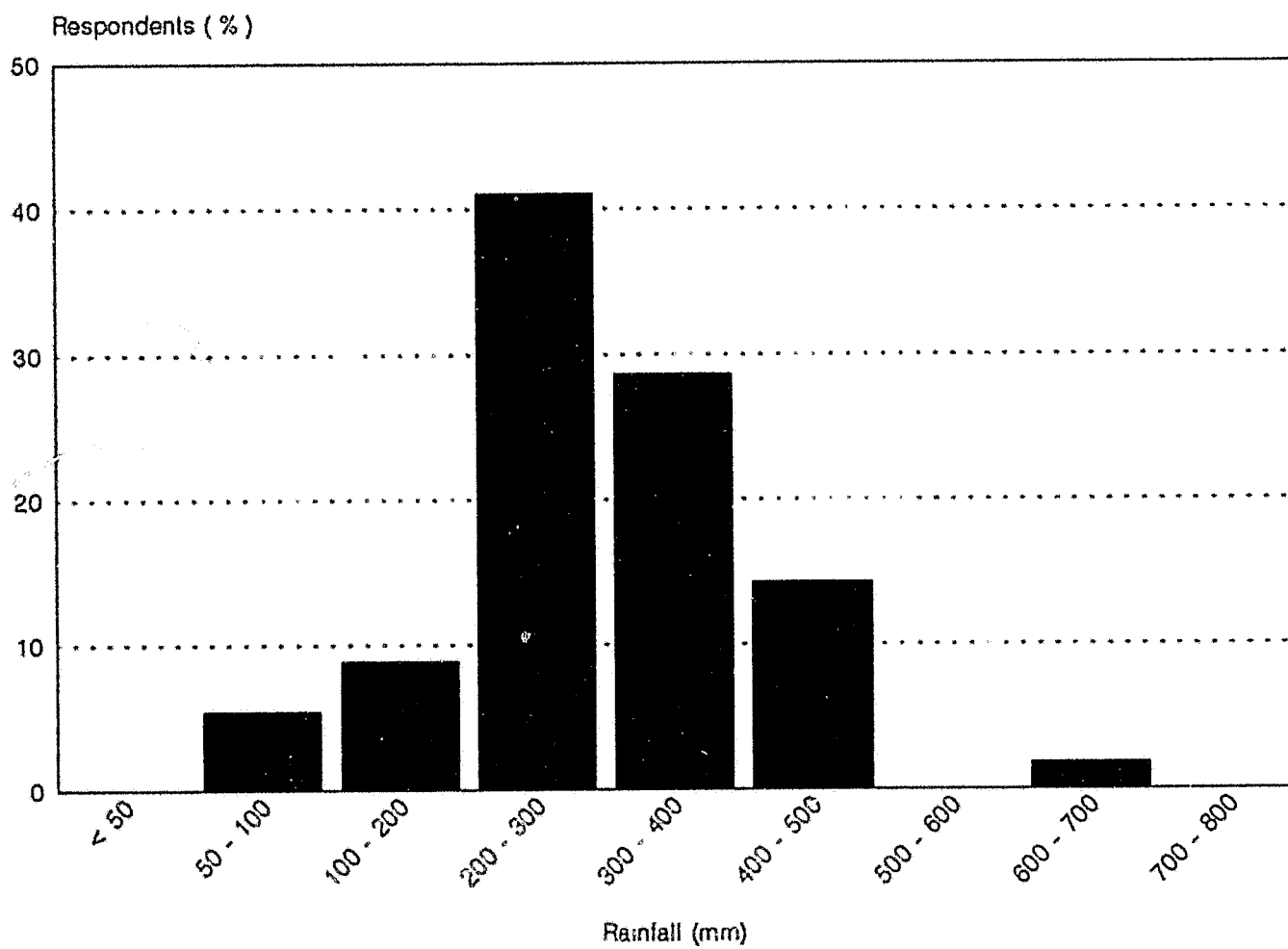
FIGURE 2 2 1 Average rainfall figures indicated by Damara sheep breeders

keeping. For distribution of the questionnaire the latest
available list of members of the Damara Sheep Breeders
Association, indicating 130 members, was used as source of
reference. An unsatisfactory first response was succeeded by a
second forwarding which yielded the same disappointing results.
The combined data from both forwardings was however sufficient
to portray certain trends. A total of 57 breeders responded
although some questionnaires were only partly completed.

Complementary to the questionnaire, data on the slaughterings
of Damara sheep at The Meat Corporation of Namibia (Meatco)
has been accumulated over a period of 12 months that commenced
during November 1992 and concluded during November 1993.
Information on a total number of 612 Damara sheep slaughterings
was made available during this period. Meatco do not
differentiate between breeds, but they do differentiate between
fat-tailed sheep and non-fat-tailed sheep. Karakul sheep
constitutes the largest component of the fat-tailed sheep made
available to the market through Meatco, while Damara sheep
comprises only a very small percentage of the total (personal
communication, exact figures not available).

2.2   AVERAGE RAINFALL AND VELD TYPES

Figure 2.2.1 depicts the highest incidence of distribution in
the 200 - 300 mm average rainfall per annum category followed
by the 300 - 400 mm category. The highest rainfall incidence

averages 700 mm in certain areas of Namibia (Van der Merwe, 1983) and 1400 mm in certain areas in the RSA (Tainton, 1988). Compared to these figures, the rainfall figures as indicated are relatively low and indicative of arid and semi-arid regions which fits in with the description of the character of the Damara sheep. Climate, in the broad sense, is a major determinant of the geographical distribution of species and vegetation types (Tainton, 1988).

Veld types (Acocks, 1975) as indicated by breeders in the RSA have been consolidated into three major divisions for the purpose of this discussion (Table 2.2.1) in declining order of significance viz.

Karoo (succulent and non-succulent) (20.7 %)
Bushveld (sweet, sour and mixed) (15.5 %)
Climax grasslands (5.2 %)

In Namibia veld types are expressed in terms of savanna systems (Giess, 1971) which, apart from the Namib desert that stretches along the whole of the west coast of Namibia, can sustain small stock production to a greater or lesser extent. Highland savanna (13.8 %), Camelthorn savanna (12.1 %) and Mopane savanna (12.1 %) were indicated as veld types where the highest dispersion of Damara sheep could be expected in Namibia. It is evident from the available information however

TABLE 2.2.1 Veld types and associated average rainfall figures (Van der Merwe, 1983; Tainton, 1988)

	Veld type (%)	Average rainfall
Namibia	Highland savanna (13.8)	300 - 400 mm
	Camelthorn savanna (12.1)	300 - 400 mm
	Mopane savanna (12.1)	200 - 500 mm
	Dwarf shrub savanna (6.9)	100 - 200 mm
	Mountain savanna (5.2)	500 - 600 mm
	Thornbush savanna (5.2)	300 - 500 mm
	Semi-desert and savanna transition (3.5)	100 - 200 mm
RSA	Karoo (20.7)	200 - 400 mm
	Bushveld (15.5)	200 - 600 mm
	Climax grasslands (5.2)	600 - 800 mm

that breeders exploit the adaptability of the Damara sheep in
the dryer regions of both countries.

2.3 SIZE OF BREEDING HERDS, BREEDING METHODS AND CROSS-
BREEDING

A rather skew distribution is depicted in Figure 2.3.1 with
regard the size of breeding herds, but which apparently gives a
clear indication of the true situation representing the Damara
sheep industry with the majority of breeders in the 0 - 100
flock size category, gradually diminishing toward the 400 - 500
flock size category and only a very small number with larger
flock sizes. The curve displays what can be described as an
early developmental phase and the purpose would inevitably be
to move the curve towards the right.

Considering breeding methods, 84.2 % of the respondents
indicated that they use flock mating as breeding mechanism
(Figure 2.3.2). Artificial insemination and hand mating are
hardly implemented. 5.3 % indicated that they use both ram-ewe
groups and flock mating. The fact that 75.4 % of the herd sizes
indicated are smaller than 200, might have something to do with
this method being applied and to a smaller extent, ram-ewe
groups. Following is a short description of the mentioned
breeding methods:

- Artificial insemination: depositing of semen by means of
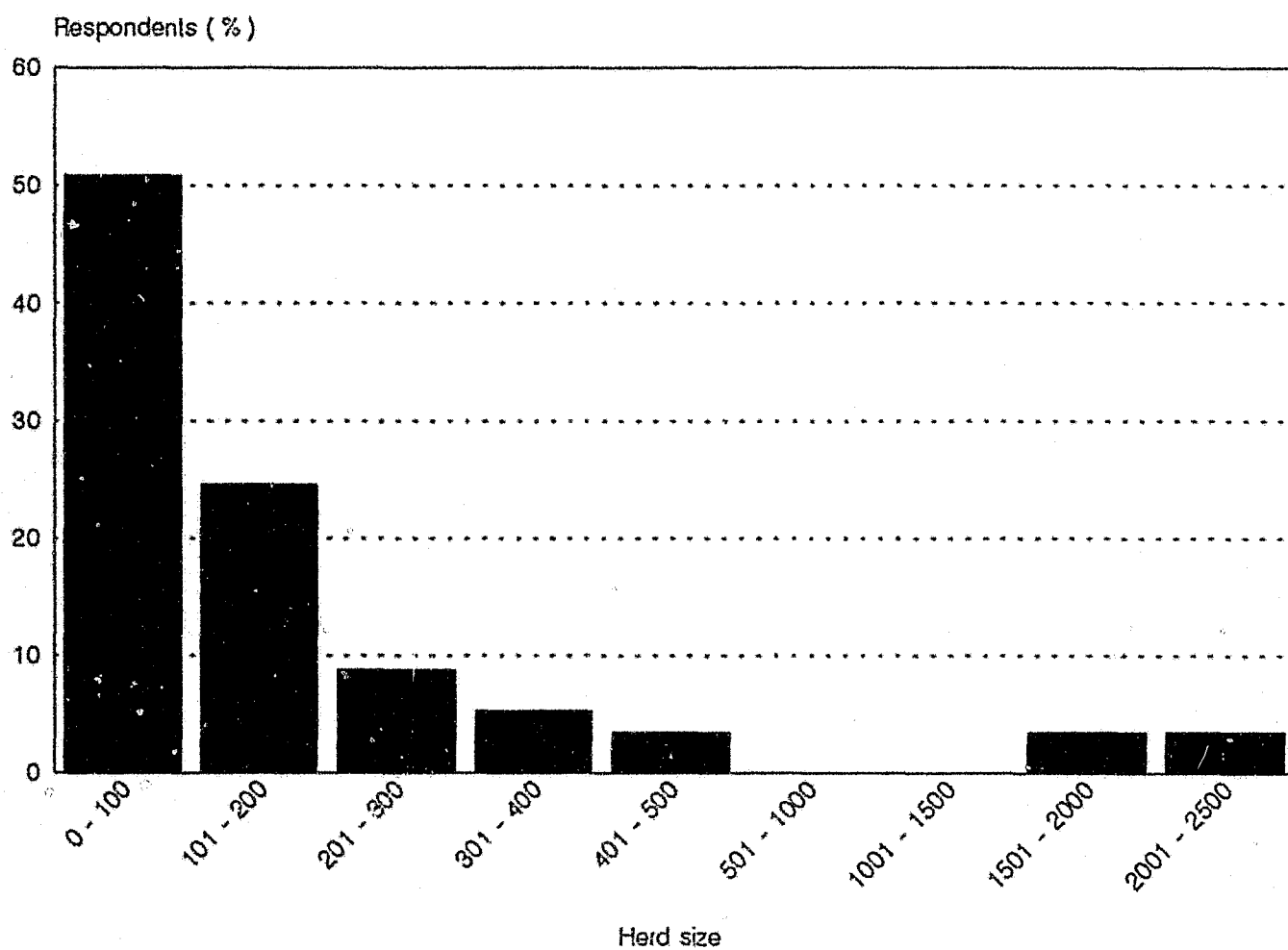
FIGURE 2.3 1 Indicated size of breeding herds
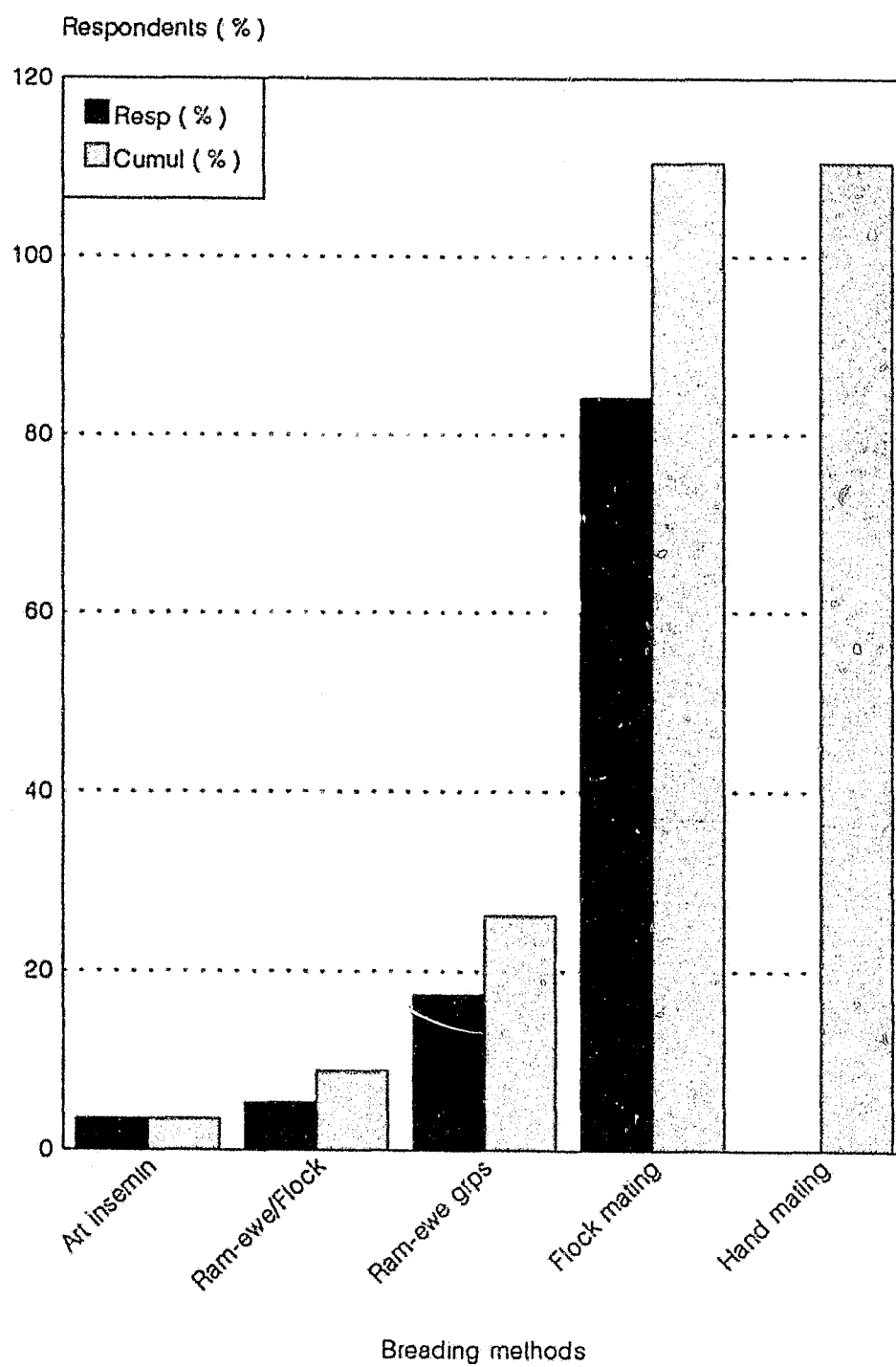
FIGURE 2.3.2 Breeding methods practised by Damara sheep breeders

artificial methods in the vagina of an ewe
- Hand mating: allowing an ewe identified on heat to be served by a ram under supervision
- Ram-ewe groups: introducing an identified ram to a specified number of ewes for specified periods of time for breeding purposes
- Flock mating: rams are continuously in the presence of the ewes and breeding takes place on a year round basis

With regard to cross-breeding, the Damara sheep is primarily a mutton sheep but with a carcass conformation which can not be compared with true mutton breeds such as the Dorper. 40.4 % of the respondents indicated that they crossbreed with Damara sheep. The purpose for this is mainly to improve on the carcass conformation of the Damara sheep. It therefore stands to reason that the Dorper would be the popular choice as Table 2.3.1 indicates with the Persian and Van Rooy next in line. A factor which most probably plays a role in the choice of the mentioned breeds, is that they are all well adapted to dry, arid environments which is complementary to the characteristics of the Damara sheep. Some respondents indicated that they cross with more than one breed. From Table 2.3.1 it is however clear where the line of preference is drawn since apart from the Afrikaner, which has much the same conformation as the Damara, the rest are all dual-purpose breeds.

TABLE 2.3.1   Breeds harnessed for crossbreeding purposes by
individual breeders

Breeds	Breeders (%)
Dorper	36.8
Persian	18.4
Van Rooy	13.2
Afrikaner	7.9
Ile de France	7.9
Merino	5.3
Mutton Merino	5.3
Letelle	2.6
Romanoff	2.6

2.4   MATING SEASON AND RAM/EWE RATIO

Respondents who indicated that they breed during both autumn
and spring, can for all practical reasons be grouped with those
respondents who indicated that they breed throughout the year
representing 38.2 % of all respondents (Figure 2.4.1).
Without more detailed information, concerning for instance
birth rates, it would not be appropriate to assume from this
data that the Damara sheep is prone to breed throughout the
year. Spring however seems to be the most popular season
(45.5 %). Information presented in Chapter 3 gives more
substantive evidence in this regard.
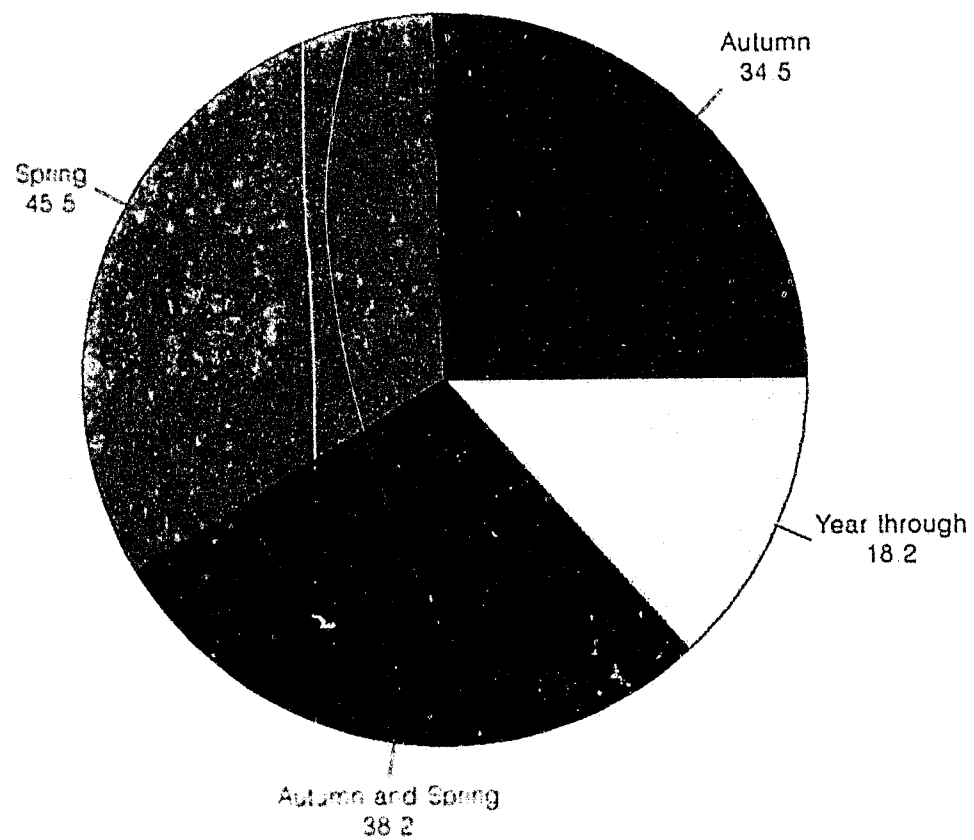
FIGURE 2.4.1 Mating season preferred by Damara sheep breeders (%)

Ram : ewe preferences showed that a 1 : 30 ratio is mostly
applied and represents 34% of the respondents (Figure 2.4.2)
followed by the 1 : 50 ratio (32,1 %) and then a 1 : 40 ratio
(20,1 %), a division which seems somewhat inconsistent. The
ram : ewe ratio can however be influenced by various factors,
inter alia breeding season, breeding method, herd and camp
size.

2.5 LAMBING PERCENTAGE, LAMB PERCENTAGE AND WEANING PERCENTAGE

Information made available by respondents on Lambing percentage
Lamb percentage, and Weaning percentage is represented in
Figures 2.5.1, 2.5.2 and 2.5.3 respectively. The distribution
of data in Figure 2.5.1 and 2.5.3 both depicts a sharp incline
from 75 % to 100 % with an average of 91.3 % and 90.7 %
respectively for lambing percentage and weaning percentage.
Data on lamb percentage displays a normal distribution with the
highest frequency rate in the 91 % - 100 % interval and an
average of 97.6 % (Refer Chapter 3).

2.6 REPLACEMENT STOCK, MARKETING AND AGE AT MARKETING

There is no clear distribution pattern as to the percentage
stock retained for breeding purposes. From Figure 2.6.1 it can
be assumed that the high frequency in the lower and middle
percentage brackets represents breeders with larger flock

FIGURE 2.4.2 Ram-ewe ratios used in studying breeding practices
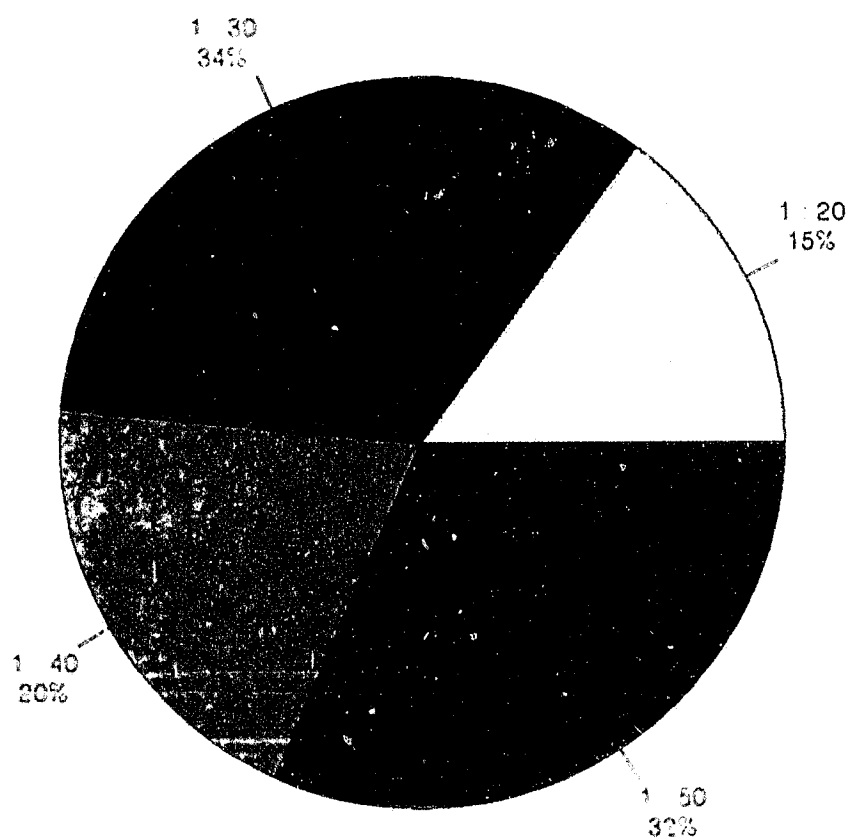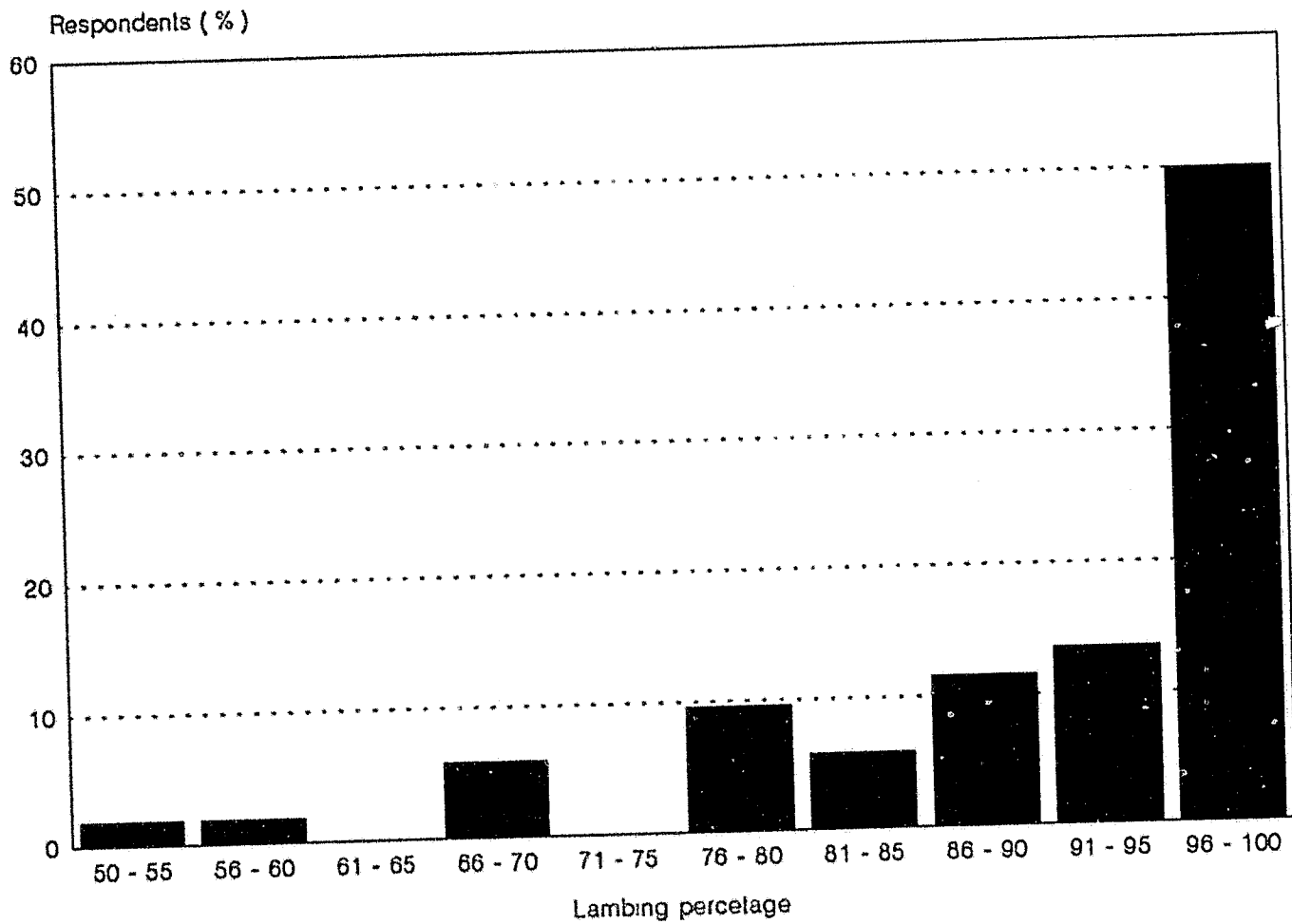
Respondents (%)

FIGURE 2 5.1 Lambing percentage in relation to respondents expressed as percentage

FIGURE 2.6.2 Lamb percentage distribution to respondents expressed in percentage

Respondents (%)
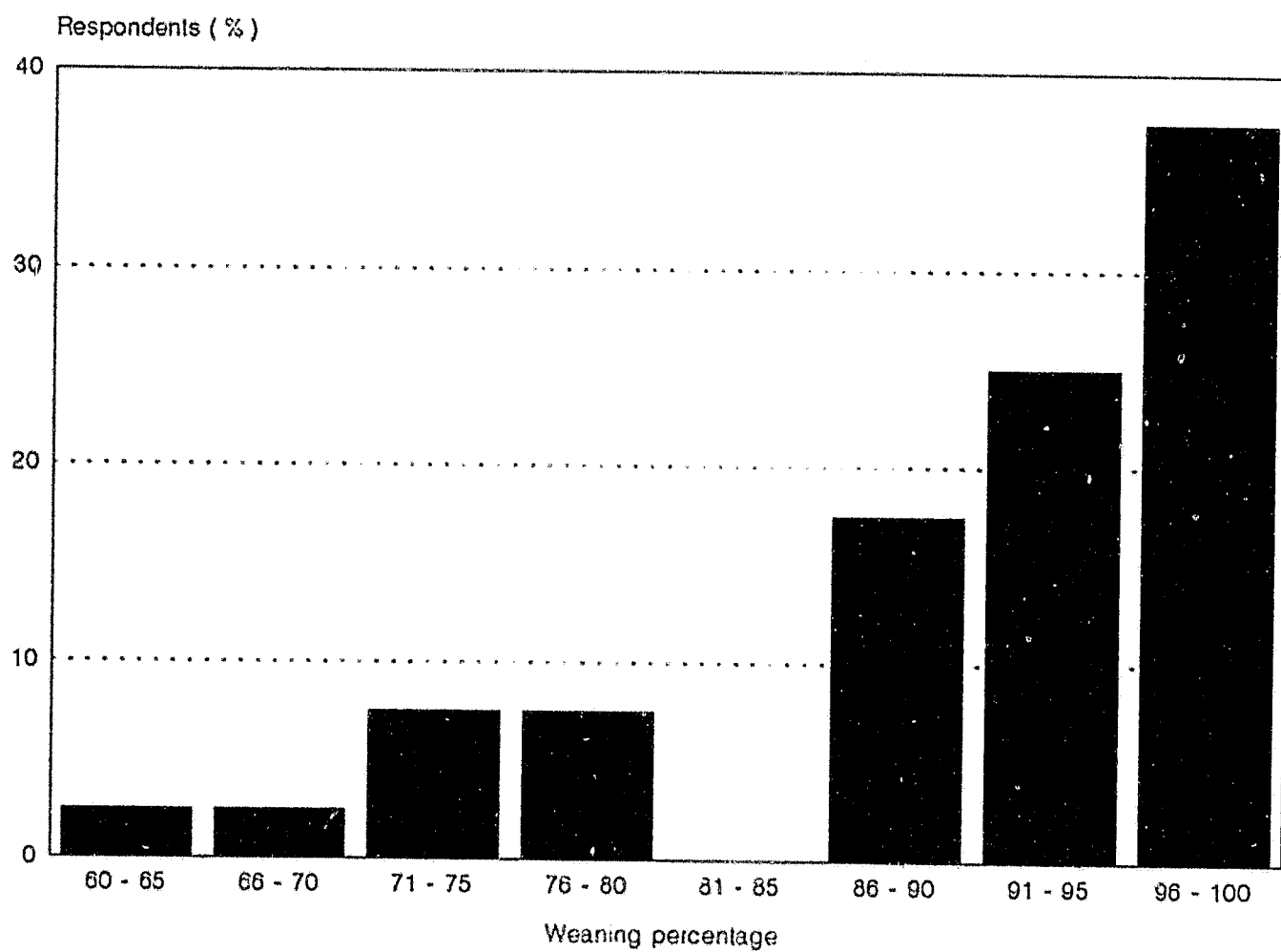
FIGURE 2 5 3 Weaning percentage

Respondents (%)
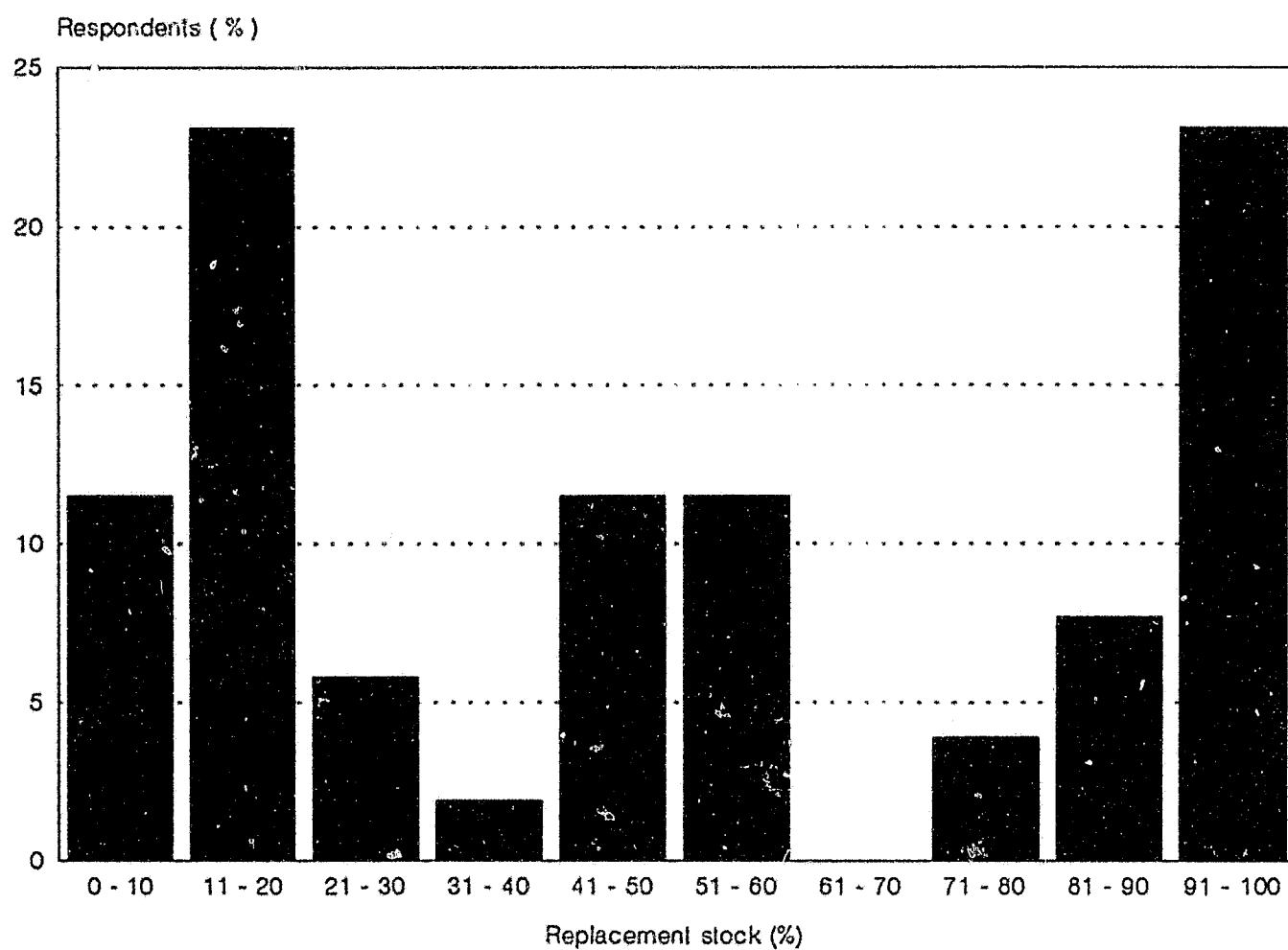
Replacement stock (%)

FIGURE 2.6.1 Percentage replacement stock

sizes, whereas the high frequency in the higher percentage
bracket represents those breeders who keep smaller herds. This
data is probably reflected in the number of respondents
(47.4 %) who replied to the question on stock marketed
(Figure 2.6.2) which data closely resembles the data
displayed in Figure 2.3.1 where again the smaller herd size
represents the higher rate of incidence.

There is a considerable difference noticeable when data on
marketing age (Figure 2.6.3) gathered from the questionnaire
is compared to data gathered at Meatco on the same issue
(Figure 2.11.1). This can be ascribed to deficient record
keeping as has been mentioned previously.

2.7   OTHER FARMING OPERATIONS

A fair number of respondents have indicated that they practice
more than one farming operation. The outcome of the processed
data in this regard is displayed in Figure 2.7.1 which
immediately draws the attention to the practice of combining
small stock, whether it be sheep or goats, with large stock.
80.7 % of the respondents have indicated that they farm with
cattle, 38.6 % with goats and 33.3 % with other sheep, while
cropping systems, probably small scale irrigation projects, and
game farming follow suit. The practice to combine goats, and
for that matter Damara sheep with cattle, has become
commonplace where bush encroachment plays a role in pasture
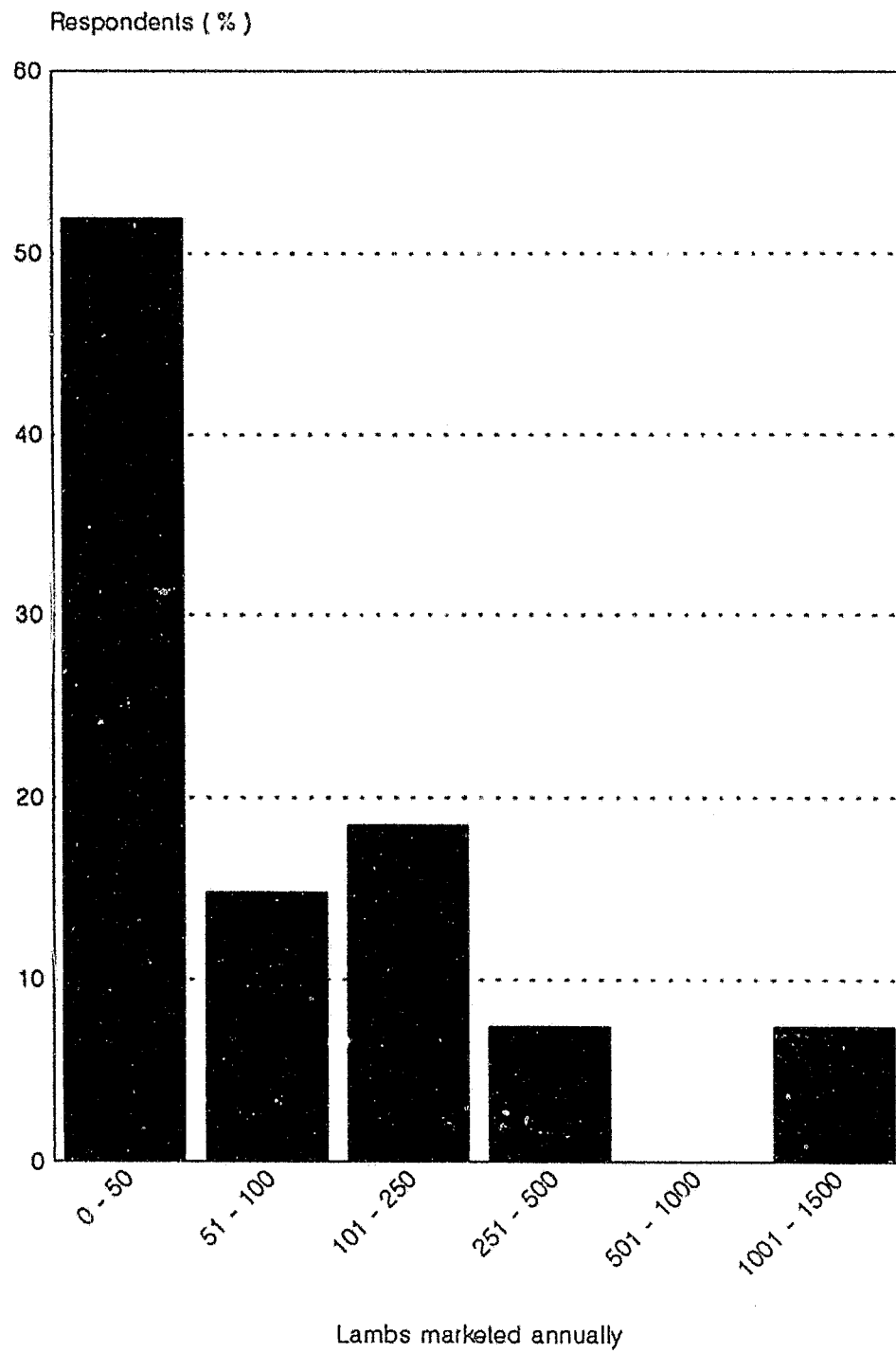
FIGURE 2.6.2 Annual marketing of Damara lambs by breeders
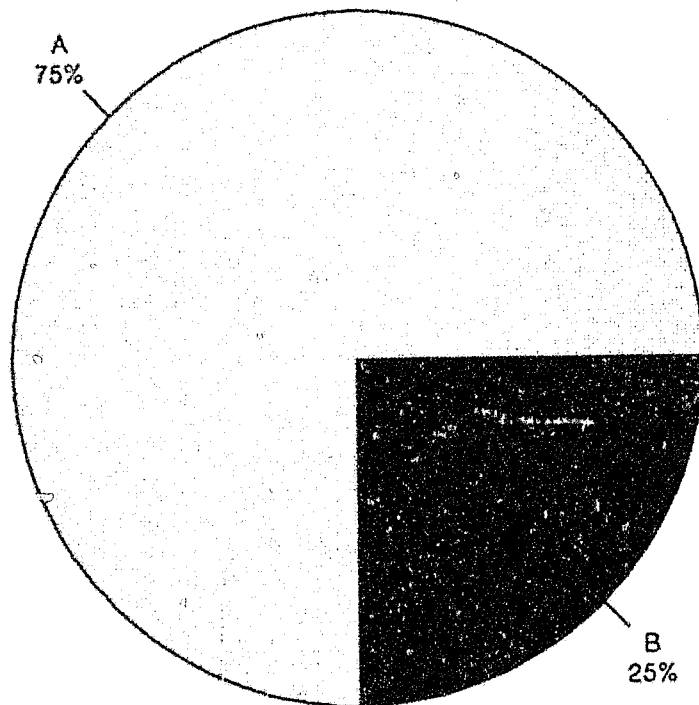
(A < year; 1 year ≤ B ≤ 3 years)

FIGURE 2.6.3 Age distribution at marketing (% Respondents)
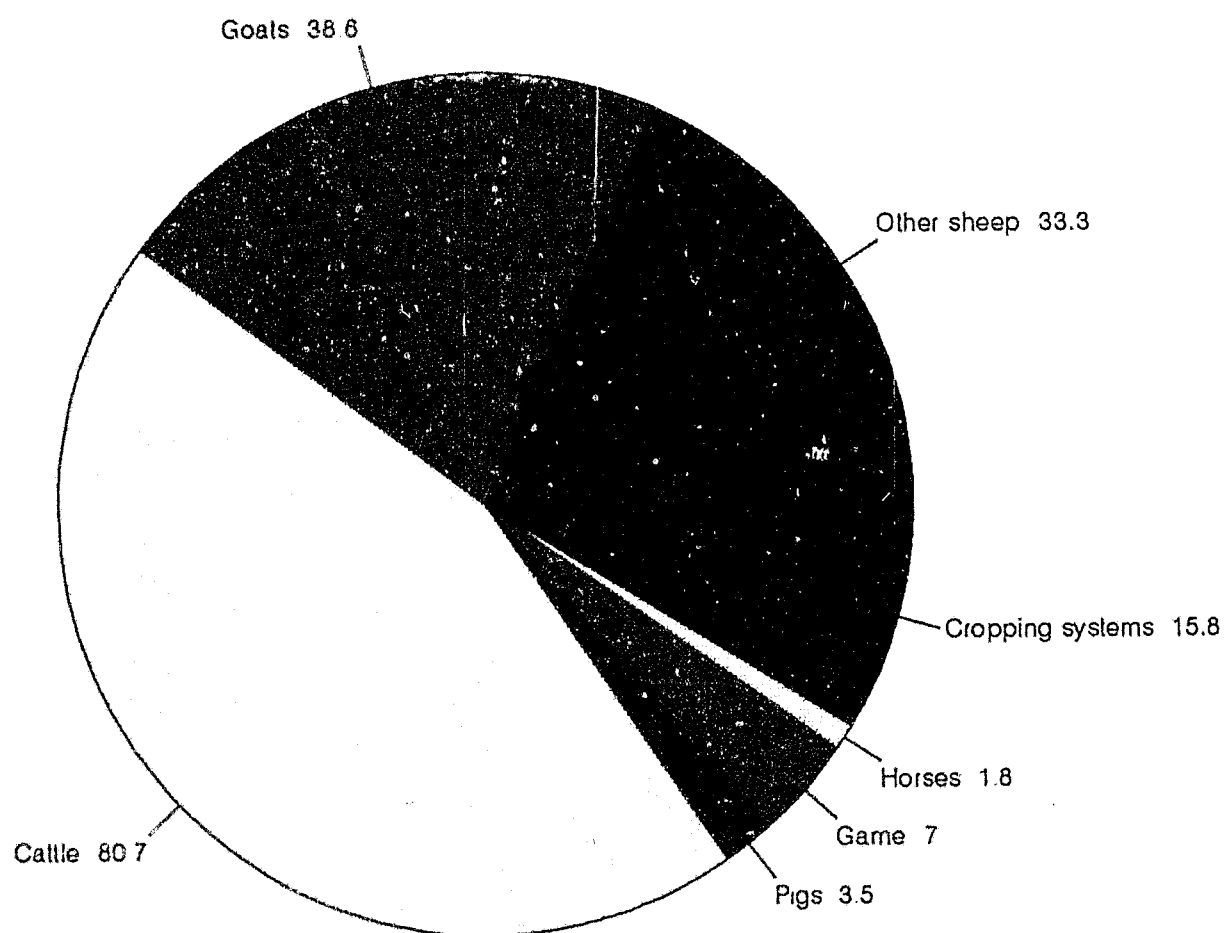
FIGURE 2.7.1 Other commercial farming operations practised by Damara sheep breeders (%)

management as is often the case in Bushveld and Savanna
ecosystems.

2.8 HEALTH CARE

It has been suggested by a few respondents that the Damara
sheep is allegedly sensitive towards pulpy kidney disease as
can indeed be concluded from the results displayed in Figure
2.8.1.   66.7 % of the respondents indicated that they inoculate
against disease and 70.2 % indicated Enterotoxaemia followed by
Pasteurellosis and Blue-tongue in sequence of importance.

Inevitably farmers will treat against diseases which are
pathogenic in specific areas such as Wesselsbron disease and
Rift Valley fever including a few others with low incidence
ratios as indicated.

2.9 POSITIVE AND NEGATIVE CHARACTERISTICS ASCRIBED TO THE
DAMARA BREED

The first five points in Table 2.9.1 includes all that is
needed to be said about the Damara sheep. Most of the rest are
derivatives from these five points. The negative points quoted
and summarized in Table 2.9.2 are mostly valid but does not
affect the inherent qualities of the animal. Weighing the
positive reactions (223) up against the negative ones (37),
the conclusion can be made that the Damara sheep is a suitable,
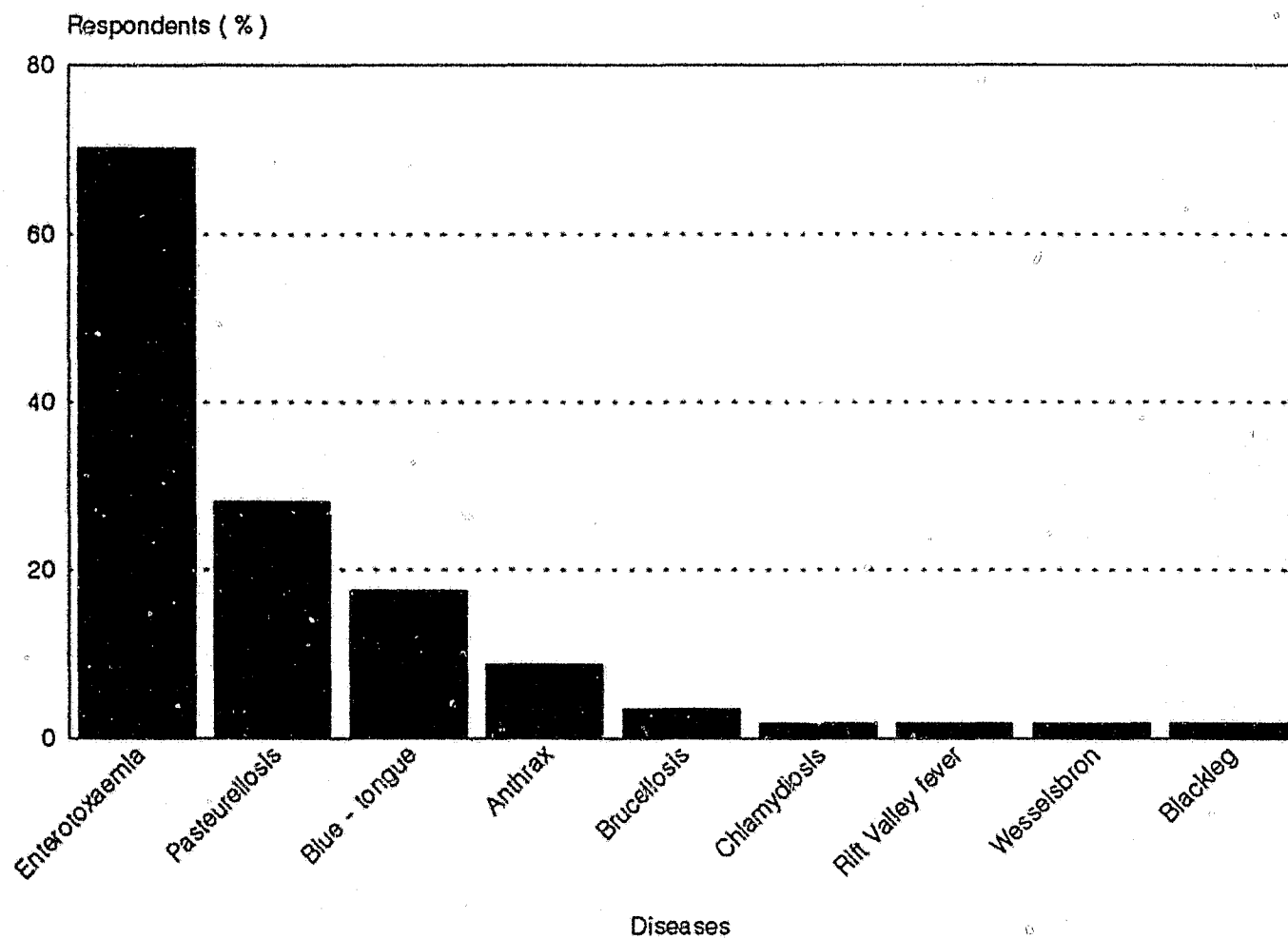
Respondents (%)

FIGURE 2.8.1 Diseases against which preventative measures are taken

TABLE 2.9.1 Positive breed characteristics proposed by respondents

Characteristics	No
Hardy, adaptable, low maintenance breed	47
Strong mother instincts	34
Effective grazer and browser	25
Resistive towards diseases and parasites	23
High fertility rate	23
Resistive toward vermin and stocktheft	15
Produce an outstanding carcass from the veld	14
Perform well under poor grazing conditions	10
Suitable for crossbreeding	10
Strong herd instinct	7
Good walking ability with easy gait	8
Mature early with long reproductive life	5
Intelligent with lively temperament	3
Combine well with cattle farming	1

TABLE 2.9.2 Negative breed characteristics proposed by respondents

Characteristics	No
Consumer resistance to fat tail and carcass conformation	14
Difficult to handle as consequence of spirited temperament	12
Indiscreet selection results in upgrading of specific traits and degeneration of natural traits	5
Fat tail inconvenient for crossbreeding	2
Good breeding material is scarce	2
Agressiveness of rams results in injuries during breeding season	1
Sensitive to Enterotoxaemia	1

and also a desirable breed of sheep to farm with under specific climatic, environmental and economic conditions.

2.10   MISCELLANEOUS DATA

Data on various parameters are displayed in Table 2.10.1. No particular conclusion can be drawn from any of this data in respect of any outstanding characteristics unique to the breed and can only assist in shaping a more complete image of the Damara sheep.

TABLE 2.10.1   Various husbandry management practices employed by Damara sheep breeders

Reference	Breeders (%)		
	Yes	No	Both
Studfarming	71.9	28.1	
Breeding male material	10.5	33.3	56.1
Veld marketing	91.8	6.1	2.0
Feed supplements	33.3	66.7	
Treat internal parasites	66.7	33.3	
Treat external parasites	49.1	50.9	

2.11 DATA ON COMMERCIAL SLAUGHTERINGS

During the period January 1994 until December 1994 a total of 22 628 fat-tailed sheep (average carcass weight 15,9 kg) and 168 754 non-fat-tailed sheep (average carcass weight 16,69 kg) were slaughtered at Meatco Namibia in Windhoek. Compared to these figures, the number of Damara sheep of which information was made available, is virtually nonexistent (612 or 0.32 % of the total number of sheep slaughtered). Even if the number should be tripled, it would still be less than one percent of the total which clearly indicates the backlog the Damara breed experiences relative to other breeds of sheep on the open market.

Analyzing available information however, the following groupings are revealed from Figures 2.11.1 and 2.11.2: 22.2 % falls in the A age group (0 - 1 year), 39.7 % in the B age group (1 - 3 years) and 38.1 % in the C age group (> 3 years), whereas 60.1 % are females, 37.9 % are wethers and 2 % are male. A certain degree of logic can be derived from the subdivision of the male and female groupings (Figure 2.11.2) where the largest numbers slaughtered, occurs in the C age grouping. The subdivision presented by the wethers is probably the result of the relatively small numbers under discussion and the influence of private utilization on the number of animals made available to the consumer (Figure 2.11.3).

Percentage of total
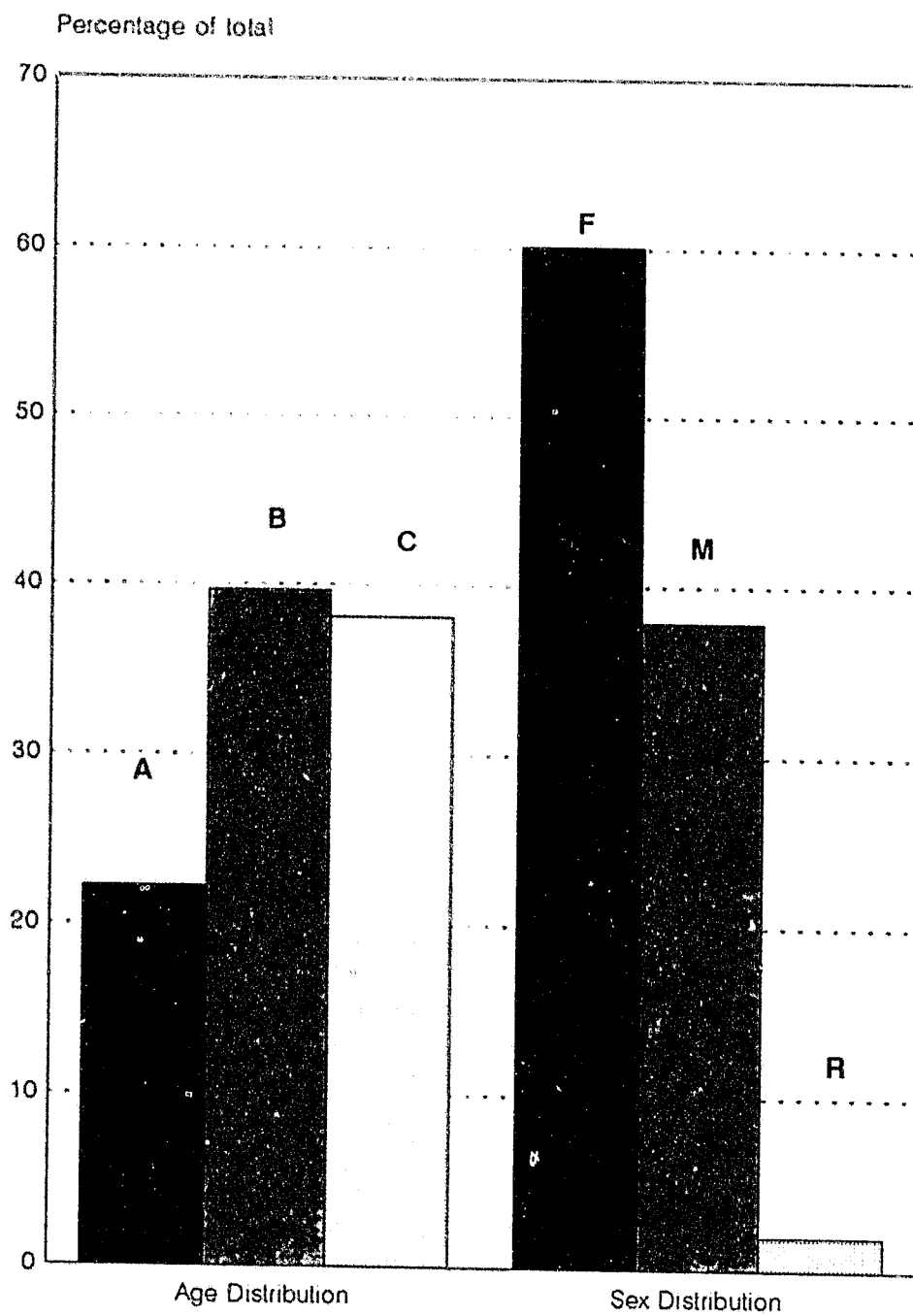
(F female; M wether; R ram)
(A < 1 year; 1 year ≤ B ≤ 3 years; C > 3 years)
FIGURE 2 11.1 Damara sheep slaughterings (age and sex distribution)

Sex grouping (%)
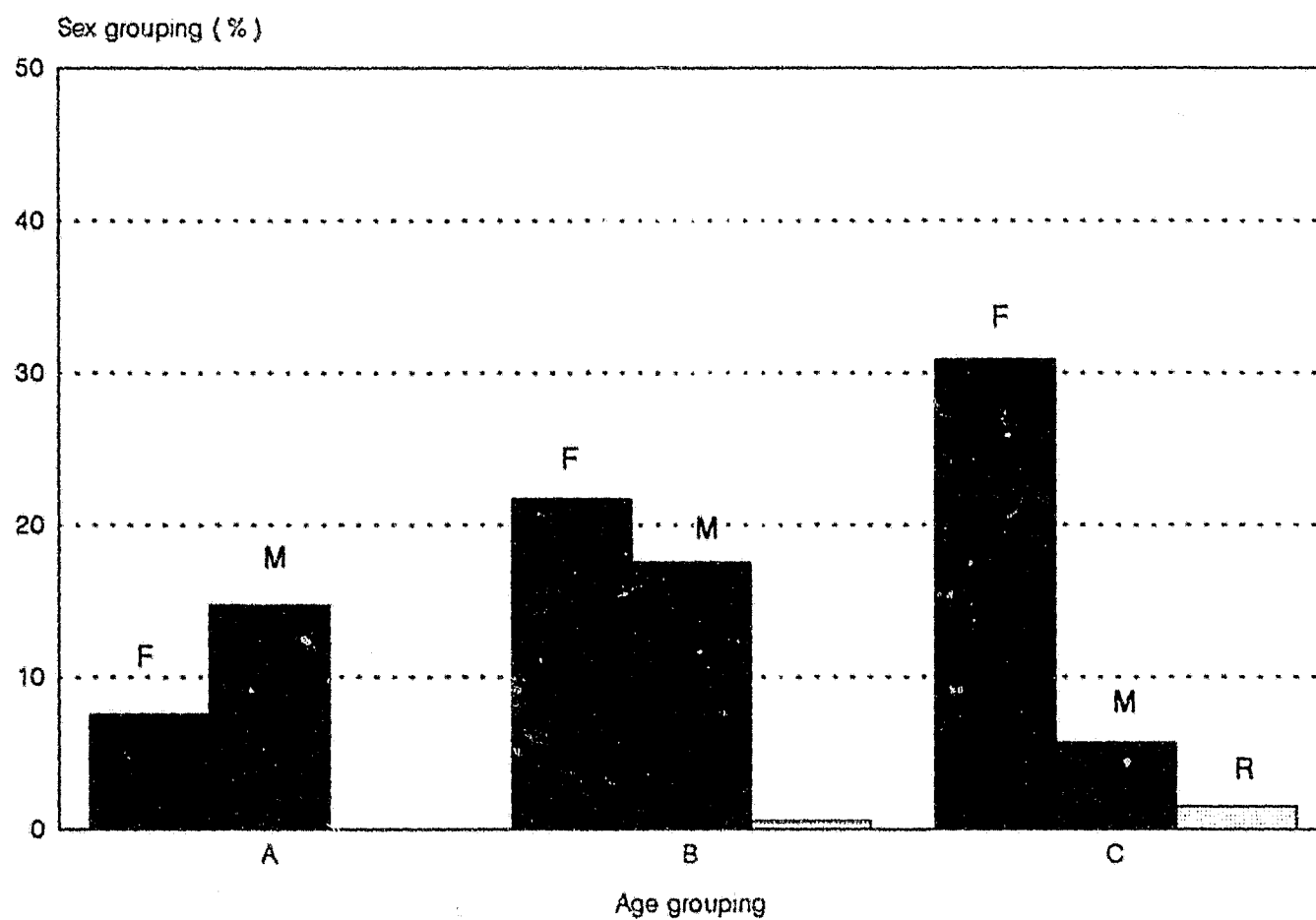
Age grouping

(F: female, M: wether, R: ram)
(A < 1 year; 1 year ≤ B ≤ 3 years; C > 3 years)
FIGURE 2.11 2 Damara sheep slaughterings (sex vs age distribution)
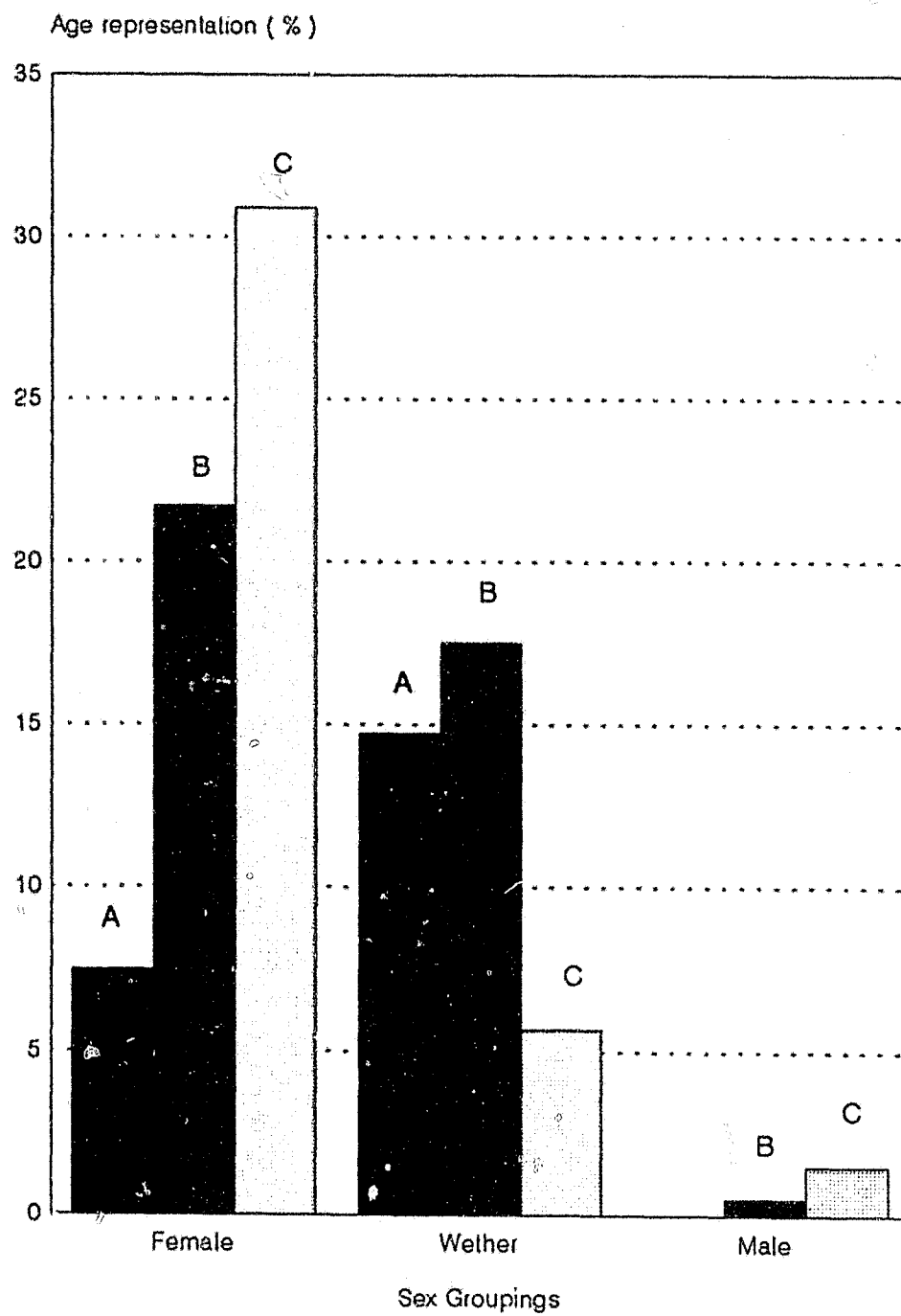
(A < 1 year; 1 year ≤ B ≤ 3 years; C > 3 years)
FIGURE 2.11.3 Age grouping of female, wethers and male Damara sheep
slaughtered at a commercial abattoir

Not much can be deducted from the data displayed in Figure
2.11.4 apart from the 0 fatness degree category, representing
20.6 % of the total, and which can probably be ascribed to
producers in draught stricken areas getting rid of access
stock. Apart from this seemingly major deviation, a positive
aspect is the fact that the representation in the prime
categories viz. gradings 2 and 3 are predominant.

Figure 2.11.5 displays the carcass weight distribution amongst
the different sex groupings. Disregarding the influence of the
rams a rather normal distribution is displayed with the highest
frequency in the 14 - 16 kg weight category which compares well
with Meatco's averages. This data should however be compared to
the data obtained under extensive husbandry conditions
presented in Chapter 3.

2.12 DISCUSSION AND CONCLUSION

Due to circumstances mentioned in the Introduction viz.
inadequate record keeping systems, small numbers of breeders
and small herd sizes, the significance of the data extracted
from the questionnaire should be viewed with open minded
discretion. The impression is however created that a general
purpose for breeding with Damara sheep exists viz. that there
is room for a breed which can flourish under harsh, dry and
arid conditions. How competition from established breeds with
much the same characteristics such as the Namaqua and Ronderib

Percentage of total
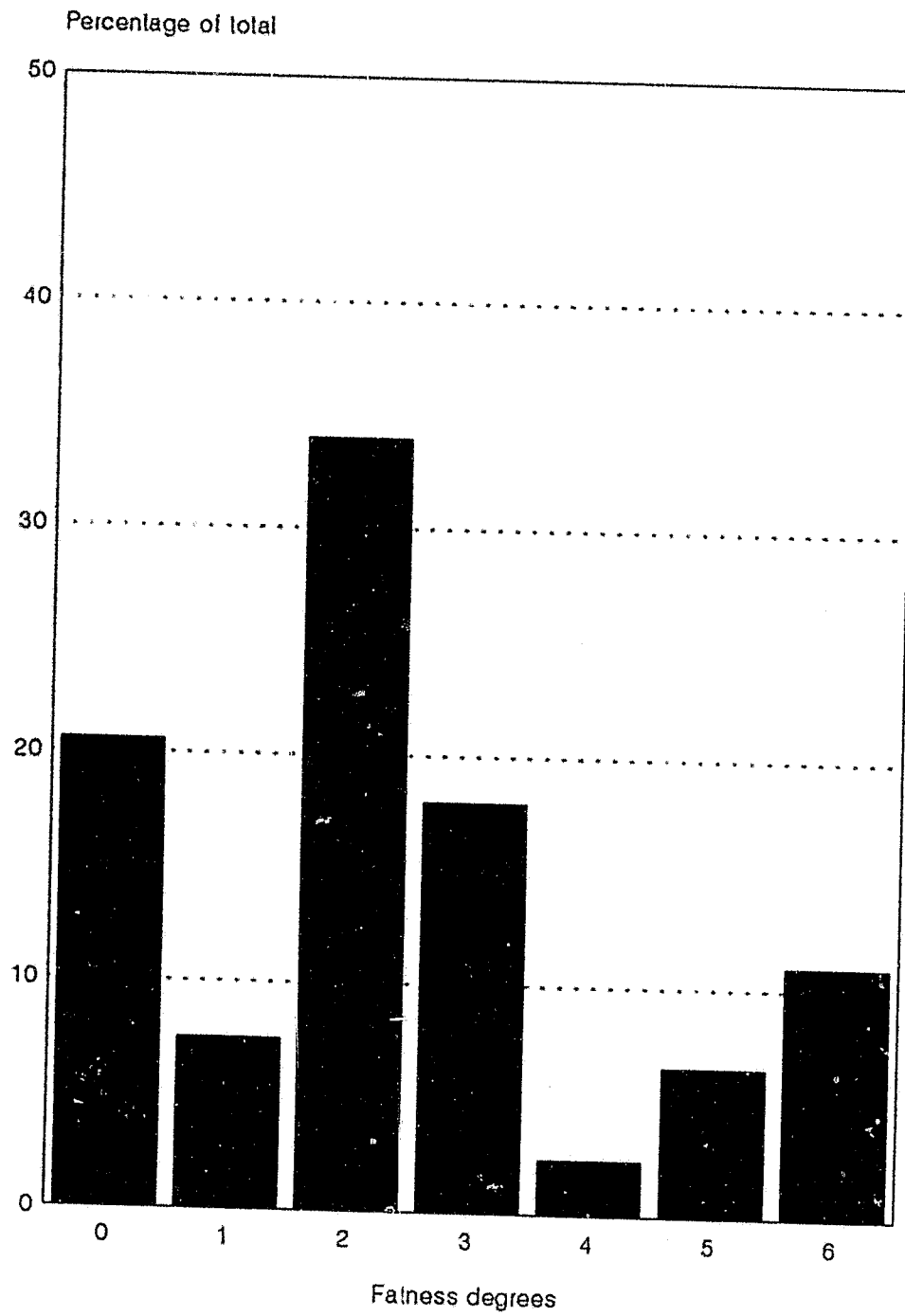
Fatness degrees

0 = no fat; 1 = very lean; 2 = lean; 3 = medium; 4 = fat; 5 = super fat; 6 = extremely fat

FIGURE 2.11.4 Damara sheep slaughterings (degrees of fatness)
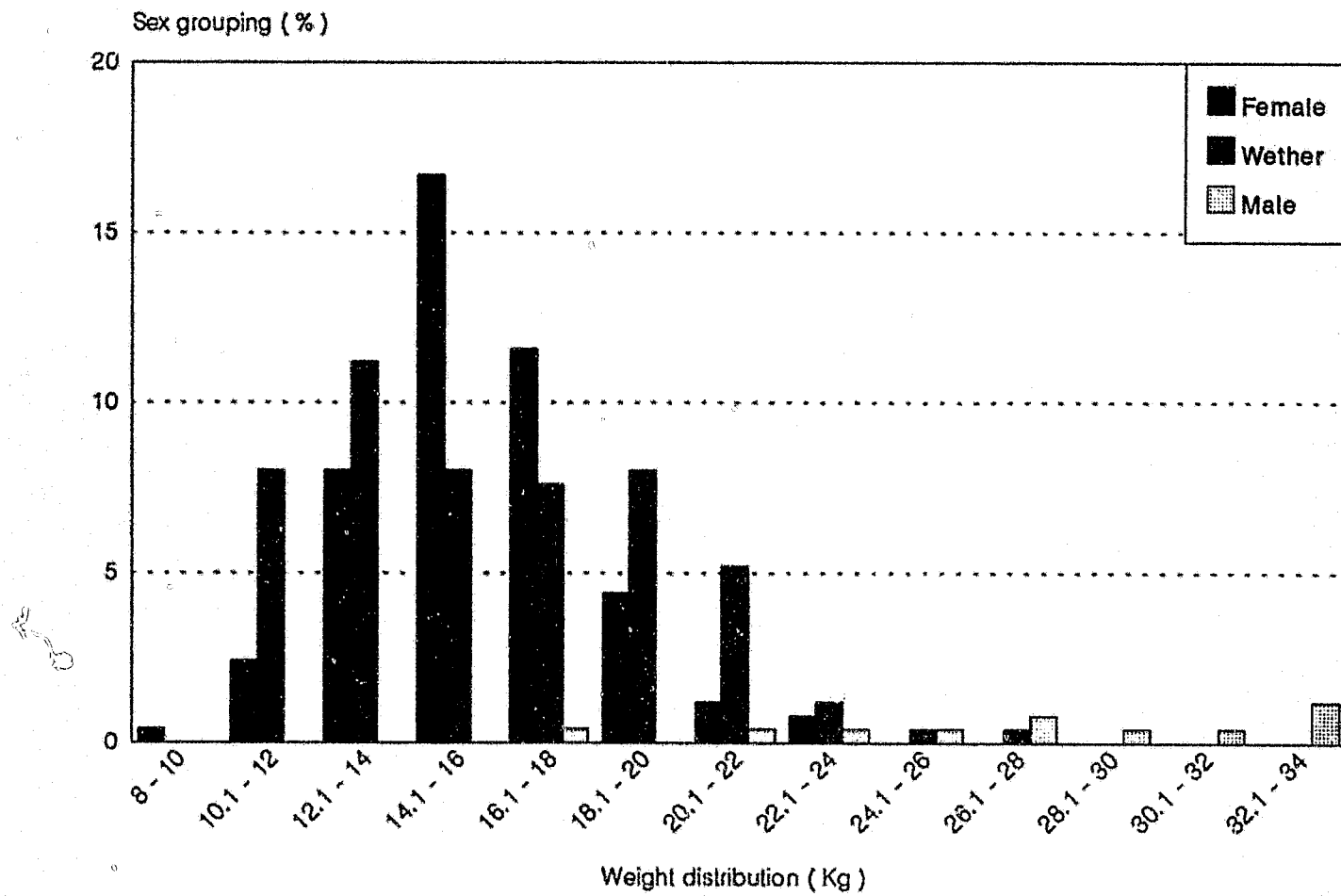
FIGURE 2.11.5 Damara sheep slaughterings (carcass weight distribution)

Afrikaner and the Van Rooy sheep affects the dispersion of the Damara sheep, is a factor that should be taken into consideration.

From the questionnaire it can however be concluded that:

i) Damara sheep are mainly herded in small numbers by a small number of breeders in the commercial areas

ii) Damara sheep are essentially kept as a secondary or tertiary industry on the farm

From the large number of positive aspects gathered from the questionnaire it can however be speculated that there is potential for the Damara sheep to expand its presence in the overall small stock industry. These viewpoints are underlined by data gathered from Meatco when consideration is given to numbers, gradings and weight distribution.

CHAPTER 3

**GROWTH AND REPRODUCTION RELATED INFORMATION COMPILED AT
OMATJENNE RESEARCH STATION (NAMIBIA) AS REFERENCE TO
EXTENSIVE HUSBANDRY PRACTICES INVOLVING THE DAMARA BREED**

3.1 INTRODUCTION

The existence of the Damara sheep is, from a historic point of
view, nomadic in nature. Emanating from this background, the
breed has become adapted to survive under extensive husbandry
conditions as a result of specific inbred qualities which makes
the Damara an obvious choice to farm with under specific
conditions.

The trials performed and described during the current
investigation (Chapters 4 - 10) were carried out under
intensive conditions due to the intensive nature of the work
done. It would therefore seem appropriate to make use of
available information gathered over an extended period of time
at Omatjenne Research Station where conditions can be described
as fairly extensive. The Station is 17 666 ha in extent and the
vegetation consists of thornbush savanna with palatable shrubs
and a good coverage of perennial grasses. It receives
approximately 410 mm of rainfall per annum with the rainy
season extending from October to April (Figure 3.1.1). A
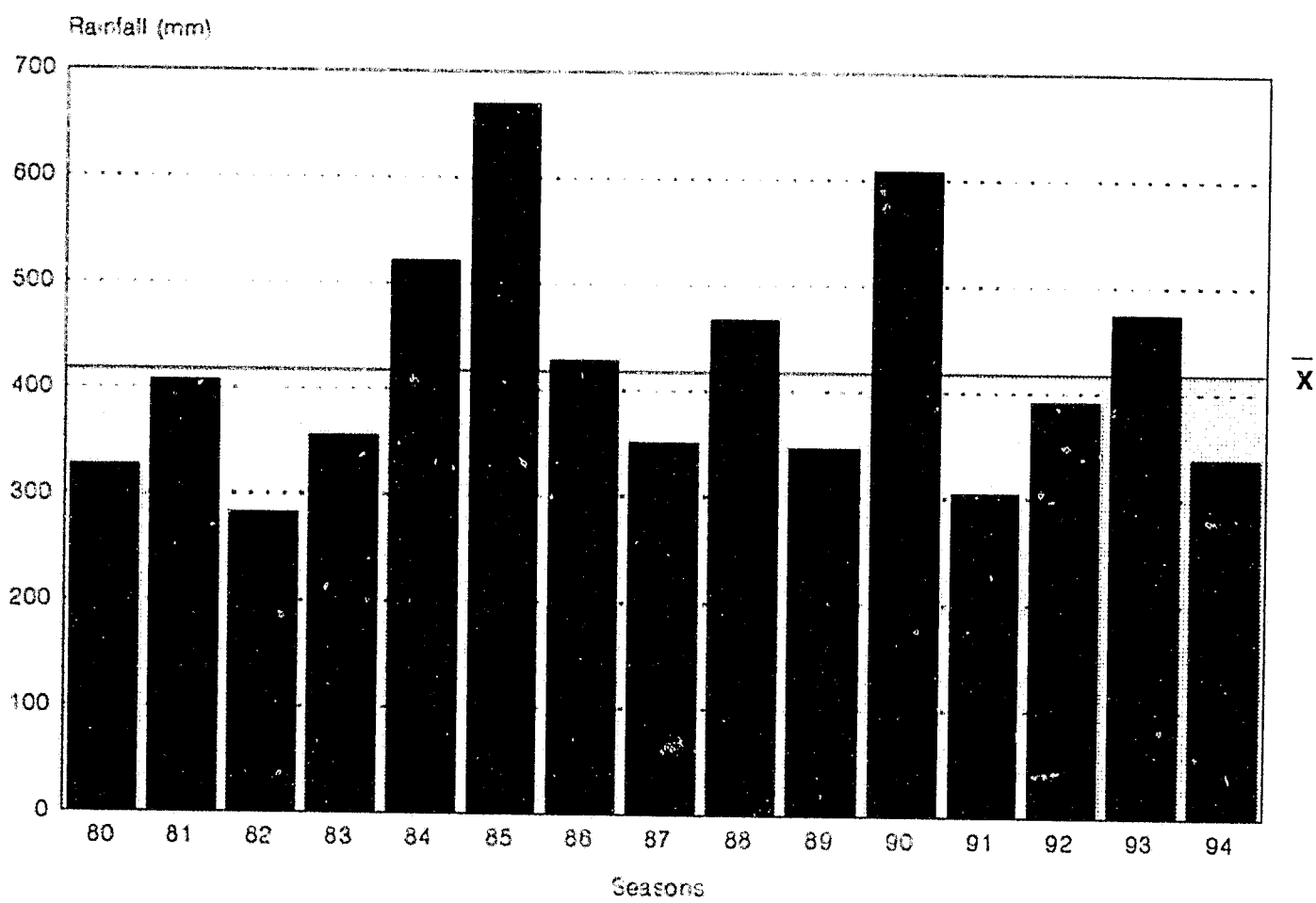
FIGURE 3 1 1 Total rainfall figures per season Omatjenne (rainfall season: October to April)

great number of the Damara sheep which is herded in Namibia and
South Africa today originated from Omatjenne.

Statistical analysis performed on numerical data from the
thesis is based on the T-test and Mann-Whitney test for two-
sample analysis of variance, the Kruskal-Wallis test for
multiple sample analysis of variance and the Chi-square test
for categorical data analysis.

3.2 SEASONAL VARIATION IN LIVE WEIGHT FROM BIRTH TO 12 MONTHS
OF AGE

Live weights are, as a normal practice, determined at birth,
weaning (± 90 days), 6 months, 9 months and 12 months of age
at Omatjenne. During the lambing period, the pregnant ewes are
brought in and kept in pens where the lambs are born. This
allows for identifying, marking and weighing the newly born
lamb and to perform the necessary functions with regard record
keeping and health care. After delivery, the ewe and her lamb
are kept together for two or three days before they are removed
to veld camps where they are to fend for themselves.

Data accumulated over a period of 14 years on live weights is
displayed in Table 3.2.1. The average weight increases of
Spring bred lambs and Autumn bred lambs are presented in Figure
3.2.1. A point of interest is the fact that the two curves
cross over at a stage which corresponds with January/February

TABLE 3.2.1 Average weight (all groups) from birth to 12 months of age

Age	Weight (Kg)				
	Spring (m+f)	Fall (m+f)	Female	Male	Male + Female
Birth	3.9	4.1	3.8	4.2	4.0
Wean (90 days)	17.9	19.5	17.8	20.0	18.9
6 months	32.5	30.3	26.6	35.9	31.2
9 months	40.3	38.1	34.4	43.0	38.8
12 months	47.6	44.9	40.3	51.3	46.1
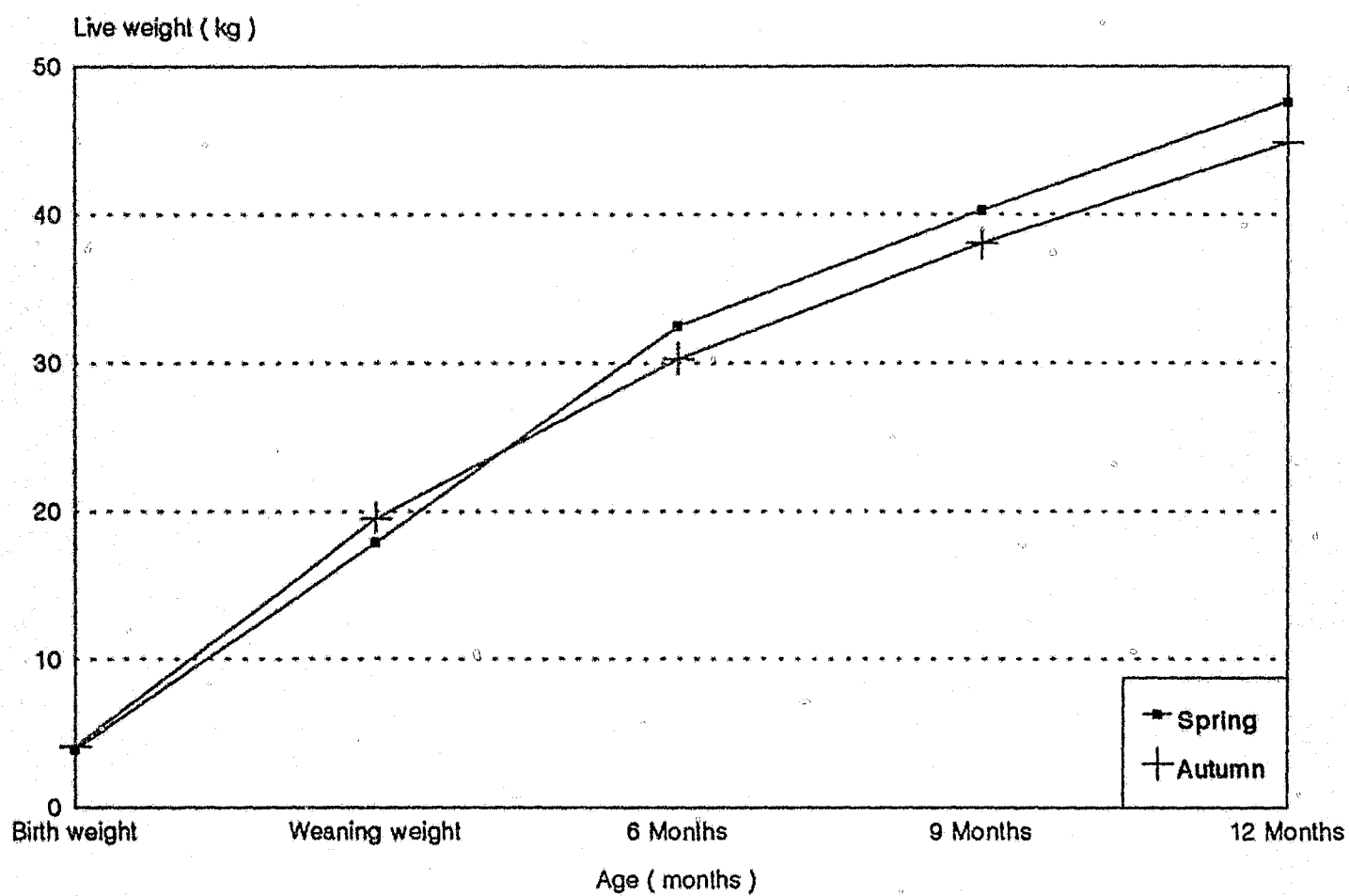
FIGURE 3.2.1 Average weight increase: Spring vs Autumn born lambs

for the Autumn bred lambs with the delay in growth rate starting at approximately the month of December. The heavier rainfalls resulting in vegetation growth normally occurs from January to March, and the vegetation obtaining flowering stage a month or two later. The crossing over that occurs, seems to be an obvious reaction on the part of the animals towards vegetation growth. At the stage when Autumn bred lambs are weaned, grazing conditions are just not adequate to allow for above average growth performance. The Spring bred lambs on the other hand are weaned during the period May/June when grazing conditions are still good, the grass just beginning to turn moribund. From six months of age the incline in growth rate runs more or less parallel for both groups. Season however had no significant effect on rate of weight increase between birth and wean, wean and 6 months, 6 months and 9 months and 9 months and 12 months of age ($P > 0.05$).

Table 3.2.2 Growth rate of Damara sheep under extensive conditions (mean for both seasons)

		n	Average weight (kg)
Birth weight	(m + f)	1327	4.1 ± 0,35
Weaning weight	(m + f)	1281	18.9 ± 2.33
6 Months	(f)	1037	31.2 ± 4 92
9 Months	(f)	975	38.8 ± 6 22
12 Months	(f)	894	46.1 ± 7 56
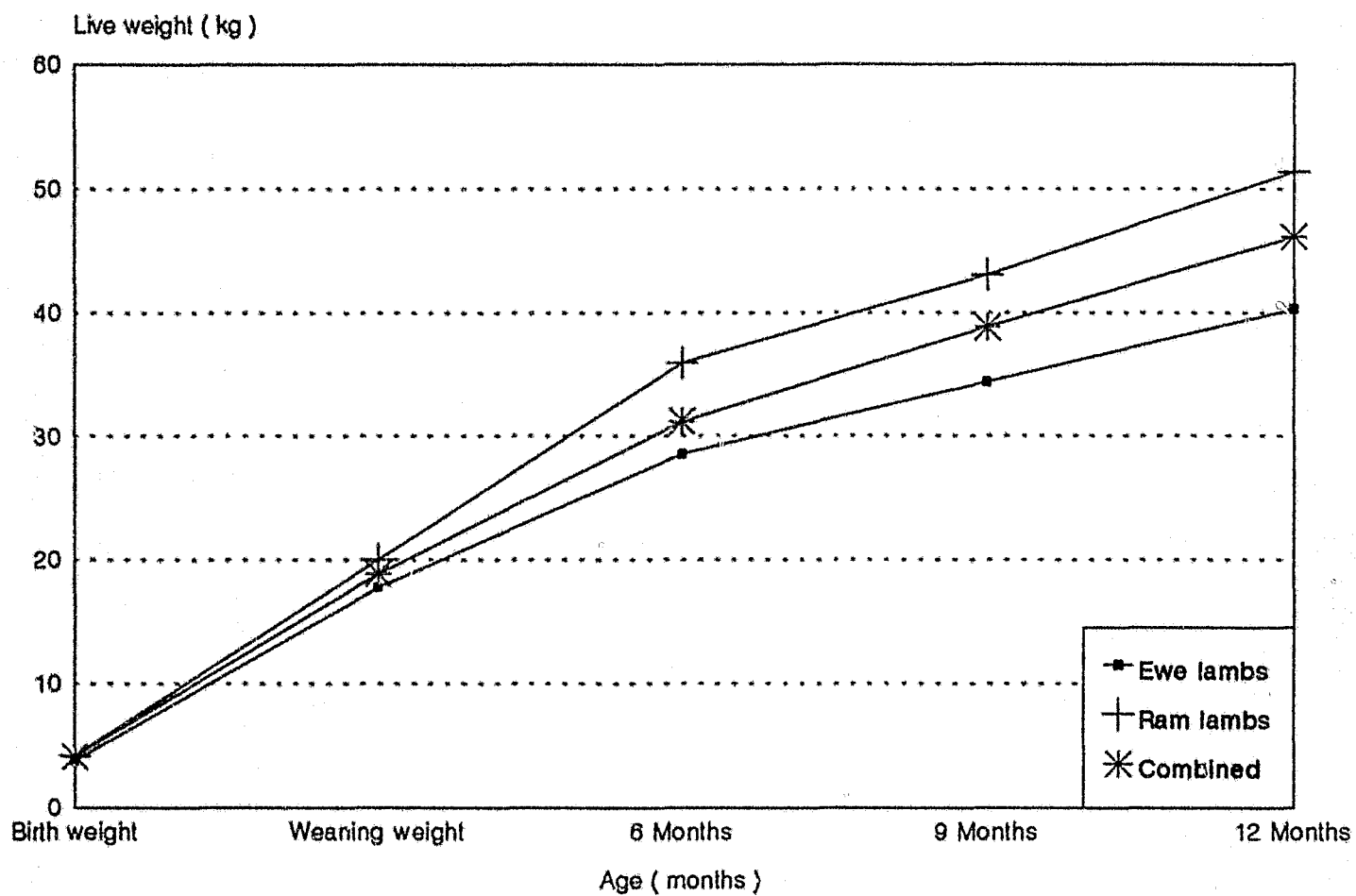
FIGURE 3.2.2 Average weight: ewe lambs, ram lambs and ewe and ram lambs combined

The average weight increases for ewe lambs, ram lambs and ewe and ram lambs combined, registered over the period 1977 to 1991 are displayed in Figure 3.2.2. The relative decline in growth rate that occurs at approximately 6 months of age for both groups can be ascribed mainly to winter grazing conditions. The following data on birthweight and weanweight (100 days) can serve on a comparative basis for mentioned variables where different breeds of male were crossed with Merino ewes. This data was obtained on pasture supplemented with maize rations (Greeff, Wyma, Van Deventer, Greyling, & Brink, 1989).

	Birthweight (kg)	Weaning weight (kg)
Ile de France	3.7	16.8
Dohne Merino	3.5	15.3
SA Mutton Merino	3.5	16.4
Merino	3.4	14.3
Finish Landrace x Merino	3.8	15.1
Mean ± std dev	3.58 ± 0.164	15.58 ± 1.013

3.3 REPRODUCTIVE PERFORMANCE OF DAMARA EWES AT OMATJENNE RESEARCH STATION

Biannual breeding is not implemented as a normal management practice at Omatjenne Research Station. It does however happen that an additional breeding season is incorporated to include the maiden ewes in the breeding program as a separate group.

Reproductive figures covering both seasons are therefore not available on a continuous scale.

Maiden ewes are initially introduced to the ram at an age of 12 to 18 months. As has been mentioned the maiden ewes are mated during the Autumn season while the main breeding season is exercised during Spring which is contradictory to normal breeding practice. This arrangement is however dictated by the overall management program at the Station in which cattle and goats are also represented.

During the breeding period the ewes are herded into groups of approximately 35 ewes. Each group is served by a single identified ram for a period of 3 weeks. After 3 weeks the ram is removed for a period of 10 days and replaced by a second identified ram for a subsequent period of 3 weeks. The interlamb period extends over a period of 365 days.

All available data on reproduction were collected and graphically represented in Figures 3.3.1, 3.3.2, 3.3.3, 3.3.4 and 3.3.5. Unfortunately there is a lack of data during the period 1980 to 1983 for the Autumn breeding season. Regardless this unfortunate coincidence, a general tendency can still be identified. Averages representing these parameters for the Autumn and Spring breeding seasons are disclosed in Table 3.3.1. None of the indicated parameters were significantly affected by season (P > 0.05).

Weaning percentage
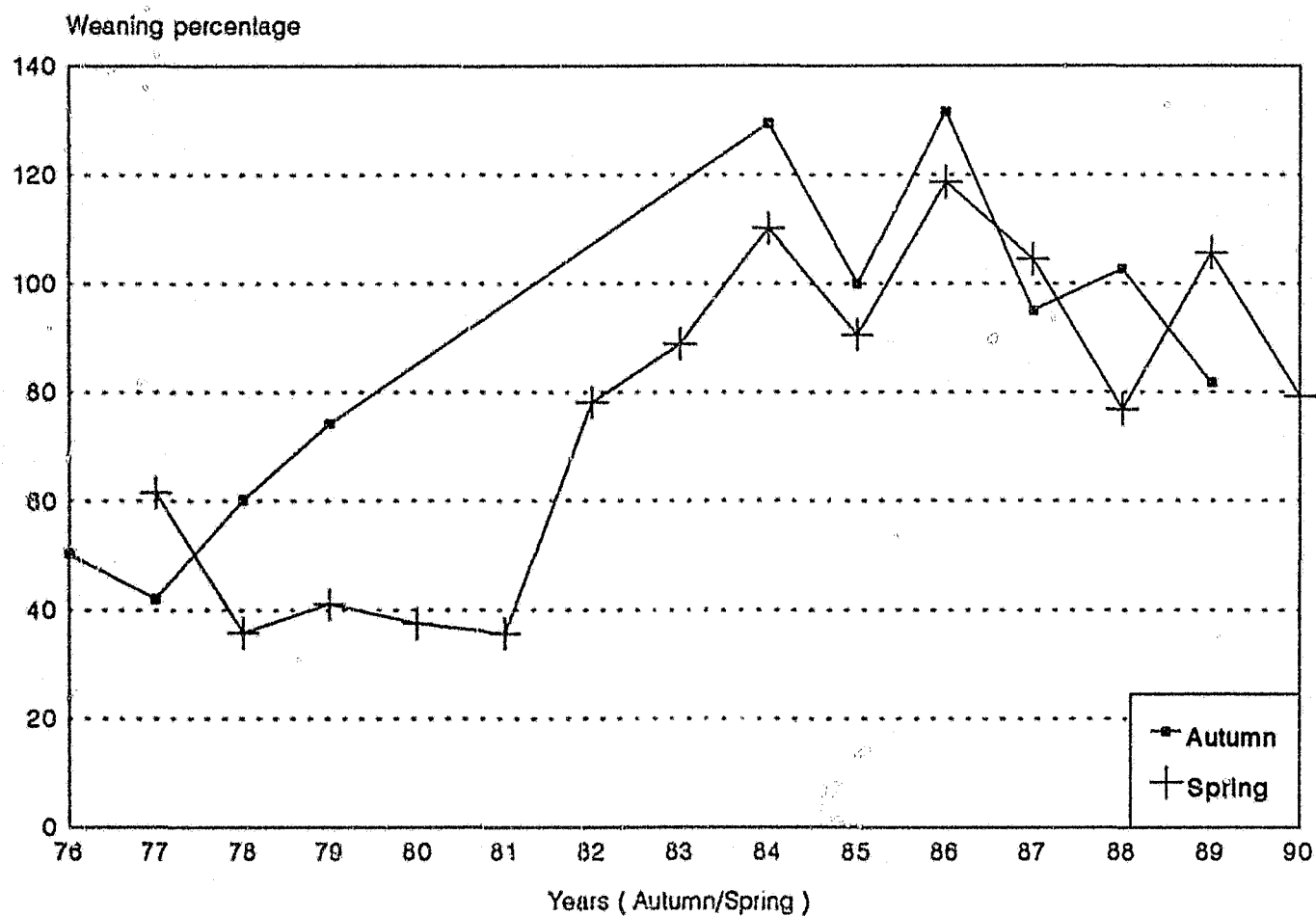
FIGURE 3.3.1 Weaning percentage (Autumn vs Spring breeding)
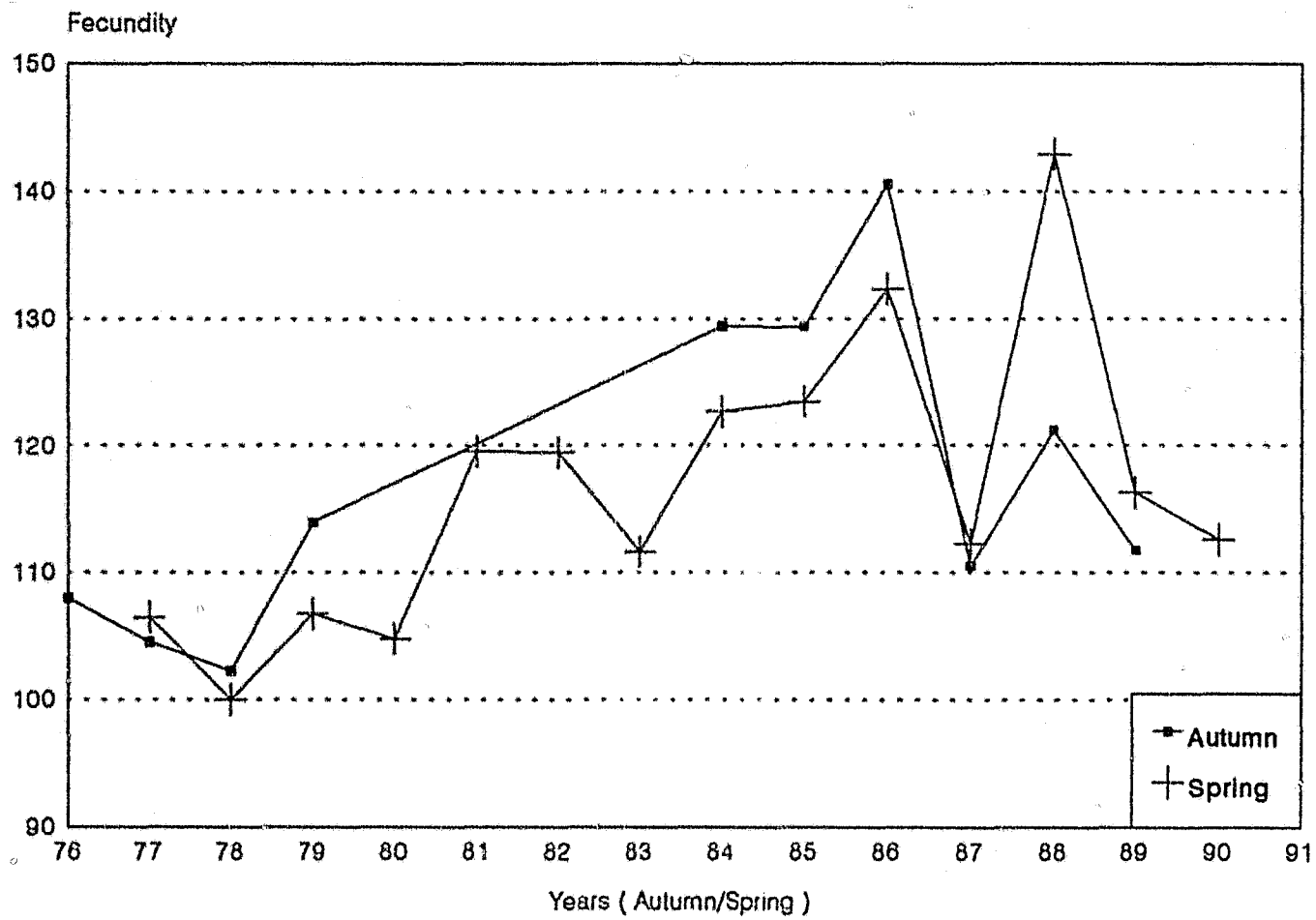
FIGURE 3 3 2 Reproduction parameters Fecundity (Autumn vs Spring breeding)
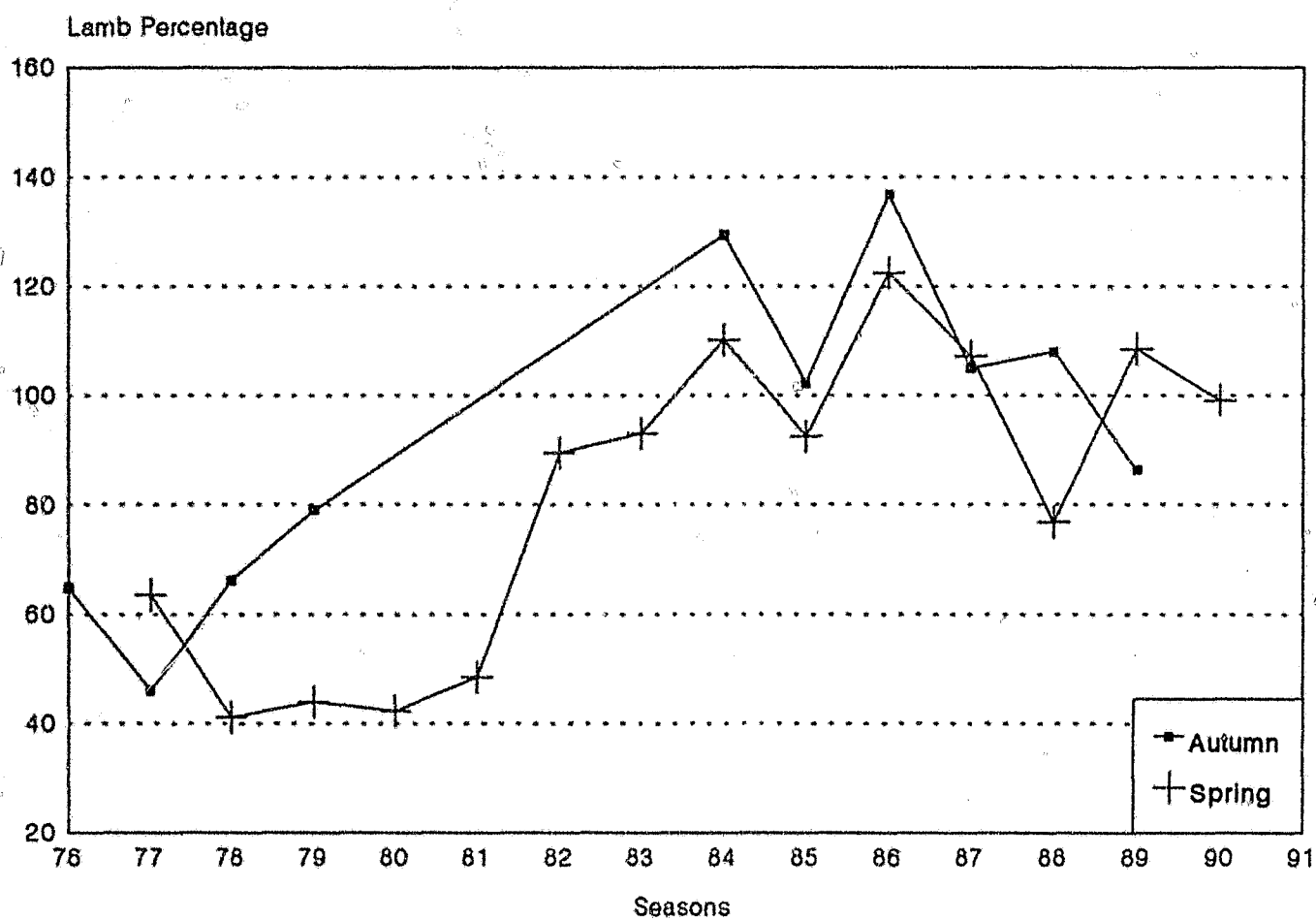
FIGURE 3.3.3 Reproduction parameters: Lamb percentage (Autumn vs Spring breeding)

Lambing percentage
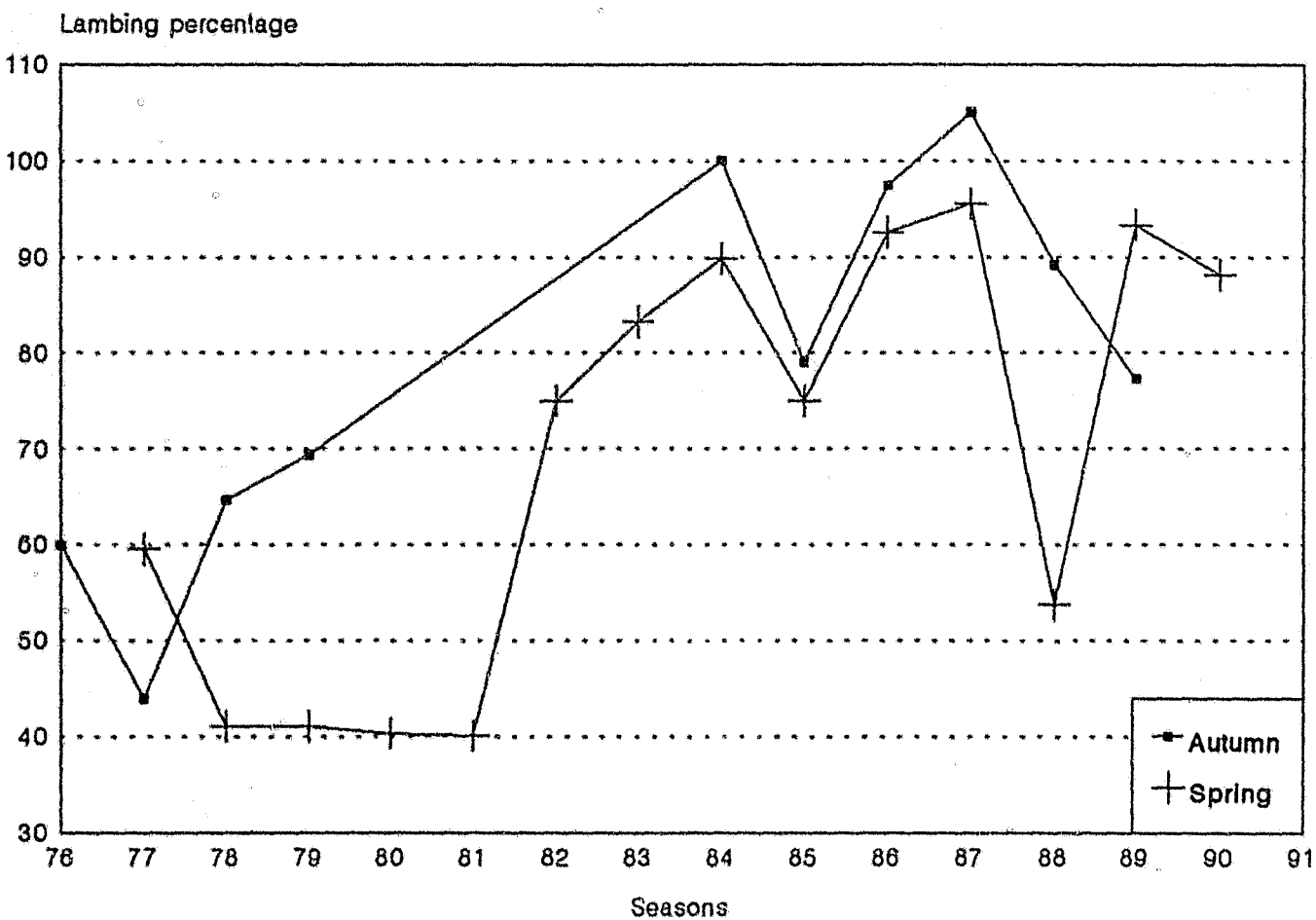
FIGURE 3.3 4 Reproduction parameters: Lambing percentage (Autumn vs Spring breeding)
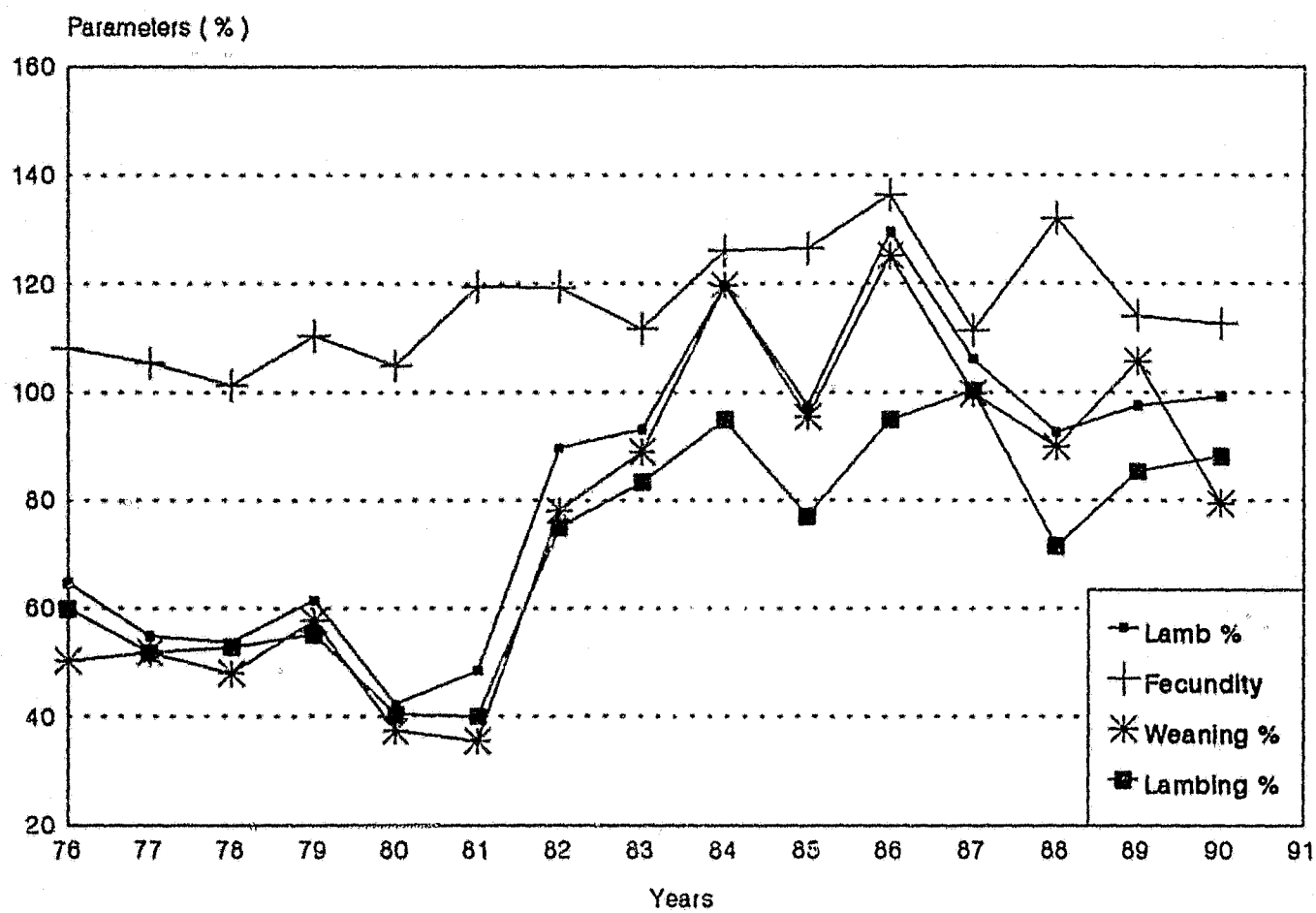
FIGURE 3.3.5 Lamb percentage, fecundity, weaning percentage and lambing percentage
(average figures for both autumn and spring seasons)

Definitions: (Schutte, van Tonder, van der Westhuysen, Herbst & Steyn, 1986)

$$\text{Lambing percentage} = \frac{\text{Ewes lambed (lambs dead or alive)}}{\text{Total number of ewes serviced}} \times 100$$

$$\text{Lamb percentage} = \frac{\text{Lambs born (dead or alive)}}{\text{Total number of ewes serviced}} \times 100$$

$$\text{Fecundity} = \frac{\text{Lambs born (dead or alive)}}{\text{Number of ewes lambed}}$$

$$\text{Weaning percentage} = \frac{\text{Lambs weaned}}{\text{Total number of ewes serviced}} \times 100$$

Table 3.3.1   Mean values for lamb percentage, fecundity, weaning percentage, and lambing percentage for ewes bred during Spring and Autumn

	Spring	Autumn
Lamb %	81.36 ± 28.48	92.40 ± 29.17
Fecundity	1.16 ± 0.12	1.17 ± 0.13
Weaning %	76.03 ± 29.42	87.28 ± 32.62
Lambing %	69.19 ± 22.27	78.61 ± 19.56

Figures in Table 3.3.1 compare favorably with figures reported for Merino sheep recorded in the RSA (Olivier, 1982) viz.

    Ewes lambed / 100 ewes serviced   84 ± 8

    Lambs born / 100 ewes lambed   114 ± 7

    Lambs weaned / 100 ewes lambed   70 ± 11

In all instances it appears as if Autumn breeding is generally speaking, more beneficial than Spring breeding. This assumption is supported by available figures for twinning (Table 3.3.2). The average percentage for twinning from Autumn breeding is 20.59 % compared to 14.40 % for Spring bred ewes. There is however no significant difference in twinning rate between seasons ($P > 0.05$). The assertion that the Damara sheep can breed throughout the year can however not be refuted by this evidence.

Table 3.3.2 Twinning incidence (%) between Autumn and Spring breeding

Season	Autumn (%)	Spring (%)
1977	4.55	6.45
1978	2.27	0
1979	13.95	6.82
1980		4.76
1981		19.51
1982		19.44
1983		11.67
1984	29.41	22.73
1985	29.41	23.46
1986	40.54	32.32
1987	10.53	12.26
1988	42.86	21.21
1989	11.76	16.33
1990		12.61
Mean ± std dev	20.59 ± 14.40	14.97 ± 8.48

The initial poor performance for particularly the two parameters Lamb percentage and Lambing percentage (Figure

3.3.5) is quite evident. The improvement which set in since 1981 is remarkable in contrast. The reason for this improvement can presumably be ascribed to improved management practices. A positive aspect which showed up, is that lamb percentage has stabilized above the 100 % level from 1984 onwards.

3.4 INFLUENCE OF DOCKING ON THE REPRODUCTIVE PERFORMANCE OF DAMARA EWES AND RAMS

The base of the tail of the Damara sheep accumulates fat under good grazing conditions to such an extent that it can be an obstacle for the ram when mounting the ewe. This problem has been encountered during the trials executed at Neudamm when handmating was applied during the current investigation.

During 1987 twenty maiden ewes, 12 months of age, were included in trials at Omatjenne Research Station to determine the influence of docking on reproduction. Ten ewes were docked (Group D) and ten ewes were left intact (Group T). The purpose of these trials were to determine whether docking would have a significant influence on the reproductive performance of both male and female Damara sheep. During Trial 1 both groups were mated for 42 days. This procedure was repeated during Trial 2 to determine lambing interval and the repeatability of the results obtained in Trial 1. The results of both Trials 1 and 2 are displayed in Table 3.4.1. The lambing results from Trial 1 for docked and intact ewes were 120 % and 90 % and for

TABLE 3.4.1. Performance of docked ewes versus intact ewes (Test 1 and Test 2)

Parameters	Test 1		Test 2	
	Docked	Tailed	Docked	Tailed
Ewes paired	10	10	10	9
Ewes lambed	10	9	10	8
Lambs born alive	12	9	11	8
Total lambs born	12	9	11	8
% Ewes lambed	100	90	100	88.9
% Lambs born	120	90	110	88.9
% Lambs weaned	100	77.8	100	100
Total mass weaned	196.5 kg	135 kg	215.5 kg	161.5 kg
Total mass 6 mths	334 kg	218 kg	360 kg	244 kg
Total mass 9 mths	479.5 kg	300 kg	354 kg	232 kg
Total mass 12 mths	560 kg	360 kg	461 kg	305.5 kg

Trial 2, 110 % and 89 % respectively. Lambing intervals were
245 days and 255 days respectively. Data displayed in Table
3.4.1 accordingly illustrates that taildocking Damara ewes can
be beneficial from an economic point of view. In both Tests 1
and 2 there is however no significant statistical difference
distinguishable in the performance between docked and tailed
ewes (P > 0.05).

3.5 LOSSES RECORDED FOR DAMARA SHEEP AND BOER GOAT AS REFERENCE, AT OMATJENNE RESEARCH STATION

Available data with regard to the allegation made by producers
that Damara sheep are resistive towards vermin and stocktheft
(Paragraph 2.9, Table 2.9.1), has been presented in Tables
3.5.1 and 3.5.2. The Boer goat as such does not easily fall
prey to vermin and thieves. Data of two flocks of approximately
200 goats and 200 sheep were recorded. Comparing therefore the
performances of the Damara sheep and the Boer goat in this
regard (refer Tables 3.5.1 and 3.5.2) it can be concluded
that apart from fatalities resulting from disease, the
performance of the Damara sheep outweigh that of the Boer goat
by far. The Damara sheep is significantly less prone to losses
as a result of mentioned causes than the Boer goat
(P < 0.05). The figures demonstrating disease as reason for
fatalities, is peculiar as a result of the fact that Damara
sheep allegedly also shows resistance against disease. The
final outcome for this parameter as displayed in Table 3.5.2,

TABLE 3.5.1 Recorded losses of Damara sheep compared to Boergoat in an extensive farming system
(flock sizes approximately equal)

Year	Rams		Ewes		Lambs		Castrates		Total		% of Total	
	Damara	Goats	Damara	Goats	Damara	Goats	Damara	Goats	Damara	Goats	Damara	Goats
1984	0	4	13	4	6	5	2	13	21	26	10.7	8 6
1985	1	1	5	12	4	7	1	2	11	22	5.0	8 0
1986	4	1	7	5	0	4	0	3	11	13	3 6	4 0
1987	1	2	1	12	1	10	4	3	7	27	2.3	9 1
1988	2	7	2	19	1	12	2	7	7	45	2.5	16.2
1989	7	4	8	12	3	29	7	5	25	50	8.0	17.6
1990	2	4	2	5	21	26	5	11	30	46	13.3	25.8
1991	6	4	4	8	13	17	7	8	32	36	15.7	21.8
1992	6	5	11	14	12	17	4	21	33	57	9.6	20.3
1993	2	0	10	10	9	16	1	16	22	42	6.4	14.9
Total:	31	32	63	101	70	143	33	89	199	364	7.8	13.8

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TABLE 3.5.2 Reasons for losses suffered in an extensive farming system of Damara sheep and Boergoat (flock sizes approximately equal)

Year	Vermin		Theft		Disease		Unknown		Accidents		Total	
	Damara	Goats	Damara	Goats	Damara	Goats	Damara	Goats	Damara	Goats	Damara	Goats
1984	20	16	0	3	1	5	0	1	0	1	21	26
1985											11	22
1986	8	11	0	0	1	2	0	0	2	0	11	13
1987	2	12	0	9	4	3	0	0	1	3	7	27
1988	4	28	0	7	0	3	0	0	3	7	7	45
1989	13	36	0	7	8	4	0	0	4	3	25	50
1990	10	31	0	6	14	4	2	0	4	5	30	46
1991											32	36
1992	0	25	16	26	15	5	0	0	2	1	33	57
Total:	57	159	16	58	43	26	2	1	16	20	177	322

is however grossly influenced by figures reported for 1990 and 1992. No clear explanation for this phenomenon could be obtained (Von Wielligh, 1984, 1986, 1987, 1988, 1989, 1990/91 and 1992).

3.6 CONCLUSION

The Damara flock at Omatjenne consists of approximately 200 animals and shares the facility with approximately the same number of Boer goats and about 900 cattle. Apart from the fact that it is a closed herd and that selection is carried out with the breed characteristics described in Chapter 2 as basis, the Damara sheep at Omatjenne is expected to be self-reliant, depending on their alleged inherent characteristics for survival. Nevertheless it can be concluded that the performance of the Damara breed (Tables 3.2.2 and 3.3.1) is in general comparable to related data reported by Cloete & de Villiers (1987) for Dorper sheep viz. birth mass (4.1 kg), weaning mass (41.3 kg), lambs born alive/lambs born (0.98) and lambs weaned/lambs born (0.91) and Quirke (1979 b) for Galway and Fingalway sheep viz. weaning weight (28.5 kg and 27.0 kg respectively) and live weight at 9 months (40.8 kg and 39.7 kg respectively).

Production and reproduction potential in farm animals are influenced by a number of factors. The more important ones are nutrition, climate, breed differences and age (Boshoff, Gouws

& Nel, 1975) which, together with others, give rise to the variation in results so often encountered in research reports. All or one such factors can act as a roleplayer to influence the eventual result generated by a database in the short term. In the long term a tendency is normally revealed which can serve as a guideline or criterium of measurement.

CHAPTER 4

**THE EFFECT OF DIFFERENT SYNCHRONISATION REGIMES ON THE
OCCURRENCE OF THE OESTROUS CYCLE, OVARIAL FUNCTION AND SERUM
PROGESTERONE AND LUTEINISING HORMONE CONCENTRATIONS DURING THE
OESTROUS PERIOD**

4.1 INTRODUCTION

The Damara breed is represented by relatively small numbers
today. Very little is known about the breed as a result of poor
publicity which the breed was subjected to until recently and
the almost complete lack of research done on this particular
animal. This gave rise to the need to investigate specific
parameters which will broaden the information base on the
Damara sheep, especially in the field of reproduction. Since
certain positive characteristics associated with the breed have
been identified, which make the breed employable under specific
conditions as has been mentioned in previous chapters, a
program was launched which was aimed at establishing the
potential of the breed. Due to circumstances this was done
under close to optimal conditions. The application of improved
breeding techniques and principles, could lead to an increase
in breed numbers and at higher rates. As a logical consequence,
selection practices could be intensified, thereby improving the
status of the breed in the total smallstock environment.

The division and subdivision of the different experimental groups employed during the investigation are represented in Table 10.1.

According to several authors (Gordon, 1975; Hackett, Robertson, Penner & McLaughlin, 1981; Acritopoulou-Fourcroy, Pappas, Peclaris & Zervas, 1982; Ainsworth & Wolynetz, 1982) the regulation of luteal function in farm animals through the application of hormone preparations, such as analogues of progesterone or prostaglandin F2a (PGF2a), have become general procedure in animal husbandry practices.

The most commonly used technique to control the reproductive cycle in sheep, is based on the treatment of ewes with polyurethane intravaginal sponges impregnated with a synthetic progestagen, often in combination with pregnant mare serum gonadotropin (PMSG) (Acritopoulou-Fourcroy et al., 1982; Ainsworth, 1985; Cognie, Perret & Oldham, 1980; Killian, Kiesling & Warren, 1985; Langford, 1982; Le Roux, 1976; Pearce & Robinson, 1985; Quirke, 1979 a; Robinson, Scaramuzi & Smith, 1987; Smith, Boland & Gordon, 1981).

Profiles of plasma hormone concentrations are used to assess the regulatory events that occur during the oestrous cycle, which in the ewe is normally devided into a 12-13 day luteal phase and a 3-4 day periovulatory period (Driancourt, Gibson & Cahill, 1985; Legan & Karsch, 1979). The pattern of

circulating progesterone reflects the secretory activity of the corpus luteum and is governed by an interplay between stimulatory factors from the pituitary and inhibitory ones from the uterus (Legan, et al., 1979). The luteinising hormone (LH) surge is accompanied by behavioral oestrus which precedes ovulation by approximately 24 hours (Cumming, Buckmaster, Blockey, Goding, Winfield & Baxter, 1973; Fairnie & Wales, 1980; Inskeep, Lewis, Stilley, Mulledy & Dinsmore, 1983; Robinson et al., 1987).

On the basis of considerable experimental evidence, the farmer could expect about 60-70 % of ewes treated to conceive to first oestrus and some 80 % to produce offspring to the combined first and second services after treatment(Gordon, 1975; Inskeep et al., 1983). When considering suitable hormone techniques for fertility control in sheep, it should be emphasized that the proper application thereof is but one of several elements necessary for a successful response and lambing outcome and that controlled breeding should be exercised in the appropriate setting of feeding, breeding technique, management and season.

A high level of progestagen followed by adequate ovarian stimulation through exogenous FSH, is a necessary prerequisite for acceptable fertility in sheep. Administration of PMSG results in more precise and reliable synchronisation and also has merit in inducing a mild but unpredictable superovulatory

effect. The capability of the ram must receive careful
consideration in the application of controlled breeding
techniques whether for the purpose of natural service or
artificial insemination (Gordon, 1975). This relates *inter*
alia to the phenomenon of subfertility associated with
progestagen treatment in sheep due to fertilization failure
which results from impairment of normal transport and survival
of spermatozoa in the cranial part of the cervix (Gordon,
1975; Hunter, Belonje & Van Niekerk, 1971; Mac Donnell, 1985;
Pearce *et al.*, 1985).

If pre-conditioned by a period of isolation from rams,
prepubertally, seasonally or lactationally anovulatory ewes of
many breeds can be stimulated to ovulate by the introduction of
rams. The signal from the rams is mainly pheromonal and
activates neural connections between the main olfactory tract
and the anterior hypophysis (Lindsay, Cognie, Pelletier &
Signoret, 1975; Smith, Swartz, Kiesling & Warren, 1986). This
leads to an increase in the frequency of LH-pulses, a process
which is essential for the introduction of ovulation and is
usually completed within a few minutes. The high pulse
frequency stimulates advanced follicular growth and oestradiol
secretion by the ovaries. The subsequent build-up of oestradiol
in the blood has two effects: in the short term (first 2-12
hours) it reduces the levels of follicle-stimulating hormone
(FSH) and the amplitude of LH-pulses; in the longer term

(12-48 h) it induces preovulatory surges of both LH and FSH.
The LH surge induces ovulation and the formation of a corpus
luteum. In some ewes, the corpus luteum is normal and a normal
luteal phase follows the first ovulation. In other ewes, the
first corpus luteum secretes little progesterone and regresses
within 6 days. The proportion is variable but can be considered
to be in the region of 50% (Martin, Oldham, Cognie & Pearce,
1986). A second LH surge is then released, inducing a second
ovulation and the formation of an apparently normal corpus
luteum (Oldham, Pearce & Gray, 1985; Smith et al., 1986).
Work that has been done in this field, showed that as little as
two weeks of isolation will ensure a full ovulatory response
and that exposure of the ewes to rams for only short periods
(up to 3 h per day) is sufficient to accomplish this
endocrine response (Martin et al., 1986). The peak incidence
appear to commence two oestrous cycles after the introduction
of rams however. By exposing ewes to sexually active
vasectomised rams for 14 to 16 days prior to joining working
rams, it could be expected to obtain a high incidence of
oestrus during the first week of mating (Schinckel, 1954).

For the purpose of this investigation four different
synchronisation techniques were applied to compare the effects
of the treatments on time from cessation of treatment to onset
of oestrus and also the oestrous response between the treatment
groups as is described in Paragraph 4.2.

4.2 MATERIAL AND METHODS

4.2.1 Experimental Animals

Forty adult (4-6 teeth) Damara ewes which have lambed at least once, which was regarded as an indication of proven fertility, were utilized as experimental animals in this project. All the animals were relocated from Omatjenne Research Station in the Otjiwarongo district (approximately 16.5° longitude and 20.5° latitude) to Neudamm Agricultural College in the Windhoek district during October 1992 (approximately 17.5° longitude, 22.5° latitude) (Van der Merwe, 1983).

4.2.2 General Management

All animals were treated against internal and external parasites and were inoculated with a multipurpose vaccine (Multivax, Hoechst) before leaving Omatjenne Research Station. Disease control was exercised on a prescribed basis during the experimental period. The ewes were divided into different treatment groups and housed in a shed fitted with louvre floors in a separate pen for each group. Ample floorspace was provided with a feeding trough per ewe. The leeward side of the shed was completely open above a 1.5m high retaining wall, allowing for adequate and continuous ventilation.

Each pen was provided with a haystack. *Cenchrus ciliaris* hay
was fed *ad lib* while each subject received 500 gram drought
cubes in the morning and 500 gram in the evening (Table 4.1)
Fresh water was available at all times. This feeding regime was
applied throughout the entire program to all experimental
animals.

Each individual ewe was provided with an eartag with clearly
discernible hand-written numbers and was randomly allocated
into one of four treatment groups, A1, A2, A3 and A4
(Table 10.1).

Table 4.1   Nutritional composition and values of drought
            cubes fed during the trials

Substance	Fraction
	%
Lucerne	47
Maize meal / Grain sorghum	20
Oat bran / Wheat bran	25
Molasses	5
Salt	1
Lime	1
Sodium bentonite	1
Energy content	54
	g/kg
Protein	100 (14% ex urea)
Fat	25
Fibre	200
Moisture	120
Calcium (Ca)	15
Phosphorus (P)	3
Urea	5

The role of the ram in identifying oestrus and the problem of individual preferences were minimized by establi hing a large pool of teaser rams from which sufficient virile rams were always available. No adaptation period was provided for and treatment started as soon as the experimental ewes were divided into their respective groups.

4.2.3 Treatments

In order to acquire a synchronised oestrus, the following treatments were administered:

GROUP A1:

Vasectomised rams were introduced at the same time pessaries were inserted in the other experimental groups and were removed at the same time the pessaries were removed (12 days).

GROUP A2:

Progestagen impregnated intravaginal pessaries (60 mg Medroxy Progesterone Acetate, Repromap, Upjohn) were insert d for 12 days and 1 ml PGF2a (Dinoprost Tromethamine, Lutalyse, Upjohn) was administered intramuscularly at pessary removal (1 ml = 5mg Dinoprost).

GROUP A3:

Progestagen impregnated intravaginal pessaries (60 mg Medroxy Progresterone Acetate) were inserted for 12 days and 300 IU pregnant mare serum gonadotropin (Fostim, Upjohn) were administered intramuscularly at pessary removal.

GROUP A4:

Progestagen impregnated intravaginal pessaries (60 mg Medroxy Progesterone Acetate) were inserted for the duration of 12 days.

Before insertion every pessary was treated with an antiseptic preparation (0.5% Cetrimide, 0.1% Chlorhexidine). The applicator was rinsed in a solution of 5% chlorhexidine gluconate (Biotaine) between every insertion. The pessaries were left *in situ* for a period of 12 days. After removal the ewes were monitored twice daily for oestrous behaviour with vasectomised rams until termination of the ensuing oestrus. Blood samples were taken from the jugular vein once daily from two days before commencement of treatment until the end of oestrus from all ewes in each group.

As the ewes came on heat at the cessation of synchronised oestrus, they were divided into three groups for ease of handling. They were then fasted for 24 hours. The three groups were examined laparoscopically on three consecutive days, 5 to

6 days after oestrus was concluded, to establish ovarian response to the applied treatments.

4.2.4 Hormone assays

Serum progesterone concentrations combined with the employment of teaser rams served to assess the degree of synchronisation and the duration of oestrus which resulted from these trials. Blood samples were collected on a daily basis by jugular venepuncture into 10 ml heparinized Vacutainer tubes (Becton Dickinson & Co., Rutherford, New Jersey) from two days prior to treatment until termination of oestrus from each individual ewe, indicated by a teaser ram. Bloodsamples were centrifuged at 2000 rpm for 10 minutes and stored at -20° C until required for hormone analysis. All plasma progesterone concentrations were determined by radioimmunoassay (RIA) as described by Erasmus (1988). The progesterone antibody was prepared and made available by courtesy of Prof J.C. Morgenthal (Dept. of Human and Animal Physiology, University of Stellenbosch, Stellenbosch). Plasma samples (collected every 6 hours during the oestrous period of each ewe) were analysed for luteinising hormone (LH) concentrations as described by Yallow & Berson (1960) and modified by King (1995).

4.2.5 Laparoscopic examinations

For the laparoscopic examinations that were performed, ewes from the different treatment groups (A1 - A4) were randomly allocated into three new groups according to the cessation of the oestrous periods of the individual ewes. The three groups were separated from each other by one day and were fasted for 24 hours before being examined laparoscopically, approximately three days following cessation of the oestrous period. The following procedure was applied:

Ewes were placed in a dorsal recumbent position, head down on a 30° sloped cradle. Surgical preparation consisted of shaving the abdominal area from the udder approximately 10 cm anteriorly and disinfecting the area with Biotane and alcohol solution. General anesthesia was induced with an intravenous application of 0.6 ml Combelin (propionyl promazine, Bayer) combined with local anesthesia (Lignocaine hydrochloride 0.02 g, Centaur). The laparoscope was inserted through a 6 mm cannula assembly equipped with an attachment for abdominal insuflation. This was inserted with the aid of a conical trocar through a 1 cm skin incision, placed approximately 8 cm anterior to the mammary gland and 4 cm lateral to the mid-line. Care was taken to release pressure on the trocar which was pushed into the peritoneal cavity at an angle of 30° to avoid intestinal damage. Insuflation of the cavity with compressed air through the laparoscopic cannula attachment and the use of

a tactile probe, placed 5 - 6 cm lateral to the laparoscopic incision, facilitated the examination procedure. After inspection of both ovaries, the abdominal cavity was deflated and the endoscope and cannulae removed. Incisions are not sutured under normal circumstances. Each ewe received 5ml Streptopen (Procaine penicillin, Centaur) intramuscularly after completion of the operation (Roberts, 1968; Snyder & Dukelow, 1974).

4.3 RESULTS AND DISCUSSION

4.3.1 Plasma progesterone concentrations during the interval from cessation of treatment to onset of oestrus

Data which became available through the analysis of plasma samples for progesterone concentrations are described in the following paragraphs:

GROUP A1:

Figures 4.1.1 to 4.1.10 display progesterone levels (ng/ml) of all ewes from two days before the ram was introduced until the end of the subsequent oestrus relative to time (days) for Group A1. Figure 4.2 presents the interval from ram removal to oestrus. Apart from ewe 523 (Figure 4.1.4), all ewes displayed high progesterone concentrations on the day the ram was introduced (4/11/92) after which the progesterone levels

of all ewes dropped to basal levels (< 1 ng/ml) on days 2, 3
and 4 after commencement of treatment. These low levels of
progesterone which occurred in a very synchronised manner could
be indicative of regressing corpora lutea which is fairly
consistent with the findings of Martin et al. (1986) who
reported that ewes are induced to ovulate within 50 hours after
contact with the ram. Most of these ovulations are not
accompanied by overt oestrus (Lopez & Inskeep, 1988; Smith et
al., 1986). The stimulated ewes do however show oestrus and
ovulate again one oestrous cycle after joining (Hunter et al.,
1971; Schinckel, 1954; Smith et al., 1986). This effect is
only seen in the transition from the non-breeding to the
breeding season. The introduction of the ram has no effect on
incidence of oestrus when the breeding season is established as
a result of the operation of other exteroceptive factors
(Schinckel 1954). During the present study plasma
progesterone levels indicated that ovulation could have taken
place and first visible oestrus occurred 15 to 16 days later.

Ewes 515, 525, 524 and 528 showed standing oestrus at 14, 15,
17 and 18 days respectively after introduction of the ram which
is in accordance with Hunter et al. (1971) and Schinckel
(1954). Ewes 523, 529, 530 and 531 showed basal levels of
progesterone just prior to and at the time when the ram was
removed (12 days) with resulting oestrus 15, 16, 17 and 17
days respectively (approximately one oestrous cycle) after
the ram was removed. These four ewes could have formed part of
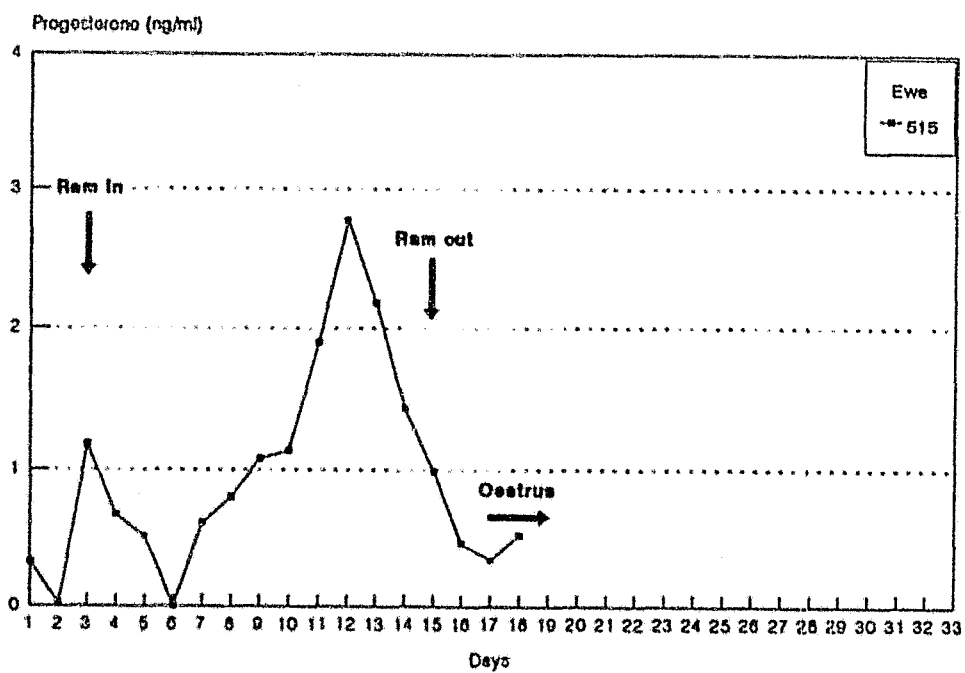
FIGURE 4.1.1 Progesterone levels and oestrous response (teaser ram for 12 days)
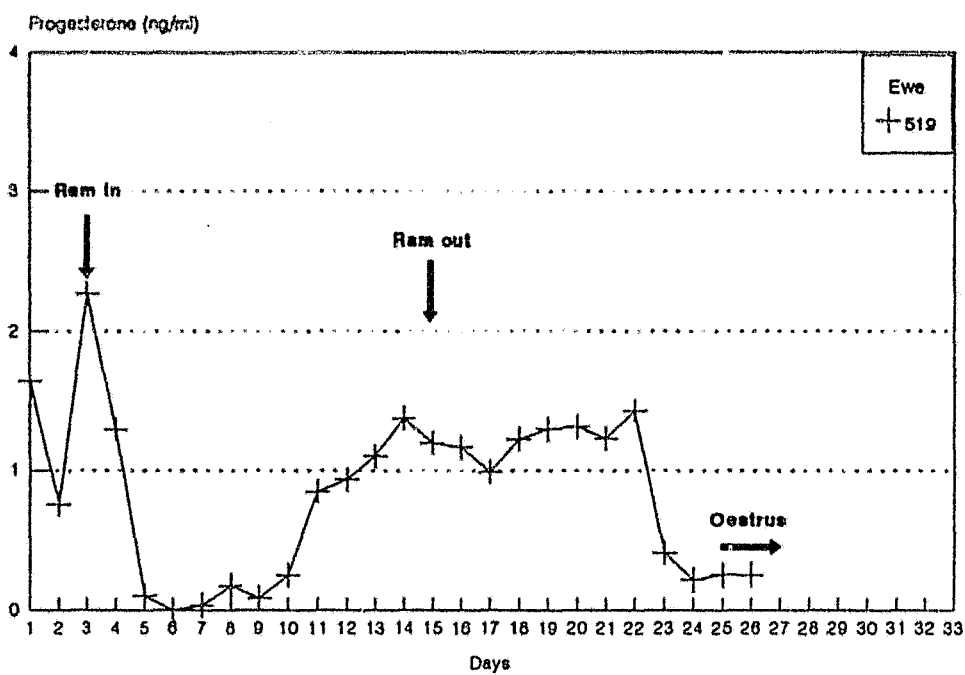
FIGURE 4.1.2 Progesterone levels and oestrous response (teaser ram for 12 days)
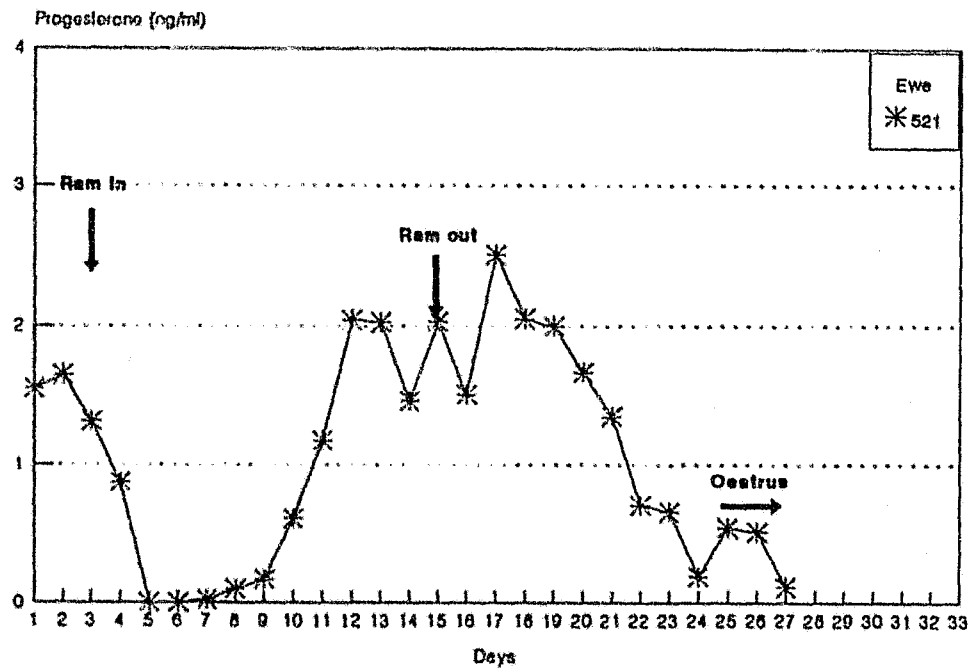
FIGURE 4.1.3 Progesterone levels and oestrous response (teaser ram for 12 days)
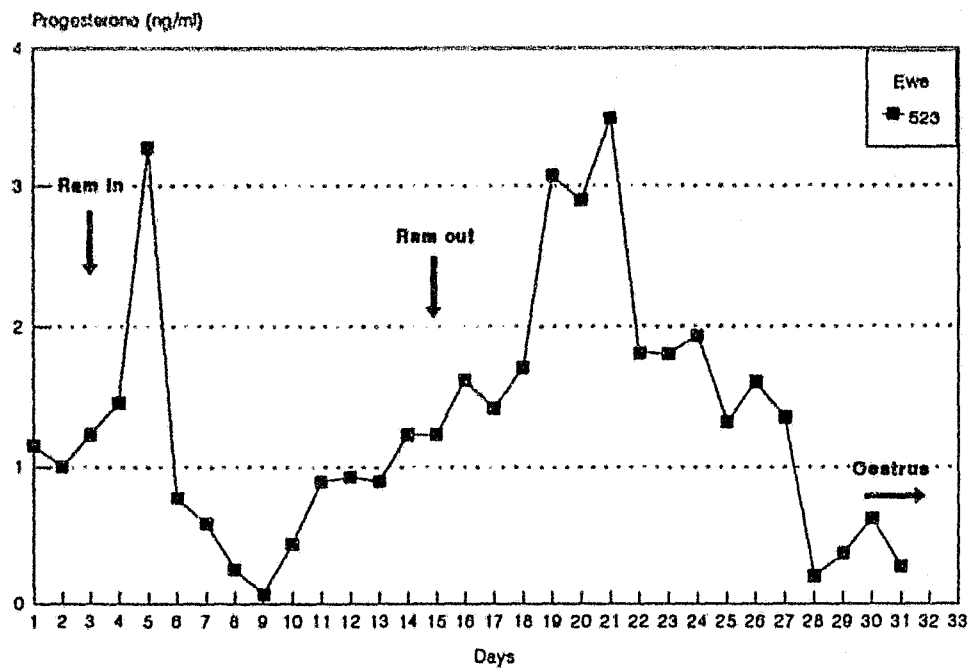
FIGURE 4.1.4 Progesterone levels and oestrous response (teaser ram for 12 days)
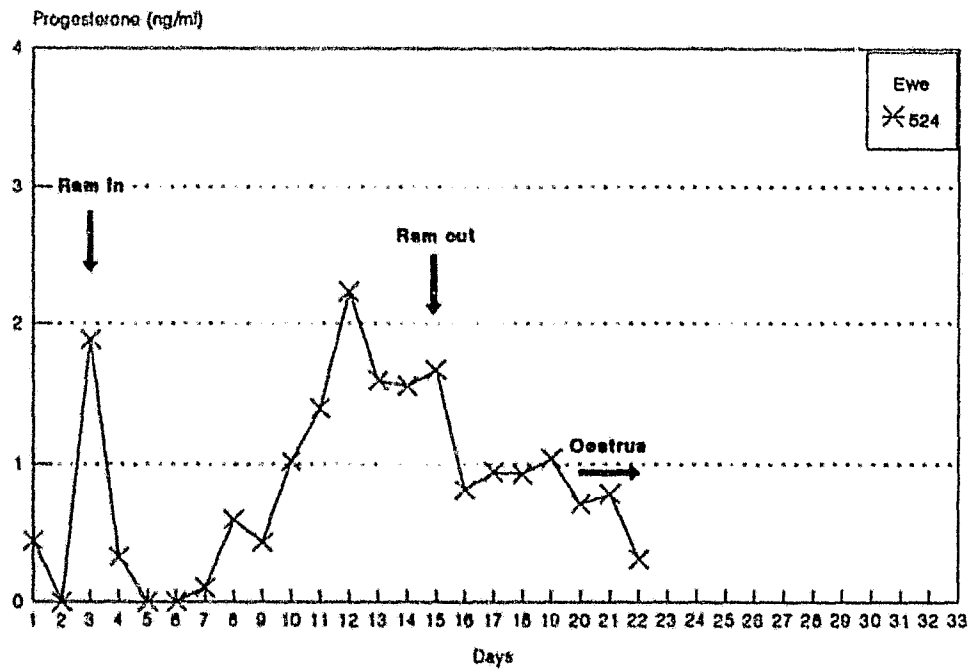
Progesterone (ng/ml)

FIGURE 4 1 5   Progesterone levels and oestrous response (teaser ram for 12 days)
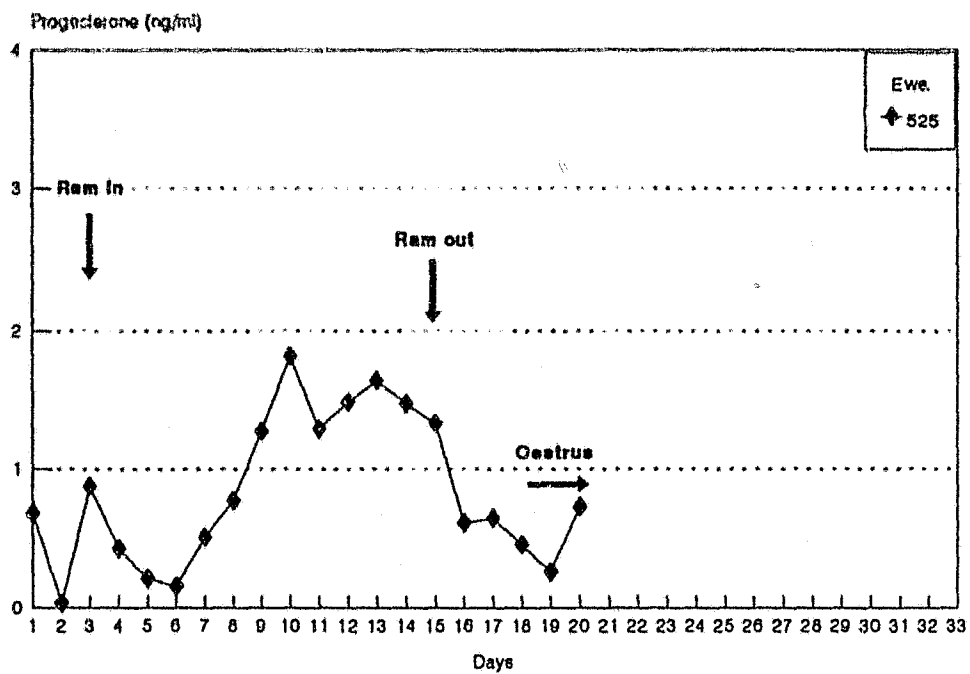
Progesterone (ng/ml)

FIGURE 4.1.6   Progesterone levels and oestrous response (teaser ram for 12 days)
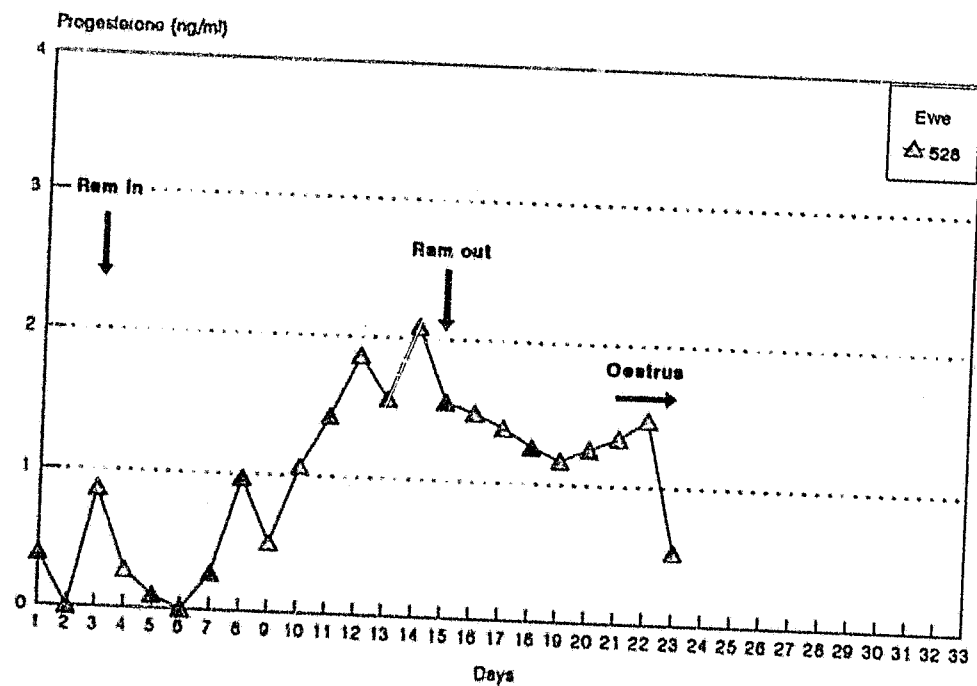
FIGURE 4.1.7 Progesterone levels and oestrous response (teaser ram for 12 days)
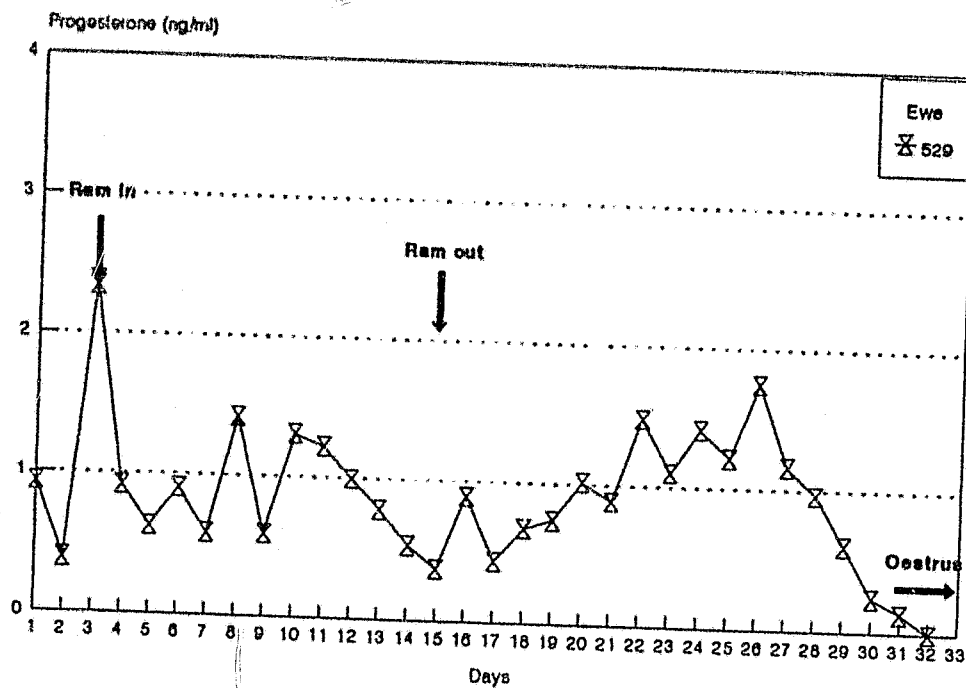
FIGURE 4.1.8 Progesterone levels and oestrous response (teaser ram for 12 days)
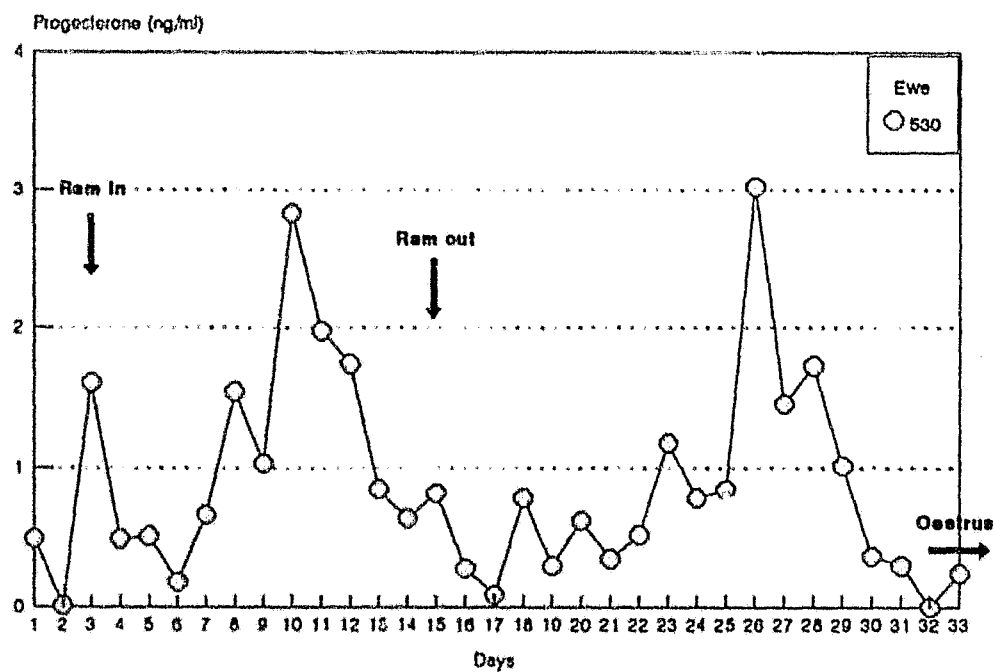
Progesterone (ng/ml)

FIGURE 4 1 9   Progesterone levels and oestrous response (teaser ram for 12 days)
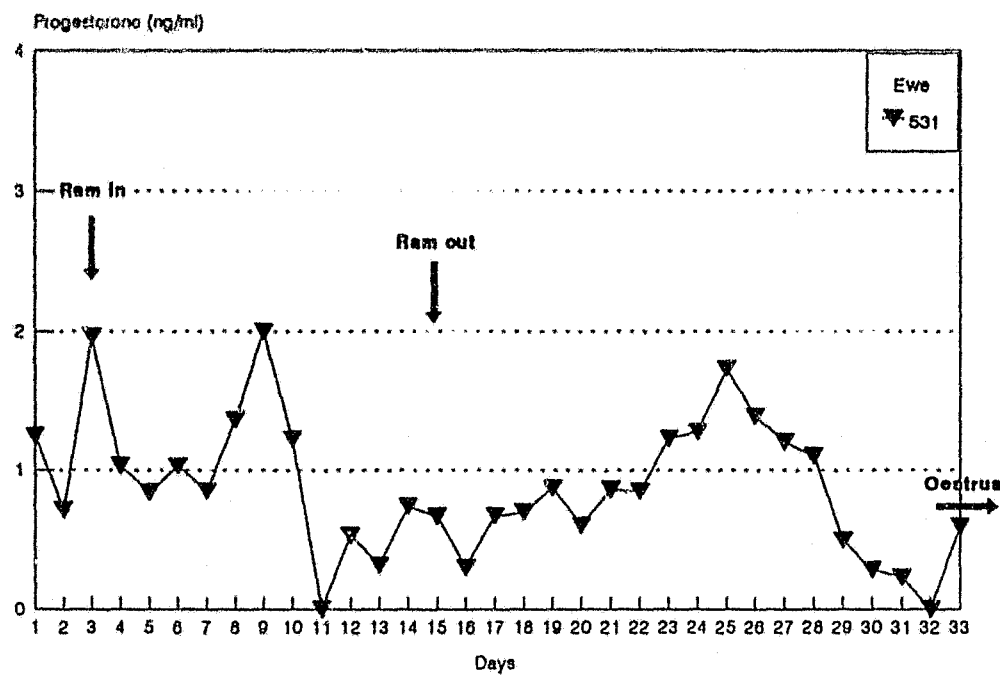
Progesterone (ng/ml)

FIGUPE 4 1.10 Progesterone levels and oestrous response (teaser ram for 12 days)
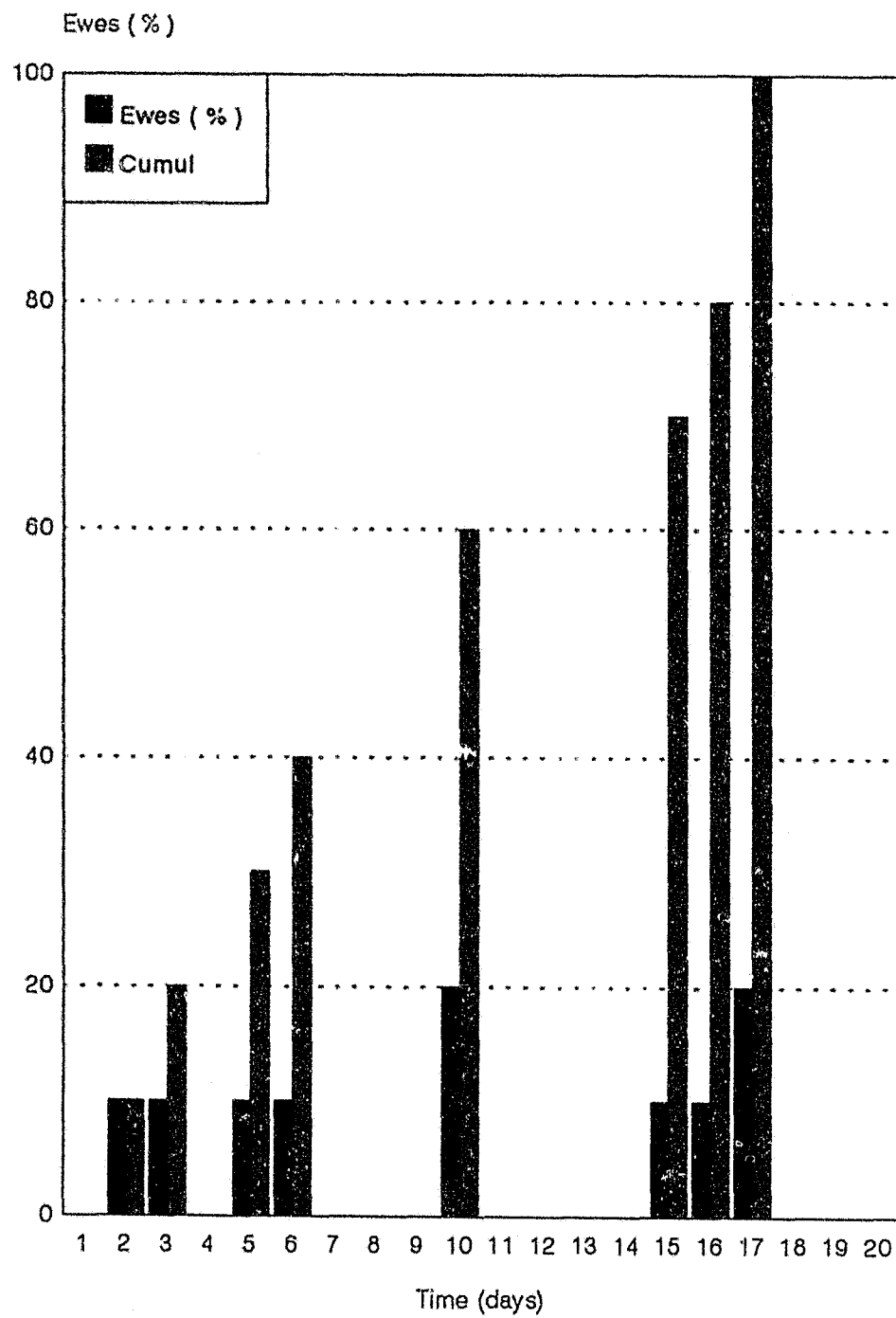
FIGURE 4.2 Time from teaser ram removal to oestrus (Group A1)

a larger group of eight including the four ewes previously mentioned, of which the occurrence of oestrus could have been influenced by the introduction of a ram.

The highest incidence of ewes showing oestrus, occurred in the first week after conclusion of the teasing period and is approximately 40 % (Schinckel 1954) which is quite similar to the results obtained in the experiment under discussion where another 40 % showed oestrus approximately one cycle period later. Ewes 519 and 521, both showing oestrus 10 days after ram removal, were apparently not affected by the introduction of the ram.

GROUP A2:

PGF2a is synthesized by the uteral endometrium and has been postulated to be the naturally occurring luteolysin in the female of several species and could cause regression of the corpus luteum between approximately day 5 and 14 of the oestrous cycle (Acritopoulou, Haresign & Lamming, 1978; Deaver, Stilley, Daily, Inskeep & Lewis, 1986; Douglas & Ginther, 1973; Inskeep et al., 1983). Treatment with PGF2a causes an abrupt decline in progesterone concentrations resulting in behavioral oestrus (Acritopoulou, 1979). Prostaglandin can therefore successfully be used to synchronise oestrus in cyclic sheep (Reid & Crothers, 1980).

The progesterone levels of all PGF2a treated ewes are displayed in Figures 4.3.1 tc 4.3.10. The average interval from cessation of treatment to onset of oestrus, was found to be 94.8 ± 10.51 hours in the trials under discussion (Figures 4.4 and 4.5). Greyling, Van der Westhuysen & Van Niekerk (1979) who during the active breeding season (March) treated Mutton Merino ewes with 125 μg, 62.5 μg and 31.25 μg PGF2a, reported an average duration of 69.4 hours. Greyling & Van der Westhuysen (1979) injected Mutton Merino ewes during the early breeding season (February) with 4 different dosages of PGF2a viz. 31.25 μg, 62.5 μg, 125 μg and 250 μg, reported an average duration of 42.71 hours. Greyling & Van der Westhuysen (1980) treated Merino ewes toward the end of the breeding season (July) with double intramuscular injections of 125 μg PGF2a 9, 10 and 11 days apart, observed an average duration of 55.56 hours. Comparing the results, there seem to be a lack of consistency amongst the outcomes of corresponding trials executed on different occasions by different research personnel.

During the normal oestrous cycle luteolysis is induced through the uterine secretion of PGF2a which normally precipitate on day 12 post oestrus (Acritopoulou, 1979; Silvia & Niswender, 1984; Thorburn, Bassett & Smith, 1969) with luteolysis occurring from day 14. The developmental and functional stages of the corpus luteum has therefore an endurance of at least 13 days under normal conditions, the functional stage commencing approximately on day four of the oestrous cycle (Acritopoulou,
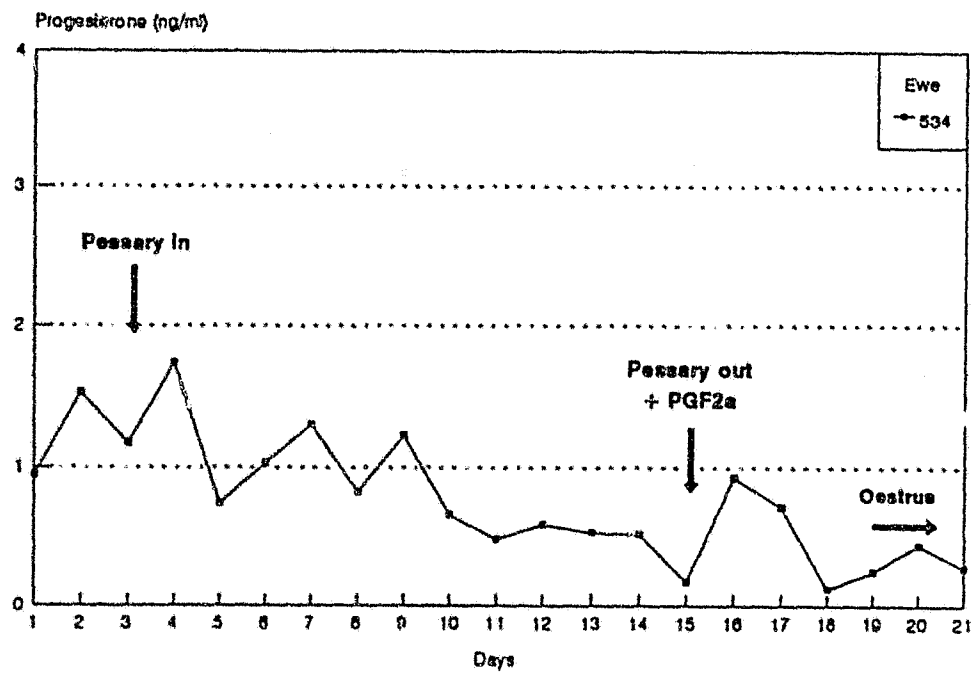
Progesterone (ng/ml)

FIGURE 4.3.1 Progesterone levels and oestrous response (progestagen pessary + PGF2a)
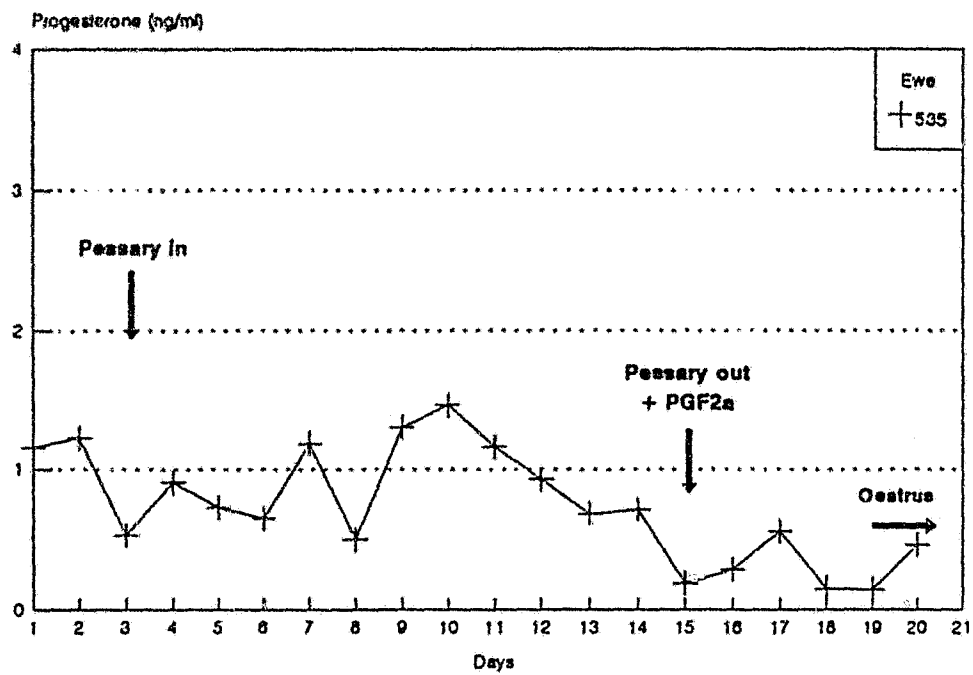
Progesterone (ng/ml)

FIGURE 4.3.2 Progesterone levels and oestrous response (progestagen pessary + PGF2a)

FIGURE 4.3.3 Progesterone levels and oestrous response (progestagen pessary + PGF2a)

FIGURE 4.3.4 Progesterone levels and oestrous response (progestagen pessary + PGF2a)

FIGURE 4.3.5 Progesterone levels and oestrous response (progestagen pessary + PGF2a)

FIGURE 4.3.6 Progesterone levels and oestrous response (progestagen pessary + PGF2a)

Progesterone (ng/ml)

FIGURE 4.3.7 Progesterone levels and oestrous response (progestagen pessary + PGF2a)

Progesterone (ng/ml)

FIGURE 4.3.8 Progesterone levels and oestrous response (progestagen pessary + PGF2a)

Progesterone (ng/ml)

FIGURE 4.3.9 Progesterone levels and oestrous response (progestagen pessary + PGF2a)

Progesterone (ng/ml)

FIGURE 4.3.10 Progesterone levels and oestrous response (progestagen pessary + PGF2a)

FIGURE 4.4 Time from pessary removal and PGF2a administration to oestrus
(Group A2)

Haresign & Lamming, 1978; Acritopoulou & Haresign, 1980;
Fairnie & Wales, 1980).

Cytological evidence of regression of the corpus luteum was
obtained as early as day 12 to 13 and was marked on day 15.
Thorburn et al. (1969) reported a decline in the
concentration of progesterone in peripheral plasma by day 14
and concluded that decreased secretory activity of the corpus
luteum starts as early as day 13 of the oestrous cycle.

Exogenous progestagens affects the corpus luteum only during
the period of active development i.e. the first few days post
ovulation. Treatment with exogenous progestagen impedes the
development of the corpus luteum, but early regression does not
occur and progesterone secretion is not affected (Boshoff,
1980). When intravaginal progestagen pessaries are left in
situ for a period of 12 days, most ewes will show oestrus
within three days after cessation of treatment (Hackett et
al., 1981; Henderson, Downing, Beck & Lees, 1984). Treatment
with PGF2a after progestagen treatment for a period of 12 days
would therefore be superfluous as was indeed the case during
the current investigation. PGF2a can however be applied with
success during shorter periods of exposure to progestagen and
even without the administering of progestagen. (The average
period from cessation of treatment to onset of oestrus for
Group A4 treated with progestagen only, was 85.2 ± 8.854 h
compared to 94.8 ± 10.51 h for Group A2).

GROUP A3:

The use of PMSG in conjunction with progestagen shortens the interval between treatment and onset of LH discharge compared to ewes treated with progestagen alone (Ainsworth, LaChance, & LaBrie, 1983). The earlier onset of LH release in progestagen/PMSG treated ewes may be explained on the basis that PMSG promotes an increase in the number of steroidogenically activated follicles such that the threshold level of oestrogen necessary to trigger pituitary LH release is reached earlier than in ewes treated with progesterone alone (Ainsworth, et al., 1983).

The interval from treatment to onset of oestrus in progestagen/PMSG treated ewes, was found by the following authors to be 36.7 ± 1.3 hours for 40 ewes of the Karagounico and Seres breeds receiving 500 IU PMSG during the breeding season (Acritopoulou-Fourcroy et al., 1982), 34.5 ± 2.6 hours for 6 ewes coming from crossbred strains receiving 500 IU PMSG during the spring season (Ainsworth, et al., 1983), on average 36 hours during both seasons for 30 Merino ewes receiving 400 IU PMSG (Walker, Smith, Godfrey & Seamark, 1989), 46.7 ± 2.1 hours for 66 Galway ewes receiving 500 IU PMSG during the breeding season (Quirke, Jennings, Hanrahan, & Gosling, 1979) and 31.2 ± 1.5 hours for 23 Galway ewes receiving 500 IU PMSG during the breeding season (Quirke, Hanrahan & Gosling, 1981).

The current trials executed on Damara ewes resulted in an average of 50.7 ± 15.620 hours which is significantly longer than the intervals quoted but notably shorter than found in Group A2 (Figures 4.6.1 to 4.6.10 and Figures 4.5 and 4.7) which again demonstrated that PGF2a is a superfluous agent in the kind of regime applied in Group A2.

GROUP A4:

Figure 4.8 displays the graphic distribution of Damara ewes treated with progestagen pessaries only, which were left *in situ* for 12 days. 20% ewes showed oestrus 72 hours, 50% 84 hours and 30% 96 hours after pessary removal with an average interval of 85.2 ± 8.854 hours (Figure 4.5 and Figures 4.9.1 to 4.9.10). This is again notably longer than the findings reported by Greyling *et al.* (1980) of 43.59 ± 16.93 hours (SA Mutton Merino ewes during the breeding season), Van Wyk (1977) 58.2 hours (Karakul ewes during the breeding season). Inskeep *et al.* (1983) reported 38 hours (crossbred strains during the breeding season) and Ainsworth *et al.* (1983) 47.4 ± 3.2 hours after pessary removal with crossbred strains.

It appears as if there is a general inconsistency prevailing with regard the interval from cessation of treatment to onset of oestrus under various treatment procedures where the Damara
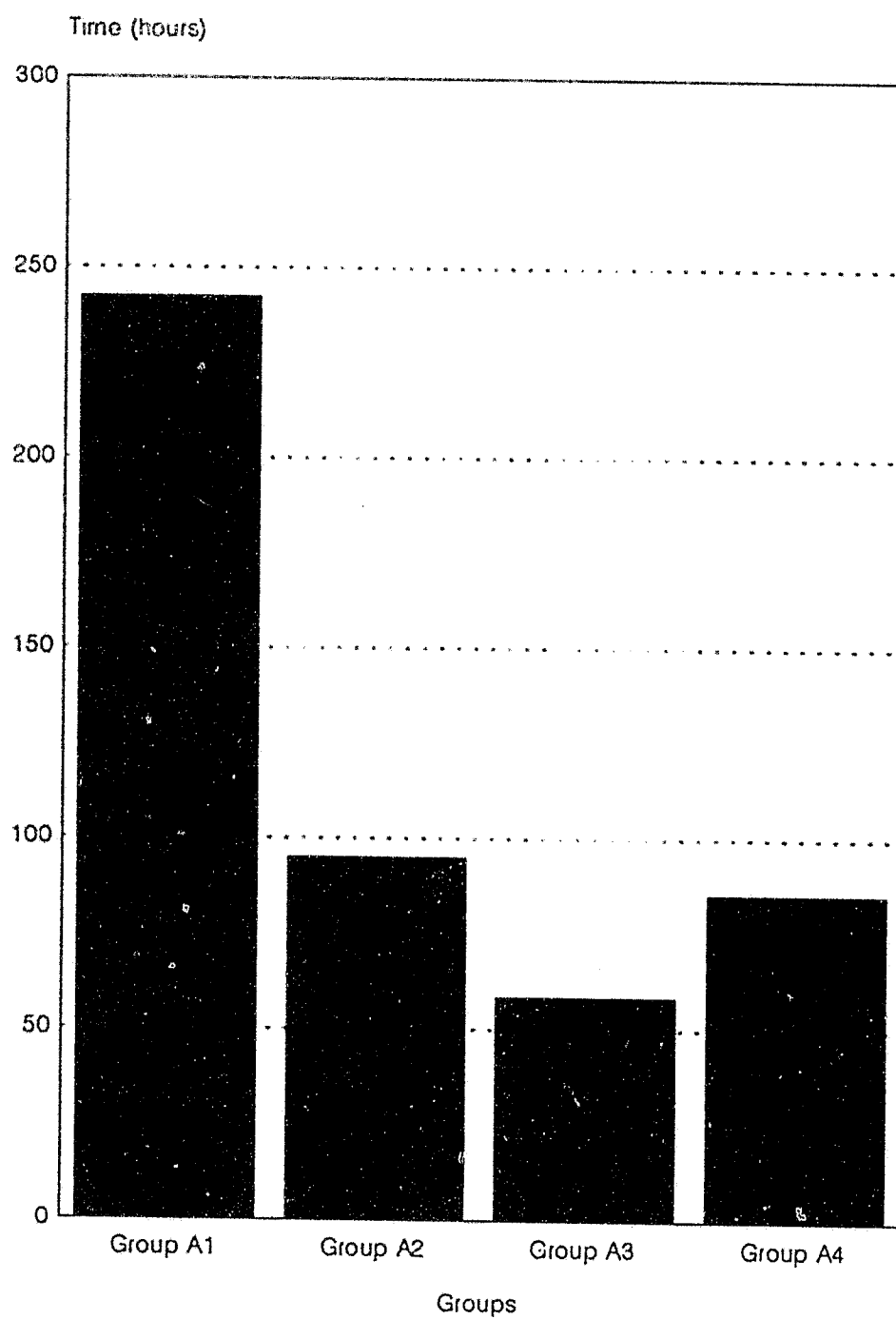
FIGURE 4 5 Average interval (hours) from cessation of treatment to onset of
oestrus for all groups
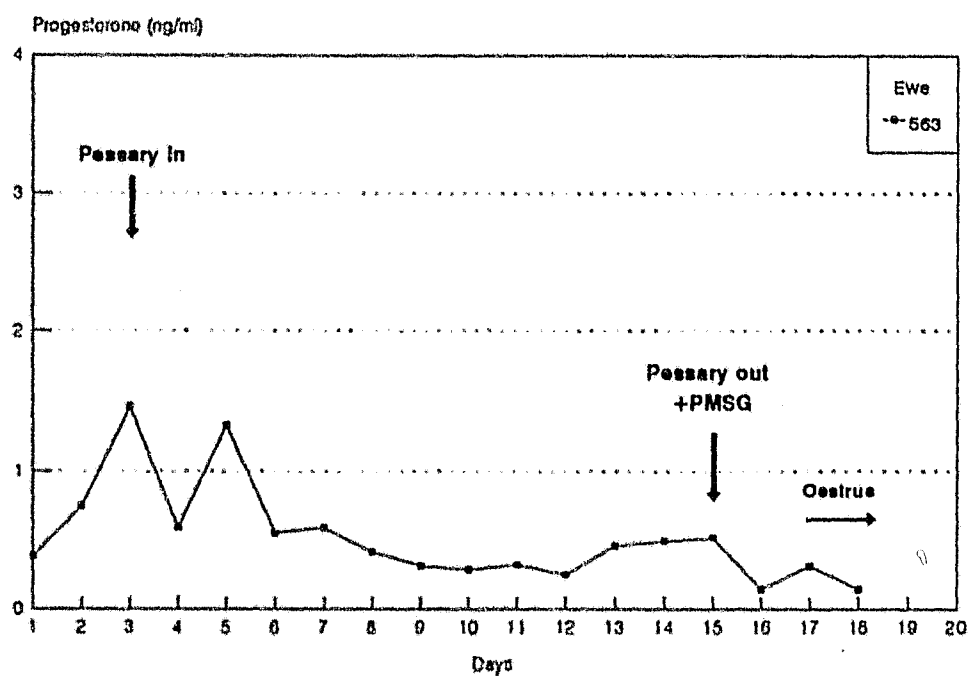
Progesterone (ng/ml)

FIGURE 4 6 1 Progesterone levels and oestrous response (progestagen pessary + PMSG)
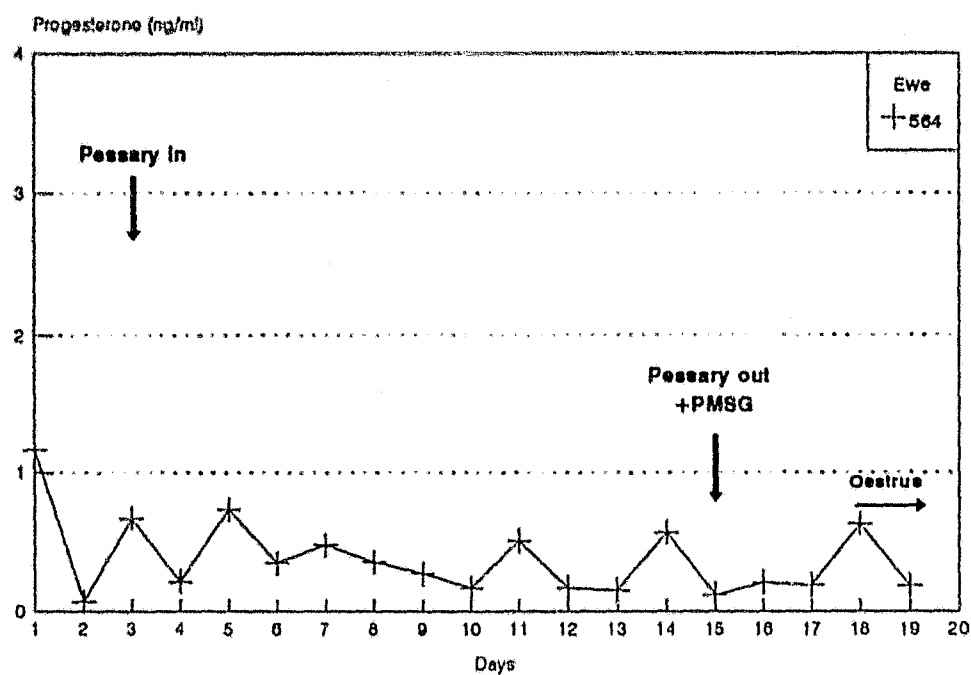
Progesterone (ng/ml)

FIGURE 4 6 2 Progesterone levels and oestrous response (progestagen pessary + PMSG)
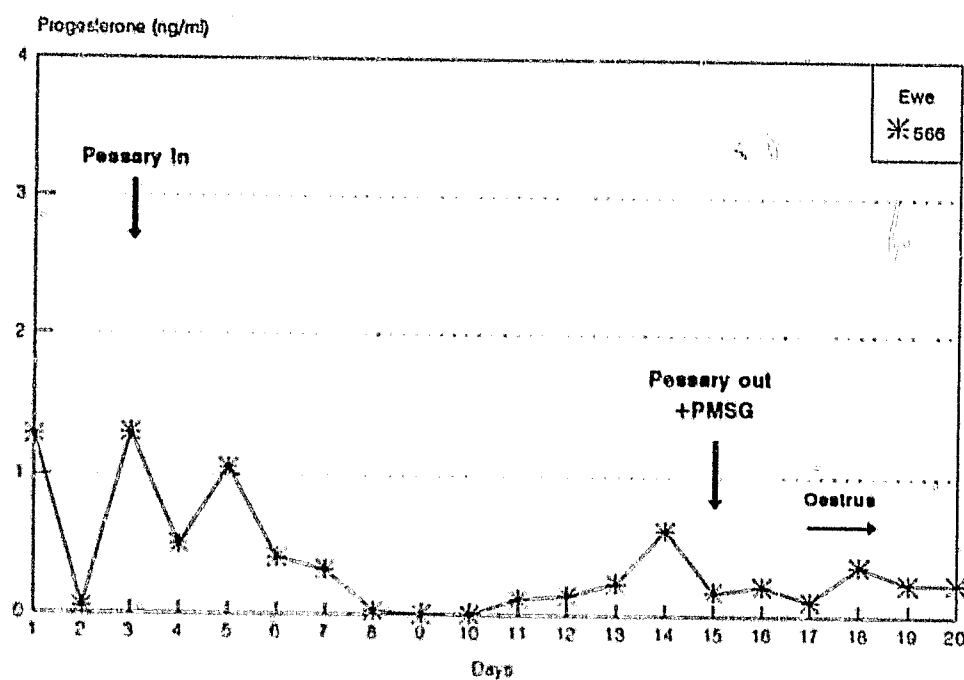
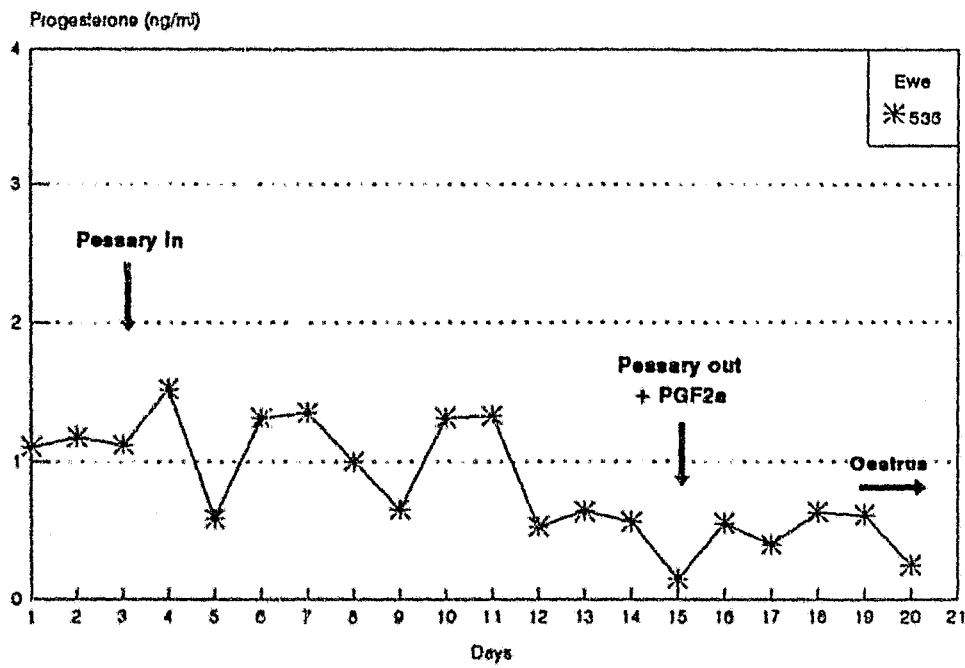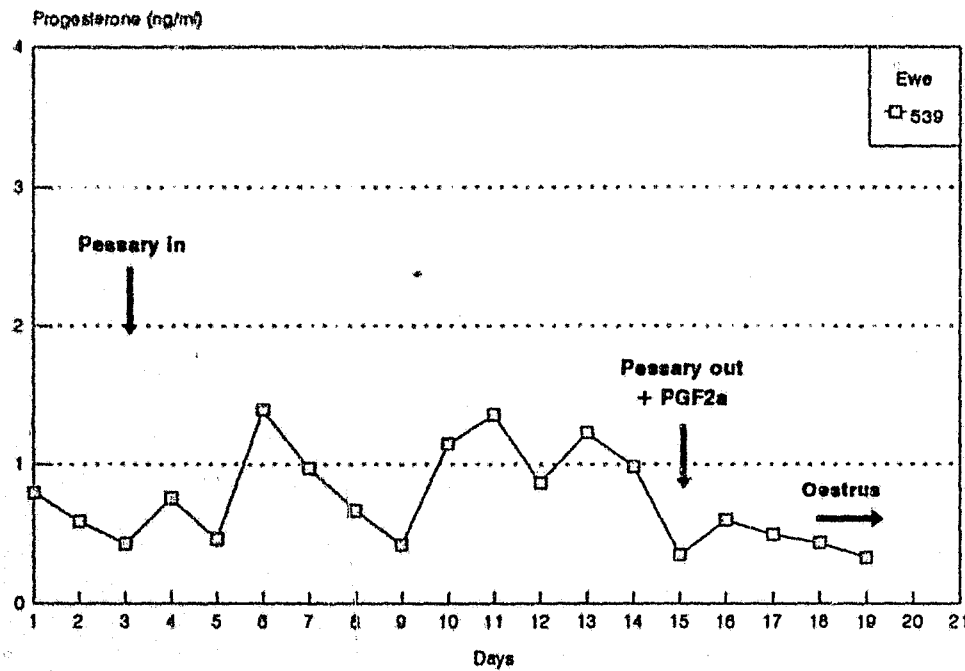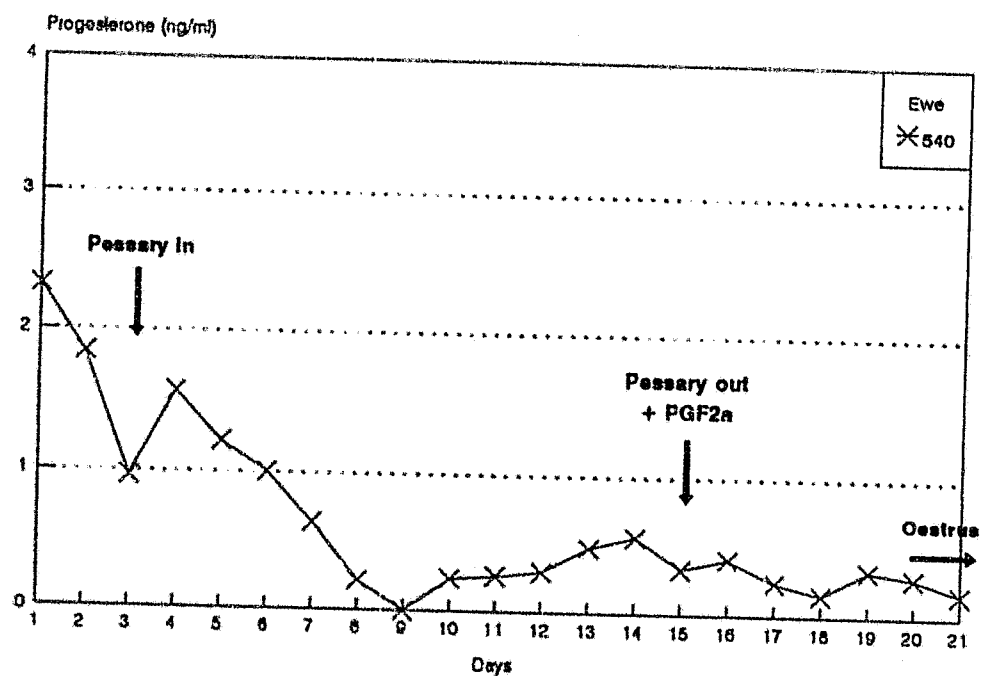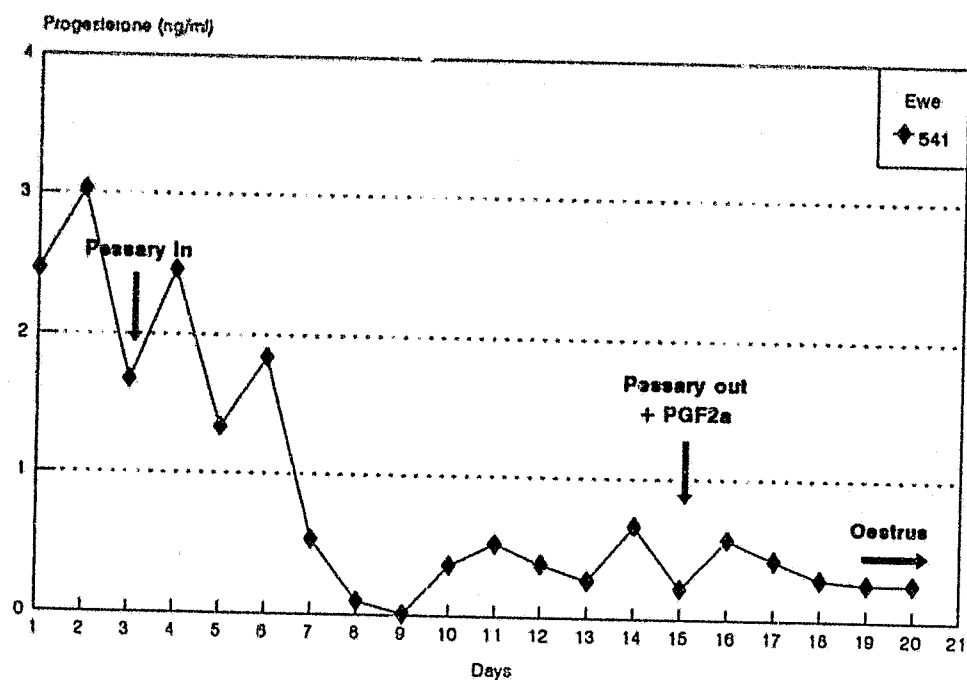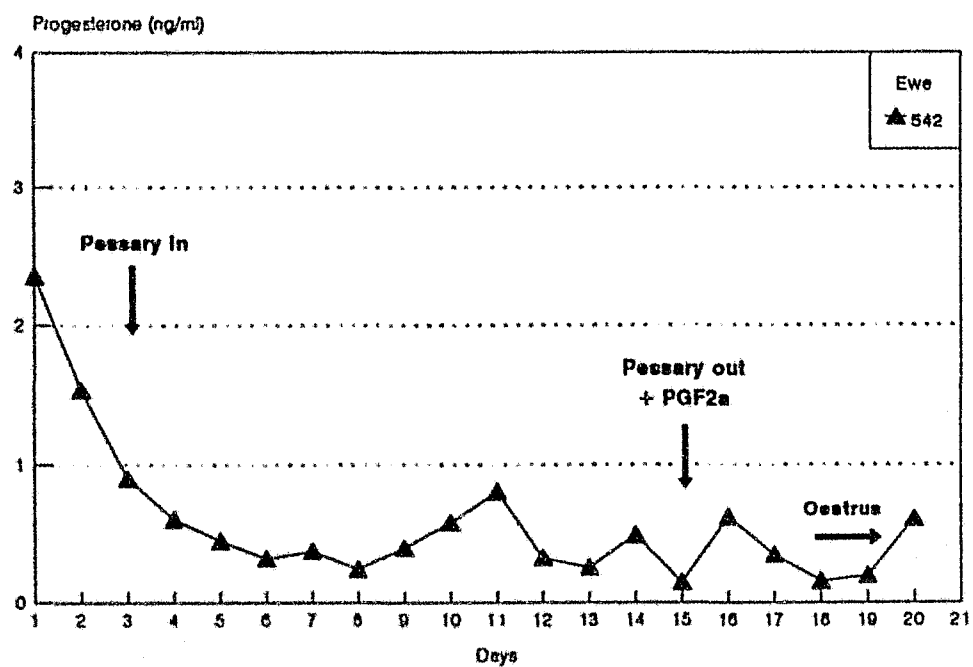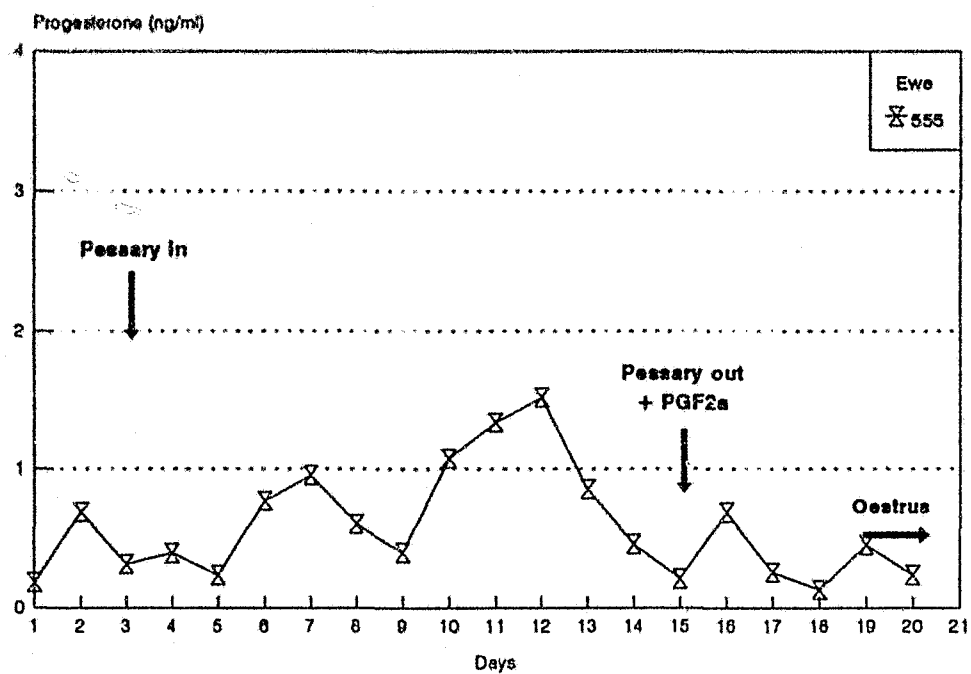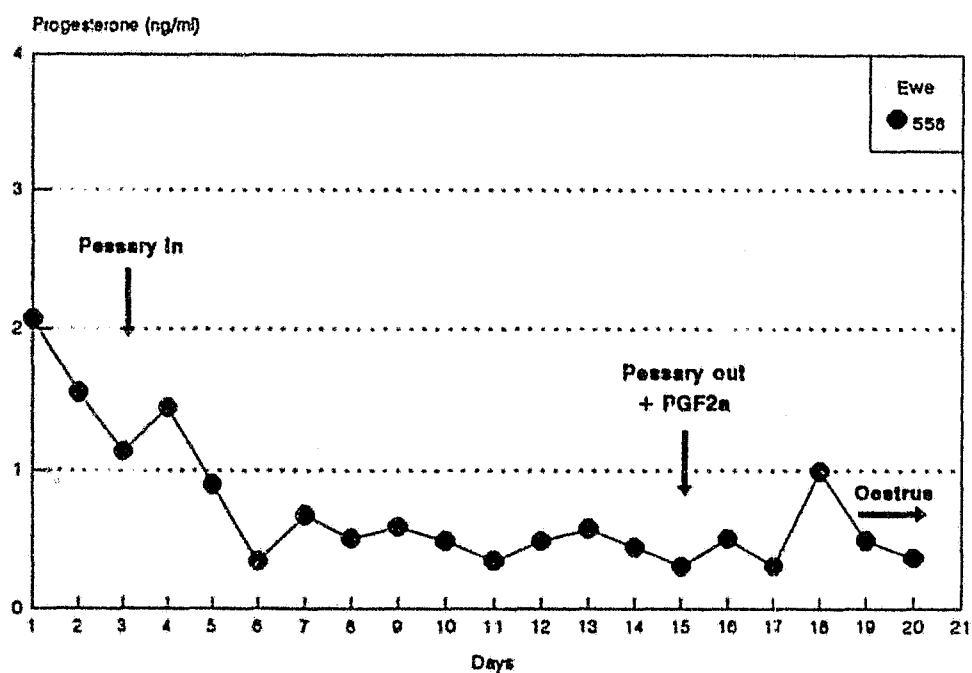FIGURE 4 0 3 Progesterone levels and oestrous response (progestagen pessary + PMSG)
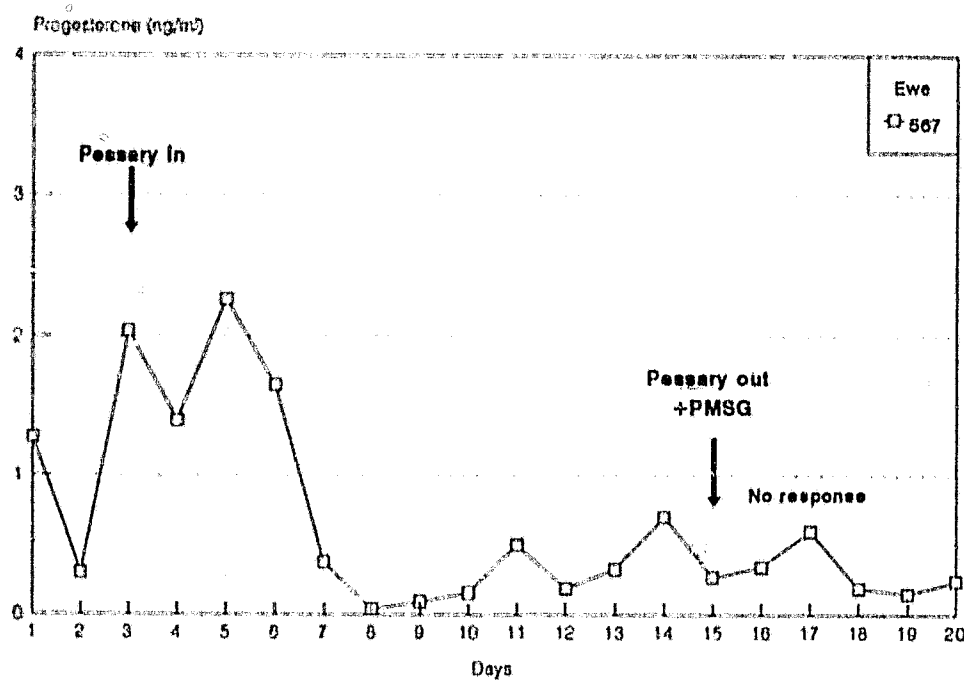
FIGURE 4 0 4 Progesterone levels and oestrous response (progestagen pessary + PMSG)
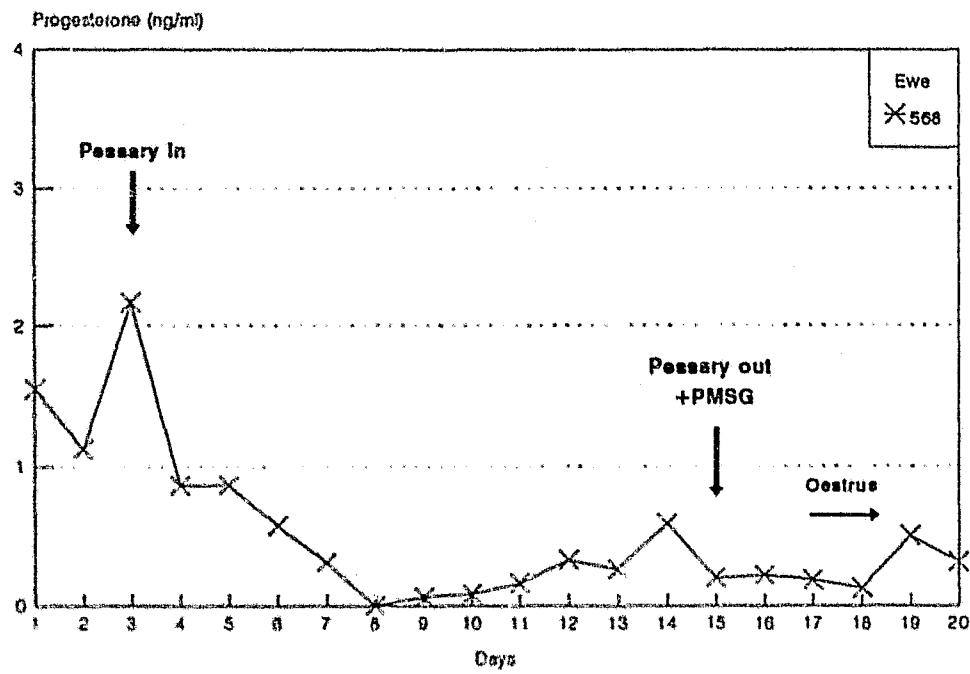
FIGURE 4 6 5 Progesterone levels and oestrous response (progestagen pessary + PMSG)
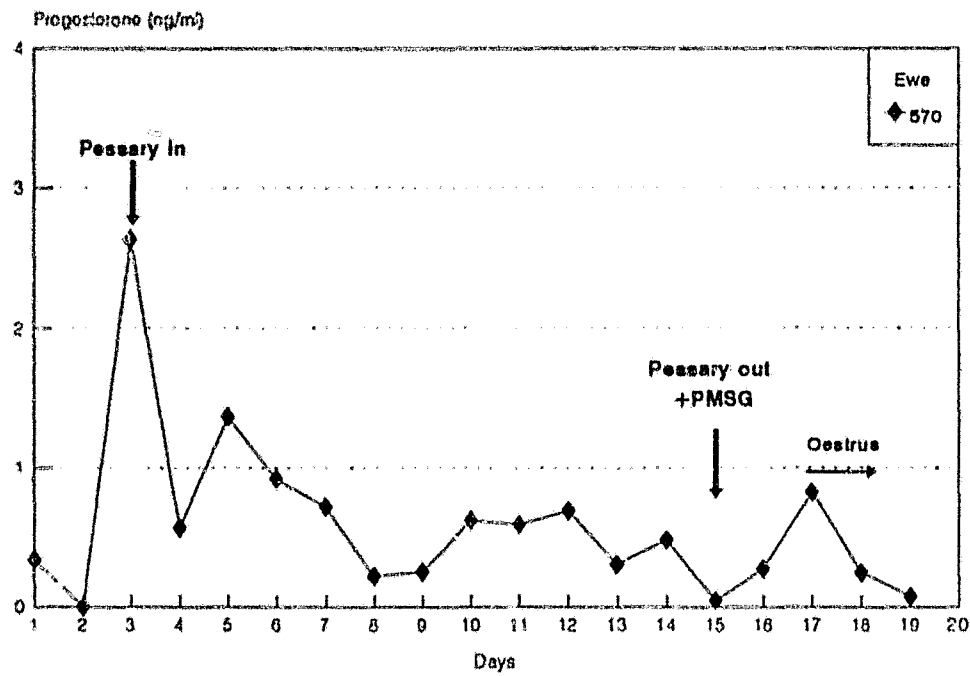
FIGURE 4 6 6 Progesterone levels and oestrous response (progestagen pessary + PMSG)
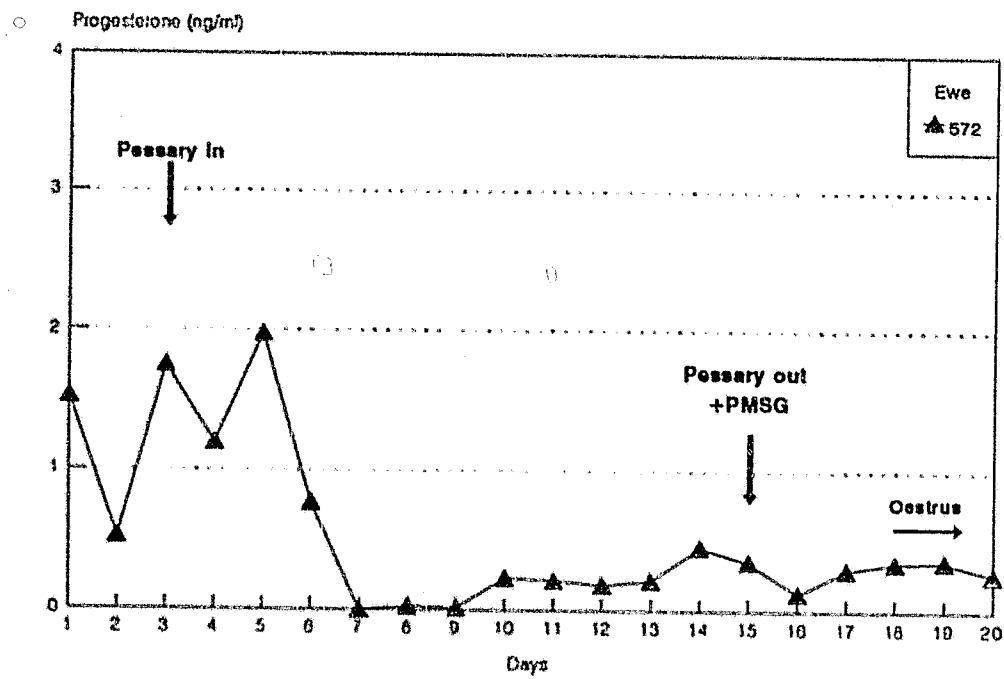
FIGURE 4.6.7 Progesterone levels and oestrous response (progestagen pessary + PMSG)
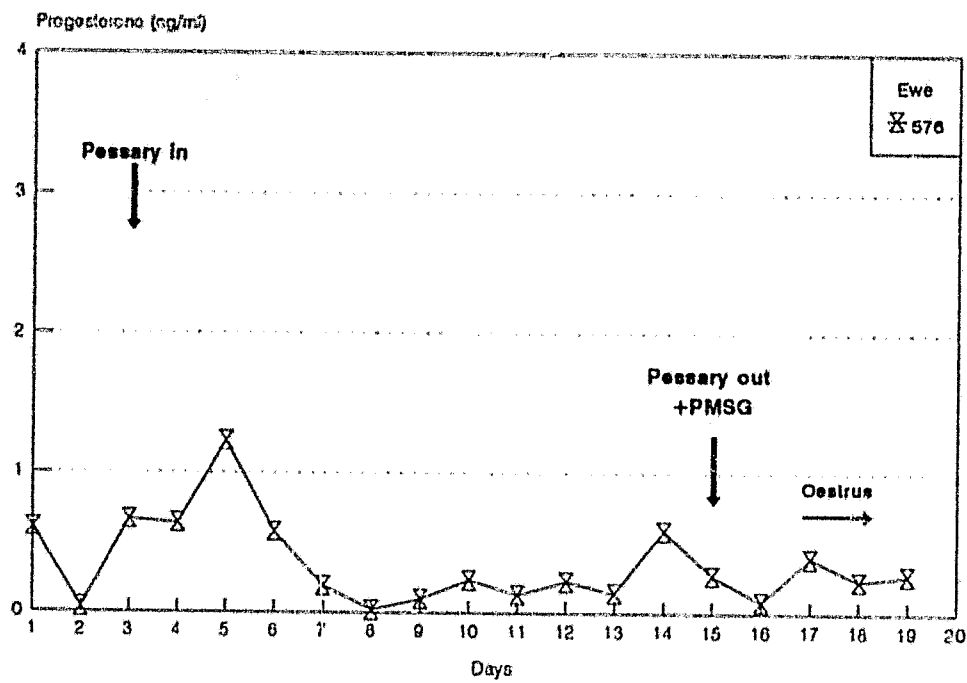
FIGURE 4.6.8 Progesterone levels and oestrous response (progestagen pessary + PMSG)
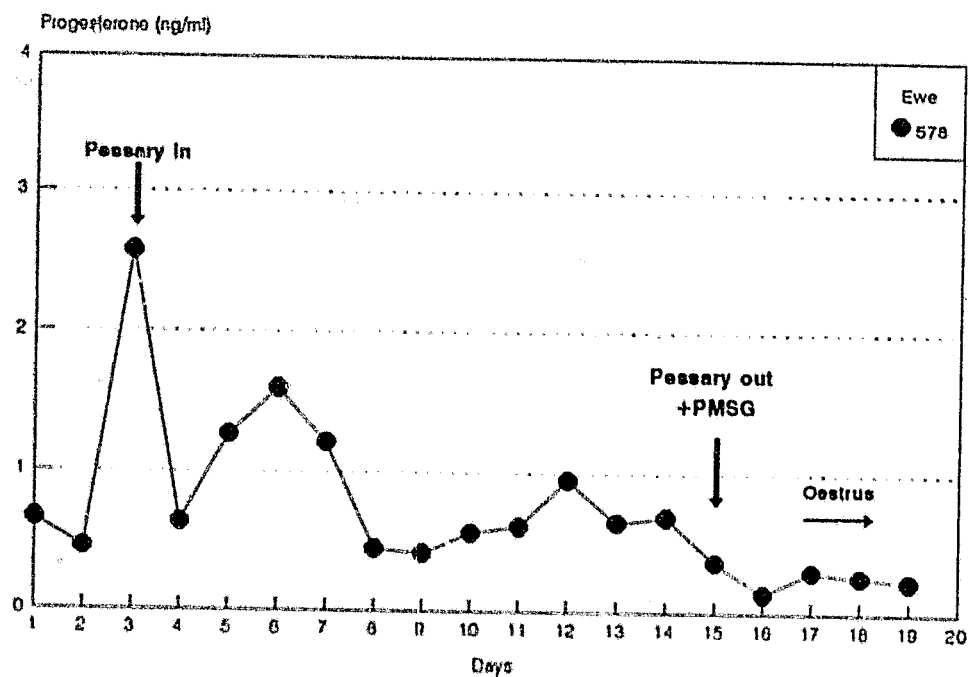
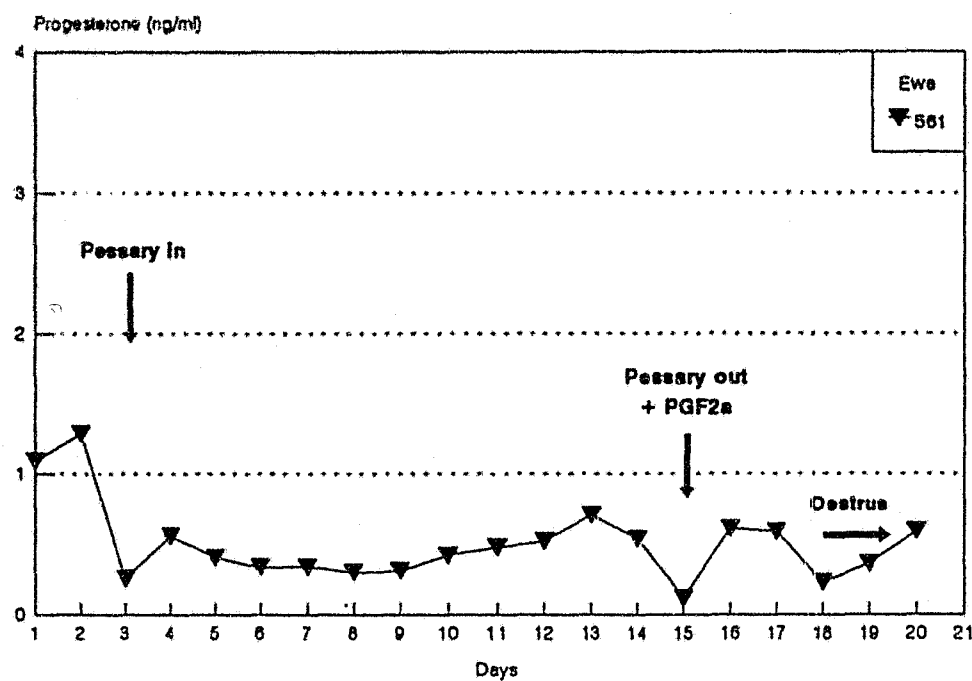FIGURE 4.6.9 Progesterone levels and oestrous response (progestagen pessary + PMSG)
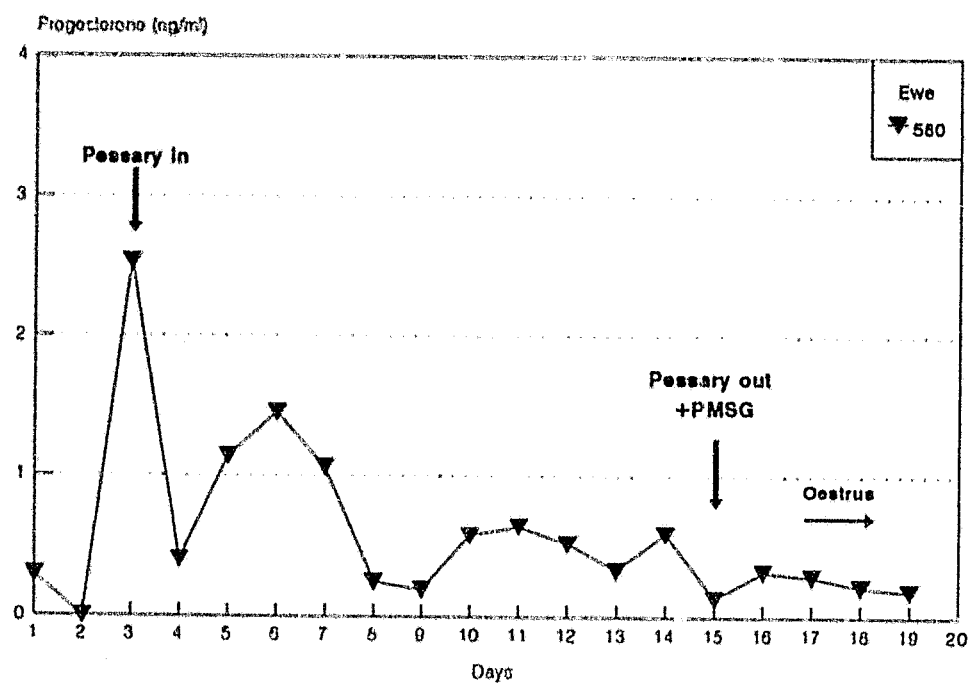
FIGURE 4.6.10 Progesterone levels and oestrous response (progestagen pessary + PMSG)
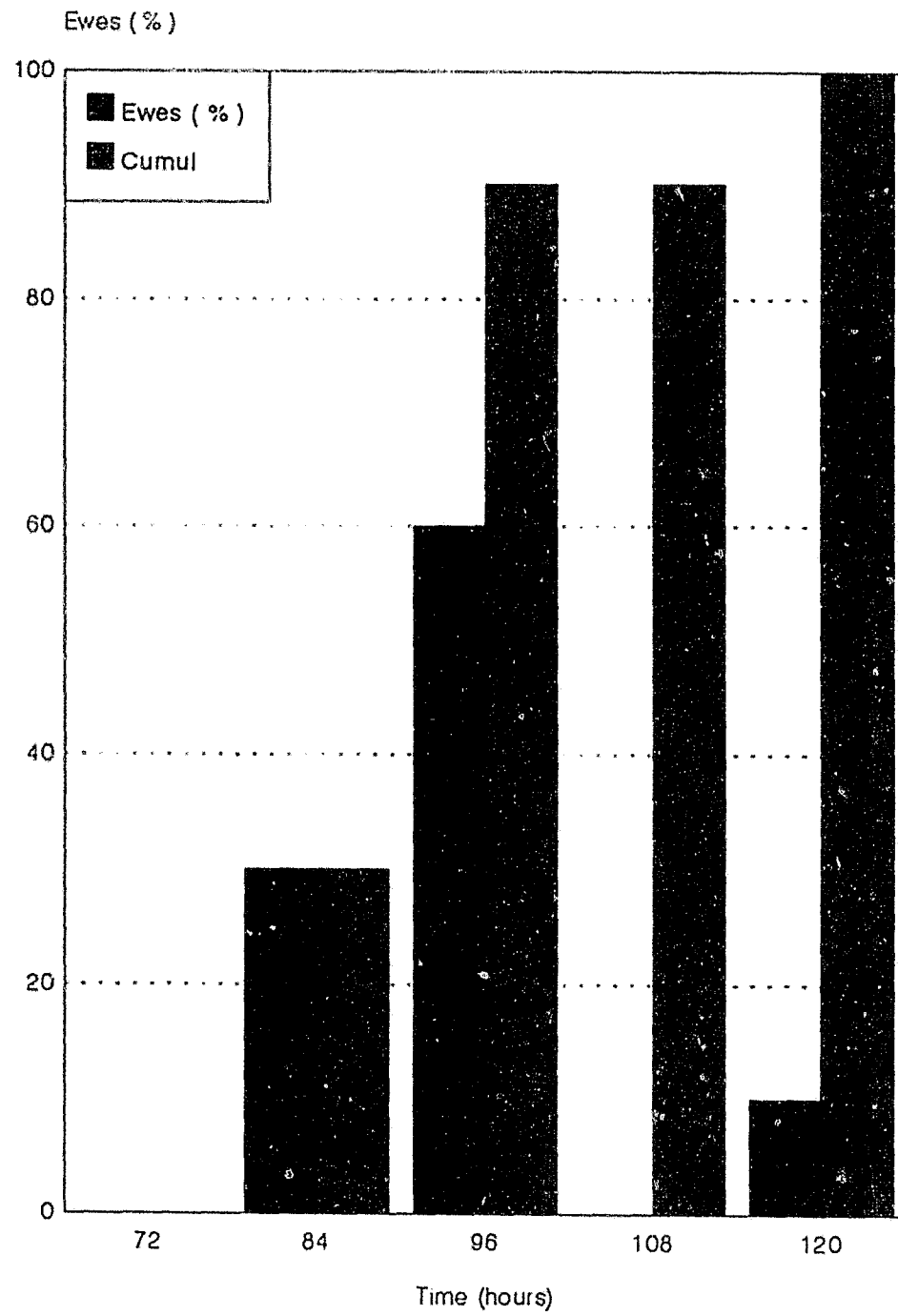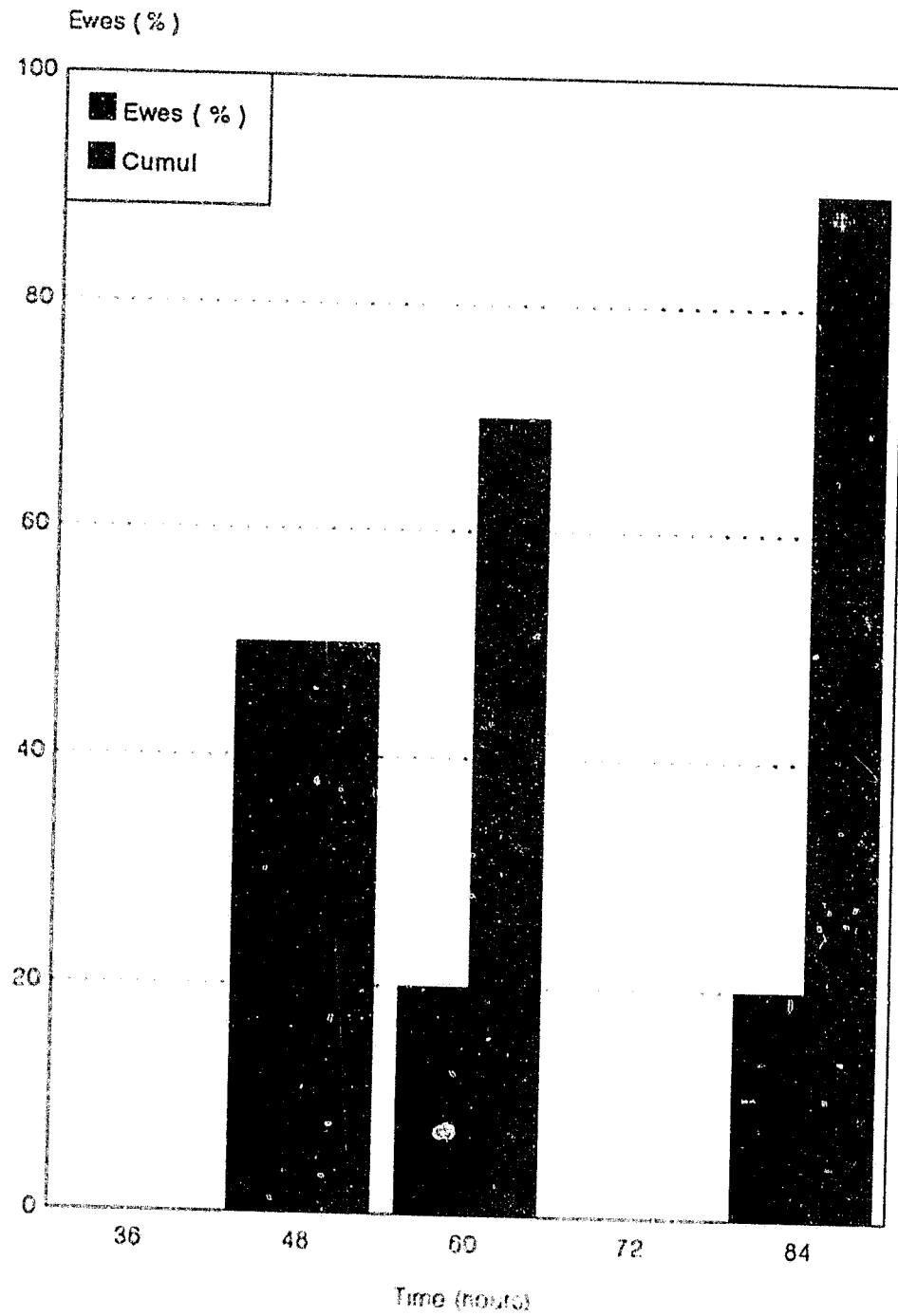
FIGURE 4.7 Time from pessary removal and PMSG administration to oestrus
(Group A3)
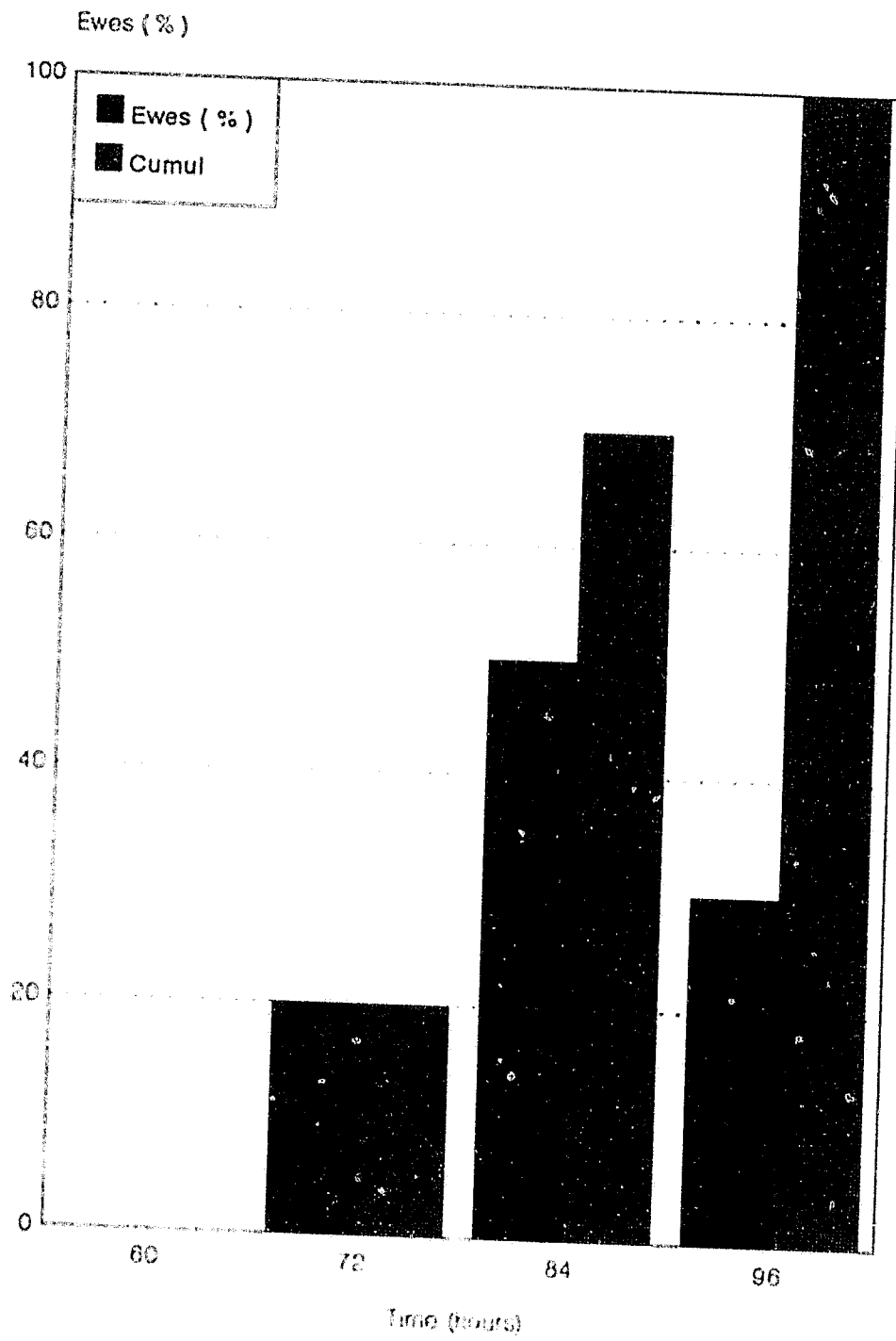
FIGURE 4.8 Time from pessary removal to oestrus (Group A4)
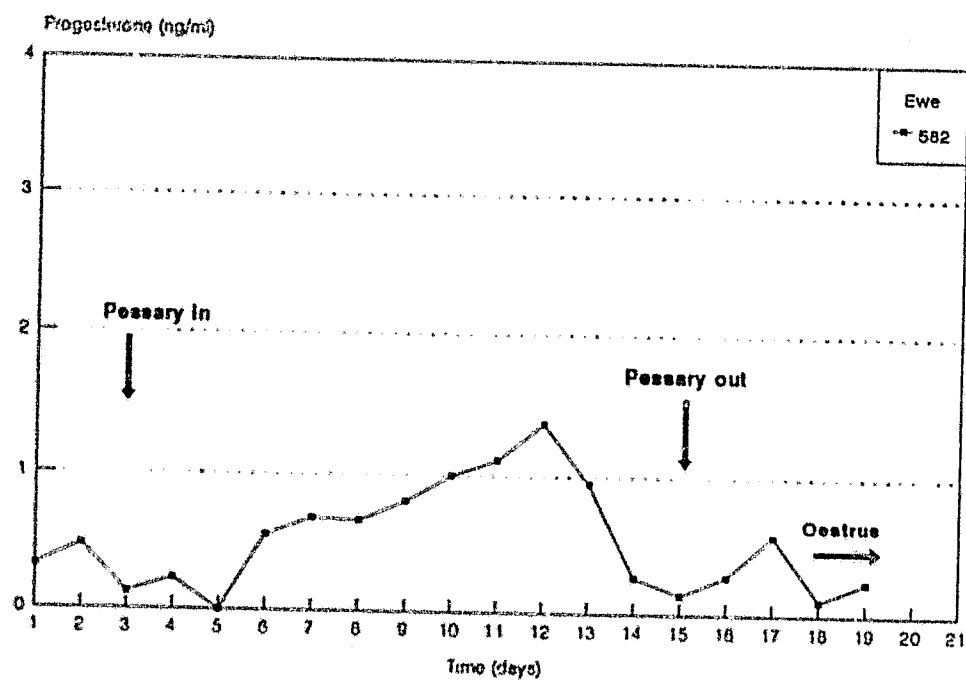
FIGURE 4 9 1   Progesterone levels and oestrous response (progestagen pessary)
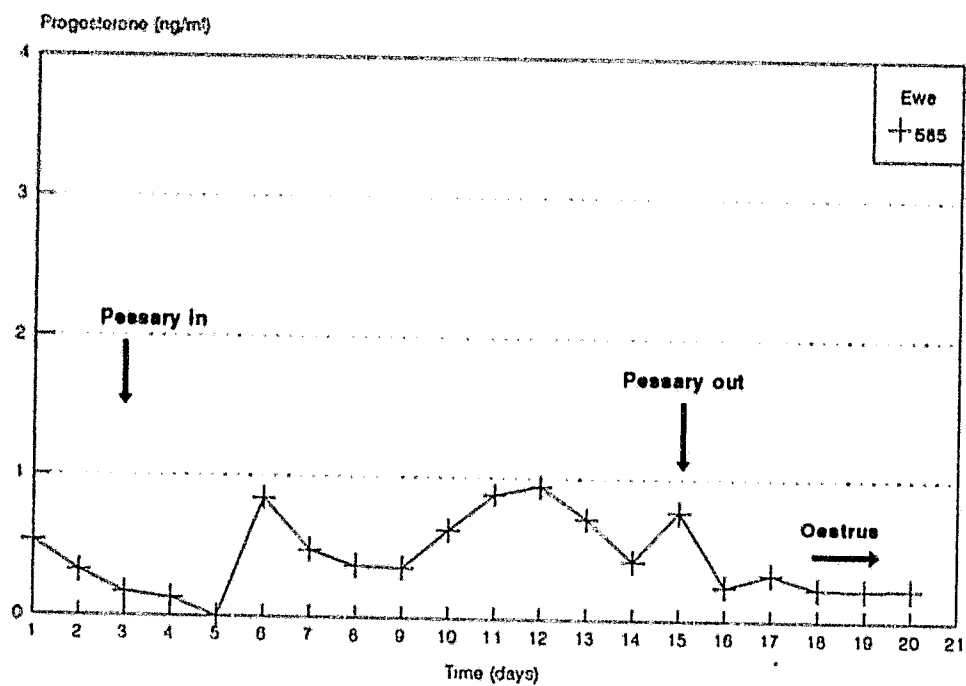
FIGURE 4 9 2   Progesterone levels and oestrous response (progestagen pessary)

Progesterone (ng/ml)

Pessary In

Pessary out

Oestrus

Ewe
❊ 586

Time (days)
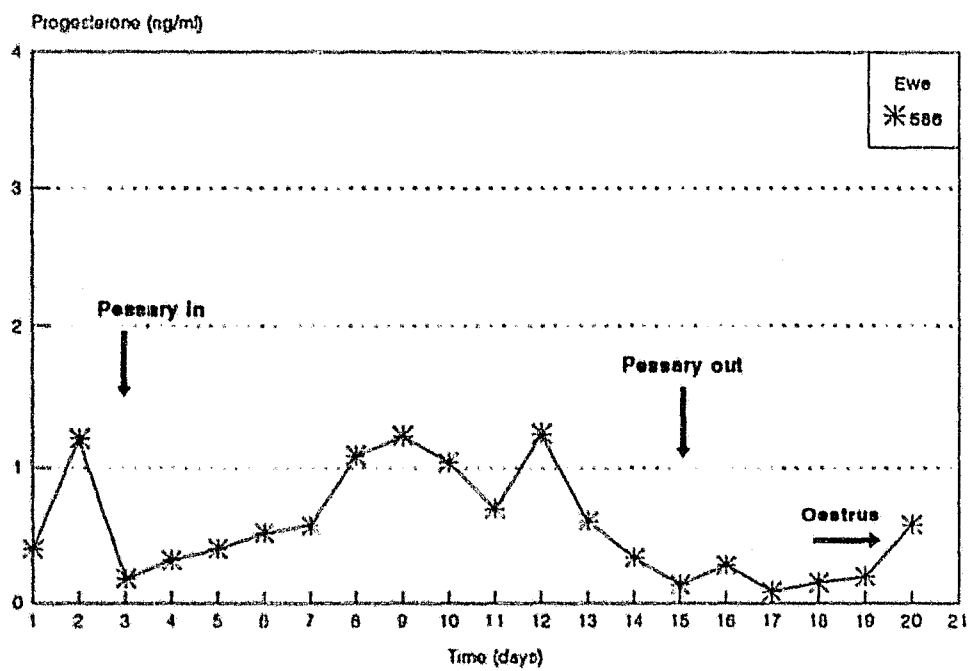
FIGURE 4.9.3 Progesterone levels and oestrous response (progestagen pessary)

Progesterone (ng/ml)

Pessary In

Pessary out

Oestrus

Ewe
▱ 594

Time (days)
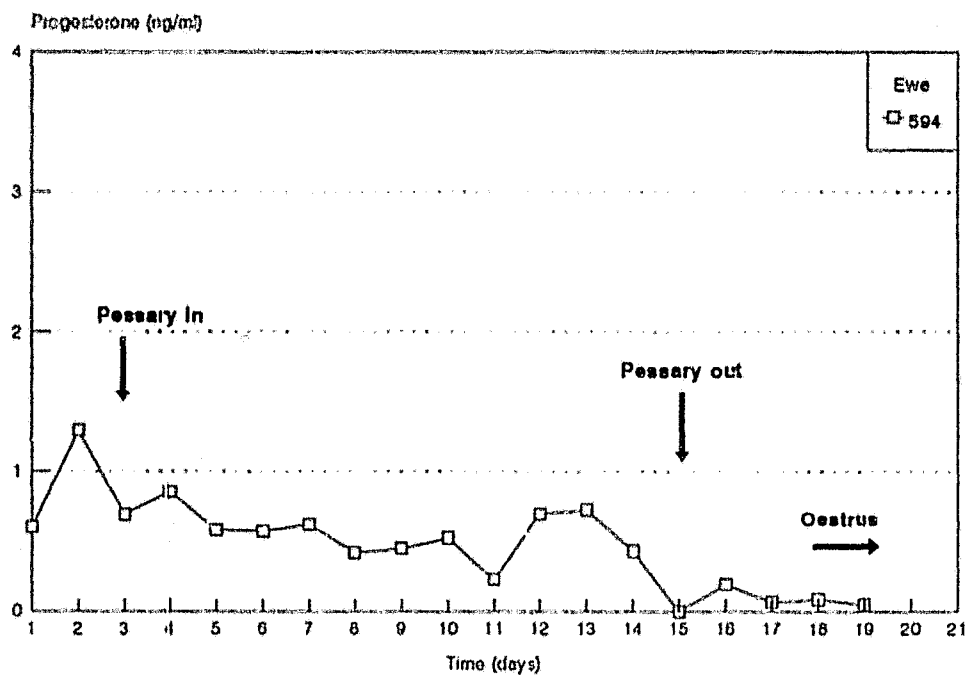
FIGURE 4.9.4 Progesterone levels and oestrous response (progestagen pessary)
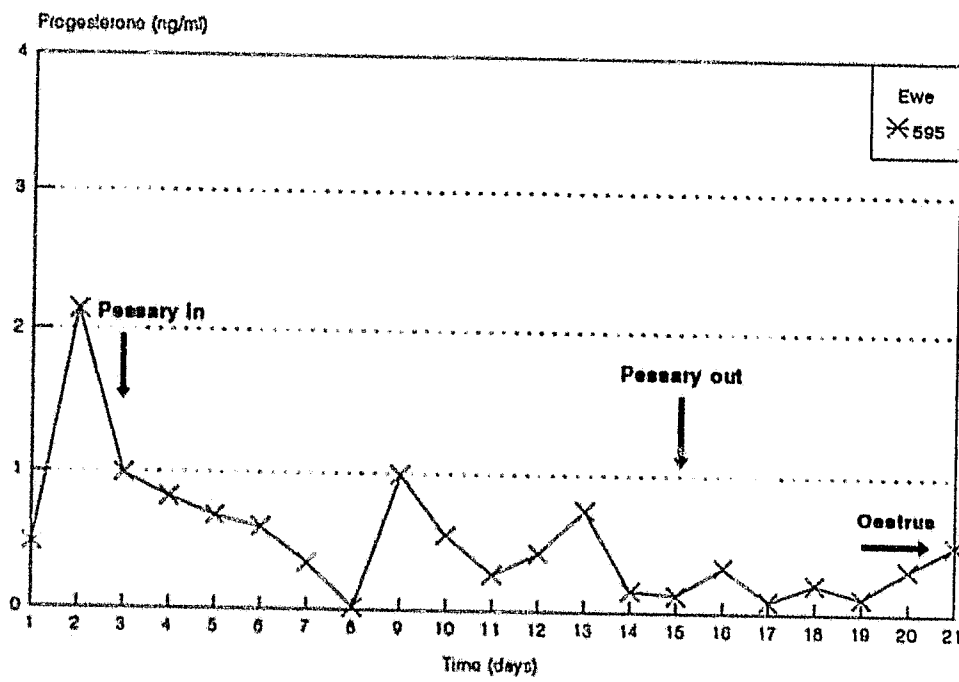
FIGURE 4 9 5 Progesterone levels and oestrous response (progestagen pessary)
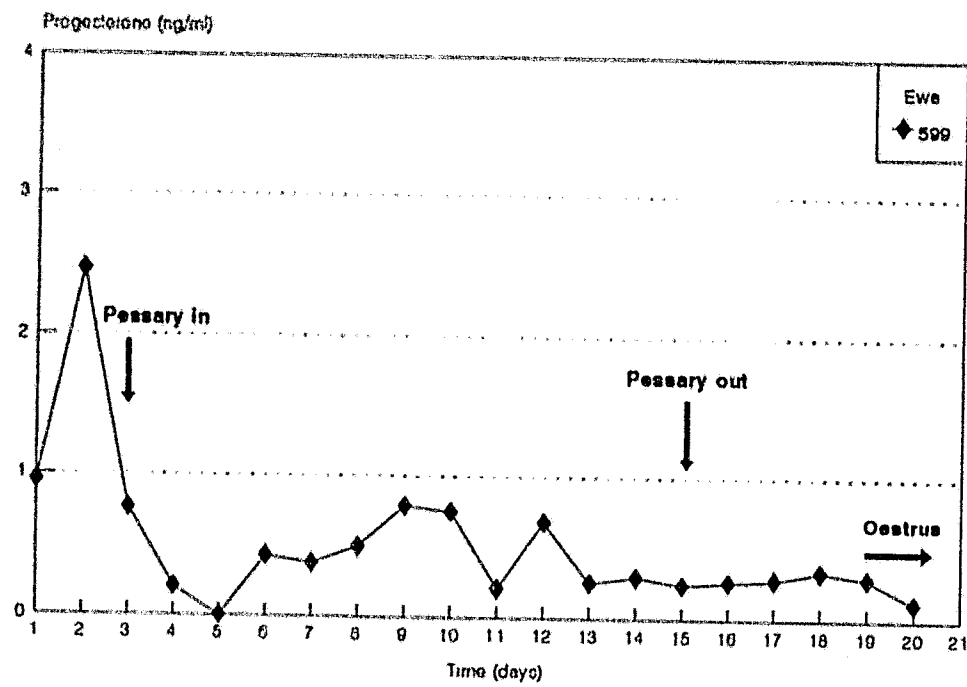
FIGURE 4 9 6 Progesterone levels and oestrous response (progestagen pessary)
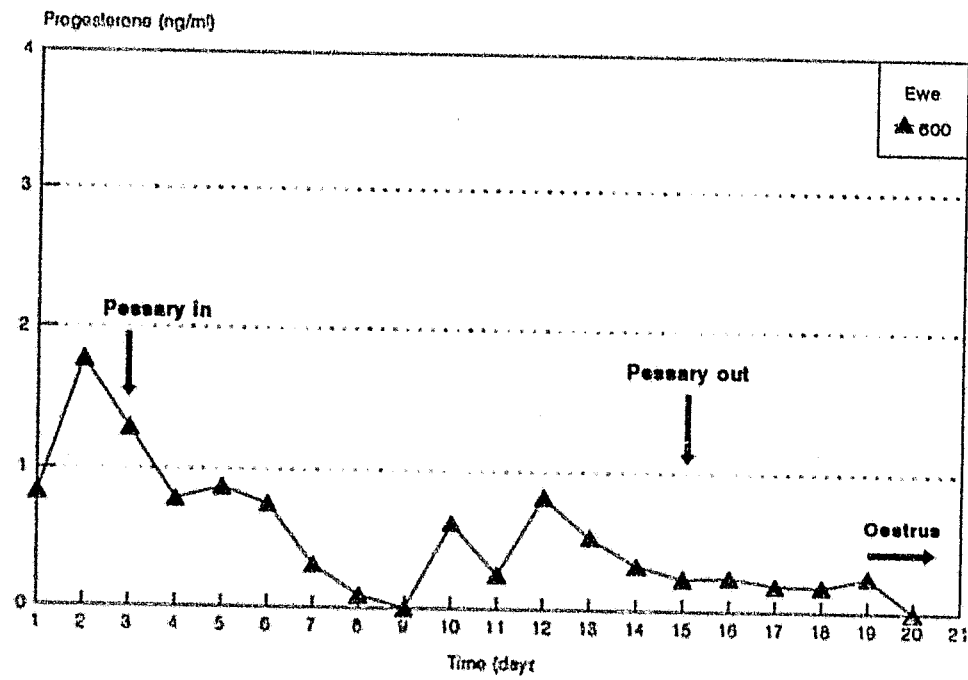
FIGURE 4.9.7   Progesterone levels and oestrous response (progestagen pessary)
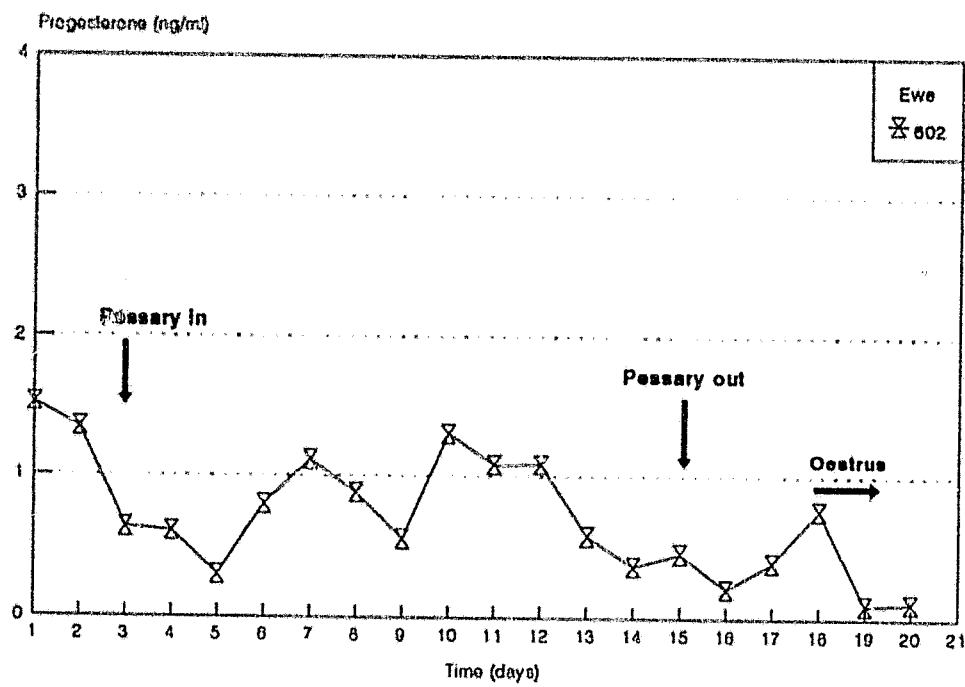
FIGURE 4.9.8   Progesterone levels and oestrous response (progestagen pessary)
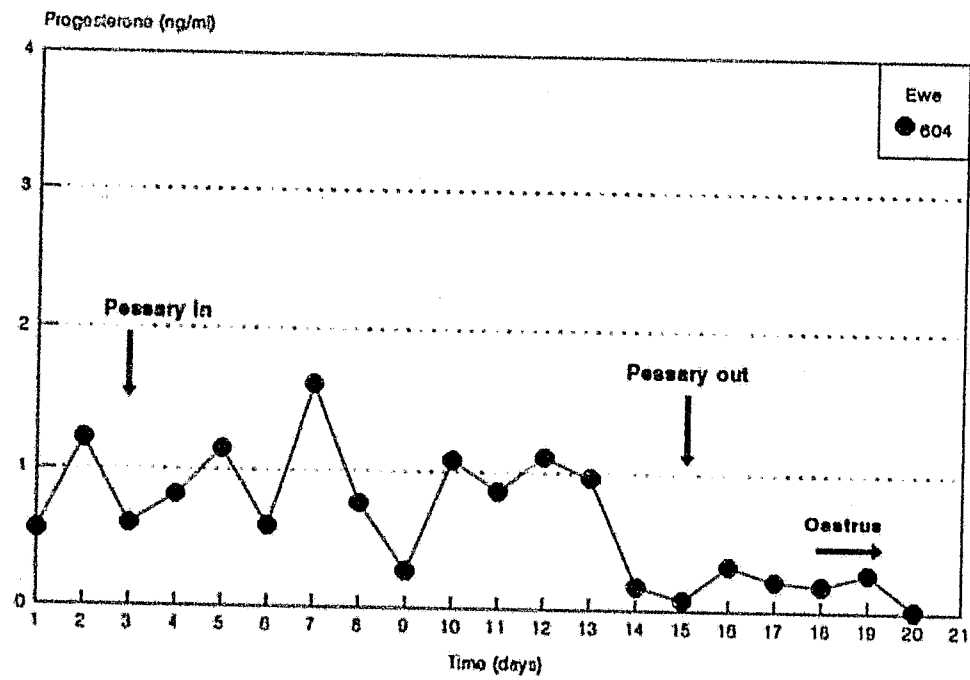
FIGURE 4 9 9 Progesterone levels and oestrous response (progestagen pessary)
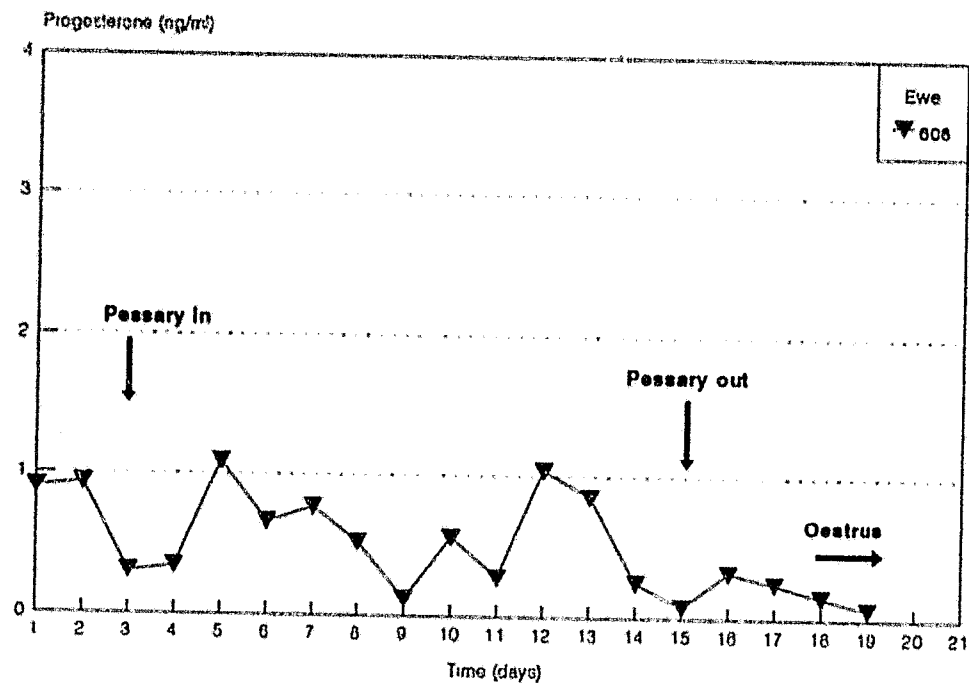
FIGURE 4 9 10 Progesterone levels and oestrous response (progestagen pessary)

sheep under every procedure discussed, differed distinctively from reports by other workers on the same issues. In most instances the interval from cessation of treatment to onset of oestrus was notably longer than findings quoted in the literature. Within-day variation in peripheral plasma progesterone concentrations is possible (Parsons & Hunter, 1967). This variation in each ewe is particularly pronounced during the luteal phase when concentrations can vary between 1.0 and 5.0 ng/ml (Mc Natty, Revfeim & Young, 1973). Data obtained from the trials under discussion is summarized and presented in Table 4.2. There is a significant difference between Group A1 and A2, Group A1 and A3 and Group A1 and A4, but not between Groups A2, A3 and A4 ($P < 0.05$).

Results showed that the interval from cessation of treatment to onset of oestrus was under every test procedure longer than comparable figures quoted in other breeds. Consideration should however be given to the fact that figures quoted for Damara sheep in this field of study, are the first and only reported thus far and more investigative work should be done to substantiate the available data. From an economical point of view it would therefore be recommendable at this stage to consider the administration of exogenous progestagen only for practical application purposes.

TABLE 4.2 Interval from cessation of treatment to onset of oestrus for all groups

Group	A1 (hours) T rams	A2 (hours) Prog + PGF2a	A3 (hours) Prog + PMSG	A4 (hours) Prog
Ewe no.				
1	48	96	48	84
2	240	96	84	72
3	240	96	60	84
4	360	84	48	72
5	120	120	48	96
6	72	96	84	96
7	144	84	60	96
8	384	96	48	84
9	408	96	48	84
10	408	84		84
n	10	10	9	10
Average	242.4	94.8	58.67	85.2
Std dev.	134.250	10.507	14.36	8.854

4.3.2 Duration of oestrus

The overall results for the four treatment groups with regard
duration of oestrus are summarized in Tables 4.3 and 4.4. There
was no significant difference between Groups A1, A2, A3 and A4
(P > 0.05).

GROUP A1:

The complex patterns of behavior which emerge during oestrus
are innate and mediated through the central nervous system. In
the ewe, oestrous behavior is attributed to the direct action
of oestrogen on the central nervous system. The amount of
oestrogen secreted by the ovaries does however not appear to
affect the duration of oestrus (Parsons & Hunter, 1967).
The mean duration of oestrus can differ substantially among
breeds and from season to season (Quirke, Stabenfeldt &
Bradford, 1988) viz :

	Suffolk	Rambouillet	Dorset	Finn
1980/81	35.8 h	29.5 h	41.0 h	37.0 h
1981/82	40.1 h	31.2 h	40.3 h	40.1 h

Parsons et al. (1967) teased Merino ewes at 4 hourly
intervals during the month of November. The duration of oestrus

TABLE 4.3 Duration of oestrus recorded for all groups

Group	A1 (hours) T rams	A2 (hours) Prog + PGF2a	A3 (hours) Prog + PMSG	A4 (hours) Prog
Ewe no.				
1	36	48	36	24
2	36	24	24	48
3	48	36	60	48
4	24	36	72	36
5	48	36	60	60
6	48	24	36	24
7	48	36	48	24
8	24	36	60	36
9	24	36	60	36
10	24	36		24
n	10	10	9	10
Average	36.0	34.8	50.67	36.0
Std dev.	10.7	6.46	14.73	12.0

TABLE 4.4 Summary of the mean results obtained from four different treatment groups

Group	A1 T rams	A2 Prog + PGF2a	A3 Prog + PMSG	A4 Prog
Number of ewes	10	10	9	10
Number of ewes showing oestrus	10	10	9	10
Interval from cessation of treatment to onset of oestrus (h) mean±SD	10 1±5 89 (days)	94 8±10.51	58 67±14.36	85.2±8.85
Duration of oestrus (h) mean±SD	36 0±10 7	34.8±8.46	50.67±14.73	36.0±12.0
Mean serum progesterone concentration at onset of oestrus (ng/ml)	0 44±0 38	0.33±0 15	0.37±0.21	0.23±0.19
Mean serum LH peak (ng/ml)	8 48±12 08	14 34±15 64	7.39±11.17	7.45±18.13

recorded was 21.9 ± 1.5 h. Van der Westhuysen, Van Niekerk + Hunter (1970), under similar conditions, recorded a duration of 40.7 ± 3.17 h. Method and frequency of association with the ram can affect the duration of oestrus (Parsons et al., 1967).

Figure 4.10 presents the duration of oestrus of ewes that were in the continuous presence of a teaser ram for 12 days and consequently teased twice daily until cessation of oestrus. The average duration of oestrus recorded was 36.0 ± 10.7 hours and within the range of most of the existing data as indicated.

GROUP A2:

Duration of oestrus after termination of intravaginal progestagen therapy followed by PGF2a administration was recorded to be 38.6 ± 7.12 hours in SA Mutton Merino ewes (Greyling et al., 1979) and 32.46 ± 7.39 hours in Merino ewes (Greyling et al., 1980). Results from the trial under discussion are presented in Figure 4.11 which indicate an average duration of 34.8 ± 6.46 hours which does not deviate notably from the above quoted figures.

GROUP A3:

In strict contrast to the findings recorded by Quirke et al. (1979) viz. 32.7 ± 2.4 hours and 27.0 ± 1.6 hours by Quirke
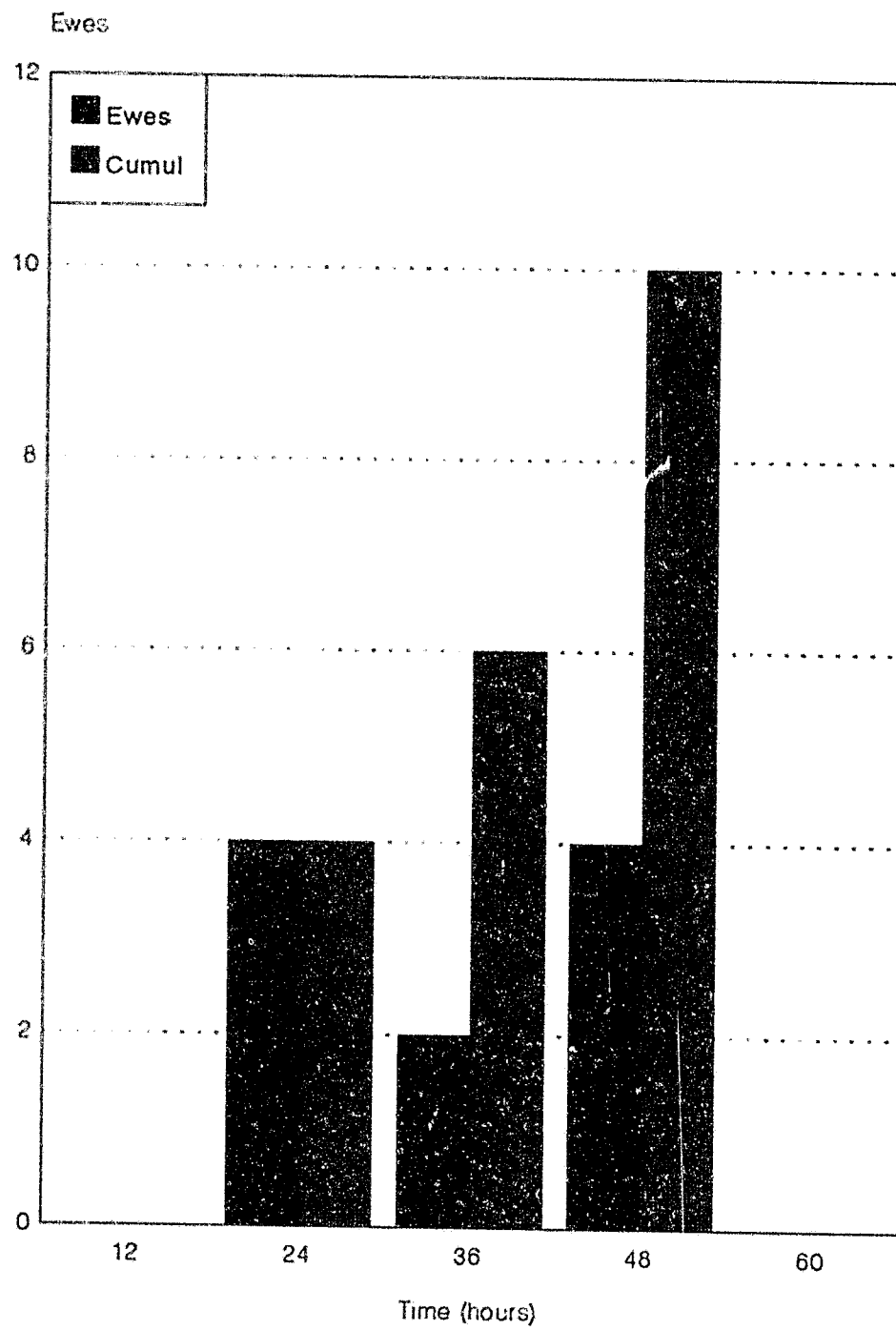
Ewes

FIGURE 4.10 Duration of oestrus (teaser ram for 12 days)
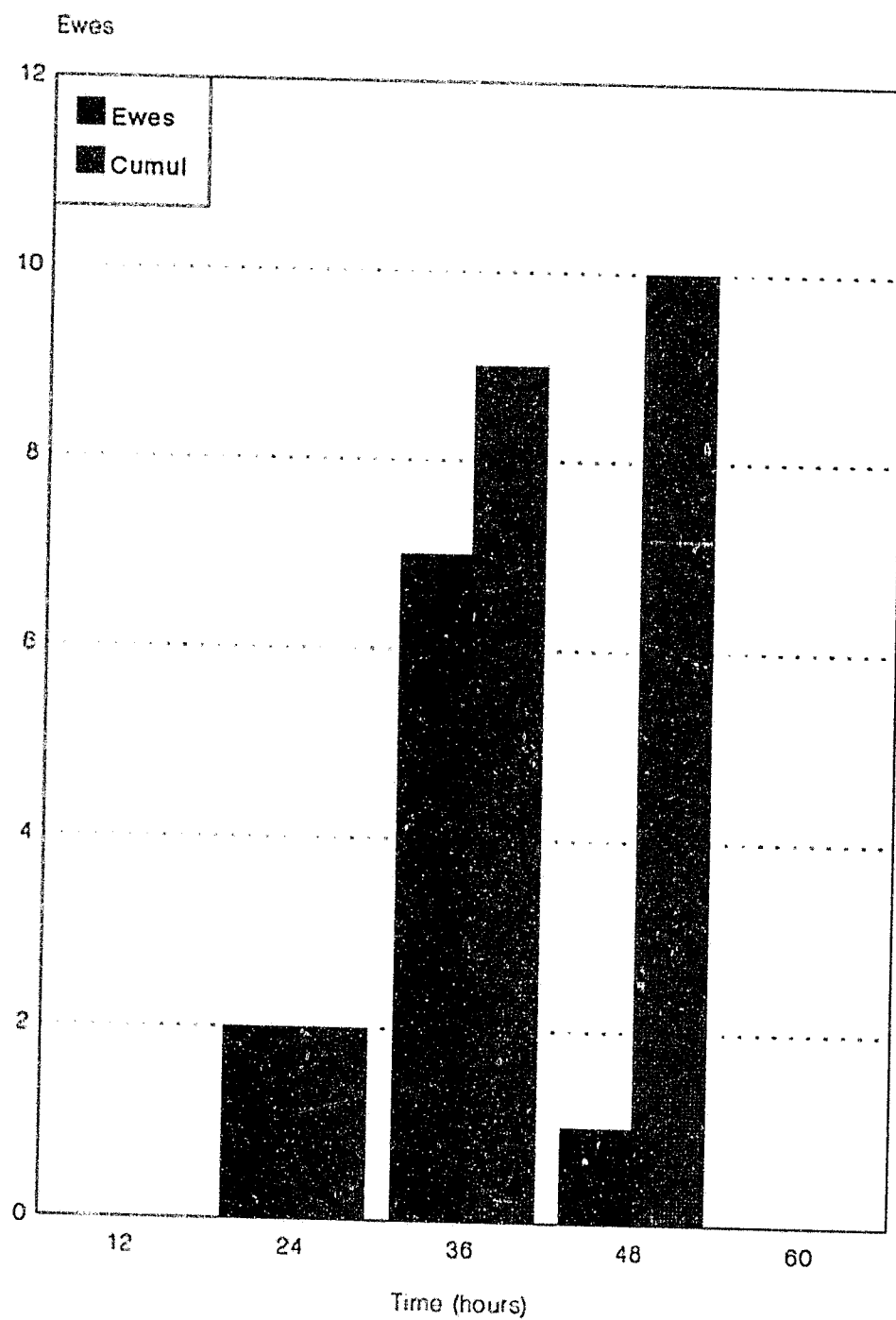
Ewes

FIGURE 4.11 Duration of oestrus (progestagen pessary + PGF2a)

et al. (1981), in both instances injecting Galway ewes during the autumn season with 500 IU PMSG after progestagen treatment, the average duration of oestrus recorded in the trial under discussion was found to be 50.67 ± 14.73 hours (Figure 4.12). One ewe out of the 10 included in this trial failed to show oestrus and showed heat one cycle period later. The reason for this dissimilarity is unknown, but probably lies with the administered dosage (300 IU) compared to dosages quoted in the literature: 500 IU under artificial light regimen of 10 hours daylength (Ainsworth *et al.*, 1983), 750 IU during the breeding season (Fukui, Sotto & Ono, 1983) and 250-1000 IU during the breeding season (Gordon, 1975).

GROUP A4:

Duration of oestrus sequential to progestagen therapy was monitored on a 12 hourly basis and recorded to be 30.18 ± 7.13 hours in Merino ewes treated during the month of July (Greyling *et al.*, 1980), 29.3 ± 3.04 hours in Merino ewes treated during the month of November (Van der Westhuysen *et al.*, 1970) and 36.81 ± 5.51 hours in Mutton Merino ewes treated during the early breeding season (Schoombee, Van Niekerk & Coetzer, 1989). The same treatment performed on Damara ewes resulted in an average duration of oestrus of 36.0 ± 12.0 hours (Figures 4.13 and 4.9.1 to 4.9.10). Improved substantivity of results would have been possible in all instances with a higher observation frequency.
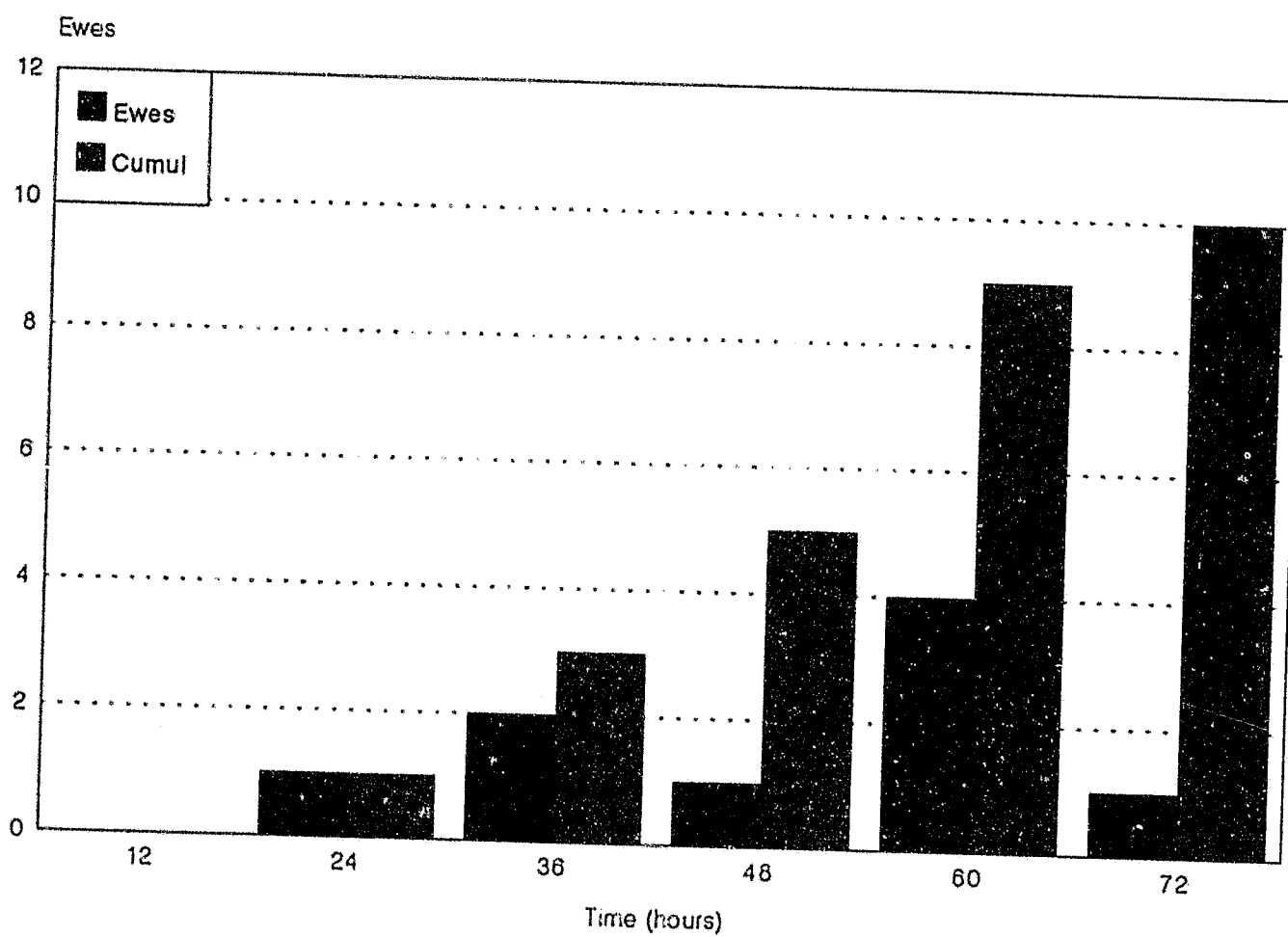
FIGURE 4 12 Duration of oestrus (progestagen pessary + PMSG)
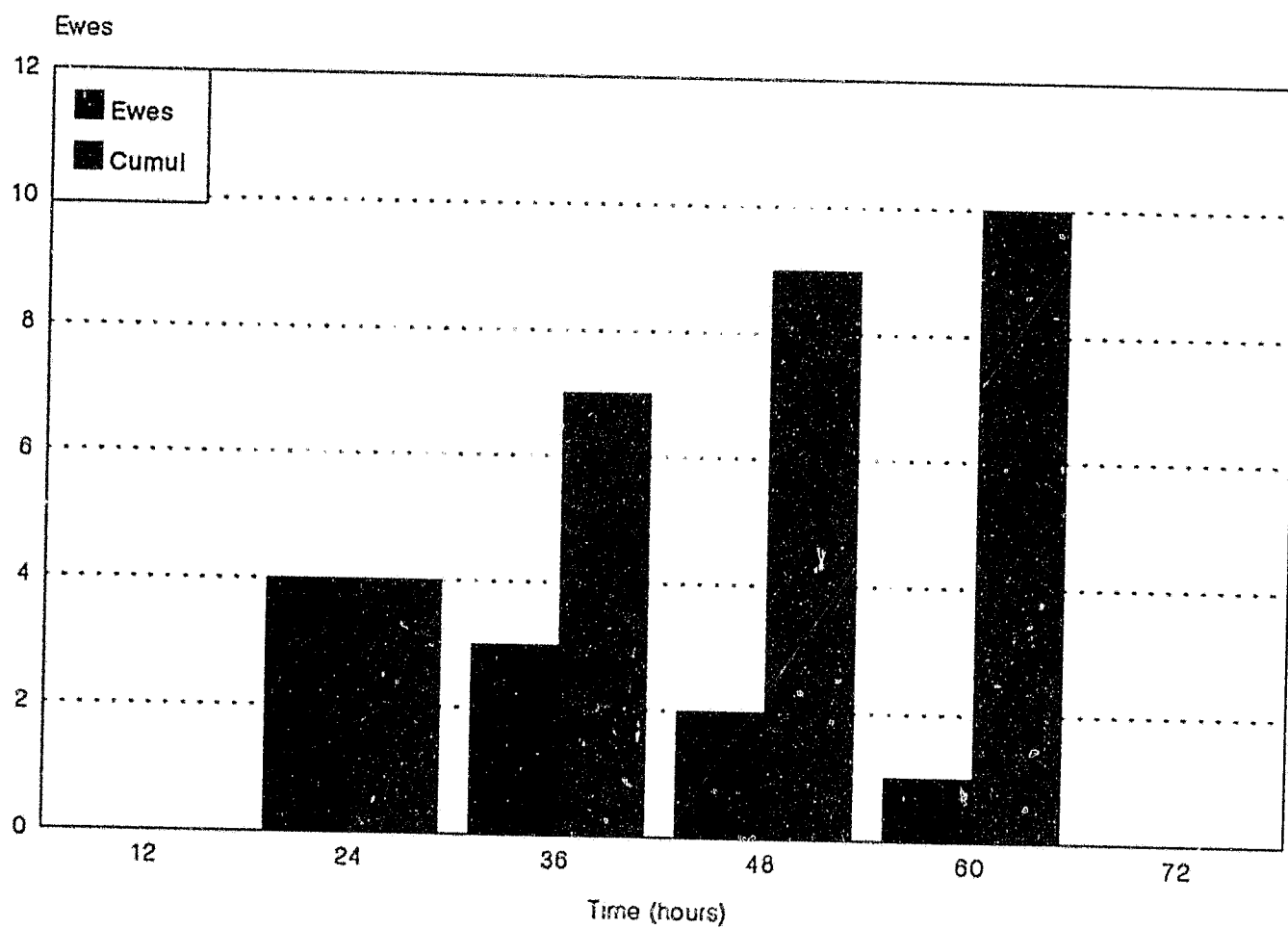
FIGURE 4 13 Duration of oestrus (progectagen pessary)

4.3.3 Peripheral serum LH levels obtained from the four
different synchronisation applications

Developments in our understanding of the endocrine control of
the oestrous cycle in the ewe indicate that the regulation of
tonic LH secretion is determined by the combined negative
feedback effects of oestradiol 17ß and progesterone.
Furthermore, the tight temporal relationship between episodic
LH secretion and oestradiol secretion rate from the ovary
indicates that tonic LH secretion is a major factor responsible
for driving oestradiol secretion by developing follicles
(Baird & Scaramuzzi, 1976; Baird, 1978). This is further
supported by the observation of parallel increases in plasma LH
and oestradiol concentrations during the follicular phase of
the oestrous cycle (Haresign, 1985; Martin et al. 1986).

Pulsatile secretions of gonadotropins from the anterior
pituitary gland enters the circulation via the hypophyseal
vein. Among the factors known to affect the frequency of the
pulses are nutrition, pheromones, photoperiod and gonadal
steroids (negative and positive feedback) (Martin et al.
1986). Variations in the frequency and amplitude of pulses are
primarily a reflection of the intensity of the action of the
sex steroids (Rieger & Rawlings, 1985; Thièry & Martin, 1991)
derived almost exclusively from the ovarian follicles, several

of which develop and undergo atresia during the course of each
cycle (Legan et al., 1979).

Approximately 48-60 hours prior to the onset of the LH surge
circulating progesterone begins its precipitous decline as a
consequence of the rapid demise of the corpus luteum.
Associated with this decrease in progesterone, mean serum LH
concentrations rise progressively, reaching levels at least
5-fold greater than baseline (Baird, 1978) by the time of
onset of the preovulatory LH surge. This rise reflects an
increase in the frequency of pulsatile LH discharges and it
constitutes an increase in tonic LH secretion separate from the
LH surge. The increase in oestradiol suppresses FSH release and
thereby prevent the recruitment of more follicles and
consequently triggers the positive feedback mechanism which
results in the LH surge (Lindsay et al., 1975; Martin et al.,
1986). This leads to ovulation and formation of the corpus
luteum (Legan et al., 1979). Steroid secretion rates and the
peripheral concentrations of LH can vary considerably both
within and between individual ewes (Scaramuzzi & Baird,
1977).

Lack of consistency in the literature on data recorded with
regard to different aspects aimed at pinning down the role and
function of LH in reproduction physiology seems to be the rule
once more. Considerable variation on individual level is also
possible (Acritopoulou, 1979). In most instances the

application of either an analogue of PGF2a, progestagen or a
combination of progestagen and PMSG are involved as
synchronizing agents. In general the effects of these
applications were of such a variable nature (between and
within treatments) that the existing data on the different
aspects of relevance, might for all practical reasons, be
pooled together with the aim to form a general perception of
the status of LH. A brief summary of various data from
different sources is presented to illustrate the above
statement:

Interval from -

cessation of treatment to onset of oestrus:
32.0 h (progestagen + 500 IU PMSG) (Robinson et al., 1987).
37.7 ± 1.6 h (PGF2a: single i.m. injection) (Acritopoulou &
Haresign, 1980).
46.5 ± 3.5 h (PGF2a: double i.m. injection 9 days apart)
(Acritopoulou, 1979).

cessation of treatment to LH surge:
37.5 ± 2.6 h (progestagen + 500 IU PMSG) (Ainsworth et al.,
1983).
42.9 ± 3.8 h (progestagen + PMSG) (Lindsay et al., 1975).
50.3 ± 2.9 h (PGF2a: double i.m. injection 9 days apart)
(Acritopoulou, 1979).

onset of oestrus to LH surge:

-2.6 ± 8.1 h (progestagen pessaries) (Cumming et al.,
1973).

4.5 ± 0.7 h (progestagen + 500 IU PMSG) (Robinson et al.,
1987).

7.7 ± 2.7 h (progestagen pessaries) (Van der Westhuysen,
Malan & Dierkse, 1977).

Duration of the LH surge:

8.1 ± 0.49 h (Quirke et al., 1981).

10.1 ± 2.2 h (Wallace, Martin & Mc Neilly, 1988).

14.0 ± 1.2 h (Ainsworth et al., 1983).

Pulse frequency:

1 per 5 h (luteal phase)   (Scaramuzzi et al., 1977).

2.3 ± 0.5 per 6 h ("   )   (Wallace et al., 1988).

> 1 per h (follicular phase) (I' Anson & Legan, 1988).

Basal levels of LH:

0.57 ± 0.08 - 2.97 ± 0.57 ng/ml (Baird, Swanston & Scaramuzzi,

                                  1976).

0.87 - 3.99 ng/ml   (Baird et al., 1976).

1.7 ± 0.1 - 5.1 ± 0.2 ng/ml   (Haresign, 1985).

Maximum LH levels:

58 ± 2.5 ng/ml   (Robinson et al., 1987).

100.0 ± 10.0 ng/ml   (Quirke et al., 1981).

140.1 ± 24.6 ng/ml   (Wallace *et al*., 1988).

The release of LH from the anterior pituitary does not normally
begin until just after the onset of oestrus (Acritopoulou,
1979). In progestagen treated ewes however, the onset of LH
surge can occur much earlier in relation to the onset of
oestrus than in untreated ewes and can begin at 4 to 26 hours
before the onset of oestrus (Cumming, Blockley, Brown, Catt,
Goding & Kaltenbach, 1970).

During the current investigation blood serum samples were taken
every 6 hours during the oestrous period of each ewe from all
four groups to determine LH concentrations. The LH
concentration values for each 6-hourly drawing were pooled for
each group respectively. The mean values were calculated for
each specific 6-hourly interval during the oestrous period from
onset of oestrus as determined with the aid of a teaser ram
until cessation of oestrus. Figures 4.14, 4.15, 4.16, 4.17 and
Table 4.6 illustrate the average position of the LH peak
relative to the onset of oestrus (0 hours) as it occurred in
the different treatment groups. In Group A1 the LH peak
concentrations were dispersed between 6 and 18 hours relative
to onset of oestrus (0 hours) (Figure 4.14). The highest
mean concentration indicated was 8.479 ± 12.081 ng/ml at 6
hours after onset of oestrus. In Group A2 the LH peak
concentrations congregated between 6 and 12 hours after onset
of oestrus (0 hours) with the highest average concentration
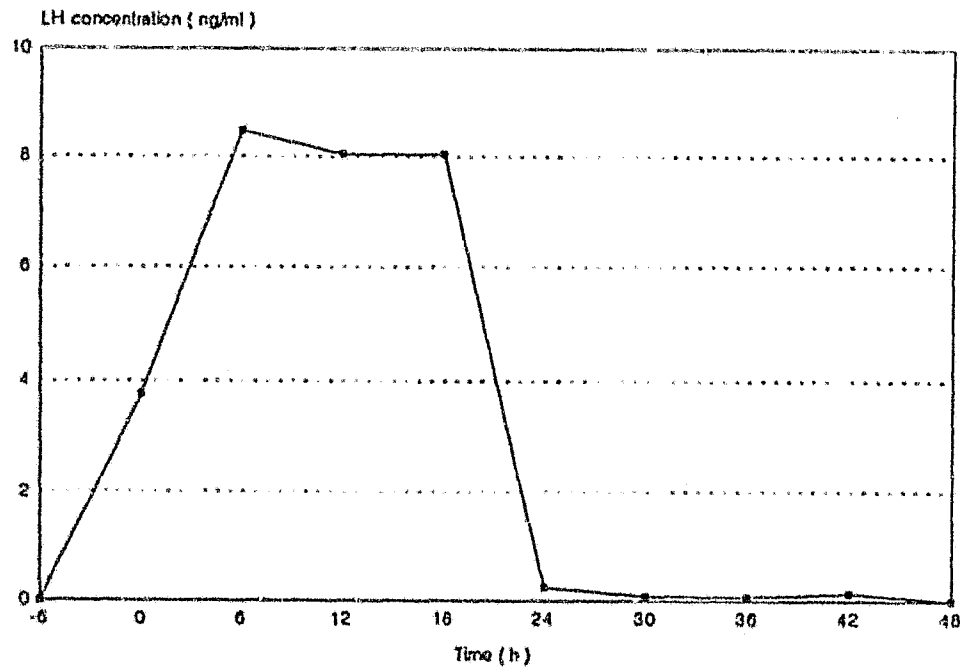
FIGURE 4.14 Mean serum LH concentrations relative to onset of oestrus (0 h) Group A1
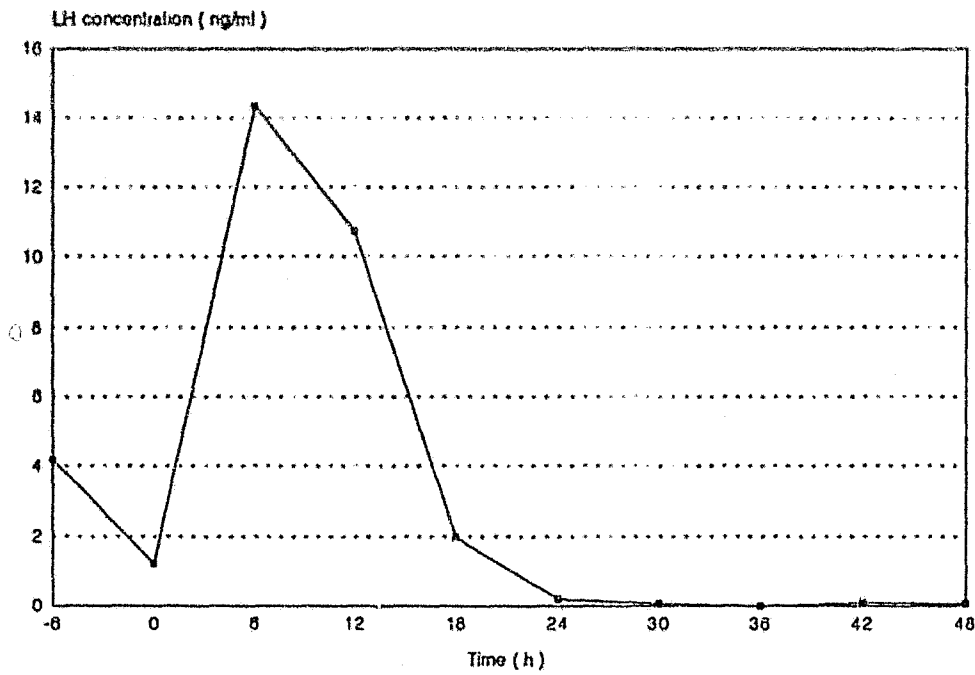
FIGURE 4.15 Mean serum LH concentrations relative to onset of oestrus (0 h) Group A2
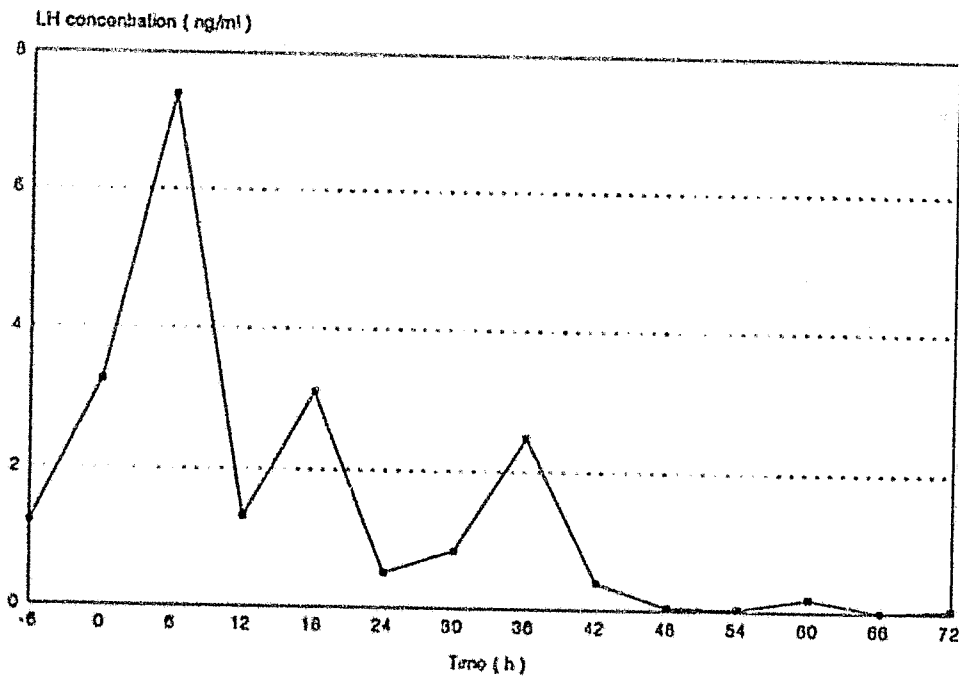
FIGURE 4 16 Mean serum LH concentrations relative to onset of oestrus (0 h) Group A3
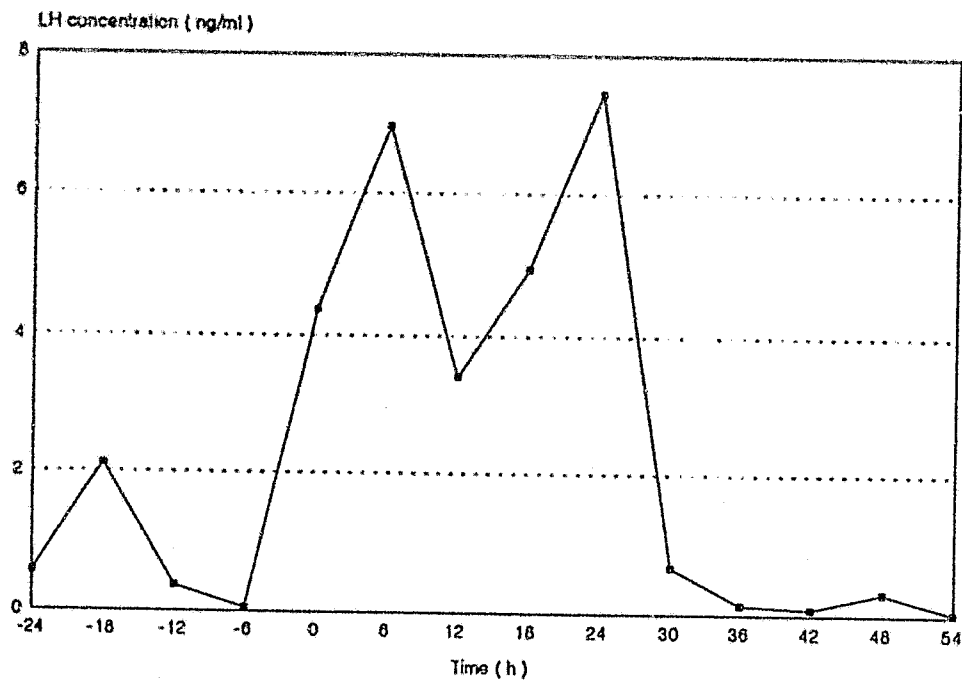
FIGURE 4 17 Mean serum LH concentrations relative to onset of oestrus (0 h) Group A4

indicated as 14.337 ± 15.644 ng/ml at 6 hours after the onset
of oestrus (Figure 4.15). In Group A3 a singular average peak
was observed at 6 hours after onset of oestrus (0 hours)
reaching a mean concentration of 7.393 ± 11.170 ng/ml (Figure
4.16). Figure 4.17 portrays a dispersal of peak concentrations
for Group A4 situated between onset of oestrus (0 hours) and
24 hours after onset of oestrus with 7.447 ± 18.127 ng/ml as
the highest average concentration. Above data was accumulated
and expressed in terms of percentage LH peaks in relation to
onset of oestrus in Figure 4.18. There is no significant
difference in the occurrence of the LH peak relative to the
onset and cessation of oestrus between the four treatment
groups ($P > 0.05$).

Table 4.5 indicates the positions of the LH peaks of individual
ewes relative to the onset and cessation of oestrus. This data
is summarized in Table 4.6 depicting the average positions per
group.

The average time lapse from cessation of treatment to LH peak
for the different groups is depicted in Table 4.7. Group A1
differs significantly from Groups A3 and A4 but not from Group
A2 ($P < 0.05$). The mean peak LH concentrations and mean basal
LH concentrations for the different groups are illustrated in
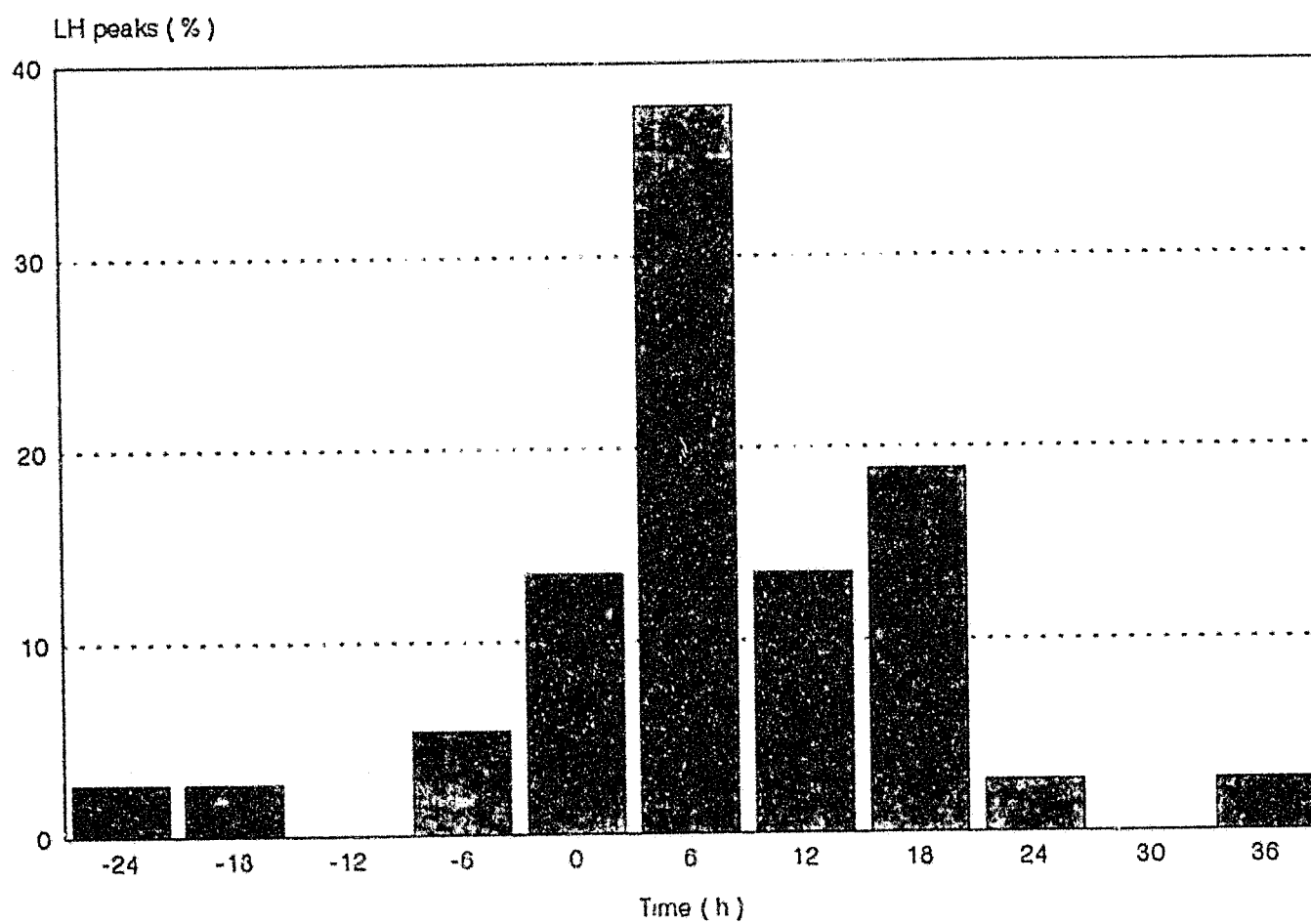
FIGURE 4 18 The distribution of LH peaks relative to the onset of oestrus (0 h) (Groups A1-A4)

Table 4.5 Position of the LH peak relative to onset and
cessation of oestrus

	Ewe no.	After onset (h)	Before cessation (h)
Group A1:	1	12	24
	2	6	30
	3	12	30
	4	0	18
	5	18	24
	6	6	36
	7	6	36
	8	18	0
	9	18	0
	10	0	18
Mean:		9.6 ± 6.681	21.6 ± 12.355
Group A2 :	1	-6	36
	2	12	18
	3	-	-
	4	12	30
	5	6	12
	6	6	24
	7	6	12
	8	6	24
	9	6	24
	10	6	24
Mean :		6.0 ± 4.899	22.67 ± 7.364
Group A3:	1	6	24
	2	36	30
	3	18	36
	4	6	48
	5	18	36
	6	6	48
	7	-	-
	8	-6	24
	9	0	30
	10	-	-
Mean:		10.5 ± 12.278	34.5 ± 8.874
Group A4:	1	-24	66
	2	24	6
	3	6	12
	4	18	24
	5	18	12
	6	6	24
	7	-18	36
	8	12	42
	9	0	18
	10	0	18
Mean:		4.2 ± 14.709	25.8 ± 16.981

Table 4.8. No significant difference was found between the peak

LH concentrations presented by the four treatment groups

(P > 0.05).

Table 4.6   Position of the LH peak concentrations relative to
the onset and cessation of oestrus between the
different groups (A1 - A4)

Group	After onset (h)	Before cessation (h)
A1	9.6 ± 6.681	21.6 ± 12.355
A2	6.0 ± 4.899	22.6 ± 7.364
A3	10.5 ± 12.278	34.5 ± 8.874
A4	4.2 ± 14.709	25.8 ± 16.981

Table 4.7   Mean duration from cessation of treatment to LH
peak concentration

Group A1:	253.2 ± 132.408 hours
Group A2:	102.0 ± 11.662 hours
Group A3:	69.0 ± 11.225 hours
Group A4:	89.4 ± 17.483 hours

Table 4.8   Mean basal and peak serum LH concentrations

Group	Basal levels (ng/ml)	Peak levels (ng/ml)
A1	0.7202 ± 1.056	24.35 ± 8.474
A2	0.5414 ± 0.882	24.82 ± 13.424
A3	0.4427 ± 0.745	19.56 ± 8.4
A4	0.8011 ± 1.183	27.11 ± 13.388

There appears to be a marked difference in the time interval
recorded in these trials with regard the interval from
cessation of treatment to onset of oestrus and figures quoted
in the literature. Disregarding the outcome of group A1
(Table 4.7) which is expressed in terms of days as a
consequence of the treatment regime it underwent, there is also
great variation between groups viz. 102.0 ± 11.662 h for the
MAP + PGF2a treated ewes, 69.0 ± 11.225 h for the MAP + PMS
treated ewes and 89.4 ± 17.483 h for the MAP treated ewes.
These times are also exceptionally longer than the 37.5 ± 2.6 h
(crossbred strains), 42.9 ± 3.8 h (Ile-de-France) and 50.3
± 2.9 h (Clun Forest) quoted by Lindsay et al. (1975),
Acritopoulou (1979) and Ainsworth et al. (1983)
respectively.

There seems to be a closer relationship with regard the
interval between onset of oestrus and the LH surge obtained in
these experiments and those quoted in the literature. Data
displayed in Table 4.5 compares well with the 7.7 ± 2.7 h
quoted by Van der Westhuysen et al. (1977) for Merino ewes.
Group A2 was well synchronised with 6 ewes showing peak
concentrations 6 hours after the onset of oestrus, while the LH
peak concentrations in the rest of the groups were scattered to
a greater or lesser extent. In Group A4 two ewes showed peak
concentrations before onset of oestrus viz. at -18 and -24 h
relative to onset of oestrus, resulting in the relatively short
average time interval of 4.2 ± 14.709 h. When considering the

data displayed in Figure 4.18 for all groups however, there is
a general tendency towards an average interval of 6 hours
(37.8 %). It would therefore seem as if the intervals from
cessation of treatment to onset of oestrus and onset of oestrus
to LH peak are more extended for Damara sheep than for other
breeds of sheep as concluded from the literature. Again the
relevancy of such conclusions is based on the amount of data
available.

4.3.4   Determination of the effect of applied treatments on
ovarial function by means of laparoscopic investigation

Driancourt et al. (1985) maintains that the ovary of adult
ewes contains between 12 000 and 86 000 primordial follicles
and between 100 and 400 growing follicles of which 10 to 40 are
visible on the surface of the ovary. In most sheep breeds, only
one follicle ovulates at the end of each oestrous cycle of 16
days. The follicles grow until they reach 4 - 6 mm in diameter
and then regress. The number of such follicles may vary
considerably among individual animals. The differentiation of
the ovulating follicle is a two-step process in which the large
antral follicles are recruited from a pool when exposed to
sufficient gonadotropin stimulation. From these a single
follicle is selected, continues maturation, becomes dominant
and ultimately ovulates to become a corpus luteum. Recruitment
occurs around 48 hours before the LH surge and probably
coincides with luteolysis (Driancourt et al., 1985).

Whatever the stage of the cycle, follicles of various sizes are apparent on the surface of the ovary. Growth probably occurs at random until the follicle attains a size of 4 - 7 mm. The recruitment of a crop of follicles, including the one which will ovulate, occurs at variable times around luteolysis due to the interaction of endocrine and follicular factors (FSH priming, sensitizing the follicle to increased LH pulsatility). All healthy follicles larger than 2 mm in diameter are recruited. Selection of the follicle due to ovulate can be defined by morphological criteria (size) or by its "killing" ability. The dominant follicle is probably maintained because of its high oestradiol content, while the other undergo atresia (Driancourt et *al.*, 1985).

Group A1 (Teaser ram) yielded 12 corpora lutea; Group A2 (MAP + PGF2a) yielded 10; Group A3 (MAP + PMS) also yielded 10 and Group A4 (MAP only) yielded 11 corpora lutea. The treatment applied therefore, did not appear to have an effect on ovulation rate in the sense of ova production. There were large numbers of medium sized (4 - 7 mm) follicles and small (1 - 3 mm) follicles visible on the ovaries which is in accordance with Driancourt et *al.* (1985). There were a larger number (15 %) of corpora lutea observed on the right hand side than on the left hand side. It appears as if the administration of PMSG did not have the desired effect. Without any further appropriate investigations, it is doubtful whether

these differences in figures are of any meaningful consequence
(Table 4.9)

4.4 CONCLUSION

When considering the performance of the Damara sheep under
experimental conditions, it should be kept in mind that these
animals are known for there spirited temperament and untamed
behavior. The experimental animals were brought from a highly
extensive situation where cheetah, jackal and lynx forms part
of their daily livelihood and placed into a highly intensive
situation from where work started without time allowed for
adaptation. Keeping this in mind, the outcome during the
initial phases of the research program can in the least be
described as unexpected considering the reaction of the ewes on
treatments and the results obtained with regard oestrous
behavior, ovarial function and eventually conception.

TABLE 4.9 Laparoscopic observations of ovaries after different synchronisation treatments

	Follicles						C Lutea		C Albicans		Empty	
	Large		Medium		Small							
Ovary	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Group A1	0	0	6	0	15	7	6	6	3	1	0	3
Group A2	0	1	11	3	10	15	3	7	0	0	0	0
Group A3	1	0	5	7	10	10	7	3	0	0	0	2
Group A4	1	0	3	3	18	10	4	7	2	0	0	0
Total:	2	1	25	13	53	42	20	23	5	1	0	5

Large = 8-12 mm; Medium = 4-7mm; Small = 1-3 mm

CHAPTER 5

THE EFFECT OF TWO DIFFERENT METHODS OF FERTILIZATION ON REPRODUCTIVE OUTCOME

5.1 INTRODUCTION

A controlled program for sheep production would increase the efficient use of labour, facilities and breeding material. For improved effectiveness, synchronisation of the oestrous cycle would be required at a predetermined time if the aim is to practice artificial insemination. If natural mating is intended, the ram to ewe ratio should be one ram for every 10 synchronised ewes (Hackett, Inskeep, Robertson, Shrestha & Wolynetz, 1979).

According to Fulkerson, Synnot & Lindsay (1982) one of the aims in an artificial insemination program is to utilize spermatozoa as sparingly as possible. Contrary to expectations only 60×10^6 spermatozoa from a single natural service is necessary for good conception. By contrast, a single attempt at artificial insemination requires twice as many fresh spermatozoa for conception. Assuming that semen of equivalent quality is used, the only consistent differences between natural and artificial insemination appear to be the absence of, or interruption to normal courtship behavior, stress associated with handling practices and strange surroundings

when artificial insemination is used. Methods should therefore be devised to minimise the resultant effects.

When rams are subjected to frequent ejaculation (up to eight times daily), the number of spermatozoa appearing in each ejaculate, falls to low and relatively stable levels. Under such circumstances the number of spermatozoa present in a single ejaculate may be low enough to reduce the chances of conception after natural mating. The proportion of pregnant ewes increases with the number of times ewes are served (Cameron, Fairnie, Curnow, Keogh & Lindsay, 1984 a). To plan the requirements for males in an artificial insemination program, one must be able to predict the rate of output of spermatozoa from the rams. Regular ejaculation leads to a reduction in the epididymal reserves of spermatozoa. This means that during a period of regular semen collection, the initial semen characteristics differ from those obtained following depletion of the epididymal sperm reserves. It takes several days for semen characteristics to stabilize when collection begins after a period of sexual rest or when regularly ejaculated males move to a different frequency of semen collection. Although the estimated rate of production and output of spermatozoa are correlated with testicular weight, there still remains a large discrepancy between estimated production and output.

In summary, as few as two ejaculations per day may yield the
maximum number of spermatozoa from regularly ejaculated rams.
Measurement of testicular weight is a simple means of
predicting the rate at which spermatozoa can be collected from
rams being ejaculated at this frequency (Cameron, Fairnie,
Curnow, Keogh & Lindsay, 1984 b).

Semen characteristics, such as volume, concentration,
morphology, chemical composition, and fertilizing capability
are inter alia influenced by breed and can display a high
degree of variation among rams within a breed (Cochran, Judy,
Parker & Hallford, 1985). Semen abnormalities tend to be
higher when rams are subjected to increasing daylength than
when they are submitted to decreasing daylength. The resulting
fertility is markedly reduced (51 % vs 66 %). Lambing rates
obtained by artificial insemination centers internationally
during the breeding season range between 65 % and 75 %
(Cognie, Colas & Thimonier, 1984). 75.5% ewes detected on
heat and inseminated 12 hours later can be expected to lamb.
This figure can increase to 80.9 % after a second insemination
10 hours later (Schutte, van Tonder, van der Westhuizen,
Herbst & Steyn, 1986).

5.2 MATERIALS AND METHODS

5.2.1 Experimental animals

Refer to Paragraph 4.2.1 for an outline of experimental animals used in this section.

Two adult Damara rams were trained well in advance to ejaculate in an artificial vagina. A trained Karakul ram served as stand-by while an adequate number of teaser rams were available.

5.2.2 General management

Refer Paragraph 4.2.2

All male animals were housed in singular pens distant from the ewes.

5.2.3 Treatments

Refer Paragraph 4.2.3 and 4.2.4

From the forty ewes eventually treated for synchronisation of the oestrous cycle (Groups A1 to A4) the first twenty ewes that came on heat were allocated to a new Group M after laparoscopic investigations were completed while the remaining twenty ewes were allocated to Group N (Table 10.1). Both

groups were monitored twice daily for oestrus. Blood samples were continuously taken on a daily basis until onset of oestrus during which period collection was performed every 6 hours.

Ewes in Group M were subjected to artificial insemination and ewes in Group N were naturally mated. Both groups were serviced 12 hours after heat detection and again 12 hours later. Rams which served as donors were conditioned in advance to serve in an artificial vagina. All apparatus used in the process of semen collection and handling was sterilized beforehand. Semen was collected with the aid of an artificial vagina with an inside temperature of approximately 38° C. A teaser ewe was contained in a headclamp to allow the ram to mount. As the ram mounted, the penis of the ram was deflected into the artificial vagina. The flask in which the semen was collected, was held inside the palm of the hand to minimize variation in temperature and placed in a water bath at 37° C after the collection process was completed. The semen was immediately examined for colour and motility to determine the approximate concentration and percentage live sperm in the sample. On grounds of these estimates a dilution factor was calculated as per following example:

Volume available:	1 ml
Concentration per ml:	3000×10^6 sperm cells
Percentage alive:	80 %
Live sperm per ml:	$3000 \times 10^6 \times 80$ %

$$= 2400 \times 10^6 \text{ sperm cells}$$

0.2 ml containing 100×10^6 sperm cells is required per insemination which is equal to 500×10^6 sperm cells per ml.

The dilution factor is therefore: $\dfrac{2400}{500} \times 10^6$

$$= 4.8 \text{ times dilution}$$

Skimmed milk heated for 10 minutes at 92° C and cooled to 37° C was used as semen dilutent. After dilution the diluted sample was again microscopically examined. Plastic pipettes attached to a 1 ml syringe served to deposit the diluted semen with the aid of a vaginoscope in the exterior os servix of ewes of which the hind quarters were raised. A clean sterile pipette was used for each ewe. On completion of insemination all ewes were tested twice daily with vasectomised rams for return oestrus.

5.2.4 Progesterone assays

Refer Paragraph 4.2.4

5.3 RESULTS AND DISCUSSION

For the purpose of this investigation, twenty ewes (Group M) were subjected to artificial insemination and twenty ewes (Group N) to natural tupping which was exercised during the second oestrous period after treatment described under Paragraph 5.2.3. Ewe 525 (Group M) originally from Group A1

(teaser ram) came on heat 3 days after cessation of treatment
(removal of teaser ram) and then again three cycles later
when she was inseminated and conceived. Ewe 578 (Group M)
displayed the true temperament of the Damara breed during the
AI proceedings which was undoubtedly the reason why she did not
conceive. She was however successfully inseminated during the
subsequent oestrous period (Table 5.1). All other ewes
conceived during the first attempt at both artificial
insemination and hand-mating. Total conception was therefore
100 % giving rise to a lamb percentage of 100 % and a lambing
percentage of 110 % implying a twin frequency of 5 % viz. one
pair in Group M and one pair in Group N. Fecundity was 1.10 and
the weaning rate (90 days), 105 % for both groups.
Statistical analysis of the contents of Table 5.1 revealed no
significant difference between the two treatments (P > 0.05).

5.4   CONCLUSION

From the available data it would therefore appear as if the
treatment the ewes underwent, including the two insemination
methods, had no significant effect on the prolificacy of the
ewes that took part in the trials which is in accordance with
the findings of Gordon (1975), Hackett et al., (1979) and
Hackett & Wolynetz (1981) whose findings are in agreement
with the observation that there is no significant difference in
the reproductive performance of ewes bred by natural mating or
artificial insemination. With regard to treatment,

TABLE 5.1 Conception, Lambing percentage, Fecundity and Twinning incidence
(Natural tupping vs Artificial insemination)

	Artificial insemination	Natural tupping		
	Number	Number	Total	%
Ewes treated	20	20	40	100
Ewes serviced	20	20	40	100
Conceived	19	20	39	97.5
(2nd estrus after treatment)				
Conceived	1	0	1	100
(3rd estrus after treatment)				
Total conception	20	20	40	100
Number of Lambs	22	22	44	
Number of Twins	1	1	2	
Lambing percentage	100	100		100
Fecundity	1.1	1.1		1.1
Lamb percentage	110	110		110
Wean percentage	105	105		100

Acritopoulou-Fourcroy *et al.* (1982) noted that MAP + PMSG and PGF2a are equally effective in synchronizing oestrus and subsequent fertility. The results obtained from the test groups were indistinguishable from those obtained from the controls.

One important advantage of artificial insemination over natural breeding, is that superior males can be used more widely both in terms of the number of matings possible within a given flock and over a greater geographical area. This has a number of potential genetic advantages. The selection intensity of sires can be increased with a resultant increase in production, provided there are no deleterious effects of inbreeding. In addition, genetic material can be preserved for future use (Evans, 1988).

CHAPTER 6

**DURATION OF THE GESTATION PERIOD AND SENSITIVITY OF THE CORPUS
LUTEUM TOWARDS PROSTAGLANDIN F2a (PGF2a) DURING THE GESTATION
PERIOD**

6.1 INTRODUCTION

According to Hafez (1974) the mean duration of pregnancy for
different sheep breeds varies from 144 to 151 days. The early
maturing meat breeds and the highly prolific breeds have
shorter gestation periods averaging about 145 days. Slow
maturing fine wool breeds have longer periods of, on average,
150 days. Individual gestation periods within a breed can vary
up to 13 days with a standard deviation of about 2.2 days.
Pregnancy is shorter for twin lambs than singles, is sometimes
longer for ram than ewe lambs and increases with age of dam. A
low plane of nutrition tends to reduce gestation length,
particularly in late pregnancy and for twins.

PGF2a plays a major role during parturition in most domestic
species and is in this regard considered to be mainly of
uterine origin (Fredriksson, 1985). During early pregnancy,
the conceptus have a depressing effect on the response of the
corpus luteum to PGF2a. 200 μg of PGF2a injected
intrafollicularly 12 days post oestrus resulted in luteal
regression occurring in only 17% of pregnant ewes compared with

83% in non-pregnant ewes (Reid et al., 1980). Treatment of ewes on day 74 of gestation with 0.14 mg PGF2a/kg body weight resulted in regression of the corpus luteum of pregnancy as indicated by decreased serum progesterone by 24 hours after treatment. All ewes that received PGF2a during mid-gestation subsequently lambed however (Campbell, Hallford & Wise, 1994).

The corpus luteum of the ewe is composed of a heterogeneous population of cells. Only about 45% of the cells of corpora lutea during the mid luteal phase of the oestrous cycle are capable of producing steroids. In populations of small and large luteal cells, the small steroidogenic cells are highly responsive to gonadotropins while the large cells are relatively unresponsive to gonadotropins but contain most of the binding sites for PGE2 (stimulatory effect on luteal cell function) and PGF2a (inhibitory effect on luteal cell function). PGE1 and PGE2 appear to be blood-borne antiluteolysins that are delivered locally to prevent the actions of PGF2a during early pregnancy (Silvia & Niswender, 1984). The PGE:PGF2a ratio in the uterine vein is 12:1 at mid gestation. Administration of PGF2a increases the placental secretion of oestradiol-17B which is followed by increases in PGE secretion. Oestradiol-17B and PGE may protect placental secretion of progesterone from PGF2a. PGF2a given at mid gestation causes the corpus luteum to regress but does not affect placental progesterone secretion and fails to terminate

pregnancy in the presence or absence of the ovary. (Weems, Vincent & Weems, 1992).

During early pregnancy, a specific class of interferon (omega interferon) is released from the developing embryo in sheep which inhibits pulsatile release of uterine PGF2a (Jenkin, 1992). Studies in ovariectomised, steroid treated ewes indicate that conceptus secretory proteins inhibit the pulsatile secretion of PGF2a directly via an effect on PG-synthesis and indirectly by maintaining a plasma progesterone concentration that inhibits the development of endometrial oxytocin receptors, which normally increase at the time of luteolysis. As pregnancy progresses, there is an increase in basal secretion of PGF2a and PGE from the uterus into the fetal and maternal circulation. The release of maternal PGF2a, but not PGE, in response to oxytocin is also increased in late pregnancy. Endometrial oxytocin receptor concentrations follow a similar pattern, except at parturition, when there appears to be down-regulation of oxytocin receptors. However, release of PGF2a in response to oxytocin remains high at this time, and is further increased if progesterone receptors are blocked. Although oxytocin concentrations in maternal and fetal plasma are not increased until parturition, uterine oxytocin receptor concentrations, uterine activity and maternal PGF2a release in response to oxytocin are high in late pregnancy (Jenkin, 1992).

Under normal cyclic conditions, luteolysis in the ewe is induced by the uterine secretion of PGF2a which begins on day 12 post-oestrus. In order for pregnancy to be maintained therefore, the corpus luteum must continue to secrete progesterone through the first 50 days of gestation. The embryo must be present in the uterus on days 12 to 13 if the corpus luteum is to persist beyond day 14. This is a critical period for the corpus luteum during which luteolysis is either initiated or prevented. Because the presence of an embryo in the uterus does not appear to reduce secretion of PGF2a during the critical period, luteal maintenance must be due either to an insensitivity of the corpus luteum to PGF2a or to an inactivation of PGF2a before it reaches the corpus luteum (Silvia & Niswender, 1984).

6.2. MATERIAL AND METHODS

6.2.1. Experimental animals

Refer Paragraph 4.2.1

6.2.2 General management

Refer Paragraph 4.2.2

All male material were housed in singular pens distant from the ewes.

6.2.3 Treatments

Refer Paragraph 4.2.3

One pair of pregnant ewes coming from each of the original
Groups A1 - A4 were selected at random to represent a specific
month of pregnancy (X1 - X4) (Table 10.1). Each pair of
ewes were consecutively, according to the month of gestation
they represent, injected i.m. with 1 ml PGF2a (5 mg Dinoprost
tromethamine) on days 30, 60, 90, and 120 of gestation
respectively. Blood samples were collected every 12 hours from
treatment for three days and then once daily until abortion
occurred, or alternatively for 10 days following treatment.
Since no abortions occurred during the first trial, it was
supplemented by a second trial to test for PGF2a sensitivity:

12 Damara ewes were devided into three groups of 4 ewes each
viz. Group A representing day 30, Group B representing day 60
and Group C representing day 90 of the gestation period
(Table 10.1). All ewes were synchronised with the aid of
progestagen pessaries which were left in tact for a period of
12 days. On sponge removal each ewe was treated intramuscularly
with 300 units of PMSG while each group was exposed to a
fertile ram for a period of 7 days. After this period expired,
the rams were removed for a period of 7 days after which they
were again introduced for another period of 7 days. During the

second introduction the rams were fitted with raddling blocks and interchanged between groups. Since no ewes were marked during the second introduction, it was accepted that all ewes conceived during the first introduction of the rams. Each group of 4 ewes was again subdivided into two groups of 2 ewes as follows:

Group A (30 days): A1 and A2

Group B (60 days): B1 and B2

Group C (90 days): C1 and C2

Groups A1, B1 and C1 were treated with 1 ml PGF2a and Groups A2, B2 and C2 treated with 2 ml PGF2a on days 30, 60 and 90 of the gestation period respectively.

6.2.4 Progesterone assays

Refer Paragraph 4.2.4

6.3 RESULTS AND DISCUSSION

6.3.1 Length of the gestation period and progesterone levels during pregnancy

In the current investigation the gestation period ranged between 147 and 153 days according to data displayed in Figure 6.1. Two ewes, representing each group, gave birth to twins with gestation periods of 149 and 150 days which does not
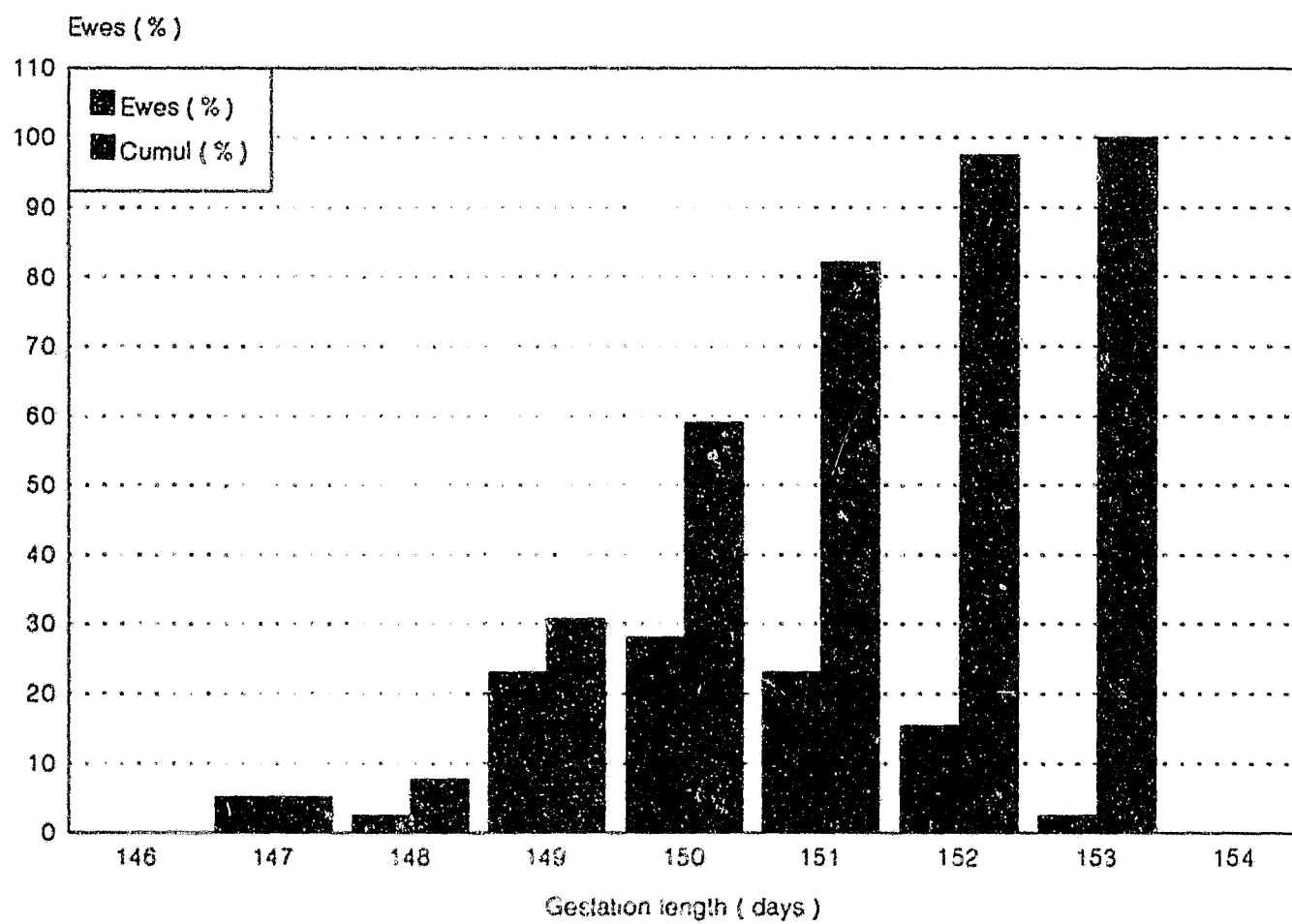
Ewes (%)

FIGURE 8.1 Distribution of the gestation length of Damara ewes

differ considerably from the average duration of 150.18 ± 1.37 days.

The graphical presentation of serum progesterone concentrations (Figures 6.2 and 6.3) displayed a characteristic decline in concentration levels towards oestrus where the lowest serum levels of progesterone were represented by an average concentration of less than 1 ng/ml at insemination for both groups. This decline was followed by a sharp peak with an average concentration of 1.747 ± 0.350 ng/ml, another decline with a lowest average of less than 1 ng/ml, which was again followed by a second somewhat more pronounced peak with an average concentration of 3.693 ± 0.466 ng/ml approximately 11 days post oestrus. This result seems to correlate with the statement made by Silvia et al. (1984) with regard the inducement of luteolysis by the uterine secretion of PGF2a which begins on day 12 post oestrus and that the conceptus must be present in the uterus on days 12 and 13 if the corpus luteum is to persist beyond day 14.

In accordance with Stabenfeldt, Drost & Franti (1972), sequential to the second peak described above, the concentration levels seem to settle down to a gradual increase as gestation proceeds, eventually reaching average levels of 8.635 ± 2.205 ng/ml before descending rather quickly to basal levels at parturition.
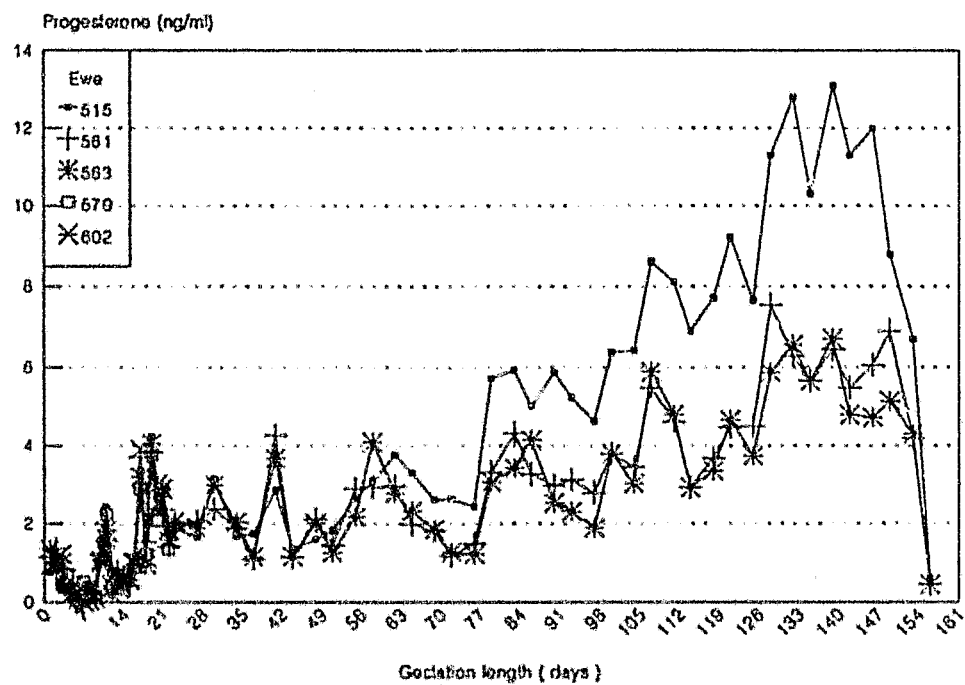
FIGURE 6 2 Serum progesterone concentrations during the gestation period
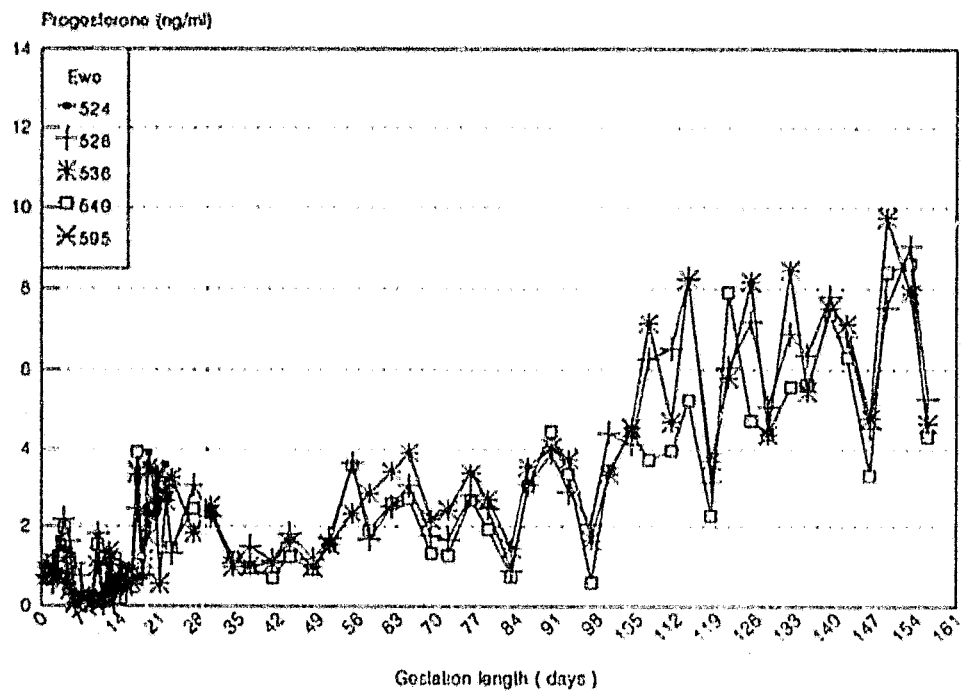
FIGURE 6 3 Serum progesterone concentrations during the gestation period

Stabenfeldt *et al.* (1972) found that progesterone levels
increased from about 3 ng/ml at day 55 to approximately 9.5
ng/ml at day 125 (week 18) in single pregnancies and from
about 3 ng/ml at day 75 to about 15.5 ng/ml at day 130 (week
19) in twin pregnancies. In both cases (single and twin
pregnancies) progesterone levels decreased over the last two
weeks of gestation and converged at the day of parturition.
Levels decreased from about 4 ng/ml to about 2 ng/ml during the
last 12 hours before labour. A further final withdrawal to 0.8
ng/ml usually occurred within 30 to 45 minutes after delivery
and levels in general remained low during the following 48 hour
period. The possibility that the placenta could be a source of
progesterone during the latter part of pregnancy, is supported
by results from cannulating the ovarian and uterine veins in
pregnant sheep which indicated that uterine secretion of
progesterone is approximately 5 times greater than the ovarian
contribution during this period. Progesterone levels reached a
peak at approximately 125 to 130 days of gestation. Thereafter
progesterone levels decline until parturition, indicating that
endocrine preparation for delivery begins about 2 weeks prior
to parturition. Levels decline rather sharply during the final
24 hour period of labour.

6.3.2 Sensitivity towards PGF2a during gestation

PGF2a treatment (1 ml containing 5 mg Dinoprost) during
different stages of the gestation period did not lead to any

abortions. According to Weems *et al.* (1992) the conceptus depress the response of the corpus luteum to PGF2a during early pregnancy. PGF2a causes premature luteolysis when given at mid cycle, however, when given at mid gestation, PGF2a causes the corpus luteum to regress but does not affect placental progesterone secretion and fails to terminate pregnancy in the presence or absence of the ovary.

The higher levels of progesterone that Group X4 displayed (Figure 6.4.4), are in accordance with the late stage of pregnancy which this group represented. Figures 6.4.1 to 6.4.4 show that progesterone concentration levels dropped on average for Group X1 from 2.999 ng/ml to 1.487 ng/ml, for Group X2 from 3.445 ng/ml to 1.444 ng/ml, for Group X3 from 3.486 ng/ml to 2.073 ng/ml and for Group X4 from 7.135 ng/ml to 4.842 ng/ml after treatment with PGF2a with an average decline of 1.805 ng/ml. Apart from Group X2 of which the levels maintained a declining tendency towards day 10 after treatment, all other groups showed a recovery within 24 hours. During the supplementary trial (Trial 2), abortions only occurred in Group A2 representing day 30 of pregnancy and treated with 10 mg dinoprost.

Silvia *et al.* (1984) reported that the minimum luteolytic dose of PGF2a defined as the lowest dose of PGF2a that resulted in a significant reduction in the concentration of serum progesterone, is 4mg/58 kg bodyweight. At this dose, corpora
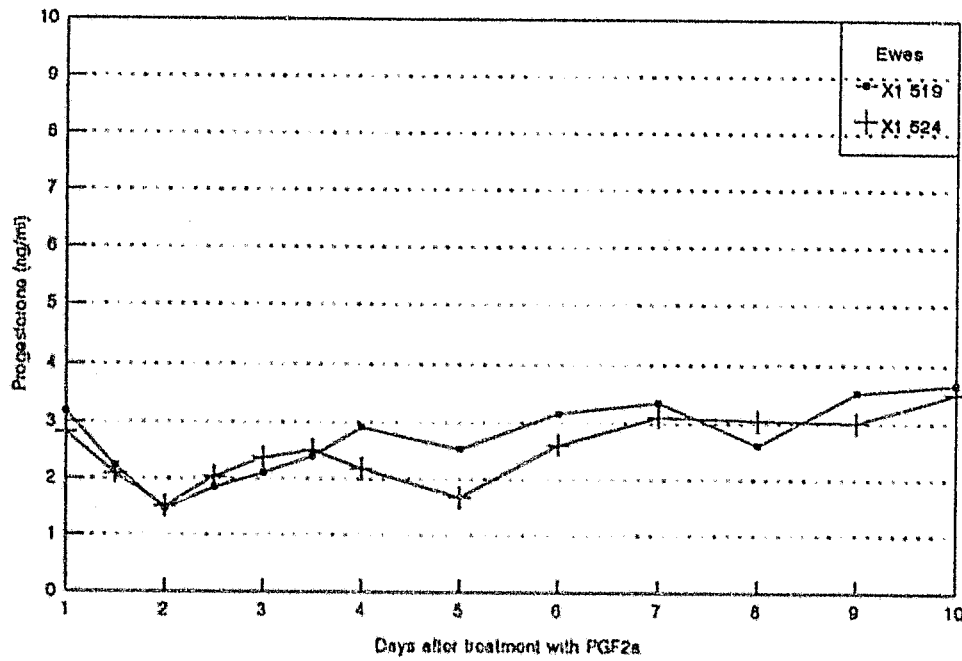
FIGURE 6 4 1 PGF2a sensitivity during the gestation period in Damara ewes
(Day 30)
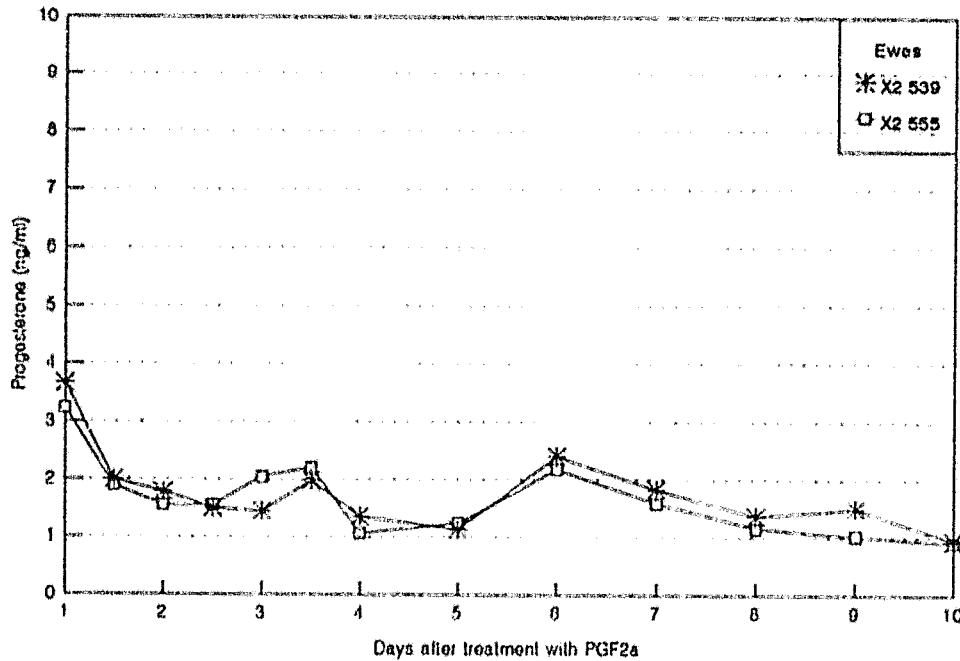
FIGURE 6 4 2 PGF2a sensitivity during the gestation period in Damara ewes
(Day 60)
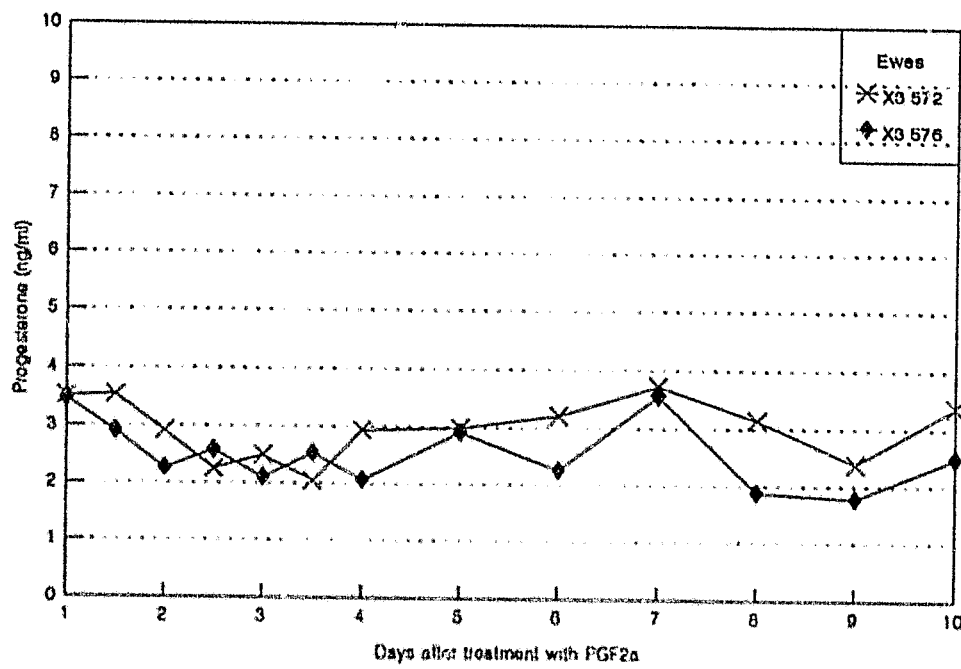
FIGURE 6 4 3 PGF2a sensitivity during the gestation period in Damara ewes
(Day 90)
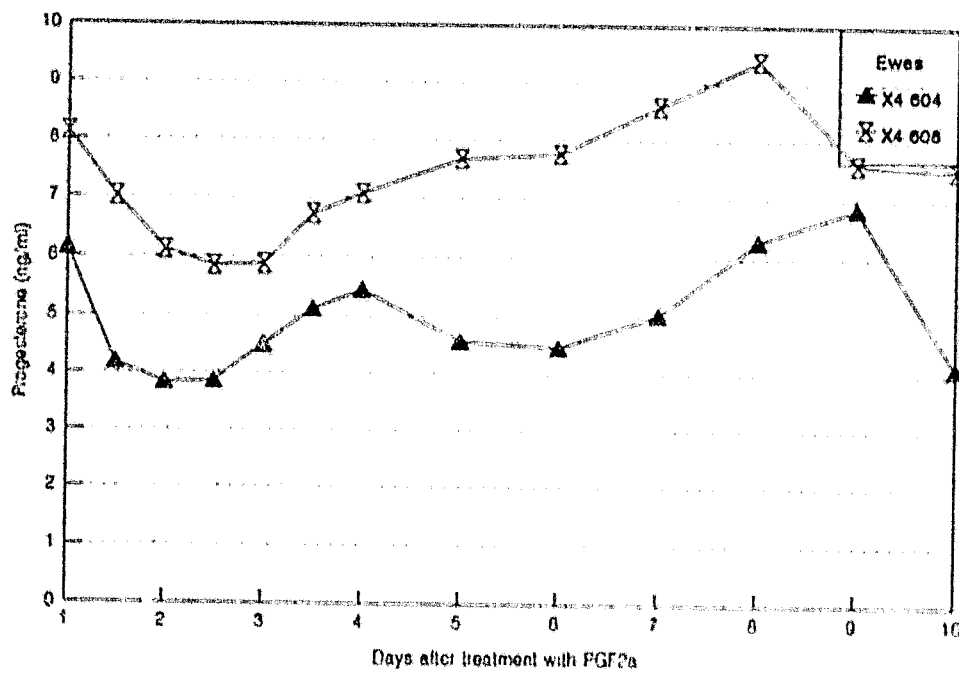
FIGURE 6 4 4 PGF2a sensitivity during the gestation period in Damara ewes
(Day 120)

lutea from five of eight non-pregnant ewes regressed while none
of the corpora lutea from nine pregnant ewes regressed.

Table 6.1   The effect of PGF2a on pregnancy (Trial 2)

Group	Ewe No	Treatment (ml PGF?ʌ)	Observation
Day 30			
A1	72	1 ml	lambed
A1	23	1 ml	lambed
A2	245	2 ml	aborted
A2	228	2 ml	aborted
Day 60			
B1	244	1 ml	lambed
B1	223	1 ml	lambed
B2	31	2 ml	lambed
B2	139	2 ml	lambed
Day 90			
C1	394	1 ml	barren
C1	173	1 ml	barren
C2	213	2 ml	lambed
C2	65	2 ml	lambed

6.4   CONCLUSION

6.4.1   Length of the gestation period

Observations made by Stabenfeldt *et al.* (1972) suggests that
progesterone levels during the first 50 days of pregnancy are
similar in both single and twin pregnancies and correspond to
those found during the luteal phase of the oestrous cycle. This
implies that the corpus luteum is the main source of

progesterone for the maintenance of pregnancy during this period. According to Stabenfeldt et al. (1972) a gradual increase in progesterone concentration begins at about day 55 (week 8) in ewes with twin lambs and approximately day 75 (week 11) in ewes carrying single lambs which is in agreement with the results of the tests under discussion.

6.4.2 Sensitivity towards PGF2a during gestation

In pregnant ewes with one and two corpora lutea, the minimum luteolytic doses of PGF2a are 6 and 10 mg/58 kg body weight respectively (Western range ewes, Colorado). Luteal regression was induced with 6mg/58 kg body weight in three of four pregnant ewes with one corpus luteum, but in none of five ewes with two corpora lutea (Silvia et al. 1984). Since no abortions resulted during the present study from treatment with 5mg PGF2a of pregnant ewes with an average body weight of 45 kg at any stage of pregnancy and no abortions apart from the first month of pregnancy occurred as a result of treatment with 10 mg PGF2a, the resistiveness of the Damara sheep towards PGF2a seems to fall more or less in the same category as quoted by above mentioned authors both with regard dosage per kg bodyweight and stage of pregnancy.

CHAPTER 7

THE POST PARTUM PERIOD OF THE DAMARA EWE AND THE INFLUENCE OF SEASON ON REPRODUCTIVE ACTIVITY

7.1 THE POST PARTUM PERIOD

According to Mandiki, Bister, & Paquay (1993) the lack of ovarian and oestrous activity in the ewe following parturition is one of the most important factors negatively affecting reproductive efficiency. Progestagen impregnated pessaries in association with PMSG and other hormone treatments are successfully used to induce oestrus in non-lactating ewes, but these treatments have limited success when administered less than 30 days after parturition. In the post partum ewe, inhibitory factors such as suckling and uterine involution, work against the reestablishment of ovarian activity and oestrous behavior. High PGF2a release also seems to be involved in the failure to express oestrus in the early post partum period by acting as an inhibiting factor by preventing the reintroduction of the hypothalamo-pituitary functions. Since prolactin secretion is enhanced by pregnancy and/or parturition events and suckling stimuli, high prolactin concentrations are believed to be causally related to the post partum anoestrus. Reduction of prolactin concentrations in lactating ewes by denervating the mammary gland, results in an earlier re-establishment of LH pulsatility and in reducing the interval

between parturition and the onset of oestrus (Mandiki *et al.*, 1993).

Normal reproduction and gestation is not likely to take place within a month post partum even though oestrus can occur within this period (Restall & Starr, 1977). Involution of the uterus takes more or less 30 days to be completed and it appears as if the uterus is one of the determining factors why ewes are not able to conceive within four weeks post partum (Call, Foote, Eckre & Hulet, 1976; Honmode, 1977; Nel & Pretorius, 1968; Wallace, Robinson & Aitken, 1989).

In the ewe the early post partum period in the sheep is characterized by a gradual recovery of ovarian activity, high prolactin levels which decline gradually after the first week, and low basal LH levels which increase gradually. The first ovulations are characterized by a lower oestrogen peak in lactating than in non-lactating animals (Novoa, 1984), lower pre-ovulatory LH peaks and subsequent lower progesterone production by the corpus luteum (Wallace *et al.*, 1989). On day 1 post partum small (1 - 2 mm) follicles can be observed on the ovarian surface, on day 5 medium (2 - 4 mm) follicles and on day 17 larger preovulatory follicles (> 4 mm) can be present (Rubianes & Ungerfeld, 1993).

Management programs for more economical sheep production dictate a need for more than one lamb crop per year. In order

to achieve this, more knowledge of post partum physiology is necessary. Since the Damara breed seems not to be restricted to a particular breeding season, information on first post partum ovulation and behavioral oestrus could assist the breeder in executing management strategies.

7.1.1 Material and methods

7.1.1.1 Experimental animals

Refer Paragraph 4.2.1

7.1.1.2 General management

Refer Paragraph 4.2.2

After the insemination practices were concluded, all groups were moved to roof covered pens with Groups M (AI) and N (natural tupping) each occupying a separate pen. Here the ewes remained for the duration of pregnancy and the post partum period.

7.1.1.3   Treatments

Refer Paragraph 4.2.3

Ewes were tested once daily with vasectomised rams until first oestrus after gestation. Blood samples were collected twice a week from 4 ewes (Group Q: consisted out of 2 ewes from Group N and 2 ewes from Group M) (Table 10.1).

7.1.1.4   Progesterone assays

Refer Paragraph 4.2.4

7.1.2   Results and discussion

The progesterone profiles for Group Q of which blood samples were collected during the post partum period, present peaks on day 59 (ewe 535), day 56 (ewe 570), day 70 (ewe 519) and day 59 (ewe 594) after parturition (day 0) (Figures 7.1.1, 7.1.2, 7.1.3 and 7.1.4). In the present study all ewes were lactating for 90 days post partum. Ewe 535 demonstrated oestrus after the first progesterone peak at 86 days post partum. Ewe 570 also demonstrated oestrus after the first progesterone peak at 67 days post partum. Ewe 519 demonstrated a normal profile which reached above 2 ng/ml progesterone concentration on day 70 in close coherence to first oestrus post partum on day 74. Ewe 594 demonstrated oestrus 50 days after the first
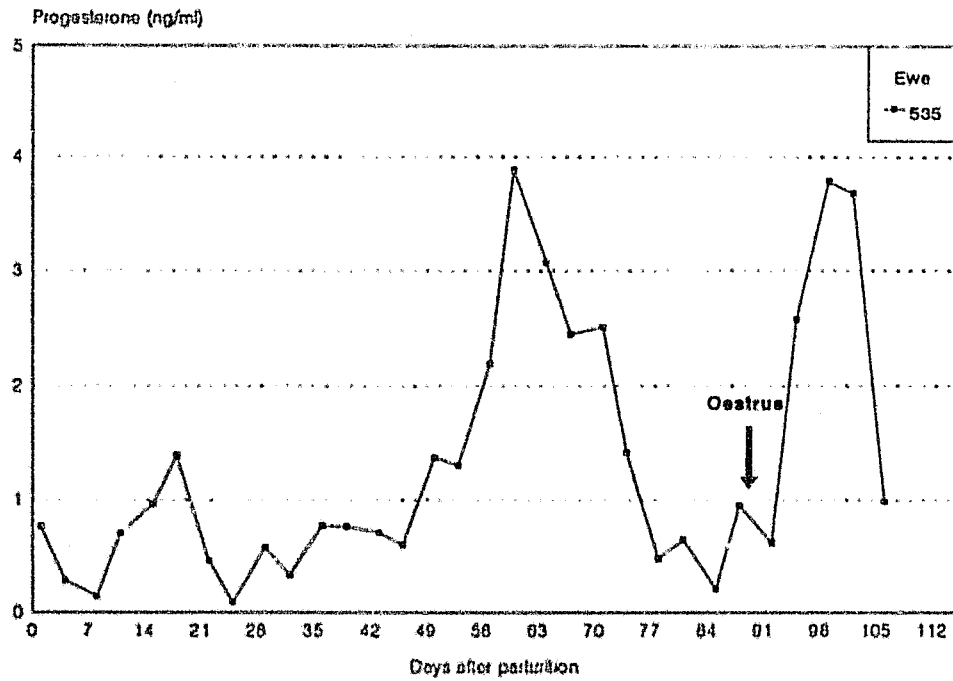
FIGURE 7 1 1 Serum progesterone concentrations representing the post partum period in Damara ewes
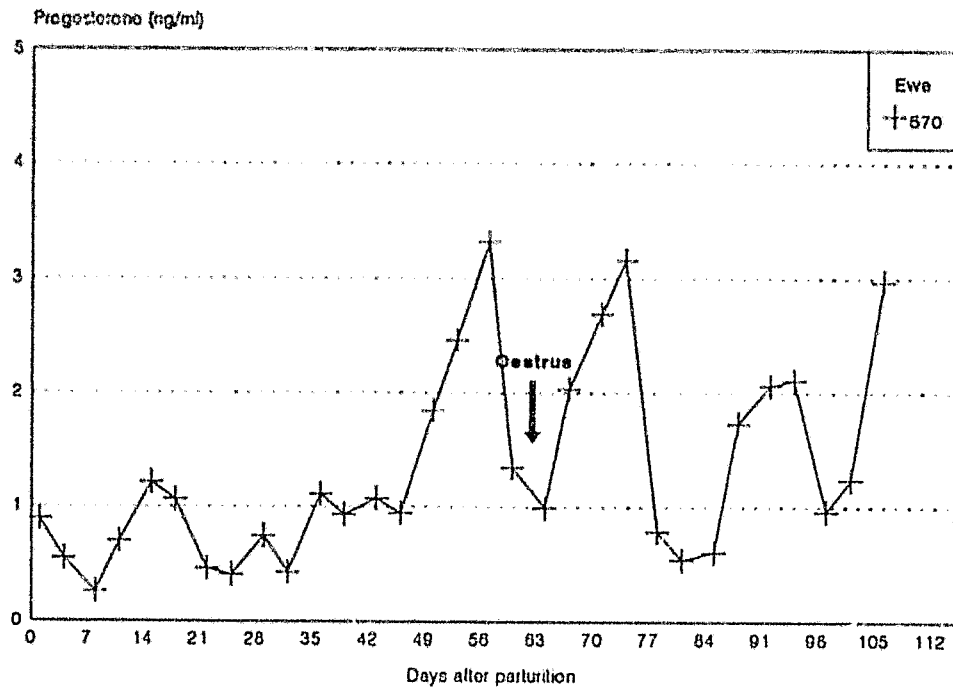
FIGURE 7 1 2 Serum progesterone concentrations representing the post partum period in Damara ewes
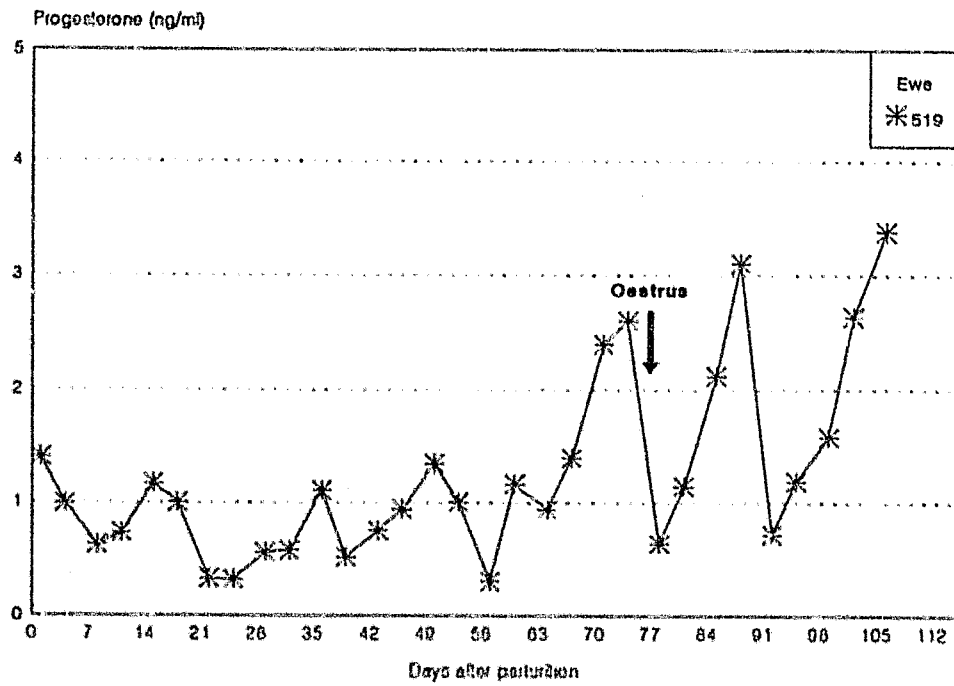
Progesterone (ng/ml)

FIGURE 7 1 3 Serum progesterone concentrations representing the post partum period in Damara ewes
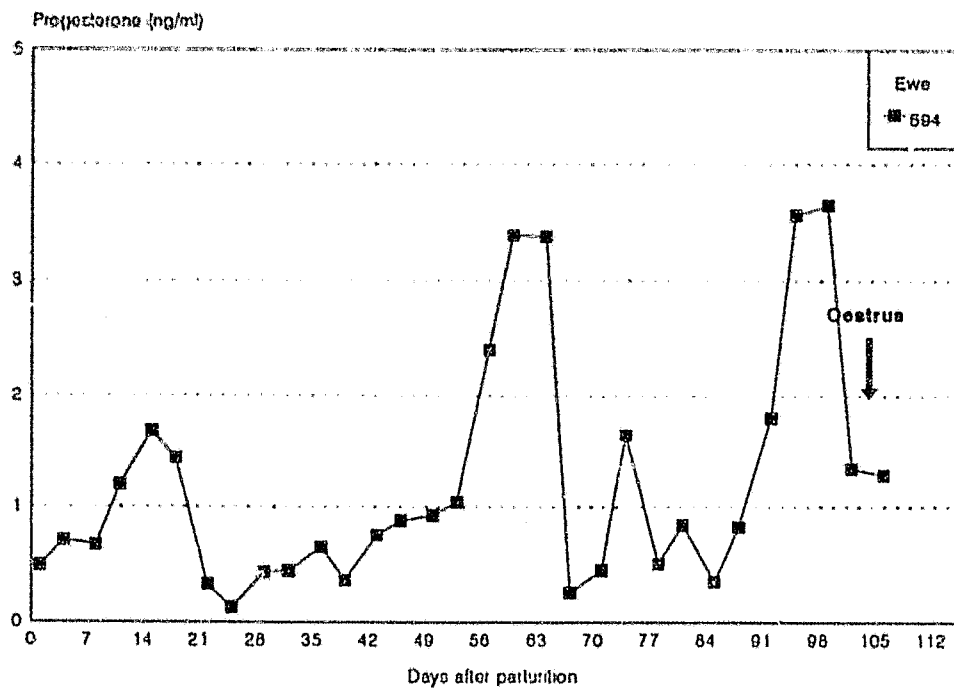
Progesterone (ng/ml)

FIGURE 7 1 4 Serum progesterone concentrations representing the post partum period in Damara ewes

Ewes (%)

Days after parturition
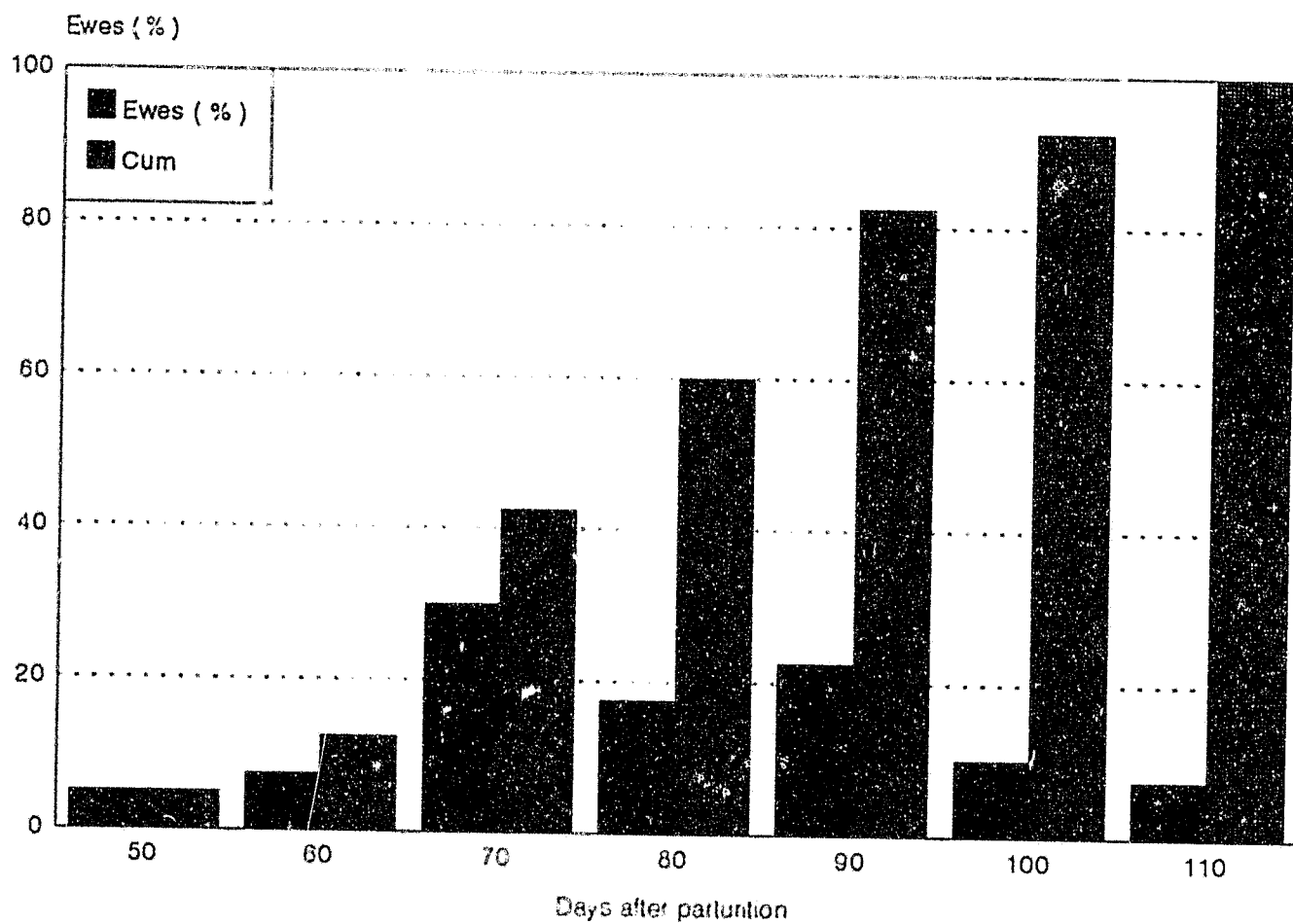
Intervals 46-55 56-65 66-75, 76-85, 86-95; 96-105, 106-115

FIGURE 7.2 Length of the post partum period as measured in the Damara ewe

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progesterone peak at 109 days post partum. The average duration
of the post partum period for Group Q was 84 ± 15.953 days and
for the total experimental group (40 ewes) 79.65 ± 15.791
days. The distribution of ewes as they came on heat during the
post partum period, is presented in Figure 7.2.

7.1.3 Conclusion

Above observations agree with findings by Wallace *et al.*
(1989) who noted lower amplitudes of progesterone secreted by
the corpora lutea resulting from first ovulations post partum,
and the observations by Rubianes *et al.* (1993) with regard
the appearance of follicles on the ovaries at specific times
post partum from which can be deducted that ovulations are
possible at the indicated times viz. at approximately 20 days
post partum. This again corresponds with the findings by
Wallace *et al.* (1989) and Quirke, Stabenfeldt & Bradford
(1983) who noted 22.7 days for Rambouillets and 22.5 days for
Finnish Landrace ewes. Sharpe, Mc Kibbin, Murphy & Manns
(1986) reported 22.3 ± 1.1 days to first ovulation while
Restall *et al.* (1977) noted that winter lambing ewes ovulate
earlier (16.6 days) than spring lambing ewes (24.7 days),
Oestrus is not usually associated with the first ovulation post
partum (Quirke, *et al.*, 1983) while lactation has a delaying
effect on the post partum return to oestrus (Call *et al.*,
1976; Sharpe *et al.*, 1986).

7.2 INFLUENCE OF SEASON ON REPRODUCTIVE ACTIVITY OF THE DAMARA SHEEP

According to Legan et al. (1979) the annual reproductive
cycle of the ewe consists of a breeding and a nonbreeding or
anoestrous season. In most breeds of sheep, the breeding season
begins in late summer and is characterized by successive 17 day
oestrous cycles. The anoestrous season begins in late winter
and is characterized by the absence of regular ovarian cycles.
In its simplest sense, the oestrous cycle may be envisioned as
a sequence of component events, each of which must occur for
successful completion of one cycle as well as for progression
of one cycle to the next. Intervention of any single event in
the sequence would disrupt the cycle. Restoration of this event
would reinstate the cycle. Implicit in this scheme for seasonal
breeding, is that the remaining events need not be disrupted
for cycles to cease. Most of the essential components of the
hypothalamo-hypophysial-ovarian axis remains functional in ewes
during the anoestrous season (Scaramuzzi et al., 1977).
Ovarian follicles develop, produce steroids and are capable of
ovulating; gonadotropic hormones are secreted and both positive
and negative feedback effects of ovarian steroids on
gonadotropin secretion are readily demonstrable. (Martensz,
Baird, Scaramuzzi & Van Look, 1976; Roche, Foster, Karsch, Cook
& Dziuk, 1970; Symons, Cunningham & Saba, 1973;
Yuthasastrakosol, Palmer & Howland, 1975). Nonetheless,
oestrous cycles cease (Legan et al., 1979).

Seasonal anoestrous results from absence of the sustained increase in tonic LH secretion. Each preovulatory oestradiol rise of the breeding season is accompanied by a sustained parallel increase in LH, a relationship which precludes the possibility that oestradiol is a potent inhibitor of tonic LH secretion during the breeding season. Once the last corpus luteum of the breeding season begins to regress, tonic LH secretion would increase, thus stimulating an increase in oestradiol secretion. Unlike in the breeding season, however, the rising titers of oestradiol would feed back and inhibit LH, thereby preventing the occurrence of a sustained 48 hours rise in tonic LH secretion. As a consequence, oestradiol secretion would decrease before attaining threshold for triggering the LH surge, oestrous cycles would cease and a classical negative feedback loop between LH and oestradiol would be established. A necessary corollary to this proposal is that response to the negative feedback action of oestradiol would decrease at the end of the anoestrous season (I' Anson et al., 1988). This would permit sustained, parallel increases in LH and oestradiol secretion and a consequent resumption of oestrous cycles.

The changes in response to oestradiol are dictated by photoperiod (Gibson & Robinson, 1971; Williams & Helliwell, 1993) the major environmental factor governing seasonal breeding in the ewe. In sheep the decreasing photoperiods of late summer are stimulatory and induce onset of the breeding

season. The increasing photoperiods of late winter are
inhibitory and bring about onset of anoestrus (Lax, French,
Chapman, Pope & Casida, 1979; Legan et al., 1979).

There appears to be a transition period before the first full-
length cycle lasting 1 - 4 weeks in most ewes. Brief increments
in progesterone occur just before the first full-length luteal
phase of the breeding season. In most instances, these
increases in progesterone only last one to three days, attain a
maximum of about 1 ng/ml and are associated with structures
which macroscopically resemble corpora lutea. These brief
increments in progesterone during the transition to breeding
season may represent short or full-length luteal phases, which
result from ovulation of immature or mature follicles
(I' Anson et al., 1988).

Sheep indigenous to countries in the temperate zone tend to
have shorter and more marked breeding seasons than those that
have originated near the tropics where ewes may breed
throughout the year (Lax et al., 1979; Yeates, Edey & Hill,
1975). Seasonality in sheep and other mammals involves
profound changes in metabolism, appetite and coat growth as
well as reproductive status. The pineal hormone melatonin
influences all of these changes and acts as an accurate
reflection of the ambient photoperiod. In sheep, exposure to
short daylengths or administration of melatonin significantly
advances the breeding season and appears to enhance ovulation

rate but only after a delay of approximately 60 days. Evidence has accumulated that the photoperiodic history of an animal commences in utero with the foetus being receptive to the maternal melatonin signal from early in gestation. Seasonal breeding is a reproductive strategy which in the wild maximizes the survival of the offspring by timing their birth to the spring when ambient temperature and food supply are increasing (Williams & Helliwell, 1993).

Photoperiod is transduced by the pineal gland into a hormonal signal, melatonin. Evidence from brain implant studies in seasonally breeding rodents showed melatonin to be most effective when administered in or near the medial hypothalamus. A study using brain implants in the highly seasonal Soay ram found melatonin to be most effective when placed in the medial basal hypothalamus. Intrinsic to the action of any hormone is the existence within its target tissue of specific receptor proteins which bind the hormone and elicit a cellular response. The most notable feature of studies done on this subject is the fact that the localization of melatonin receptors is species specific with just two areas of binding being common to most species studied, the suprachiasmatic nucleus and the pars tuberalis of the pituitary. In sheep, apart from a high concentration of binding sites in the pars tuberalis of the pituitary, there is an extensive but less intensive labelling in widespread regions of the brain. During daylight, plasma levels of melatonin are undetectable. With the onset of

darkness levels rise rapidly to reach peak values which are maintained until the end of the subjective night. The melatonin signal, therefore, forms a square wave pattern with elevated levels reflecting the duration of the dark phase. Alteration of the photoperiod modifies the amplitude and duration of the melatonin signal and changes its coincident circadian phase (Williams et al., 1993). The extended duration of the nocturnal secretion of melatonin that occurs in the shortening daylength of autumn is believed to be the stimulus for the onset of the breeding season in sheep. Administration of melatonin orally or via intravaginal pessary or subcutaneous implants when continued for a period of 8 to 10 weeks, results in the early commencement of the breeding season (Donovan, Boland, Roche & O'Callaghan, 1994; Durotoye, Rajkumar, Argo, Nowak, Webley, Mc Neil, Graham & Rodway, 1991).

The purpose of this investigation was to determine the occurrence and duration of sexual activity and the variation in length of the oestrous cycle in Damara ewes. This is to determine the possible influence that successive seasons over a period of one year may have on the sexual receptivity of the Damara breed.

7.2.1 Material and methods

7.2.1.1 Experimental animals

Refer Paragraph 4.2.1

Ten ewes were monitored throughout a period of twelve months to determine their sexual activity by daily exposure to vasectomied rams.

7.2.1.2 General management

Refer Paragraph 4.2.2

7.2.1.3 Treatments

Refer Paragraph 4.2.3

7.2.1.4 Progesterone assays

Refer Paragraph 4.2.4

Blood samples were collected twice weekly.

7.2.2 Results and discussion

Seasonal effect on the reproductive processes of the Damara ewe
was investigated by monitoring the oestrous cycles of 9 ewes
over a period of 12 months commencing during the month of
November. Testing was done on a daily basis with the aid of
vasectomied rams. All ewes displayed regular oestrous cycles
with an average duration of 17.801 ± 0.577 days compared to
16.8 days (Dorset), 16.8 days (Leicester) and 16.2 days
(Suffolk) (Dufour, 1974), 16.1 days (Suffolk), 17.7 days
(Rambouillet), 17.0 (Dorset) and 17.1 (Finn) (Quirke, et
al., 1988), 16.3 ± 0.2 and 17.0 ± 0.3 days (Ottobre, Lewis,
Thayne & Inskeep, 1980) and 18.4 days for Karakul sheep
(Boshoff, 1980) (Figures 7.3.1 to 7.3.9 and Table 7.1.).
Ewe 511 displayed the longest cycle length with an average
duration of 19.0 ± 0.725 days. The majority of the ewes
demonstrated cycle lengths between 17 and 18 days with the
shortest average duration of 17.1 ± 0.538 days (ewe 503). An
average cycle duration of 17.8 days for the Damara ewe renders
a potential 20.5 cycles/ewe/year and 1.71 cycles/ewe/month.
Significant differences in duration of oestrus were found
between ewe 507 and ewe 511; ewe 511 and ewes 504, 335, 458,
510, and 503; ewe 504 and ewes 458 and 503; ewe 335 and ewes
458, 510 and 503; ewe 458 and ewes 500 and 508; ewe 510 and
ewes 500 and 508 and ewe 503 and ewes 500 and 508 ($P < 0.05$).
There is however no significant difference with regard duration
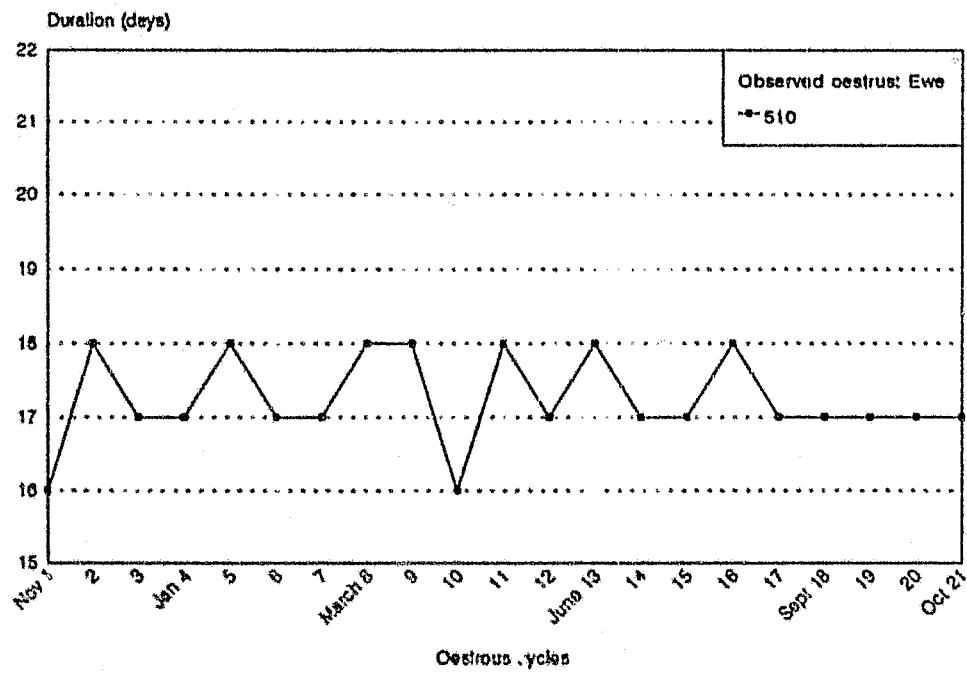
FIGURE 7.3.1 Incidence and duration of the oestrus cycle monitored over a period of 12 months
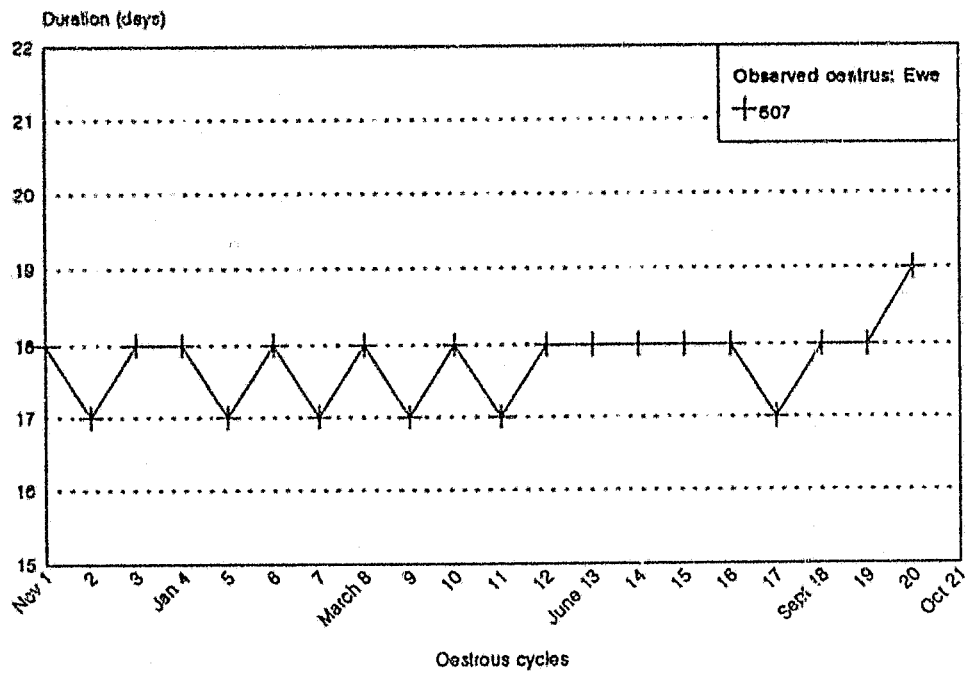
FIGURE 7.3.2 Incidence and duration of the oestrus cycle monitored over a period of 12 months
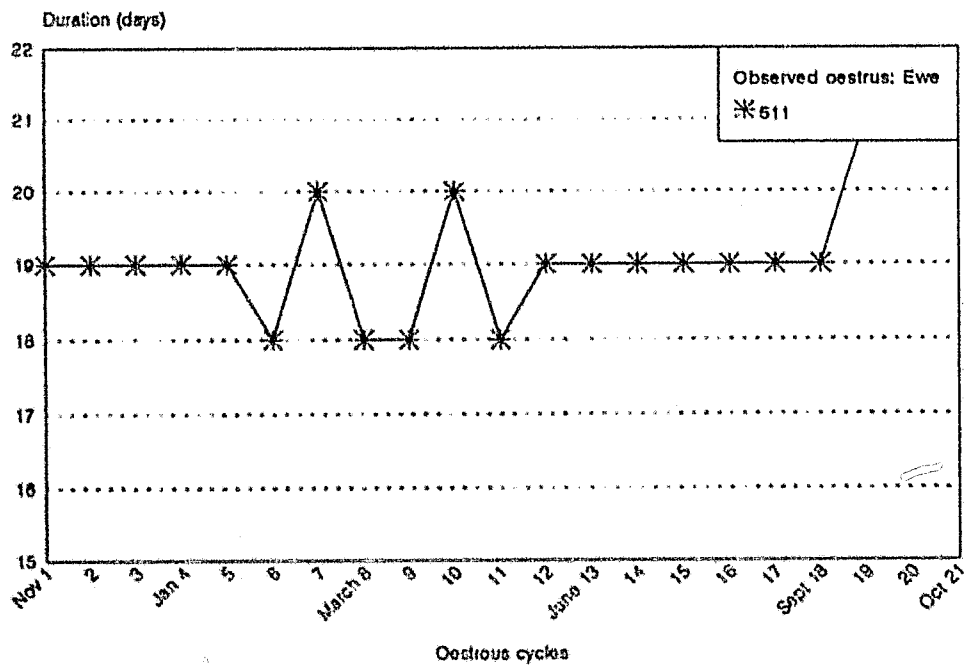
FIGURE 7 3 3 Incidence and duration of the oestrus cycle monitored over a period of 12 months
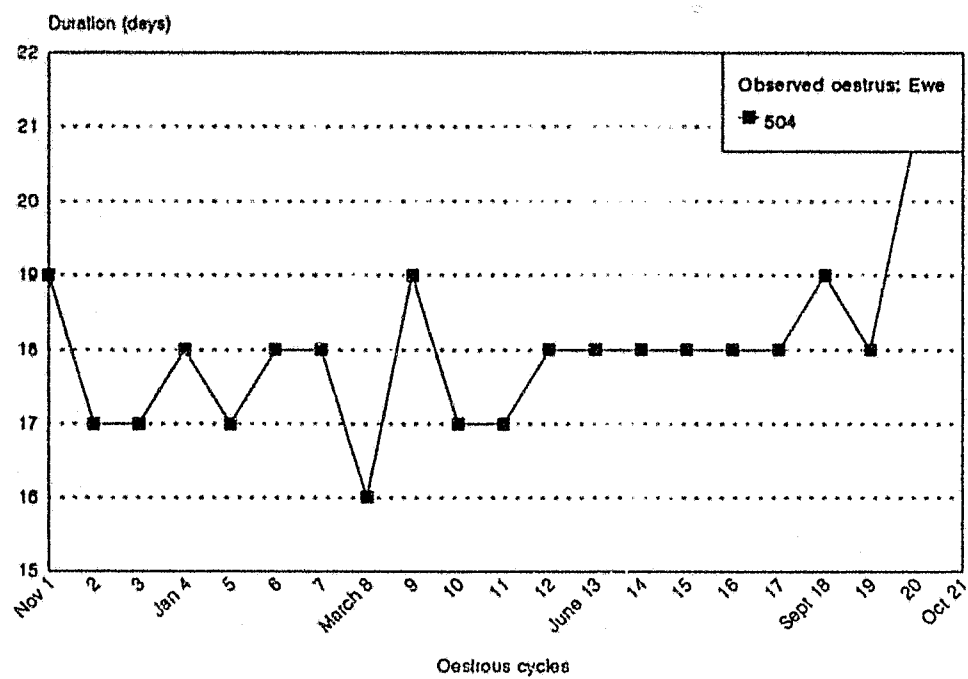
FIGURE 7 3 4 Incidence and duration of the oestrus cycle monitored over a period of 12 months
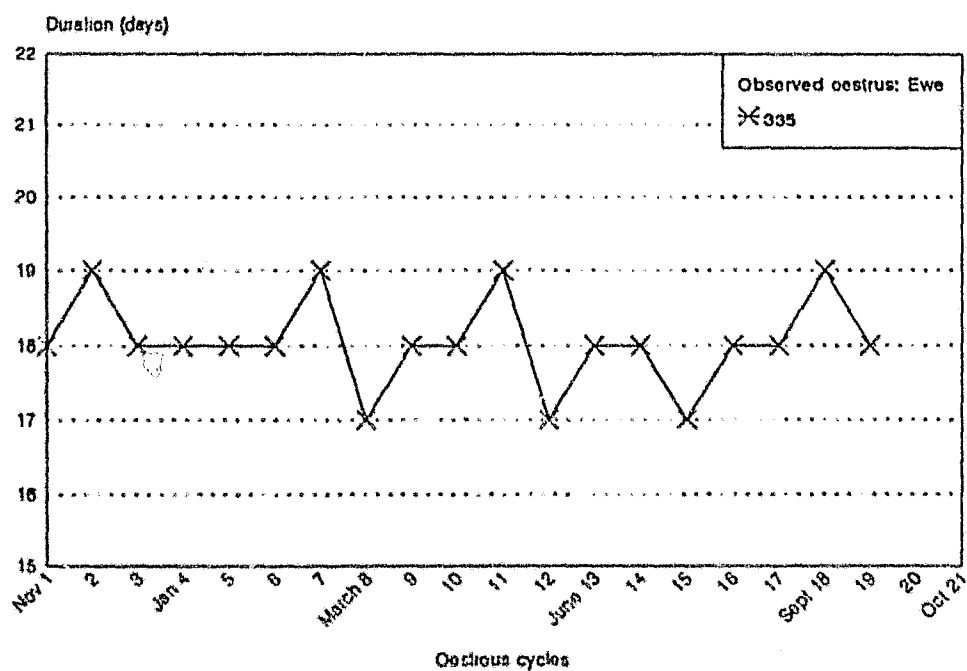
FIGURE 7.3.5 Incidence and duration of the oestrus cycle monitored over a period of 12 months
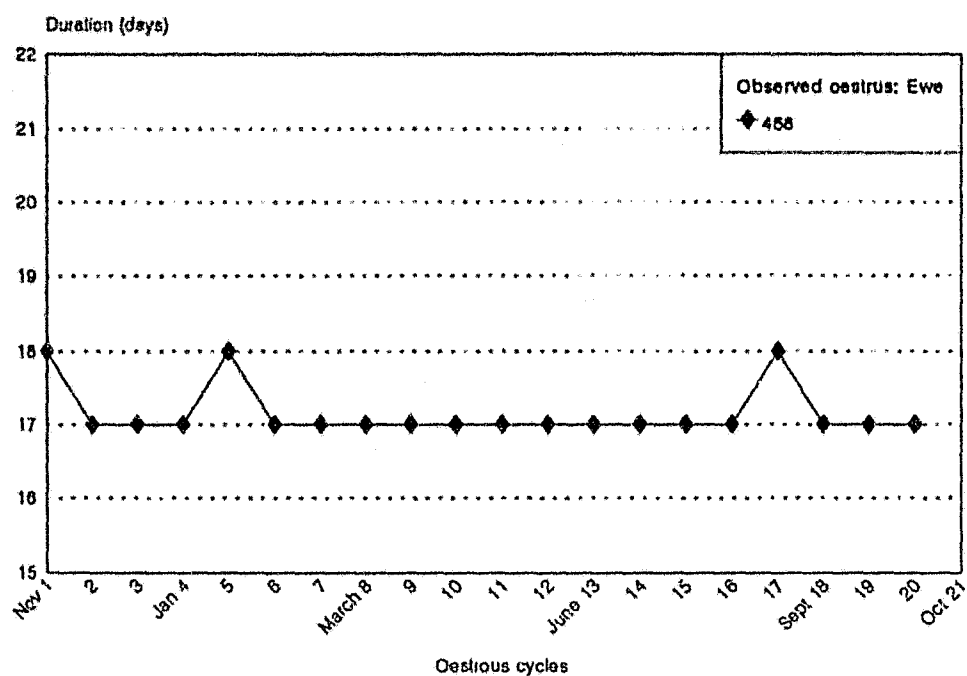
FIGURE 7.3.6 Incidence and duration of the oestrus cycle monitored over a period of 12 months
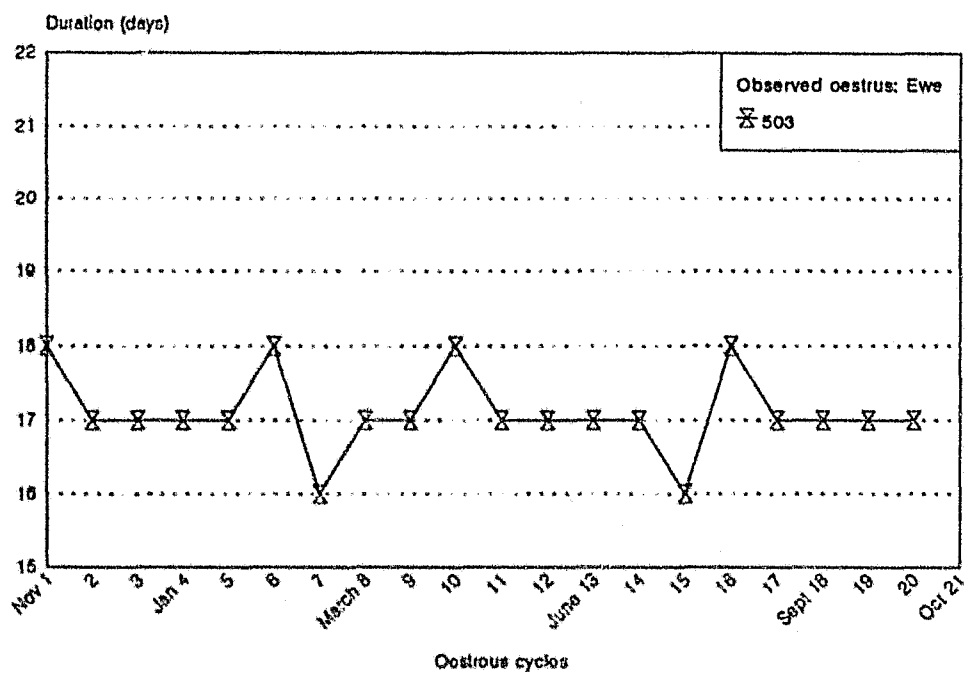
FIGURE 7 3 7 Incidence and duration of the oestrus cycle monitored over a period of 12 months
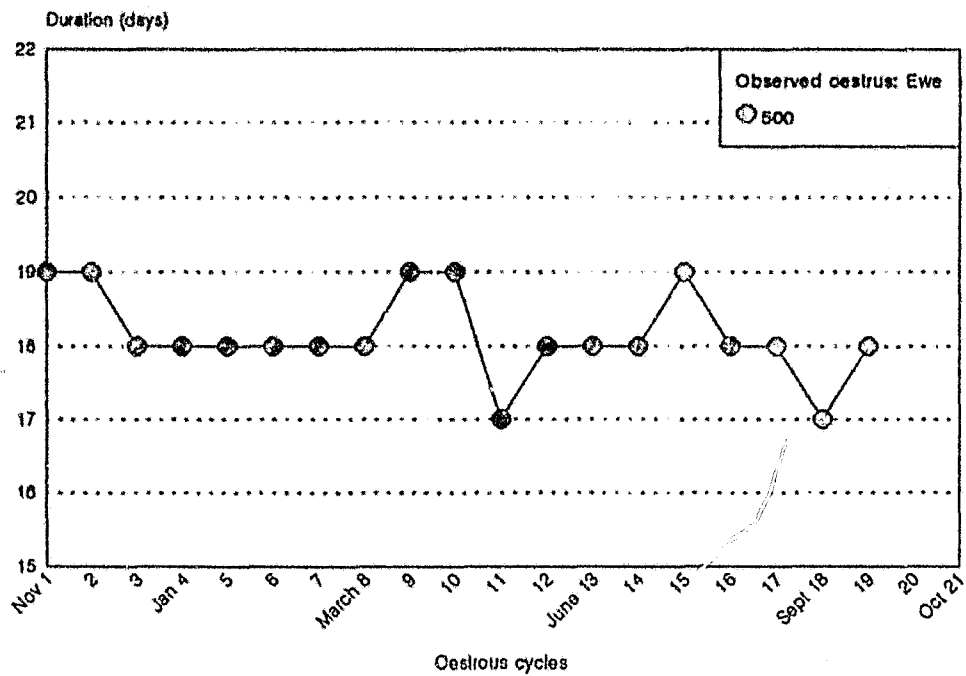
FIGURE 7.3 8 Incidence and duration of the oestrus cycle monitored over a period of 12 months
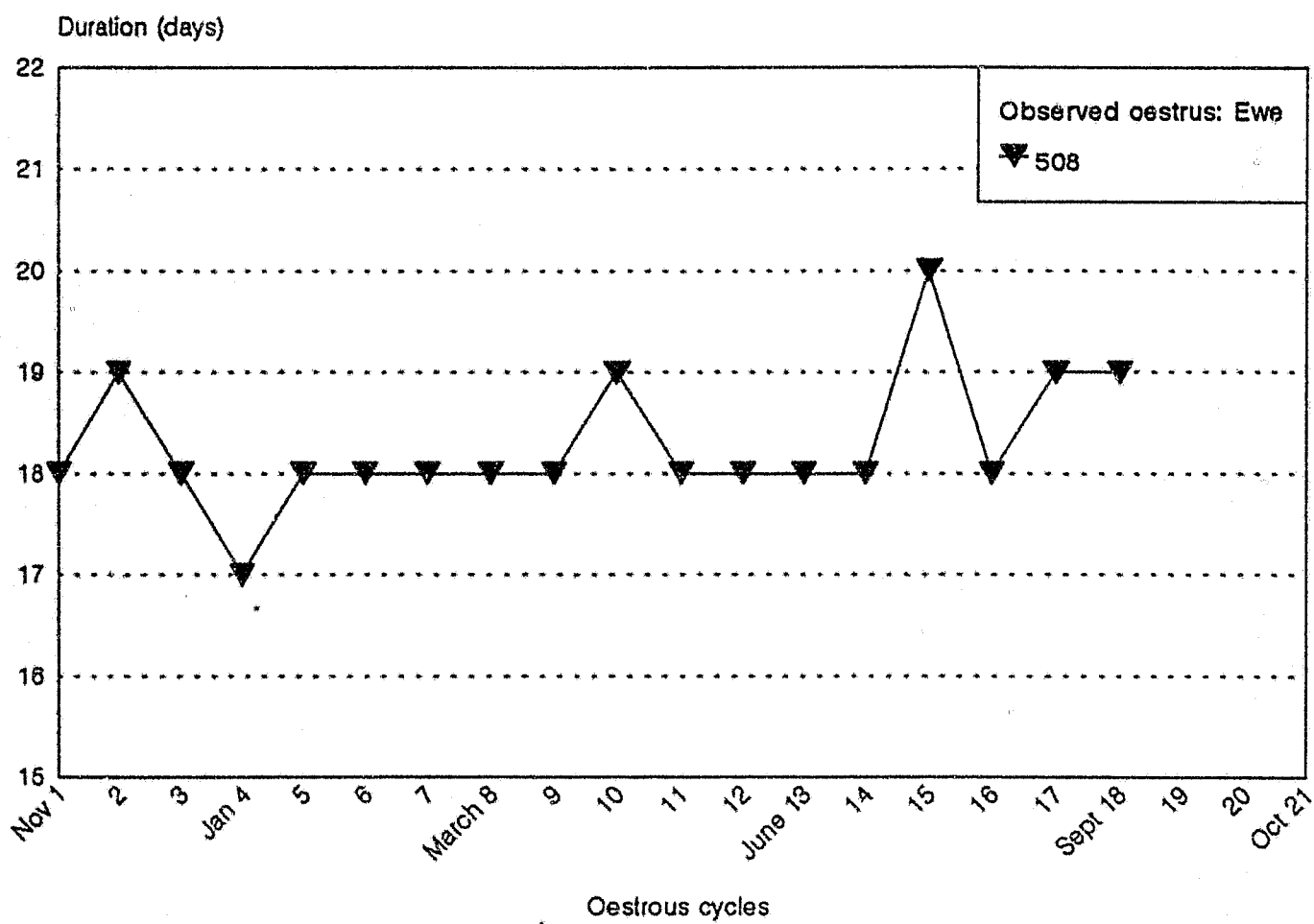
FIGURE 7.3.9 Incidence and duration of the oestrus cycle monitored over a period of 12 months

TABLE 7.1 The incidence and duration of oestrous cycles registered over a period of one year

Months (±)	Cycles	507	511	504	Ewe number 335	458	510	503	500	508
November	1	18	19	19	18	18	18	18	19	18
December	2	17	19	17	19	17	18	17	19	19
	3	18	19	17	18	17	17	17	18	18
January	4	18	19	18	18	17	17	17	18	17
	5	17	19	17	18	18	18	17	18	18
February	6	18	18	18	18	17	17	18	18	18
March	7	17	20	18	19	17	17	16	18	18
	8	18	18	18	17	17	18	17	18	18
April	9	17	18	19	18	17	18	17	19	18
May	10	18	20	17	18	17	16	18	19	19
	11	17	18	17	19	17	18	17	17	18
June	12	18	19	18	17	17	17	17	18	18
	13	18	19	18	18	17	18	17	18	18
July	14	18	19	18	18	17	17	17	18	18
August	15	18	19	18	17	17	17	16	19	20
	16	18	19	18	18	17	18	18	18	18
September	17	17	19	18	18	18	17	17	18	19
	18	18	19	19	19	17	17	17	17	19
October	19	18	21	18	18	17	17	17	18	
November	20	19		21		17	17	17		
Mean (days)		17.75	19.00	17.95	18.05	17.15	17.24	17.10	18.16	18.28

of oestrus during summer (September until February) and winter (March until August) seasons (P > 0.05).

Boshoff, Gouws & Nel (1975) assigned average cycle lengths to different breeds of sheep under extensive conditions very similar to Namibian conditions as follows:

Merino	17.8 days
Karakoel	18.4 days
Dorper	17.3 days
Black-headed Persian	17.4 days
Namaqua-Afrikaner	17.6 days
Damara	17.8 days (present study)

Above mentioned authors found that the reproductive activity measured by the daily incidence of oestrus, occurred all year round in the Namaqua-Afrikaner with the lowest incidence during December. The Black-headed Persian displayed almost the same level of reproductive activity as the Namaqua-Afrikaner while the Merino, and to a lesser degree the Karakoel, displayed the shortest period of reproductive activity of the breeds mentioned. There does not seem to be a significant difference in oestrous cycle length observed in the Damara ewe (17.8 days) compared to cycle lengths quoted in the literature.

Serum progesterone concentration levels revealed a very similar pattern amongst all ewes with a clearly discernible trend towards seasonality. (Figures 7.4.1 - 7.4.9). The mean
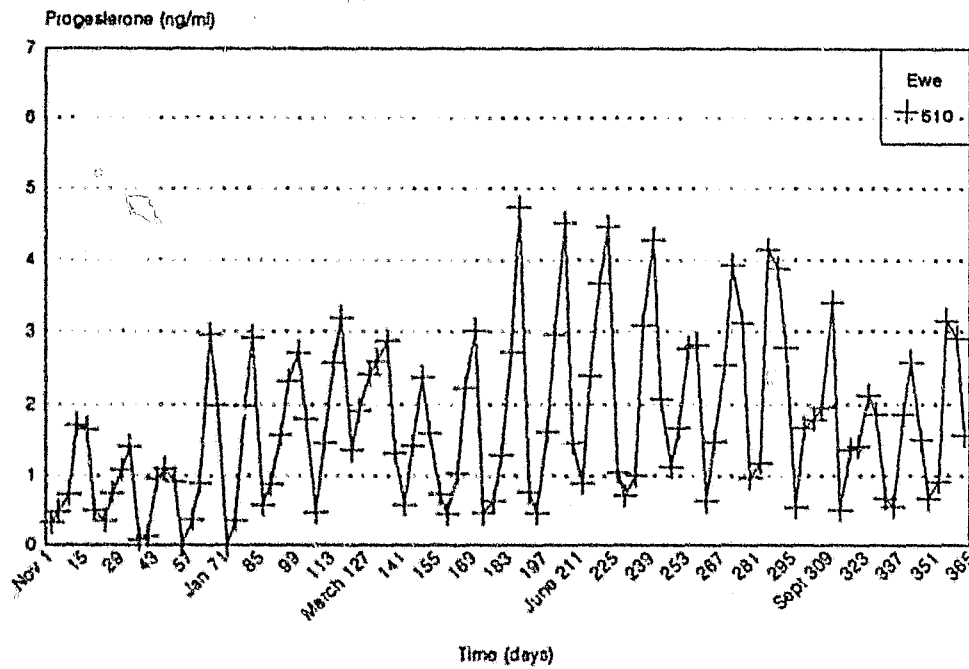
FIGURE 7 4 1   Progesterone concentrations representing cyclic activity over a period of 12 months
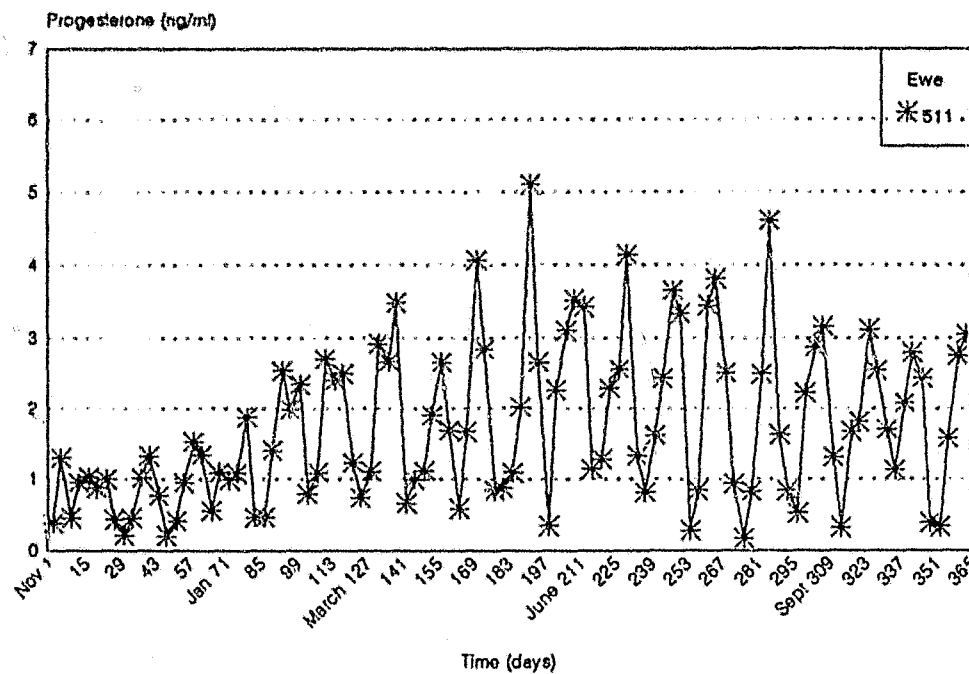
FIGURE 7.4.2   Progesterone concentrations representing cyclic activity over a period of 12 months
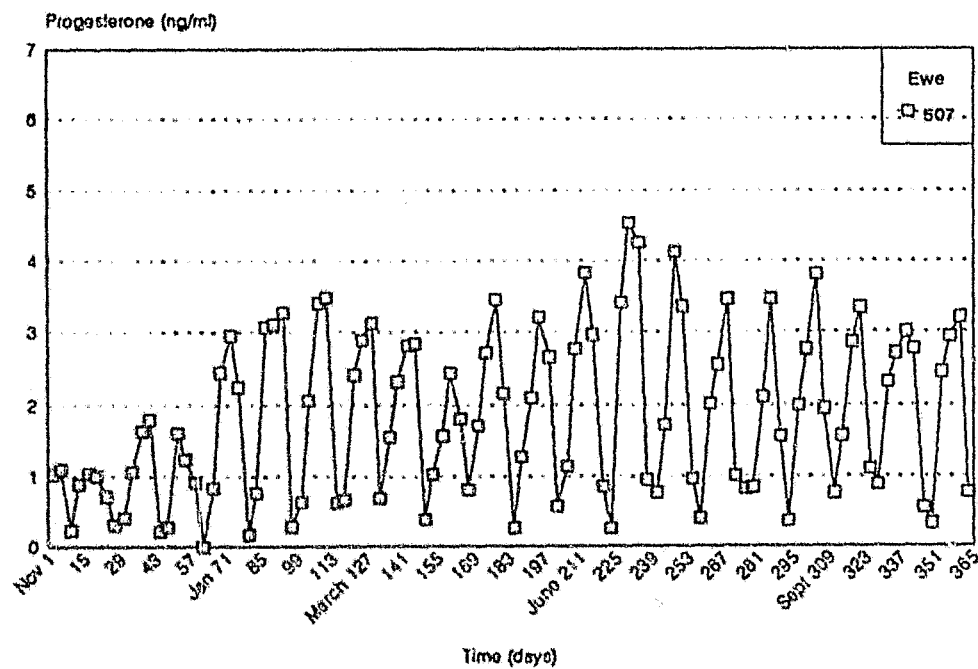
FIGURE 7.4.3 Progesterone concentrations representing cyclic activity over a period of 12 months
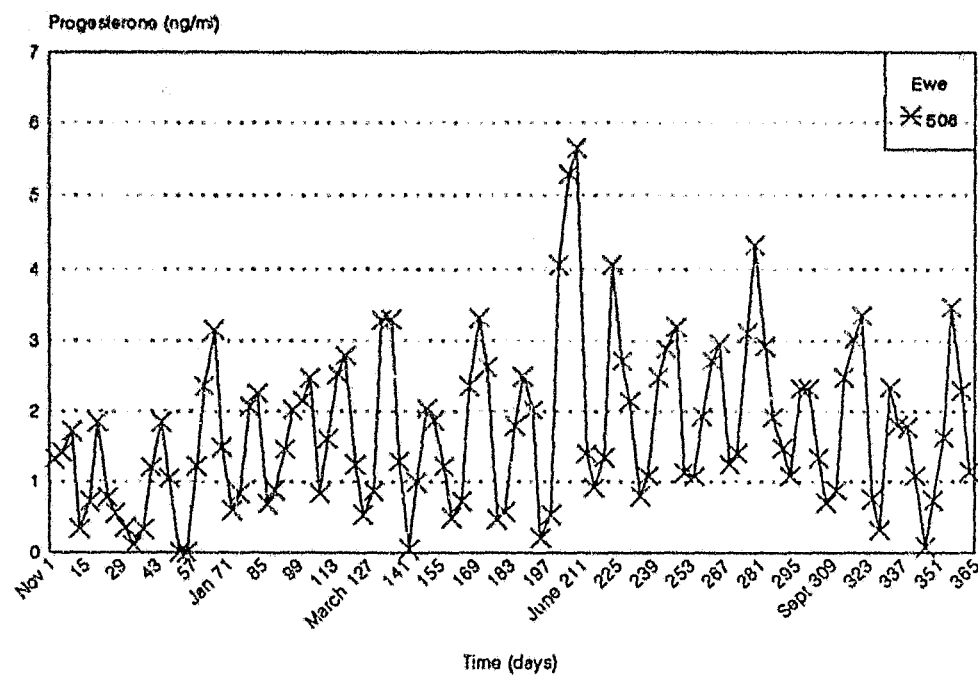
FIGURE 7.4.4 Progesterone concentrations representing cyclic activity over a period of 12 months

FIGURE 7.4.5   Progesterone concentrations representing cyclic activity over a period of 12 months
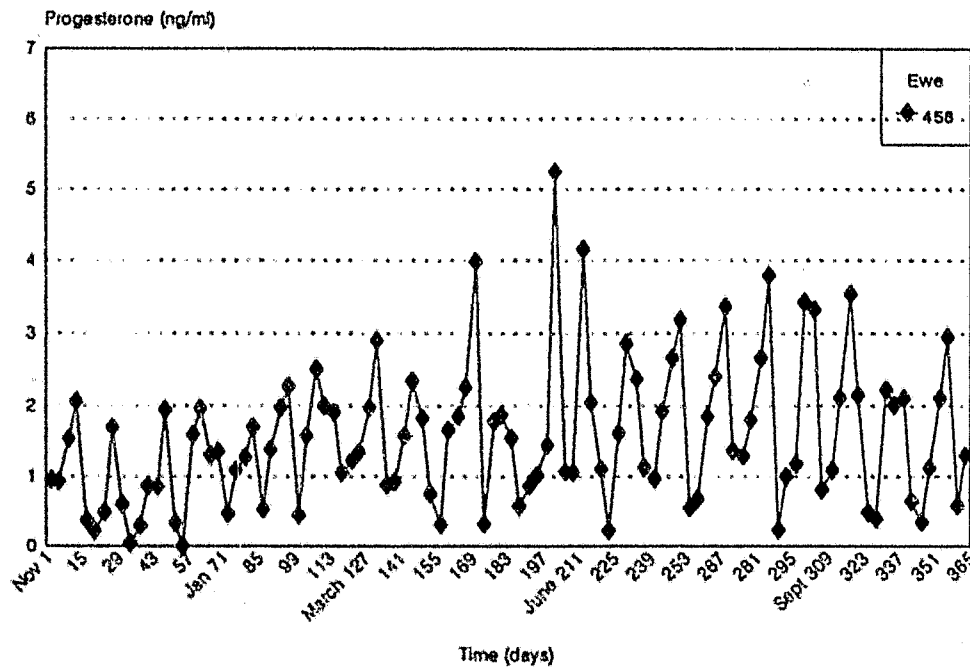
FIGURE 7.4.6   Progesterone concentrations representing cyclic activity over a period of 12 months
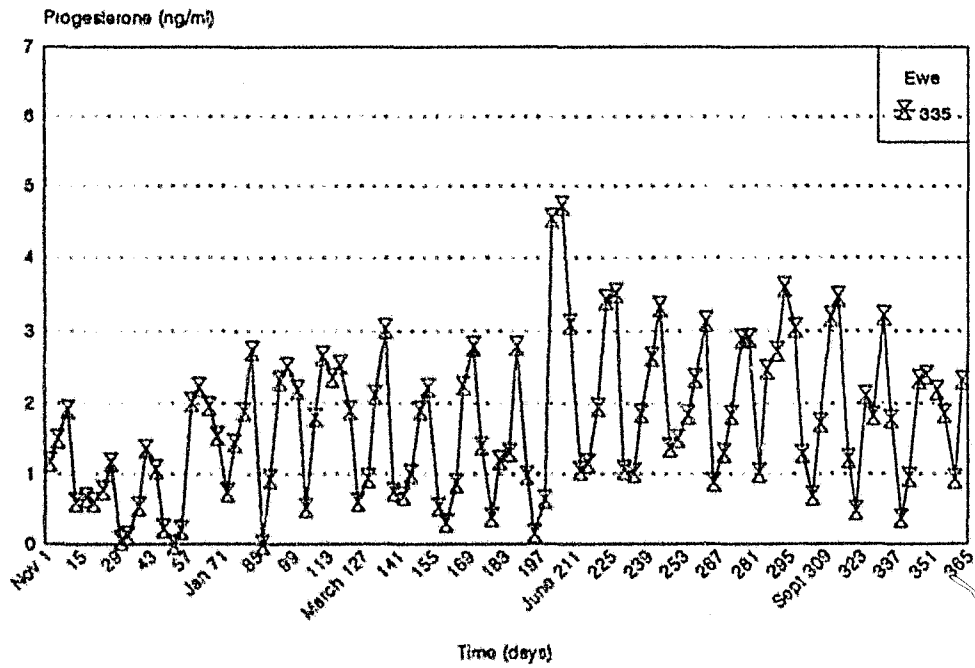
FIGURE 7.4.7   Progesterone concentrations representing cyclic activity over a period of 12 months
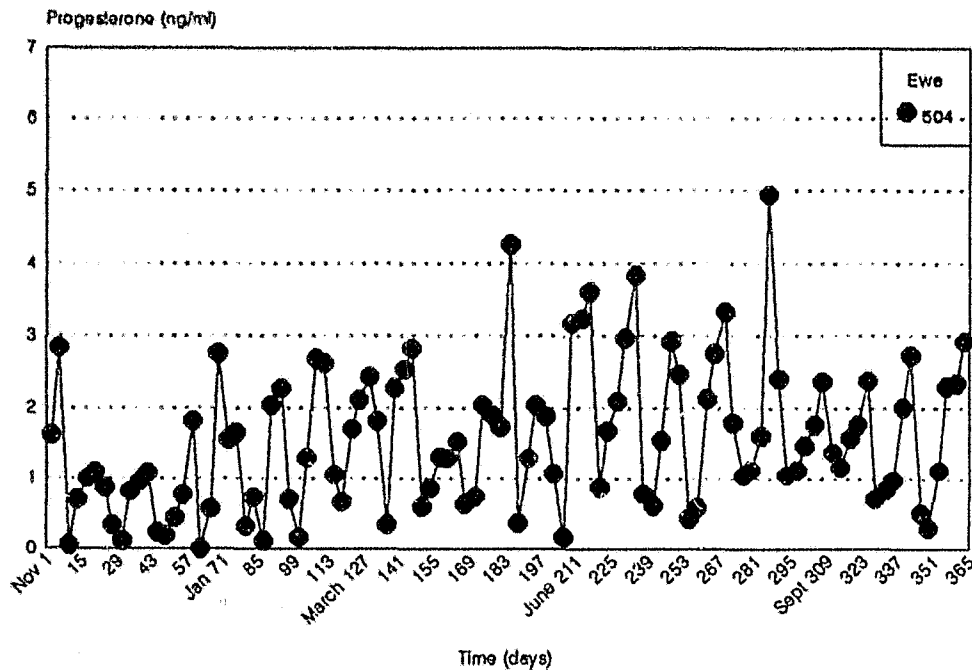
FIGURE 7.4.8   Progesterone concentrations representing cyclic activity over a period of 12 months
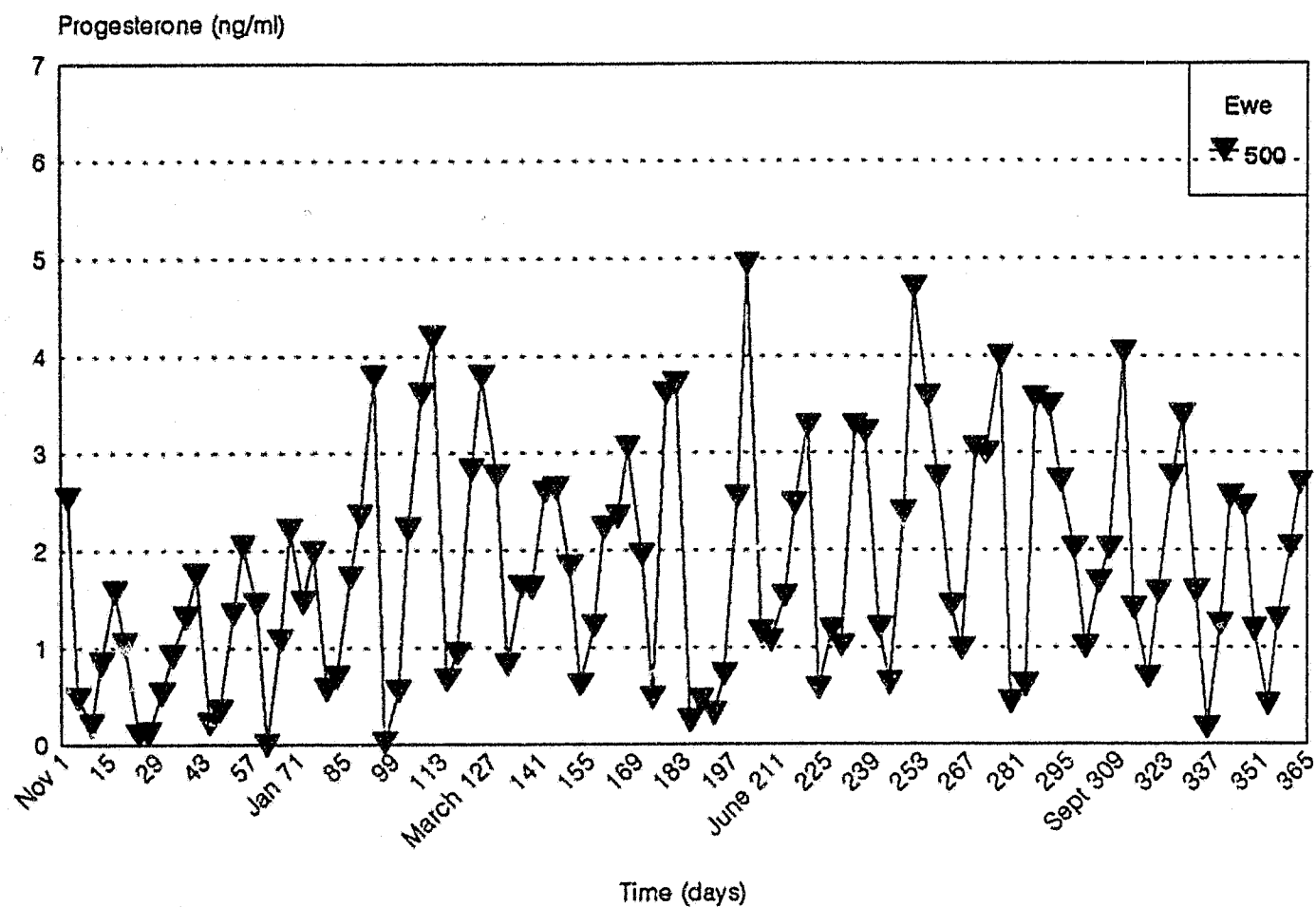
FIGURE 7.4.9   Progesterone concentrations representing cyclic activity over a period of 12 months
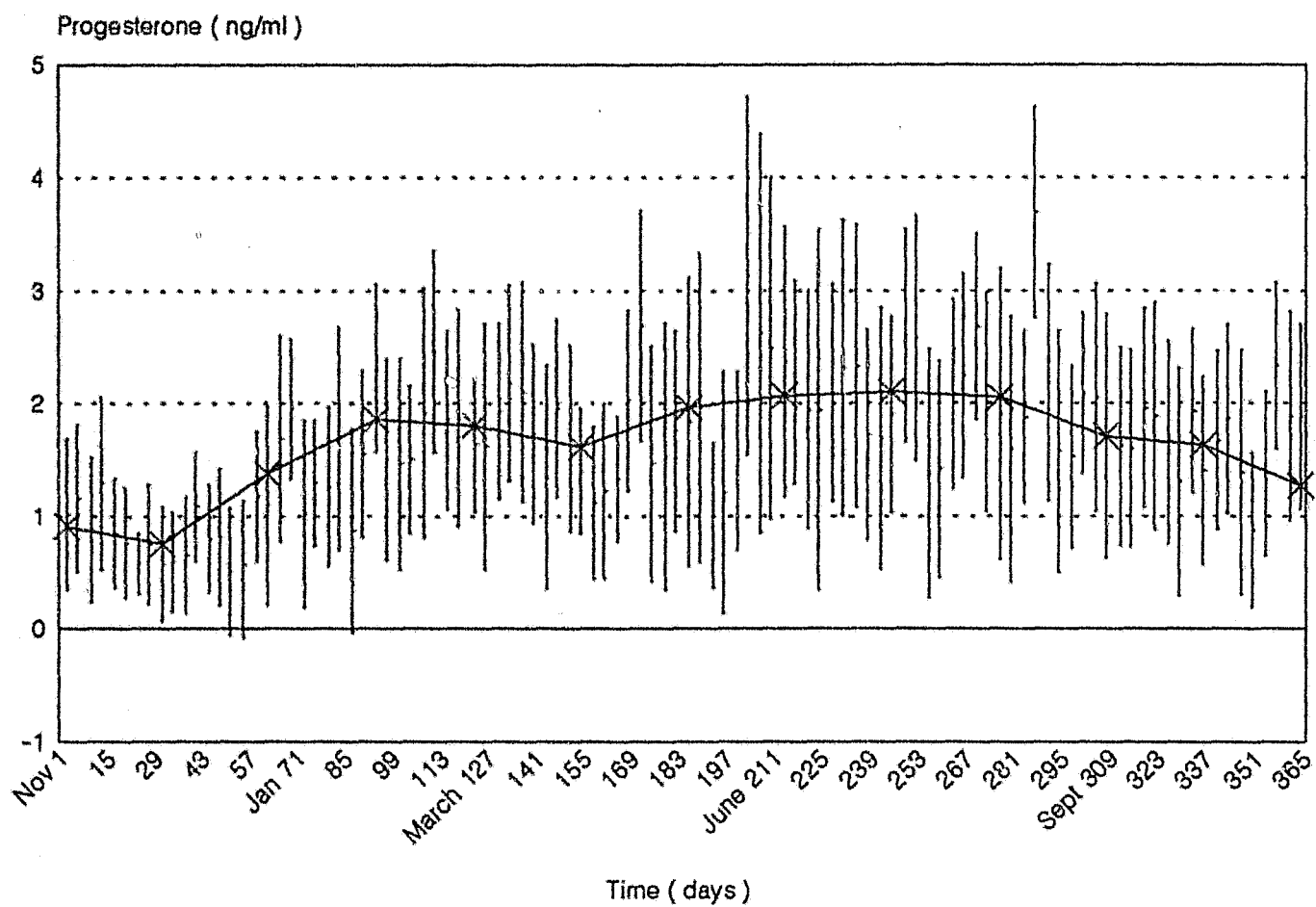
FIGURE 7.5 Mean plasma progesterone concentrations representing the reproductive activity
of 9 Damara ewes over a period of 12 months

values for this data are presented in Figure 7.5 from which the impact of seasonal influence is fairly obvious. Ovarial activity as measured by progesterone concentration is in a relatively subdued state during November (< 1 ng/ml) gradually increasing towards February at which point it levels off at approximately 2 ng/ml where it remains until August. From August the progesterone levels decline toward November.

7.2.3 Conclusion

From the present study it can be concluded that the Damara sheep has a fairly extensive natural breeding season which lasts from approximately February until August, a period of more or less 8 months including both autumn and winter seasons. Dufour (1974) (Dorset 6.9 months, Leicester 5.2 months and Suffolk 4.4 months), Quirke et al. (1988) (Suffolk 156 days, Rambouillet 160 days, Dorset 187 days and Finn 172 days) and El-Wishy, El Sawaf & Fouad (1977) (information based on ovaries from fat-tailed ewes with unknown history collected from an abattoir) describe clearly distinquishable breeding seasons during autumn and winter and non-breeding seasons during spring and summer with the peak of the breeding season during April (southern hemisphere) (Van der Westhuysen et al., 1970).

Even though a tendency toward seasonality in the Damara sheep is implicated by progesterone concentrations as demonstrated,

it would be appropriate to refer to Chapter 4, Paragraph 4.1.2., which describes the outcome of both artificial insemination and natural mating practices which were applied during early December and which coincided with the period when ovarial activity is presumably most subdued. 97.5 % conception was obtained in both instances during the occurrence of one oestrous period. From this a fair assumption can be made that reproduction in the Damara sheep is not meaningfully restricted by season and breeding can occur throughout the year.

CHAPTER 8

THE ATTAINMENT OF PUBERTY IN MALE AND FEMALE DAMARA LAMBS

8.1   FEMALE PUBERTY

A close association exists between general body growth and
sexual development in ewe lambs. Puberty may be delayed or
advanced by varying the plane of nutrition during rearing
(Dyrmundsson, 1973 a). Attainment of a minimum threshold
bodyweight is an important component in the sequence of events
leading to sexual maturity in sheep (Fitzgerald, Michel &
Butler, 1982). Lambs reared on a high plane of nutrition tend
to attain puberty at a lower age and heavier body weight than
those reared on a low plane of nutrition (Fitzgerald & Butler,
1982; Hulet, Wiggens & Ercanbrack, 1969; Southam, Hulet &
Botkin, 1971; Watson & Gamble, 1961). A body weight of more or
less 34 kg can be conducive to oestrus and conception during
the first breeding season after birth in Karakul sheep (Faure,
Morgenthal & Burger, 1987).

It seems however likely that the attainment of puberty in the
ewe is dependent upon a complex brain-pituitary mechanism
regulating the synthesis and release of gonadotropic and
gonadal hormones (Fitzgerald *et al.*, 1982; Foster & Ryan,
1979). Considerable differences exist both between and within
breeds of sheep in age and body weight at first oestrus and

there is general agreement that puberty in the ewe lamb is determined by both genetic and environmental factors (Dyrmundsson, 1973 a).

The occurrence of anovulatory oestrus in puberal sheep is common in the first breeding season of young ewes (Edey, Chu, Kilgour, Smith & Tervit, 1977). It seems evident that two ovarian cycles are necessary to pave the way for first oestrus (Foster, 1981; Huffman, Inskeep & Goodman, 1987;). During the preceding silent cycle, a normal luteal phase occurs in which ovulation is not accompanied by sexual receptivity. The cycle preceding the silent cycle is a brief cycle less than half the length of a normal cycle and which is initiated by an initial LH surge (Berardinelli, Daily, Butcher & Inskeep, 1980; Faure, Minnaar & Morgenthal, 1989; Fitzgerald & Butler, 1982; Foote, Sefidbakht & Madsen, 1970; Quirke, Stabenfeldt & Bradford, 1985).

Puberty in the lamb is a process consisting of a series of developmental events culminating in first oestrus or the final stage of maturation. Mechanisms by which oestradiol controls both the tonic and surge modes of gonadotropin secretion are functionable by 9 - 12 weeks of age. The pattern of basal LH secretion is characterized by marked pulses of LH which are about one tenth the size of the preovulatory surge (Fitzgerald & Butler 1982; Huffman et al., 1987). The frequency of these pulses are variable and remains well below one per hour. This

low frequency coupled with the 20- to 30-minute half-life of circulating LH in sheep permits the LH baseline to decrease to very low levels between each pulse. This causes only transient increases in production of ovarian oestradiol in the immature lamb, much the same as in the seasonally anoestrous adult. These short-lived increases in oestradiol are however not of sufficient magnitude and/or duration to induce a preovulatory surge of LH and hence ovulation. With the onset of puberty, a sustained rise in the LH baseline occurs over a period of a few days. This rise reflects an increase in rate of pulsatile LH discharges to about one per hour which does not allow the LH baseline between pulses to return to the extremely low levels prior to puberty. As a consequence of this, one or more follicles begin to develop. The transient rises in oestradiol becomes transformed into a sustained rise in circulating oestradiol which affects the dormant preovulatory surge mechanism to evoke the first surge of LH (Foster & Ryan, 1979).

In the adult female, photoperiod appears to be the primary stimulus to activate the surge mechanism. It is likely that the pineal gland through its pattern of melatonin secretion serves to transduce photoperiod cues into signals that increase the frequency of the GnRH pulse generator, which in turn initiates the endocrine events leading to puberty in the ewe lamb (Foster, 1984). An increase in the frequency of episodic LH

secretion can be a key event leading to the onset of ovarian
cycles in the lamb (Huffman *et al.*, 1987). Fitzgerald *et al.*
(1982) proposed that a small transient rise in progesterone
of 4 - 7 days duration (Berardinelli *et al.*, 1980; Robinson,
1954) which is observed prior to ovulation appears to provide
a stimulus for oestrus and ovulation after other determinants
(body weight, season, age) have been obtained. Lambs born
early during the lambing season tend to obtain puberty at
higher ages than lambs born later which on the other hand, may
fail to attain puberty during the subsequent breeding season
(ewe lambs not reaching the age of 180 days) (Dyrmundsson,
1973 a; Dufour, 1975; Fitzgerald *et al.*, 1982).

The aim of this investigation is to obtain information related
to the attainment of puberty in the Damara ewe lamb and to
ascertain whether the ram effect will have an influence on the
occurrence of puberty. The observations with regard standing
oestrus will be substantiated by serum progesterone
concentrations.

8.1.1 Material and methods

8.1.1.1 Experimental animals

30 ewe lambs were relocated at weaning (90 to 100 days) from
Omatjenne Experimental Farm to Neudamm Agricultural College for
the purpose of this investigation.

8.1.1.2 General Management

Refer Paragraph 4.2.2

30 Ewe lambs were randomly divided into 3 treatment groups of
10 ewes each (Table 10.1):

Group X: control group

Group Y: tease once daily

Group Z: teaser ram present on a continuous basis

Group Y was housed in conditions as described in Paragraph
4.2.2 while Group Z was accommodated in a roofed shed with open
sides distant from Group Y in the constant presence of a
vasectomied ram, all other factors remaining constant. Group X
was kept separately and as isolated as possible from external
influences.

8.1.1.3 Treatments

The 30 ewe lambs were subject to a diet similar to the one
described in Paragraph 4.2.3. Each lamb was provided with an
eartag for identification purposes.

Group Y was teased once daily during the morning while Group Z
was monitored on a regular basis. Group X were isolated from

contact with males as far as circumstances permitted to rule out the possible influence the opposite sex may exercise on the attainment of puberty (Dyrmundsson, 1973a).

Blood samples were taken twice weekly from all ewe lambs from the age of 6 months until manifestation of first oestrus. All lambs were weighed once a week. At the conclusion of the test period (age 12 months), all ewes from Groups Y and Z which did not show oestrus, including all ewes in Group X were treated with progestagen pessaries for a period of 14 days after which they were monitored for oestrus twice daily for a period of 21 days.

First oestrus was accepted as positive indication of puberty in Groups Y and Z. The progesterone profiles of the members of Group X were used as indicators of pregnancy for that group (Figures 8.1.1 - 8.1.10).

8.1.1.4 Progesterone assays

Refer Paragraph 4.2.4

8.1.2 Results and discussion

The ewe lambs which took part in the investigation under discussion were born during late summer, (late February, early

March). This implies that they were born too late to reach
puberty during their first natural breeding season
(March/April). Puberty would therefore be postponed until the
next breeding season should the Damara be a strictly seasonal
breeder which appears not to be the case (Paragraph 7.2.2).

Considering progesterone concentration profiles for Group Y,
ewe 712 (Figure 8.1.6) displayed three very prominent and
evenly spaced assumed luteal phases which extended roughly
between the middle of September toward the end of November
(spring season) with progesterone concentrations reaching
above 3 ng/ml. At the end of the third phase, the progesterone
leveled off before assuming a low amplitude, beneath 2 ng/ml,
cyclic progression.

During the whole of the observation period ewe 712 never
allowed mounting by the teaser ram and was eventually treated
with a progestagen pessary which also failed to induce oestrous
behavior even though clear indications of cyclic activity are
discernible in her profile.

Both ewes 720 and 716 displayed almost negligible ovarial
activity during the observation period as can be deducted from
their progesterone profiles (Figures 8.1.7 and 8.1.8). Ewe
716 stood to be mounted at the end of the observation period
while ewe 720 reacted during the second oestrus after treatment
with a progestagen intravaginal pessary.

The rest of the ewes in Group Y (ewes number 725, 728, 705, 700, 704, 692 and 699) displayed to a certain extent adequately definable luteal phases as are indicated by their respective progesterone profiles (Figures 8.1.1, 8.1.2, 8.1.3, 8.1.4, 8.1.5, 8.1.9 and 8.1.10) which correspond with their individual sexual receptivity as was determined with the aid of vasectomised rams. In most instances the occurrence of one or more presumable silent ovulations can be confirmed when date of first oestrus is related to ovarial activity as indicated by the circulating progesterone concentrations. The average age and body weight for group Y, determined at puberty, was 281.22 ± 64.62 days and 43.78 ± 7.90 kg (Figure 8.2 and Table 8.1).

From Group Z ewes 701 and 708 did not show any evidence of oestrus during any stage of the investigation period. This observation is substantiated by their respective progesterone profiles (Figures 8.3.3 and 8.3.4). The rest of the members of Group Z displayed oestrus at various stages during the observation period. As is the case with Group Y the incidence of one or more, as much as three, presumable silent ovulations can be extrapolated from the progesterone profiles (Figures 8.3.1, 8.3.2, 8.3.5, 8.3.6, 8.3.7, 8.3.8, 8.3.9, and 8.3.10). Ewe 714 deviates somewhat from the rest in the sense that she displayed five clearly definable luteal phases before mounting was permitted. Body weight and age at puberty for Group Z was 46.125 ± 4.9 kg and 299.625 ± 19.82 days respectively and is
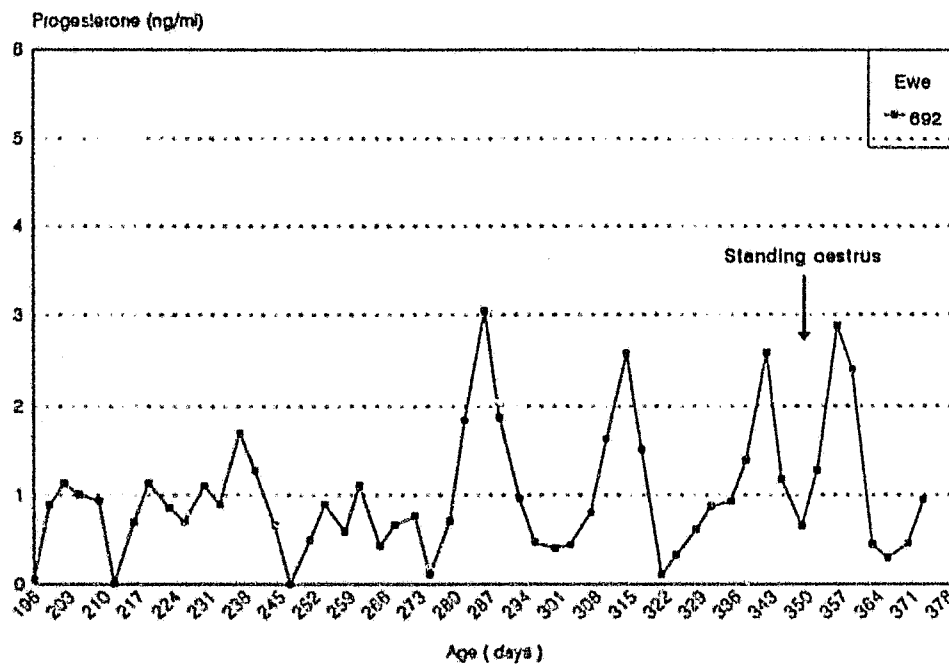
FIGURE 8 1 1 Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Y)
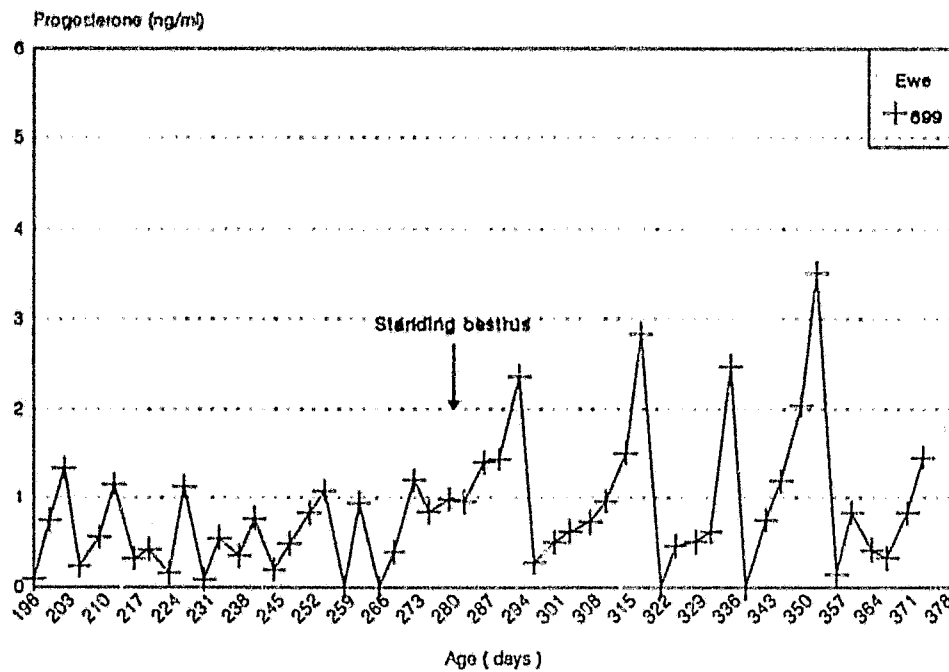
FIGURE 8 1 2 Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Y)
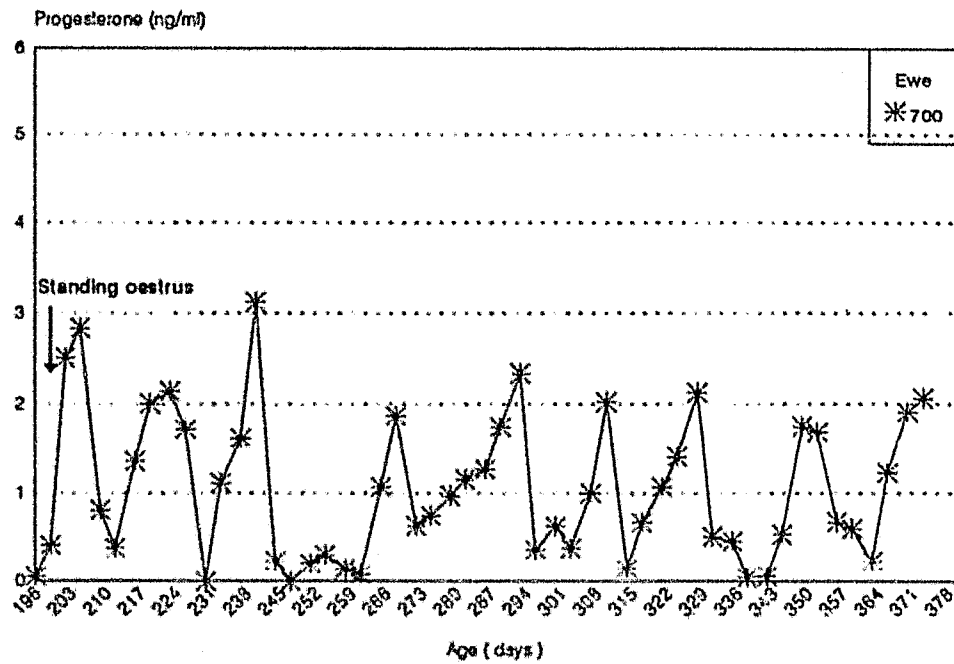
FIGURE 8 1 3 Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Y)
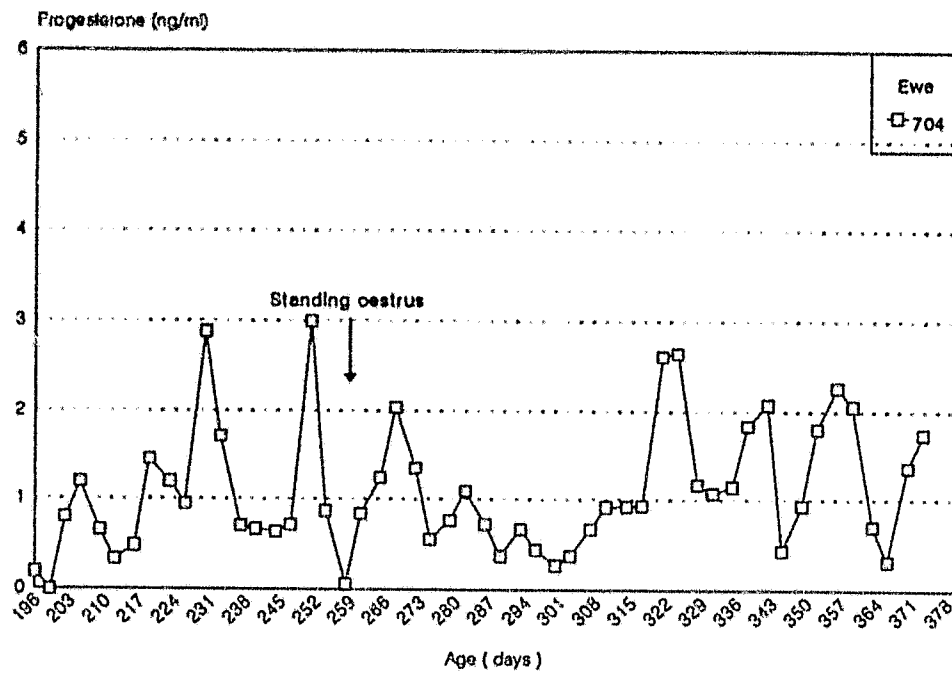
FIGURE 8 1 4 Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Y)
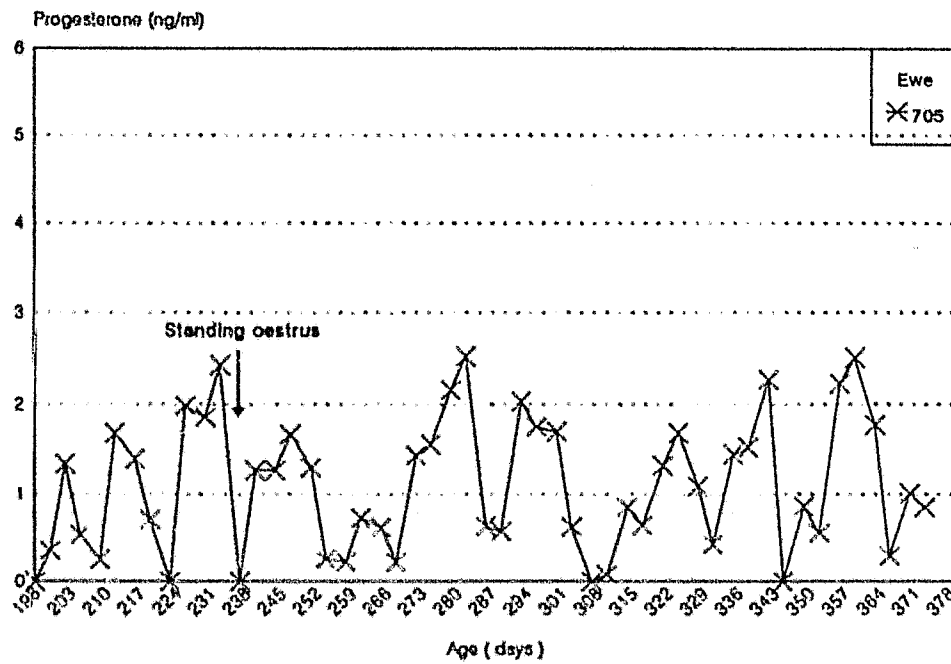
FIGURE 8 1 5 Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Y)
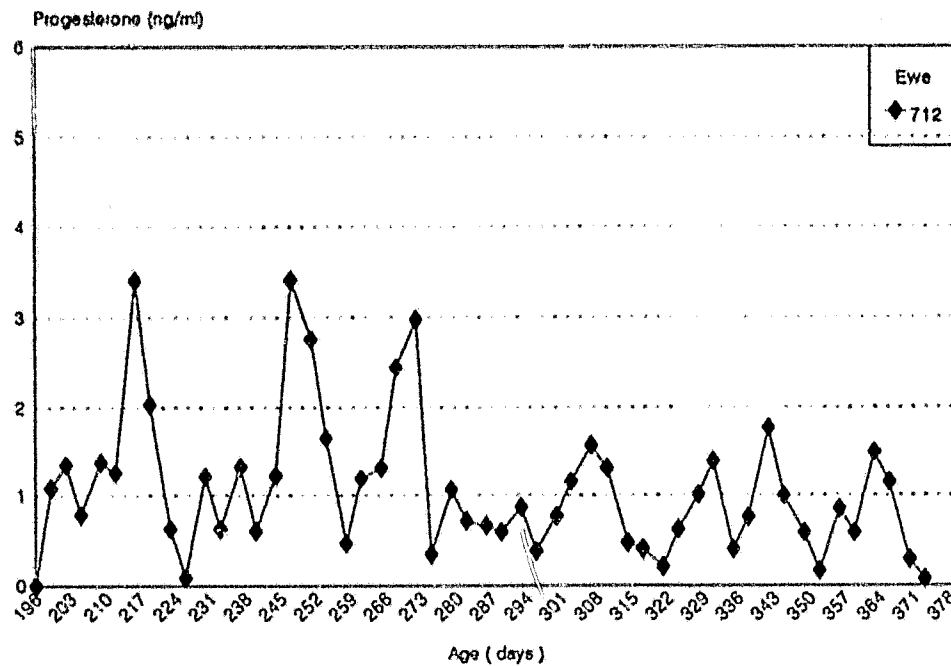
FIGURE 8 1 6 Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Y)
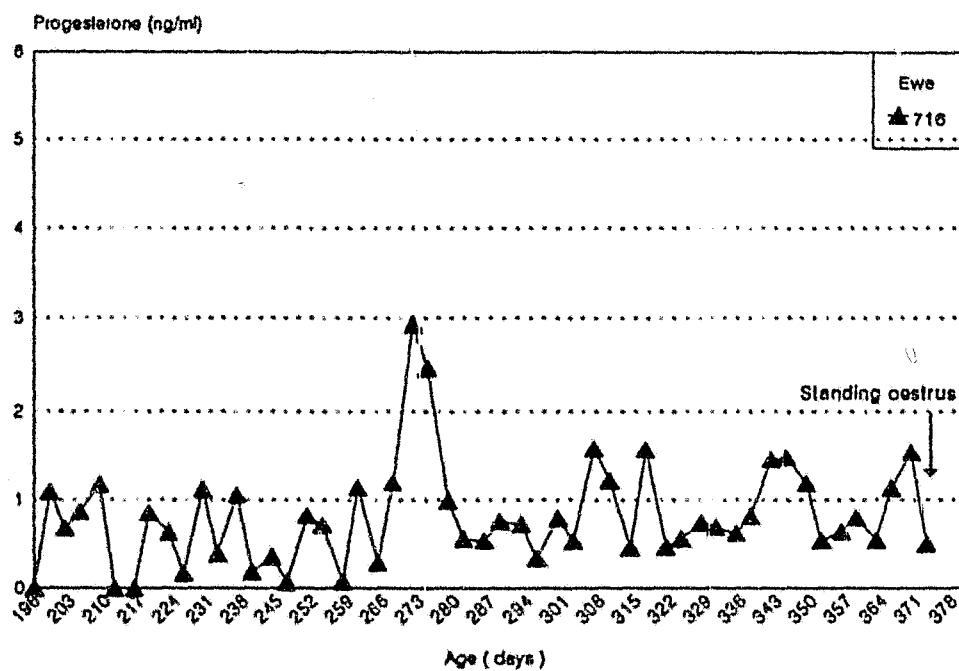
FIGURE 8.1.7 Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Y)
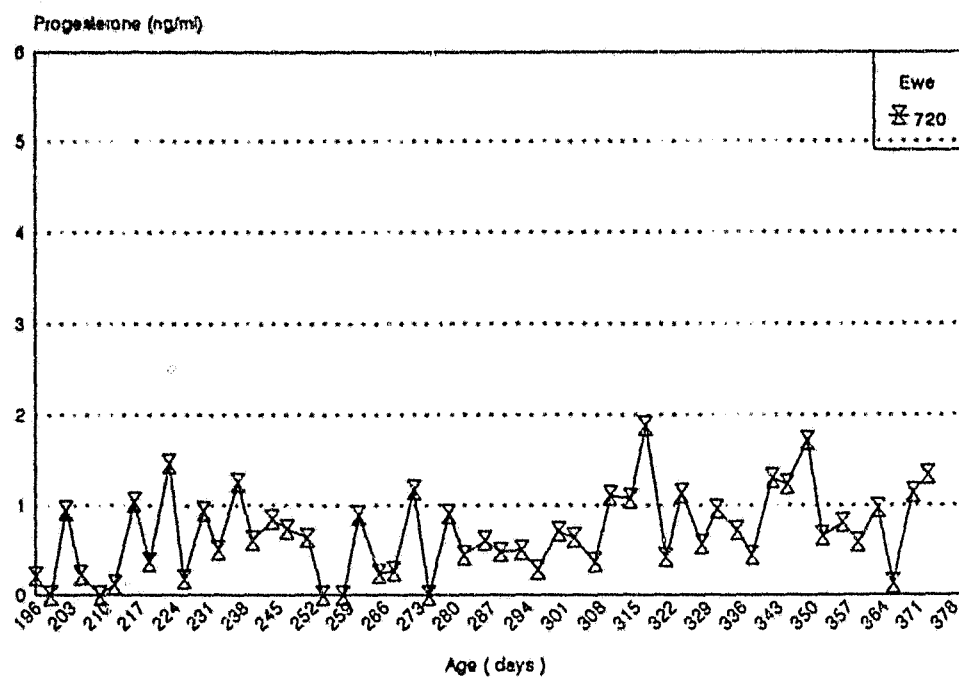
FIGURE 8.1.8 Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Y)
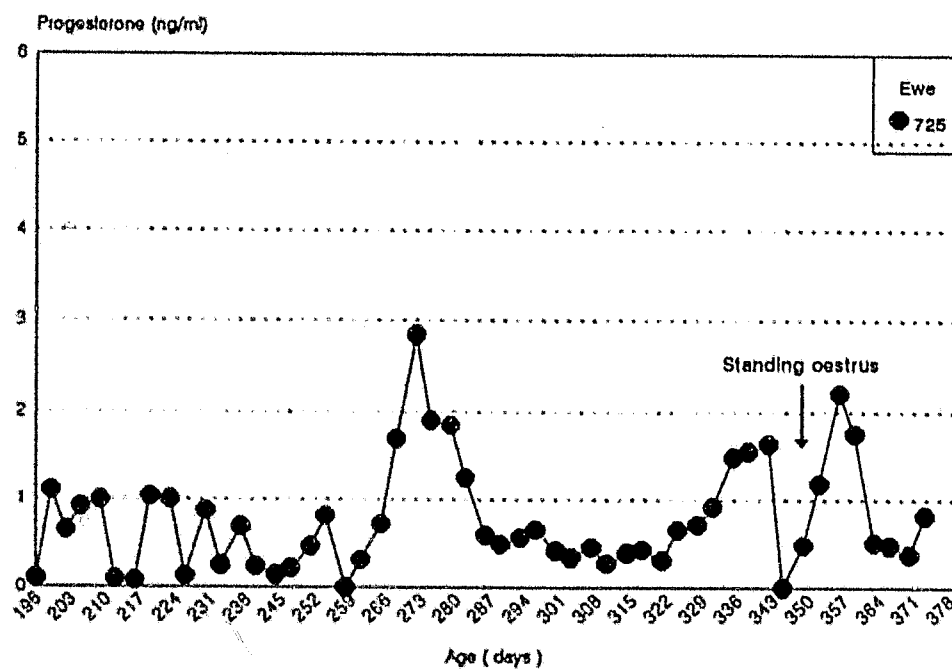
FIGURE 8 1 9 Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Y)
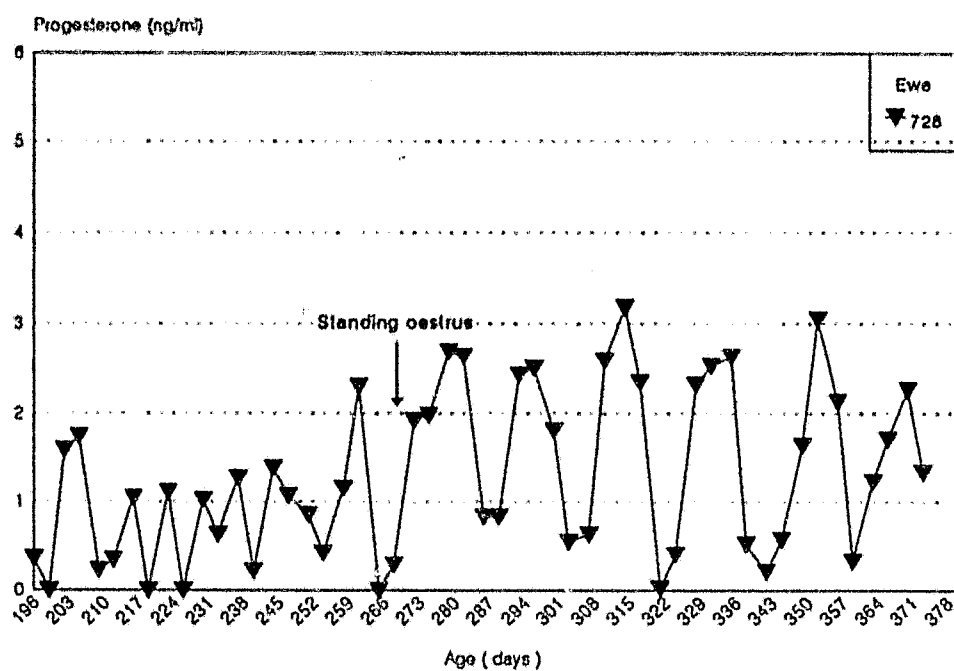
FIGURE 8 1 10 Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Y)
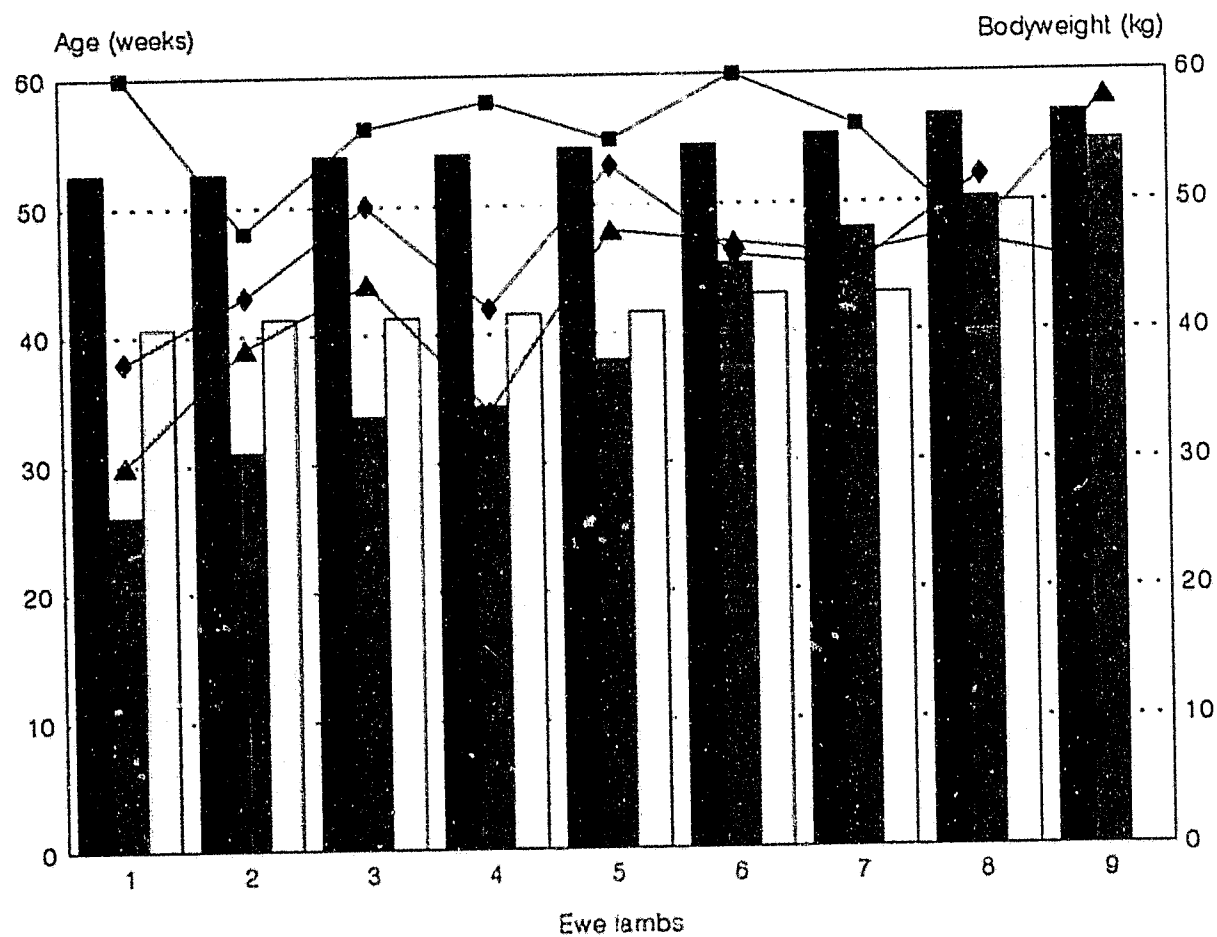
FIGURE 8 2 Age (weeks) and body weight (kg) at first oestrus in idividual ewes
Bar chart = Age (days). Line chart = Bodyweight (kg)
Group X (control), Group Y (tease daily), Group Z (continuous male presence)

TABLE 8.1 Age (days) and body weight (kg) at first oestrus

| Ewe number | Group Y | | Ewe number | Group Z | |
	Age (days)	Bodyweight (kg)		Age (days)	Bodyweight (kg)
700	182	30	726	284	38
705	217	39	713	289	43
728	236	44	718	289	50
704	241	34	717	291	42
699	266	48	714	292	53
725	318	47	693	301	46
692	336	46	695	301	45
716	352	48	722	350	52
720	383	58			
n	9	9		8	8
$\bar{x}$	281.222	43 778		299.625	46.125
Std dev	64 623	7 899		19.824	4.885
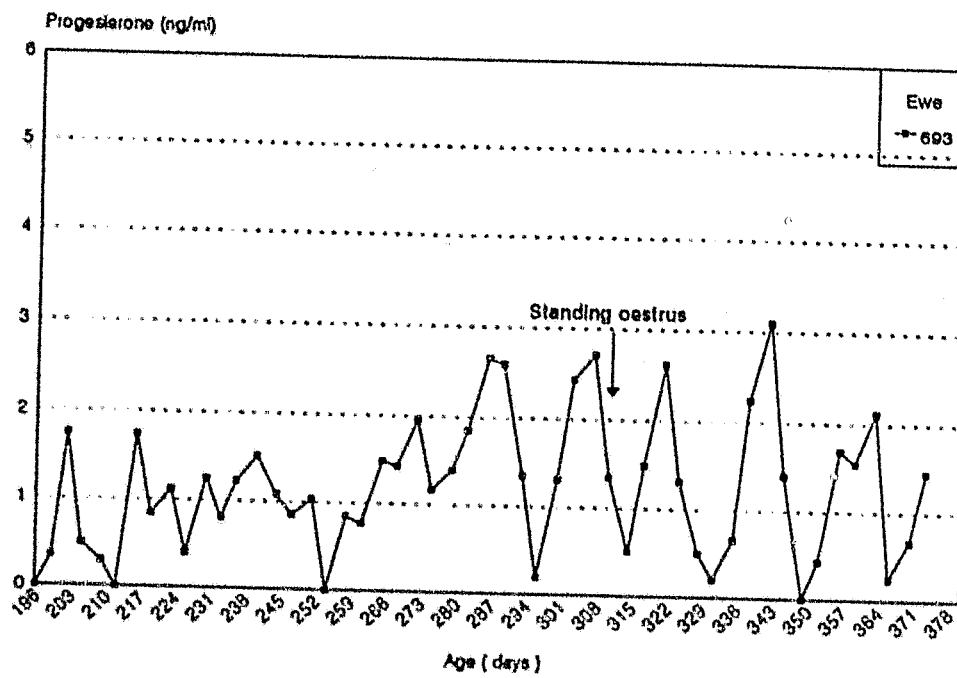
FIGURE 8 3 1 Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Z)
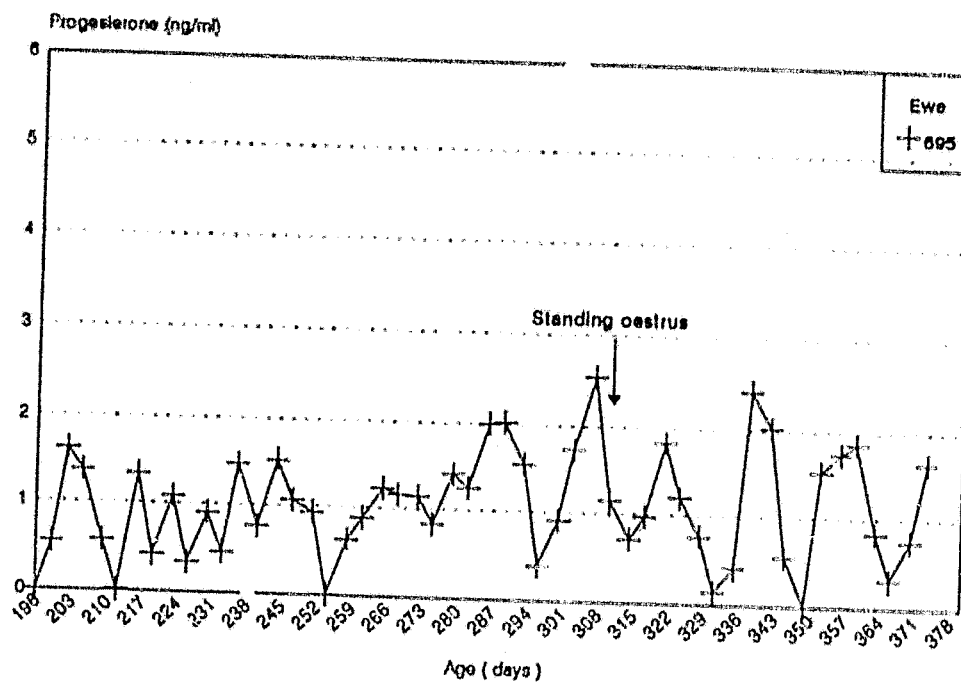
FIGURE 8 3 2 Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Z)
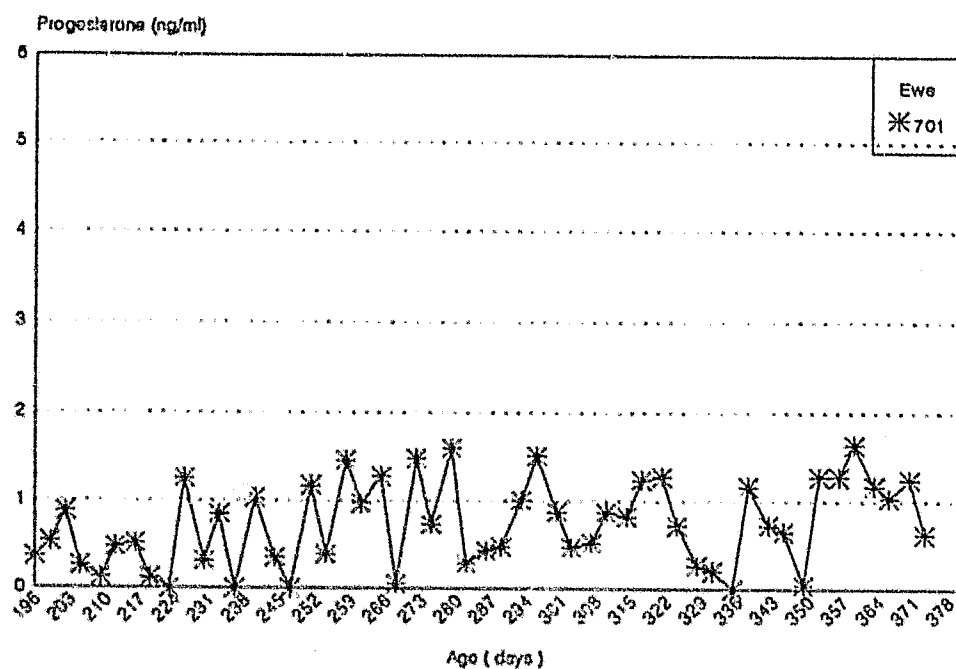
FIGURE 8.3.3 Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Z)
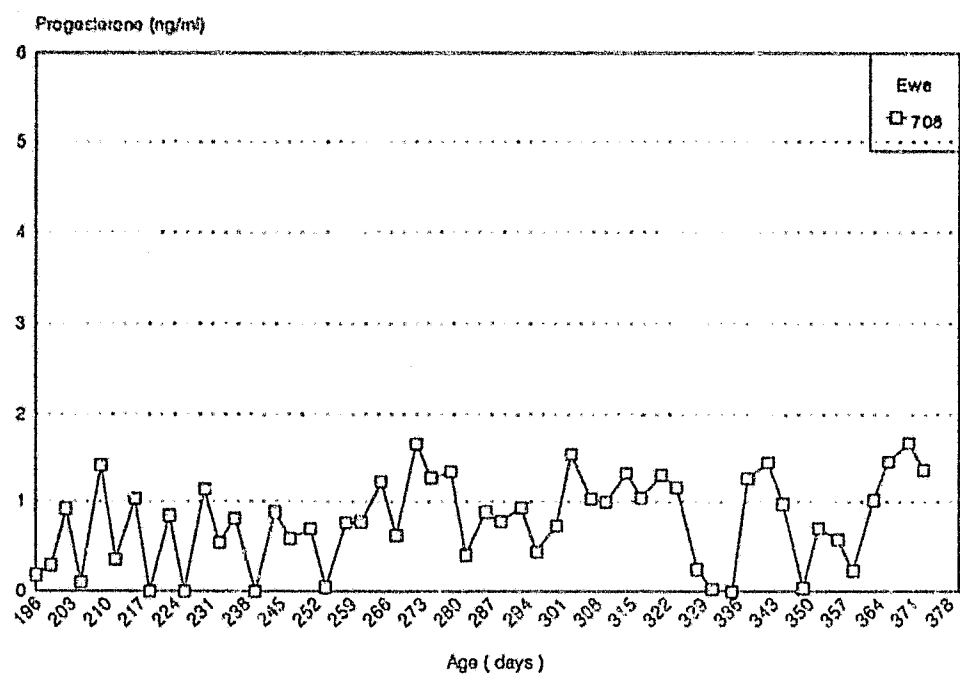
FIGURE 8.3.4 Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Z)
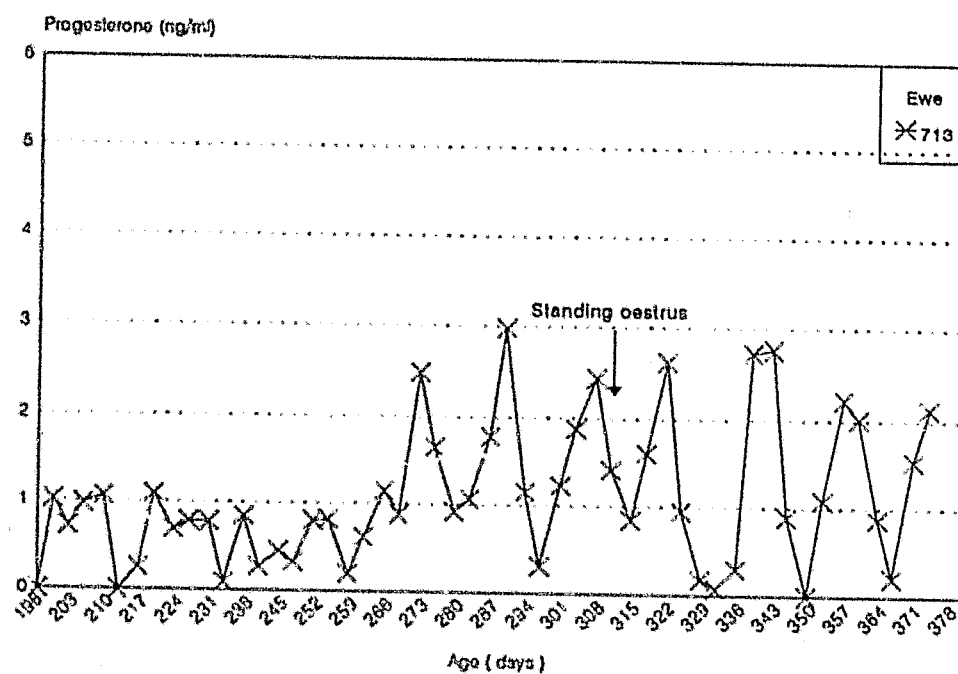
FIGURE 8.3.5 Plasma progesterone concentrations prior to and after onset of puberty (1st standing oestrus) (Group Z)
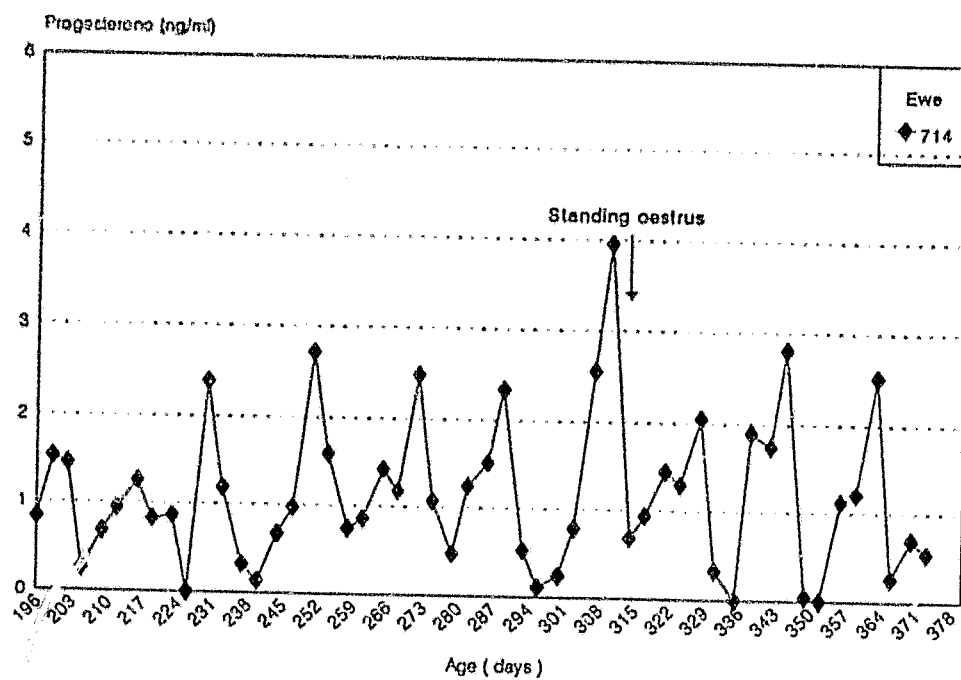
FIGURE 8.3.6 Plasma progesterone concentrations prior to and after onset of puberty (1st standing oestrus) (Group Z)
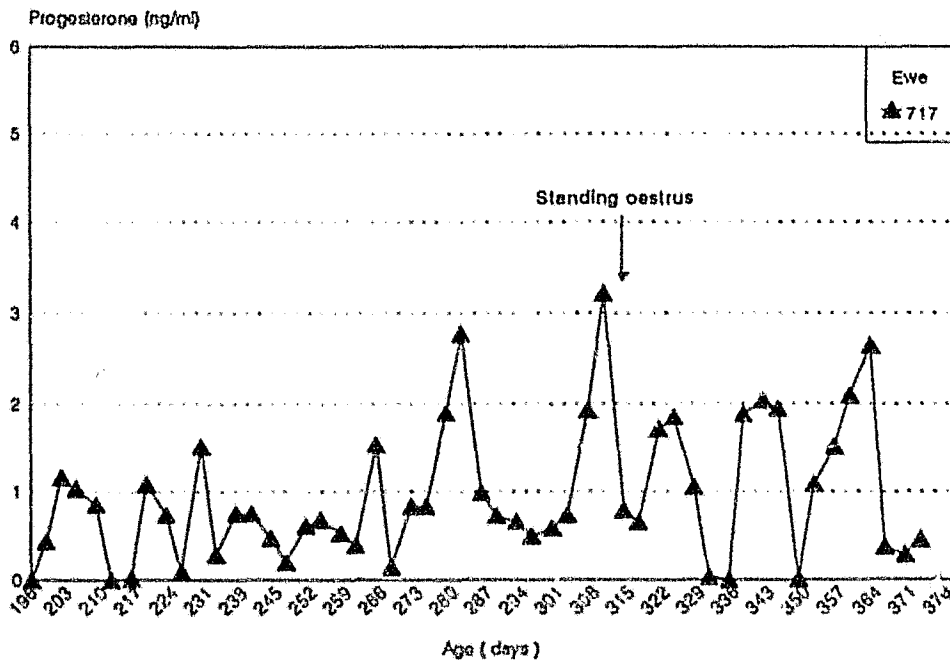
FIGURE 8.3.7   Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Z)
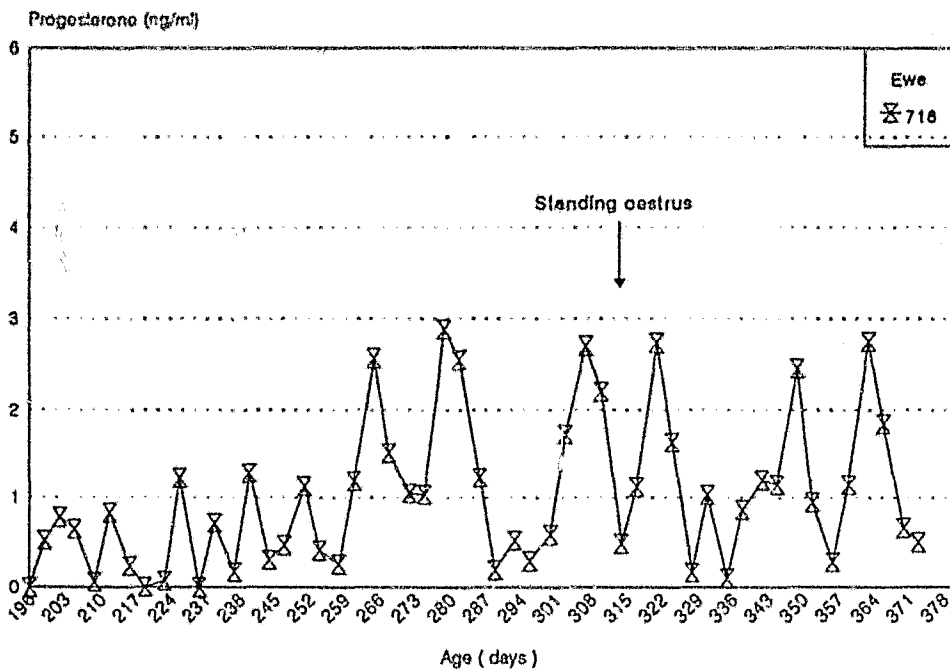
FIGURE 8.3.8   Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Z)
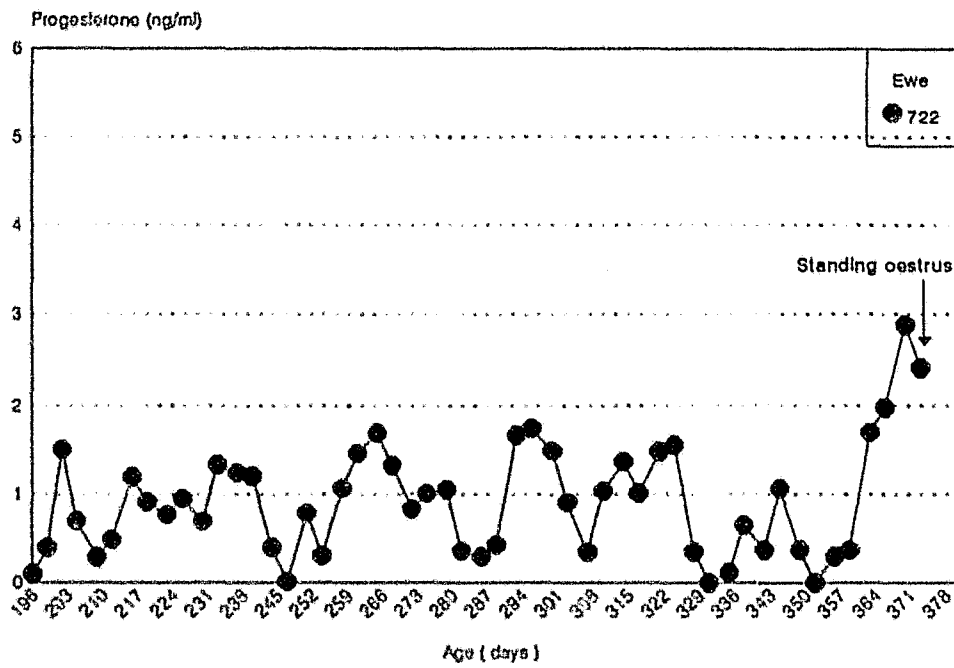
FIGURE 8 3 9   Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Z)
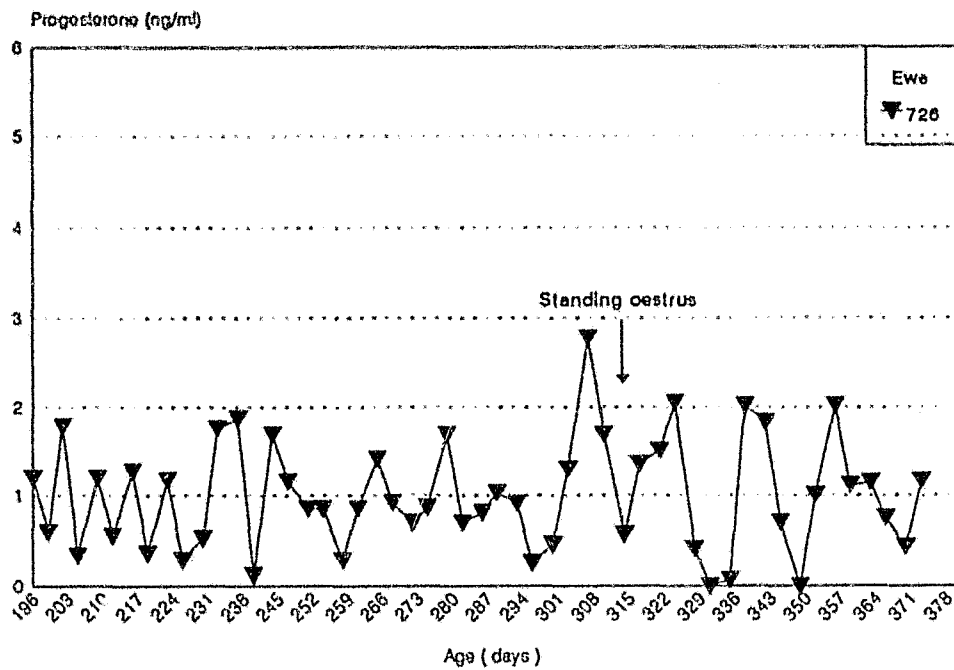
FIGURE 8 3 10 Plasma progesterone concentrations prior to and after onset of puberty
(1st standing oestrus) (Group Z)

summarized with corresponding data for Group Y in Table 8.1 and
Groups X and Y in Figure 8.2. There is no significant
difference with regard age and bodyweight at puberty between
Groups Y and Z (P > 0.05).

Six ewes from Group X showed oestrus during the first oestrous
period after sponge removal and three ewes during the
subsequent oestrous period. Ewe 711 (Figure 8.4.7) did not
respond by displaying oestrous symptoms but showed two
particularly prominent peaks separated by a period of ± 40
days, followed by yet another rather extended period. The first
peak materialized at the approximate age of 260 days. Ewes 691
and 723 showed regular cyclic activities since commencement of
bloodsampling. (Figures 8.4.1 and 8.4.9) which was
approximately at the age of 191 days and 170 days respectively.
Both responded during the first oestrous period after sponge
removal. The remaining four ewes which responded during the
first oestrous period viz. ewes number 703, 707 and 727 started
to display regular cyclic activity at the approximate ages of
279 days, 240 days and 279 days respectively. The progesterone
profile for ewe 706 appeared rather erratic and a clear
indication of cyclic activity can not be deduced from the
available data (Figures 8.4.4, 8.4.5, 8.4.6 and 8.4.10). Ewes
696, 697 and 719 which reacted during the second oestrous
cycle, displayed regular ovarial activity at the approximate
ages of 306 days and 292 days respectively for ewes 696 and 697
(Figures 8.4.2 and 8.4.3). Ewe 719 (Figure 8.4.8) displayed
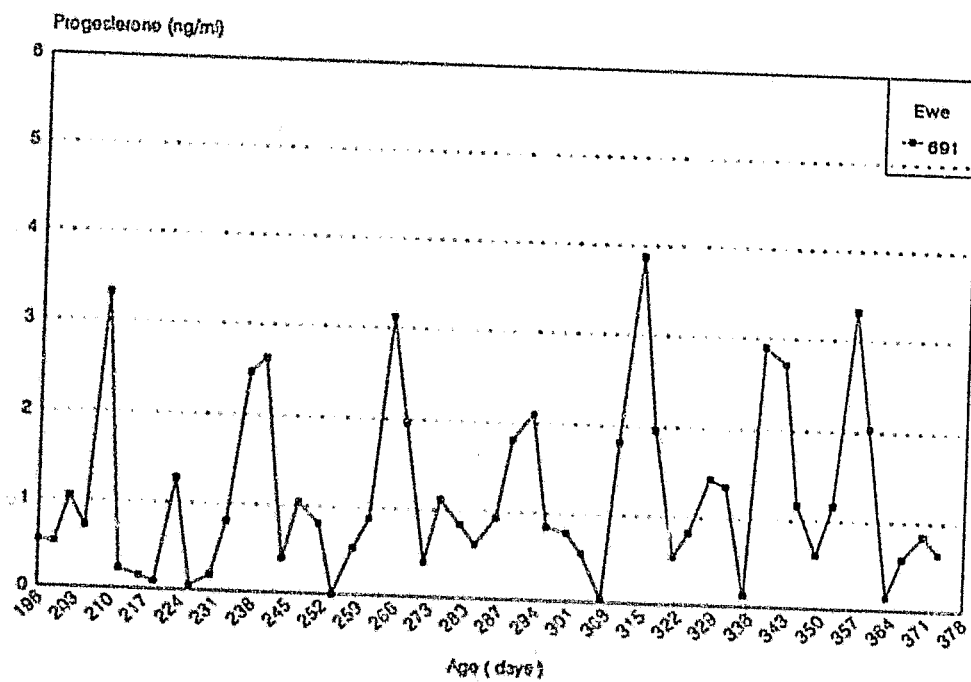
FIGURE 8 4 1 Plasma progesterone concentrations indicating onset of puberty
(Group X)
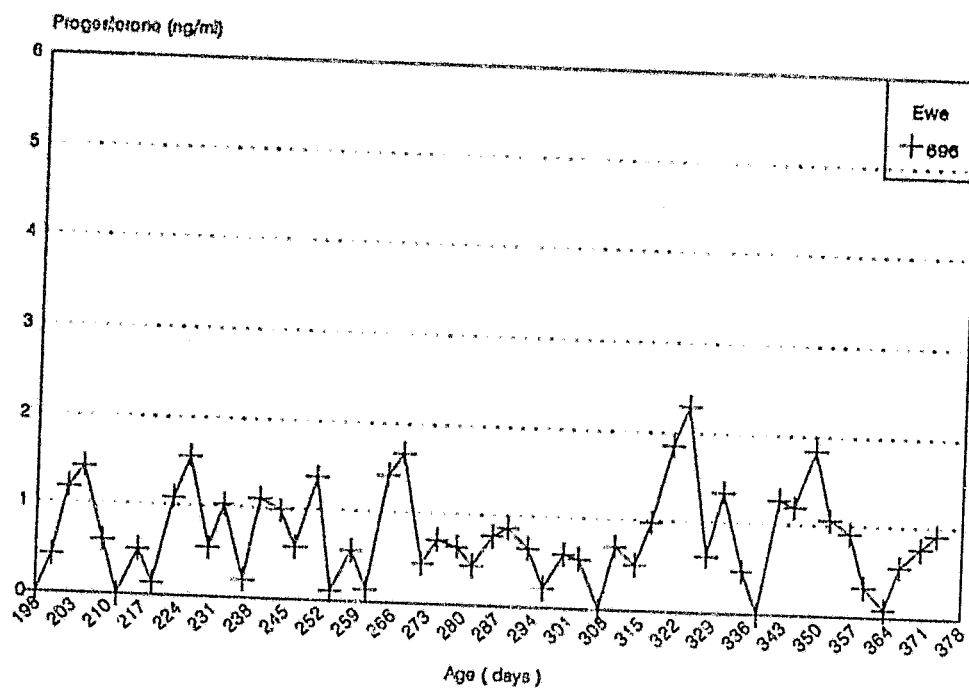
FIGURE 8 4 2 Plasma progesterone concentrations indicating onset of puberty
(Group X)
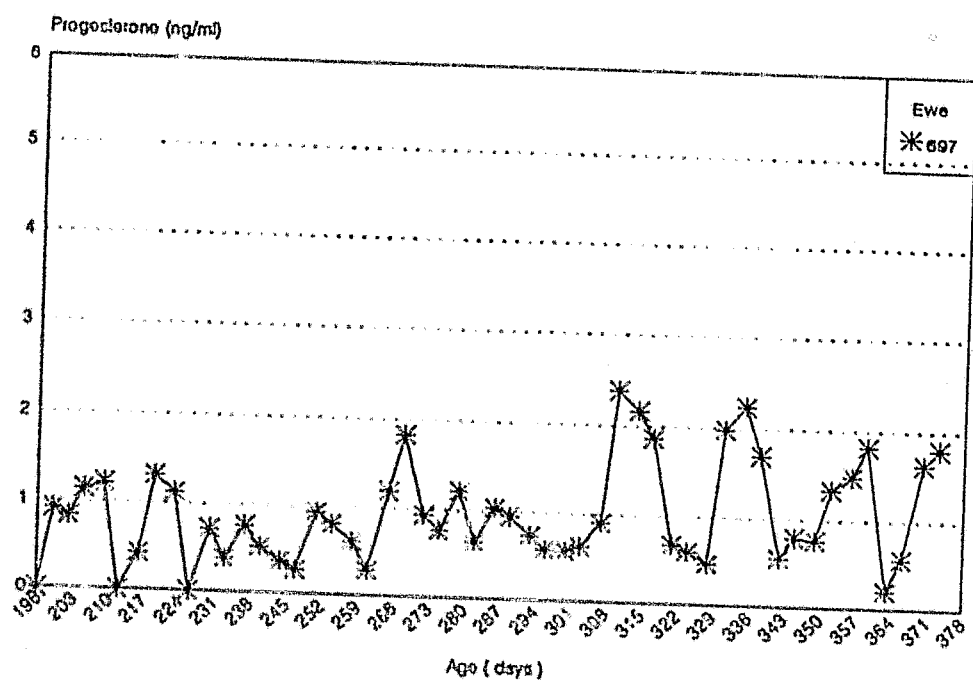
FIGURE 8 4 3 Plasma progesterone concentrations indicating onset of puberty
(Group X)
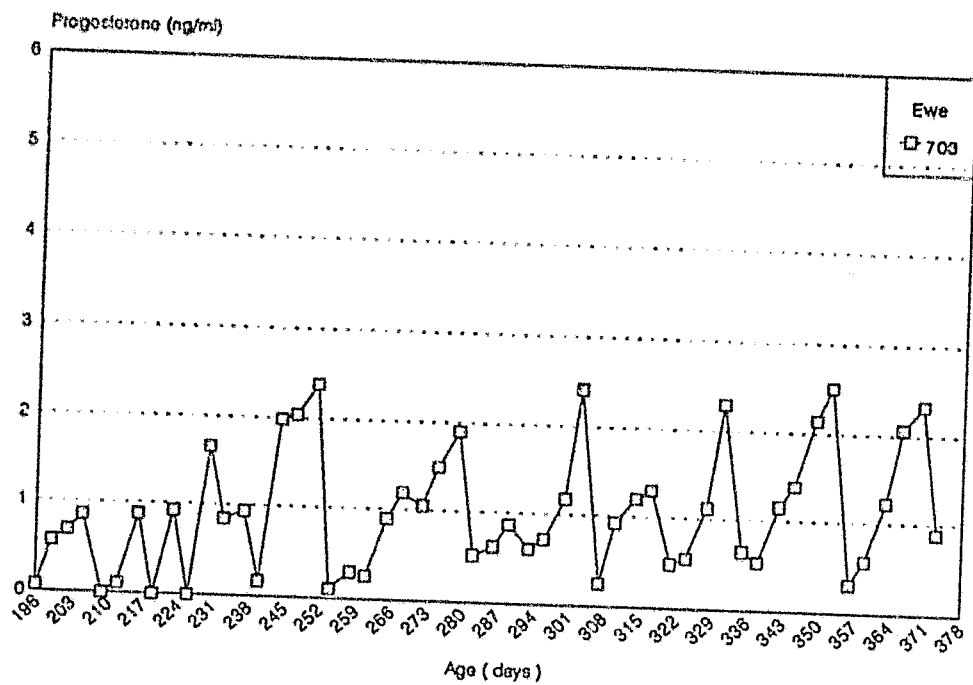
FIGURE 8 4.4 Plasma progesterone concentrations indicating onset of puberty
(Group X)
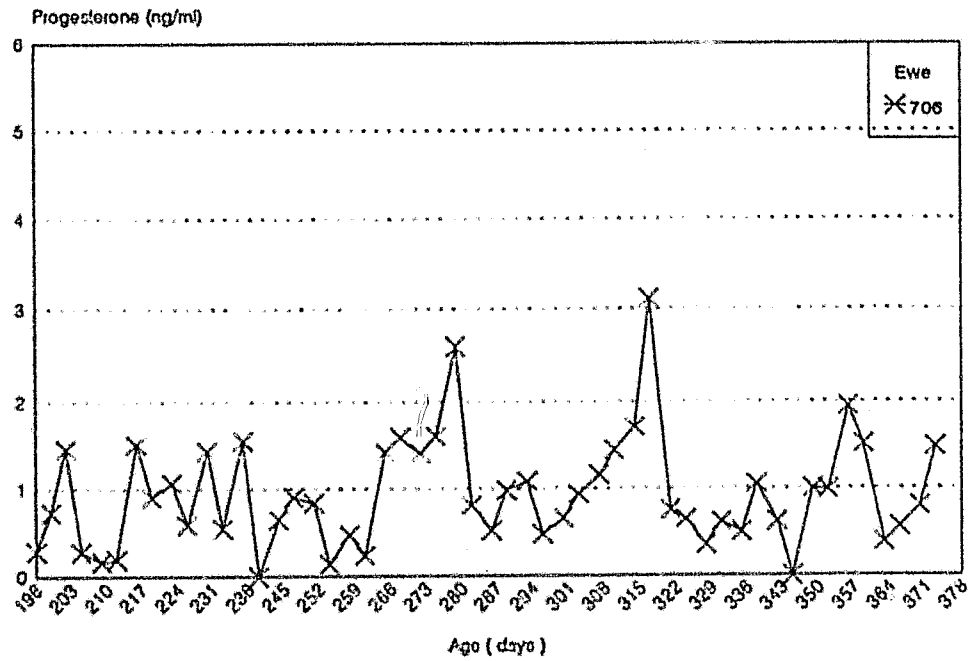
FIGURE 8.4.5 Plasma progesterone concentrations indicating onset of puberty
(Group X)
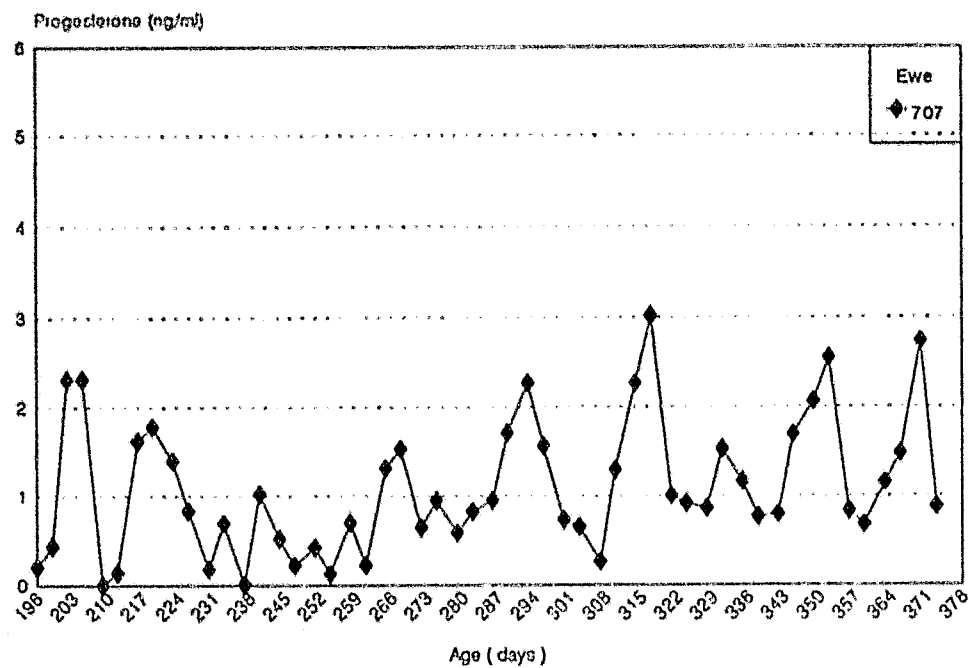
FIGURE 8.4.6 Plasma progesterone concentrations indicating onset of puberty
(Group Y)
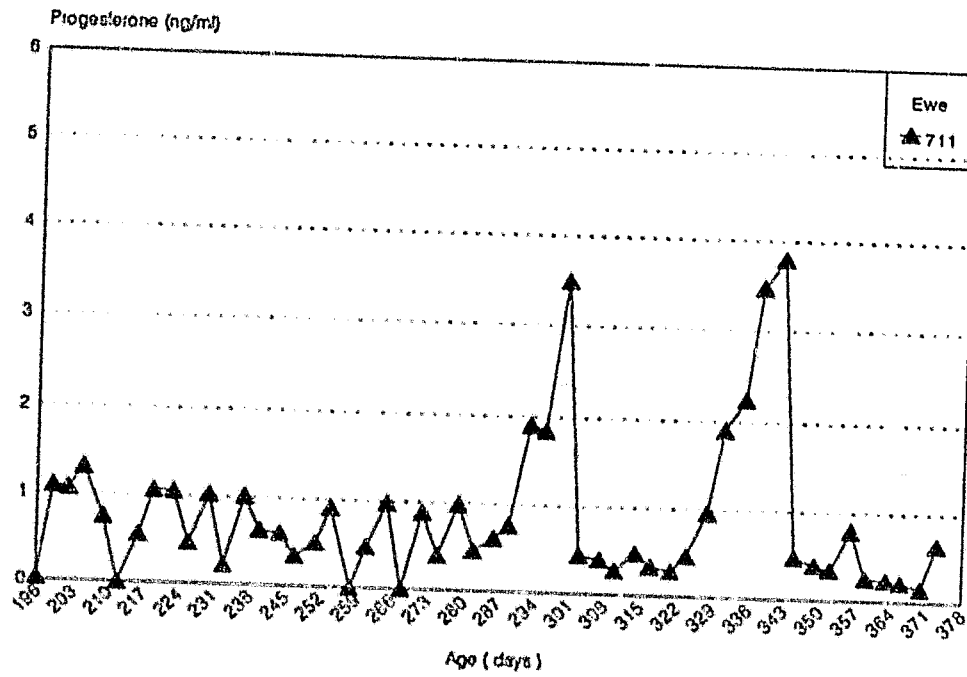
FIGURE 8 4 7 Plasma progesterone concentrations indicating onset of puberty
(Group X)
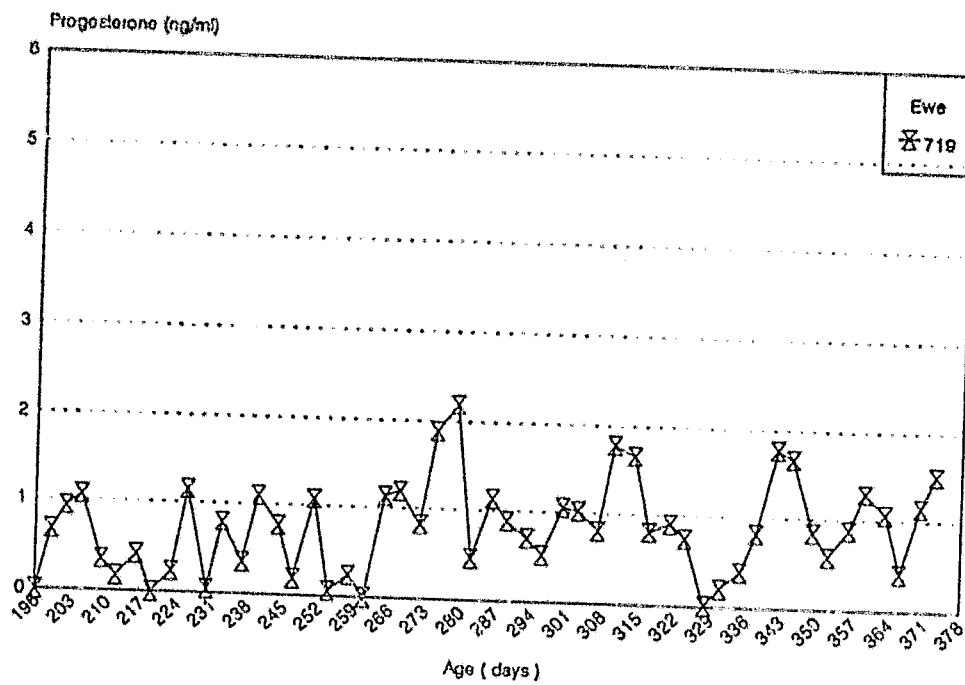
FIGURE 8 4 8 Plasma progesterone concentrations indicating onset of puberty
(Group X)
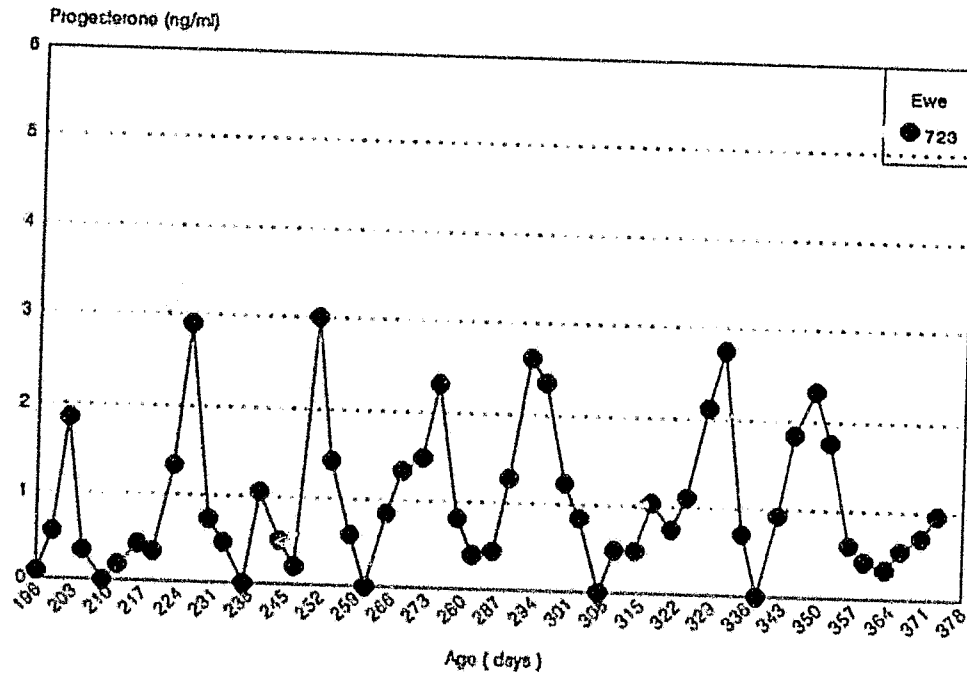
FIGURE 8.4.9 Plasma progesterone concentrations indicating onset of puberty
(Group X)
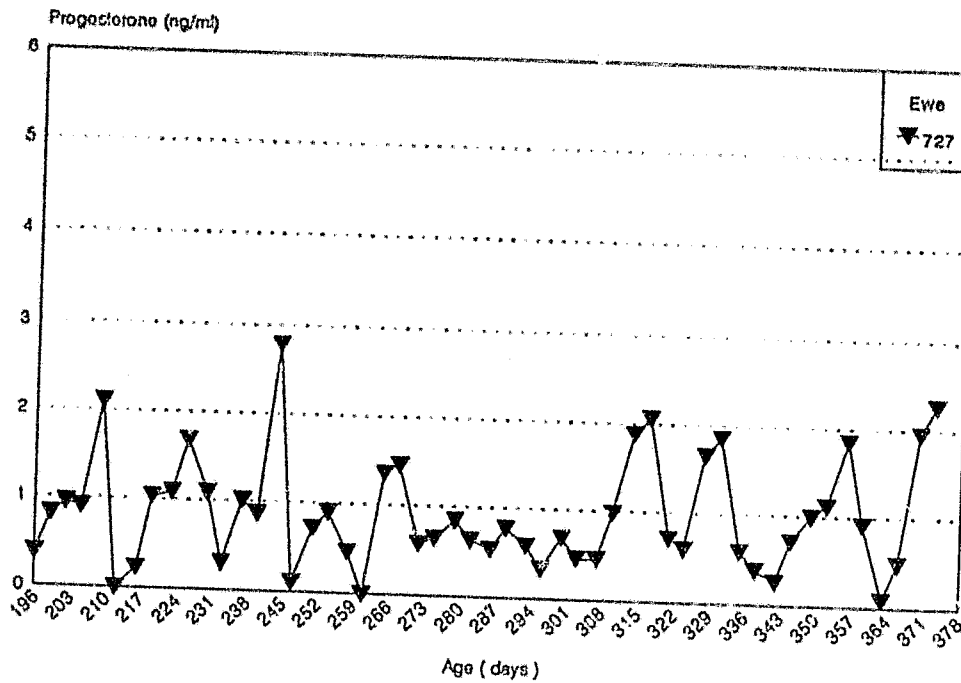
FIGURE 8.4.10 Plasma progesterone concentrations indicating onset of puberty
(Group X)

a low profile semi-eratic cyclic activity which makes
estimation of the time of first ovulation a dubious exercise.

Made on the supposition that a silent heat precedes the
incidence of first oestrus in the ewe lamb on reaching puberty
and that the length of the preceding cycle leading to oestrus
is 17 days, the inferred average age at puberty for Group X is
approximately 268.63 ± 45.52 days. To derive an approximate
body weight at puberty for Group X would not be possible with
available information. Figure 8.2 represents, in the case of
Group X, data which was recorded after treatment with
progestagen and is based mainly on a single observation. It can
therefore not be regarded as a true reflection of body weight
and age at puberty for Group X.

Foster (1981) reported that ewe lambs born in spring and
raised in natural photoperiod, first ovulation occurred at 31 ±
1 weeks of age, about 4 - 8 weeks after the onset of the
breeding season for adults. Lambs born in autumn and reared in
natural environment exhibited no evidence of ovulation at 26 -
35 weeks of age attained during the anoestrous season.
Ovulations were delayed until shortly after the onset of the
breeding season when they were 49 ± 1 weeks old. In spring-born
lambs under favorable photoperiod (short days) developmental
cues are responsible for the decrease in inhibitory feedback
responsiveness and sexual maturation is completed by
approximately 30 weeks of age in most ewes (Dyrmundsson,

1973 a; Fitzgerald *et al.*, 1982; Quirke, 1979 b; Quirke and Gosling, 1979). Two conceptionally different models are proposed to account for the delayed initiation of ovulation in the fall-born lamb. In the first model the long photoperiod of spring and summer delay maturity by retarding the developmental processes that are necessary to drive the change in responsiveness to oestradiol inhibition of LH secretion. The late decrease in negative feedback response under decreasing daylength at 50 weeks of age, therefore reflects the late attainment of sexual maturity.

The second model postulates that development is not retarded and sexual maturity occurs at the normal age of 30 weeks. The lamb becomes seasonally anoestrus at sexual maturity and therefore the transition to adulthood is masked (Yeates *et al.*, 1975).

In the second model the reduction in feedback response at 50 weeks of age reflect onset of a breeding season in response to decreasing daylength rather than onset of adulthood in response to endogenous developmental stimuli as is the case in the first model (Foster, 1981).

Dufour (1975) reported the percentage ewe-lambs reaching puberty and the average age at puberty for ewe-lambs born in the fall to be 93.3% and 312.8 days and for those born in spring, 57.1% and 201.8 days which differs notably from the 96%

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spring-born lambs reaching puberty at an average age of 212
days and an average weight of 45.5 kg reported by Southam
et al., (1971). Edey, Kilgour & Bremner (1978) observed
that a high proportion of spring-born lambs should show oestrus
during the subsequent breeding season, but a lambing
performance of only 62.3% was obtained at a mean weight of
41.0 ± 0.44 kg on reaching puberty.

Fitzgerald et al., (1982) reported that spring-born lambs are
older than summer-born lambs (220.9 ± 5.8 days vs. 170.0
± 129 days) when reaching puberty and they are also heavier
(40.8 ± 1.9 kg vs. 38.0 ± 1.5 kg). Ewe-lambs attain puberty
at between 212 and 220 days of age and between 34 and 36 kg
body weight (Fitzgerald et al.,1982). Body weight varied
between 25.5 kg and 38.7 kg (Quirke, 1978) and again between
35.1 kg and 44.6 kg for different breeds of sheep (Quirke,
1979 b). Age at first oestrus varied between 258 and 277 days
and age at first ovulation between 233 and 245 days again for
different breeds of sheep (Quirke et al., 1985). Faure
et al., (1987) indicated differences in age and body weight
of Karakul ewes kept under intensive and extensive conditions
of 337.2 ± 96.6 days and 401.9 ± 188.6 days and 45.2 ± 8.0 kg
and 34.2 ± 5.9 kg respectively.

Progesterone levels as indicators of ovarial activity remain
low (< 0.5 ng/ml) until such time as puberty occurs when
levels rise above 1 and 2 ng/ml (Faure et al., 1989).

Berardinelli et al., (1980) reported average basal
concentrations of progesterone of 0.3 ± 0.1 ng/ml which
increased to 1.1 ± 0.1 ng/ml during the first rise after which
it decreased to 0.4 ± 0.1 ng/ml for a short period of 4 ± 1
days before it rose again to 1.9 ± 0.3 ng/ml. This second rise
in progesterone is implicated as representative of the first
normal corpus luteum due to its approximate duration of 14
days. These progesterone concentrations are very much in
agreement with those found in the investigation under
discussion. Progesterone concentrations as index of first
ovulation occurred at 29.3 ± 0.7 weeks of age (Huffman et al.,
1987).

8.1.3 Conclusion

From the quoted literature there seems to be a great measure of
variation as to the age at which ewe lambs reach puberty e.g.
180 days for spring-born Suffolk lambs to 350 days for fall-
born Suffolk lambs and to a lesser extent with regard body
weight (40-49 kg and 33-44 kg respectively) (Foster, 1981).
When comparing figures reported by Faure et al. (1987) on
another fat-tailed breed, the Karakul, also kept under
intensive conditions, it appears as if the Damara ewe reaches
puberty at an earlier stage than the Karakul (281.22 ± 64.62
days for Group Y and 299.63 ± 19.82 days for Group Z vs. 424.6
± 154.3 days for summer born Karakul lambs and 351.8 ± 117.8

days for winter born Karakul lambs) and at approximately the
same body weight (43.78 and 46.13 kg vs. 45.2 kg).

The large disparity which is observed in the above figures can
possibly be attributed to male influence. There is also a very
distinct contrast in the rate at which the ewe lambs in Groups
Y and Z respectively obtained puberty (Group Y: 9 ewes
dispersed between 182 and 383 days; Group Z: 7 ewes dispersed
between 284 and 301 days). This occurrence can confirm
existing evidence (Dyrmundsson, 1973) that the male factor
(ram effect) can influence the attainment of puberty.

8.2   MALE PUBERTY

Spermatozoa found in the epididymides at castration of ram
lambs implicate by definition, attainment of physiological
puberty (Dyrmundsson, 1973b; Louw & Joubert, 1964). During
the period of sexual development in the ram lamb, reproductive
organs increase in size at rapidly accelerating rates and this
coincides with enhanced endocrine function (Skinner, Booth,
Rowson & Karg, 1968). There are no statistically significant
differences between the weights and volumes of the left and
right testes and epididymides indicating a high degree of
symmetry in the testicular growth of ram lambs (Carmon &
Green, 1952; Colyer, 1971; Dyrmundsson, 1973b). There is a
very marked variation in the age and body weight at which ram
lambs attain physiological puberty, both between and within

breeds (Dun, 1955 b; Dyrmundsson, 1973 b; Johnstone, 1948; Louw & Joubert, 1964; Wiggens & Terrill, 1953). It would seem that not only is there a certain degree of body growth and testicular size required before sperm could be released, but also a limit of chronological age below which puberty can not be attained irrespective of both body and testes weights (Watson, Sapsford & Mc Cance, 1956). Neither absolute threshold levels of age, body weight and testes weight required for the attainment of puberty, nor the interaction between these could be defined accurately. The mere attainment of physiological puberty in the ram lamb does not seem to imply the ability to achieve normal mating with ewes (Dyrmundsson & Lees, 1972). Physiological puberty normally precedes complete mating ability, indicating that these two phenomena are not synonymous in the ram lamb (Dyrmundsson, 1973b; Louw & Joubert, 1964).

Puberty in the male may also be defined as the time when the secretions of androgens, in response to pituitary gonadotropins, accelerates the development of their target organs and secondary sexual characteristics (Colyer, 1971; Skinner et al., 1968). In the ram lamb puberty is attained at a relatively early age, and is associated with a marked increase in endocrine function (Johnstone, 1948), onset of spermatogenesis and subsequently the manifestation of full normal sexual behavior.

The completion of spermatogenesis is dependent upon the
secretion of gonadotropic and gonadal hormones governed by
neural control via the pituitary and brain. Ram lambs with
lower circulating LH concentrations prepuberally, matures at a
slower rate sexually and reaches puberty at an older age. The
rate of sexual maturation in ram lambs is therefore related to
the level of postnatal LH stimulation and to the prepuberal age
when increased LH stimulation occurs. Breed differences in
prepuberal LH secretion and testes size appear to be related to
rate of sexual maturation rather than to fecundity of the breed
(Echternkamp & Lunstra, 1984). Testicular growth rate and
development of libido are correlated with ovarian development
and age at puberty in ewe lambs of the same breed (Severiano
& Pijoan, 1984).

Pituitary gonadotropin content increases sharply from 42 days
of age in Suffolk ram lambs. Small amounts of testosterone were
found to be released into the bloodstream by the testes in 3.5
month old ram lambs. Testosterone constitutes the principal
testicular androgen in the ram. The accessory glands which are
under the control of testosterone produces secretions
containing choline, fructose, citric acid and other substances
which act both as a fluid medium for the spermatozoa and as a
source of nutrients supporting sperm motility and metabolism.
In ram lambs androgen production and accessory gland
development precede the onset of spermatogenesis by several
weeks (Skinner et al., 1968; Skinner, 1970; Skinner, 1971)

which is in line with findings in other species. A close relationship has been shown to exist between weight increases in testes and both weights and contents of the accessory glands (Skinner et al., 1968; Colyer, 1971). Before and during the puberal period, the testes and to a lesser extent the epididymides, grow at a relatively faster rate than the body as a whole. Clear signs of libido are observed in young rams before the onset of puberty which is caused by testosterone secretion prior to the onset of active spermatogenesis (Louw & Joubert, 1964).

Certain anatomical developments gradually take place under the control of testosterone. The normal succession of these developments is that the testes first descend into the scrotum. In the immature lamb, the glans penis and the processus urethrae are completely adherent to the prepuce. Under influence of the testicular hormones, there is a gradual breakdown in the adhesions and the penis becomes freed. The freeing of the penis is more closely associated with the growth rate than the chronological age of the animal which by inference is correlated to testicular functions which results in mucosal resolution (Belonje, 1965; Dun, 1955 b; Johnstone, 1948; Pretorius & Marincowitz, 1968; Watson et al., 1956; Wiggins & Terrill, 1953;).

In the young and growing male, nutritive deficiency, especially low energy intake, will retard sexual development and

eventually lead to some delays in the onset of puberty. An adequate plane of nutrition is clearly of vital importance in the development of the ram lamb, and the rate of sexual development is found to be highly dependent on the growth rate of the animal (Dun, 1955 b; Johnstone, 1948; Louw & Joubert, 1964; Watson *et al.*, 1956; Wiggens & Terrill, 1953). Ram lambs reared on higher planes of nutrition will normally attain puberty at lower ages and heavier body weights than ram lambs on lower levels of feeding (Pretorius & Marincowitz, 1968). Vitamin A deficiency and zinc deficiency are known to severely impair the progress of sexual maturation in ram lambs (Dyrmundsson, 1973 b). Long days seem to depress gonadotropin secretion and consequent testicular development in the ram lamb (Howles, Webster & Haynes, 1980).

8.2.1 Material and methods

8.2.1.1 Experimental animals

Eleven ram lambs born during May 1993 from ewes that served as experimental animals during the project under discussion and which were weaned between 90 and 100 days, served as subjects in obtaining data with regard the attainment of puberty in the Damara male.

8.2.1.2   General management

Refer Paragraph 4.2.2

The subjects were housed together in an open sided roofed shed.

8.2.1.3   Treatments

Refer Paragraph 4.2.3

Gathering of data was based on the methods and procedures applied by Pretorius & Marincowitz (1968). Live weights were measured on a weekly basis. After all penial adhesions were freed (anatomical puberty), ejaculates were collected at weekly intervals using a bipolar electro-ejaculator. Smears of ejaculates were examined microscopically for the presence of sperm. The age at which sperm first appeared in the ejaculate was considered to be the age of physiological sexual maturity and as such constituted the actual age of puberty.

8.2.2   Results and discussion

The earliest age at which anatomical puberty was attained in Damara ram lambs during the tests under discussion was 97 days (13.9 weeks) and at a body weight of 30 kg. The range extended from 97 days to 134 days (19.1 weeks) for age and

between 30 kg and 43 kg for body weight (Table 8.2). There was however no correlation between age and body weight.

The first incidence of complete testes descent occurred at an age of 90 days (12.9 weeks), a body weight of 32 kg and a scrotal circumference of 18 cm. In the last ram lamb, testes descent was accomplished at 127 days (18.1 weeks), a body weight of 40 kg and a scrotal circumference of 22 cm.

The first incidence of physiological puberty was reached at an age of 120 days (17.1 weeks), a body weight of 39 kg and a scrotal circumference of 23.5 cm. The last ram lamb attained physiological puberty at an age of 169 days (24.1 weeks), a body weight of 48 kg and a scrotal circumference of 26.5 cm. Age ranged between 120 and 169 days, body weight between 35 kg and 48 kg and testes circumference between 22.5 cm and 26.5 cm (Table 8.2 and Figure 8.5). As was the case with anatomical puberty, no correlation was found between these three parameters. Mean values for the discussed parameters are summarized in Table 8.3. Growth rate and the dispersion of ram lambs as they attained physiological puberty are presented in Figure 8.6.

According to Johnstone (1948) anatomical puberty (development of the penial structure) is seldom completed by less than fifteen weeks (105 days) of age. The developmental process can be devided in stages as follows:

TABLE 8.2 Attainment of puberty in Damara ram lambs

Parameters	Ram	lamb	numbers									$\overline{x} \pm$ Std dev
	1	2	3	4	5	6	7	8	9	10	11	
Birth Date	3/5/93	4/5/93	4/5/93	5/5/93	5/5/93	6/5/93	6/5/93	6/5/93	7/5/93	11/5/93	16/6/93	
Anat Puberty:												
Age (days)	114	106	134	119	119	116	104	97	124	99	110	113.1 ± 11.16
Test Desc:												
Age (days)	107	99	127	112	112	104	90	97	103	99	96	104.2 ± 10.13
Test Circ (cm)	23.6	24.5	26.5	25.0	25.5	25.5	25.0	22.6	24.0	23.5	24.5	24.6 ± 1.13
Phys Puberty:												
Age (days)	126	134	169	140	161	139	125	125	131	120	138	137.3 ± 15.22
Weight	39.0	37.0	46.0	35.0	42.0	40.0	43.0	36.0	38.0	39.0	38.0	39.6 ± 3.67
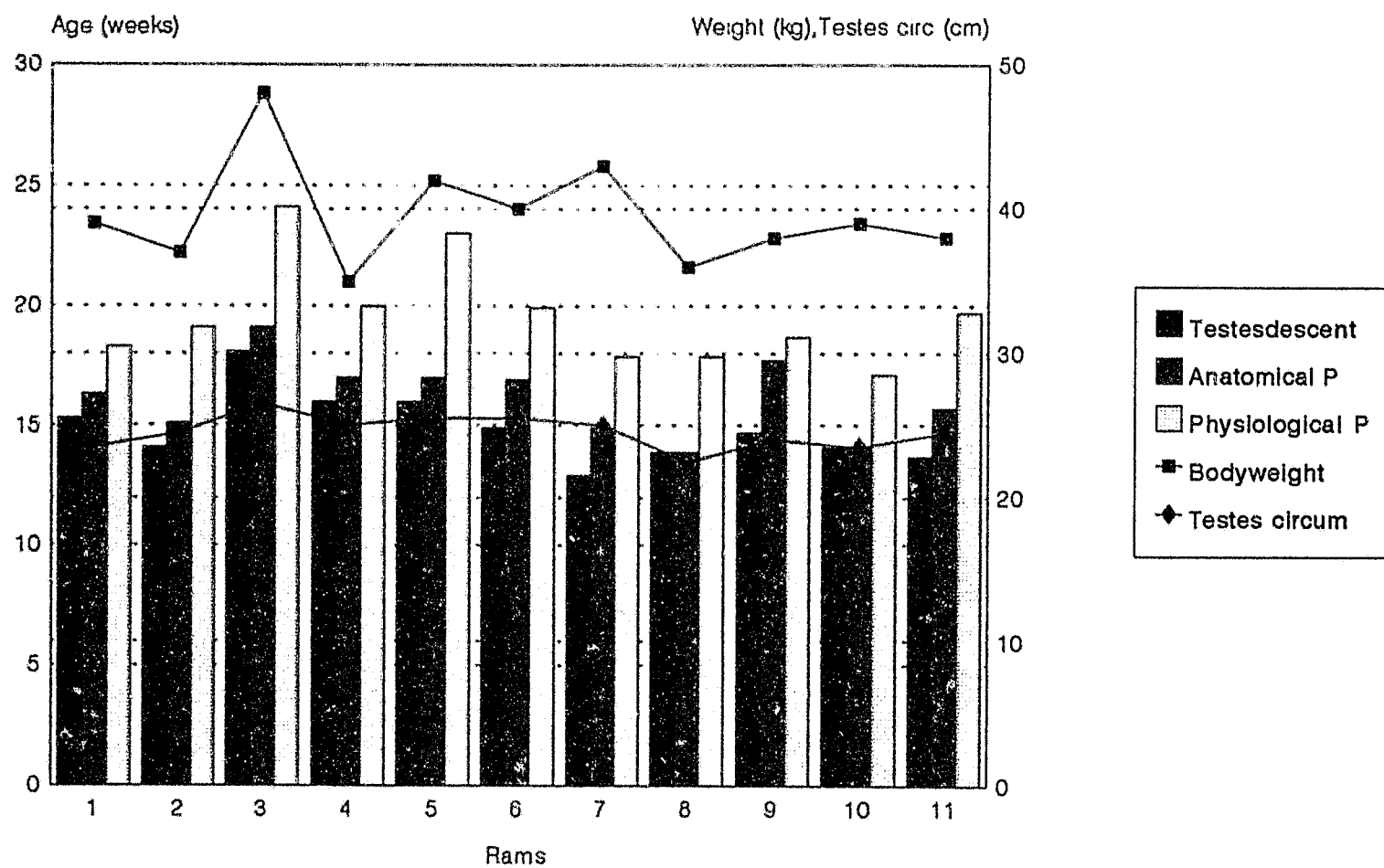
FIGURE 8 5 Parameters representing attainment of puberty in individual ramlambs

TABLE 8.3 Body weight, age and scrotal circumference at anatomical puberty,
testes descent and physiological puberty (mean ± SD)

Parameter	Mean ± SD
Anatomical puberty	
Body weight (kg)	34.82 ± 3.56
Age (days)	113.1 ± 10.66
Age (weeks)	16.15 ± 1.52
Testes descent	
Body weight (kg)	32.91 ± 3.58
Age (days)	104.18 ± 9.66
Age (weeks)	14.88 ± 1.37
Scrotal circumference (cm)	19.59 ± 1.41
Physiological puberty	
Body weight (kg)	39.54 ± 3.50
Age (days)	137.27 ± 14.51
Age (weeks)	19.61 ± 2.06
Scrotal circumference (cm)	24.55 ± 1.08
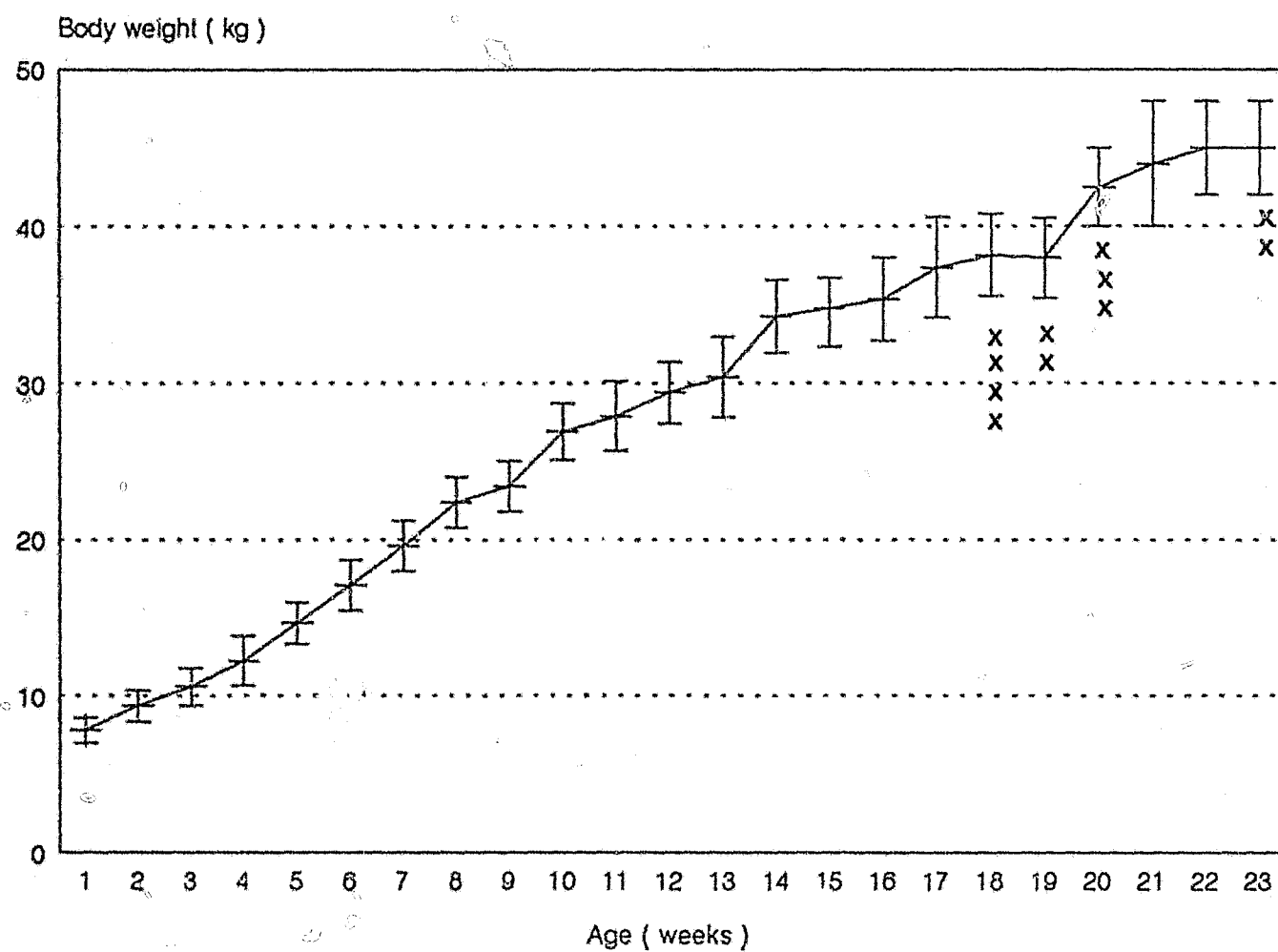
FIGURE 8.6 Mean growth rate in prepuberal Damara ram lambs and age at which individual lambs attained physiological puberty (x)

i)   Birth to ten weeks - All lambs show a poorly developed
     penis. The tip of the urethral process is visible but
     still adherent.

ii) Ten to fifteen weeks - The tip of the urethral process is
     free for a distance of approximately 6mm.

iii) Fifteen to twenty weeks - Anatomical puberty may be
     completed in individual cases.

iv) Over twenty weeks - Development is rapid. The majority of
     lambs attain anatomical puberty at five months of age.

Dyrmundsson & Lees (1972) found that the majority of ram
lambs of the Clun Forest breed attained physiological puberty
at between 4.5 to 5 months with the age range extending from 99
to 176 days. The mean body weight at puberty was found to be
32.5 kg ranging from 24.5 to 38.0 kg. The mentioned authors
concluded that ram lambs attain physiological puberty at
approximately 35 to 45 % of adult body weight.

Severiano & Pijoan (1984), working with Rambouillet and
British Down crossbreeds in the Mexican highlands where grazing
conditions are generally poor, reported attainment of puberty
at an average body weight of 29.5 ± 2.6 kg representing
approximately 46.5 % of adult body weight at an average age of
320.7 ± 38.8 days and a scrotal circumference of 25.74 ± 2.094
cm.

Investigations by Pretorius & Marincowitz (1968) showed that the *glans penis* became free from the preputial mucous membrane about 14 days after the *processus urethra* in Merino ram lambs. All penial adhesions were free in the last lamb at an age of 34 weeks for lambs at a high level of nutrition (70 % above maintenance) as to 40 weeks for lambs on a low level of nutrition (10 % above maintenance). The testes of all lambs were fully descended at an age of 30 weeks and 41 weeks for the two feeding regimes respectively. First sperm was observed in the ejaculate at a mean age of 191 days and body weight of 28.64 kg and 219 days and body weight of 24.73 kg for the two groups respectively.

In the Pedi and Namaqua breeds the *processus urethrae* and penis were both free at 168 days. Spermatozoa were present in the Pedi by 168 days and 196 days in the Namaqua compared to 112 days in the Dorper. Average body weight for the two breeds was 33.2 kg at 196 days compared to 47.3 kg for the Dorper. Skinner (1970; 1971) concluded that the two fat-tailed breeds are slow maturing when compared to other breeds. During previous work on Suffolk ram lambs Skinner et al. (1968) observed that spermatozoa were present in the seminiferous tubules at an age of 112 days and that testicular growth in the Suffolk is in accordance with that of other breeds of sheep.

Louw & Joubert (1964) observed that Dorper rams attain puberty at an average age of 128.5 ± 2.27 days and an average

body weight of 27.045 ± 0.774 kg, Hampshire ram lambs at an age of 5.5 to 6 months of age (Carmon & Green, 1952) and Barki ram lambs at an age of 7 months (Hassan, Youns, Ibrahim & Nawito, 1984).

8.2.3 Conclusion

Nutrition and consequently body weight seems to have a major effect on attainment of puberty in ram lambs. Affirmative of this assumption are the observations made by Severiano et al. (1984) (age 10.69 months and body weight 29.5 ± 2.6 kg) compared to those of Skinner (1971) (average age 3.73 months and body weight 47.3 ± 4.2 kg) and the report made by Pretorius & Marincowitz (1968) on different nutritional levels. Apart from nutrition other factors such as breed, season and environment may also influence attainment of puberty. Compare Louw & Joubert (1964) and Skinner (1971).

Therefore a general tendency is the nearest conclusion that can be derived at viz. that ram lambs can attain puberty at an age varying from approximately 4 months and older and an average body weight varying from approximately 25 kg and higher depending on the degree and extent of the various factors that effect the attainment of puberty in the ram. It should be kept in mind that the Damara breed is pre-eminently suited for extensive conditions and that the data described for the Damara was obtained under conditions which could be described as very

favorable. As a precautionary management practice however ram lambs should be separated from the ewe flock to prevent untimely conceptions.

CHAPTER 9

**MACROSCOPIC TRANSFORMATIONS OF THE REPRODUCTIVE TRACT OF MAIDEN
DAMARA EWES AT DIFFERENT STAGES OF THE REPRODUCTIVE CYCLE**

9.1   INTRODUCTION

The cervix is the most caudal portion of the uterus and its
constricted lumen is surrounded by a thick musculo-connective
tissue wall. Between species differences exist in the
complexity of the cervical folds, organization of the inner and
outer orifices, length and complexity of the cervical lumen and
anatomic relationships with the uterine body and vagina. The
passage has an average length of about 5.5 cm. The internal
morphology is characterized by six annular folds. Some authors
found between 4 and 6 folds (Dun, 1955 a). A particular
characteristic encountered concerns the second fold from the
posterior (vaginal) end. This fold is consistently out of
alignment with the first fold which makes it almost impossible
to introduce any instrument into the cervix. Passage of an
injection pipette into the cervical canal is however possible
in recovered tracts because hand manipulation of the pipette
and the tract could be applied to help guide the instrument.
(Halbert, Dobson, Walton & Buckrell, 1990). Unlike the
eccentrically positioned second fold, the annular folds beyond
it are consistently aligned with each other (Moré, 1984). The
alignment, number, size and spacing of rings is however

variable between ewes (Halbert et al., 1990). The cervical
epithelium is arranged in large folds and undergoes cyclic
changes as do all other parts of the reproductive tract. The
hight of the epithelium reaches a maximum during oestrus and
secretory activity also appears to be maximal at this time. At
the internal os the epithelium merges into the columnar
epithelium of the uterus. At the external os it is replaced by
stratified vaginal epithelium.

The cervical musculature of the ewe is devided into two layers,
an inner layer composed of circular and radial bundles and an
outer layer composed of longitudinal bundles. The different
smooth muscle bundles are embedded with dense connective tissue
fibers. Five well defined layers can be observed between the
serosa and the surface epithelium (Moré, 1984). The length of
the cervix varies between 4 and 10 cm with an outside diameter
of 2 to 3 cm. It is a sphincter-like structure which projects
caudally into the vagina which can be 10 to 14 cm long. The
uterus horns are 10 to 12 cm long and the body of the uterus 1
to 2 cm. The inner surface of the uterus contains nonglandular
projections, the caruncles which are arranged in four rows,
extending from the uterine body into the two uterine horns.
There are 88 to 96 caruncles in the uterus of the ewe. (Hafez,
1974). The oviducts of the ewe are 15 to 19 cm long. The
ovaries are oval shaped, 2.5 cm x 0.5 cm and weighs 2 to 3
grams (May, 1970).

9.2   Material and methods

9.2.1   Experimental animals

Six ewe lambs from the program, which previously attained
puberty, were employed to investigate changes that may occur in
the macroscopical structure of the reproductive organs of
maiden ewes during the oestrous cycle.

9.2.2   General management

Refer Paragraph 4.2.2

9.2.3   Treatments

Nutrition, health care, identification and detail with regard
progestagen treatment and heat detection: refer Paragraph
4.2.3.

Each ewe was treated with an intravaginal progestagen pessary
for a period of 14 days. At cessation of treatment two ewes
were allocated to day 0 (0-1 and 0-2), two ewes to day 7
(7-1 and 7-2) and two ewes to day 13 (13-1 and 13-2) of the
oestrous cycle (Table 10.1). The two ewes representing each
of the three designated stages of the oestrous cycle were
weighed and slaughtered at the respective stages during the
oestrous cycle which they represent. The reproductive organs

were carefully disected out and weighed. It was then examined
and described under the following criteria:

1 Ovaries

- Length and diameter of both left and right ovaries
- The number of follicles larger than 0.2 cm and the cross-
  section of each follicle
- Weight of each ovary
- Weight and diameter of corpora lutea (if present)
- The mass of the follicular fluid of all ovaries by cutting
  up the ovaries on filter paper and determining the weight of
  the ovarial tissue alone

2 Uterus

All unrelated superfluous tissues were removed by dissection

- The external appearance and colour of the uterus was
  described and muscle tone was determined through palpation
- The length of the uterus on the outside from the *os uteri* to
  the utero-tubal junction for both the left and right horns
- The diameter of each horn at the point of bifurcation
- The diameter of the uterus at its broadest point

The uterus was opened dorsally by means of a longitudinal
section from the vestibulum to the utero-tubal junction and
the vagina removed posterior to the *os uteri*

- The weight of the uterus alone (cervix, body and horns)
- The colour of the endometrium (pale, straw-coloured, pink or red)
- The surface of the endometrium (dry, moist, dull or clear)
- The shape, appearance and dispersion of the caruncles
- The diameter of the largest caruncle in each horn
- The volume of each uterus by displacement of water in a calibrated measuring cylinder

3 Cervix

- The diameter of the cervix posteriorly and anteriorly
- The permeability of the cervical canal (applying pins of various diameters)
- The appearance of the annular rings in the cervix

4 Vagina

The vagina was cut open dorsally and described as follows:

- The nature and quantity of fluid present
- The colour of the mucosal epithelium (pale, straw-coloured, pink or red)

9.3 Results and discussion

Data collected from the reproductive tracts of six maiden ewes at three different stages of the oestrous cycle (day 0 =

oestrus, day 7 and day 13) is presented in Tables 9.1 and 9.2.

Comparing the weights of the intact reproductive tracts presented by the six ewes, the weights for the Day 0 ewes (ewes 0-1 and 0-2) representing the oestrous period, are significantly higher (average = 85.38 g) than the weights for the Day 7 ewes (ewes 7-1 and 7-2), representing the luteal phase and the Day 13 ewes (ewes 13-1 and 13-2), representing the follicular phase, viz. average weights of 69.76 g and 64.51 g respectively.

According to Hafez (1974) there is, during the oestrous period or progestational period, a decrease in muscular activity and tonicity of the uterus, which may help to retain the blastocysts in the uterine lumen. At the same time an increased blood supply to the uterine epithelium develops. The epithelial lining of the uterus undergoes striking histologic changes during the oestrous cycle. Proliferation of the epithelium during the progestational phase provides increased uterine surface and also increased glandular activity. In the absence of fertilization the epithelium regresses. An interesting feature is the fact that the ewe which had the highest body weight (59 kg) displayed the smallest reproductive tract in terms of weight (62.08 g). Greyling (1988) reported a similar trend in Boer goat does.

TABLE 9.1 Anatomical data of the female reproductive tract (1)
(Representative stages of the oestrous cycle: day 0; day 7; day 13)

		Ewe 0-1	Ewe 0-2	Ewe 7-1	Ewe 7-2	Ewe 13-1	Ewe 13-2
Body weight (live) (kg)		52	45	49	43	59	47
Weight: Repr tract (g)		89.29	81.46	75.62	63.91	62.08	66.93
Ovary lenght (mm)	Left	15	14	11	13	17	17
	Right	12	12	16	14	15	15
Ovary diameter (mm)	Left	12	11	9	11	13	13
	Right	10	10	14	12	13	11
Number of Follicles	Left 8mm	1	1				
and diameter (mm)	7mm				1		
	6mm						
	5mm						6
	4mm	1			2	1	
	3mm	3	4	4		7	4
	Right 8mm					1	
	7mm						1
	6mm			3	1		
	5mm					1	1
	4mm	1			1	5	
	3mm		4	4	1		4
Ovary weight (g)	Left	0.92	0.74	0.41	0.63	1.56	1.55
	Right	0.53	0.47	1.24	1.29	1.01	0.89
Corpora Lutea present	Number	0	0	1 right	1 right	1 left	1 left
	Weight (g)			0.52	0.67	0.56	0.82
	Diam (mm)			11	11	11	12

TABLE 9.2 Anatomical data of the female reproductive tract (2)
(Representative stages of the oestrous cycle: day 0; day 7; day 13)

		Ewe 0-1	Ewe 0-2	Ewe 7-1	Ewe 7-2	Ewe 13-1	Ewe 13-2
Weight of Follicular fluid	Left	0.24	0.21	0.08	0.20	0.81	1.01
(g)	Right	0.08	0.10	0.84	0.88	0.30	0.25
Endometrial appearance		pink	pink	pink	pink	pink	pink
Caruncle appearance		dome	dome	dome	dome	dome	dome
Uterine appearance (ext)		pink	pink	pink	pink	pink	pink
Uterine tonus		firm	firm	firm	firm	firm	firm
Uterus length: os uteri to	Left horn	16.1	18.2	19.6	20.7	17.2	19.2
uteri-tubal connect (cm)	Right horn	14.9	17.6	20.8	22.9	17.2	19.0
Horn diameter at	Left horn	19	19	13	12	14	13
bifurcation (mm)	Right horn	19	19	13	13	12	12
Diameter of largest	Left horn	7	7	6	5	6	6
caruncle (mm)	Right horn	7	7	6	5	6	6
Diameter of uterus (mm)		35	38	27	24	26	22
Uterus volume (cc)		42	40	32	32	23	26
Uterus weight (g)		44.05	42.37	32.77	32.91	24.92	27.16
Endometrial fluid		moist	moist	moist	moist	moist	moist
Diameter of cervix (mm)	Anterior	12	12	10	8	9	9
	Posterior	11	13	13	10	12	11
Cervix permeability (mm)		0	2.5	2	1	2.5	0
Cervical obstructions		5 rings	4 rings	6 rings	4 rings	6 rings	1st 2 rings prominent
Vaginal fluid		viscous	viscous	moist	moist	moist	moist
Vaginal mucosa		pale	pale	pale	pale	pale	pale

There was a notable difference between the ovarial dimensions, both in terms of size and weight, of ewes 13-1 and 13-2 (average weight: 1.28 g and 1.22 g respectively) and the dimensions for ewes 7-1, 7-2, 0-1 and 0-2 (average weights: 0.83 g, 0.96 g, 0.73 g and 0.61 g respectively). Both ewes 0-1 and 0-2 revealed a large follicle on the left ovaries which would probably have ovulated during the prevailing oestrous period. Ewes 13-1 and 13-2 presented the largest number of underdeveloped follicles viz. 15 and 16 respectively. Both Day 7 ewes and Day 13 ewes had a corpus luteum each while the ovaries of Day 0 ewes were clear of corpora lutea.

The weights of the follicular fluid of ewes 0-1 and 0-2 (average weight: 0.16 g and 0.15 g respectively) were significantly lower than for the rest of the ewes, increasing sharply towards Day 7 and Day 13 with an average weight of 0.56 g and 0.63 g for ewes 13-1 and 13-2 respectively. Greyling (1988) reported that most follicles larger than 0.2 cm occur during oestrus. The smallest number of follicles occur during the early luteal phase. This was manifested by the weight of the follicular fluid for day 0 ewes which proved to be lower compared to ovaries representing later stages of the oestrous cycle. It can be assumed that the same reason probably accounts for the low weights recorded for follicular fluid in the investigation under discussion since the number of follicles recorded were also the lowest for the relevant ovaries.

Uterus length varied from 15.5 cm (average for both sides) for ewe 0-1 to 21.8 cm (average for both sides) for ewe 7-2. Uterus horn diameter, cervical diameter, uterus body diameter and uterus weight were significantly more pronounced in ewes 0-1 and 0-2 compared to the observations made on the rest of the ewes with regard these criteria. It seems as if there is a gradual decline in uterus weight from Day 0 to Day 13. The average weights for the three groups were 43.21 g, 32.84 g and 26.04 g respectively.

In all instances the endometrium had a pink appearance while the surface was clear and moist. The caruncles were dome shaped with varying diameters. Apart from ewe 13-2 the caruncles were arranged in clearly definable rows. The largest caruncles, 7 mm in diameter, were presented by ewes 0-1 and 0-2. In the rest of the ewes the diameter of the largest caruncles were 6 mm except for ewe 7-2 where it was 5 mm.

The volumes of the uteri is closely correlated with uterus weight. The volumes for ewes 0-1 and 0-2 were 42 ml and 40 ml respectively, for ewes 7-1 and 7-2, 32 ml and 32 ml respectively and for ewes 13-1 and 13-2, 23 ml and 26 ml respectively. This phenomenon must be indicative of the regressive processes that are taking place in the uterus from the oestrous period towards the follicular phase if fertilization does not occur.

With the small amount of data available, it would be unacceptable to come to any clear conclusion as to the permeability of the cervix with regard the different stages of the oestrous cycle represented in the trials under discussion. The cervix of ewe 0-1 could not be penetrated whereas in ewe 0-2 the cervix could be breached with a 2.5 mm diameter pin; ewe 7-1, 2 mm; ewe 7-2, 1 mm and ewe 13-1, 2.5 mm. The cervix of ewe 13-2 could also not be penetrated. The number of annular rings in the cervices examined, varied from 4 to 6. The cervix of ewe 13-2 was characterized by two very prominent rings posteriorly, followed by 4 diminutive rings anteriorly which was probably the causal factor for the impenetrable condition of that particular cervix.

Inspection of the consistency of the vaginal fluid of ewes 0-1 and 0-2 revealed a tendency to thread when touched with the finger. The moisture present could therefore be described as slightly viscous while the vaginal surfaces in the other cases could merely be described as moist. The vaginal mucosae were pale in all instances while the outer surfaces of the uteri appeared pink. The tonicity could be described as firm in all instances.

9.4 CONCLUSION

Compared to the general descriptions of the female reproductive tract as presented by authors such as Hafez (1974), May (1970) and others mentioned in the script, the Damara ewe fits well inside the picture with no clear deviations from the general appearance of the ovine reproductive system.

CHAPTER 10

SUPEROVULATION AND EMBRYO TRANSFER

10.1 INTRODUCTION

The term embryo transfer encompasses a variety of procedures which include superovulation, embryo recovery, short-term culture of embryos *in vitro* and transfer of embryos. Embryo transfer success rates are highly variable and are susceptible to sub-optimal conditions associated with one or more of the above procedures. One component that contributes substantially to this variability is the range of response, both between and within individuals, to the superovulatory gonadotropins used to induce the maturation and ovulation of a larger than normal number of oocytes (Ryan, Hunton & Maxwell, 1991; Wright, Bondioli, Grammer, Kuzan & Menino, 1981).

The potential value of egg transfer in farm animals, both for practical purposes and as a research tool, has been amply demonstrated. Moore & Shelton (1962) have shown that large numbers of lambs can be obtained from selected ewes, whilst Averill & Rowson (1958) and Moore & Rowson (1960) have used the technique to study the survival and development of fertilized sheep eggs. The use of multiple ovulation and embryo transfer schemes in the sheep industry remains however limited in contrast to their widespread use for genetic improvement in

cattle. Techniques for recovering embryos from ewes usually involved major surgery in the form of a laparotomy and exposure of the uterus (Armstrong & Evans, 1983; Averill & Rowson, 1958; Moore & Rowson, 1960). The inherent risks involved in the healing of wounds, the formation of post-operative adhesions leading to subsequent infertility (Mc Millan & Hall, 1994; Schiewe, Bush, Stuart & Wildt, 1984) casted doubt on the acceptability of such a procedure. From the perspective of genetic improvement, for which approximately 10 offspring per donor are desirable to double the rate of genetic gain (Smith, 1986), the formation of adhesions following laparotomy often precludes further attempts of recovery when the initial attempt has failed to meet the target number of progeny.

Laparoscopy has been effectively used in the ewe to study ovarian morphology, ovulation rate, laparoscopic pregnancy diagnosis, follicular aspiration (Snyder & Dukelow, 1974) and artificial insemination in sheep (Killen & Caffery, 1982; Mc Kelvey, Robinson & Aitken, 1985). Mc Kelvey, Robinson, Aitken & Robertson (1986) presented results for the first successful recovery of embryos from experimental ewes using laparoscopy. This technique minimizes the formation of adhesions and allows for repeated collection of embryos from the same donor. The technique is however difficult and time-consuming. Laparoscopy allows semen to be deposited into the lumen of each uterine horn thereby minimizing fertilization failure (Rexroad, Brinster & Hammer, 1984). The general handling and positioning

TABLE 10.1   An outline of the project group divisions

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Chapter 4
Synchronisation methods:
Group A1: Teaser rams     (10)
Group A2: Pessaries + PGF (10)    Chapter 5
Group A3: Pessaries + PMS (10)    AI vs Natural tupping
Group A4: Pessaries       (10)    Group M: AI           (20)
                                  Group N: Nat tupping (20)
Laparoscopic examinations (40)


Chapter 6
Sensitivity towards PGF2a:
                                  Chapter 7
Trial 1:      Trial 2:            Post partum period:
Group X1 (2) Group A1 + A2 (4)    Group Q               (4)
Group X2 (2) Group B1 + B2 (4)
Group X3 (2) Group C1 + C2 (4)    Influence of season on
Group X4 (2)                      reproduction         (10)


Chapter 8
Puberty determination:
Ewe lambs (additionally
obtained)                         Chapter 9
Group X: Control          (10)    The reproductive tract:
Group Y: Tease daily      (10)    Day 0                 (2)
Group Z: Teaser ram       (10)    Day 7                 (2)
                                  Day 13                (2)
Ram lambs                 (11)

Chapter 10
Superovulation procedures:
Superovulation Program 1
Group 1: Embryo S         (5)
Group 2: Ovagen           (5)

Superovulation Program 2
Treatment Group           (5)
Control Group             (5)
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of the ewe for intra-uterine insemination and/or the introduction of the laparoscope and insemination pipette under local anesthesia however may interfere with the normal collection and transport of ova into the oviducts. This confirms that the major benefits of laparoscopic intra-uterine insemination in superovulated ewes, namely high fertilization rates and therefore by implication high yields of embryos, are very dependent on the time of insemination in that timing influences both fertilization and egg recovery rates. According to Mc Kelvey et al. (1985) the time range for maximal fertilization is 48 to 60 hours after progestagen withdrawal. A delay in insemination time until 60 hours after progestagen withdrawal in order to maximize fertilization and ovum recovery rates in superovulated ewes, is strongly advocated by Robinson, Wallace & Aitken (1989).

Using currently licensed products, successful superovulation resulting in a large number of good quality embryos remains elusive and represents the limiting step in any commercial embryo transfer program (Sharma, Gupta, Khar & Khurana, 1993). Using the laparoscopic method, it is however possible to compensate for reduced recovery rates by the ability to repeat collections. Theoretically four or five collections could be made in one breeding season. (Scudamore, Robinson, Aitken, Kennedy, Ireland & Robertson, 1991).

Superovulation has been induced in sheep by the administration of pregnant mare serum gonadotropin (PMSG) (Hancock & Hovell, 1961; Moore & Rowson, 1960), horse anterior pituitary extract (HAP) (Boland & Gordon, 1982; Moore & Shelton, 1964), follicle stimulating hormone (FSH) (Evans & Armstrong, 1984; Moore, 1970; Wright et al. 1981) and human menopausal gonadotropin (hMG) (Schiewe et al., 1984). Increasing the superovulatory dose of PMSG is associated with an increase in the number of persistent large follicles which results in a decrease in embryo recovery and ovulation rate (Alwan, Boland & Gordon, 1988; Armstrong & Evans, 1983; Bondioli & Wright, 1980; Shelton & Moore, 1967; Torres & Cognie, 1984; Whyman & Moore, 1980), a response which has been attributed to the prolonged half-life of the gonadotropin. The abnormal endocrine status associated with the presence of these large follicles is also thought to be detrimental to fertilization and development of embryos in vivo. On the other hand, a significant proportion of ewes treated with FSH alone, may also fail to show a superovulatory response (Wright et al., 1981) thus reducing yields of embryos available for transfer or cryopreservation. In embryo transfer programs, the production of large numbers of embryos suitable for subsequent transfer, is determined not only by the ovulatory response to exogenous gonadotropins but also by the proportion of embryos or ova that are recovered, the proportion of ova fertilized and the subsequent normal development of embryos (Ryan et al., 1991).

The onset of oestrus in donor and recipient ewes must be closely synchronised in order to obtain the maximal survival of transferred embryos (Averill & Rowson, 1958; Hancock & Hovell, 1961; Moore & Rowson, 1960; Moore & Shelton, 1964; Rowson & Moor, 1966; Walker, Smith, Seamark & Godfrey, 1987). Maximal survival of 5-day morulae and 7-day blastocysts occurs when the recipients are in oestrus within 8 hours of their respective donors. When the stage of development of the uterus and embryo differs by more than 2 days (Wilmut, Ashworth, Springbelt & Sales, 1988), a high percentage of embryos do not survive. The progesterone concentration in the ovarian venous blood rises rapidly during the six days after oestrus. This level remains relatively constant until Day 15. Despite the relatively constant level of progesterone during this period, the endometrium must presumably be undergoing continuous and rapid changes so that if the embryo and the endometrium are out of phase by 3 days, the embryo will not survive (Moore & Shelton, 1964). Egg losses has a strong tendency to fall on litters as a whole which implies that success or failure tends to be an all-or-none phenomenon. It would also seem that a number of ewes at any oestrous period are suffering from some form of transient infertility which may well be of endocrine origin (Moore & Rowson, 1960; Rowson & Moor, 1966).

Superovulation of ewes by injection of FSH preparations, reduces sperm transport and fertility in ewes (Evans &

Armstrong, 1984; Hawk, Cooper & Conley, 1987). The effective application of intra-uterine artificial insemination can overcome this problem (Rexroad et al., 1984). Precise time of ovulation following hormonal control of the oestrous cycle is desirable in both artificial insemination and embryo transfer programs (Walker, Lampe, Heard, Matthews & Seamark, 1990). Significant variation occurs within and between flocks in the time of ovulation following synchronisation of oestrus which can contribute to fertilization failure. Evidence indicate that ewes 2 years of age may ovulate earlier than older ewes (Walker, Smith, Ancell & Seamark, 1989) and the level of superovulation obtained in ewe lambs is lower than that of older ewes (Cognie, Chupin & Saumande, 1985; Torres & Sevellec, 1987). According to Walker et al. (1987) timing of multiple ovulations in the ewe following treatment with either PMSG or FSH is imprecise unless GnRH is included in the treatment protocol. August was found to be the month in which greatest variability in the timing of ovulation was observed in the southern hemisphere with South Australian Merino strains.

The present investigation was included in the program with the purpose to ascertain whether the Damara sheep with its spirited nature is suitable for the collection and transfer of embryos. At the time the study was performed, the number of pure, well-bred Damara sheep, especially males, were rare and sought-after both locally because of the emphasis on local endemic breeds which are well adapted to the local climate and range

conditions and abroad where, in certain countries, a demand existed for specialized breeds suited for their specific environmental conditions. Due to a lack of facilities and expertise in Namibia, 10 ewes and a ram were transported from approximately 22° latitude South to approximately 34° directly South. This encompasses a straight distance of approximately 1200 km from a subtropical summer rainfall area to a winter rainfall area and approximately three months after the peak breeding season.

10.2 MATERIAL AND METHODS

10.2.1 Experimental animals

Ten cycling maiden Damara ewes, which have completed the puberty trials described earlier, were taken during May 1995 from Neudamm Agricultural College together with an adult Damara ram and a teaser ram to Welgevallen Experimental Farm at the premises of the University of Stellenbosch where they were allowed to adapt for approximately one month.

10.2.2 General management

The group of 10 maiden ewes were devided into two groups of 5 ewes and kept separately in adjacent semi-roofed pens. Their diet consisted of pelleted rations with the same nutritional composition as described in Paragraph 4.2.2. The *Cenchrus*

ciliaris hay was replaced by chopped oathay. Fresh drinking water was available at all times.

10.2.3   Treatments

Two superovulation programs (Superovulation Program 1 and Program 2) were exercised (Langenhoven, 1990; Van der Walt, 1990):

(i) Superovulation Program 1.

A 2 x 2 factorial designed experiment using Embryo S (Jurox Pty. Ltd), Ovagen (Immuno-chemical Products Ltd.), intravaginal pessaries (60 mg Medroxy Progesterone Acetate, Repromap, Upjohn) and ear implants was implemented. The ewes which all showed regular oestrous cycles were numbered 1 to 10 and subjected to the following treatment during May/June 1994:

Ewes 1 to 5 were treated with intravaginal progestagen pessaries and ewes 6 to 10 with subcutaneous progestagen impregnated ear implants. Ewes 1,2,3,6, and 7 (Group 1) were treated with Embryo S and ewes 4,5,8,9 and 10 (Group 2) with Ovagen (Table 10.2). Both reagents are FSH substitutes. The following procedure was carried out:

Day 1:   Pessaries and implants were administered to Group 1
Day 2:   Pessaries and implants were administered to Group 2

Day 8: 10 NIH (National Institute of Hormones) units
        Embryo S + 300 IU PMSG (Fostim, Paines & Byrne, Ltd.)
        were administered intramuscularly (im) to each ewe in
        Group 1

Day 9: 7.5 NIH units Embryo S were administered to each ewe in
        Group 1

        72 NIH units Ovagen + 300 IU PMSG were administered to
        each ewe in Group 2

Day 10: 2.5 NIH units Embryo S were administered to each ewe in
        Group 1

        54 NIH units Ovagen were administered to each ewe in
        Group 2

Day 11: 18 NIH units Ovagen were administered to each ewe in
        Group 2

Day 12: Pessaries and ear implants were removed from Group 1.
        Teasing commenced 12 hours later and subsequently every
        12 hours

Day 13: Pessaries and ear implants were removed from Group 2.
        Teasing commenced 12 hours later and subsequently every
        12 hours

The ewes were inseminated laparoscopically with 0.25 ml fresh
diluted semen 12 hours after detection of oestrus and again 12
hours later. Flushing took place on days 6 or 7 after
artificial insemination.

Table 10.2 Superovulation treatment applied to two groups of 5
            maiden Damara ewes (Superovulation Program 1)

Group	1	2
	Embryo S	Ovagen
	Ewe no	Ewe no
Pessaries	1 2 3	4 5
Implants	6 7	8 9 10

(ii) Superovulation Program 2.

Due to the poor reaction of the ewes on Superovulation Program
1, a relatively uncomplicated follow-up procedure was exercised
34 days later by implementing Superovulation Program 2. All
ewes (10) received the same treatment. Oestrous
synchronisation and superovulation was obtained by the
application of progestagen pessaries (60 mg Medroxy
Progesterone Acetate, Repromap, Upjohn) and the administration
of FSH (Embryo S) and PMSG as follow:

Day 1: All ewes were provided with intravaginal progestagen
        pessaries (Repromap, Upjohn)
Day 12: 20 NIH units Embryo S + 400 IU PMSG per ewe were
        administered intramuscularly

Day 14: The intravaginal pessaries were removed 48 hours after
        FSH and PMSG administration

Teasing was commenced 12 hours after pessary removal and
subsequently every 12 hours

Day 15: 0.1 mg GnRH (Fertagyl, Intervet) per ewe was
        administered intravenously 24 hours after pessary
        removal

Insemination was performed laparoscopically with 0.25 ml fresh
diluted semen (1:1 dilution with fat free heat treated milk)
at detection of oestrus and again 12 hours later. The ewes were
flushed on days 6 after artificial insemination.

On completion of treatment (Superovulation Program 2), the 10
ewes were devided into two groups of 5 (Treatment Group vs
Control Group). The Treatment Group received via intramuscular
injection 25 mg progesterone/ewe/day from Day 2 until Day 6
post oestrus to prevent mortification of possible embryos
(superovulation apparently influences luteal function)
(Jabbour, Ryan, Evans, & Maxwell, 1991). The Control Group
received no further treatment. Blood samples were collected
once daily from each ewe in the Control Group from Day 1 post
oestrus for a period of 10 days. The Experimental Group was
excluded from bloodsampling as a result of the progesterone
treatment.

(iii) Flushing technique.

Ewes were prepared for general anesthesia by fasting for a period of 24 hours. Anesthesia was induced by the intravenous administration of thiopentone (Intraval Sodium, Rhône-Poulenc Animal Health) and maintained, following endotracheal intubation by using a halothane/oxygen mixture. After restraining the animal on a laparoscopy cradle in dorsal recumbancy, the ventral abdomen was shaved and surgically prepared. The cradle was tilted at an angle of approximately 45° to the horizontal. Two small incisions were made 2 cm on either side of the midline about 10 cm anterior to the udder to allow for entrance of the trocar and cannulae. The endoscope was inserted through the left cannula and the abdomen insufflated with CO_2 after which the right trocar and cannula was inserted. Both ovaries were located and the corpora lutea counted. The incision through which the rightsided cannula protruded into the peritoneal cavity was enlarged to approximately 5 cm and the cannula removed. The uterus horn to be flushed was elevated through this incision. A sterile 20 gauge teflon intravenous catheter was placed in the tip of the uterine horn and directed towards the oviduct. A puncture wound was made into the uterine horn at the uterine bifurcation using a pair of closed artery forceps to prevent haemorrhage. A custom made sterile glass tube (Barry, 1994 unpublished) was inserted through the puncture towards the utero-tubal junction and kept in position with the aid of a modified forceps

(Barry, 1994 unpublished). A sterile 20 cc syringe containing
PBS flushing medium (Dulbecco's phosphate buffered saline)
was connected to the intravenous catheter in the tip of the
uterus horn. Digital pressure was applied to the oviduct to
occlude the lumen and prevent retrograde flow of media and ova
into the oviduct. Flushing medium was then infused via the
intravenous catheter into the uterus horn and drained through
the glass tube into a sterile glass beaker. When flushing was
completed, the uterine horn was gently massaged beginning at
the tip of the uterus horn and moving towards the glass tube to
remove all the remaining media from the horn. The catheter and
glass tube were removed and the puncture wound from the glass
tube was closed with a single suture. The procedure was
repeated for the second horn if corpora lutea were present.
When flushing was completed, the uterus was rinsed with sterile
flushing medium and replaced into the abdomen. Finally, the
wound was sutured and disinfected (Barry, 1994 unpublished;
Mc Kelvey et al., 1986; Schiewe et al., 1984; Smith & Murphy,
1984; Tervit & Havik, 1976; Walker, Warnes, Quinn, Seamark &
Smith, 1985).

The flushing medium was filtered off through a microfilter and
the embryos rinsed into Petri dishes which were systematically
scanned under a stereomicroscope at 40 x magnification.

10.2.4   Hormone assays

Refer Paragraph 4.2.4

(i) Bloodsampling Superovulation Program 1:

Blood samples for the determination of progesterone concentrations were collected once daily from all ewes from cessation of progestagen treatment until flushing commenced.

(ii) Bloodsampling Superovulation Program 2:

Blood samples were collected every 3 hours from 08:00 hours until 20:00 hours after administration of GnRH from all ewes to determine LH concentrations.

10.3   RESULTS AND DISCUSSION

The live weights of the 10 ewes that served as subjects in the trials involved, varied between 49 and 61 kg and remained fairly constant when monitored over a period of two weeks with ages varying between 15 and 16 months. These ewes were constantly monitored for standing oestrus and were well familiar with the operator and teaser rams and teasing procedures. All ewes were cyclic.

During the first attempt at superovulation (Superovulation Program 1; Paragraph 7.2.3 (i)) the ewes were divided into two groups of five viz. Group 1 (Embryo S) and Group 2 (Ovagen) (Table 10.2). The results of Superovulation 1 was disappointing in the sense that only one ewe from Group 2 (ewe no 705) displayed oestrous behavior following treatment. This particular ewe came on heat approximately 12 hours after cessation of treatment and was accordingly inseminated. Four ewes from Group 1 showed eostrus 10, 12, 13 and 15 days after cessation of treatment respectively. Apart from ewe no 705 in Group 2, only one other ewe from that Group came on heat 14 days after cessation of treatment. Four ewes, including ewe 705, were randomly selected and the ovaries laparoscopically examined 8 days after cessation of treatment with the following results. It should however be emphasized that structures which resemble corpora lutea, could be confused with cystic follicles or non-ovulatory luteinised follicles (Armstrong et al., 1982; Torres & Cognie, 1984).

Ewe no.

705	Left ovary	2 corpora lutea
	Right ovary	2 corpora lutea
716	Left ovary	1 corpus luteum
	Right ovary	2 corpora lutea + 4 follicles
695	Left ovary	3 corpora lutea + 5 follicles
	Right ovary	4 corpora lutea

704   Left ovary   1 corpus luteum + 7 follicles

         Right ovary   9 follicles

These observations are indicative of the fact that the
superovulation treatment exercised during Superovulation
Program 1 was only effective to a certain degree. The reasons
why the ewes did not display behavioral oestrus is however not
clear.

All ewes were treated with PGF2a (1 ml per ewe im) 15 days
post cessation of progestagen treatment. Two ewes showed
oestrus within 24 hours after treatment, 4 ewes within 48 hours
after treatment and 2 ewes within 72 and 96 hours after
treatment respectively. The remaining 2 ewes showed standing
oestrus only at 14 and 15 days after treatment with PGF2a.

Oestrous behavior was significantly better in reaction to
Superovulation Program 2 (Paragraph 10.2.3 (ii)) compared to
Superovulation Program 1. Six ewes showed oestrus within 36
hours after cessation of treatment. All ewes were inseminated
at detection of oestrus and again 12 hours later. Five ewes
(Treatment Group) were randomly selected and treated with
progesterone from day 2 to 6 after detection of oestrus
(Paragraph 10.2.3 (ii)). Flushing was performed 7 days after
artificial insemination. Laparoscopic examination of the
ovaries revealed the following results:

Treatment Group:

Ewe no.

713	Left ovary	2 corpora lutea
	Right ovary	2 corpora lutea
704	Left ovary	no corpora lutea
	Right ovary	3 corpora lutea
699	Left ovary	no corpora lutea
	Right ovary	1 corpus luteum (atrophic)
718	Left ovary	4 follicles
	Right ovary	2 follicles
728	Left ovary	1 corpus luteum + 1 corpus albicans
	Right ovary	2 follicles

Control Group:

Ewe no.

695	Left ovary	5 follicles + 1 corpus luteum (fresh)
	Right ovary	2 follicles (luteanised)
717	Left ovary	6 corpora albicans
	Right ovary	5 corpora lutea
705	Left ovary	3 corpora albicans
	Right ovary	5 corpora albicans
716	Left ovary	2 corpora albicans + 2 follicles
	Right ovary	3 corpora albicans + 1 follicle
714	Left ovary	4 follicles
	Right ovary	1 corpus albicans + 1 follicle

The final outcome of Superovulation Program 2 was similarly as disappointing as the results of Superovulation Program 1 due to the fact that no embryos or ova were detected in the flushing media. Since superovulation and embryo flushing and transfer is exercised on a regular basis in the host Department, the reasons for the atypical reactions that came forth during these tests are not clear. A number of reasons leading to poor results have been reported by different researchers and have been quoted under Paragraph 10.1. Speculation can be supplemented by the following suggestions supported by abstracts from the litterature.

In comparable work Armstrong et al. (1982) found that all animals which ovulated in response to PMSG administered 2 days before progestagen withdrawal had atropic, avascular appearing corpora at the time of laparotomy. A striking relationship was furthermore found between the number of unruptured follicles on the ovaries at the time of laparotomy and the maximal serum oestradiol concentration reached after PMSG treatment. Mean ovulation rate was also found to be lower when PMSG was administered 2 days before progestagen withdrawal (Armstrong et al. 1982). This was argued by mentioned authors to be the reason for complete failure of ovulation in all but three animals in the treatment group. In the three animals that did ovulate, the corpora lutea failed to be maintained, resulting in basal levels of progesterone concentration.

Hyperstimulation with PMSG was found to be highly correlated with raised serum oestradiol-17ß concentrations which could bring into play a premature luteolytic response which results in low progesterone concentration levels while PMSG also increases the rate of egg transport (Whyman & Moore, 1980). The early arrival of ova in the uterus in coherence with high oestradiol and low progesterone concentrations, which affects uterine contractility, could lead to the expulsion of ova from the uterus via the cervix.

The high level of oestrogen secreted by the stimulated follicles may contribute to an apparently inadequate endogenous LH surge. LH secretion is essential for ovulation to take place following PMSG treatment. Failure of ovulation may therefore be due to inadequate timing or amounts of LH released (Armstrong et al. 1982). It is also possible that ova could fail to enter the Fallopian tubes due to preceding manipulation of the ovaries during the processes of laparoscopic examinations and AI procedures by laparoscopy and stress associated with treatment.

During Superovulation Program 1, bloodsamples were only collected from ewe 705 as a result of the fact that she was the only ewe which demonstrated oestrous behavior. According to her progesterone profile (Figure 10.1) she apparently developed adequate luteal tissue since her progesterone levels rose from 2.384 ng/ml on the day of artificial insemination to 6.324
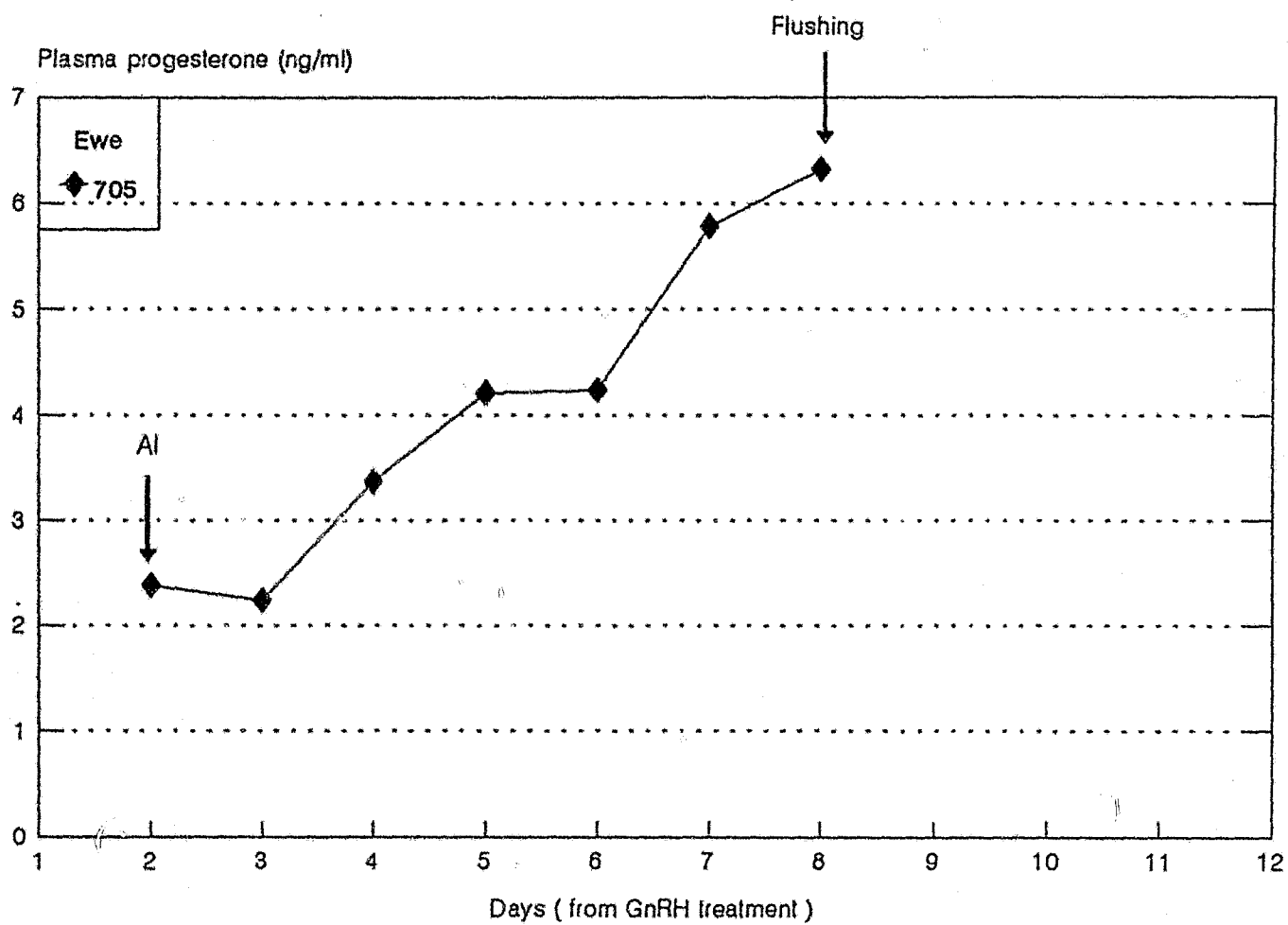
FIGURE 10.1 Plasma progesterone concentration after superovulation treatment
(Superovulation Program 2) (Oestrus: day 0)

ng/ml seven days later. This confirmed the results of the
laparoscopic investigation reported earlier.

Repeating the superovulation exercise, but applying a different
protocol (Superovulation Program 2, Paragraph 10.2.3 (ii)) an
attempt was made to investigate the influence of superovulation
on luteal function. Progesterone concentrations were recorded
for 5 ewes (Control Group) over a period of 10 days. Three of
the five ewes (Nos. 705, 717 and 695) displayed oestrous
behavior. Two of the three (Nos. 717 and 695) revealed a
distinctive rise in progesterone levels during the first two
days after artificial insemination (Figure 10.2) followed by
a sharp decline on Day 3 after artificial insemination. Only
one ewe (No. 717) recovered from this decline and displayed
what could be described as normal luteal development.
Progesterone concentrations for ewe 695 dropped to basal levels
on the third day where it remained. Progesterone concentration
levels for the remainder of the ewes (Nos. 705, 714, 716)
were at basal levels at artificial insemination and remained
there for the whole of the sampling period. This includes Ewe
705 which displayed oestrous symptoms. From these results it
therefore seem as if the hypothesis with regard the effect of
superovulation on luteal function may be substantive.

Ewe 705 (Superovulation Program 1) and ewe 717
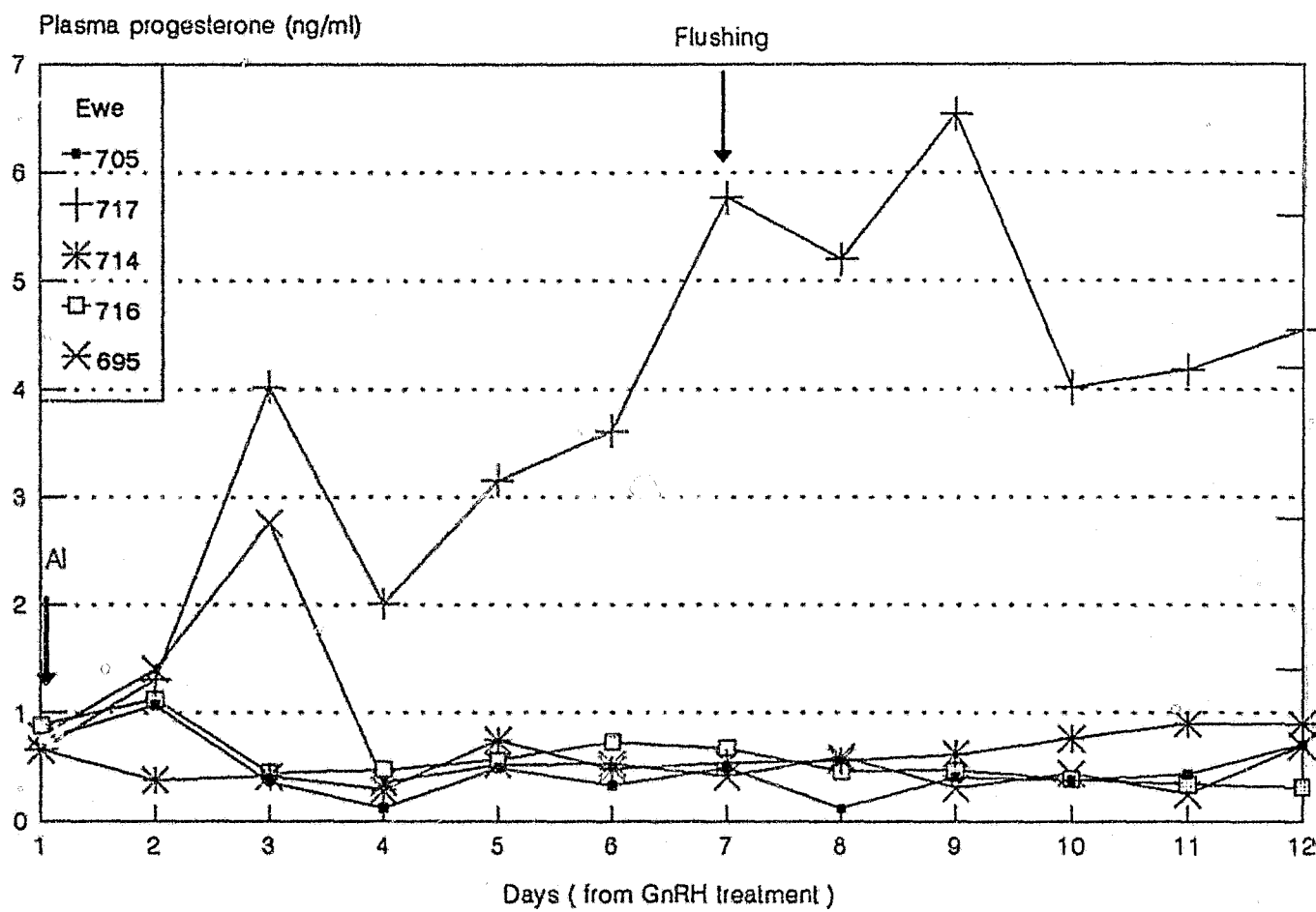
FIGURE 10.2 Plasma progesterone concentration after superovulation treatment
(Superovulation Program 2) (Oestrus: day 0)

(Superovulation Program 2) showed exceptionally high plasma progesterone levels (Figure 10.1 and 10.2). The reason for this could lie in the large amount of luteal tissue present (4 and 5 corpora lutea in ewe 705 and 717 respectively). The application of superovulation could have resulted in premature ovulations which could have been instrumental to the untimely high levels of progesterone on the one hand and the absence of embryos on the other.

Luteolysis in ewes requires pulsatile secretion of PGF2a from the uterine endometrium (McCracken, Schramm & Okulicz, 1984; Southee, Hunter, Law & Haresign, 1988) which in cyclic ewes appears to be controlled by pulsatile release of oxytocin from the corpus luteum and/or neurohypophysis. Oxytocin receptors are present in the endometrium of cyclic ewes and the number of receptors increases to near peak levels during luteolysis. Oxytocin-stimulated secretion of PGF2a probably occurs via activation of the inositol phosphate diacylglycerol second-messenger system within the endometrium.

Establishment of pregnancy in sheep requires the presence of a conceptus in the uterus by Day 12 to 13. Secretory products of sheep conceptuses are presumed to prevent luteolysis by altering endometrial secretion of PGF2a during the period of maternal recognition of pregnancy. Although basal secretion of PGF2a do not decrease during pregnancy in sheep, the number of

pulses of PGF2a is significantly reduced between days 12 and 17 of pregnancy.

The numbers of endometrial oxytocin receptors increase near the end of the oestrous cycle in cyclic ewes, but do not increase on equivalent days of pregnancy. This suggests that reduced uterine responsiveness to oxytocin secretion during pregnancy results from inhibition of oxytocin receptor formation. Ovine trophoblast protein-1 can block oxytocin-stimulated uterine production of PGF2a by inhibiting oxytocin receptor synthesis and therefore pulsatile secretion of PGF2a (Mirando, Ott, Vallet, Davis & Bazer, 1990).

Battye, Fairclough, Cameron & Trounson (1988) stated that regression of corpora lutea within 6 days of superovulation in goats and sheep is a major problem in embryo transfer programs since it results in low rates of embryo recovery. Available data indicates that uterine PGF2a plays a major role in luteolysis in the nanny goat and the ewe. It appears as if regression begins as early as 3 to 4 days after sponge removal in most animals. Most ovulations occur 36 to 60 hours after sponge removal in PMSG stimulated goats and it appears therefore as if regression of corpora lutea can occur within 2 days of their formation.

Comparatively high progesterone concentrations found on day 0 in females with premature ovulations, raise the possibility

that progesterone may be involved in early luteal failure. In the naturally cycling goat progesterone concentrations are at undetectable basal concentrations on Days 0 and 1 in contrast to levels in females with premature ovulations. Progesterone administration to ewes in the first three days after oestrus induces the early release of PGF metabolite and oxytocin and as a consequence shortens the luteal phase. It is possible therefore that progesterone, present because of premature ovulations may advance the maturation of the uterine PGF2a secretory system, thereby inducing early luteal failure (Battye et al., 1988).

Oestrogens play a role in regulating the uterine PGF2a synthetase system and this may be mediated by oxytocin as oestrogen can induce the development of oxytocin receptors in the endometrium. The oestrogen-induced rise in endometrial oxytocin receptor concentrations may provoke an increase in oxytocin-induced PGF2a response. It is possible therefore that PMSG-induced increases in plasma oestrogen concentrations may lead to an increase in the development of oxytocin receptors in the uterus much earlier than in the naturally cycling animal, permitting an oxytocin induced release of PGF2a and early luteolysis (Battye et al., 1988; Bainbridge, Hunter, Chapple, Flint & Jabbour, 1996).

According to Sharma et al. (1993) the lowest progesterone concentrations occurred 24 hours post progestagen withdrawal,

coinciding with oestrus. Post oestrus progesterone levels
showed an initial trend of gradual increase towards Day 4
(non-breeding season) and Day 5 (breeding season). High
progesterone levels at the mid-luteal phase of the previous
cycle are considered necessary for recruiting a greater number
of medium-sized follicles, thereby improving the superovulatory
response.

A summary of the comparative results of the laparoscopic
examinations from the Treatment Group and the Control Group are
displayed in Table 10.3. The difference in ovarial function
presented by the two Groups can however not be ascribed to the
application of progesterone to one Group, since treatment
commenced only two days after oestrus and can therefore be
viewed as circumstantial.

From Figures 10.3.1 and 10.3.2 it can be concluded that the
administration of GnRH resulted, within three hours, in a
distinctive rise in LH concentrations from basal levels to as
high as 31.64 ng/ml in one specific case. The LH levels of
eight of the ten treated ewes rose above 5 ng/ml during the
mentioned period of time. Even though the levels of the
remaining two ewes did not exceed 5 ng/ml, a slight incline
was discernible in both instances. These elevated levels of LH
lasted for less than 6 hours before returning to basal levels
approximately six hours after administration of GnRH.
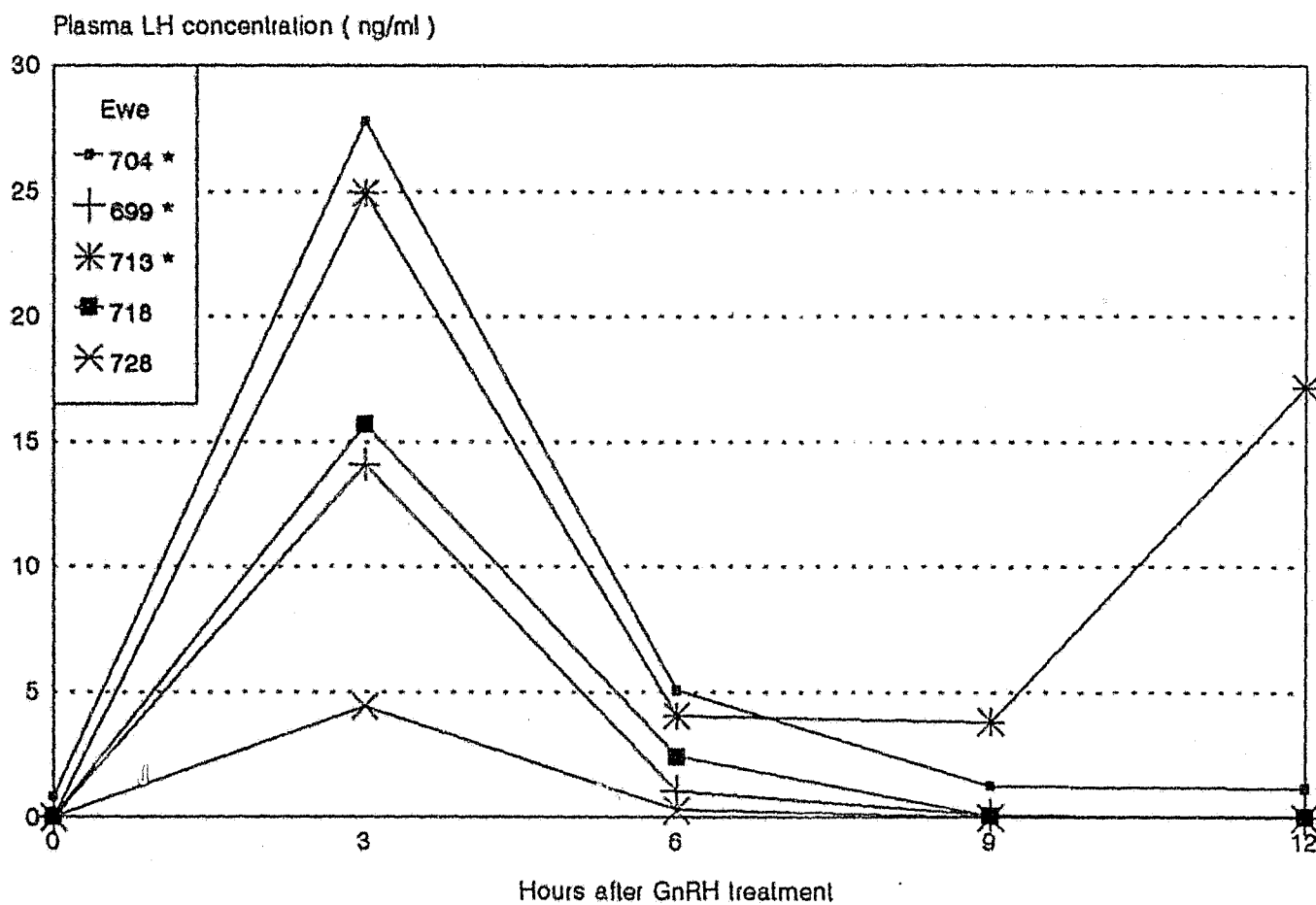
FIGURE 10 3.1 The influence of GnRH on LH secretion administered 24 hours after cessation of progestagen treatment (Superovulation Program 2: Experimental group)
* Exhibited standing oestrus

Plasma LH concentration (ng/ml)

Hours after GnRH treatment
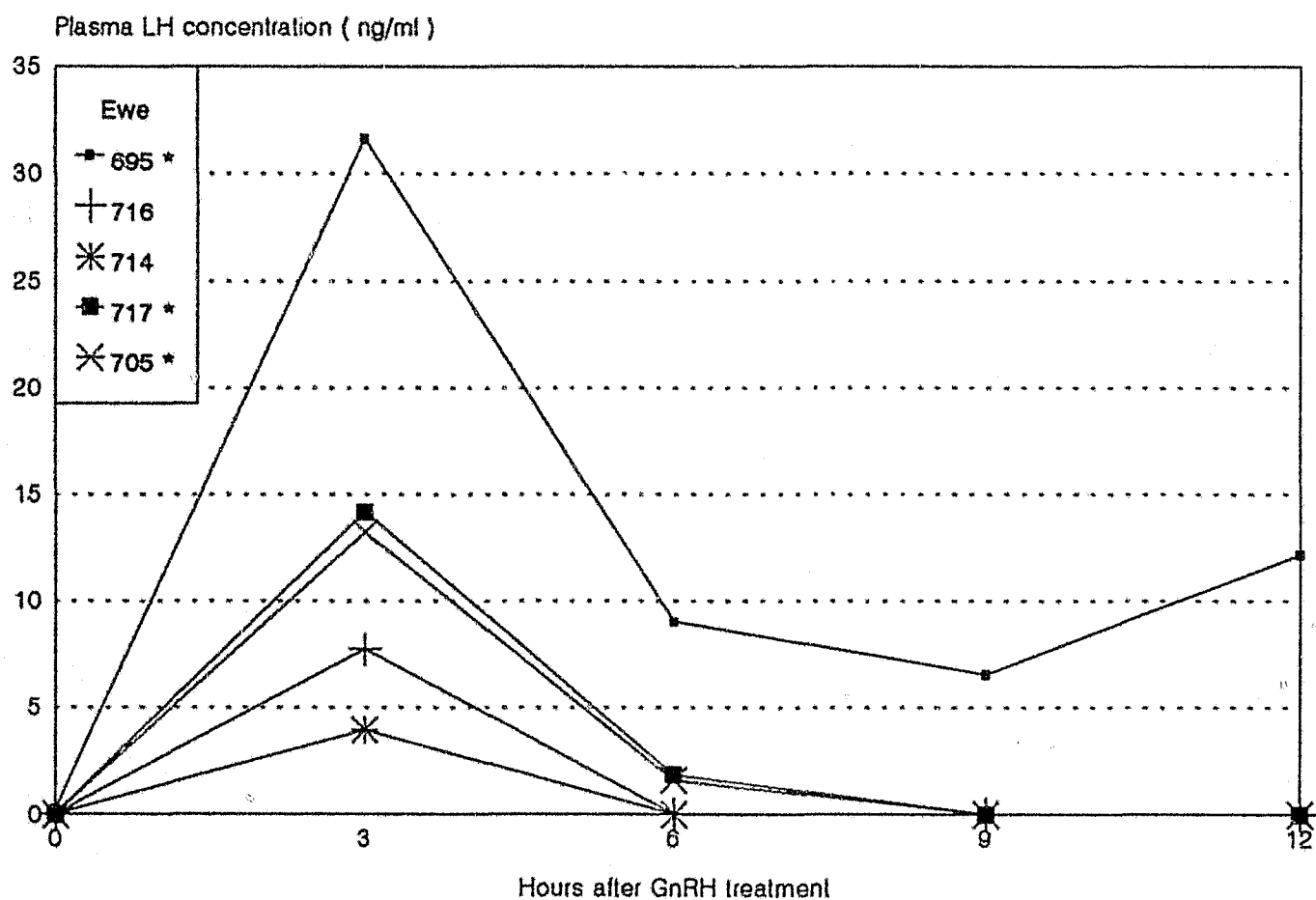
FIGURE 10.3 2 The influence of GnRH on LH secretion administered 24 hours after cessation of progestagen treatment (Superovulation Program 2: Control group)
* Exhibited standing oestrus

Table 10.3 Ovarial response to superovulation (Control
Group) and superovulation plus progesterone
treatment (Treatment Group)

	Treatment Group	Control Group
Corpora lutea	9	6
Follicles	8	16
Corpora albicans	1	20

The timing factor which is influenced by the application of
GnRH (Walker et al., 1987) has been confirmed in these
results. All six ewes that did show oestrus symptoms came on
heat simultaneously within 12 hours after administration of
GnRH.

Wright et al. (1981) demonstrated that ewes could be
superovulated with a treatment of six injections of FSH in a
declining dose regime. Superovulation was obtained when ewes
were injected with the same total dosage (20 mg) of FSH over
3.5 days (seven injections) or 2.5 days (five injections).
Robinson et al. (1989) were able to obtain acceptable
superovulation results with four injections of FSH (total of
16 mg) over two days. Limited observations suggest that at
least one injection should follow pessary removal. Agents used
for cycle regulation (progestagen or PGF2a) seem not to be a
factor in determining ovulation rate (Evans & Armstrong, 1984;
Rexroad & Powell, 1991).

Different protocols of FSH, PMSG and FSH + PMSG were
investigated by different research stations. In most instances
equal success rates were obtained in comparative studies
(Cognie et al., 1985; Cseh & Seregi, 1993; Sacher, Niemann,
Schilling & Smidt, 1984). According to Evans, Maxwell & Wilson
(1994) and Meinecke-Tillman, Lewalski & Meinecke (1993) the
number of FSH injections administered has no effect on
ovulating response, ova or embryo recovery.

Torres & Cognie (1984) reported widely varying responses
between animals whatever the composition or mode of injection
of FSH implemented. The yield of fertilized ova in ewes treated
with FSH can be maximized by administering GnRH 36 hours after
progestagen treatment and when insemination occurs at 6 hours
before the median time of ovulation which can vary between 48
and 60 hours after pessary removal depending on treatment and
season (Walker et al., 1990; Walker et al.,1987; Walker,
Smith, Frensham, Ashman & Seamark, 1989).

10.4   CONCLUSION

From a broad perspective these tests did not provide
substantial results, which led to a quest for possible reasons.
No clear-cut answers could be gained but quite a few
speculations arose under which the following: The relative
large north-south relocation distance could have had an effect
on the reproductive processes since photoperiod is affected to

a certain extent. Environment and climate could be involved. The animals were removed from a dry sub-tropical climate to a humid environment which was overcast most of the time. A third speculative reason that could be considered was body condition. The ewes were kept under optimal conditions since they were weaned and in the process accumulated superfluous body reserves which could be accountable for poor reproductive performance. There may be more unknown reasons which may be a cause for further investigation and which places a question mark over the justification of performing this kind of work on the Damara sheep.

SUMMARY OF THESIS

THE DAMARA SHEEP: AN APPRAISAL OF ITS REPRODUCTIVE
PERFORMANCE AND POTENTIAL

by

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1 INTRODUCTION

1.1 The Damara sheep is described in terms of its general
characteristics, the appearance of the head, conformation,
colour and hair covering, the tail, fertility and reproductive
organs. Discriminations and culling faults applicable to the
breed are also discussed.

1.2 Epstein (1971) relates the views of different historians
on the origin of the fat-tailed sheep. Apparently the ancestry
of both long thin-tailed sheep and long fat-tailed sheep is
identical and both originated from domesticated breeds from
Asia with *Ovis orientalis arkal* as the earliest known ancestor.
The fat-tailed sheep entered Africa via a northern route
through the Isthmus of Seuz and via a southern route through
the straits of Bab el Mandeb. The southern stream migrated from
the Red Sea littoral and Ethiopia into the lake districts of
Uganda, Kenya and Tanzania and further southwards to Zimbabwe,
Southern Africa and westwards to Angola. A breed of sheep
answering to a description related to the Damara sheep
eventually reached South Western Angola and North Western
Namibia where they were herded by the Himba and Sjimba people
and remained relatively free from outside influences. In 1954 a
nucleus herd was established at Omatjenne Research Station
where they were submitted to a breeding program and from where
breeding stock was made available to breeders.

2 STATUS OF THE DAMARA SHEEP IN COMMERCIAL FARMING: RESULTS FROM A QUESTIONNAIRE

2.1 In an attempt to establish the economic status of the Damara sheep, a questionnaire was compiled and dispatched to Damara sheep breeders in Namibia and South Africa. Information gathered from the questionnaire was combined with data received from The Meat Corporation of Namibia in Windhoek on commercial slaughterings.

2.1.1 Average rainfall and veld types

Damara sheep are primarily farmed with in areas which receive 200 - 300 mm average rainfall per annum which is indicative of arid and semi-arid regions and is in agreement with the veld types where Damara sheep are farmed with according to results from the questionnaire viz. Karoo (RSA), Highland savanna, Camelthorn savanna and Mopane savanna (Namibia) (Table 2.2.1 and Figure 2.2.1).

2.1.2 Size of breeding herds, breeding methods and cross-breeding

Herds consist of small numbers (less than 100) with only a few breeders indicating more than 500 sheep. This implies that there is enormous potential for development of the national Damara sheep herd (Figure 2.3.1).

Flock mating is the favored breeding method and the Dorper sheep is the favored breed employed for cross-breeding purposes (Figure 2.3.2 and Table 2.3.1).

2.1.3 Mating season and ram/ewe ratio

Spring-breeding (45.5 %) is preferred by respondents followed by Autumn breeding (34.5 %) which is quite abnormal in view of the fact that autumn breeding is the natural breeding season for small-stock (Figure 2.4.1).

A 1:30 ram to ewe ratio (34 %) is mostly applied by breeders followed by a 1:50 ratio (32.1 %) and a 1:40 ratio (20.1 %) (Figure 2.4.2).

2.1.4 Lambing percentage, lamb percentage and weaning percentage

Mean percentages for above mentioned parameters are indicated as 91.3 %, 97.6 % and 90.7 % respectively (Figures 2.5.1, 2.5.2 and 2.5.3).

2.1.5 Replacement stock, marketing and age at marketing

There is no clear indication as to the number of animals retained for breeding purposes. 53.8 % of the respondents

indicated that they market less than 50 animals per annum which could reflect on the average herd size (Figures 2.6.1, 2.6.2 and 2.6.3).

Data made available on marketing age should be compared to similar data made available by Meatco in Windhoek (Paragraph 2.11).

2.1.6 Other farming operations

Keeping of Damara sheep is primarily combined with cattle farming (80.7 %) and to a lesser extend to goat farming (38.6 %) and other sheep (33.3 %). 15.8 % of the respondents indicated cropping systems while game, pigs and horses are only marginally represented (Figure 2.7.1).

2.1.7 Health care

66.7 % respondents indicated that they inoculate against disease of which enterotoxaemia, pasteurellosis and blue-tongue are the most important. 66.7 % also indicated that they take preventative measures against internal parasites and 49.1 % against external parasites (Figure 2.8.1).

2.1.8   Positive and negative characteristics ascribed to the
Damara breed

The most important positive characteristics were indicated as
follows:

- a hardy, adaptable, low maintenance breed

- strong mother instincts

- effective grazer and browser

- resistive towards diseases and parasites

- high fertility rate

The two most relevant negative characteristics were indicated
as:

- consumer resistance towards fat tail and carcass conformation

- difficult handling as consequence of spirited temperament

2.1.10   Data on commercial slaughterings

Data on slaughterings of Damara sheep at Meatco, Namibia in
Windhoek was accumulated over a period of 12 months.
Information about age and sex slaughtered are presented in
Figures 2.11.1 and 2.11.2 and summarized in Figure 2.11.5
(Chapter 2). Distribution of slaughtered sheep on grounds of
degree of fatness is presented in Figure 2.11.4.

3   GROWTH AND REPRODUCTION RELATED INFORMATION COMPILED AT
OMATJENNE RESEARCH STATION (NAMIBIA) AS REFERENCE TO
EXTENSIVE HUSBANDRY PRACTICES INVOLVING THE DAMARA BREED

At Omatjenne Research Station, live weights are normally
determined at birth, wean (± 90 days), 6 months, 9 months and
12 months of age. The difference in weight gain (1.678kg,
2.183kg, 2.182kg, 2.711kg respectively) observed between
spring and autumn bred lambs can probably be ascribed to range
conditions during specific times of the year but are not
significant (P > 0.05).

Weight increases at Omatjenne as compared to weight increases
of experimental animals kept under intensive conditions at
Neudamm, showed a noticeable difference (1.0kg at birth, 8.5kg
at weaning, 5.1kg at 6 months, 1.4kg at 9 months and 4.8kg at
12 months) which can be regarded as indicative of the real
growth potential of the Damara sheep.

Maiden Damara ewes are normally introduced to the ram at an age
of 12 to 18 months. During the breeding period ewes are herded
into groups of approximately 35 ewes. Each group is served by a
single identified ram for a specified period of time. Lambing
percentage has stabilized at above 100% since 1984. Related
data is displayed in Table 3.3.1. No significant difference
with regard breeding parameters were observed between seasons
(P > 0.05)

A trial during which the influence of docking on reproductive performance was investigated, revealed a marked improvement on lambing results by docked ewes (120% to 90%). This led to the conclusion that the tail of the Damara ewe can pose a certain degree of difficulty for the ram when mounting. The differences were however not significant (P > 0.05).

Available figures concerning losses with regard vermin, stocktheft, disease and accidents on Damara sheep were compared to those on Boergoats. These figures were obtained from Omatjenne records. The Damara significantly outweighed the Boergoat in almost every respect (P < 0.05).

4   THE EFFECT OF DIFFERENT SYNCHRONISATION REGIMES ON THE PERIODICITY OF THE OESTROUS CYCLE, OVARIAL FUNCTION AND SERUM PROGESTERONE AND LUTEINISING HORMONE CONCENTRATIONS DURING THE OESTROUS PERIOD

Different techniques applied in the regulation of oestrus in sheep and its effect on fertilization have been investigated. Reference is made to the role of progesterone and LH and the significance of these two hormones on the events that take place during the oestrous cycle.

Four different treatment groups of 10 ewes each were employed:

Group A1 : Continuous presence of a male during the trial
period of 12 days.

Group A2: Insertion of progestagen pessaries for a period of 12
days and administration of PGF2a at pessary removal.

Group A3: Insertion of progestagen pessaries for a period of 12
days and administration of PMS at pessary removal.

Group A4: Insertion of progestagen pessaries for a period of 12
days.

In Group A1, 40 % of the ewes displayed oestrus within one week
after removal of the ram and another 40 % approximately one
cycle period later. Two ewes were apparently not affected.
In Group A2 the average interval from cessation of treatment to
onset of oestrus was 94.8 hours. Notable variation exists
however in reports made by other researchers in this regard.
In Group A3 the average interval was 58.67 hours which is
significantly longer than intervals observed under the same
treatment quoted in the literature. In Group A4 the average
interval between pessary removal was recorded as 85.2 hours.
Group A1 differed significantly from Groups A2, A3 and A4
(P < 0.05).

In most instances the interval from cessation of treatment to
onset of oestrus was notably longer than similar observations

quoted in the literature. General inconsistency prevailed with regard the interval from cessation of treatment to onset of oestrus.

In Group A1 the average duration of oestrus was found to be 36 ± 10.7 hours and within range of most of the existing data. The mean duration of oestrus can however differ significantly among breeds and from season to season (Quirke *et al.*, 1988). The duration of oestrus in Group A2 was found to be 34.8 ± 6.46 hours which is in agreement with quoted figures. The average duration of oestrus for Group A3 was 50.67 ± 14.73 hours which appears to be significantly longer than figures quoted in the literature. Duration of oestrus for Group A4 was 36.0 ± 12.0 hours. The differences were however not significant (P > 0.05).

The average position of the LH peak relative to the onset of oestrus (0 hours) occurred between 6 and 18 hours for Group A1 with the highest mean concentration of 8.479 ± 12.081 ng/ml at 6 hours. In Group A2 the mean LH peak congregated at 6 and 12 hours after onset of oestrus with the highest average concentration of 14.337 ± 15.644 ng/ml at 6 hours. Group A3 displayed a singular average LH peak at 6 hours, reaching a mean concentration of 7.393 ± 11.170 ng/ml.

Group A4 portrays a dispersal of mean LH peak concentrations situated between onset of oestrus (0 hours) and 24 hours with

7.447 ± 18.127 ng/ml as the highest average concentration. The aggregate average position for all four groups relative to onset and cessation of oestrus is 7.58 ± 2.575 hours and 26.14 ± 5.066 hours respectively. The occurrence of LH peak concentrations did not differ significantly between groups (P > 0.05).

The four treatment groups (A1 - A4) were laparoscopically examined to determine the status of the ovaries in possible reaction to treatment. The applied treatments did not seem to differ in their influence on ovarial function.

5 THE EFFECT OF DIFFERENT APPLICATIONS OF FERTILIZATION ON REPRODUCTIVE OUTCOME

Twenty ewes were subjected to artificial insemination and twenty to natural tupping one oestrous period subsequent to treatments described in the previous chapter. All ewes, except one, conceived during the first attempt at AI and hand mating. The outstanding ewe conceived during the ensuing oestrous period. Total conception was therefore 100 % with a consequent lamb percentage of 100 %, a lambing percentage of 110 % and fecundity of 1.10. and no significant difference between treatments (P > 0.05).

6 DURATION OF THE GESTATION PERIOD AND SENSITIVITY OF THE
CORPUS LUTEUM TOWARDS PGF2A DURING THE GESTATION PERIOD

One pair of ewes, each coming from the original treatment
groups (A1 - A4) was allocated to a specific month during the
gestation period (1 - 4). Each pair of ewes were injected
with 1 ml PGF2a according to the month of gestation they
represented. Blood samples were taken from treatment until
abortion or alternatively for 10 consecutive days. No abortions
however occurred. This first trial was succeeded by a second
trial in which the concentration of PGF2a was doubled and which
resulted in abortions during early pregnancy. Duration of the
gestation period varied between 147 and 153 days.

7 THE POST PARTUM PERIOD OF THE DAMARA EWE AND THE INFLUENCE
OF SEASON ON REPRODUCTIVE ACTIVITY

During the post partum period ewes were tested daily with
vasectomised rams while blood samples were collected twice
weekly. All ewes were lactating for 90 days post parturition.
Oestrus is however not associated with the first ovulation post
partum while lactation delays the post partum return to
oestrus. The mean post partum period for the trial under
discussion was 79.65 ± 15.791 days.

Ten ewes were monitored daily throughout a period of 12 months
to determine their sexual activity by daily exposure to

vasectomised rams and taking of blood samples twice a week. All
ewes displayed regular cyclic activity throughout the whole
testing period with an average cycle duration of 17.801 ± 0.577
days. Season exercises an influence on reproductive activity
which is subdued during the month of November, gradually
increasing towards February whence it levels off until August
followed by a decline towards November. Cyclicity did however
not differ between seasons (P > 0.05). This leads to the
assumption that the Damara breed has a fairly extensive natural
breeding season. Practical experience however proved that
breeding can be exercised successfully throughout the year.

8   THE ATTAINMENT OF PUBERTY IN MALE AND FEMALE DAMARA LAMBS

Thirty weaned ewe lambs were transferred from Omatjenne
Research Station to Neudamm Agricultural College to serve in
trials during which various aspects leading to the attainment
of puberty were investigated. Eleven ram lambs were
simultaneously put on trial. The ewe lambs were devided into
three experimental groups viz.

Group X: Control group (isolated)
Group Y: Monitored daily with vasectomised rams
Group Z: Males continuously present

Blood samples were collected from all ewe lambs from the age of
6 months until manifestation of first oestrus. All lambs were
weighed once a week.

The average age and body weight for Group Y at puberty was 281.22 ± 64.62 days and 43.78 ± 7.9 kg and for Group Z 299.65 ± 19.82 days and 46.125 ± 4.9 kg. The difference is however not significant (P > 0.05).

In ram lambs certain anatomical developments gradually take place under the control of testosterone. The normal succession of these developments is that the testes first descend into the scrotum. In the immature lamb, the glans penis and the *processus urethrae* are completely adherent to the prepuce. Under the influence of the testicular hormones, there is a gradual breakdown in the adhesions and the penis becomes freed.

After all penial adhesions were freed (attainment of anatomical puberty) ejaculates were collected at weekly intervals. The age at which sperm first appeared in the ejaculate was considered to be the age at which physiological puberty was attained. The youngest age at which anatomical puberty was attained was 97 days at a body weight of 30 kg and for physiological puberty, 120 days and 39 kg with a scrotal circumference of 23.5 cm.

9   MACROSCOPIC TRANSFORMATIONS OF THE REPRODUCTIVE TRACT OF
MAIDEN DAMARA EWES AT DIFFERENT STAGES OF THE REPRODUCTIVE
CYCLE

The reproductive organs of six maiden Damara ewes were
investigated for possible changes in the macroscopic structure
of the reproductive organs during the oestrous cycle. The
oestrous cycles of these ewes were synchronised and two ewes
were allocated to day 0, two ewes to day 7 and two ewes to day
13 of the oestrous cycle. The two ewes representing each of the
three designated stages of the oestrous cycle were weighed and
slaughtered at the respective stages during the oestrous cycle
which they represented. The reproductive organs were carefully
disected out and weighed after which it was examined and
described according to the headings set out in Chapter 9. No
indications were observed which distinguishes the Damara ewe
from any other breed with regard the macroscopic structure of
the reproductive organs.

10   SUPEROVULATION AND EMBRYO TRANSFER

Ten cycling maiden Damara ewes were transferred from Neudamm
Agricultural College to Welgevallen Experimental Farm at
Stellenbosch where they were allowed to adapt for approximately
one month. Two subsequent superovulation regimes
(Superovulation Program 1 and Program 2) were applied to
these ewes. Blood samples were collected for analysis.

Insemination was performed laparoscopically with fresh diluted semen at detection of oestrus and again 12 hours later. The ewes were flushed on day 6 or 7 after AI. The results of both Superovulation Programs 1 and 2 were similarly disappointing due to lack of oestrous symptoms (Superovulation Program 1) and failure to trace ova or embryos in the flushing medium (Superovulation Program 2).

The effect superovulation presumably has on luteal function was investigated by dividing the ten ewes into a Treatment Group (administered 25 mg progesterone/ewe/day from Day 2 until Day 6 post oestrus) and a Control Group (blood samples were taken for 10 consecutive days post oestrus and analyzed for progesterone). The outcome of this trial supported the view that superovulation may have a negative influence on luteal function.

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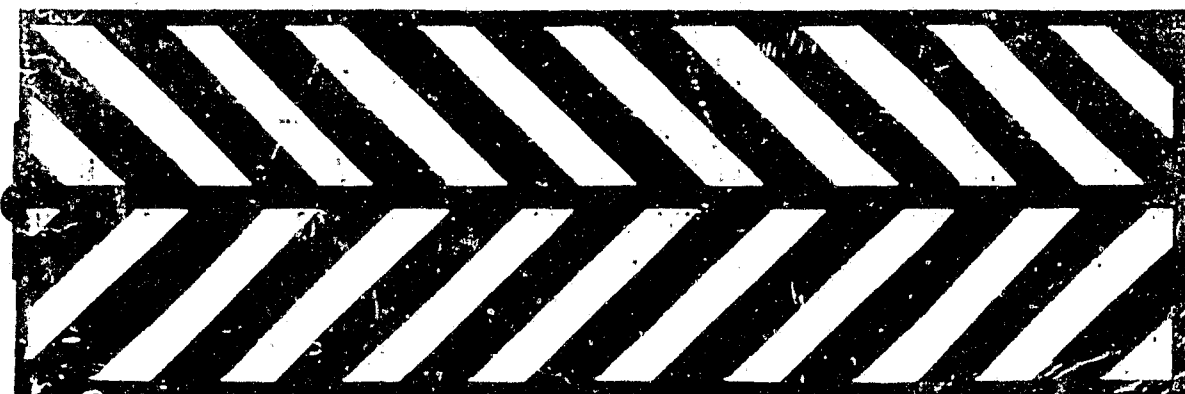   *Theriogenology 28, 129.*

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END OF ROLL

MGX

ROLL NO.