Early Foetal Death in the Mare
Histological, Bacteriological and Cytological Findings in the Endometrium

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Darenius, K.: Early faetal death in the mare: Histological, bacteriological and cytological findings in the endometrium. Acta vet. scand. 1992, 33, 147-160. – Fifteen mares which had each lost their pregnancies 2 to 8 times during the preceding 6 years were used in a study comprising 1 or 2 breeding seasons for each mare. During the research period all 15 mares conceived and 10 of the mares had normal pregnancies in the 1st experimental year. Five mares resorbed/aborted once or twice during the 1st year. This was followed by a pregnancy that terminated in a live foal.

Histopathological examinations of uterine biopsies showed a wide range of histopathological conditions, from absence of changes excessive for the mare's age and parity to the most severe changes of the endometrium. Most likely, endometritis, acute as well as chronic degenerative endometritis, is the most common cause of early foetal death in the mare.

Good breeding management is essential and was often enough to make the mares produce a foal. Additional treatment was needed in some of the mares and was based on the course of the conceptus loss and the condition of the endometrium, as determined by clinical, histological, bacteriological and cytological examinations.

Introduction

Several studies have indicated a relationship between the severity of chronic degenerative changes in the endometrium and the mare's potential to carry a foal to term. *Kenney* (1978) suggested that periglandular fibrosis may be a common cause of early foetal death (EFD) in mares before day 90 of gestation and field studies have supported this hypothesis (*Doig et al.* 1981, *de la Concha-Bermejillo & Kennedy* 1982, *Shideler et al.* 1982).

Chronic degenerative endometritis is characterized by the presence of glandular degenerative changes, gland nests and cysts, and diffuse and periglandular stromal fibrosis (*Ricketts* 1978). The fibrosis leads to separation of the glandular epithelium from the normal underlying capillary network, which seriously impairs the function of the gland. Separation often also occurs just beneath the basal membrane of the luminal epithelium (*Kenney* 1978). Fibrosed mares are suspected to have a lowered resistance to bacterial challenge at the time of breeding (*Doig et al.* 1981).

Ricketts (1975, 1988) stated that recurrent acute endometritis often leads to widespread diffuse fibrosis which decreases the functional area of placental exchange and may cause EFD. *Neely et al.* (1983) considered fibrosis to be a permanent and irreversible change, whereas *Ricketts* (1988) reported that successful treatment of the acute endometritis followed by pregnancy was sometimes accompanied by a reduction in the signs of stromal fibrosis.

In a field study, *Woods et al.* (1987) found a significantly higher rate of EFD in mares

with a history of endometritis than in mares with no history of endometritis. A higher EFD frequency has also been reported in mares with cytological or ultrasonographic evidence of inflammation (*La Cour & Sprinkle* 1985, *Adams et al.* 1987).

The aim of this work was to investigate the condition of the uterine endometrium according to clinical, histological, bacteriological and cytological examinations in mares with a history of repeated pregnancy loss. The term early foetal death (EFD) in this paper covers both embryonic and foetal death up to 150 days of gestation.

Material and methods

Animals

Fifteen mares, which had each lost their pregnancies 2 to 8 times during the preceding 6 years, were used in the study. The experi-

mental period comprised 1 or 2 breeding seasons for each mare. The age, breed and breeding history of the mares are summarized in Table 1. The mares were housed at an experimental station in central Sweden and kept on pasture during the summer when their feed was supplemented by hay, oats and minerals. The mares were in good nutritional condition. They were teased daily and mated/inseminated as few times as possible close to ovulation, beginning at the end of May. The mares that had normal pregnancies directly during the experimental period had been mated/inseminated during only 1 oestrous period, except mare C which was mated/inseminated during 3 oestrous periods.

Clinical examination of the genital organs

The uterus and ovaries of the mares were examined by palpation and ultrasound scan-

Table 1. Age, breed and breeding history of 15 mares.

Mare	Age years	Breed	Total no. of live foals	Results from mating											
				1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
A	12	Sb	5	F	F	R	R	F	R	**A**	**F**				
B	14	Sb	5	F	B	F	R	R	R	**NP**					
C	19	Sb	5	F	R	R	A	A	A	**F**					
D	14	Tb	1	F	-	-	-	R	R	**NP**					
E	11	Sb	2	B	R	R	F	R	-	**NP**					
F	16	Sb	9	F	F	A	F	R+F	R	**NP**					
G	15	Sb	6		F	F	F	B	R	R	**F**				
H	9	Tb	0		-	-	R+R	R+R	R+R	R+R	**R+F**	B	F		
I	10	Sb	0		-	-	R	R	R	-	**NP**				
J	16	Sb	3		-	B	B	B	R	R	**R**	F			
K	12	Sb	1				-	F	R	R	A	A	**R+R**	F	
L	12	Tb	2				R	F	R	R	R	A	**F**		
M	13	Sb	0				-	-	R	R+R	R	R	**F**		
N	9	Sb	1				-	-	-	F	R	R	**F**		
O	10	Sb	0					-	-	-	B	R	**R+R**	**R+F**	**R+F**

Sb = Standardbred, Tb = Thoroughbred, A = confirmed abortion, B = barren (mated, not confirmed pregnant), F = foaled, NP = Normal pregnancy at 5 months of gestation, R = resorption, - = not mated. The results during the research period are printed in bold type.

ning per rectum using a real-time B-scanner, with a frequency of 3.5 MHz (Vetscan, Fischer Ultrasound Ltd, Edinburgh, UK). The vaginal mucosa and cervix were visualized using a speculum. Genital examinations were performed daily during oestrus, once a week during dioestrus, at least twice a week between days 14 and 100 of gestation and once a week between days 100 and 150.

Laboratory examinations
Endometrial samples for bacteriological and cytological examinations were taken with guarded swabs (Teigland Swabs, Haver Lockhart Lab., Shawnee, KS, USA or Kalayan Swabs, Kalayan Industries Inc., Long Beach, CA, USA) during oestrus, generally 4-6 weeks before mating. The bacteriology swabs were placed in a transport medium (modified Cary-Blair Bacterial Transport Medium, Marion Scientific, Kansas City, MO, USA or Amies Charcoal Transport Medium, Exogen, Clydebank Industrial Estate, Clydebank, UK) and cultured within 24 h under aerobic and anaerobic conditions, as described by *Darenius et al.* (1988). Cytology smears were prepared and interpreted according to *Ricketts & Mackintosh* (1987). The classification used in the present work was 0 = no polymorphonuclear leukocytes (PMNLs), ± = <0.5% of the cells in the smear PMNLs, + = 0.5-5% PMNLs, ++ = 5-30% PMNLs and +++ = >30% PMNLs.
Endometrial biopsies were taken from 1 uterine horn using a Kenney-type forceps (Narco-Pilling, Fort Washington, PA, USA). The biopsies were taken during the luteal phase after the oestrus when samples were taken for bacteriological and cytological examinations. The material was fixed in Bouin's fluid and the histological interpretation was made according to *Ricketts* (1978).
After spontaneous resorption/abortion, the laboratory examinations were repeated during oestrus. After a period of barrenness, new endometrial swabs were taken for bacteriological and cytological examinations.
In mare K endometrial swabs were also taken during the 1st year at the oestrus for insemination (no. 2), during resorption (no. 3) after the 1st resorption (no. 4), after a barren period (no. 5) and after the 2nd resorption (no. 6) (*Darenius et al.* 1989). During the 2nd year additional swabs were also taken at the oestrus for insemination (no. 2).
In mare O, which originally was a clinical case, endometrial swabs were taken the 1st year 3 weeks before insemination and at the oestrus for insemination (no. 2).

Results
During the research period, all 15 mares conceived and 10 of the mares had normal pregnancies in the 1st experimental year. Five mares resorbed/aborted once or twice during the 1st year, followed by a pregnancy which resulted in the birth of a live foal (Table 1).
The results from the laboratory examinations of the normal pregnant mares are summarized in Table 2. The results for the mares that resorbed/aborted during the research period are summarized in Table 3.

Mare A: Mare A aborted the 1st year in research on day 113 of gestation and developed a normal pregnancy the 2nd year, resulting in delivery of a healthy foal. The laboratory findings from examinations performed before breeding in both experimental years and after abortion were consistent: no growth of bacteria, no inflammatory cells present in the smears and no histopathological findings in the endometrium, i.e. the chronic infiltrative and degenerative changes seen were acceptable for the age and parity of the mare (Table 3, Figs. 1 and 2).

Mare B: Histopathological examination showed only low-grade acute endometritis despite a layer of degenerated polymorpho-nuclear leukocytes (PMNLs) in the uterine lumen overlying the luminal epithelium (Fig. 5). The bacteriological and cytological examinations were negative (Table 2).

Mare C: Mare C had a purulent discharge from the uterus and a cervical laceration involving the posterior part of the cervix. There was pure growth of *Streptococcus zooepidemicus* and more than 30% of the cells in the smear were PMNLs (Table 2). Histopathological examination showed that mare C had severe acute endometritis (pyometra), accompanied by severe chronic infiltrative endometritis and advanced chronic degenerative changes (Fig. 3). The mare was treated with benzyl penicillin parenterally and locally and inseminated using the Minimal Contamination Technique (*Kenney et al.* 1975, *Darenius et al.* 1988).

Mares D, E, F: See table 2.

Mare G: Histopathological examination showed the mare to have low-grade acute endometritis, with PMNLs migrating through the luminal epithelium into the uterine lumen, and moderate chronic infiltrative endometritis. The acute endometritis was verified by the presence of 5-30% PMNLs in the smear, but there was no growth of bacteria (Table 2). The mare was treated with antibiotics due to a penetrating skin wound associated with lymphangitis before mating.

Mare H: In the 1st experimental year, mare H resorbed the conceptus on day 21-25 of pregnancy. After the resorption the mare developed a twin pregnancy which turned into a singleton pregnancy around day 60-66 and delivery of a healthy foal. During the 2nd year in research the mare had a normal pregnancy and gave birth to a single healthy foal (*Darenius et al.* 1992). The findings from

Table 2. Normal pregnant mares. Results from microbiological, cytological and histopathological examinations of the uterus 4 to 6 weeks before mating.

Mare	Microbiology		Cytology	Histology
	Aerobic	Anaerobic		
B	0	0	0	Low grade AE
C	Strept. zooepidemicus	Strept. zooepidemicus	+++	Severe AE, severe CIE and advanced CDE
D	0	0	0	Early CDE
E	0	Clostridium sp.	0	Low grade AE and early CDE
F	0	0	0	Low grade AE, moderate CIE and advanced CDE
G	0	0	++	Low grade AE, moderate CIE
I	Strept. zooepidemicus	Strept. zooepidemicus	+	Severe CIE and advanced CDE
L	Acinetobacter sp.	Clostridium sp.	±	Low grade AE
M	0	Bacteroides intermedius	0	No histopathological changes
N	Strept. zooepidemicus	Strept. zooepidemicus	0	No histopathological changes

Microbiology: 0 = no growth of bacteria or fungi.
Cytology: 0 = no polymorphonuclear leukocytes (PMNLs), ± = <0.5% PMNLs, + = 0.5-5% PMNLs, ++ = 5-30% PMNLs, +++ = >30% PMNLs.
Histology: AE = acute endometritis (low, moderate or severe grade), CIE = chronic infiltrative endometritis (low, moderate or severe grade), CDE = chronic degenerative endometritis (early, moderate or advanced).

Table 3. Mares resorbing/aborting during the experimental period. Results from microbiological, cytological and histopathological examinations of the uterus before mating and after eventual period of barrenness, resorption or abortion.

Mare	Year	Oestrus no.	Microbiology		Cytology	Histology
			Aerobic	Anaerobic		
A	1982	1	0	0	0	No histopathological changes
		2*	0	0	0	"-
	1983	1	0	0	0	"-
H	1983	1	0	0	0	Low grade CIE
		2*	0	0	0	-
	1985	1	0	0	0	Low grade CIE
J	1983	1	0	0	+	Moderate AE
		2*	E. coli	0	+	Severe AE
		3	0	0	0	Low grade AE
	1984	1	0	0	+	Low grade AE
		2	Strept. uberis	0	0	-
K	1985	1	Bacillus sp.	0	±	No histopathological changes
		2	0	0	+	-
		3	0	Actinomyces	0	-
		4*	Ps. fluoresc.	-	0	Severe CIE
		5	Gram - rod	0	+	-
		6*	Acinetobacter lwoffi	-	0	Low grade AE, Low grade CIE, early CDE
	1986	1	Bacteroides sp.	0	0	Low grade AE, low grade CIE, early CDE
		2	E. coli α Streptococci Gram - rod	-	±	-
O	1986	1	Staph. sp.	0	±	No histopathological changes
		2	0	-	0	-
		3*	0	-	+	-
	1987	1	Ps. fluorescens	0	±	-
		2*	E. coli	-	±	Severe CIE, early CDE
		3	Ps. fluorescens E. coli	-	+	-

Microbiology: 0 = no growth of bacteria or fungi, - = not cultured.
Cytology: 0 = no polymorphonuclear leukocytes (PMNLs), ± = <0.5% PMNLs, + = 0.5-5% PMNLs, ++ = 5-30% PMNLs, +++ = >30% PMNLs.
Histology: AE= acute endometritis (low, moderate or severe grade), CIE= chronic infiltrative endometritis (low, moderate or severe grade), CDE= chronic degenerative endometritis (early, moderate or advanced).
* = resorption or abortion.

laboratory examinations performed before breeding in both experimental years and after resorption were consistent: no growth of bacteria and no PMNLs in the smears. Biopsies were only taken before breeding in both years and revealed low-grade chronic infiltrative endometritis with mononuclear cell infiltration (Table 3).

After the resorption during the 1st experimental year, no laboratory results were avail-
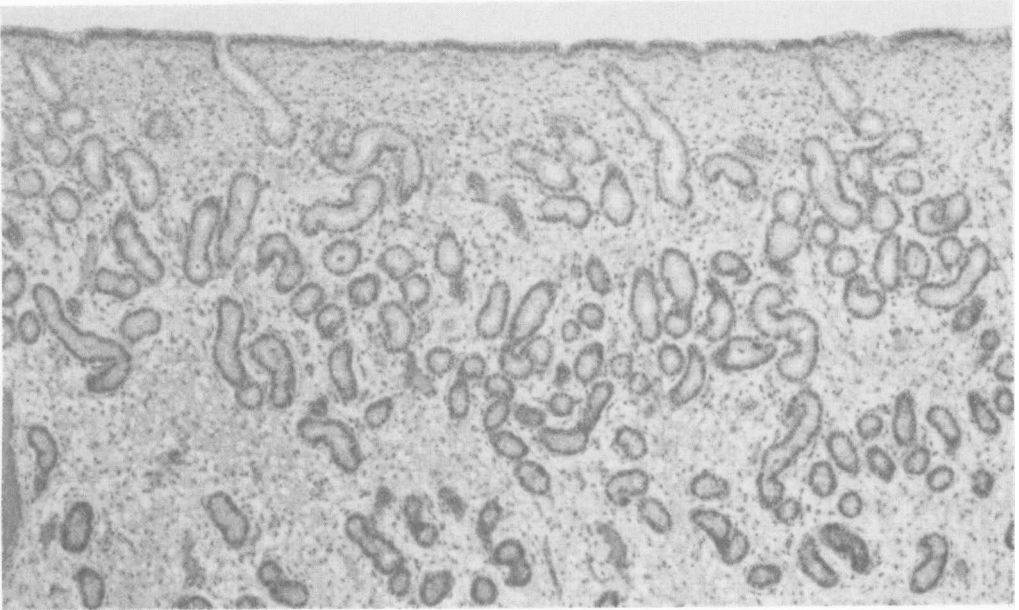
Figure 1. Normal endometrium, i.e. no histopathological findings excessive for the age and parity of the mare (× 100, mare A).
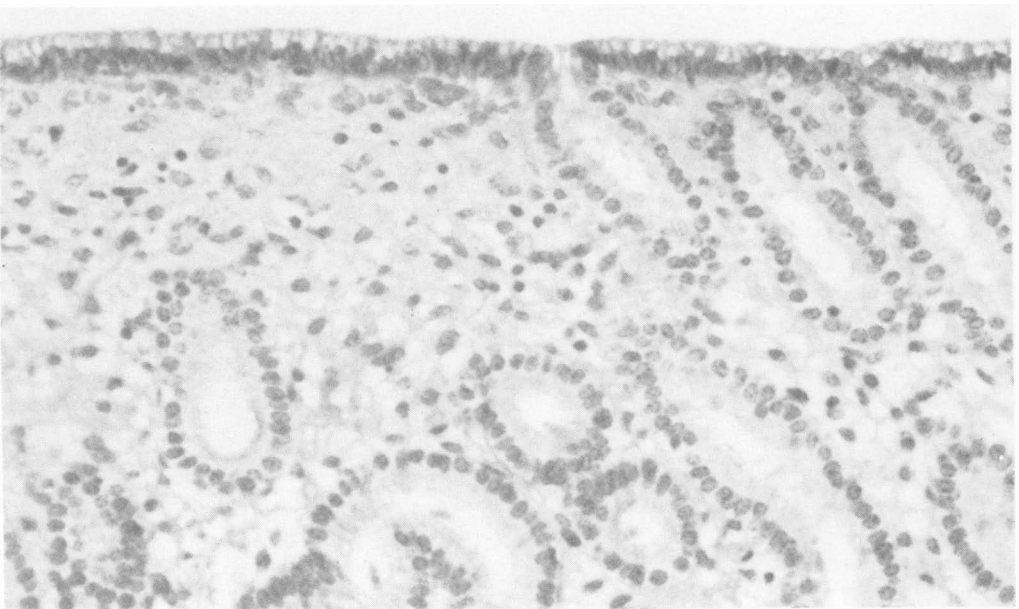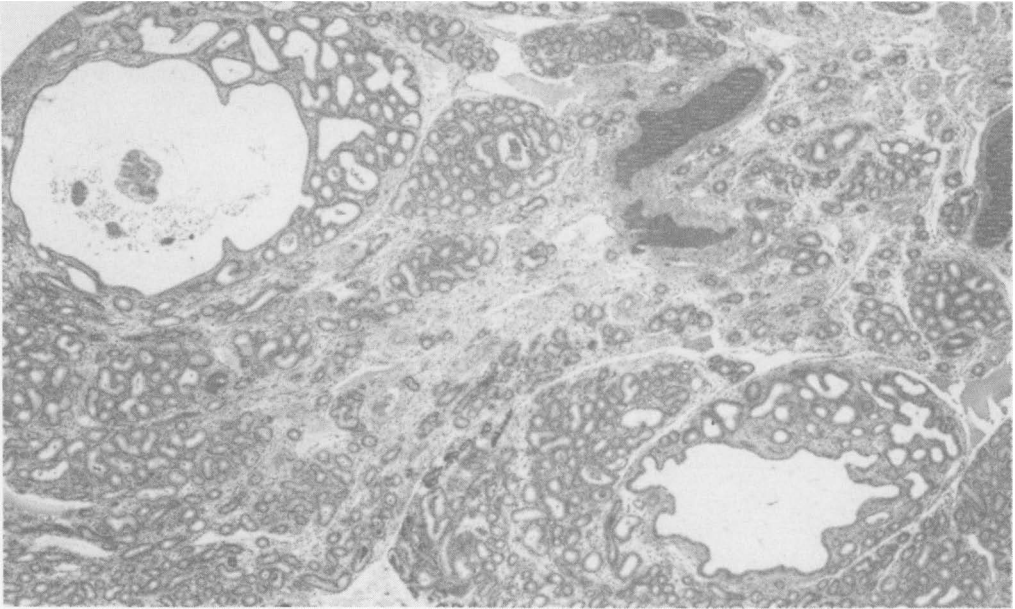

Figure 2. Normal endometrium (× 400, mare A).

Figure 3. Advanced chronic degenerative endometritis with prominent glandular cysts and periglandular fibrosis ($\times$ 40, mare C).
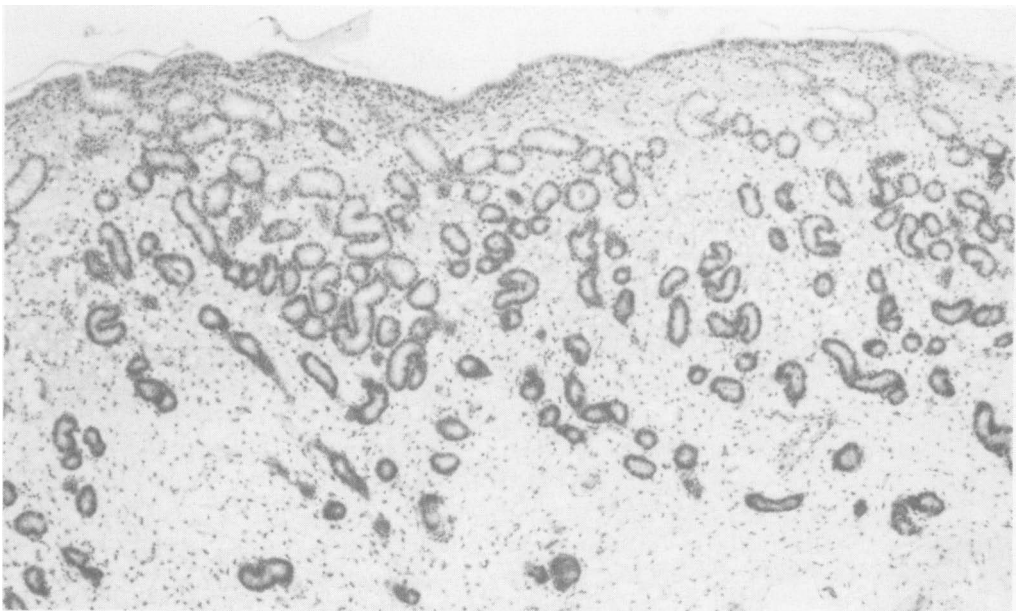

Figure 4. Inactive endometrium ($\times$ 100, mare J).

able at the time of the next mating. For that reason, the mare was treated with penicillin and streptomycin parenterally in combination with flumethasone (*Darenius et al.* 1992). The treatment was given in order to minimize the risk of infection/inflammation in both the mare and the stallion. During the 2nd experimental year the mare received no treatment.

Mare I: Histopathological examination showed that the mare had severe chronic infiltrative endometritis and advanced chronic degenerative changes. Cytological and bacteriological examinations showed acute endometritis, as evidenced by the presence of 0.5-5% PMNLs in the smear and growth of *Streptococcus zooepidemicus* (Table 2). The mare was treated parenterally and locally with penicillin and was later inseminated using the Minimal Contamination Technique.

Mare J: During the 1st experimental year mare J resorbed twins between days 31 and 42 of pregnancy. During the 2nd year only 1 of the twins died around day 22-26 of gestation and the mare later gave birth to a single healthy foal.

Histopathological examination showed that the structure of the endometrium was almost anoestral, which was extraordinary for a biopsy in June (Fig. 4). There was moderate acute endometritis present, but the chronic infiltrative and degenerative changes were within the acceptable limits for the age of the mare.

Cytological and bacteriological examinations showed presence of a few PMNLs in the smear but no growth of bacteria (Table 3). After the resorption of the twins there was pure growth of *Escherichia coli,* repeated findings of a few PMNLs in the smear and histologically severe acute endometritis.

After treatment, insemination and a prolonged luteal phase there was no growth of bacteria, no PMNLs in the smear and only low-grade acute endometritis. Before breeding the 2nd experimental year there was no bacterial growth, a few PMNLs in the smear and low-grade acute endometritis. After one period of barrenness, growth of Streptococcus uberis was detected but no PMNLs were seen in the smear.

Mare J was treated parenterally with sulfadoxin trimetoprim after resorption of twins during the 1st experimental year and inseminated using the Minimal Contamination Technique (*Darenius et al.* 1992).

Mare K: Mare K aborted the conceptus twice around day 30-40 during the 1st experimental year. The 2nd year she succeeded in carrying a foal to term (*Darenius et al.* 1989).

By laboratory examinations mare K was found to harbour a variety of pathogenic and saprophytic microorganisms in the uterus. However, judging from cytological and histological examinations, there was little inflammatory response to the infection (Table 3). The histopathological changes found were not excessive for her age before mating during the 1st experimental year. After the 1st resorption severe chronic endometritis was seen (Fig. 6) and after the 2nd resorption she had low-grade acute endometritis accompanied by low-grade chronic infiltrative endometritis and early degenerative changes.

During the 1st experimental year the mare was treated during oestrus no. 5 with large-volume intrauterine saline flushes and gentamycin. This treatment was repeated the 2nd year and the mare was also given intravenous injection of flunixin meglumine (Finadyne/-Banamine, Schering Corp., NJ, USA) between days 10 and 60 of pregnancy, followed by reducing doses of this compound for
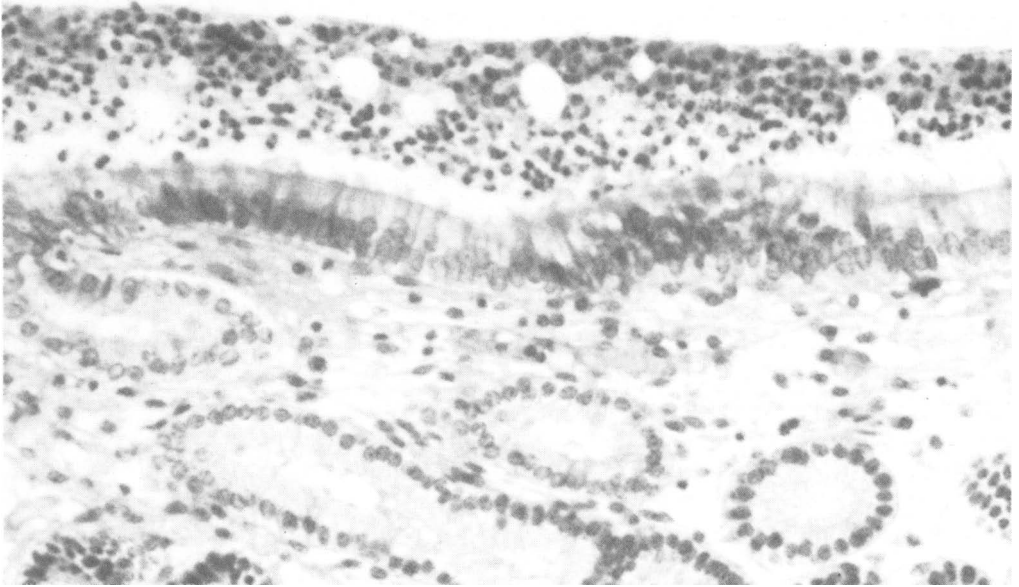
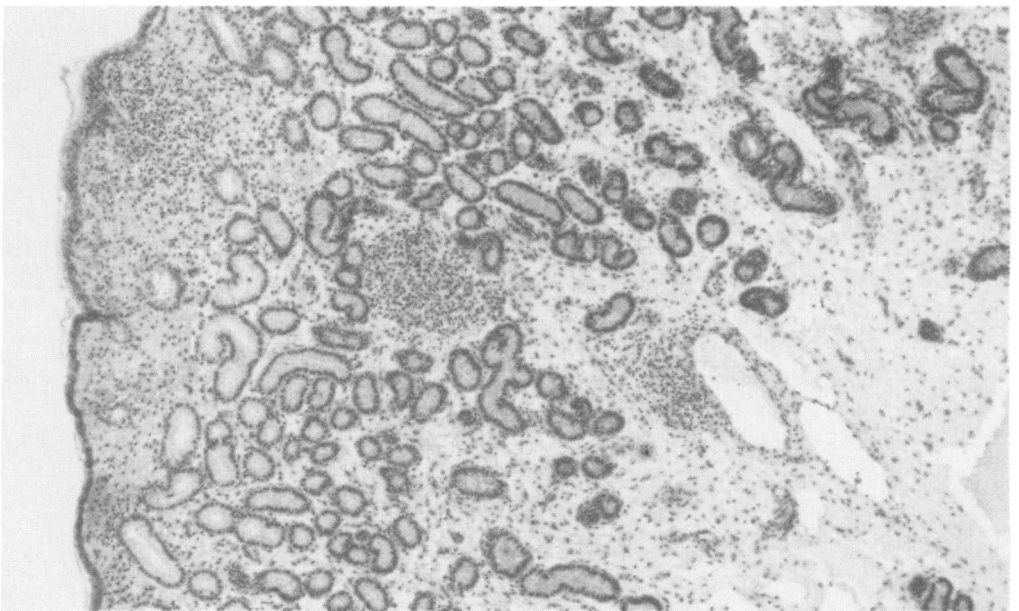Figure 5. A thick layer of polymorphonuclear leukocytes overlying the luminal epithelium (× 400, mare B).

Figure 6. Nodular chronic infiltrative endometritis (× 100, mare K).

another 14 days. The purpose of the latter treatment was to reduce the release of $PGF_{2\alpha}$ possibly associated with the inflammatory process in the endometrium and/or the presence of bacterial endotoxins (*Darenius et al.* 1989).

Mare L: Laboratory examination showed mare L to harbour *Acinetobacter* sp. and *Clostridium* sp. in the uterus. However, the inflammatory response was minimal and seen as only very few polymorphonuclear cells (<0.5%) in the smear and histologically low-grade acute endometritis, superimposed upon a degree of chronic infiltrative and early degenerative endometritis which was considered to be within the acceptable limits for a mare of her age (Table 2).

Mare L was treated with penicillin parenterally 1 week before breeding because of a puncture wound followed by lymphangitis. A Caslicks operation was performed in mare L after breeding, due to bad perineal conformation. On day 101 of pregnancy a purulent discharge from the vestibulum was noticed. Vaginal examination showed the cervix to be relaxed and hyperaemic. The vaginal mucosa was hyperaemic and a large amount of a purulent discharge was present at the floor of the vagina. Culturing revealed pure growth of *Streptococcus zooepidemicus*. Local treatment with a condensation product of metacresolsulfonic acid and formaldehyde (Nelex, Byk Gulden Lomberg Chem. Fabrik, Konstanz, Germany) was unsuccessful, for which reason parenteral treatment with penicillin (Penovet, Novo Nordisk AB, Malmö, Sweden) was initiated, together with intravaginal treatment with benzyl penicillin in sterile water. After the treatment, the vagina was free from the purulent discharge and the mucosa had a normal colour. The faeces was less well formed and foul-smelling. Three

weeks after the antibiotic treatment the vaginitis recurred, together with severe diarrhoea, loss of appetite and mild depression. Treatment was directed towards replacement of the intestinal flora by oral administration of live non-pathogenic *E. coli* in a 100 ml dose of approximately 10^{11} bacterial cells. The mare recovered quickly. Reculturing of the vaginal discharge revealed *Enterococci* sp. and *Acinetobacter Lwoffi.* The local treatment consisted of ampicillin (Ampivet, Novo Nordisk AB, Malmö, Sweden) in sterile water for 3 days. During the rest of the pregnant period further changes of the intestinal flora were successfully prevented. No more vaginitis or diarrhoea were noticed and the mare gave birth to a healthy foal at term.

Mare M: The mare was inseminated very late in the breeding season, at the end of July, because of a failure of the cervix to open properly. During the earlier oestrous periods the cervix remained pale, half closed and with too much resistance to allow insemination. The histopathological findings indicated the presence of some degree of chronic infiltrative and early degenerative endometritis, which was considered to be within the acceptable limits for a mare of this age. Bacteroides intermedius grew in an anaerobic culture, but was not accompanied by PMNLs in the smear (Table 2).

Mare N: Histopathological examination revealed no excessive changes for her age. No PMNLs were present in the smear but there was pure growth of *Streptococcus zooepidemicus* (Table 2).

Parenteral and intrauterine treatment with penicillin was administered during one oestrous period. The mare was inseminated using the Minimal Contamination Technique

and a Caslicks operation was performed after breeding.

Mare O: During the 1st year in research mare O resorbed the conceptus on day 15-17 of gestation, followed by pregnancy and delivery of a healthy foal. During the 2nd year the mare resorbed the conceptus on day 22-23, followed by pregnancy and delivery of a healthy foal (*Darenius et al.* 1989).

Laboratory examinations showed mare O to harbour a variety of pathogenic and saprophytic organisms in the uterus but the inflammatory response to the infection was low (Table 3). No histopathological changes excessive for the age was recognized during the 1st experimental year. During the 2nd year there was severe chronic infiltrative endometritis and early degenerative changes after resorption (Table 3).

During the 1st experimental year the mare was treated daily during the 2nd pregnancy with allyl trenbolone (Regumate-Equine, Hoechst AG, Frankfurt, West Germany) between days 9 and 150 of pregnancy. The treatment was initiated because of suspicion of a failure in the transmission of the maternal recognition of pregnancy signal to induce luteostatis (Darenius et al., 1989). During the 2nd experimental year the mare was treated after resorption with large-volume intrauterine saline flushes followed by intrauterine gentamycin due to an oedematous endometrium and repeated growth of microorganisms (Table 3). During the 2nd pregnancy allyl trenbolone was administrated daily between days 10 and 72 of pregnancy, after which it was gradually withdrawn (*Darenius et al.* 1989).

Discussion

Histopathological examination of uterine biopsies showed a wide range of histopatho-logical conditions, from absence of changes excessive for the mare's age and parity to the most severe changes of the endometrium (Tables 2 and 3). Mares with no histopatho-logical findings initially, such as mares A, K and O, resorbed/aborted during the experimental period whereas mares with a severely inflamed uterus with advanced degenerative changes, such as mares C and I, could develop normal pregnancies if the infection and inflammation were controlled. The endometrium is by no way static and has a remarkable potential for recovery.

Endometritis, acute as well as of the chronic degenerative type, is likely to be the most common cause of early foetal death in the mare. Many authors have pointed to the chronic degenerative endometritis (*Ricketts* 1975, *Kenney* 1977 & 1978, *Ricketts* 1978, *Doig et al.* 1981, *Shideler et al.* 1982, *de la Concha-Bermejillo & Kennedy* 1982, *Leishman et al.* 1982, *Torp* 1989), while fewer have drawn attention to the acute endometritis (*Ricketts* 1975, *Asbury* 1987; *Ricketts* 1987, *Torp* 1989). In this experiment, acute endometritis was as common as chronic degenerative endometritis 4-6 weeks before mating (-Tables 2 and 3). However, the time lapse between laboratory examinations and breeding may have given the mares the possibility to clear a low-grade acute endometritis before mating/insemination took place. In mare B for instance, the thick layer of PMNLs overlying the luminal epithelium may originate from a reaction to the swabs, taken during oestrus 2 weeks earlier (Fig. 5). In some mares the acute endometritis was subclinical, i.e. without bacteriological and cytological evidence of an inflammation. More often, especially in the more severe cases of acute endometritis, there was bacterial growth and/or cytological evidence of inflammation.

In this experiment, 10 out of 15 mares with a known history of conceptus loss (Table 1) had normal pregnancies at the end of the experimental period, at 5 months of pregnancy. Only 3 of the 10 mares were treated with antibiotics before breeding due to growth of *Streptococcus zooepidemicus* in the endometrial samples. In addition 2 mares, mares G and L, were treated with antibiotics due to puncture wounds. Mare L was also treated during pregnancy because of severe vaginitis which responded satisfactorily to treatment only after replacement of the intestinal flora. The fact that the foetus survived inside a half-open, deeply inflamed cervix was remarkable. *Whitwell* (1980) reported ascending infection as being the most common cause of bacterial/fungal abortions and a connection between ascending vaginal infection and the intestinal flora has been described (*Gadd and Schirmer* 1968, *Gadd* 1975). The repeated antibiotic therapy in mare L resulted in a shifting predominance of one type of bacteria over the other, suggesting overgrowth of one species at different times during infection. *Acinetobacter* sp. and *Clostridium* sp. were present in the endometrial swabs before breeding as well as after initial treatment of the vaginitis directed against Streptococci. *Acinetobacter* sp., which is considered to be non-pathogenic, is occasionally found in mares with or without clinical signs of endometritis, but with a history of infertility. Unless treatment of the endometritis is initiated the mares often fail to get pregnant or maintain the pregnancy (*Darenius*, unpublished observations).

In the group of untreated, normal pregnant mares, mare M was inseminated very late in the breeding season due to earlier failure to attain the relaxation and lubrication of the cervix needed for insemination. *Bane* (1959) proposed that this imperfect state of the cervix could be a symptom of insufficient oestrogen stimulation from the ovaries. This type of reversible cervical dysfunction has been observed in mares exposed to unfavourable social stress (*Darenius*, unpublished observations) and stress-induced interference with the reproductive function has been suspected by *Asa & Ginther* (1982) also in the mare. *Andrews* (1976) proposed that adrenal steroid secretions may act in coordination with gonadal hormones on peripheral targets. One of these targets is the cervix, the function of which is very important for breeding success, but to which little attention has been paid.

Five mares resorbed/aborted once or twice during the research period, which was followed by another pregnancy and delivery of a healthy foal. Initially, little information was obtained about these mares from the microbiological and cytological examinations. Reexamination after resorption/abortion often provided more information (Table 3). Different treatment of 4 of the mares (*Darenius et al.* 1992) resulted in a maintained pregnancy and delivery of a healthy foal. The remaining mare A, for which no explanation of the reproductive failure could be found, received no treatment and gave birth to a healthy foal at term.

There may be several explanations of the good breeding results during the trial, compared with the mares' previous problems of repeated pregnancy loss. Good management seems to be essential and many factors may have contributed to the successful breeding results, such as the mares being in good nutritional condition, and the fact that matings/inseminations were carried out during the height of the ovulatory season (May-August) when the endometrium had been given the possibility to recover completely from the anoestral period. Endometritis,

which was clinically diagnosed on the basis of bacteriological examinations, was treated before or during the period of breeding. Renewed infection was avoided by performing matings/inseminations as few times as possible close to ovulation and by using the Minimal Contamination Technique (*Kenney et al.* 1975). Additionally stressful conditions were avoided by keeping the mares as a group at pasture and by ensuring uniformity of daily routines such as feeding, teasing and blood sampling.

In conclusion, histopathological examinations of the uterus in mares with a known history of repeated conceptus loss showed a wide range of endometrial conditions, from a normal endometrium to severe endometritis. Good breeding management is essential in order to succeed with these mares.

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Sammanfattning

Tidig fosterdöd hos sto: Histologiska, bakteriologiska och cytologiska observationer i endometriet.

Femton ston, vilka tidigare resorberat eller aborterat ett flertal gånger, intensivstuderades före betäckning/insemination samt till och med 5 månaders dräktighet. Alla de 15 stona blev dräktiga under försöksperioden; 10 ston hade normal dräktighet under det första försöksåret. Fem ston resorberade/aborterade 1 eller 2 gånger följt av en dräktighet vilken resulterade i levande fött föl.

Vid histopatologisk undersökning av endometriet återfanns hela skalan från en normal slemhinna till mycket kraftiga förändringar. Endometrit, akut såväl som kronisk degenerativ, utgör med stor sannolikhet en av de viktigaste orsakerna till tidig fosterdöd hos sto.

Skötselfaktorer är av stor vikt för att undvika tidig fosterdöd. God skötsel innebär att stona hålls i god näringsbalans, betäcks få gånger nära ägglossning under den sexuella säsongen, att man söker undvika stressfaktorer, att akut endometrit diagnosticeras och behandlas före betäckning samt att preventiva åtgärder vidtages mot förnyad endometrit hos infektionskänsliga ston.