

INVESTIGATION OF ABORTION IN SHEEP AND GOAT

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The ewe and doe are both normally a very fertile animal but may have a high incidence of abortions when compared to other farm animals. Infectious causes of abortion play an important role in this process and could be a major cause of economic loss. In an abortion outbreak the safest approach is to assume that all causes of abortion are infectious in nature. Several microbial agents have been incriminated as causes of abortion in the goat, but the most common ones are: *Chlamydia psittaci*, *Toxoplasma gondii*, and *Coxiella burnetii*. In the United States, chlamydiosis and toxoplasmosis are the most frequently identified infectious causes of caprine abortion. In a study of 1784 abortion and stillbirth specimens submitted during a ten-year period in western North America, *Toxoplasma gondii*, *Campylobacter spp.* and *Chlamydia psittaci* caused about 25% of all abortions in sheep. Many of the organisms causing abortion in sheep also cause abortions in goats with the exception of campylobacteriosis, which is rare in goats in North America. Abortion rate of 5% for sheep and goats are common; rates less than 5% are considered good; and less than 2% abortion rate is considered excellent.

The most common lesion in all cases of infectious abortion is placentitis. The fetus either dies due to inability to exchange nutrients through the placenta, or becomes infected itself and dies. Economically and emotionally midterm or late abortions are of great concern to the owner, whether the animal is on a commercial or hobby farm, because the fetuses are lost and the unproductive female must be maintained until next breeding season or sold at a loss. A prolonged period of uterine disease and infertility may follow and in case of infectious abortion, the disease threatens the rest of the herd.

Most of the diseases that cause abortion are zoonotic, including chlamydiosis, Q-fever, toxoplasmosis, campylobacteriosis, brucellosis and listeriosis. Owners should be advised to wear gloves when handling aborted fetuses and to burn or bury any placentas and fetuses not needed for diagnostic efforts. In addition pasteurization of milk for human consumption should be stressed.

Chlamydia

Chlamydia abortion is the most common cause of infectious abortion of goats in North America. The disease is also one of the major causes of reproductive wastage in sheep breeding. The disease has been described in Scotland, England, and in western United States. Chlamydia has also been described as causing pneumonia, kerato conjunctivitis, epididymitis, and polyarthritis in sheep and goats.

Etiology

Chlamydia psittaci, a gram negative, intracellular organism that contains both RNA and DNA, is the agent responsible for chlamydiosis. This organism was established as the causative agent of Enzootic Abortion of Ewes (EAE) in the late 1950's.

The antigenic strains found in goats appear to be closely related to those in sheep. Antigenic Type 1 is implicated in abortions, birth of stillborn weak kids, and in neonatal chlamydial pneumonia, whereas Type 2 isolates cause polyarthritis and conjunctivitis in adult goats. However, Serotype 2 have been recently reported as the abortion-inducing strain in ruminants as well. There is no cross protection between these two antigens.

Epidemiology and Pathogenesis

Pigeons and sparrows may serve as reservoirs for the organism, and it has been suggested that ticks or insects may play a role in transmission of the disease. *Chlamydia psittaci* can persist in the feces of the infected animals and may explain why the infection carries over from one kidding season to the next. Aborting females shed large numbers of organism from the uterine discharge, fetus and placenta, particularly in the first three weeks after abortion, with complete elimination of chlamydia from the uterus within three months. Inflammation and necrosis caused by multiplication of the chlamydia prevent normal transfer of nutrients across the placenta and the fetus dies and is aborted. Does exposed to *Chlamydia psittaci* for the first time in the first half of gestation abort that pregnancy. Whereas, susceptible does exposed for the first time in the last half of pregnancy usually abort in the subsequent pregnancy. Regardless of the time of infection in the female, the organism does not begin to proliferate and attack the placenta until about day ninety(90) of gestation. Even though chlamydia have been isolated from the semen of experimentally infected rams for up to twenty-nine(29) days after inoculation, venereal transmission during breeding has not been investigated.

There is no evidence of infertility during subsequent breeding season in the aborting does and the natural immunity after an abortion lasts about three years. Older does may abort with chlamydia again. Outbreaks of abortion among goats by dual infection with *Coxiella burnetii* have also been reported.

Clinical Signs

In the United States, in endemically infected herds, 25 to 60 percent of ewes or does may abort. Abortions usually occur in the last month of gestation but it can occur as early as day 100 of gestation. Does and ewes are not normally ill but may show a bloody vaginal discharge two to three days prior to abortion. The fetus may be autolyzed or fresh. Some weak newborns may be seen, and a few females may retain the placenta. Pathologic changes in the fetus are nonspecific. The fetus may be delivered in a fresh state but may be autolyzed if retained in the uterus for a day or two. The placenta shows regional to generalized placentitis (white to yellow necrotic areas) involving the cotyledons and intercotyledonary space.

Diagnosis

Diagnosis is by history of abortion along with clinical signs and demonstration of the characteristic inclusion bodies in the impression smears of placenta, fetal tissue or uterine discharge. A definitive diagnosis is made by culturing the organism from the placenta or fetal tissue. Serological test is also a valuable aid in diagnosis. Ewes, does and cows have significant rises in antibodies against chlamydial antigen after abortion. Paired blood samples from the aborting females, two to three weeks apart, are necessary for serology. Antibodies may be detected in fetal serum as well. The tests of choice are the Enzyme-Linked Immuno-Sorbent Assay (ELISA) or the Indirect Inclusion Fluorescence Antibody (IIFA) test. Titers in the range of 1:32 to 1:256 suggest chlamydial infection. A four fold increase in antibody titer between paired serum samples is significant.

When chlamydiosis is suspected, the following samples should be submitted for diagnostic evolution:

- (1) Fresh placenta and fetus packed in ice.
- (2) A vaginal swab taken within three days of parturition is useful if the placenta is not available.
- (3) Paired serum samples from the aborting dam as well as non-aborting females.

Treatment and Control

Limited success has been gained in controlling an outbreak with treatment of all females with tetracycline, in the last 4 to 6 weeks of gestation. Suppression of the organism may prevent additional placental damage, and also reduce shedding of chlamydia by treated females. Large herds are commonly treated with oral tetracycline (400 to 500 mg per head per day) for two weeks. This would be a reasonable approach for fiber-producing animals. In dairy herds, it is more customary to treat individual non-lactating does or ewes by injection of long-acting oxytetracycline preparation at a dose of 20 mg/kg SC every 10 to 14 days. Others have given the drug twice a week, in the last 4 to 6 weeks of gestation. Considering the management difficulties and cost associated with mode of prevention, the most effective protocol appears to be one injection of long-acting oxytetracycline at 6 to 8 weeks prior to parturition, followed by a second injection three weeks after parturition.

Enzootic abortion is of such serious economics consideration in some countries that compulsory government vaccination programs have been implemented. A killed vaccine for sheep is available in the United States and can be used in goats (extra-label use) but may cause local as well as systemic reaction for several days (marked soreness and stiffness). The vaccine is usually available only in combination with campylobacter bacterin or campylobacter and *Escherichia coli* bacterin (ovine vibrio/chlamydia/E. Coli, Grand Laboratories, Inc. Freeman, S.D.). The vaccine should be given IM or SC eight weeks prior to breeding; followed in four weeks with a second vaccination. Even though trials in sheep have shown that protection for abortion lasts for about three years, annual revaccination is recommended. Vaccination helps to prevent abortion but it does not eliminate infection. Does and ewes aborting should be removed from the herd for

at least three weeks, and the fetus and placenta should be burned or buried in quick lime. Care must be taken to prevent the contamination of feed and water. No feed should be given on the ground, and feeders should be designed to prevent animals from getting into them.

Zoonotic Potential

Chlamydia psittaci is contagious to humans. During lambing and kidding season, pregnant women assisting with parturitions may become infected and abort. An influenza like syndrome has also occurred in men assisting with lambing in infected flocks. Veterinarians and farmers attending normal parturition, dystocia, or abortions should wear plastic gloves to limit exposure to uterine fluids. The same precautions apply when collecting fetuses or placentas for disposal or diagnostic evaluation. Pregnant women should avoid contact with the herd during the kidding and lambing season.

Toxoplasmosis

Toxoplasmosis is one of the most common parasitic infections in sheep and goats, other livestock and people worldwide. Toxoplasmosis is a major cause of abortion in sheep in New Zealand and England and is known to cause reproductive losses in goats and other animals.

Etiology

The protozoa, *Toxoplasma gondii* is the agent, which causes abortion, mummification, stillbirth and birth of weak kids in goats as well as in sheep.

Epidemiology and Pathogenesis

Cats are pivotal in the transmission of *Toxoplasma gondii*. They become infected by ingestion of infected rodents and birds, which can lead to excretion of large numbers of environmentally resistant oocysts. Transplacental infection can develop in cats, and kittens infected in utero can shed *Toxoplasma gondii* oocysts after birth. Cats often defecate and bury their feces in the hay and food bins of barns. Ewes and does become infected by ingestion of food or water contaminated with oocytes from feces of infected cat. The organism enters the blood and spreads to other tissues within two weeks of ingestion of oocysts. In the pregnant ewe or doe, toxoplasma can invade and multiply in the placenta and then spread to the fetus causing abortion, fetal death, resorption of the fetus, stillbirth, birth of a live but weak lambs and kids, or the birth of a normal kid depending on the stage of pregnancy. Although *Toxoplasma gondii* can be found in goat semen, it is doubtful if venereal transmission is important in causing abortion.

Clinical Signs

Goats appear to be more susceptible to toxoplasma infection than sheep. Abortion can occur in does of all ages but primarily in does that acquire infection during pregnancy although abortion may be repeated in the next gestation. The incidence of abortion in a flock may vary from 3 to 30 percent. Ewes and does infected prior to breeding do not abort. Those infected 30 to 90 days

after breeding usually have fetal resorption or mummification. Most observed abortions occur in the last trimester of gestation, 2 to 3 weeks before term, after occurrence of infection during the latter half of gestation. Ewes and does themselves are generally clinically normal at the time of abortion.

Abortion occurs due to necrosis of the placenta, particularly the cotyledons, or due to fever in the doe. The intercotyledonary areas of the placenta are usually normal with the cotyledons having white to yellow focal areas of necrosis and calcification up to 1 cm in diameter. These lesions are clearly visible to the eye when the cotyledons are washed in saline. The lesion is characteristic of only toxoplasmosis and can be used in the field as a diagnostic tool. On the other hand, *Coxiella burnetii*, *Brucella spp.* and *Chlamydia spp.* usually cause placentitis that include the intercotyledonary region.

Diagnosis

Rapid diagnosis of infective abortion in goats is important. Several tests are available for diagnosis. A presumptive diagnosis can be made from placental lesions alone. However, placenta often is not available for examination because it may be decomposed.

The preferred diagnostic procedure is determination of *Toxoplasma gondii* antibody in fetal fluids or pre-suckling blood. Their presence indicates transplacental toxoplasma infection. However, the absence of *Toxoplasma gondii* antibody does not preclude the possibility of infection. It is important to ensure that a serological examination of lambs and kids is done before colostrum is given because the amount of antibody in colostrum is several times greater than that in serum and may cause higher neonatal antibody titers. The presence of high antibody titers in doe serum is not necessarily diagnostic of recent infection because titers may remain high into the next breeding season. However, absence of antibodies is considered to be conclusive evidence that toxoplasmosis was not the cause of abortion. The Modified Agglutination Test (MAT) can be used to detect antibody in fetal and maternal serum. MAT is easy to perform and more sensitive than other tests. The ELISA and Indirect Fluorescent Antibody (IFA) Test have also been used.

Positive diagnosis of toxoplasmosis requires isolation of the organism from placenta or fetal brain, lung and muscles. The samples for isolation studies should be shipped on ice but not frozen.

Treatment and Control

Control of toxoplasmosis is based on preventing exposure of pregnant females to cat feces. Cats should be prevented from defecating in feeders or hay. Fetal membranes and dead fetuses should be buried or incinerated to prevent infection of cats and other animals. Cats should not be allowed near pregnant sheep and goats, but in practice this is difficult to do.

A vaccine that contains a strain of tachyzoites (S48) that does not persist in tissues of sheep is available in Europe and New Zealand, but it is not available in the United States. Ewes

vaccinated with the S48–strain vaccine remain immune for at least 18 months.

Breeding goats, which have been exposed to *Toxoplasma gondii* infection, are likely to be relatively resistant to the effects of re-exposure in subsequent pregnancies and are less likely to abort again from this cause and therefore should be culled. Feeding decoquinate (2mg/kg bw/day) or monensin (15-30 mg/head/day) throughout gestation may reduce the incidence of abortion.

Zoonotic Potential

Fetal membranes and dead fetuses of sheep or goats that abort should be handled with caution by persons wearing gloves to prevent infection in humans. Toxoplasmosis has been reported in human beings after drinking raw goat milk. Therefore, goat and sheep milk should be pasteurized or boiled before human consumption. This is particularly true for its use in infants, which are more susceptible to toxoplasmosis than adults.

Q-Fever

Query or Queensland Fever is a zoonotic infection affecting a variety of animal species and human beings. It can be the cause of abortion in sheep and goats, and it has been reported in Canada, United States and many other countries.

Etiology

Q-Fever is caused by *Coxiella burnetii*, an obligate intracellular rickettsial organism.

Epidemiology and Pathogenesis

Cattle, sheep, goats, and wildlife may carry the organism which are shed in large numbers in placentas, uterine fluids, colostrum, and milk. Therefore, cows and sheep may be a source of infection for goats when they share pasture. Animals and man can be infected by inhaling contaminated dust. Grazing contaminated pastures and tick bites are other modes of transmission.

Clinical Signs

The primary significance of this disease is its zoonotic potential. In livestock, the disease is usually in-apparent. However, occasional abortion outbreaks due to *Coxiella burnetii* have been reported in sheep and goats. Clinical signs are infrequent but abortion or stillbirth usually occurs late in gestation due to severe damage to placenta and necrosis of cotyledons and thickening of the intercotyledonary areas. Some does abort without apparent clinical signs, while others show anorexia and depression 1 to 2 days before abortion.

Diagnosis:

Diagnosis is based on placental findings, serology and isolation of the organism. While isolation of *Coxiella burnetii* is the ideal means for diagnosis of the disease, it is usually not feasible due to the contagious and zoonotic potential of the organism. Very few diagnostic laboratories are willing to handle such organisms because of strict biosafety procedures. The Fluorescent Antibody (FA) Test can be used to identify organism in frozen section of placenta. Even though a variety of serological tests have been described, since asymptomatic infections without abortion are possible, a diagnosis of abortion cannot be given solely on the basis of positive serological test. Antibody titers of 1:20 or higher indicates exposure to *Coxiella burnetii*. A fourfold increase in antibody titer between acute and convalescent samples indicate recent infection.³¹ A rapid presumptive diagnosis of *Coxiella burnetii* is possible by identification of a large number of characteristic organism in the placental tissue together with ruling out other causes of placentitis such as *Brucella*, *Campylobacter*, and *Chlamydia*.

Treatment and Control

Once the infection is established, the organism is carried by the female indefinitely, and is shed in the milk and at parturition. Placenta and aborted fetuses should be burned or buried. There is no vaccine for goats. Treatment with tetracycline in cattle for a period of two weeks has been shown to prevent excretion of the organism at parturition. In an outbreak of Q-fever abortion in goats, abortions stopped following feeding of 200 mg/animal/day of chlortetracycline in the feed for 19 days. Some people recommend injection of 20 mg/kg of long acting oxytetracycline every three days or as far apart as every 10 to 14 days.

Zoonotic Potential

Q-fever is a zoonotic disease transmitted to man via milk, placenta and feces. The disease is characterized in human by influenza-like symptoms. In the majority of human cases, there is a history of contact with infected sheep, goats, or cattle. The organism is killed by pasteurization, but is readily transmitted by non-pasteurized milk. A mask should be worn when manure is removed from the barn since inhalation of the aerosolized microorganisms is thought to be the most important route of infection in human. Gloves should be worn at the time of kidding or when handling aborted fetus.

Q-Fever illnesses in goat workers were associated with abortions in goats in rural Newfoundland, Canada in 1999, farm workers helping with FMD outbreak in UK in 2001, and farmers working with sheep during the lambing season in Germany in 2000-2001.

Campylobacter

Campylobacter (vibrio) is the most significant cause of abortion in sheep in the United States. However, campylobacter abortion has been rarely documented as the cause of abortion in goats in North America.

Etiology

Of the cases reported in the United States, *Campylobacter jejuni* and *Campylobacter fetus* (formerly *Vibrio fetus intestinalis*) have been identified as the causative organism.

Clinical Signs

Clinical signs include late gestation abortions in does and weak and/or stillborn kids. Aborting does may or may not show signs of systemic illness. A mucopurulent or sanguinopurulent vaginal discharge is reported in all aborting does. In South Africa where campylobacter abortion appears to be common, as many as 30% of aborted kids have grossly visible liver necrosis. The placenta is often edematous, with necrosis of cotyledons.

Diagnosis

Definitive diagnosis of campylobacter abortion is through isolation of the organism. Direct microscopic examination and isolation of *Campylobacter spp.* from placenta, fetal abomasal contents and maternal vaginal discharge is the preferred diagnostic procedure. Serological test can be done at a few specialized laboratories.

Treatment and Control

Treatment is similar to sheep. The antibiotic regimen is penicillin/streptomycin preparation or tetracycline in feed. In a confirmed outbreak, vaccination of all pregnant does with an ovine campylobacter bacterin is advisable.

A combined killed bacterin of *Campylobacter fetus* and *Campylobacter jejuni* is available for use in sheep but not routinely used in goats. The vaccine is administered prior to breeding with a booster in 2 to 3 months. Annual revaccination, shortly before or just after breeding, is recommended.

Because of the probable oral route of infection, sanitary conditions, avoiding fecal contamination of feedstuff and isolation of aborting does are recommended. As with other abortions, placenta and aborted fetuses should be burnt or buried deeply.

Zoonotic Potential

Campylobacter jejuni has been recognized as a cause of mild gastroenteritis in man and is of public health importance. Domestic animals and unpasteurized milk are thought to be the source of *Campylobacter jejuni* infection in man. Aborted fetuses infected with *Campylobacter jejuni* should be handled carefully. In Scotland, shepherds giving artificial resuscitation to infected lambs have acquired the disease.

Brucellosis

Brucellosis is an infectious disease of goats characterized by abortion, the birth of weak kids, mastitis, and formation of localized lesions in various tissue. The incidence of brucellosis in goats is extremely low to nonexistent in the United States but is widespread in the Middle East, India, Pakistan, Africa, Mexico, and parts of South America. Sporadic outbreaks have been reported from Texas and Colorado. The most recent report of caprine brucellosis in the United States was in October 1999 where a herd of meat goats in south Texas found to be infected with *Brucella melitensis*. *B. ovis* is widespread in sheep throughout the western portion of North America.

Etiology

Brucella melitensis, a small gram-negative coccobacillus, specific for goats, is the cause of brucellosis in goats as well as cause of Malta fever in humans. Occasionally, *Brucella abortus* infection occurs in goats running with infected cattle or vaccination with strain 19 by ill informed veterinarians, but does not spread within the herd and is not readily transmitted between herds. Although considered goat specific, *B. melitensis* may cause abortion in sheep.

Epidemiology and Pathogenesis

The most common route of transmission in goats is by the ingestion of contaminated food and water. The organism enters through mucous membranes and becomes localized in lymph nodes, udder, uterus, testes, and spleen. In pregnant animals, localization in the placenta leads to the development of placentitis with subsequent abortion. The organism is excreted in milk, urine, feces, placenta and for 2 to 3 months in vaginal discharge. Kids born alive to infected does often are infected and capable of shedding the organism.

Clinical Signs

Infection occurs in both sheep and goats and produce abortion in late pregnancy. As in other species, there may be an “abortion storm” when the disease is introduced followed by a period of herd resistance during which abortions do not occur. A systemic reaction with fever, depression, loss of weight and sometimes diarrhea occurs and may be accompanied by mastitis, lameness, hygroma and orchitis in males. On gross examination, the placenta is normal in *B. melitensis* infection in goats, whereas *B. ovis* infection of sheep result in thickened, necrotic placentitis.

Diagnosis

Identification of brucellosis as the cause of abortion is usually made by isolation of the organism from aborted fetus, placenta or vaginal discharge. Various agglutination, precipitation and complement fixation tests are used to detect carrier goats.

Treatment and Control

There is no treatment for brucellosis in goats. In countries where the prevalence of infection is very low, slaughter of the entire herd (both sheep and goats) would probably be the control measure of choice. This was the method successfully used to eradicate the outbreak reported in Texas. In other situations a test and slaughter program may be more appropriate. All new animals imported to a farm should be blood tested and bucks should be tested before they are used for breeding. Placentas and aborted fetuses should be burned or buried deeply.

Vaccination of goats is not permitted in the United States. In most countries where caprine brucellosis is prevalent, the disease is controlled by intensive vaccination program, which is very effective. A live attenuated strain of *Brucella melitensis* Rev 1, is usually given subcutaneously in kids and lambs 3 to 8 months of age. The vaccine will cause abortion, and thus is to be avoided in pregnant animals or those within one month before mating. Immunity from a single dose is considered to be life long.

Zoonotic Potential

Goats were the first species associated with the occurrence of brucellosis in man on the Island of Malta. Often, the first indication of brucellosis in goats is the occurrence of undulant fever in humans consuming unpasteurized milk or cheese. Therefore, a large percentage of the infections occurring in man can be prevented by pasteurization of goat dairy products.

Listeriosis

Listeriosis most commonly causes meningoencephalitis but can also cause abortion and septicemia in goats and sheep.

Etiology

Listeria monocytogenes, a gram positive, non-acid fast organism, is the agent responsible for listeriosis. Abortion strains are often serotype 1.

Epidemiology and Pathogenesis

Listeria monocytogenes may be found in soil, water, plant litter, silage, and the digestive tract of ruminants and man. The organism can survive in soil and feces for a very long time, and grows in poorly fermented silage (pH greater than 5.5). On some farms abortion has been associated to silage feeding in goats. However abortions have also been reported on farms in which goats were fed hay and concentrate, or were on woody browse.

Clinical Signs

Abortion results from infection early in gestation, but later infection results in stillbirth or weak kids. The abortion form and the encephalitic form of listeriosis do not usually occur

simultaneously in a herd. Abortion occurs in the last two months of pregnancy preceded by septicemia. Signs of septicemia may include fever, decreased appetite and reduced milk production. Kids grafted to the aborting does may die of listerial septicemia contracted through the milk.

Treatment and Control

Feeding of poor quality or spoiled silage should be discontinued. Administering 500 mg of chlortetracycline/goat/day, added to the feed stopped the abortion in a listeriosis outbreak.

Vaccination with the aim of producing cellular immunity has been investigated. Theoretically, live vaccine should be more effective than killed preparation. Two doses of reduced virulence live vaccine before breeding is reported to have provided significant protection against experimental challenge in pregnant does.

Zoonotic Potential

Persons should take care when handling aborted fetuses because listeria can cause neurologic disease in human beings.

Noninfectious Causes of Abortion

Noninfectious causes such as hereditary, stress, nutritional deficiencies, pharmaceutical effects, and toxic plant ingestion can result in pregnancy loss. Stress may trigger a higher percentage of abortions in goats than in sheep because of the goat's dependency on the CL for the maintenance of pregnancy. Predator attack, severe weather, or shearing may all trigger early regression of the CL in the doe, resulting in abortion. Angora goats experience some forms of abortion not typically seen in other breeds. Young Angora does are susceptible to stress abortions. Some older Angora does experience habitual abortions as a result of adrenal dysfunction. These does are heavier than average and have very fine mohair. This habitual, familial form of abortion usually starts when the doe is 4 or 5 years old. Abortions occur at approximately day 100 of gestation. Mature Angora does that abort in this fashion should be removed from the breeding stock, and their offspring should be culled. Heat stress also may result in early embryonic losses, abortions, stillbirths or weak kids.

Energy and protein deficiencies can result in embryonic loss, decreased fetal growth, depressed placental growth, fetal mummification, and the birth of weak young. Fetal wastage resulting from nutritional deficiencies often occurs between day 90 and 120 of gestation. Deficiencies in a number of minerals and vitamins such as iodine, copper, magnesium, manganese, vitamin A, and selenium can cause abortion or the birth of weak kids and lambs. Some heavy metal toxicities (lead) can cause fetal wastage in ewes. High concentrations of dietary sulfur, particularly sulfate, may result in both selenium and copper deficiency. Maintaining optimal body condition scores, ensuring adequate protein intake, and supplementing the diet with a good quality, complete trace mineral mixture offered free choice are usually protective.

Various pharmaceuticals have proven to be abortifacients, or at least their use has been reported to be followed by abortion. A number of anthelmintics such as phenothiazine and levamisole given in the final months of gestation may cause abortion. Anecdotal reports of abortion following the use of other dewormers (ivermectin, fenbendazole) exist, but are largely unsubstantiated. Xylazine and high doses of acepromazine in the first half of pregnancy may cause abortion because of their adverse effects on uterine contraction and placental perfusion. The administration of corticosteroids in late gestation and estrogen and prostaglandins throughout most of gestation may induce abortion. Plants that accumulate nitrate such as sweet clover, Johnson grass, sorghum, lamb's quarter, Jimsonweed, sunflower, pigweed, and oat hay can cause abortion as a result of nitrate-nitrite toxicity. If nitrate-nitrite toxicity is suspected, diluting the affected forage with other feedstuffs is a useful treatment. Cutting suspected forage 30 cm above the ground and avoiding the feeding of drought-stressed crops help decrease nitrate concentrations in feeds to less than 1000 ppm nitrate as nitrogen, or less than 0.44% nitrate. Concentrations higher than this should be avoided or diluted with other feeds. Feeds containing more than 3500 ppm of nitrate nitrogen, or more than 1.76% nitrate, should not be fed to pregnant animals.

Diagnostic investigation of abortion

A systematic approach is essential for the diagnosis of abortions in sheep and goats. Whenever losses continue or abortion storms occur, there is a need for a thorough investigation of the problem. Many different causes need to be considered and each requires special tests. The laboratory needs to be aware of the infectious agent most likely to be present in the area. The practitioner must obtain a good nutritional and clinical history, including possible exposure to carrier animals. Although history seldom provides information pointing directly to the cause of abortion, clues may be found that will indicate what needs to be done to determine the diagnosis. The owner should keep detailed records and accurately identify each aborting animal and the stage of gestation at which the animal aborted.

The first abortion in a herd may be the most important one, but many owners do not become seriously concerned until an abortion storm is evident. The owner should be instructed to freeze any fetus and placenta, no matter how certain he or she might be that the abortion was caused by fighting or a fall. When abortion occurs, the animal should be isolated and any aborted fetus kept for further laboratory examination. Each diagnostic laboratory has slightly different preferences for specimens to be submitted. Therefore, the diagnostic laboratory should be consulted prior to sample submission. In sheep and goats, the entire fetus, placenta, and paired serum samples from aborting dam should be submitted to the diagnostic laboratory. Without the placenta, identification of chlamydiosis and toxoplasmosis is unlikely. If the placenta and fetus cannot be quickly and suitably transported in their entirety, samples may be removed and one portion placed in a fixative and another in plastic containers packed on ice for culture. Tissues may be frozen for future viral culture or tested for agents using the fluorescent antibody technique. Samples from the fetus for culture should include caruncle, placenta, abomasal content, lung, liver, spleen, and kidney. Whenever possible, a fetus and placenta from several aborting does should be submitted. Mummified fetuses (a brownish, hairless fetus with an elongated muzzle and sunken eyes) are unsuitable for either culture or histologic examination. Autolysis

commonly obscures diagnostic changes. A summary of diagnostic materials that may be needed for an abortion investigation is presented in Table 1.

Paired serum samples may be required to confirm or deny suspicion of toxoplasmosis or chlamydiosis. Results of examination of a single serum sample from an animal that has aborted must be interpreted with great care, or confusion may result. Although certain titers are set as significant for disease regulation purposes, there is no specific titer for any infection that absolutely will differentiate infected from uninfected animals. Serologic results should always be correlated with herd history, clinical findings, and necropsy and laboratory findings.

The diagnosis in the event of an abortion storm often is not available for several days. It is reasonable to begin treatment of remaining pregnant animals with tetracycline in the event that a susceptible infectious agent is involved. One possible protocol is three injections of long-acting tetracycline at 20 mg/kg at 3-day intervals. Withdrawal time in lactating animal should be observed.

Table 1: Samples to be submitted to diagnostic laboratory for abortion in vestigation

FROZEN OR REFRIGERATED TISSUES

- ♦ Whole fetus and entire placenta preferred
- ♦ Fetal lung, liver, kidney, spleen
- ♦ Fetal stomach content
- ♦ Dam's serum

FORMALIN-FIXED TISSUES

- ♦ Fetal lung, liver, kidney, spleen
- ♦ Fetal brain
- ♦ Fetal heart and skeletal muscle
- ♦ Placenta

OTHER

- ♦ History
- ♦ Feed if indicated
- ♦ Water if indicated