

CURRENT CONCEPTS IN CAMELID REPRODUCTION

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Basic Camelid Reproductive Anatomy and Physiology: Llamas and alpacas can essentially be regarded as similar reproductively. Once having achieved sexual maturity they are capable of breeding any time of the year. Breeding seasons are chosen by management to avoid hot and frigid times of the year. Size of body does influence size of reproductive anatomy with the larger llama of course having somewhat larger tracts. **Female** anatomy is characterized by a relatively non-prominent vulva that rarely demonstrates tumefaction even at term pregnancy. The vaginal vault is variable in length depending upon parity history, normally being no longer than 25 cm. A cervix measuring 4-5 cm. will have 2-3 cartilaginous spirals in a clockwise pattern. Uterine anatomy of a nulliparous female features a very short body with two “stubby” symmetrical horns separated by a vertical intercornual septum. Ovaries found normally quite near the tip of uterine horns tend to measure 1.5 x .5 x .5 cm at puberty but will vary in size and symmetry as relates to follicular and luteal activity. Fallopian tubes are only slightly tortuous and enter the uterine horns via distinct papillae. Post pubertal ovarian activity (8-24 mos.) will be characterized by follicular waves at intervals of 12-21 days as evidenced by a single dominant follicle that will regress unless the female is bred. Receptive breeding at any time will cause LH release, however if a follicle is not 7-12 mm. in size and growing, ovulation will not occur. Breeding when a follicle is regressing has been observed to cause luteinization without ovulation. Following a normal breeding, ovulation tends to occur within 24-26 hours. Detectable progesterone levels above basal are readily observed by 7 days post breeding originating from a bulging corpus luteum of variable size (.5-1.5 cm.). Infertile mating will result in a return to follicular wave patterns as the corpus luteum is lysed beginning 12-18 days after ovulation. Successful breeding will be detected by persistence of serum progesterone levels above basal ranging from 1-13 nanograms per ml. Camelids are CL dependant throughout pregnancy which makes them susceptible to stress abortion as well as to being affected by exogenous steroid administration or topical application especially in the third trimester.

The **male** camelid at birth normally has testicles in the scrotum. Simulated breeding behavior is commonly observed as early as the first month of age. Unique features of male anatomy include a non pendulous scrotum with relatively small testicles relative to body size. While the fibro-elastic penis with a sigmoid flexure is comparable to classic ruminants, the penis is unique in having a cartilaginous tip that serves to dilate the cervix during copulation. There is only a very short urethral process characterized by a very small opening. Accessory sex glands include paired bulbourethral glands and a prostate. In the non-sexually aroused state, the prepuce points backwards causing urine to be directed posteriorly. As with the female, there appears to be a wide range of time for male puberty expression (12-36 mos.). Serum testosterone levels consistent with maturity are variably observed but should ideally be present by 18-24 mos. of age. Of note, elevation of testosterone levels seems to correlate well with eruption of the male's fighting teeth. While young males have on occasion proven capable of successful breeding, it is generally unwise to assume good fertility before 24 mos. of age. South American managers do not normally use males for herd breeding until 36 mos. of age.

Breeding management markedly influences male behavior. Hand breeding generally causes a male to be relatively aggressive to females presented for breeding. This often results in breedings that are not necessarily productive due to lack of ovulation. The current recommendation for hand breeding is to not attempt rebreeding more often than every 7 days to minimize non-productive attempts that traumatize as well as contaminate the female. Left to his natural instincts, a male in a pasture breeding situation will monitor the communal dunging area for perception of estrogen conjugates, demonstrate the flehman response and proceed to locate any female responsible for having urinated the encouragement.

The receptive female will minimally resist the male's approach, allow him to mount and soon assume sternal recumbency. Vocalizing by the male referred to as orgling accompanies his intromission attempts. With penis extended, his thrusts include a clockwise twisting of the glans which upon cervical contact will facilitate passage of the penis into the uterus. Duration of breeding is variable ranging from 5-45 minutes. Ejaculation occurs with pulsatile dribbles throughout the duration of copulation which normally continues in sternal recumbency. Volume of semen has been variably reported using various techniques, but suffice it to say the volume is relatively small (3-5 ml.) and consistency is extremely viscous markedly influencing post collection sperm motility.

Pregnancy diagnosis is suspected by female rejection response to an attentive male as well as by follow up serum progesterone levels taken at least 21 days after the last male contact. Definitive diagnosis is best accomplished by trans-rectal ultrasound with suspicion being evident as early as 14 days post breeding which is subsequently confirmed by observation of fetal heart beat at 25-28 days. Use of a 7.5 mhz. probe will of course provide the best information at early attempts for confirmation. Alpacas and maiden llamas make for difficult hand guided US rectal probing, necessitating use of a probe guide. This technique is actually extremely well tolerated by Camelids and gives comparable results to hand guided efforts. Follow-up confirmation can of course be accomplished by either trans-rectal or trans-abdominal US procedure. Alpacas in particular have proven to be less tolerant to trans-abdominal procedures in my experience. Late gestation trans-abdominal probing is somewhat challenging due to the paucity of fetal fluids that normally outline fetal structures.

Parturition usually occurs during morning daylight hours. Gestation length is anticipated to be 340-345 days +/- 10 days. Pregnancies have been reported to exceed 365 days even when accurate breeding records are available. Embryonal diapause has been conjectured to account for prolonged pregnancies however has not been proven. Successful premature births as early as 300 days have been observed. First stage labor is generally more prolonged in nulliparous females possibly even continuing from the previous day. A veteran will usually not exceed 2-3 hours for first stage labor and rarely go beyond 1 hour for second stage. Normally, the diffuse (syndesmo-chorial) placenta will pass within 4-6 hours.

In their native Andean environment an **infertility** diagnosis based on failure to reproduce is grounds for culling (slaughtered for food). However, in North America efforts generally are made to diagnose and treat the cause of infertility. This difference in approach is undoubtedly based on the current economic value of the llama and alpaca in North America. As with most animal production species, Camelids seem to have their fair share of female fertility problems. Explanations range from congenital/genetic anomalies, breeding and birthing injuries often related to poor management, subsequent infections or strictures and perhaps some hormonal imbalance. Evaluation of infertility relies on a detailed history including studs involved, thorough routine physical examination including external genitalia, a digital as well as vaginoscopic exam, and a rectal exam if possible accompanied by an US exam of the genital tract. If the female is young, an effort needs to be made to rule out the possibility that she is prepuberal and as such may have been repeatedly bred without the possibility of producing an ovulation but a very good chance of acquiring a metritis. Admittedly on occasion, some degree of suspicion will have been gained by the previous vaginal, rectal and US examinations. Criteria that strongly implicate some degree of uterine concerns include observation of vaginitis or cervicitis at the vaginal exam, detection of uterine distension without pregnancy and extremes of uterine tone at the rectal exam and either abnormal fluid or extremes of echogenicity observed via US.

Assuming that an unrevealing history other than unsuccessful breeding has taken place and that a detailed examination has failed to give a most obvious explanation for the problem, the diagnostic plan could also be expanded to include uterine biopsy and culture. Uterine biopsy and culture procedures

have been successfully employed in Camelids since 1985. While there are other options, notably cervical and uterine swabs for cytology and culture, directed at obtaining diagnostic and prognostic information none are deemed to be as helpful as the uterine biopsy with culture. This is particularly true since biopsy allows evaluation of endometrial glands as well as depth of inflammatory involvement.

While there are no doubt any number of techniques that will afford the needed biopsy and culture sample, following is what I have found to be the technique that has consistently been successful. The vaginal exam may have yielded a most inviting cervix for passage of the forceps, but in my experience that is a rare occurrence unless the intervention is relatively recent post partum or there is a bonafide pyometra. For alpacas and llamas, I will administer 3 and 5 mg. respectively of ECP (estradiol cycloproprionate) IM 12-24 hrs before the procedure. At the time of the procedure, I will give sedation with butorphanol or actually anesthetize with a **Ketamine/Xylazine/Butorphanol** combination. In case of anesthesia, the animals are maintained in sternal recumbency throughout the procedure. Generous rectal lubrication is administered followed by manual removal of feces. Ideally, the rectum is then “bunded” with 4x4 sponges to make the vaginoscopic procedure less messy. After thorough perineal scrubbing, a digital vaginal exam is repeated primarily for the purpose of sizing the diameter to facilitate in selection of vaginoscope size. Employing the largest size diameter that will comfortably fit will reduce the forward distance for engaging the forceps in the cervical external os. When the vaginoscope has been properly positioned for the cervix to be in view, the uterine biopsy forceps is advanced through the vaginoscope to minimally engage in the external os. Only rarely do I find the forceps to readily pass into the uterus

At this stage there are essentially 4 courses of action that may take place. The first and most ideal is for my rectal palpation hand to assist passage of the forceps through the cervix by the combination of gentle manipulation of the cervix while applying gradual forward and clockwise twisting pressure with the forceps. With success, the forceps is palpable in the uterus and I then direct it to the left horn. While applying rectal hand pressure to the lateral left horn, I partially open the forceps jaws, and gradually close them against my rectal hand. Before applying maximal pressure on the forceps, I will gently tug on the uterus to confirm the forceps placement. The actual biopsy is accomplished by maximally closing the forceps jaws and gently twisting to tear the tissue free a less than comfortable feeling to be sure. Before removing the forceps, the rectal arm is removed and the vaginoscope is replaced so as to facilitate a reasonably clean exit of the forceps. Blood may exit the vulva at this time associated with the biopsy and is to be expected.

The jaws of the forceps are opened and a sterile swab is taken for subsequent culture ideally transported in Portacul media facilitating both aerobic and anaerobic culture. The tissue biopsy is then placed in buffered formalin for submission. If I am unable to pass the forceps using the ideal technique, I abandon the vaginoscope and if size allows, will pass my well lubricated sleeved and gloved hand vaginally to the level of the cervix. If my hand is too large, I will recruit a small hand to do the same. The external os is then located and with index finger flexing, the cervix is gradually dilated with a definitive endpoint being the encountering of the intercornual septum. The forceps is then advanced into the vagina being careful to not pass it inside the gloved hand before then guiding it into the now dilated cervix. If rectal guidance is possible from this point, it is surely preferable. If not, then US observation per rectum is the next most preferable rather than to proceed with a blind biopsy, a final option.

Having been successful by one or a combination of the described options, the question that emerges is should I treat now or wait for the laboratory results? Because the cervix is passable at this time, I am of the opinion that conservative treatment should commence independent of the lab results. In the past, I

have more or less assumed that all cases needed aggressive intrauterine antibiotic therapy and had utilized dilute oxytetracycline, gentamycin, penicillin and amikacin in varying regimes and likely variable results depending on the true need for the therapy utilized. Following is my current approach to therapy which I feel has given equally good if not better results however bearing in mind the variable bacterial isolates and degrees of pathology involved, no definitive conclusions can be made. As such, I place a self retaining polyethylene catheter into the uterus and flush up to 500 cc of warm saline (PSS) into the genital tract which washes out any blood remaining. The owner is then left with two 250 cc vials of saline one of which contains dilute Betadine with instructions to administer 50 cc of the Betadine/PSS solution in the AM and the PSS in the PM pending results from the labs. The animal is given SQ injections of Aqueous Procaine Penicillin G (APPG) @ 20,000 units/# q. 24 hrs. for up to 5 days. If laboratory results reveal a particular isolate and antibiotic sensitivity, the therapy is modified accordingly. Ideally, the indwelling catheter remains in place for up to 5 days, however on occasion the female will abort it. Parenteral therapy will continue for the 5 days however.

The vast majority of male fertility concerns center around unproven males who in many cases are expected to be fertile before their time. Many males may not be successful breeders until after three years of age. Even with adequate libido, complete intromission and what appears to be effective servicing of a female, there appears to be a required period of time for sperm maturation or production of sufficient sperm to create a minimum insemination dose. Occasionally males have been encountered with congenital anatomical abnormalities, including persistent frenulum, corkscrew penis, preputial stricture, hypospadias, hypoplastic testicles, and cystic testicles to explain post pubertal infertility. The major problems observed in formerly proven males that are now deemed infertile include preputial tears, scarring strictures, hematomas and adhesions. In addition, infertility, usually of a transitory nature, follows heat stress in formerly fertile males.

A complete physical examination including routine laboratory tests should begin the professional examination. In addition, unless there is possibility of physical compromise, breeding should be observed, so as to confirm the owner's observations. While the external genitalia can be observed and appreciated by palpation, anesthesia is generally required for detailed assessment including testicular palpation, rectal palpation (at least digitally to evaluate the bulbourethral glands and prostate), penile extension, and electroejaculation. Inability to extend the penis from the sheath due to laceration and subsequent preputial stricture is unfortunately common. Trauma to the glans penis can also be observed.

Semen collection and evaluation of male llamas remains difficult. While some success at semen sampling has been achieved with electroejaculation, as well as using semen retrieval from bred females, an artificial vagina and an intravaginal condom, none of these techniques has allowed consistent collection of a full ejaculation, or even a representative sample. Moreover, owing to the normal viscosity of camelid semen, motility evaluation is exceedingly difficult. At least 50% of observed spermatozoa should be motile but not necessarily showing progressive motility. The most valuable assessment of semen quality is derived from morphology of spermatozoa, where interpretation of abnormalities is comparable to other species. Normally, greater than 50% should be of normal type, with minimal numbers of primary abnormalities as well as few white blood cells and bacteria. Depending on the technique used for semen collection, variable numbers of elliptical shaped red blood cells may contaminate the sample which may give the impression that the sample has sperm with separated heads. Ultrasonography is emerging as a useful tool to evaluate the accessory sex glands via the transrectal approach as well as to evaluate testicular texture via the percutaneous route. Cysts, scarring, hydrocoele and scrotal edema, the latter associated with heat stress, are readily demonstrable with this technology.

Testicular biopsy and/or epididymal aspirates are relatively invasive and somewhat controversial techniques. After a thorough physical examination including external genitalia, as well as internal genitalia using anesthesia and ultrasound, which reveal no obvious explanation for the poor performance some means of collecting semen will have been initiated. Assuming that results of semen collection have yielded poor to questionable fertility whether by electro ejaculation, vaginal retrieval or artificial vagina, a serious discussion with the owner is in order. In the case of a veteran breeder that has become infertile, sexual rest for 45-60 days may be in order followed by a few service attempts before a subsequent semen evaluation is attempted. In the case of the “late to perhaps never bloomer” the owner should be apprised that delayed puberty has genetic implications for any subsequent offspring that may be produced and as such, “do we really want to proceed with further evaluations”? Assuming the owner to be inclined to stay the course, I would still wait at least another 30 days before reattempting semen evaluation of this young male. I will discuss the possibility of a biopsy procedure at this time indicating the results of the procedure will give us a more definitive prognosis but not without some possible risks.

At the follow up visit, I’m most inclined to do a vaginal retrieval from a receptive female and failing to observe encouragement from the semen evaluation will proceed with the biopsy. While there have been some theoretical concerns expressed as regards initiation of an autoimmune reaction causing infertility associated with testicular response to biopsy procedures, to date that has yet to be proven. There will of course be variable hemorrhage associated with either a surgical wedge, true-cut, or needle flow biopsy as well as some degree of inflammatory response. Fortunately with my preferred method, the “needle flow” technique, little in the line of compromising complications have been observed even when applied to known fertile males that were subsequently evaluated 4 weeks post biopsy.

The technique options include surgical wedge true-cut and needle flow biopsies. In my hands, the wedge is difficult to achieve without excessive hemorrhage and facing the risk of the teste escaping from the incised tunic. Surgical closure of the tunic and skin are necessary. The true-cut technique is readily performed without making a skin incision but compared to the wedge, only a small sample is achieved. Both these techniques will require sample fixing, ideally in Bouin’s solution, to be evaluated by a pathologist at a later date. The needle flow technique is essentially a cytological evaluation achieved by a hypodermic needle penetrating into the parenchyma of the teste causing cells to flow into the needle for slide preparation, staining and on the spot evaluation microscopically.

Details of the “Needle Flow” Technique: While it is no doubt possible to perform this procedure using sedation or without anesthesia, I much prefer use of the KXB combination allowing additional opportunity to reevaluate the penis, prepuce, testes and secondary sex glands. A surgical scrub is performed over the entire scrotal area. With sterile procedure, a 1 ½ inch 16 gauge needle is directed deep into a well isolated teste. Prior to retracting the needle, an index finger is placed over the needle hub. Being careful so as to not exit the skin, the index finger is removed and the needle is redirected deep into the tissue. Again, the index finger is placed over the hub prior to removing the needle completely. A cytological preparation is made by gently blowing on the needle allowing the contents to flow onto 2 microscopic slides. A smear is then made comparable to a routine blood smear, air dried and ideally stained with Wrights-Giemsa however Diff-Quik is totally satisfactory.

Microscopic Evaluation: While admittedly the specimen does not allow evaluation of histological architecture, a normal sample will nicely demonstrate the progression from spermatogonia to spermatocytes and subsequently spermatids. What is often observed in infertile individuals is a maturation arrest at some level resulting in a disproportionate number of one stage of development.

Camelid infertility should be approached comparably to other domestic species. Knowledge of reproductive anatomy, physiology, and breeding management is imperative to successfully resolve problems. Much is yet to be learned about unique aspects of camelid infertility. The practitioner should be encouraged to utilize all skills and techniques proven to be of value in other animals and share the information with the profession.

As with most domestic species, the cause of **camelid abortion** may remain undiagnosed, even when sophisticated diagnostic procedures are employed. In the broadest use of the term, abortion implies the loss of an established pregnancy; however, in the present sense it implies expulsion from the uterus of the products of conception that may or may not be observed. Therefore, other fates of the conceptus (namely resorption and mummification) are not necessarily covered by abortion. To date, little correlation with real or theoretical causes of conception wastage to stages of camelid conceptus development has been made. As such, assumptions will be made that certain infectious involvements, namely, toxoplasmosis, leptospirosis and chlamydiosis, will manifest effects on the conceptus comparable to those observed in other species. Some causes of abortion will appear to be anecdotal as well as conjectured. Moreover, idiopathic conception loss may well account for the majority of cases. Published reports dealing with camelid conceptus wastage are sparse, however, and only briefly dealt with in the text and in llama lay publications.

Other factors influencing embryonic mortality include infection, endocrine, lactation, nutrition, parity, uterine crowding, thermal stress, physiological stress, genetic incompatibility and immunologic incompatibility. From all causes and in all species of domestic farm animals, approximately 25-40% of all embryos are normally lost. There is generally an expected embryonic loss in North American llamas up until 65 days of gestation; however, it does not appear to be as significant as the 50% loss prior to 30 days of gestation observed in alpacas in Peru.

To date, no recognized infectious entity has been described to account for a contagious/venereal embryonic mortality. However, organisms commonly isolated via uterine culturing techniques, including streptococcal, staphylococcal, and coliform species, as well as various anaerobes, including *Actinobacillus pyogenes*, clostridial species, *Peptostreptococci* and *Bacteroides*, will undoubtedly cause embryonic mortality in addition to infertility. If a female is unable to establish a noninflammatory environment conducive to continued implantation, embryonic mortality will likely ensue. If nutrition were to be considered a factor of and by itself, a poor plane of nutrition during early (0-35 days) gestation could account for some embryonic mortality. Considering the relatively high plane of nutrition that most llamas are afforded in North America, this is relatively unlikely. However, it is possible for certain feeds and forages or moldy feedstuffs to be high in estrogenic activity, causing infertility and embryonic mortality, as well as fetal attrition

In the author's personal experience, twin conception in Camelids has been estimated to occur in from 5-10% of successful breedings. Unfortunately, the success rate of carrying these to term is low, as relatively few twin births have been reported. As with the equine species, this poor twinning success rate is related to overcrowding *in utero*. The phenomenon of overcrowding is likely related to both embryos implanting in close proximity in the same horn (usually left). Uterine capacity does not appear to be a factor. The twin pregnancy attrition is most likely, then, a result of a compromise of space and vascular supply within the uterus, restricting placental development. Most deaths in other species studied occurred during the early stages of attachment, or about the 14th day. Successful twin pregnancies are likely explained by the transuterine migration of each conceptus to a separate horn and maintenance by adequate levels of progesterone.

Camelid species in North America have been observed to be subject to thermal stress, no doubt being predisposed by excessive body fat, an abundant fiber cover, and inadequate cooling environments to face the combination of high ambient temperature and humidity. Pregnant animals affected by heat stress not only face a life-threatening situation but the pregnancy is in jeopardy. In some species this thermal effect will prevent successful conception or subsequent cleavage stages within the oviduct, essentially resulting in infertility observations. In other circumstances, maternal recognition of the pregnancy is altered, causing embryonic mortality in the critical stages of implantation. Suffice it to say that thermal stress is a considerable factor affecting camelid reproduction at the fertility, embryonic mortality, fetal mortality and postnatal levels. As such, camelid breeders are making an effort to avoid predictable hot weather seasons for breeding and birthing activities. On the same principle as heat stress, high body temperature caused by fever may have deleterious effects on a pregnancy. Any time core body temperature reaches (105 F +) for a prolonged period, the pregnancy is threatened.

While in general genetic influence in reproduction affects the observed offspring, unfortunately genetics may account for significant embryonic mortality as well. With increased homozygosity, chances for an abnormal embryo are increased, which fortuitously may be deemed incompatible for further development in the uterus and will be resorbed. With the relatively narrow genetic base existing in the camelid population, this may be a more significant factor than in most domestic species. As camelid pregnancies are deemed to be corpus luteum dependent, any factors that cause luteolysis will cause termination of pregnancy by either embryonic resorption or fetal abortion.

Drug-induced pregnancy termination can reliably be accomplished with prostaglandin products any time after seven days of gestation. Injected estrogens will also cause pregnancy termination. Parenteral and topical steroids have been observed to cause abortion, particularly at high doses and in the last trimester. Consideration should therefore be given to pregnancy status when considering steroid therapy. For the same reason, physiologic stress should be kept to a minimum, as the endogenous steroid response would also likely cause luteolysis. Since it is as difficult to assess stress in a llama, as in any species, including human beings, suffice it to say that unnecessary procedures, e.g., foot trimming, grooming, vaccinations, etc. should be minimized during pregnancy. In addition, major transport of pregnant animals should be done with discretion for comfort of body and mind. With Camelids being the herd-oriented animals that they are, uprooting their social order may contribute to significant stress and cause the chain of events leading to pregnancy termination

Camelid abortions may be spontaneous or induced, infectious or noninfectious. Noninfectious causes of spontaneous abortion may be genetic, chromosomal, hormonal, nutritional, or managerial-related. Breeding too soon after puberty or immediately after parturition has been associated with increased abortion tendencies in other species. The true impact of genetic/chromosomal effects in camelid abortion, stillbirths/neonatal deaths and genetic defects is unknown.

Twin pregnancy producing abortion of one or both fetuses is the second most likely outcome after resorption. On more than one occasion, mummification of one fetus has occurred, with the mummy either being prematurely delivered or delivered at term along with a term fetus which may be stillborn or fully viable. Another outcome to twin pregnancy if involving fraternal (dizygotic) twins of both sexes is apparent freemartinism.

While stress was mentioned as a likely cause of corpus luteum regression at any stage of gestation, a number of late term abortions examined at Colorado State University have been characterized by extreme fetal thymic tissue atrophy. Our interpretation of this observation is that the dam has likely undergone a period of stress, resulting in an outpouring of endogenous glucocorticoids and causing

thymic tissue atrophy in the fetus. Therefore, when no other explanation for abortion or stillbirth is found, demonstration of thymic atrophy strongly suggests chronic stress abortion. Other noninfectious causes of camelid fetal wastage include anaphylaxis or allergies, high levels of dietary nitrates, selenium, or arsenic, and dietary deficiency of vitamins A or E, copper, iodine, or selenium. While numerous poisonous plants may well compromise the dam, few are alleged or reported to be of principal reproductive concern. Notable, however, is the possibility of pine needle abortion, as has been described for cattle. Circumstantial evidence has incriminated ponderosa pine (*Pinus ponderosa*) needles as a cause of camelid abortion. Of note is the fact that ingestion of either green or dry needles containing isocupressic acid appears to be effective in causing abortion. Any pine needles may cause abortion but those of the ponderosa pine are deemed the most toxic. Abortion has been reported in association with vaccinating late gestation llamas with seven or eight antigen clostridial vaccines. Whether this is a result of the stress of vaccination or some adverse effect from the vaccine is unexplained at present. Abortions following injections of vitamin E/selenium preparations have also been observed and on occasion the fetus was shown to have toxic levels of selenium in the liver. An abortion presented to the Colorado State University diagnostic laboratory was found to have an ocular fluid nitrate level of 35 ppm. This would be deemed a significant level in cattle, where values greater than 20 ppm are considered toxic.

The list of possible infectious agents causing abortion might well include all those known to infect common domestic species, and perhaps in time all may be incriminated. Of those that have been observed, confirmed, or strongly suspected in North America there are just four agents, namely, leptospirosis, chlamydiosis, toxoplasmosis, and *E. coli*. Others that could well produce abortion include the orbi virus of blue tongue, various species of brucellosis, salmonellosis and listeriosis, the herpesvirus of infectious bovine rhinotracheitis (IBR), the toga virus of bovine viral diarrhea (BVD), and the equine herpes I (EHVI) virus of rhinopneumonitis. If these problems were to emerge as producing a high-risk threat to the camelid population, vaccination may be in order. However, one should be cautious in using any modified live virus vaccine in a species other than that for which it was developed. That being the case, an initial and booster dose of killed virus vaccine would be the recommended procedure.

While the occasional abortion in Camelids is realistically no cause for alarm, each should be carefully investigated both for possible zoonotic implications as well as the potential for an epizootic to emerge. Therefore, blood samples should be collected from the dam for possible acute serum titer determination. In addition, the aborted fetus and placenta should be necropsied, and tissue samples cultured, as well as special stains made of placental smears to detect the presence of meronts consistent with *Toxoplasma gondii* or the elementary bodies consistent with *Chlamydia* sp. At the very minimum, portions of placenta and the aborted fetus should be frozen for future evaluation if additional concerns develop. A follow-up convalescent dam serum sample should be taken at least two weeks, up to one month, from the abortion. If the fetus is shown to be septic, uterine culture may be indicated, as a bacterial infection may have been initiated *en utero*.

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