Ram and Buck Breeding Soundness Examination

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Abstract

Male breeding soundness examination (BSE) is an important component of sheep and goat farming. BSE is best performed 2 months before the breeding season and is based on clinical and physical examination as well as sperm abnormalities detection. Rams are classified based on physical examination and semen evaluation finding in one of 4 categories: Unsatisfactory, questionable, satisfactory, and excellent. The satisfactory rams will achieve good reproductive performance if joined to ewes at a ratio of 1:50 for 60 days. However exceptional rams are expected to achieve good reproductive performance at a ratio of 1 ram to 100 ewes. For Buck, scrotal circumference should be at least 25 cm for breeds weighing more than 40 kg. Buck is deemed satisfactory breeder if he passes the physical examination, and has an ejaculate with at least 50 % progressively motile spermatozoa and less than 30 % total sperm abnormalities. This paper reviews factors affecting fertility, sperm production and quality as well as libido and mating ability in the ram. Details of genital examination and semen evaluation and interpretation of results are discussed. Classification of rams according to their reproductive potential is presented. Specific recommendations, when available for the buck, are highlighted. The main genital diseases are presented. The most frequent culling reason for ram is epididymitis due to *Brucella ovis*. Systematic culling of rams with epididymitis improves flock lambing rates by 10 to 15 %. Overall, the examination of the reproductive capacity in the ram and the buck is an important tool for improvement of flocks/herds fertility and prevention of contagious or hereditary diseases.

Keywords: Genital diseases, fertility, sheep, goat

Examen de l'aptitude à la reproduction chez le bélier et le bouc

Résumé

L'examen de l'aptitude à la reproduction (EAR) du mâle est une composante importante de l'élevage des petits ruminants. L'EAR est mieux réalisée 2 mois avant la saison de reproduction. Il est basé sur l'examen clinique et physique ainsi que sur la détection des anomalies des spermatozoïdes. En considérant les résultats de cet examen, les béliers sont classés en 4 catégories: Insatisfaisant, douteux, satisfaisant et excellent. Les béliers satisfaisants permettront d'obtenir de bonnes performances de reproduction s'ils sont mis pendant 60 jours pour saillir des brebis au ratio de 1:50. Cependant, des béliers exceptionnels peuvent réaliser une bonne performance reproductive au ratio de 1 bélier pour 100 brebis. Chez le bouc, la circonférence scrotale doit être d'au moins 25 cm pour les races pesant plus de 40 kg. Il est considéré comme satisfaisant s'il passe l'examen physique et produit un éjaculat avec au moins 50 % de spermatozoïdes progressivement mobiles et moins de 30 % d'anomalies totales des spermatozoïdes. Cet article examine les facteurs affectant la fertilité, la production et la qualité du sperme ainsi que la libido et la capacité de saillie chez le bélier. Les détails de l'examen de l'appareil génital et du sperme et l'interprétation des résultats sont traités. La classification des béliers selon leur potentiel de reproduction est présentée. Des recommandations spécifiques, lorsqu'elles sont disponibles pour le bouc, sont mises en évidence. Les principales maladies génitales sont traitées. La cause de réforme la plus fréquente chez le bélier est l'épididymite à *Brucella ovis*. La réforme systématique des béliers à épididymite améliore les taux d'agnelage des troupeaux de 10 à 15 %. Globalement, l'examen de l'aptitude de reproduction chez le bélier et le bouc est un outil important pour l'amélioration de la fertilité des troupeaux et la prévention des maladies contagieuses ou héréditaires.

Mots-clés: Reproduction, maladies génitales, fertilité, bélier, bouc

INTRODUCTION

Male breeding soundness examination (BSE) has become common practice in all domestic animal species. This examination is meant to forecast the ability of a male to impregnate a given number of females within a defined period of time. It is not a fertility test because many males that do not meet the requirements set for the BSE may not be completely sterile and can even impregnate a large number of females under some specific management conditions (Ott and Memon, 1980; Gouletsou and Fthenakis, 2010; Rowe, 2010; Ridler *et al.*, 2012; Van Metre *et al.*, 2012). In small ruminants BSE is best performed 2 months before the breeding season as part of a flock health visit. About 10% of rams have poor fertility. Many of these can be detected by palpation of testicles without the need for electroejaculation although there are some conditions that are missed if examination of fresh semen is not carried out. The present paper describes an approach commonly used for BSE in rams and bucks. An emphasis is placed on health, physical and sperm abnormalities warranting culling of rams and bucks from reproduction.

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FACTORS AFFECTING RAM FERTILITY

Outside of the breeding season (before June in Morocco), the size of testicles and numbers of spermatozoa are lower, especially in breeds with a short breeding season. The testicles should be of similar size, very resilient (turgid) and move freely in the scrotum (compare with others of the same age and similar breed). If the history and examination of the ram and semen show reduced fertility, treatment is not normally possible. A potentially valuable ram may be tested again 2 months later, as infertility is occasionally temporary. The only final evidence of fertility is the production of lambs (Ridler *et al.*, 2012).

Seminal characteristics are highly correlated with the ability to impregnate ewes and semen evaluation can identify most rams of low fertility. A scoring system based on the quantity and quality of semen obtained by artificial vagina can be used. Actual fertility (conception rates) obtained from rams with different semen scores was verified in breeding trials. Synchronized ewes were bred to rams and slaughtered 25 days later to determine conception rates (presence of embryos). The results of these trials showed that 96 to 97% of the rams with semen scores of 3 to 5 had a conception rate of 80 to 100% whereas only 35 and 25 % of rams with scores 2 and 1, respectively, could settle more than 80 % of the ewes (Hulet, 1977; Kimberling, 1984).

A high correlation was found between some semen parameters and fertility or fecundity. In fact, the percentage of live normal spermatozoa, motility, pH and abnormal heads or mid-pieces were the most correlated with fertility (>60 %). Correlation between fecundity and semen parameters was highest for the percentage of live normal spermatozoa, % abnormal necks and % abnormal mid-piece (33 to 44 %) (Hulet, 1977; Kimberling, 1984).

Under natural mating conditions, the reproductive performance of rams can be affected by several factors. These can be grouped into 3 large categories: 1) Factors affecting sperm production, 2) Factors affecting semen quality and 3) Factors affecting the delivery of semen to the female.

The objective of the BSE is to evaluate a male based on its ability to produce and deliver semen in sufficient quantity and achieve high conception rate and fecundity.

Table 1: What to look for during physical examination?

Parameters	Significant findings
Signs of good health	General alertness, free movement, no lameness, close and uniform fleece, active feeding, rumination, no visible wounds, abscesses or injuries.
Signs of ill health	Listlessness, abnormal posture and behavior, stiff gait, persistent coughing or panting, absence of rumination, poor BCS, unthrifty, lameness, diarrhea, patchy loss of fleece, constant rubbing, separation from flock
Body condition score	Should be 3 or 4 (out of 5 point scale). Over-conditioned or under-conditioned rams are not desirable
Temperature, pulse and respiration	Fever, abnormal cardiac or respiratory function
Mucous membrane	Look for anemia (heavy parasitism)
Teeth	Normal bite, normal jaws (no actinobacillosis, hard swelling), good apposition with dental pad
Head and neck	Check for neurological disease (head position), abnormal nasal discharge (nasal bots) , cracked horns Check for submaxillary and parotid glands swelling or abscesses (Caseous lymphadenitis) Look for signs of psoroptic mange in the ears or dermatitis due to ringworm Check for regurgitation or difficult swelling Snoring: pharyngeal or laryngeal injuries, laryngeal chondritis Head, tongue swelling (blue tongue) Orf or contagious echtyma lesions on the lips
Eyes	Check for persistent discharge, blindness or cataracts, keratoconjunctivitis (Pink eye) Entropion (hereditary), check for residual signs of previous surgery
Fleece	Check for patchy loss of wool, pruritis (fever, mange or scrapies) *Dermatophilus congolensis*: Chronic exudative infection with areas of crusting
Brisket	Common site of abrasions or abscesses
Conformation	Bad conformation include: cow hocks, straight hocks, long sloping patterns
Feet	Corkscrew claws, shelly horn, splayed claws Interdigital growths causing pain (young rams) White line disease: most common. Infection tracts up to the coronary bands. May infect joints and tendon sheaths resulting in supportive arthritis Foot rot: characteristic smell Scald: Interdigital skin inflammation Strawberry foot-rot: caused by *Dermatophilus congolensis* may be mixed with Orf virus, debilitating sores in lower limbs Lameness reduces serving capacity and daily sperm production
General	Watch for signs of urolithiasis

FACTORS AFFECTING SEMEN PRODUCTION

The number of spermatozoa produced on a daily basis is directly correlated with the amount of healthy testicular parenchyma (volume or weight). In practice, estimation of the volume or weight of the testis can easily be obtained by measurement of the scrotal circumference at the largest diameter (Braun *et al.*, 1980; Burfening and Rossi, 1992; Elmaz *et al.*, 2007). Thus, this parameter has become an important part of the BSE in males. Minimum acceptable scrotal circumferences for a breeding ram have been set for two groups of ages: Rams less than 14 months old and rams older than 14 months.

Sperm production is also affected by sexual activity, season, nutrition and general health of the ram (Mickelsen *et al.*, 1982; Ahmad and Noakes, 1995; Avdi *et al.*, 2004; Ridler *et al.*, 2012). It is important to conduct a thorough physical examination and evaluation of the body condition of the ram as part of the BSE (Table 1). Ram BSE should be conducted 30 to 60 days before joining, preferably during the natural breeding season and on sexually rested rams. Outside the breeding season or after intensive use, rams will have generally smaller and softer testicles.

FACTORS AFFECTING SEMEN QUALITY

Semen quality can be affected during spermatogenesis or during epididymal maturation and storage (Mickelsen *et al.*, 1981; Gouletsou and Fthenakis, 2010; Van Metre *et al.*, 2012). Any disease that may disturb thermoregulation of the testicles or epididymal transit will affect the morphology of the spermatozoa and the fertilizing ability of semen. These factors include systemic diseases, fever or pathological processes at the level of the scrotum, testis or epididymis. It is therefore important to know how to examine and recognize abnormalities or lesions of this part of the genital organs (Table 2).

The most common genital pathology in rams is contagious epididymitis (Figure 11). There are two separates entities in terms of etiology depending on age of the ram: Ram epididymitis (old rams) and lamb epididymitis (virgin rams).

Ram epididymitis is primarily due to *Brucella ovis* and is probably the most common disease that affects breeding rams. Systematic culling of rams with epididymitis improves flock lambing rates by 10 to 15 %. Bilaterally affected rams are usually sterile but some may retain some fertility (up to 40%). Unilaterally affected males will lose about half of their fertilizing ability (Van Metre *et al.*, 2012; Picard-Hagen *et al.*, 2015).

Table 2: Most common abnormalities of the genitalia in rams

Organ	Examination	Anomalies
Penis and prepuce	Ram should be placed in a "sitting" position in order to visualize the preputial opening. The penis is extended by pushing the sigmoid flexure upward and retracting the prepuce with the other hand at the same time. The surface of the penis and the urethral process should be examined closely for lesions	Pendulous prepuce Ulcers at the junction of the skin and mucous membrane (can be associated with Orf) Abnormal discharge: bloody or purulent (frothy whitish discharge may be normal) Ulcerative balanoposthitis: bloody discharge Adhesions, scarring tissue (Figure 1) Balanitis, absence or inflammation of the urethral process (Figure 2)
Scrotum	Inspect and palpate the scrotum and its content while the ram is in the "sitting" and standing position. Evaluate length of wool. Evaluate for symmetry. Measure scrotal circumference	Scrotal skin lesions: dermatitis (Figure 3), abscesses (Figure 4), cuts Asymmetry: testicular degeneration, atrophy, hypoplasia (Figure 5) Scrotal hernia (large soft mass between the testicles and the abdominal walls) (Figure 6) Palpate for increased sensitivity (orchitis, scrotal abscesses) (Figures 7, 8, 9)
Testicles	Palpate each testicle separately for consistency, size, and presence of lesions. Testis should be smooth, freely moveable, ovoid in shape and resilient. Ultrasonography is indicated in valuable rams or rams with abnormal semen	Soft flabby testis: degeneration or atrophy Hard firm testis: orchitis, severe degeneration with fibrosis, severe hypoplasia Hypoplasia: associated with incomplete descent and may be heritable: rams with one testicle half the length and diameter of the other testicle should be removed from breeding Cryptorchidism and monorchidism (Figure 10) Orchitis and epididymitis Varicocele: Firm lobulated mass detected at the level of the spermatic cord. Spermatocele: Spontaneous and permanent hard swelling.
Epididymis	Palpate the tail of the epididymis Size of the epididymis in relationship to size of testis	Epididymitis: enlarged, adhesions (Figures 11, 12, 13, 14)

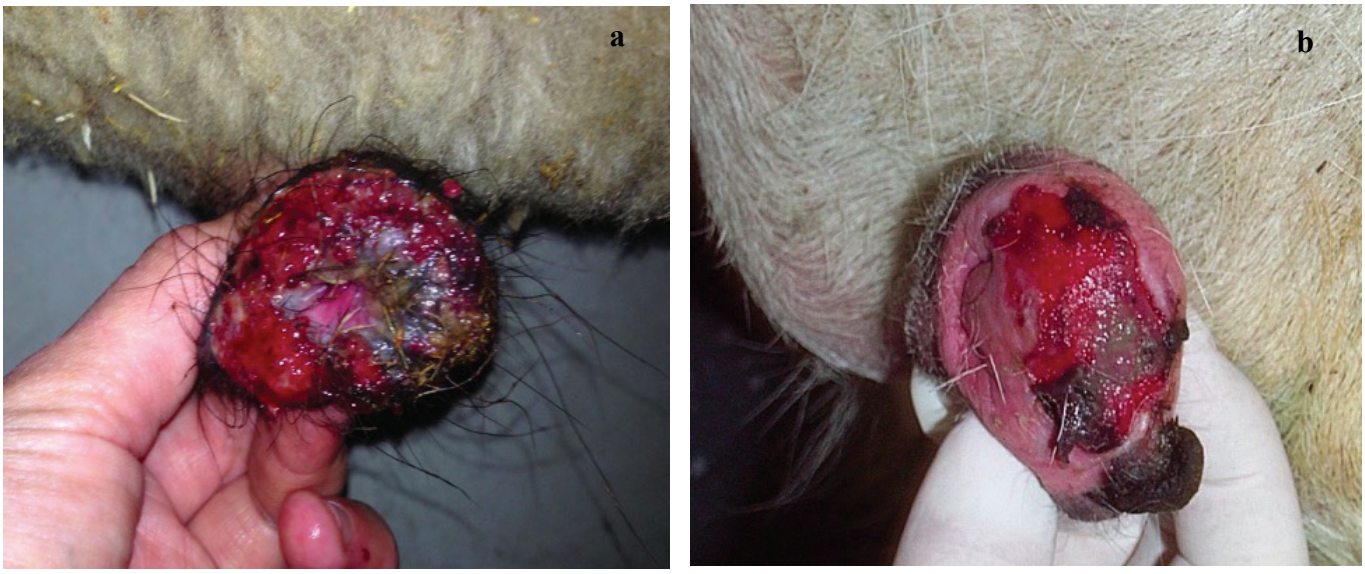

Figure 1: Ulcerative balanaposthitis (pizzle rot) in rams (a: severe; b: moderate) due to excessive production of ammonia by Corynebacterium renale.

Figure 2: Balanitis. (left) early case, (right) case with compromise (necrosis) of the urethral process due to urolithiasis.

Figure 3: Scrotal dermatitis: differentials include mange and contact dermatitis

Figure 4: Ram presenting a ruptured scrotal abscess with adhesions and periorchitis

Figure 5: Ram presenting a severe scrotal asymmetry due to unilateral testicular atrophy

Figure 6: Young ram lamb (14 months) with enlarged asymmetric scrotum due to an inguinal hernia

Figure 7: Mature ram with severe swelling of the scrotum due to a bilateral orchitis

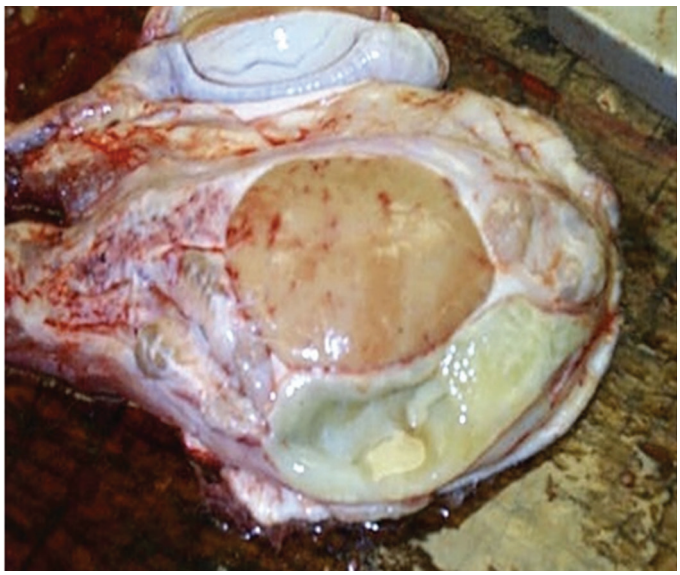

Figure 8: Testis from an infertile mature ram showing a periorchitis and abscess

Figure 9*: Enlarged inguinal area in an infertile mature ram with inguinal and peri-testicular abscesses due to C. pseudotuberculosis (a: clinical evaluation; b: postmortem evaluation)*

Figure 10: Unilateral cryptorchidism in a ram lamb (left). (a) comparison with a lamb of the same age, (b) unilateral right cryptorchidism

Figure 11: Rams with severely enlarged tail of the epididymis and testicular atrophy due to epididymitis (left, right)

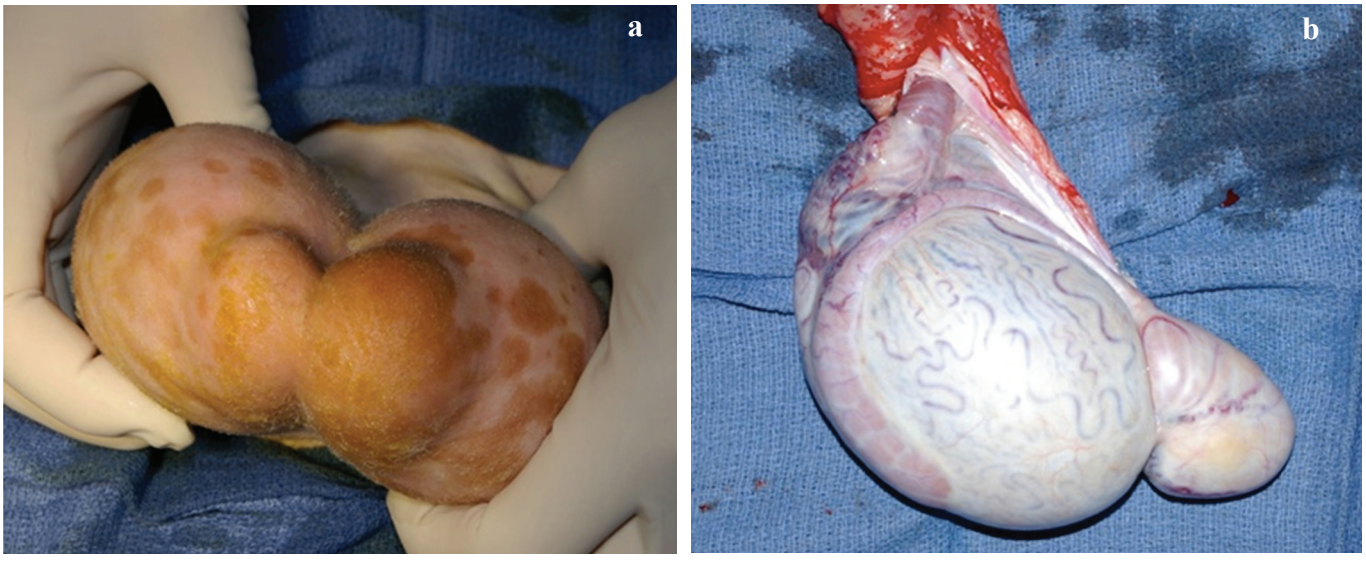

Figure 13: Unilateral cauda epididymis enlargement due to spermastasis. Clinical pre-castration evaluation (a), post-castration evaluation (b)

The primary route of infection in breeding males is the oral or ocular mucous membrane. Homosexual behavior, oral ingestion, genito-nasal investigation amongst rams or ram/ewes are suspected to be the primary mechanisms of transmission. Venereal transmission to ewes is possible. Vertical transmission from ewes to male lambs by transplacental crossing or via milk has been suggested (Ridler and West, 2011; Picard-Hagen *et al.*, 2015).

The organism causes hyperplasia of reticuloendothelial cells, septicemia, and localizes in the epididymis, seminal vesicles, bulbourethral glands and ampullae of the vas deferens, resulting in gross lesions (epididymitis and local interstitial swelling) with plasmocytic and lymphocytic infiltration in the perivascular regions and migration of polymorphonuclear leukocytes (PMN's) into the epididymal lumen. Ductal epithelial cells undergo hyperplasia in response to the inflammation and form obstructing folds into the lumen as well as mural cysts. Spermatozoa accumulate proximal to the obstruction and eventually cause a rupture of the duct and extravasation of sperm cells into the interstitial tissue and development of granulomas (Carvalho *et al.*, 2012). Pressure from the obstruction leads to degeneration of the seminiferous tissue and testicular atrophy.

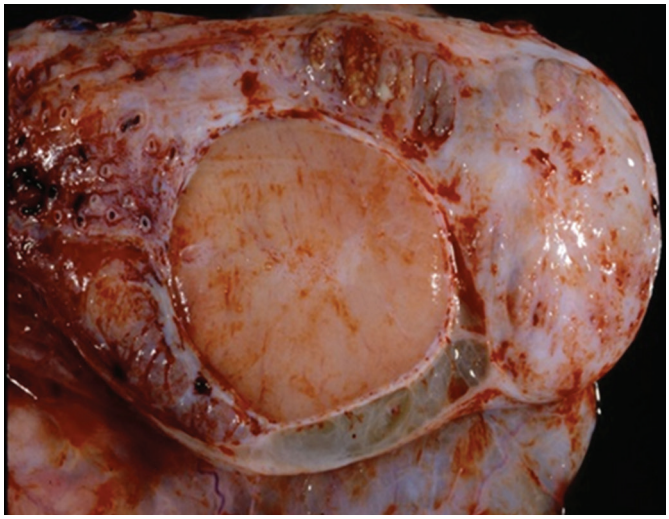

Figure 12: Postmortem gross lesion of epididymitis due to B. ovis

Semen quality may start to deteriorate within 2 to 3 weeks of infection. Ejaculate abnormalities consist of decreased motility, decreased sperm concentration and increased number of spermatozoa with detached heads (Table 3) (Cameron and Lauerman, 1976; Kimberling *et al.*, 1986; McLaren, 1988). In addition to epididymitis other differential diagnoses of increased scrotal size (i.e. swelling) include:

Inguinal hernia with omentum extending through the inguinal ring.

- Edema of the scrotal skin.
- Hematoma.
- Orchitis.
- Hydrocele.
- Varicocele.
- Spermatocele.
- Puncture wound causing cellulitis.

Infected rams can be detected by serology. Complement fixation test (CF) is usually positive within 6 to 9 weeks of infection (titer 1:160 or greater) and remains elevated for up to 7 months or longer. CF is a screening test but lacks sensitivity and specificity (too many false negative and false positive results). An ELISA test is more sensitive and false positives are generally not a problem. ELISA is also useful in the early detection of the disease (Ridler and West, 2011; Franca *et al.*, 2014; Ridler *et al.*, 2014).

Lamb epididymitis is caused primarily by *Actinobacillus seminis* (Heath *et al.*, 1991). It affects rams at pre-breeding age, particularly those that are on high plane of nutrition. The infection in a group of ram lambs is spread by oral-nasal contact with urine of preputial secretion during the typical prepuce investigation behavior displayed by rams. Ascending infection has also been incriminated. Prevention of the disease by vaccination or prophylactic antibiotics is of limited value. Some lambs with high PMN's have been treated successfully with long acting tetracycline (20 mg/kg). *Actinobacillus seminis* was isolated from rams with abnormal semen or fertility. In one study (Al-Katib and Dennis, 2005), clinical signs were not always present although two of five experimentally infected rams presented palpable

Figure 14: Cauda epididymis from an infertile mature ram showing sperm granulomas

lesions. Necrotic testicular and epididymal abscesses may be seen on postmortem examination. *A. seminis* was isolated from seminal vesicles and epididymis of a ram with no gross lesions. This suggests that *A. seminis* infection may be widespread and should be considered in cases of infertility (Mbai *et al.*, 1996; Al-Katib and Dennis, 2005; Otter, 2008; Al-Katib and Dennis 2009; Gouletsou and Fthenakis, 2015; Acosta-Dibarrat *et al.*, 2016).

Control of ram epididymitis in a flock rests mainly on periodic examination of rams and strict enforcement of guidelines for scrotal palpation, scrotal circumference, semen quality and ELISA testing. In most breeds, all ram lambs with less than 30 cm scrotal circumference or abnormal testicular consistency should be culled from breeding. In geographical areas where the disease is endemic, rams should also be evaluated after the breeding season. Vaccination may be used as an adjunct control method. However, vaccinated rams cannot be serologically tested. In this case, semen culture is needed to identify infected rams. Vaccination may be performed twice a year, pre-breeding and after the breeding season. (Ridler and West, 2011; Picard-Hagen *et al.*, 2015).

A stricter control program consists of performing a BSE on all rams in addition to serology and semen culture. Rams should be tested at pre-breeding exam and 30 to 60 days after the joining period. All rams with abnormal semen parameters, small scrotal circumference or suspected of having epididymis or are positive to the ELISA should be immediately culled (Ridler and West, 2011).

In flocks where brucellosis is already present, eradication can be accomplished using one of several management approaches based on testing and culling infected rams and avoiding the introduction of new infected animals. In the initial part of the program, rams should be tested frequently (at 30 to 60 day interval) in order to detect rams that may have been incubating the disease but were not serologically positive.

All positive or suspect rams should be culled and replaced by negative virgin ram lambs. Leasing or exchanging rams should be discouraged unless the other flocks have the same eradication program.

Eradication of brucellosis can be achieved gradually in larger flocks by first establishing two flocks: a "clean" and an "infected" flock with strict separation. Clean rams are used on separate ewes and should be tested at the end of each breeding season. Replacement for the clean flock must be ELISA negative, and rested for 30 days after purchase. As the incidence of infection is reduced in the clean flock and the natural attrition decreases infected flock numbers, a total eradication program can be initiated.

FACTORS AFFECTING DELIVERY OF SEMEN

The most important factors that play a role in the ability of the ram to deliver semen to ewes are physical unsoundness, libido and management conditions (Toe *et al.*, 1994; Gouletsou and Fthenakis, 2010; Menegassi *et al.*, 2012; Smith *et al.*, 2012; Van Metre *et al.*, 2012). Physical problems such as lameness, blindness (Table 1) and penile or preputial problems (Table 2) may not interfere with semen production or quality but rams will not be able to find estrous ewes and/or mate them, resulting in poor reproductive performance.

Libido (mating ability or serving capacity) is another factor that affects the reproductive capacity of the ram (Alexander *et al.*, 2012). Unfortunately, this is not evaluated during the routine examination of the ram. It is very important to be able to track ram sexual activity after joining and identify rams with poor serving capacity. This is easily done if the

Table 3: Summary of clinical and laboratory features of epididymitis in rams

Etiology		Effects	Diagnosis
Ram epididymitis *Acinetobacter iwoffi* *Actinobacillus* *Actinomycetem comitans* *Actinobacillus seminis* *Arcanobacter pyogenes* *Brucella ovis* *Brucella abortus* *Corynebacterium ovis* *Hemophilus somnus* *Histophilusovis* *Moraxella spp.* *Pasteurella spp.* *Staphylococcus spp.* *Streptococcus spp.*		Enlarged tail of the epididymis. However up to 25 % of positive rams may not show any lesions Presence of flocculates in semen Presence of leukocytes in semen Decreased sperm output Marked decline in sperm motility Morphology: detached heads and tail abnormalities, no significant increase in head abnormalities Main tail abnormalities: bent, coiled around the head Firs abnormalities appear 1 to 6 weeks after infection Bilaterally affected rams are usually sterile but a few may retain some fertility.	*B. ovis*: ELISA is more sensitive and false positives generally not a problem. It is also useful in the early detection of the disease. Positive complement fixation (CF) test within 1 to 2 weeks after infection.
Lamb epididymitis	*Actinobacillus* *Actinomycetem comitans* *Actinobacillus seminis* *Hemophilus somnus* *Histophilus ovis* *Pasteurella spp.*		Culture

ram is fitted with a marking harness. This management procedure will allow the breeder to also monitor sexual activity in ewes and the number of ewes returning to estrus. Monitoring of serving capacity is critical when using young virgin rams because of their lack of experience.

Ram to ewe ratio should be adjusted for each management condition according to the following general guidelines:

- 1 ram to 50 ewes for paddock mating (mature rams)
- 1 ram to 25 ewes for paddock mating (young rams)
- 1 ram to 30 ewes for mating in rough terrain
- 1 ram to 15 ewes for synchronized flock
- 1 ram to 10 ewes for out of season breeding

BREEDING SOUNDNESS EXAMINATION AND INTERPRETATION

The current Society for Theriogenology (SFT) guidelines for BSE emphasize the general health, physical examination (Tables 1 and 2), scrotal circumference (Figure 15), sperm morphology and motility. Ejaculates are collected most commonly by electroejaculation (Figure 16). The semen samples should be protected from cold shock in order to evaluate motility (Figure 17). The characteristics of the normal ram ejaculate are summarized in Table 4. Determination of sperm concentration is not usually performed in the field. However, the gross appearance of the ejaculate may be used as an estimate (Table 5) (Figure 18). Motility can be evaluated grossly (wave like motion) on a non-diluted sample without cover slip (x 100). Individual motility may be performed on a cover-slipped sample after dilution of semen with an appropriate semen extender (x 200 x 400) (Table 6). Sperm morphology should always be performed under oil (x 1000). Various staining techniques are available but the most common is eosin-nigrosin staining procedure (Figures 19, 20, 21, 22). The main abnormalities that are often missed by practitioners are head (vacuoles, diadems), acrosomal defects (folded or knobbed) (Figure23) and other cells (spheroids, medusa cells) (Figure 24). Observation under phase contrast microscopy of a fixed sample is useful for characterization of some head and acrosomal defects (Figure 26). Diffquick® or Giemsa staining techniques are helpful in identifying spheroids and white blood cells (Figure 24).

Ultrasonography of the scrotum and its content may be indicated in some cases and is discussed in detail in a separate article (Boukhliq *et al.*, 2018). This technique allows visualization of lesions that may not be palpable. Sperm granuloma or spermatic granuloma results from extravasation of spermatozoa into the interstitium of the organ. Expect for the granulomatous reaction, they are microscopically similar to spermatocele. Sperm granulomas (Figure 14) and spermatoceles (localized accumulation of spermatozoa within a dilated epididymal or testicular duct) are common and may be non-infectious due to blind efferent tubules and segmental aplasia of the Wollfian duct.

Figure 15: ***Scrotal circumference measurement is performed using a measuring tape at the largest diameter including both testicles***

Figure 16: Equipment for examination and semen collection in rams and bucks. [A]: a) small ruminant artificial vagina, b) scrotal circumference tape, c) handheld electroejaculator with linear electrode, d) handheld electroejaculator with circular electrode, [B]: e-f) Technique of electroejaculation in a standing ram

Epididymal granulomas in the caput and cauda epididymis are seen as anechoic or hyperechoic areas with a distinct margin with or without a hyperechoic capsule. Granulomas of the testis are generally microscopic and do not appear on ultrasound. Enlargement of the mediastinum testis is detected when granulomas are present in the head of the epididymis. Heterogeneous testicular parenchyma with presence of numerous hyperechoic foci is typical for testicular degeneration associated with testicular and epididymal granulomas.

Rams are classified based on physical examination and semen evaluation finding in one of 4 categories: Unsatisfactory, questionable, satisfactory, and excellent.

The Unsatisfactory ram

A ram is classified as unsatisfactory if it fails to meet the minimum requirements for any one part of the examination. Normally, these rams should be culled from the breeding program. However, if there are no infectious problems and the veterinarian thinks that the changes are reversible, the option to retest the ram should be given to the owner. Unsatisfactory category will include rams with the following:

- Severe health problems, congenital abnormalities, bad conformation.
- Cryptorchidism, hernias, epididymitis, scrotal abscess, severe balanoposthitis ("pizzle rot"), penile adhesion, very soft testicles, lumps or scrotal swelling, orchitis, testicular hypoplasia, marked difference in size between the testicles.
- Scrotal circumference: Less than 30 cm for lambs or less than 33 cm for rams
- Sperm morphology: > 50 % abnormalities
- Sperm motility: < 30 %
- Positive ELISA test for *B. ovis* (should be done on all range rams and rams over 9 months of age)
- Clinical signs: Depression, fever, pink eye, foot rot, lameness, bluetongue, sore mouth, ring worm, other contagious diseases would render the ram either unsatisfactory or questionable.

Table 4: Testicular size and evaluation of reproductive quality in rams (*Modifid from Yarney and Sanford (1993)*)

8 to 14 months		Over 14 months	
Size	**Score**	**Size**	**Score**
Less than 28 cm	Questionable	Less than 32 cm	Questionable
28 to 36 cm	Satisfactory	32 to 40 cm	Satisfactory
More than 36 cm	Excellent	More than 40 cm	Excellent

*Testicular size can be 2-3 cm smaller out of the breeding season.

Table 5: Correlation between the appearance of ram ejaculate and sperm concentration

Ejaculate appearance	Sperm concentration (x 10^9/ml)*	Comment
Watery	<0.5	Probably infertile
Cloudy	0.5-1	Probably infertile
Milky	1-3	Low fertility
Creamy	3-4	Probably fertile
Thick creamy	≥4	Probably fertile

*Accurate sperm concentration may be obtained by hemocytometer or spectrophometry

Figure 17: Field technique to protect semen from cold shock using a warm water bath

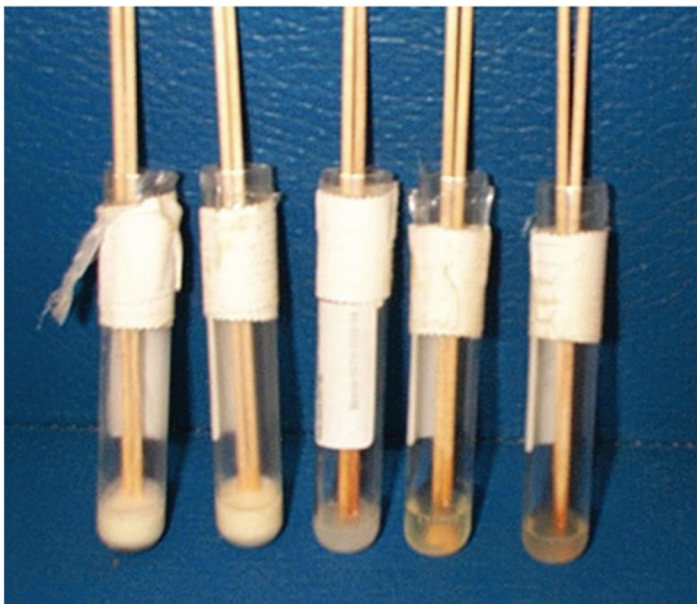

Figure 18: Gross appearance of the ejaculate with decreasing density from left to right (refer to Table 5 for explanation)

The Questionable ram

This category includes all rams with one questionable parameter or suffering from a treatable or reversible condition. These rams may be used in a limited breeding program if they do not have any contagious disease. Questionable rams should be retested within 50 to 60 days after implementation of treatment and re-classified as satisfactory or unsatisfactory breeders. Common reasons for classifying a ram as questionable include:

• Body condition score: Under-conditioned (1 or 2) or over-conditioned (5).

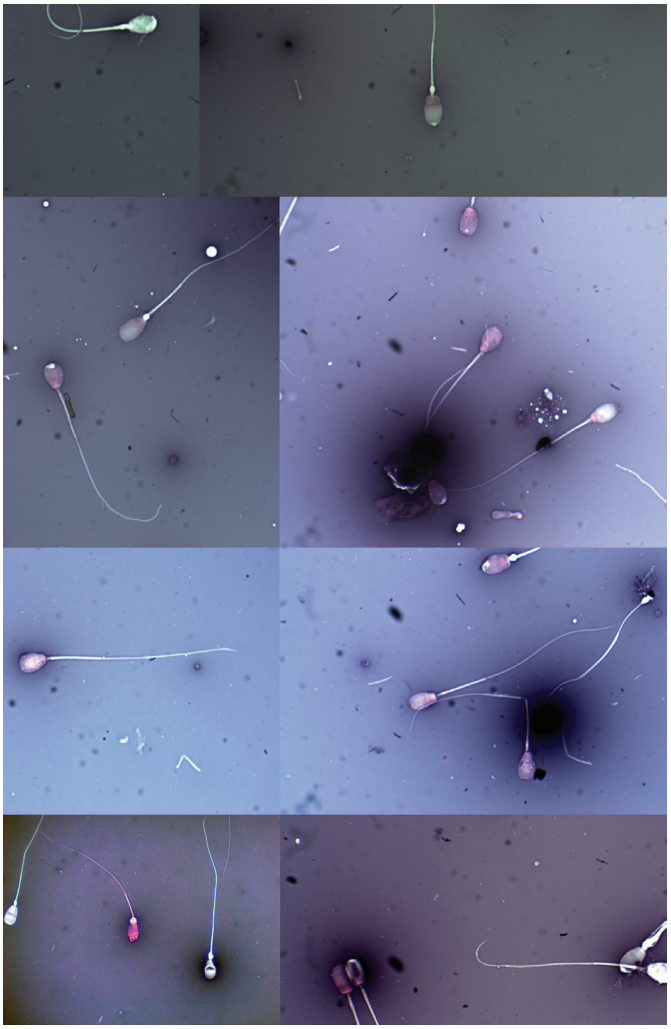

Figure 19: Morphological abnormalities of the sperm head (eosin-nigrosin stain)

• Mild to moderate balanoposthitis, scrotal dermatitis, frost bite, mange.

• Scrotal circumference: less than 30 cm for lambs or less than 33 cm for rams.

• Sperm morphology: >30% abnormalities.

• Sperm motility: < 30%.

• Suspect ELISA test for *B. ovis*, retest in 30 to 60 days.

The Satisfactory ram

This category includes rams that meet all the minimum requirements for general health, scrotal circumference, sperm motility and morphology. These rams will achieve good reproductive performance if joined to ewes at a ratio of 1:50 for 60 days. They should fulfill the following requirements:

• Good general health

• Good conformation

• Normal genital tract

• No previous history of infertility

• Body condition score of 3 to 4

• Scrotal circumference: 30 cm or more for <14 months of age, 33 cm or more for 14 months or older

• Sperm morphology: ≥70 % normal

• Sperm motility: ≥30 % progressive motility

• ELISA negative for *B. ovis.*

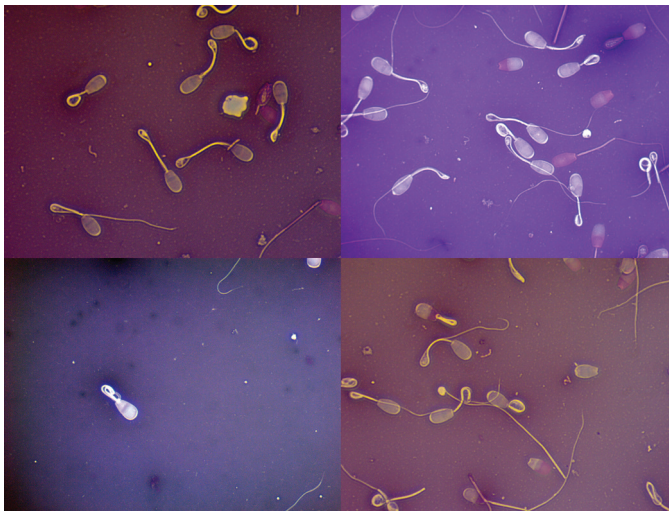

Figure 20: Morphological abnormalities of the midpiece and tail (esosin-nigrosin stain)

Table 6: Evaluation of gross sperm motility

Score	Description
5 Very good	Dense, rapidly moving waves. Individual sperm cannot be observed. 90% or more are active
4 Good	Vigorous moving waves, but not as rapid as score 5. 70-80 % or more are active
3 Fair	Only small, slow moving waves. Individual sperm can be observed. 45-65 % are active
2 Poor	No waves are formed.
1 Very poor	Some movement of sperm: 20-40 % are active Very few spermatozoa show signs of life
0 Dead	All spermatozoa are motionless

Figure 21: Sperm from an infertile ram with a high incidence of double midpiece and tail and abnormal mitochondrial sheath

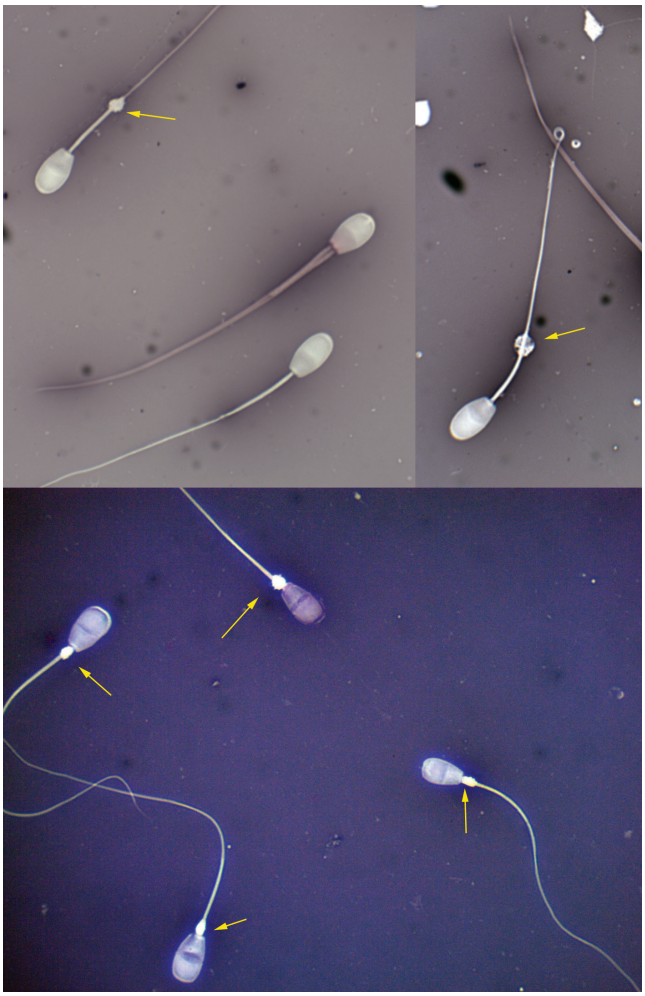

Figure 22: Cytoplasmic droplets: Proximal cytoplasmic (bottom image) and distal (top). Increased rate of droplets is usually observed in immature or overused exhausted rams or rams that are recovering from severe dyspermatogenesis or epididymal sperm transport problem

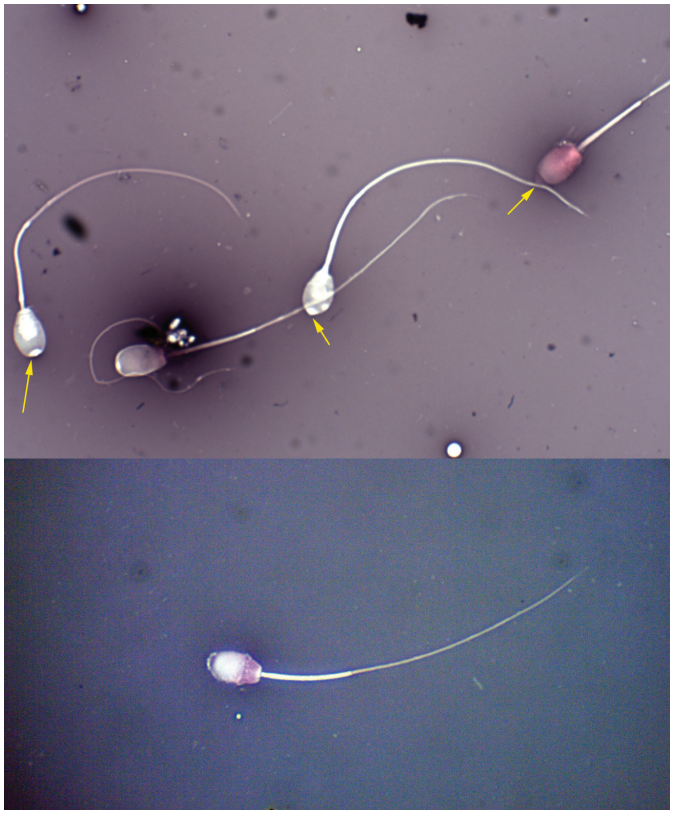

Figure 23: Abnormal acrosomes: Knobbed acrosome (top), detached/swollen acrosome (bottom)

The Excellent ram

This category includes rams that meet more stringent requirements for scrotal circumference, motility and morphology. Exceptional rams are expected to achieve good reproductive performance at a ratio of 1 ram to 100 ewes. They should have the following attributes:

- Excellent health
- BCS, 3 to 4
- Scrotal circumference: more than 33 for less than 14 months old and more than 35 for 14 months or older
- Sperm morphology: ≥ 90 % normal
- Sperm motility: > 50 % progressive
- ELISA negative for *B. ovis*

BREEDING SOUNDNESS EXAMINATION IN THE BUCK

There are no specific guidelines for BSE in the male goat (Ott and Memon, 1980; Al-Ghalban *et al.*, 2004; Rowe, 2010; Ridler *et al.*, 2012). Most practitioners use the same approach described for rams. Bucks should ideally be tested for *Corynebacterium pseudotuberculosis* and Caprine arthritis-encephalitis virus (CAEV). It is important to remind clients that bucks should be purchased from reputable breeders with sound biosecurity and preventive herd health program. Bucks should be examined for gastrointestinal parasites particularly if they come from areas where there is a problem of anthelmintic resistance. If arthritis is due to CAEV, the buck should be eliminated from reproduction because of the increased susceptibility of his daughters to the same disease. Common abnormalities of the genital organs are summarized in Table 7.

Scrotal circumference should be at least 25 cm for breeds weighing more than 40 kg (Figure 27). Most dairy breed bucks have SC of 25 to 28 cm when they reach 45 kg of body weight. Dairy bucks may be as early as 7 months of age. Meat breed bucks have a SC of 26 to 29 cm around 7 months of age (45 kg BW) (Almeida *et al.*, 2007; Rowe, 2010).

Semen can be collected by electroejaculation, however the owner should be warned that goat tends to vocalize a lot and that this procedure may be better done under sedation. The authors prefer to collect bucks using and artificial vagina, which is readily accepted when in presence of an estrous doe. Non-estrous does have also been used successfully. In general, a buck is deemed satisfactory breeder if he passes the physical examination, and has an ejaculate with at least 50 % progressively motile spermatozoa and less than 30 % total sperm abnormalities (Rowe, 2010; Ridler *et al.*, 2012). Some bucks may produce yellow

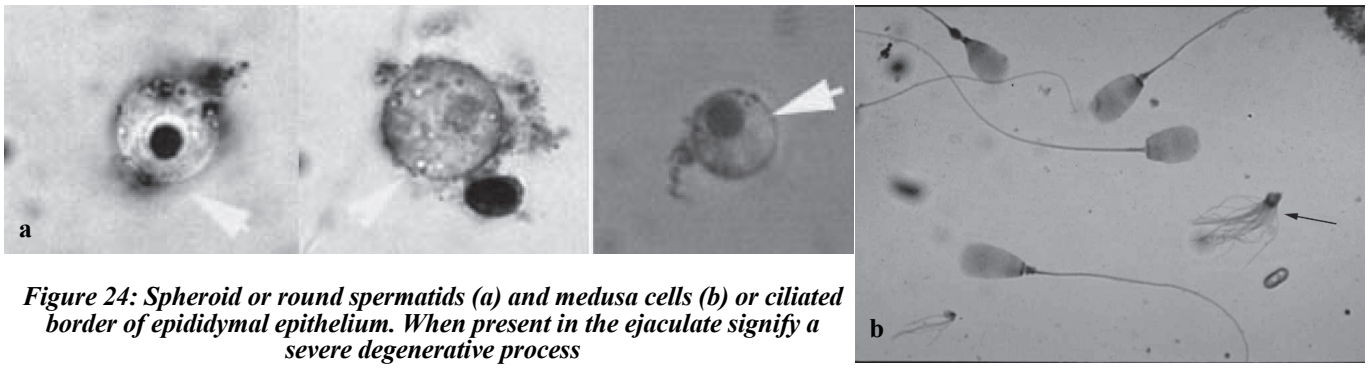

Figure 24: Spheroid or round spermatids (a) and medusa cells (b) or ciliated border of epididymal epithelium. When present in the ejaculate signify a severe degenerative process

Table 7: Common genital abnormalities in bucks.

Testis	Atrophy or degeneration Hypoplasia (nutrition, intersex XXY/XY, Robertsian translocation, Polled goats, hypothyroidism Cryptorchidism (hereditary in Angora goats) Persistent Mullerian duct syndrome: Hypoplastic testes, rudimentary epididymis, presence of bicornuate uterus and all accessory sex glands normal size Orchitis: May be due to coliform, *Pseudomonas*, *Actinobacillus seminis*, *Staphylococcus pyogenes*, *B. melitensis* (occasional orchitis) Scrotal hernia
Epididymis	Epididymitis Sperm granuloma due to obstruction of the head of the epididymis is a common cause of infertility in polled bucks Segmental aplasia of the body of the epididymis (polled and horned goats)
Penis and prepuce	Congenital diverticulum of the urethra Hair rings Loss of urethral process (accidental) Urolithiasis Balanophosthitis Balanoposthitis due to caprine herpesvirus-1 associated to vulvovaginitis in does (contagious)
Others	Poor libido Gynecomastia: Polled intersex, XO/XY. May start out fertile then fertility decreases with age due to mineralization of testicular parenchyma. High producing lines Cytogenetics: fertile XX/XXXY buck

ejaculates (Figure 28). This is due to a genetic ability to produce and concentrate large amounts of riboflavin. This character does not affect fertility (Mendoza *et al.*, 1989).

CONCLUSION

It is estimated that 3.5 to 10 % of ram population will not pass the breeding soundness examination. In a retrospective study on 14,667 BSEs on rams in the western USA, 29% of the examined animals failed (Van Metre *et al.*, 2012). The most common reason for failure was poor semen quality (43.8% of failures), which emphasizes the importance of adequate preparation and examination of semen samples. Inflammatory causes, physical abnormalities and emaciation were the cause of failure in 20 %, 15.5% and 14.2 %, respectively. In the same study, the seroprevalence of *B. ovis* was 10.0 % and seropositive status was not associated with poor semen quality in several cases which emphasize the importance of serologic testing. In another study in Spain, 16.7 % of examined rams (n = 897) were classified as unsuitable based solely on clinical examination (Mozo *et al.*, 2015). The primary cause of failure in that study were ulcerative posthitis and testicular lesions. Breeding soundness examination of rams and bucks is an important veterinary service to sheep and goat producers. Not only it can greatly impact fertility but also it reduces chance of introduction of contagious or hereditary diseases in the herd of flock.

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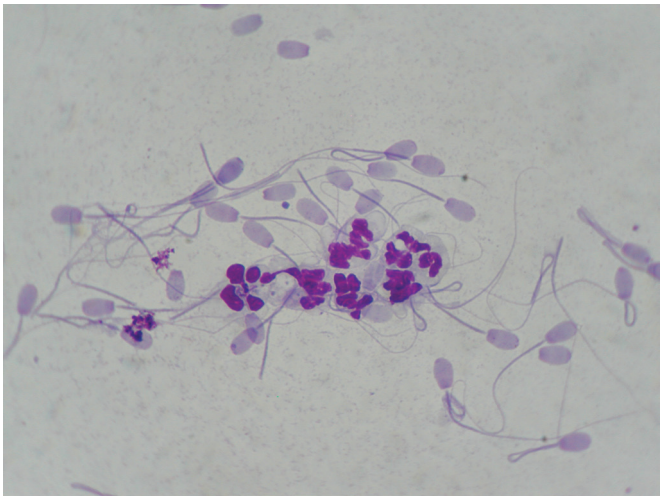

Figure 25: Polymorphonuclear leukocytes and detached sperm head in a sample from a ram with epididymitis du to B. ovis

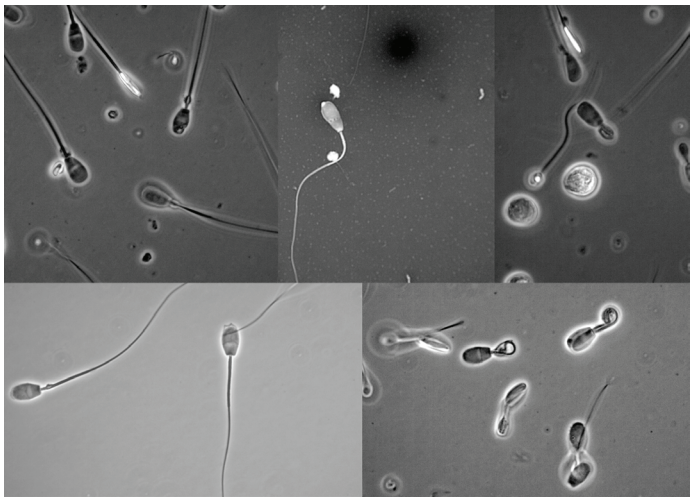

Figure 26: Acrosomal defects, vacuoles and other head and midpiece defects under phase contrast microscopy

Figure 27: Scrotal circumference measurement in a buck

Figure 28: Yellow ejaculate from a buck

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