

Ectopic testis in coati (*Nasua nasua* Linnaeus, 1766)¹

Débora C.V. Lima², Daniel B. Siqueira³, Valdemiro A. Silva-Junior², Lorena T.B. Nery², Luciana C. Rameh-de-Albuquerque³, Dênisson S. Souza³, Cibele C.S. Melo³ and Erika C.S. Oliveira^{2*}

ABSTRACT.- Lima D.C.V., Siqueira D.B., Silva-Junior V.A., Nery L.T.B., Rameh-de-Albuquerque L.C., Souza D.S., Melo C.C.S. & Oliveira E.C.S. 2016. **Ectopic testis in coati (*Nasua nasua* Linnaeus, 1766).** *Pesquisa Veterinária Brasileira* 36(10):999-1004. Universidade Federal Rural de Pernambuco, Dom Manoel de Medeiros s/n, Dois Irmãos, Recife, PE 52171-900, Brazil. E-mail: ecso21@uol.com.br

This paper reports a case of unilateral extracorporeal ectopic testes in a captive coati (*Nasua nasua*) in the State Park of Dois Irmãos Zoo, Recife/PE, Brazil. The testicle was located in the subcutaneous tissue of the inguinal region not adhered to the surrounding tissues. After bilateral orchiectomy, both testes were measured, fixed with 10% formalin buffered and embedded in paraffin for histopathological evaluation. The left testis measured 1.2 cm width by 1.7cm length, and the right one measured 1.5 cm width by 2.0 cm length. The ectopic testes had seminiferous epithelium without post-meiotic germ cell lines. The non-ectopic testis had several changes in the seminiferous epithelium that indicated degeneration. In both epididymis, the lumen did not contain sperm and the major epithelial structural alterations were more distinct in the epididymis associated to the ectopic testicle. In conclusion, the ectopic testis and epididymis had lesions compatible with testicular exposition to body temperature. Non-ectopic epididymis and testis had minor lesions but could be related to the infertility of the coati.

INDEX TERMS: Coati, *Nasua nasua*, ectopic, testis, morphology, histopathology, wild animals, Procyonidae.

RESUMO.- [Testículo ectópico em quati (*Nasua nasua* Linnaeus, 1766).] O artigo relata um caso de testículo ectópico em quati de cativeiro (*Nasua nasua*) no Zoológico do Parque Estadual Dois Irmãos, Recife/PE. O testículo encontrava-se localizado no tecido subcutâneo da região inguinal, sem estar aderido aos tecidos circunvizinhos. Após orquiectomia bilateral, ambos os testículos foram mensurados, fixados em formol a 10% e embebidos em parafina para avaliação histopatológica. O testículo esquerdo mediu 1,2cm de largura por 1,7cm de comprimento; e o testículo direito mediu 1,5cm de largura por 2,0cm de comprimento. O testículo ectópico apresentou epitélio sem linhagem de células germinativas pós-meióticas. O testículo não ectópico apresentou alterações no epitélio seminífero caracte-

terizando degeneração. Em ambos os epidídimos, o lúmen não continha espermatozoides e as principais alterações estruturais do epitélio foram mais distintas no epidídimo associado ao testículo ectópico. Conclui-se que o testículo ectópico e epidídimo apresentaram lesões características de aumento de temperatura. O testículo e epidídimo não ectópico apresentaram lesões menores mas que puderam ser associadas à infertilidade do quati.

TERMOS DE INDEXAÇÃO: Quati, *Nasua nasua*, ectópico, testículo, histopatologia, animais selvagens, Procyonidae.

INTRODUCTION

Coatis (*Nasua nasua*) have high adaptability (Beisiegel 2001, Franciulli et al. 2007, Campos 2009) and are distributed in almost all-Brazilian territory (Teixeira & Ambrosio 2006). Despite this, little is known regarding the reproductive biology and sex abnormalities in this species.

Cryptorchidism is a sex-linked autosomal hereditary disorder, characterized by the absence of one or both testes in the scrotum; the ectopic testis may remain in the pre-scrotal, inguinal or abdominal region (Nascimento & Santos

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² Universidade Federal Rural de Pernambuco (UFRPE), Dom Manoel de Medeiros s/n, Dois Irmãos, Recife, PE 52171-900, Brazil. *Corresponding author: ecso21@uol.com.br

³ Zoológico do Parque Estadual de Dois Irmãos, Praça Farias Neves s/n, Dois Irmãos, Recife, PE 52171011.

2003, Maestri 2007). Predisposing factors can be related to this disorder such as testicular hypoplasia, estrogen exposure, impairment of the blood supply to the testes during fetal life, infections during testicular descent (Romagnoli 1991, Facemire et al. 1995, Johnston et al. 2001), maternal vitamin A deficiency during fetal development, exposure to environmental contaminants and low genetic variability (O'Brien et al. 1990, Roelke et al. 1993, Barone et al. 1994, Facemire et al. 1995, Dunbar et al. 1996, Mansfield & Land 2002). Ectopic testis are associated with several clinical finds including testicular neoplasia, oligospermic or azoospermic animals, increase in local sensitivity, behavioral disorders, irritability or hypersexuality, dermatopathies and torsion of the spermatic cord (Mattos et al. 2000, Morris & Dobson 2001, Hahn 2002, Daugaard et al. 2006, Maestri 2007, Timothy et al. 2007).

Cryptorchidism can be detected by inspection and palpation during physical examination (Maestri 2007). Bilateral orchiectomy is the treatment of election to avoid possible clinical complications and hereditary transmission (Mattos et al. 2000, Nascimento & Santos 2003, Maestri 2007).

Despite cryptorchidism being an affliction that is frequently reported in pets, with prevalence of 13% in dogs (Mickelsen & Memon 1997), it is not in wild animals. Cryptorchidism has been described in the maned wolf (*Chrysocyon brachyurus*), raccoon (*Procyon cancrivorus*), black bear (*Ursus americanus*) and puma (*Puma concolor coryi*) (Burton & Ramsey 1986, Dunbar et al. 1996, Mansfield & Land 2002, Dias et al. 2007).

This is the first ectopic testis case reported in coati (*Nasua nasua*), detailing its clinical evaluation and histopathologic findings.

MATERIALS AND METHODS

A male captive coati, *Nasua nasua* (Fig.1A), about 10 years age, 4.1 kg, from the Zoo of Dois Irmãos State Park (Latitude: 8°0'20.79"S, Longitude: 34°56'51.85"O), Northeast of Brazil, was subjected to clinical examination. The animal was housed with 10 others coatis, in proportion of two males for nine females. During the physical examination, ectopic testicle was detected in the subcutaneous tissue of the inguinal region. The right testicle was located in the scrotum (Fig.1B,C). The animal had an appropriate body score and healthy mucosa. Physiological parameters including heart (155bpm), respiratory frequency (23mpm), and rectal temperature (37.1°C) were considered normal for this species. After clinical examination, it was recommended a bilateral orchiectomy.

The animal was submitted to 20 hours of food restriction prior to surgery and after physical restraint it was anesthetized with ketamine 10% (10mg/kg/IM, Cetamin 10% Syntec®, Cotia, SP, Brazil) and xylazine 2% (1mg/kg/IM, Xilazina 10% Syntec®, Cotia, SP, Brazil). Following tracheotomy, surgical area was sterilized with 70% alcohol, 10% povidone iodine and 2% chlorhexidine. Surgical access was accomplished by a midline incision of the pre-scrotal region and the testes removed. During the post-operative period, single doses of procaine benzylpenicillin (20.000UI/kg/IM, Agrovit, Novartis®, São Paulo, SP, Brazil), meloxicam (0.2mg/kg/IM, Maxican, Ourofino®, Cravinhos, SP, Brazil) and topical antibacterial and anti-inflammatory cream (Quadriderm, Schering Plough®, Cotia, SP, Brazil) were administered to the animal.

Testis and epididymis (Fig.1D) were fixed in 10% buffered formalin and stored for 48 hours in 70% alcohol. Tissue fragments

were embedded in paraffin and 5µm sections were cut and stained with hematoxylin-eosin (HE) (Behmer et al. 1976) for histopathologic evaluation.

RESULTS

Testicular measurements revealed that ectopic testicle had 1.2cm width and 1.7cm length, while the right testis had 1.5cm width and 2.0cm length (Fig.1D).

Histopathological evaluation of the ectopic testicle revealed the absence of germ cells in the seminiferous epithelium, Sertoli cells with extensive vacuolation, whereas Leydig cells had normal morphology (Fig.2A-C). In the contra-lateral testicle, seminiferous tubules revealed a reduction in the epithelium height, slough of germ cells and vacuoles in pre and post-meiotic stages. Leydig cells had normal morphology with a higher number of cells in the interstitial space when compared to the numbers observed in the ectopic testis (Fig.2D).

The epididymis located in the scrotum had a normal epithelium, columnar cells showing normal stereocilia, although some basal cells had different degrees of vacuolation. Spermatozoa were not observed in the epididymal lumen (Fig.3A,B). The epididymis associated with the ectopic testicle had absence of stereocilia in the apical aspect of the columnar cells, sloughed and vacuolated cells (Fig.3C,D).

DISCUSSION

According to the literature, the data presented in this paper is the first report of unilateral ectopic testis in coati. Reports of cryptorchidism in wild animals are scarce. In Brazil, reports have described the occurrence of right unilateral cryptorchidism located in the subcutaneous tissue of the inguinal region in a raccoon (*Procyon cancrivorus*) (Dias et al. 2007). Burton & Ramsay (1986) observed a case of monorchidism in four maned wolves (*Chrysocyon brachyurus*) born in two litters from a North American zoo. Dunbar et al. (1996) analyzed 71 black bears (*Ursus americanus*) in Florida and observed cryptorchidism in four (5.6%) animals, three being unilateral with the testicle located in the inguinal region (two on the right and one on the left), and a bilateral case with both testes found in the abdominal region. In all cases, the testis had reduced dimensions compared with the normal descended testis (Dunbar et al. 1996, Dias et al. 2007), corroborating with the findings in the presented report.

The length/width of the normal descended testis of the coati reported in the present study were lower compared to the findings described by Queiroz et al. (2010) who evaluated the reproductive anatomy of five normal pubertal coatis. The study revealed that the length and width of the right testis was 1.7±0.2 and 2.6±0.2; and left testis was 1.7±0.1 and 2.5±0.3 respectively, but had similar sizes when compared to the results reported by Francioli et al. (2007) who evaluated the anatomy of two coatis.

Dunbar et al. (1996) described the occurrence of cryptorchidism and a delay in testicular descent in black bears (*U. Americanus*) during the first year of life. In domestic dogs, testicular descent can occur between four and five

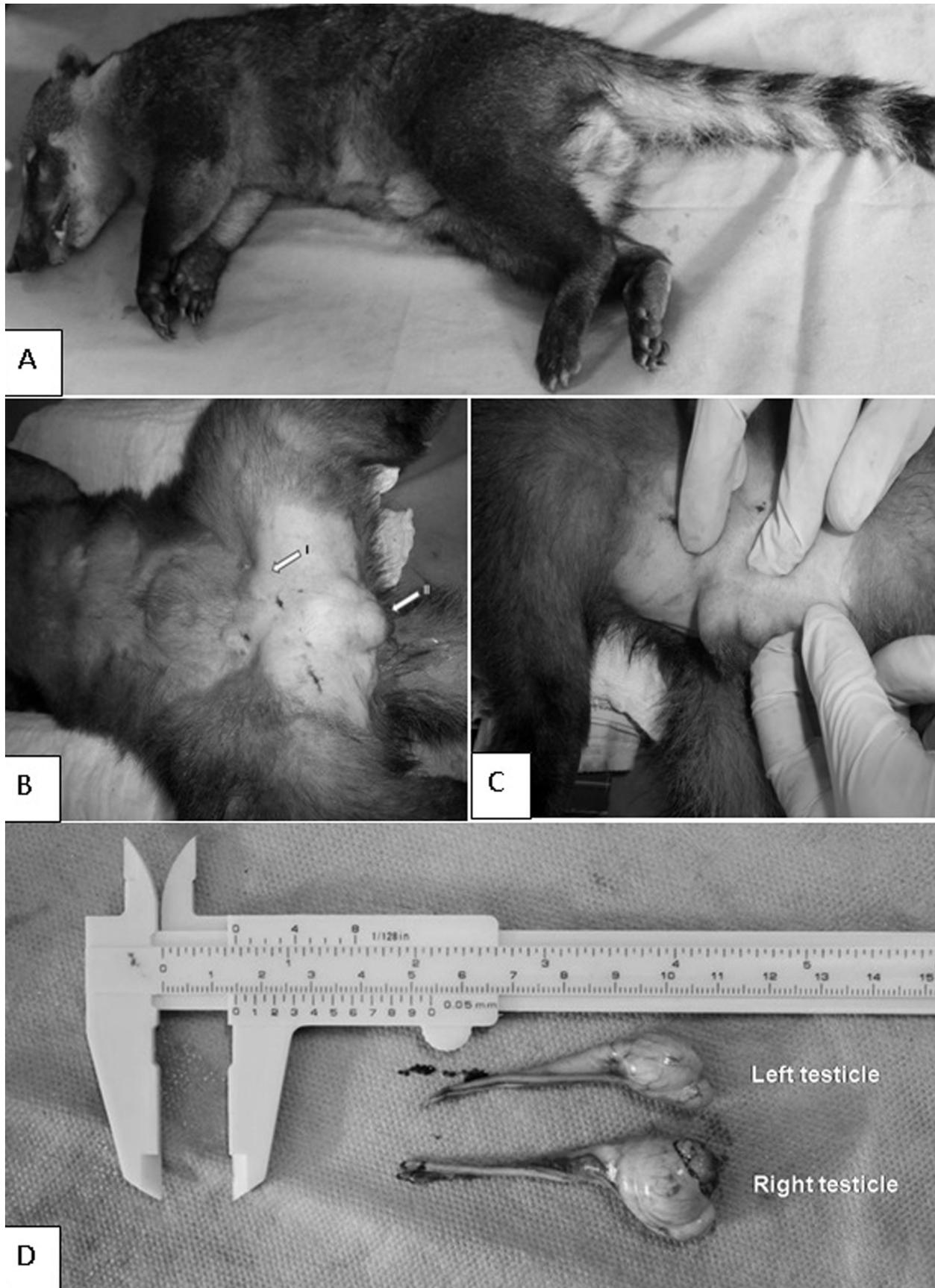


Fig.1. Left unilateral cryptorchidism in coati. (A) The coati (*Nasua nasua*). (B) Left unilateral cryptorchidism in coati. Left Testicle located in the subcutaneous tissue of the inguinal region (arrow I). Right testicle with an ovoid shape and visualization of the epididymis under the skin layer (arrow II). (C) Ectopic testis without adherence during palpation. (D) Testicles (right and left) after surgical excision.

weeks and, usually, six to eight weeks after birth (Nascimento and Santos, 2003). However, the diagnosis of cryptorchidism in this species becomes possible after six months of age (Mickelsen & Memon 1997). In coatis, there is no information in the literature regarding the migration time of the testes into the scrotum.

Cryptorchidism in captive wild animals can help to identify populations that possibly suffer with inbreeding, exposure to certain chemical products of biological risks and nutritional deficiencies (Roelke et al. 1993, Dunbar et al. 1996, Mansfield & Land 2002). Burton & Ramsay (1986) discussed the possibility of a correlation between the appearance of birth defects and loss of genetic diversity in maned wolves from North American zoos. Keller & Waller (2002) observed the effect of endogamy in wild species, demonstrating an increasing in the number of cases of anomalies related to homozygous alleles.

In the present study, there is no information about the degree of kinship of coatis that live together for about 10 years at the zoo in Dois Irmãos State Park, except for two of them who were born about two years ago and have a common origin. Considering the etiologies described in the literature, the anomaly may be associated with a possible endogamy resulting from the reduction of gene flow in the enclosure, however consanguinity exams may be necessary to support this hypothesis.

The ectopic testicle may have influenced histopathological changes observed in the non-ectopic testicle. The negative effect of the ectopic or cryptorchid testicle on the function of the normally descended testis has been studied in humans and in experimental animals by Rager et al. (1975), Jegou et al. (1983), Saalu et al. (2006) and Saalu et al. (2007), although it is not yet well established. Ono and Sofikitis (1997) suggested that the increased blood flow of

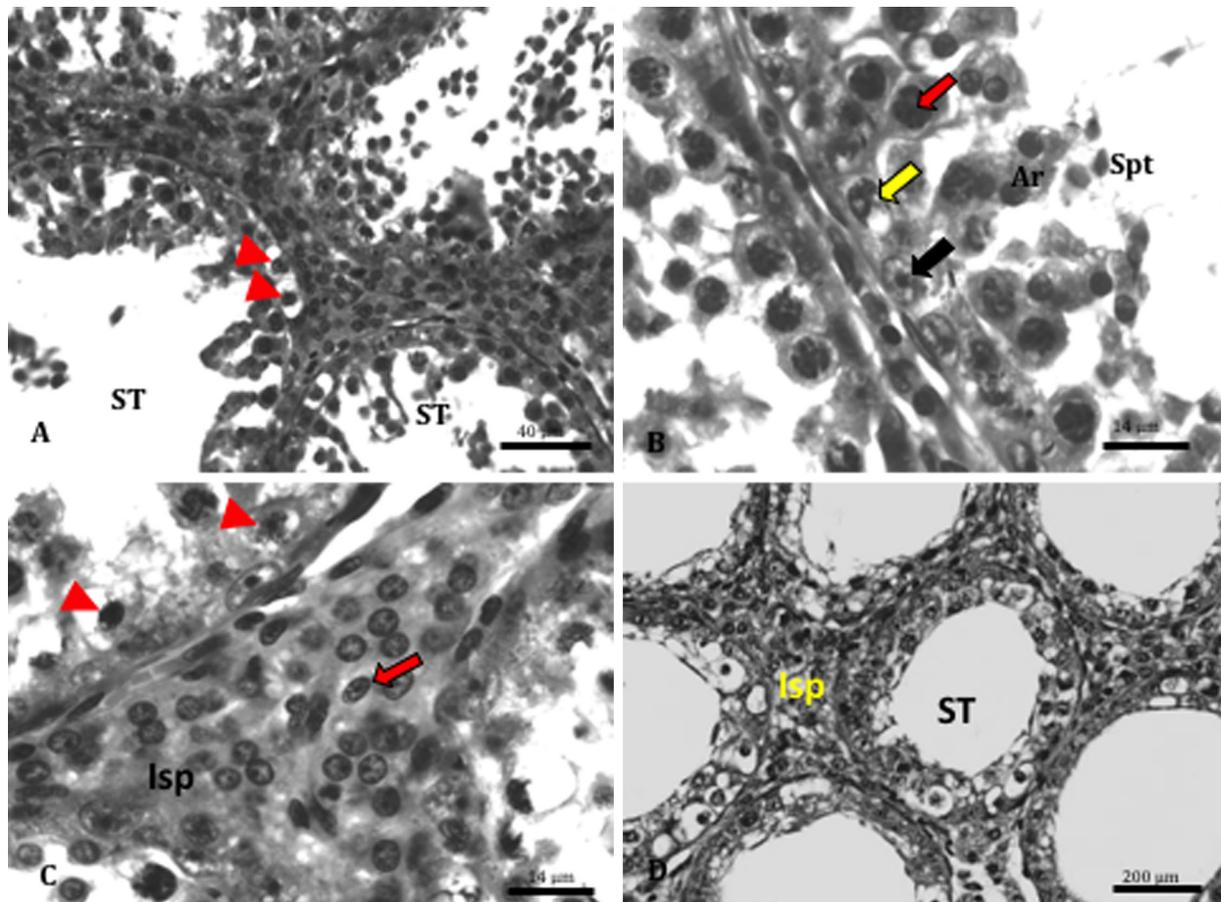


Fig.2. Ectopic testis (left testicle) and non-ectopic testis (right testicle) of coati. (A) Right testicle. Seminiferous tubules in cross section (ST) showing reduced height of the germinal epithelium, desquamation and vacuolization of germ cells. (B) Right testicle. Observe the sloughing of germinal epithelium characterized by increased space between germ cells, and primordial germ cell in the seminiferous epithelium (yellow arrow). A Sertoli cell (black arrow) without morphological changes and different germ cells in the seminiferous epithelium. Round spermatids (Ar) and elongated spermatids (Sptz). (C) Right testicle. Seminiferous tubules in cross section (ST) with vacuolated germ cells (arrowheads). Leydig cells (red arrow) in the intertubular space (Isp). (D) Left testicle. Ectopic testicle in coati. Seminiferous tubules in cross section (ST). Observe the reduction of the seminiferous epithelium height and vacuolization of Sertoli and germ cells. Between the seminiferous tubules, note increased intertubular space (Isp). (E) Left testicle. Seminiferous tubules in cross section (ST). Note Sertoli cells with extensive cytoplasmic vacuolization (yellow arrow). Observe absence of germ cells in the seminiferous epithelium or degenerating germ cells (arrows). Leydig cells in large numbers (red arrow) and with normal morphology. (F) Left testicle. Seminiferous tubules in cross section (ST). Sertoli cells with extensive cytoplasmic vacuolization (arrows). Note the absence of germ cells in the seminiferous epithelium or in an advanced stage of degeneration.

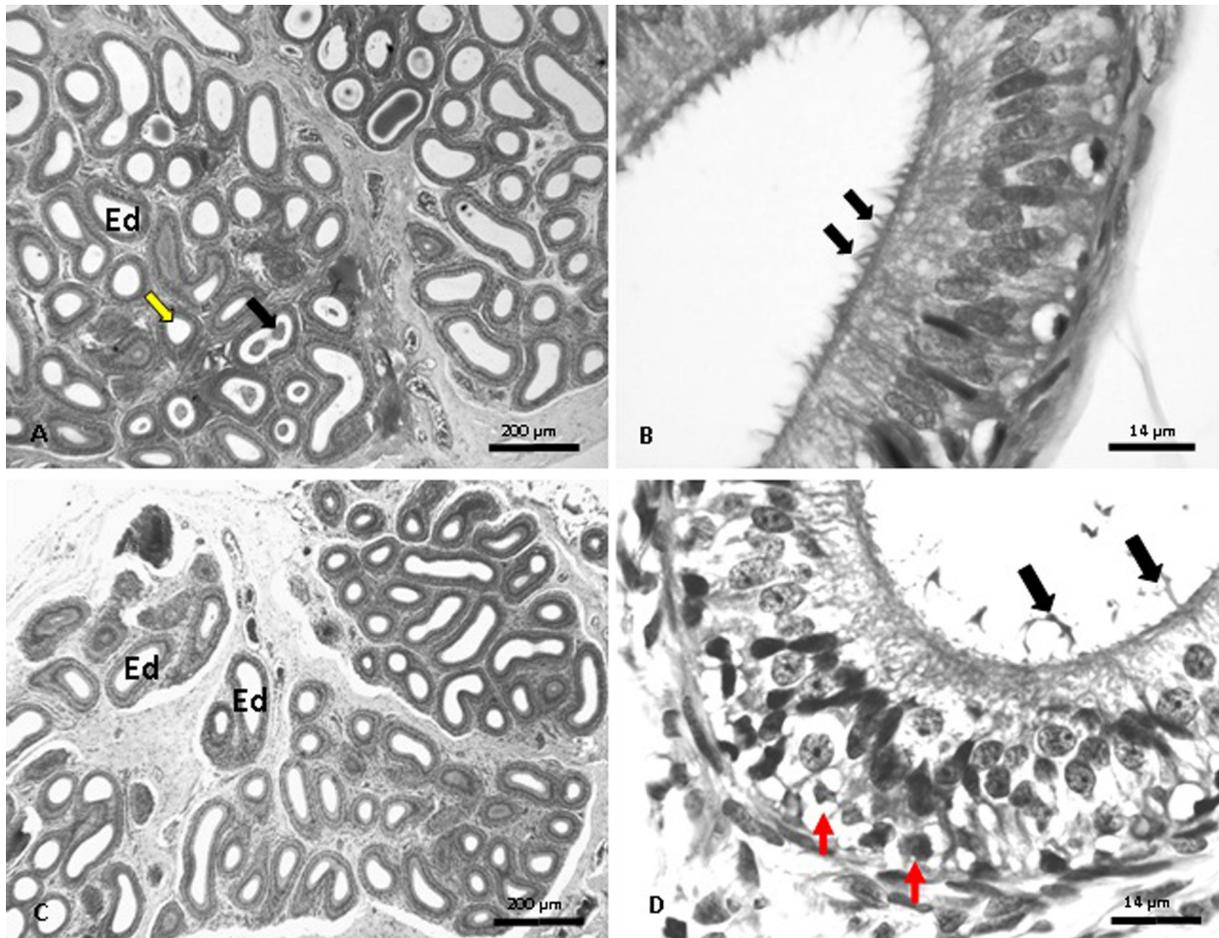


Fig.3. Ectopic epididymis associated with the left testicle and non-ectopic epididymis associated with the right testicle of coati. (A) Non-ectopic epididymis. Epididymal duct (Ed) in cross section. Note the presence of cells in the lumen (black arrow) and some lumens without cells (yellow arrow). (B) Non-ectopic epididymis. Note epithelium of the epididymal duct with stereocilia on columnar cells (arrow) and vacuolization and pyknosis of the basal cells (arrowhead). (C). Epididymis associated with the ectopic testicle of coati. Epididymal duct (Ed) in cross section. Note the absence of sperm in the lumen (arrow). (D) Note absence of stereocilia on the columnar cells (arrow) in the epididymal epithelium. Pyknosis and vacuolization were observed in the basal cells (red arrow).

the contra-lateral testis in animals with unilateral cryptorchidism could result in testicular degeneration. Kawakami et al. (1999) observed that in dogs the unilateral cryptorchidism induced a decrease in the total sperm concentration, an increase in serum levels of estrogen, as well as a decrease in testosterone and luteinizing hormone (LH) levels. These authors suggested that an increase in estradiol levels should be responsible for the inhibition of endocrine functions and spermatogenesis of the contra-lateral testis (Kawakami et al. 1999, Maestri 2007).

In the ectopic epididymis epithelial cells were sloughed; basal cells had differing degrees of vacuolization and the columnar cells showed a reduction or an absence of stereocilia. Furthermore, spermatozoa were not observed in the epididymal lumen. Several factors may contribute to the pathology observed in the ectopic epididymis in this study, including exposure to a higher temperature as reported by Jara et al. (2002).

Different degrees of vacuolization in the basal cells and few luminal spermatozoa were observed in the lumen of the contra-lateral epididymis. This finding corroborates

the degenerative changes observed in the seminiferous epithelium of the ectopic testis.

This is the first case report of an ectopic testicle in the coati. Testicular lesions were similar to those described in other mammalian species. The coati was considered infertile. Histopathological changes were observed in ectopic and contra-lateral testis as well as absence of spermatozoa in both epididymis. The ectopic testis and epididymis had lesions compatible with exposition to higher body temperature. Non-ectopic epididymis and testis had minor lesions but could also be a contributor to the infertility of the coati.

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REFERENCES

- Barone M.A., Roelke M.E., Howard J.G., Brown J.L., Anderson A.E. & Wildt D.E. 1994. Reproductive characteristics of male Florida panthers: comparative studies from Florida, Texas, Colorado, Latin America, and North American Zoos. *J. Mammal.* 75:150-162.

- Behmer O.A., Tolosa E.M.C. & Freitas Neto A.G. 1976. Manual de Técnicas para Histologia Normal e Patológica. EDART/USP, São Paulo.
- Beisiegel B.M. 2001. Notes on the coatis, *Nasua nasua* (Carnivora: Procyonidae) in an Atlantic Forest area. *Braz. J. Biol.* 61:689-692.
- Burton M. & Ramsay E. 1986. Cryptorchidism in maned wolves. *J. Zoo. An. Med.* 17:133-135.
- Campos P.K.A. 2009. Avaliação morfofuncional do testículo de quatis (*Nasua nasua* Linnaeus, 1766) adultos. UFV, Minas Gerais. Available at <http://www.tede.ufv.br/tedesimplificado/tde_arquivos/31/TDE-2009-06-26T070207Z-1711/Publico/texto%20completo.pdf> Accessed on May 5, 2014.
- Daugaard G., Karas V. & Sommer P. 2006. Inguinal metastases from testicular cancer. *BJU Int.* 97:724-726.
- Dias C.B.V., Souza T.D., Silva S.M., Melotti T. & Leite F.L.G. 2007. Criptorquidismo em *Procyon cancrivorus* (G. Cuvier, 1798) de vida livre do litoral do Espírito Santo, Brasil. I Encontro Internacional de Medicina da Conservação, Vitória, Espírito Santo, p.16.
- Dunbar M.R. & Cunningham M.W., Wooding J.B. & Roth R.P. 1996. Cryptorchidism and delayed testicular descent in Florida black bears. *J. Wildl. Dis.* 32:661-664.
- Ellenport C.R., 1986. Aparelho urogenital do carnívoro, p.1481-1493. In: Getty R. (Ed.), Anatomia dos Animais Domésticos. Guanabara Koogan, Rio de Janeiro.
- Facemire C.F., Gross T.S. & Guillette Jr L.J. 1995. Reproductive impairment in the Florida panther: nature or nurture? *Environ. Health Perspect.* 103:79-86.
- Francioli A.L.R., Costa G.M., Mançanares C.A.F., Martins D.S., Ambrosio C.E., Miglino M.A. & Carvalho A.F. 2007. Morfologia dos órgãos genitais masculinos de quati (*Nasua nasua* Linnaeus, 1766). *Biotemas* 20:27-36.
- Hahn K.A. 2002. Veterinary Oncology. British Library, Butterworth.
- Howe L.M. 2006. Surgical methods of contraception and sterilization. *Theriogenology* 66:500-509.
- Jara M., Esponda P. & Carballada R. 2002. Abdominal temperature induces region-specific independent apoptosis in the cauda epididymidis of the mouse. *Biol. Reprod.* 67:1189-1196.
- Jegou B., Risbridger G.P. & De Krester D.M. 1983. Effects of experimental cryptorchidism on testicular function in adult rats. *J. Androl.* 4:88-94.
- Johnston S.D., Kustritz M.V.R. & Olson P.N.S. 2001. Disorders of the canine testes and epididymis, p.312-332. In: Johnston S.D. (Ed.), Canine and Feline Theriogenology. W.B. Saunders, Philadelphia.
- Kawakami E., Hori T. & Tsutsio T. 1999. Function of contralateral testis after artificial unilateral cryptorchidism in dogs. *J. Vet. Med. Sci.* 61:1107-1111.
- Keller L.F. & Waller D.M. 2002. Inbreeding effects in wild populations. *Trends Ecol. Evol.* 17:230-241.
- Maestri J.S. 2007. Incidência de neoplasia testicular em cães criptorquidas. Universidade Castelo Branco, Ponta Grossa. Available at <<http://www.qualittas.com.br/uploads/documentos/Incidencia%20de%20Neoplasia%20Testicular%20em%20Caes%20Criptorquidas%20-%20Juliana%20Sousa%20Maestri.PDF>> Accessed on May 5, 2014.
- Mansfield K.G. & Land E.D. 2002. Cryptorchidism in Florida panthers: prevalence, features, and influence of genetic restoration. *J. Wildl. Dis.* 38:693-698.
- Mattos M.R.F., Pereira B.S., Domingues S.F.S., Costa M.A.L. & Lima P.R.B. 2000. Criptorquidismo em um cão: relato de caso. *Ciência Animal* 10:61-70.
- Mickelsen D.W. & Memon M.A. 1997. Distúrbios hereditários e congênitos dos sistemas reprodutivos do macho e da fêmea, p.2326-2331. In: Ettinger S.J. & Feldman E.C. (Eds), Tratado de Medicina Interna Veterinária. Manole, São Paulo, SP.
- Morris J. & Dobson J. 2001. Small Animal Oncology. Blackwell Science, Oxford.
- Nascimento E.F. & Santos R.L. 2003. Patologia da Bolsa Escrotal e dos Testículos, p.93-104. In: Nascimento E.F. & Santos R.L. (Eds), Patologia da Reprodução dos Animais Domésticos. Guanabara Koogan, Rio de Janeiro.
- O'Brien S.J., Roelke M.E., Yuhki N., Richards K.W., Johnson W.E., Franklin W.L., Anderson A.E., Bass Jr O.L., Belden R.C. & Martenson J.S. 1990. Genetic introgression within the Florida panther *Felis concolor coryi*. *Natl Geogr. Res.* 6:485-494.
- Ono K. & Sofikitis N. 1997. A novel mechanism to explain the detrimental effects of left cryptorchidism on right testicular function. *Yonago Acta Med.* 40:79-89.
- Queiroz J.P., Barros F.F., Lima G.L., Castelo T.S., Freitas C.I. & Silva A.R. 2010. Assessment of orchidometry and scrotal circumference in coatis (*Nasua nasua*). *Reprod. Domest. Anim.* 45:382-386.
- Rager K., Arnold E., Hauschild A. & Guputa D. 1975. Effect of bilateral cryptorchidism on the in vitro transformation of progesterone by testicular tissue at different stages of sexual maturation. *J. Steroid Biochem.* 6:1537-1541.
- Roelke M.E., Martenson J.S. & O'Brien S.J. 1993. The consequences of demographic reduction and genetic depletion in the endangered Florida panther. *Curr. Biol.* 3:340-350.
- Romagnoli S.E. 1991. Canine cryptorchidism. *Vet. Clin. North Am., Small Anim. Pract.* 21:533-544.
- Saalu L.C., Togun V.A., Oyewopo A.O. & Raji Y. 2006. Artificial cryptorchidism and the moderating effect of melatonin in Sprague-Dawley rats. *J. Appl. Sci. Environ. Manag.* 6:2889-2894.
- Saalu L.C., Adesanya A.O., Oyewopo A.O. & Raji Y. 2007. An evaluation of the deleterious effect of unilateral cryptorchidism on the contra-lateral normally descended testis. *Sci. Res. Essays* 2:74-78.
- Teixeira R.H.F. & Ambrosio S.R. 2006. Carnívora-Procyonidae (quati, mão-pelada, jupará), p.571-583. In: Cubas Z.S., Silva J.C.R. & Catão-Dias J.L. (Eds), Tratado de Animais Selvagens. Roca, São Paulo, SP.
- Timothy M., Fan T.M. & Lorimier L.P. 2007. Tumors of the male reproductive system, p.54-67. In: Iboid. (Ed.), Small Animal Clinical Oncology. Saunders Elsevier, St Louis.