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PATHOLOGY

# *Perosomus elumbis* in an Aberdeen Angus calf associated with intrauterine infection with BVDV-1a

**Ana Laura Vildoza[1] Carlos Omar Schild[1] Leticia Maya[2] Rodney Colina[2] Fabiana Marques Boabaid[3] Florencia Buroni[1] Karina Cresci[3] Franklin Riet-Correa[1] Luiz Gustavo Schneider Oliveira[1*]**

[1]Instituto Nacional de Investigación Agropecuaria (INIA), Plataforma de Investigación en Salud Animal, Estación Experimental INIA Tacuarembó, 45000, Tacuarembó, Uruguay. E-mail: luiz.omicron@gmail.com. *Corresponding author.
[2]Laboratorio de Virología Molecular, Centro Universitario Regional (CENUR) Litoral Norte, Universidad de la República, Salto, Uruguay.
[3]Polo de Desarrollo Universitario del Instituto Superior de la Carne, Centro Universitario Regional (CENUR) Noreste, Universidad de la República, Tacuarembó, Uruguay.

**ABSTRACT**: In a beef cattle breeding farm located in northern Uruguay, an Aberdeen Angus calf was born with complex anomalies. The offspring was sired by one of the bulls of the farm. The calf died shortly after birth, displaying multiple malformations at external examination, including agenesis of the lumbar, sacral and coccygeal vertebrae and spinal cord and arthrogryposis of both pelvic limbs, characteristic of *perosomus elumbis* (PE). At necropsy there was also brachygnathia and muscle atrophy of the pelvic limbs, along with underdeveloped small intestines, atresia ani, ectopia of the left kidney and hypoplasia of the contralateral, testicular fusion and cryptorchidism. Molecular studies of the fetal tissues revealed infection with Bovine Viral Diarrhea Virus (BVDV), an agent known for causing different malformations in cattle.
**Key words**: congenital anomalies of cattle, intrauterine infection with BVDV, calf diseases.

## *Perosomus elumbis* em um bezerro Aberdeen Angus associada a infecção intrauterina por BVDV-1a

**RESUMO**: Em um rebanho de cria destinado a produção de carne, localizado no norte do Uruguai nasceu um bezerro Aberdeen Angus com anomalias complexas. O neonato era filho de um dos touros da propriedade. O bovino morreu pouco após o nascimento, demonstrando múltiplas malformações ao exame externo, incluindo agenesia das vértebras lombares, sacrais e coccígeas assim como da medula espinhal e artrogripose de ambos membros pélvicos, característicos de *perosomus elumbis*. A necropsia revelou, além disso, braquignatismo, atrofia muscular dos membros pélvicos, intestino delgado subdesenvolvido, atresia anal, ectopia do rim esquerdo e hipoplasia do contralateral, assim como fusão testicular e criptorquidia. Estudos moleculares dos tecidos fetais revelaram infecção pelo vírus da diarreia viral bovina (BVDV), um agente conhecido por causar diferentes malformações em bovinos.
**Palavras-chave**: anomalias congênitas de bovinos, infecção intrauterina por BVDV, doenças de bezerros.

*Perosomus elumbis* or *perosomus elumbus* (PE) is a lethal congenital defect affecting different species of animals, including cattle, sheep, pigs, horses and dogs (JONES, 1999; KARAKAYA et al., 2013; ANGERHOLM et al., 2014; CRAIG et al., 2016; PIEGARI et al., 2021). The condition has also been reported in a rhesus macaque (*Macaca mulatta*), while in humans it can be categorized either as caudal regression syndrome or lumbosacral agenesis according to the location of the lesion and the stage of neurulation affected (PATRICK et al., 2020).

The malformation is characterized mainly by the partial or complete absence (agenesis) of lumbar, sacral and coccygeal vertebrae (JONES, 1999; KARAKAYA et al., 2013). Owing to the lack of innervation of the hindquarters, the spinal defect is often associated with arthrogryposis of the pelvic limbs due to muscular malformation and articular ankylosis (JONES, 1999). In many cases, affected animals present other concomitant malformations, including other skeletal anomalies, as well as cryptorchidism, renal agenesis, cerebellar hypoplasia and atresia ani, among others (KARAKAYA et al., 2013). The syndrome is considered rare in cattle, though a rise in its occurrence has been observed in recent years in Holstein cattle, attributed to the worldwide spread of a mutant allele into the breed population (ANGERHOLM et al., 2014). In contrast, the occurrence of PE in sheep has been attributed to the consumption of *Veratrum californicum* by the dam on the 16$^{th}$-17$^{th}$ days of pregnancy (DENNIS, 1975). In other countries, many different plant species are known to cause malformations in cattle, sheep, goats, pigs, horses and camelids, although PE has not been mentioned among the defects seen in those cases (PANTER & STEGELMEIER, 2011). A study in pigs revealed no chromosomal alterations in eight pigs born in two consecutive births of a Casertana sow, with no simultaneous rise in the general occurrence of

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malformations in piglets on the farm. These findings suggested a specific genetic etiology for the condition in swine, excluding chromosomal abnormalities (PIEGARI et al., 2021).

In another report of PE associated with cerebellar hypoplasia in a Holstein calf, the fetal tissue samples tested positive for the Bovine Viral Diarrhea Virus (BVDV) antigen, indicating participation of this virus in the pathogenesis of the malformation. In this case, a heritable defect of the Holstein breed could not be ruled out (KARAKAYA et al., 2013). In Uruguay, different types of congenital anomalies are reported in cattle, including malformations of the Angus breed, such as congenital osteopetrosis, brachygnathia superior and arthropathy. However, most of the cases are hereditary in nature (DUTRA, 2016). This study reported the occurrence of PE and accompanying malformations in a newborn Aberdeen Angus calf infected BVDV-1a in Uruguay.

In September 2019, a male calf was delivered at term from an Aberdeen Angus heifer and presented multiple malformations at birth. Delivery elapsed normally, requiring no obstetrical intervention. However, the calf was unable to stand and suckle, and it died seven hours after birth. The dam was part of a beef cattle breeding farm located in the Paysandú Department in northern Uruguay, presenting no previous health issues and exhibiting a good body score at the time of calving. It was part of a herd composed of 400 pregnant cows, of which 198 were 1-2-year-old first pregnancy heifers, along with 386 male and female calves, 136 1-2-year-old steers and 13 bulls. New sires from different farms regularly replaced the bulls to avoid inbreeding.

All of the herd grazed on native pastures except for the weanling calves, which received a concentrate-fiber supplementation in feeders during weaning. The paddocks were inspected in search of plant species known to be teratogenic for cattle or other invasive weeds, revealing no suspicious toxic origin. The herd was not vaccinated for BVDV. Previous occurrences of congenital anomalies, as well as other clinical manifestations suggesting BVDV infection, such as diarrhea and abortions, were not recorded in the herd.

Externally, the calf had a regular body score (3 on a 1-6 scale), presenting severe shortening of the lumbosacral region with agenesis of the lumbosacral and coccygeal vertebrae at palpation. The pelvic limbs presented with severe contracture of the tibiotarsal joints (arthrogryposis) and hyperextension of the tarsometatarsal joints, as well as marked atrophy of the intrinsic and extrinsic muscles of the hindquarter (Figure 1A). The mandible bones were shortened (brachygnathia) and the tongue was protruding out of

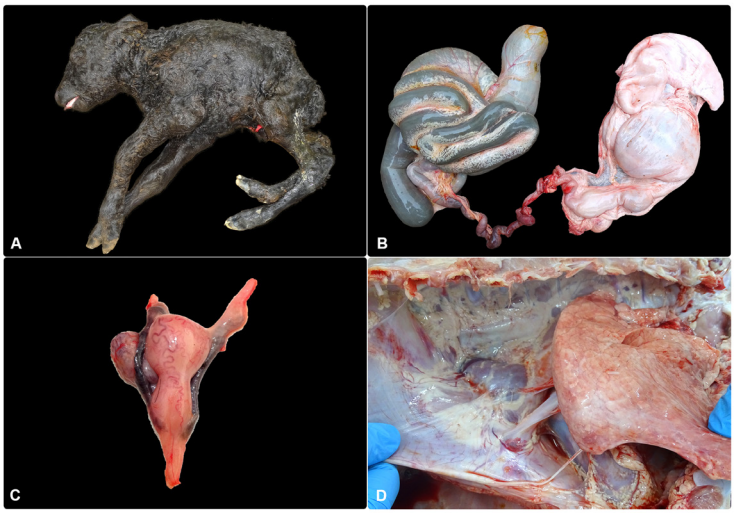


Figure 1 - *Perosomus elumbis* in an Aberdeen Angus calf. A) Note the shortened lumbosacral region and arthrogryposis of the pelvic limbs, as well as the shortened mandibular bones (brachygnathia). B) The small intestines consist of a 50 cm-long segment of hypoplastic bowel connecting the stomachs to the cecum, colon and rectum; note that the large intestines are expanded and the rectum is in a blind sac due to atresia ani. C) The testes were fused in a single structure located inside the abdominal cavity (cryptorchidism). D) The left kidney was found inside the thoracic cavity, in the dorsal portion of the mediastinum, immediately caudal to the heart.

the mouth. Moreover, the testes were not found inside the scrotum.

At the inspection of the abdominal cavity, the small intestines were short (approximately 50 cm in total length) and thin throughout (hypoplasia). The large intestines were in turn expanded by content, especially the rectum, which ended in a blind sac with no connection to the skin (imperforate anus) (Figure 1B). The testes were found inside the abdominal cavity (cryptorchidism) with fusion of the parenchyma of both (Figure 1C). The left kidney was found inside the thoracic cavity (renal ectopia) (Figure 1D), while the right kidney was hypoplastic.

Tissue samples were collected and processed for histopathology. Histologically, the right kidney presented a reduced number of normal nephrons, lobules and calyces. The skeletal muscle of the pelvic limbs demonstrated multifocal moderate diminution of myofiber diameter. The remaining tissues did not show further significant pathological changes.

RNA was extracted from the spleen tissue, retrotranscribed and then subjected to a real-time PCR assay targeting 207 bp of the 5' UTR genomic region of BVDV, as previously described (MAYA et al., 2016; MAYA et al., 2020). The spleen tissue was positive in real-time PCR to BVDV and amplified on a Ct of 30. This sample was named 5428UYPAY/2019. To genotype 5428UYPAY/2019, a fragment of 207 bp of the 5' UTR was amplified and another fragment of 428 bp of the $N^{pro}$ genomic region was amplified, as described by Maya et al. (2016). For subtyping purposes, a phylogenetic tree was constructed using 5′ UTR and $N^{pro}$ sequences obtained from sample 5428UYPAY/2019 that were concatenated into a major fragment of 607 bp length. These fragments were then aligned, along with other Uruguayan strains and BVDV-representative strains of BVDV-1, BVDV-2 and HoBi-like pestivirus genotypes and subtypes retrieved from the GenBank database. The phylogenetic tree showed that sample 5428UYPAY/2019 was of the BVDV-1a subtype as it was grouped along with other Uruguayan strains and reference strains of this subtype (Figure 2).

PE is a congenital defect that was first described in cattle in 1832, though a definitive cause for the condition is still speculative in most cases (JONES, 1999; ANGERHOLM et al., 2014). Although, the exact pathogenesis is not known for the occurrence of PE, it has been suggested that it derives from the malformation or improper migration of the neural tube during the tail-bud stage and partial agenesis of the caudal spinal cord (GENTILE & TESTONI, 2006). Different hypotheses for the occurrence of the condition have been raised, such as chromosomal mutations involving a family of genes (JONES, 1999), as well as toxic and viral infections of the fetus (DENNIS, 1975; KARAKAYA et al., 2013).

Among the viruses involved in congenital malformations in cattle, BVDV, Schmallenberg virus (SBV), Bluetongue virus (BTV), Akabane virus (AKAV) and Aino virus (AV) are enrolled; although, none produce pathognomonic findings (ANGERHOLM et al., 2015). Of those viruses, only BVDV is known to occur in Uruguay, being one of the most widespread viruses of cattle and belonging to the genus *Pestivirus* of the family Flaviviridae. The virus is largely disseminated in Uruguay and causes a wide range of clinical and pathological manifestations in cattle, such as respiratory, reproductive or gastrointestinal disorders (MAYA et al., 2016; MAYA et al., 2020; SILVEIRA et al., 2020). According to recent studies, a prevalence of 98.8% of farms and 80% of individual bovines had antibodies against BVDV in Uruguay. Among the virus subtypes reported for the country, it has been shown that the BVDV-1a subtype is the most prevalent and is estimated to have been circulating since about 1990 (MAYA et al., 2020). Furthermore, molecular studies demonstrated that the circulating strains of the BVDV-1a subtype of BVDV reported in Uruguay diverge from the strains found elsewhere in the world and also from the vaccine strain currently in use in the country (MAYA et al., 2020).

Considering the vast array of manifestations of BVDV infection in cattle, reproductive disorders are those that cause the most impact in cattle production, leading to embryonic or fetal death, mummification, abortion, congenital anomalies, stillbirth or birth of persistently infected calves, depending on the virus strain, the biotype of the virus, the immune status of the dam or the fetus and the fetal age at the time of infection, among other factors (ANGERHOLM et al., 2015; SILVEIRA et al., 2020). Intrauterine infection with BVDV can determine teratogenic effects when the virus infects the dam between days 79 and 150 of gestation, while the fetal tissues are still growing and differentiating, especially the central nervous system (GROOMS et al., 2004; ANGERHOLM et al., 2014).

Some of the anomalies affecting the nervous system of calves infected with BVDV during this period of gestation are hydrocephalus, hydranencephaly, porencephaly and cerebellar hypoplasia (BRODERSEN, 2014). Most of those conditions are also reported in SBV, BTV, AKAV or AV intrauterine infections (ANGERHOLM et al., 2015). Intrauterine infection with BVDV has also been related to extra-nervous system defects, such as

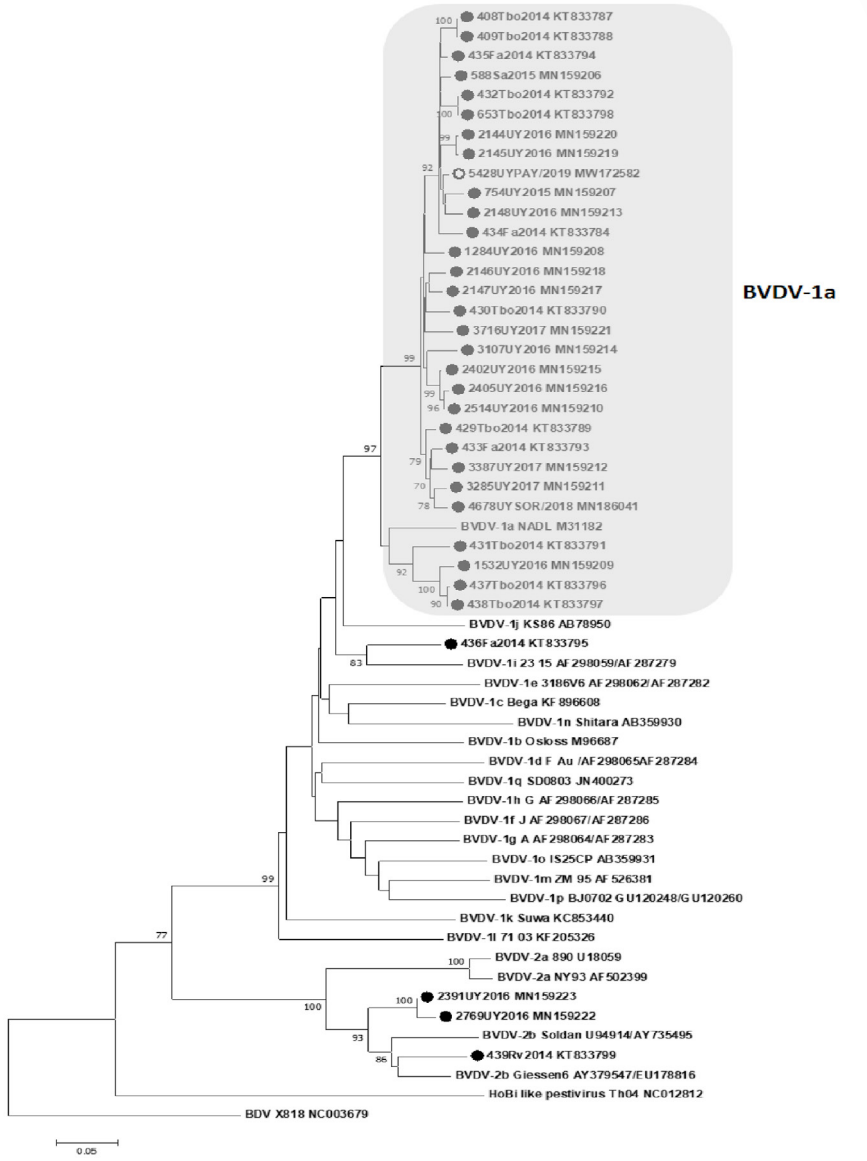


Figure 2 - Phylogenetic tree constructed by the Neighbor-Joining method using the 5' UTR/$N^{pro}$ region of the BVDV strains. Bootstraps (1000 replicates) are indicated at internal nodes. Uruguayan strains of the BVDV-1a, BVDV-1i and BVDV-2b subtypes are included and indicated with black dots, and the strain reported in this paper (5428UY/PAY2019) is indicated with white dots. Reference sequences of genotypes BVDV-1, BVDV-2 and HoBi-like pestivirus were retrieved from GenBank for comparison purposes. A BDV (border disease virus) sequence was included in the analysis as an out-group.

ocular malformations, thymic hypoplasia, defects of the hair coat, hyena disease, deranged osteogenesis, brachygnathia and growth retardation (GROOMS, 2004), of which only brachygnathia was present in our case. Plants like *Mimosa tenuiflora*. *Lupinus* spp., *Conium maculatum*, *Nicotiana glauca*, *Veratrum californicum*, *Oxytropis* spp. and *Astragalus* spp. are also known for causing congenital defects in ruminants (PANTER & STEGELMEIER, 2011), but none were found in; the paddocks where the heifer was grazing.

Nutritional imbalances, such as riboflavin, vitamin A, copper, manganese deficiencies or either molybdenum or selenium excess, are also known to produce malformations in mammals (PANTER & STEGELMEIER, 2011), but they are not likely to be the only manifestation. Finally, in veterinary medicine

some xenobiotics are used as antiparasitic drugs or antifungal agents that contaminate animal food known to cause congenital anomalies in ruminants, such as parbendazole and carbendazim, which induce overwhelmingly skeletal malformations (PANTER & STEGELMEIER, 2011; CRAIG et al., 2016; WICPOLT et al., 2019). However, in our case there was no record of those antiparasitic drugs being used during pregnancy, nor did adult cattle receive supplementary food, which could contain traces of carbendazim or other antifungal products used in agriculture.

The detection of BVDV in our case strongly suggested the participation of the virus in the malformations, as the virus is already known as a teratogen for cattle (KARAKAYA et al., 2013; ANGERHOLM et al., 2015). Moreover, in our case there is no known breed predisposition for PE, and no other potential predisposing factors, such as the consumption of toxic plants, the use of teratogenic drugs during pregnancy or a history of inbreeding. Our results suggested that intrauterine infection with BVDV should be suspected in cases of PE in cattle.

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## DECLARATION OF CONFLICTS OF INTEREST

The authors declare no conflict of interest.

## AUTHORS' CONTRIBUTIONS

ALV, COS, FMB, FB, KC, FRC and LGSO performed clinical and pathological investigation. LM and RC carried out the molecular biology studies. ALV, COS, FMB and LGSO prepared the draft of the manuscript. All authors critically contributed in conceiving and revising the text and approved the final version.

## BIOETHICS AND BIOSECURITY COMMITTEE APPROVAL

The authors of the note entitled "*Perosomus elumbis* in an Aberdeen Angus calf associated with intrauterine infection with BVDV-1a" declare for all purposes that the project that gave rise to the presented data has not been submitted for evaluation at the Ethics Committee of the Research Institute (National Institute of Agricultural Research), but they are aware of the contents of the National Council for Control of Animal Experimentation - CONCEA <http://www.mct.gov.br/index.php/content/view/310553.html>.

Thus, the authors assume full responsibility for the presented data and are available for possible questions, should they be required by the competent authorities.

## REFERENCES

ANGERHOLM, J. S. et al. *Perosomus elumbis* in Danish Holstein cattle. **BMC Veterinary Research**, v.10, n.227, 2014. Available from: <https://doi.org/10.1186/s12917-014-0227-2>. Accessed: Nov. 08, 2023. doi: 10.1186/s12917-014-0227-2.

ANGERHOLM J. S. et al. Viral induced congenital malformations in cattle. **Acta Veterinaria Scandinavica**. v.57, n.54, 2015. Available from: Accessed Nov. 08, 2023. doi: 10.1186/s13028-015-0145-8

BRODERSEN, B. W. Bovine viral diarrhea virus infections: Manifestations of Infection and recent advances in understanding pathogenesis and control. **Veterinary Pathology**, v.51, n.2, p.453-464, 2014. Available from: <https://doi.org/10.1177/0300985813520250>. Accessed: Nov. 07, 2023. doi: 10.1177/0300985813520250.

CRAIG, L. E et al. Bones and joints. In: MAXIE, M. G. **Jubb, Kennedy and Palmer's Pathology of Domestic Animals**, St. Louis: Elsevier, 2016. v.1, c.2, 6th edition, p.57-91.

DENNIS, S. M. *Perosomus elumbis* in sheep. **Australian Veterinary Journal**, v.53, n.3, p.135-136, 1975. Available from: <https://doi.org/10.1111/j.1751-0813.1975.tb09436.x>. Accessed: Nov. 08, 2023. doi: 10.1111/j.1751-0813.1975.tb09436.x.

DUTRA, F. Monstruosidades y enfermedades genéticas de los bovinos en Uruguay: su importancia y significado. In: XLIV JORNADAS URUGUAYAS DE BUIATRÍA, 2016, Paysandú, Uruguay. **Anais de la XLIV Jornadas Uruguayas de Buiatría**, Paysandú: Centro Médico Veterinario de Paysandú, 259 p., p.41-51.

GENTILE, A.; TESTONI, S. Inherited disorders of cattle: a selected review. **Slovenian Veterinary Research**, v.43, n.1, p.17-29, 2006. Available from: <https://www.slovetres.si/index.php/SVR/issue/viewIssue/37/26>. Accessed: Nov. 08, 2023.

GROOMS, D. L. Reproductive consequences of infection with bovine viral diarrhea virus. **The Veterinary Clinics of North American. Food animal practice**, v.20, n.1, p.5-19, 2004. Available from: <https://doi.org/10.1016/j.cvfa.2003.11.06>. Accessed: Nov. 07, 2023. doi: 10.1016/j.cvfa.2003.11.06.

JONES, C. J. *Perosomus elumbis* (vertebral agenesis and arthrogryposis) in a stillborn Holstein calf. **Veterinary Pathology**, v.36, n.1, p.64-70, 1999. Available from: <https://journals.sagepub.com/doi/pdf/10.1354/vp.36-1-64>. Accessed: Nov. 07, 2023. doi: 10.1354/vp.36-1-64.

KARAKAYA, E. et al. *Perosomus elumbis* in a Holstein calf infected with bovine viral diarrhea virus. **Tierärztliche Praxis Großtiere/Nutztier**, v.41, n.6, p.387-391, 2013. Available from: <https://www.thieme-connect.com/products/ejournals/abstract/10.1055/s-0038-1623199>. Accessed: Nov. 07, 2023. doi: 10.1055/s-0038-1623199.

MAYA, L. et al. Molecular diversity of bovine viral diarrhea virus in Uruguay. **Archives of Virology**, v.161, n.3, p.529-535, mar. 2016. Available from: <https://doi.org/10.1007/s00705-015-2688-4>. Accessed: Nov. 15, 2023. doi: 10.1007/s00705-015-2688-4.

MAYA, L. et al. An extensive field study reveals the circulation of new genetic variants of subtype 1a of bovine viral diarrhea virus in Uruguay. **Archives of Virology**, v.165, n.1, p.145-156, 2020.

Available from: <https://doi.org/10.1007/s00705-019-04446-z>. Accessed: Nov. 15, 2023. doi: 10.1007/s00705-019-04446-z.

PANTER, K. E.; STEGELMEIER, B. L. Effects of xenobiotics and phytotoxins on reproduction in food animals. **Veterinary Clinics of North America: Food Animal Practice**, v.27, n.2, 2011. Available from: <https://doi.org/10.1016/j.cvfa.2011.02.010>. Accessed: Nov. 09, 2023. doi: 10.1016/j.cvfa.2011.02.010.

PATRICK, T. et al. *Perosomus elumbis* in a stillborn rhesus macaque (*Macaca mulatta*): a case report. **Journal of Medical Primatology**, v.9, n.2, p.110-112, 2020. Available from: <https://doi.org/10.1111/jmp.12459>. Accessed: Nov. 07, 2023. doi: 10.1111/jmp.12459.

PIEGARI, G. et al. Perosomus elumbis in piglets: pathological, radiological and cytogenetic findings. **Animals**, v.11, n.4, 1132, 2021. Available from: <https://doi.org/10.3390/ani11041132>. Accessed: Nov. 15, 2023. doi: 10.3390/ani11041132.

SILVEIRA, C. S. et al. Diseases associated with bovine viral diarrhea virus subtypes 1a and 2b in beef and dairy cattle in Uruguay. **Brazilian Journal of Microbiology**, v.51, n.1, p.357-368, 2020. Available from: <https://doi.org/10.1007/s42770-019-00170-7>. Accessed: Nov. 10, 2023. doi: 10.1007/s42770-019-00170-7.

WICPOLT, N. S. et al. Experimental reproduction of congenital anomalies in the progeny of cows fed apple pomace during pregnancy. **Pesquisa Veterinária Brasileira**, v.39, n.6, p.371-375, 2019. Available from: <http://dx.doi.org/10.1590/1678-5150-pvb-6119>. Accessed: Nov. 10, 2023. doi: 10.1590/1678-5150-PVB-6119.