

Neuroclinical features, epidemiology and diagnosis of Cerebral Babesiosis in dogs

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Abstract

The research study was conducted to examine cerebral babesiosis in dogs of Andhra Pradesh from October 2023 to September 2024. Canine babesiosis was identified in 21.93 percent (136/620) of dogs exhibiting clinical signs of pale mucous membranes, fever, lymphadenopathy, and neurological symptoms. Babesiosis was confirmed through microscopic analysis of Giemsa-stained blood smears and polymerase chain reaction assay detecting 670 bp amplicons specific to *Babesia gibsoni*. According to the detection of *Babesia* organisms in the red blood cells of cerebrospinal fluid, 1.77 percent (11/620) of dogs examined in the study exhibited cerebral babesiosis, whereas 8.08 percent (11/136) of dogs diagnosed with babesiosis presented this disease. The 0-1 year age cohort exhibited the highest incidence of cerebral babesiosis, followed by the 4-7 year cohort. The analysis of gender-specific incidence revealed that 63.63 percent of the dogs were male, whereas 36.36 percent were female. The breed-specific prevalence indicated the highest occurrence, 18.18 percent (2/11) of Labrador Retrievers, 18.18 percent (2/11) of German Shepherds, and 18.18 percent (2/11) of Mongrels. Observed neurological symptoms encompassed ataxia, hind limb stiffness, paddling, opisthotonus, hind limb twitching, seizures, head pressing, stupor, decerebrate rigidity, decerebellate rigidity, circling, nystagmus, blindness, and paraplegia. This study conducted a neurological examination of cerebral babesiosis to assess reflexes, divided into three primary categories.

Keywords: cerebral babesiosis; incidence; dogs; Andhra Pradesh; diagnosis

Introduction

Babesia gibsoni is a significant hemoparasitic disease in India due to its frequency, clinical implications for canine health, and the challenges associated with its diagnosis and treatment (Reddy et al., 2022). Symptoms of *Babesia gibsoni* infection encompass fever, lethargy, anemia, jaundice, and in severe cases organ failure. The parasite can induce relapsing disease and is often associated with more chronic, subclinical infections, complicating diagnosis and therapy (Bilwal et al., 2017). Different researchers carried out the prevalence studies of babesiosis in bovines and dogs of Andhra Pradesh (Reddy et al., 2014; Dhanamjayam et al., 2024). Canine cerebral babesiosis, an uncommon yet severe *Babesia* infection, affects dogs' central nervous systems, typically leading to neurological manifestations such as seizures, ataxia and altered mental status. *Babesia canis* or *Babesia gibsoni* is more likely to induce it and when it manifests in the brain, it is often associated with a severe systemic infection (Liu et al., 2022). Although cerebral involvement in babesiosis is not the predominant presentation, limited case reports have recorded it.

Materials and methods

The research encompassed dogs presented to the Department of Veterinary Medicine at the College of Veterinary Science in Proddatur, as well as many veterinary clinics in the YSR and Krishna districts of Andhra Pradesh, India, from October 2023 to September 2024. This study encompassed dogs displaying clinical manifestations such as fever, anemia, lymphadenopathy, tick infestation, and neurological problems. All dogs in the current study had their annual vaccines for canine distemper, canine adenovirus, canine parvovirus, canine parainfluenza, canine leptospiral serovars and rabies. The research excluded canines having a history of trauma, uremic encephalopathy, congestive heart failure, idiopathic epilepsy, canine distemper, rabies, or episodic seizures.

Peripheral blood and whole blood samples were obtained for laboratory evaluation. A drop of blood was extracted from the ear vein, permitted to air dry and subsequently fixed with methanol for two to three minutes to produce a peripheral blood smear. Following 45-minute incubation with a diluted 1:8 Giemsa staining solution, the fixed blood smears were washed with tap water, permitted to air dry and subsequently analyzed for hemoproteoans under a microscope utilizing an oil immersion lens at 100x magnification (Sivajothi et al., 2023). Standard morphological characteristics were employed to verify the existence of *Babesia*. To extract genomic DNA, blood samples from 11 dogs exhibiting babesiosis-related neurological symptoms were collected from the cephalic vein, deposited in EDTA-coated blood collection vials, and refrigerated at -20°C. DNA was extracted from each blood sample (200 µL aliquots of EDTA blood preserved at -20°C) utilizing the QIAamp DNA Blood Mini Kit (Qiagen® Kit, Germany, Catalogue No. 51104), adhering to the manufacturer's guidelines with slight changes. The yield of the extracted DNA was quantified using UV spectroscopy and a NanoDrop 1000 spectrophotometer (Thermo Scientific, USA). The concentration was calculated based on the established principle that 40 µg of DNA per milliliter corresponds to one absorbance unit at 260 nm. The ratio of absorbance at 260 nm to that at 280 nm was utilized to assess the quality of the isolated DNA. Samples exhibiting an appropriate A260/A280 ratio of 1.7 to 1.9 were retained for further analysis. The samples were diluted to a final DNA concentration of 100 ng/µL for further application following the determination of concentration. Agarose gel electrophoresis was employed to verify the presence and quantify the concentration of the isolated DNA. Agarose was solubilized in 1X Tris-acetic acid-EDTA (TAE) buffer and subsequently heated to produce a 0.7% agarose gel. The gel was poured into an electrophoresis tray and allowed to polymerize for approximately forty minutes at ambient temperature (Gonmei et al., 2020).

A proforma specifically designed for data collection was utilized to document the information about neurological manifestations. Dogs afflicted with cerebral babesiosis received neurological assessments to evaluate their reflexes and categorize them into three principal domains. In accordance with established practice, the Glasgow Coma Scale was employed to assess the individuals' level of consciousness, motor activity, and brainstem reflexes (Teodorowski et al., 2022; Goncalves et al., 2023).

Results

Between October 2023 and September 2024, 620 dogs were tested, with babesiosis detected in 21.93 percent (136 out of 620) through microscopic analysis of Giemsa-stained blood smears. The organisms were identified by their morphology, exhibiting pleomorphic, oval, or signet ring-shaped forms, thus proving the presence of *Babesia gibsoni*. Eleven blood samples from dogs diagnosed with babesiosis and displaying neurological symptoms were subsequently analyzed using polymerase chain reaction (PCR) for confirmation diagnosis. DNA obtained from the blood of dogs afflicted with cerebral babesiosis yielded a 670 bp amplicon unique to *Babesia gibsoni*. This assay, focused on a segment of the 18S rRNA gene, was refined to amplify a 670 bp amplicon exclusive to *Babesia gibsoni*.

In this study, 11 of 136 positive *Babesia* individuals displayed neurological symptoms and were categorized as cerebral babesiosis. According to the detection of *Babesia* organisms in the red blood cells of cerebrospinal fluid, 1.77 percent (11/620) of all dogs examined in the study exhibited cerebral babesiosis, whereas 8.09 percent (11/136) of dogs diagnosed with babesiosis presented this condition. Dogs diagnosed with babesiosis were categorized into six age groups: 0-1 year, 1-4 years, 4-7 years, 7-10 years, 10-13 years, and over 13 years to evaluate the age-specific incidence of the disease. In this study, babesiosis was identified in 10.29 percent (14/136), 35.30 percent (48/136), 21.32 percent (29/136), 13.97 percent (19/136), 12.50 percent (17/136), and 6.62 percent (9/136) of canines across the relevant age cohorts. Cerebral babesiosis was identified in 27.27 percent (3/11), 18.18 percent (2/11), 27.27 percent (3/11), 9.09 percent (1/11), and 18.18 percent (2/11) of dogs across the relevant age categories, with no cases observed in the age range beyond 13 years. The gender-specific prevalence of babesiosis indicated that 65.44 percent (89/136) of cases were found in male dogs, whereas 34.56 percent (47/136) were identified in female dogs. Cerebral babesiosis showed that 63.63 percent (7/11) of cases were in male dogs, whereas 36.36 percent (4/11) were in female dogs. To assess the breed-specific prevalence of babesiosis, the dogs were classified into eleven breeds: Labrador Retriever, German Shepherd, Mongrel, Golden Retriever, Pomeranian, Doberman, Shih Tzu, Rottweiler, Pug, Belgian Malinois, and Akita. The study revealed babesiosis positivity rates of 37.50 percent (51/136) in Labrador Retrievers, 15.44 percent (21/136) in German Shepherds, 10.29 percent (14/136) in Mongrels, 9.56 percent (13/136) in Golden Retrievers, 8.09 percent (11/136) in Pomeranians, 5.88 percent (8/136) in Dobermans, 4.41 percent (6/136) in Shih Tzus, 3.68 percent (5/136) in Rottweilers, 2.21 percent (3/136) in Pugs, 2.21 percent (3/136) in Belgian Malinois, and 0.73 percent (1/136) in Akita. Cerebral babesiosis was observed in 18.18 percent (2/11) of Labrador Retrievers, 18.18 percent (2/11) of German Shepherds, 18.18 percent (2/11) of Mongrels, 9.09 percent (1/11) of Golden Retrievers, 9.09 percent (1/11) of Pomeranians, 9.09 percent (1/11) of Dobermans, 9.09 percent (1/11) of Rottweilers, and 9.09 percent (1/11) of Akitas (Figure-1 and Figure-2).

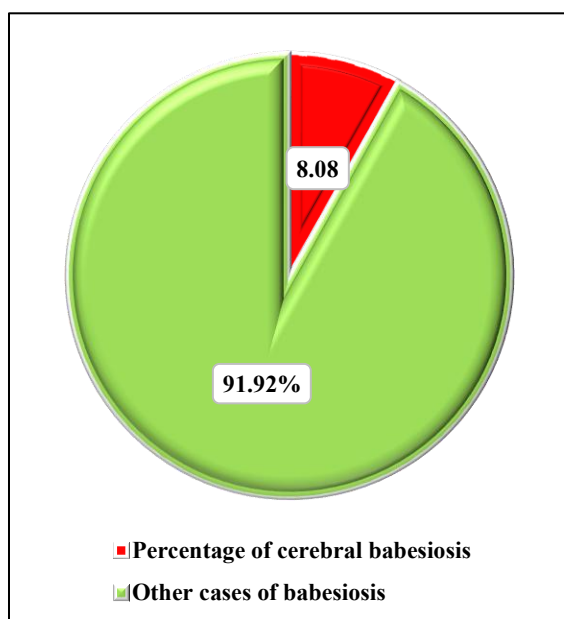


Figure-1. Incidence of cerebral babesiosis in dogs infected with *Babesia gibsoni*.

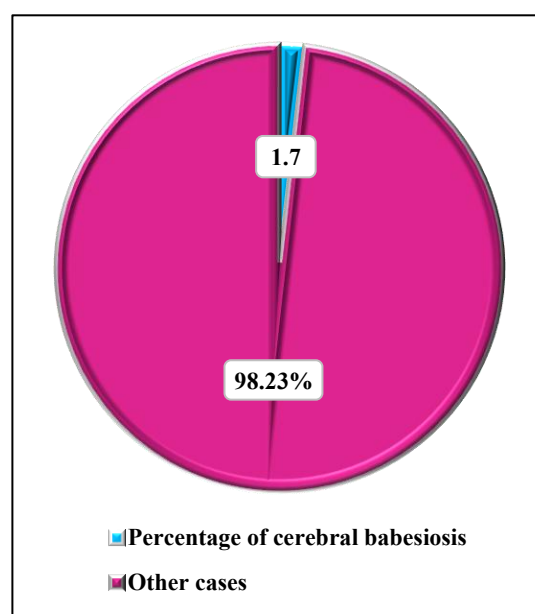


Figure-2. Incidence of cerebral babesiosis in dogs

Among 620 dogs, 11 were diagnosed with cerebral babesiosis, exhibiting neurological symptoms such as ataxia, hind limb stiffness, paddling, opisthotonus, hind limb twitching, seizures, head pressing, stupor, decerebrate rigidity, decerebellate rigidity, circling, nystagmus, blindness, and paraplegia. This study conducted a neurological examination of cerebral babesiosis to assess reflexes, divided into three primary categories. A. Level of consciousness: Intermittent awareness was noted in 54.54 percent (6/11) of canines. Depression or delirium, signifying an altered mental condition, was observed in 45.45 percent (5/11) of canines. Stupor, characterized by diminished reactivity to visual and aural stimuli, was observed in 18.18 percent (2/11) of dogs. Nine point zero nine percent (1/11) of dogs exhibited a comatose, unresponsive state, showing no reaction to repeated noxious stimuli. B. Motor activity: Normal gait and spontaneous movement were noted in 45.45 percent (5/11) of the instances, signifying preserved motor function. Hemiparesis, tetraparesis, and decerebrate activity were seen in 18.18 percent (2 out of 11) of the cases, showing moderate neurological problems. Intermittent extensor rigidity

during recumbency was observed in 36.36 percent (4/11), whereas persistent extensor rigidity was identified in 18.18 percent (2/11). Recumbency, together with diminished or absent reflexes, including hypotonia or a lack of spinal reflexes, was noted in 9.09 percent (1/11) of canines. C. Brainstem reflexes: Normal pupillary light reflexes (PLRs) and oculocephalic reflexes were noted in 63.63 percent (7/11) of dogs, suggesting partial preservation of brainstem functionality. Slow pupillary light responses with normal to diminished oculocephalic reflexes were observed in 54.54 percent (6/11), indicating delayed reflex responses. Bilateral miosis with normal to diminished oculocephalic reflexes was observed in 27.27 percent (3/11), whereas pinpoint pupils with missing oculocephalic reflexes were recorded in 18.18 percent (2/11), signifying significant brainstem involvement. Unilateral mydriasis, accompanied by diminished or absent reflexes, was noted in 9.09 percent (1/11) of canines. Furthermore, 9.09 percent (1/11) displayed bilateral mydriasis with missing oculocephalic reflexes, indicating a poor neurological prognosis (Table-1). The neurological examination of dogs infected with *Babesia gibsoni* reveals various states of awareness, motor deficits, and abnormalities in brainstem reflexes. Numerous dogs display signs of stupor, stiffness, hypotonia, or abnormal pupillary reflexes, suggesting different levels of neurological impairment, but others maintain normal ambulation and responsiveness. *Babesia gibsoni* may significantly affect the central and peripheral neurological systems of infected dogs, according to the results.

Table-1. Neurological examination of dogs with *Babesia gibsoni* infection.

S. No	Parameters	Reflexes	Number of dogs with babesiosis (11)	Percentage of dogs (%)
1.	Level of consciousness	Occasional periods of alertness	6/11	54.54
		Depression or delirium	5/11	45.45
		Stupor-response to visual stimuli	2/11	18.18
		Stupor-response to auditory stimuli	2/11	18.18
		Comatose, unresponsive to repeated noxious stimuli	1/11	9.09
2.	Motor activity	Normal gait, spontaneous movement	5/11	45.45
		Hemiparesis, tetra paresis, decerebrate activity	2/11	18.18
		Recumbent, intermittent extensor rigidity	4/11	36.36
		Recumbent, constant extensor rigidity	2/11	18.18
		Recumbent, hypotonus, depressed or absent spinal reflexes	1/11	9.09
3.	Brain stem reflexes	Normal PLRs and oculocephalic reflexes	7/11	63.63
		Slow PLRs, normal to reduced oculocephalic reflexes	6/11	54.54
		Bilateral miosis with normal to reduced oculocephalic reflexes	3/11	27.27
		Pin point pupils, reduced to absent oculocephalic reflexes	2/11	18.18
		Unilateral mydriasis, reduced to absent oculocephalic reflexes	1/11	9.09
		Bilateral mydriasis, reduced to absent oculocephalic reflexes	1/11	9.09

Discussion

Microscopic analysis of Giemsa-stained blood smears indicated that 136 out of 620 dogs exhibiting symptoms of hemoprotozoan illnesses tested positive for *Babesia* spp. *Babesia gibsoni* was validated through the identification of its distinctive morphology, characterized by pleomorphic, oval, or signet ring-shaped forms. Eleven blood samples from dogs diagnosed with babesiosis and exhibiting neurological signs were subjected to polymerase chain reaction for confirmation diagnosis. The DNA obtained from these samples produced a 670 bp amplicon unique to *Babesia gibsoni*. This PCR technique, aimed at a section of the 18S rRNA gene, was optimized to preferentially amplify the 670 bp fragment characteristic of *Babesia gibsoni*. (Temoche et al., 2018; Panda et al., 2021).

This study found the highest prevalence of babesiosis in the 1-4-year-old age group, followed by the 4-7-year-old age group. Young dogs had a greater susceptibility to illness development due to their diminished immune response. Analysis of gender-specific incidence revealed a higher prevalence of male canines compared to females. Among the current geographical area, the majority of companion dogs are male, which may account for the elevated incidence of babesiosis among male dogs. The breed-specific prevalence indicated the highest frequency in Labrador Retrievers (37.50 percent) and German Shepherds (15.44 percent) within the current geographical area. In the current geographical area, the majority of companion dogs are of larger breeds, including Labrador Retrievers and German Shepherds, which may account for the elevated incidence of babesiosis in these breeds. Study findings were in association with previous reports (Mahalingaiah et al., 2017; Mittal et al., 2019; Obeta et al., 2020). Literature indicates that canine babesiosis predominantly affects young pups. Purebred dogs were diagnosed with babesiosis more often than mixed-breed dogs. Nonetheless, the living conditions and the

nature of the dogs' employment were associated with babesiosis rather than any particular breed (Badawi et al., 2020; Karasova et al., 2022).

The clinical manifestations of cerebral babesiosis in canines are inadequately characterized, with a limited number of case reports available on the ailment. Grand mal seizures as an unusual presentation in a dog with babesiosis with alterations such as cortical atrophy with symmetry of the brain in the CT of the brain; proprioceptive deficits of the left front and both hind limbs with normal spinal reflexes; decreased menace response on the right and right-sided head tilt in a Scottish terrier dog with cerebral babesiosis, tetraplegia in a dog with babesiosis that responded to the therapy, paraplegia as a unique sign in dogs with babesiosis (Gonde et al., 2016); recumbency, ataxia, and convulsions in a dog with babesiosis (Sivajothi and Reddy, 2017); Studies should be taken to analyse and management of Behavioural changes due to cerebral condition (Kanchan et al., 2025); motor incoordination, nystagmus, anisocoria, and convulsions were recorded in a study of clinical and pathological changes during clinical babesiosis in dogs; apathy and hindlimb weakness in 80% of the dogs with babesiosis (Liu et al., 2022); and tremors and hindlimb weakness in 1/16 dogs with babesiosis; . Sivajothi et al., (2023) reported the changes in the cerebrospinal fluid consistency in calves with babesiosis. The pathophysiology of cerebral babesiosis entails parasitized erythrocytes becoming ensnared in the central nervous system's microvasculature, accompanied by the production of inflammatory mediators and tissue hypoxia, potentially leading to neurological manifestations.

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References

- 1) Badawi, N. M. & Yousif, A. A. (2020). Survey and molecular study of *Babesia gibsoni* in dogs of Baghdad province, Iraq. *The Iraqi Journal of Veterinary Medicine*, 44(E0): 34-41. 10.30539/ijvm.v44i(E0).1019
- 2) Bilwal, A. K., Mandal, G. C. & Tandel, F. B. (2017). Clinicopathological alterations in naturally occurring *Babesia gibsoni* infection in dogs of Middle-South Gujarat, India. *Veterinary World*, 10(10): 122-7. 10.14202/vetworld.2017.1227-1232
- 3) Dhanamjayam, P., Reddy, B.S., Shobhamani, B. & Sivajothi, S (2024). Study on haematological findings in cattle with clinical Babesiosis. *Journal of Livestock Science*, 15: 227-231. 10.33259/JLivestSci.2024.227-23
- 4) Goncalves, R., Maddox, T.W., Phillipps, S., Nagendran, A., Cooper, C., Orlandi, R., Fentem, R. & Walmsley, G.L. (2023) Development of a reliable clinical assessment tool for meningoencephalitis in dogs: The neurodisability scale. *Journal of Veterinary Internal Medicine*, May-Jun;37(3):1111-1118. 10.1111/jvim.16717
- 5) Gonde, S., Chhabra, S., Uppal, S. K., Singla, L. D. & Randhawa, S. S. (2016). A unique case of *Babesia gibsoni* infected dog with paraplegia. *Journal of Parasitic Diseases*, 40: 1605-1608. 10.1007/s12639-015-0739-0.
- 6) Gonmei, C., Sarma, K., Roychoudhury, P., Ali, M.A., Singh, D., Prasad, H., Ahmed, F. A., Lalmuanpuui, R., Shah, N., Singh, N. S. & Choudhury, J.K. (2020). Molecular diagnosis and clinico-hemato-biochemical alterations and oxidant-antioxidant biomarkers in *Babesia*-infected dogs of Mizoram, India. *Journal of vector borne diseases*, 57(3): 226–233. 10.4103/0972-9062.311775.
- 7) Kanchana K., Cherryl D.M., Gangaraju G., Triveni G., Vinod U. 2025. Breed and Behaviour: a scientific analysis of canine temperament. *Journal of Livestock Science* 16: 594-598 doi. 10.33259/JLivestSci.2025.594-598
- 8) Karasova, M., Tothova, C., Grelova, S. & Fialkovicova, M. (2022). The etiology, incidence, pathogenesis, diagnostics, and treatment of canine babesiosis caused by *Babesia gibsoni* infection. *Animals*, 12(6): 739. 10.3390/ani12060739 AMA
- 9) Liu, P. C., Lin, C. N. & Su, B. L. (2022). Clinical characteristics of naturally *Babesia gibsoni* infected dogs: A study of 60 dogs. *Veterinary Parasitology: Regional Studies and Reports*, 28, 100675. 10.1016/j.vprsr.2021.100675
- 10) Mahalingaiah, M. K. C., Asoor, M., Thimmaiah, R. P., Narayanaswamy, H. D., Mukartal, S. Y., Elattuvalappil, A. M. & Singh S. (2017). Prevalence of canine babesiosis in different breeds of dogs in and around bengaluru. *Advances in Animal and Veterinary Sciences*, 5(3): 140-144. 10.14737/journal.aavs/2017/5.3.140.144.
- 11) Mittal, M., Kundu, K., Chakravarti, S., Mohapatra, J. K., Singh, V. K., Kumar, B. R., Thakur, V., Churamania, C. P. & Kumar, A. (2019). Canine babesiosis among working dogs of organised kennels in India: A comprehensive haematological, biochemical, clinicopathological and molecular epidemiological multiregional study. *Preventive Vet. Med.* 169: 104696. 10.1016/j.prevetmed.2019.104696

- 12) Obeta, S. S., Ibrahim, B., Lawal, I.A., Ntala, J.A., Ogo, N.I. & Balogun, E.O. (2020) Prevalence of canine babesiosis and their risk factors among asymptomatic dogs in the federal capital territory, Abuja, Nigeria, *Parasite Epidemiology and Control*, 11 e00186. epi.2020.e00186. 10.1016/j.parepi.2020.e00186
- 13) Panda, C.M, Dehuri, M.R. Panda., Sahoo, L.K. & Mohanty, B. (2021) Molecular Investigation of Canine Babesiosis in and Around Bhubaneswar, India, *research square*, 1-10. 10.21203/rs.3.rs-237874/v1
- 14) Reddy, B.S., Sivajothi, S. & Swetha, K. (2022). Intravenous Clindamycin as a Monotherapy in Treatment of *Babesia gibsoni* in Dogs. *Chemical Science and Reviews and Letters*. 11 (44), 475-477. 10.37273/chesci.cs205311542
- 15) Reddy, B. S., Sivajothi, S., Reddy, L.S. S. & Raju, K.G.S. (2014). Clinical and laboratory findings of Babesia infection in dogs. *Journal of Parasitic Diseases*, 92: 268–272. 10.1007/s12639-014-0491-x.
- 16) Sivajothi, S. & Reddy, B. S. (2017) Successful management of nervous signs due to babesiosis in a dog. *International Journal of Veterinary Sciences and Animal Husbandry* 2017; 2(3): 33-34.
- 17) Sivajothi, S., Reddy, B.S. & Swetha, K. (2023) Cerebrospinal fluid analysis and haemato-biochemical variations in young buffalo calves with cerebral babesiosis. *Journal of Parasitic Diseases*, 47(4), 815-819. 10.1007/s12639-014-0491-x.
- 18) Temoche, L.C., Assad., R., Seabra-Junior, E.S., Lemos, T.D., Almosny, N. (2018). Frequency of Babesia vogeli in domestic dogs in the metropolitan area of Piura, Peru *Acta Veterinaria Brno*, 8, 255-260. 10.2754/avb201887030255.
- 19) Teodorowski, O., Kalinowski, M., Winiarczyk, D., Dokuzeylül, B., Winiarczyk, S., Adaszek, Ł. 2022. *Babesia gibsoni* infection in dogs - A European perspective. *Animals*, 12(6): 730. 10.3390/ani12060730.