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Review

Silent Killers: Insights from Animal Cases of Mushroom Poisoning

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Abstract: Mushroom intoxication in animals is a significant but often overlooked issue in veterinary toxicology. Mushrooms, a diverse group of fungi, include many species that produce potent toxins capable of causing severe animal morbidity and mortality. Toxic mushrooms, such as species within the genera Amanita, Cortinarius, and Galerina, produce secondary metabolites like amatoxins, muscarine, and psilocybin. This review focuses on the types of toxic mushrooms, their toxic compounds, the mechanisms of toxicity, and documented cases in domestic and wild animals. A total of 34 papers were included in this review with cases reported from 1979 to 2020. A total of 309 cases were included in this review, 71.5% in dogs, 4.2% in cats and 24.3% in other animals. Most of the animal's recovery, and the common fungi associated with intoxication was *Amanitta* spp. Pet owners and livestock managers should regularly inspect their environments for toxic mushrooms, particularly during damp and humid conditions when fungi proliferate. In the future, public education campaigns can increase awareness about the risks posed by toxic mushrooms and promote early intervention in suspected poisoning cases and provide more detailed descriptions of the cases.

Keywords: intoxication; mushroom; toxic; animals; dogs; cat; farm animal; pathology; toxicology

1. Introduction

Mushroom ingestion in animals can result in a broad spectrum of clinical effects, ranging from mild gastrointestinal upset to severe systemic toxicity, depending on the species of mushroom consumed and the quantity ingested [1]. Toxic compounds in mushrooms, such as amatoxins or muscarine, target different physiological systems, leading to symptoms that may include vomiting, diarrhoea, tremors, seizures, liver failure, and, in severe cases, death [2]. The diagnosis of mushroom poisoning can be challenging, as the clinical signs are often non-specific [1]. When ingestion is not witnessed, or mushroom fragments are not present in vomitus or faeces, identifying the cause can be difficult. This delay in diagnosis can worsen the prognosis if treatment is not initiated promptly [1]. Dogs, in particular, are at higher risk of mushroom toxicity than other companion animals [2,3]. Their natural curiosity and foraging behaviour make them more likely to consume wild mushrooms found during outdoor activities. Cats are less frequently affected, likely due to their more selective eating habits [4]. Though species-specific tolerance levels vary, livestock and wildlife may also encounter toxic mushrooms in their grazing environments [5,6]. Treatment generally focuses on decontamination, supportive care, and symptom management [1,7]. Activated charcoal, emetics, and intravenous fluids are commonly used to

mitigate toxin absorption and maintain hydration. In cases involving hepatotoxic mushrooms like *Amanita phalloides* (Death Cap) [8], aggressive interventions such as intravenous silibinin or liver support therapies may be required [9,10]. This review focuses on the types of toxic mushrooms, their toxic compounds, the mechanisms of toxicity, and documented cases in domestic and wild animals.

2. Toxic Mushrooms

2.1. Mushrooms' Definition and Characteristics

Mushrooms are multicellular filamentous fungi that belong to the kingdom Fungi or Mycota. Fungi can be divided into edible, conditionally edible, almost inedible, and poisonous [11,12]. They are categorised based on their structural and reproductive traits: Basidiomycota (most species belong in this group and produce spores on specialised cells called basidia) and Ascomycota (possess the "ascus", a microscopic sexual structure in which nonmotile spores, called ascospores, are formed) [1]. Their anatomical structure is described in Figure 1, and their life cycle is illustrated in Figure 2 [13].

Different parts of the mushroom can help identify the species, such as the cap size and shape, colour, texture, consistency, odour, margin shape, gills, type of stem and habitat. Figure 3 presents a diagram with some of these characteristics [14].

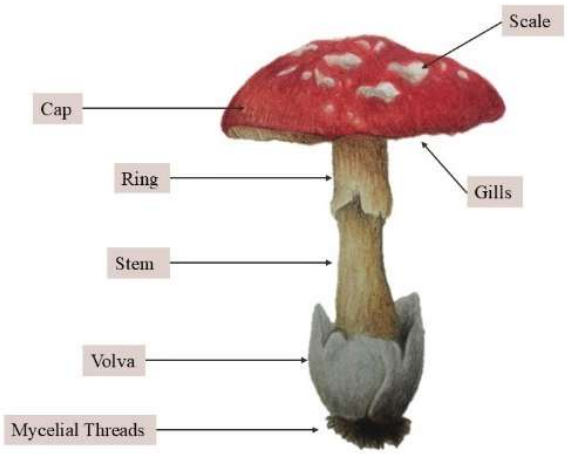

Figure 1. Different parts of mushrooms (Illustration by Andreia Garcês).

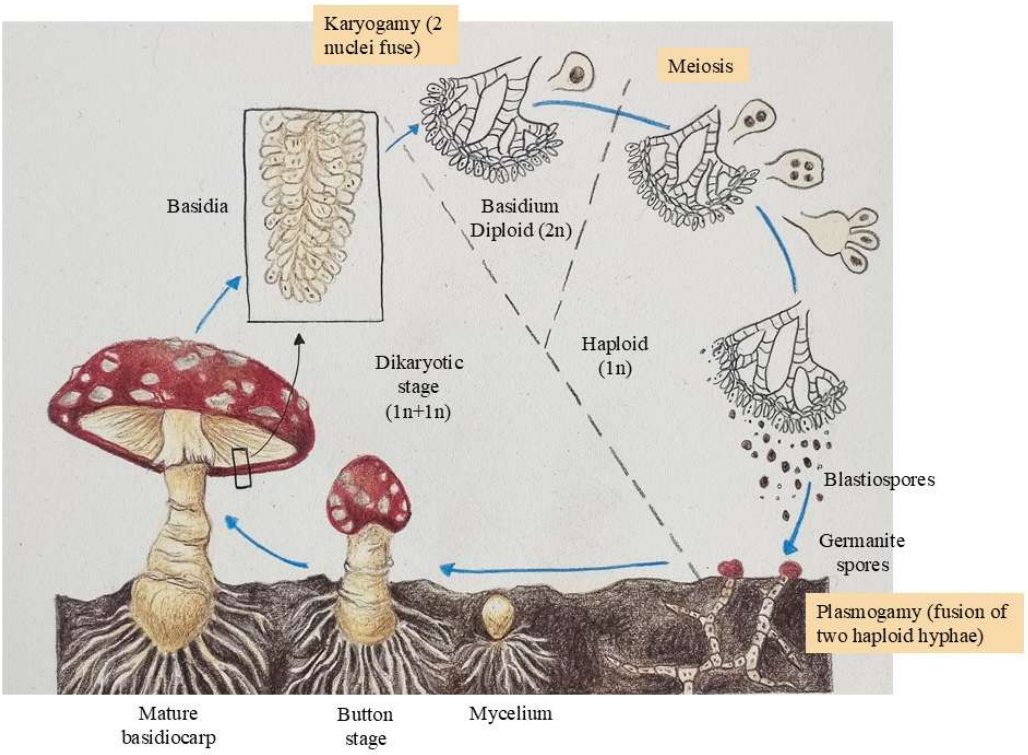

Figure 2. Different stages of the life cycle of mushrooms (Illustration by Andreia Garcês).

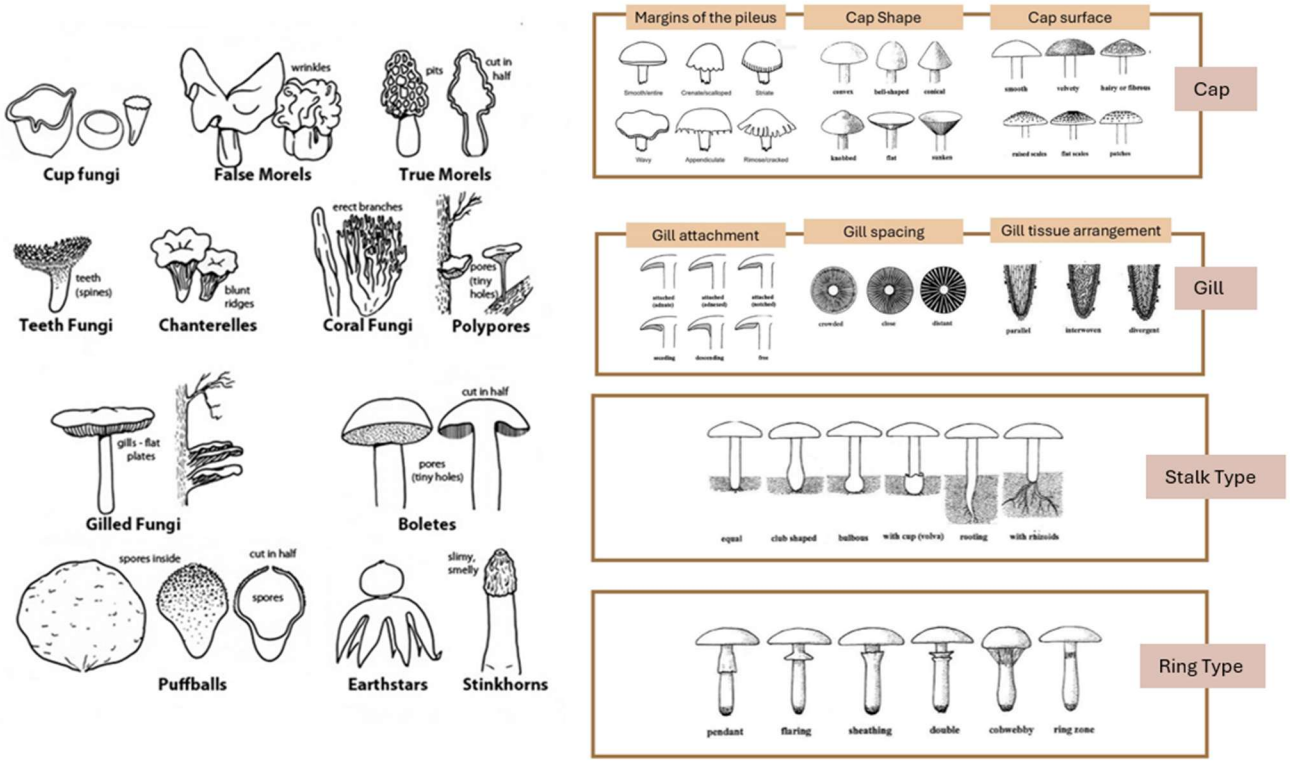

Figure 3. Diagram to help identify the different groups of mushrooms (Adapted with permission from [14] Lorenz Books, 2024).

These fungi have important ecological roles as decomposers, breaking down

organic material, recycling nutrients, and forming important mutualistic relationships (e.g., mycorrhizal fungi with plant roots) [11]. They generally grow in moist, humid and dark places, on rotten logs of wood, tree trunks, soil rich in organic matter, dung cakes, decaying organic matter, etc (Figure 4) [6,15]. In this environment, they have heterotrophic nutrition where they absorb nutrients through extracellular digestion, being saprophytic (decomposing dead organic matter), parasitic, or mutualistic (e.g., mycorrhiza) [13].

Figure 4. Some examples of mushrooms in their natural habitat (Credit to Andreia Garcês).

2.2. Toxins

Many fungi can produce toxic secondary metabolites. At least 100 species, among the 100,000 mushroom species identified worldwide, have been reported to be toxic [7]. Poisonous fungi contain various toxins, each exhibiting distinct physiological and clinical effects depending on their chemical nature and potency. These toxins can be classified based on their physiological impact, the specific organs they target, and the latency period before symptom onset [16]. The severity and nature of toxicity can vary significantly due to multiple factors, including the fungal species consumed, the quantity ingested, seasonal variations, geographic distribution, preparation methods, and individual susceptibility to the toxins [12]. Mushroom poisoning is categorized into six primary clinical syndromes: cytotoxic poisoning, neurotoxic poisoning, myotoxic effects, metabolic toxicity, gastrointestinal toxicity, and miscellaneous adverse reactions caused by fungal ingestion [1,12,17]. The toxic compounds responsible for these effects are broadly classified into seven major categories: amatoxins, orellanine, gyromitrin, muscarine, ibotenic acid/muscimol, psilocybin/psilocin, and coprine [6,12,18]. Some examples of mushrooms in the different categories of toxins are presented in Figure 5, including the period that those toxins act after ingestion.

Table 1 summarises the type of toxins, mushroom species, clinical presentation, site toxicity and molecular properties, toxicity mechanism and sources, and the most

common mushroom toxins associated with animal poisoning. Some visual examples of mushrooms in the different toxin categories are presented in Figure 5, along with the time it takes for these toxins to take effect after ingestion.

Table 1. Type of toxins, mushroom species, clinical presentation, site toxicity and molecular properties, mechanism of toxicity and sources, of the most common mushroom toxins associated with animal poisoning (GIT – Gastrointestinal tract; CNS – Central Nervous System) [3,6,16,17].

Toxins	**Mushroom Species**	**Clinical Presentation**	**Sites Toxicity**	**Molecular Properties, Mechanism of Toxicity and Sources**
Amatoxins	*Amanita verna, Amanita virosa, Amanita phalloides, Lepiota helveola, Galerina marginata, Amanita bisporigera, Galerina autumnalis, Galerina marginata, G. venenata, Conocybe filaris, Amanita ocreata, Lepiota spp*	Amanitin poisoning follows a clinical progression that can be divided into four phases, although not all cases exhibit all stages. The timeline and symptoms include: 1. Latent Phase (6–12 h Post-Ingestion): During this initial phase, there are no visible clinical signs despite toxin absorption and early hepatic damage. 2. Gastrointestinal Phase (Up to 24 h Post-Ingestion): Symptoms such as vomiting, diarrhoea, abdominal pain, and lethargy emerge. Severe hypoglycemia can occur due to rapid liver glycogen depletion. 3. False Recovery Phase (24–48 h Post-Ingestion): Animals may appear to recover, displaying an improvement in clinical symptoms. However, this phase can be misleading, as it often precedes severe organ damage. 4. Hepatic and Renal Failure Phase (36–72 h Post-Ingestion): This critical stage involves fulminant liver failure, characterised by coagulation abnormalities, encephalopathy, and renal dysfunction. Common laboratory findings include elevated serum levels of ALP (alkaline phosphatase), ALT (alanine transaminase), AST (aspartate aminotransferase), and bilirubin. Puppies or dogs that consume large doses may succumb within 24 hours, bypassing later stages. The prognosis varies, with death or recovery typically occurring 7–14 days post-ingestion. Survival rates exceed 50% when animals receive prompt and appropriate treatment during the hepatic and renal phases.	GIT, liver, kidney	Thermostable bicyclic octapeptide is found in species of the Amanita genus. Nine amatoxins were already identified, with ά-amanitine being the most active. The toxicity is associated with the inhibition of RNA polymerase-II and therefore DNA transcription resulting in the arrest of protein synthesis and cell necrosis.
Gyromitrin	*Gyromitra esculenta*	1. Latent Phase (6–12 h Post-Ingestion): After ingestion,	GIT, CNS,	Gyromitrin (acetaldehyde-N-

	Gyromitra californica, Gyomitra infula, Sarcosphaera coronaria,	symptom onset is often delayed as the toxin is metabolised to monomethylhydrazine (MMH). 2. Gastrointestinal Phase (6–12 h Post-Ingestion): nonspecific gastrointestinal distress, including nausea, vomiting, diarrhoea, abdominal pain, and dehydration. 3. Systemic Toxicity Phase (12–48 h Post-Ingestion): Neurological Symptoms (dizziness, ataxia, tremors), Seizures (from decreased gamma-aminobutyric acid [GABA] activity due to MMH-induced pyridoxine [Vitamin B6] depletion), Elevated liver enzymes (AST, ALT) may indicate liver damage, Hematuria and proteinuria are possible in severe cases.	liver and blood	methyl-N-formylhydrazone) is a volatile liquid which is quite unstable and oxidizes at room temperature to acetaldehyde and N-methyl-N-formylhydrazine and exists free or bonded with glucosides in the species *Gyromitra esculenta*. The typical gyromitrin content is 40-732 mg/kg (wet weight). The hydrazines are convulsants, they react with pyridoxal-phosphate, forming a hydrazone which results in the decreased activity of glutamic acid decarboxylase and diminished formation of gamma-aminobutiric-acid (GABA).
Orellanine	*Cortinarius orellanus, Cortinatius speciosissinus, Mycena pura, Cortinarius rubellus*	The kidney is the primary target organ, while hepatic damage is infrequent. Renal impairment caused by severe interstitial nephritis, acute focal tubular damage, and interstitial fibrosis often presents with a latent phase between ingestion and the onset of clinical signs. Gastrointestinal symptoms such as anorexia, vomiting, diarrhoea or constipation, and abdominal pain may appear within 72 hours. Clinical signs of renal failure typically develop between 3 and 20 days after ingestion, with the onset often delayed by 3 to 14 days. Renal failure symptoms include polyuria and polydipsia, while oliguria may occur initially, followed by diuresis and either recovery or progression to chronic renal failure. In most cases, significant improvement	Kidney, GIT	It is a heat-stable bipyridine N-oxide (3,3’,4,4’-tetrahydroxy-2,2-bipyridine-N,N’-dioxide), found in the mushroom *Pleurotus ostreatus* and *Cortinarius orellanus.* Orellanine chemically resembles the pyridine herbicides paraquat and diquat and is deoxidized in orelline which is not toxic. *In vitro* data strongly suggest that orellanine generates oxygen

		occurs over a prolonged period of up to six months, but chronic renal failure may persist in some instances.		radicals at the target site through redox cycling and/or redox activation of iron. Further data from cellular systems indicate that a metabolite of the toxin can inhibit protein synthesis.
Muscarine	*Citocybe gibba, Inocybe rimosa, Clitocybe dealbata, Cytocybe illudens, Inocybe fastigiata, Boletus calopus, Amanita muscaria, Clitocybe serussata, Citocybe dealbata, Clitocybe phyllophila, Citocybe rivulosa, Hygrocybe, Lactarius and Russula.*	Clinical signs of muscarine toxicity can develop rapidly, typically within 5 to 30 minutes and generally within 2 hours of mushroom ingestion. Symptoms result from mild to severe cholinergic stimulation, including salivation, lacrimation, urination, diarrhoea, dyspnea, and emesis (SLUDDE). Dyspnea arises due to increased bronchial secretions and bronchoconstriction. Other possible signs include bradycardia, miosis, hypotension, shock, and abdominal pain.	Autonomic nervous system	Tetrahydro-4-hydroxy-N,N,N-5-tetramethyl-2-furanmethanaminium is found in small amounts in *Amanita muscaria* and in larger amounts in *Clitocybe serussata, C. dealbata, C. phyllophila and C. rivulosa.* Muscarine structure is very similar to acetylcholine and binds to the same receptors. It is not hydrolyzed by cholinesterase causing a parasympathomimetic symptomatology.
Psilocybin and psilocin	*Gymnopilus spectabilis, Panaeolus foenisecii, Conocybe cyanopus, Psilocybe caerulescens, Psilocybe cubensis Psilocybe argentipes, P. mexicana, Gymnopilus aeruginosa, Panaeolus spp. Inocybe spp., Pluteus spp., and Pholiotina spp..*	Clinical signs typically appear within 30 minutes to 1 hour after ingestion, though in rare cases, they may be delayed up to 3 hours. Symptoms include euphoria, hallucinations, tachycardia, elevated blood pressure, mydriasis, tremors, and fever. Additional signs may include aggression, ataxia, vocalization, nystagmus, seizures, and increased body temperature. Recovery usually occurs within 6 hours after the onset of clinical signs.	GIT	Component of the tyramine type, 4-phosphoryloxy-N, N-dimethyltryptamine. Cleavage of the phosphoric ester group by alkaline phosphatase and unspecific esterases indicates that psilocybin acts as a prodrug and that its hydroxyl metabolite psilocin is the active agent. The activity of psilocybin is due to the activation of the serotonin 2-

				A receptor.
Muscimol and ibotenic acid	*Amanita gemmata, Amanita pantherina, Amanita muscaria*	The onset of clinical signs typically occurs within 30 to 120 minutes after ingestion. Neurological symptoms in animals may include lethargy, stupor, alternating mania, and delirium, with periods of excitation followed by inhibition of the nervous system. Other signs include disorientation, opisthotonus, paresis, seizures, chewing movements, miosis, ataxia, head tilt, nystagmus, circling, and respiratory depression. In severe cases, it can lead to coma. The duration of clinical signs usually lasts around 24 hours.	CNS	It is a 3-hydroxy-5-amino-methylisoxazole which is a decarboxylated product of ibotenic acid which is found in *Amanita muscaria and A. pantherina*. This substance shows a structural resemblance to GABA (gamma-aminobutyric acid) and imitates the action of this inhibitory neurotransmitter in the central nervous system. s the a-amino-3-hydroxy-5-isoxazole-acetic acid. It is an agonist of the N-methyl-D-aspartic-acid (NMDA) receptor. Because of the acidic property of isoxazole moiety, it is similar to glutamic acid and mimics its effects in animals.

Figure 5. Some examples of mushrooms in the different categories of toxins (Credit to Andreia Garcês).

3. Materials and Methods

The initial search identified 1000 articles from the databases (Web of Science, PubMed, ResearchGate, and Google Scholar). The research was performed between December 2024 and February 2025. The initial search included terms such as "mushroom", "intoxication", "poisoning", "toxic", "toxins", "fungi", "animals",

"dog", "cat", "horse", "wildlife" and "cattle". The research was done in English, Portuguese, and Spanish. In the first showing of all abstracts, 800 articles and the remaining 200 were excluded. Of these 45 were repeated and were excluded. To the remaining 155 articles, a primary exclusion filter was applied: 77 were excluded because they did not present reported cases in animals and 12 were reviews in toxicology. With secondary exclusion filters screening to full-review the articles: 12 there was no available information regarding the case of intoxication (data on species, mushroom species, clinical signals, outcome as not available) and 12 were no open-access full articles (it was not possible to consult methods and results). Therefore, 34 articles were identified for a full review of the Systematic Review [5].

4. Results

4.1. Data on Domestic Animals

A total of 34 papers were included in this review regarding intoxication by mushrooms in animals. The cases have been reported from 1979 to 2020. A total of 309 cases were included in this review, 221 in dogs (71.5%), 13 (4.2%) in cats and 75 in other animals (24.3%). The majority of cases occurred in North America (Figure 6). Regarding the clinical signs, the majority presented gastrointestinal alterations such as vomit, hypersalivation and diarrhea. Neurologic alterations were also present as seizures, depression and disorientation.

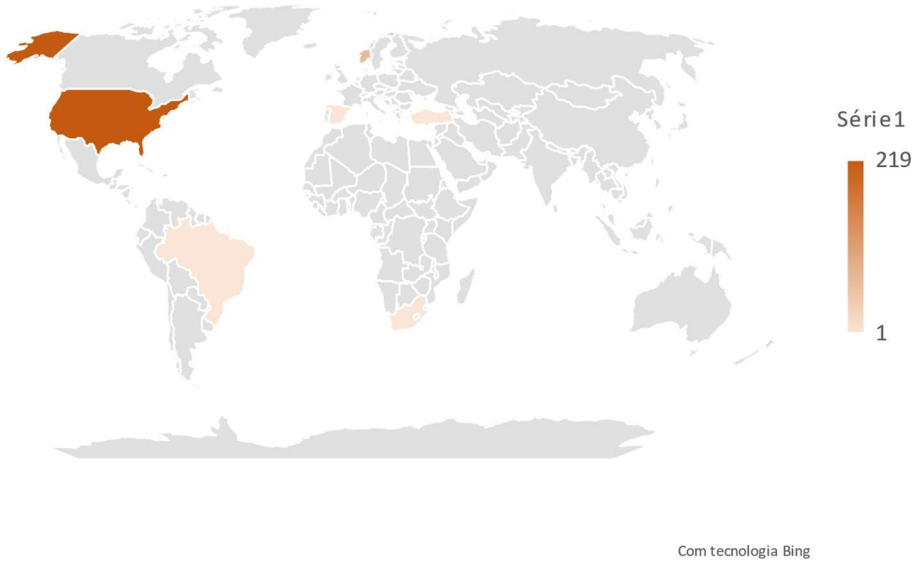

Figure 6. Distribution of mushroom poisoning around the world between 1979–2020 using the data from this review (Software used Bing).

Of the 309 poisoned in this paper, 137 recovered, 99 died or were euthanised and 21 the outcome is unknown. The most common toxic fungi were *Amanitta spp* (108/309), followed by *Inocybe* spp. (25/309) (Figure 7). In Tables 2, 3 and 4 there is a summarized description of the cases regarding the animal, age, sex, mushroom species, clinical signs and outcome.

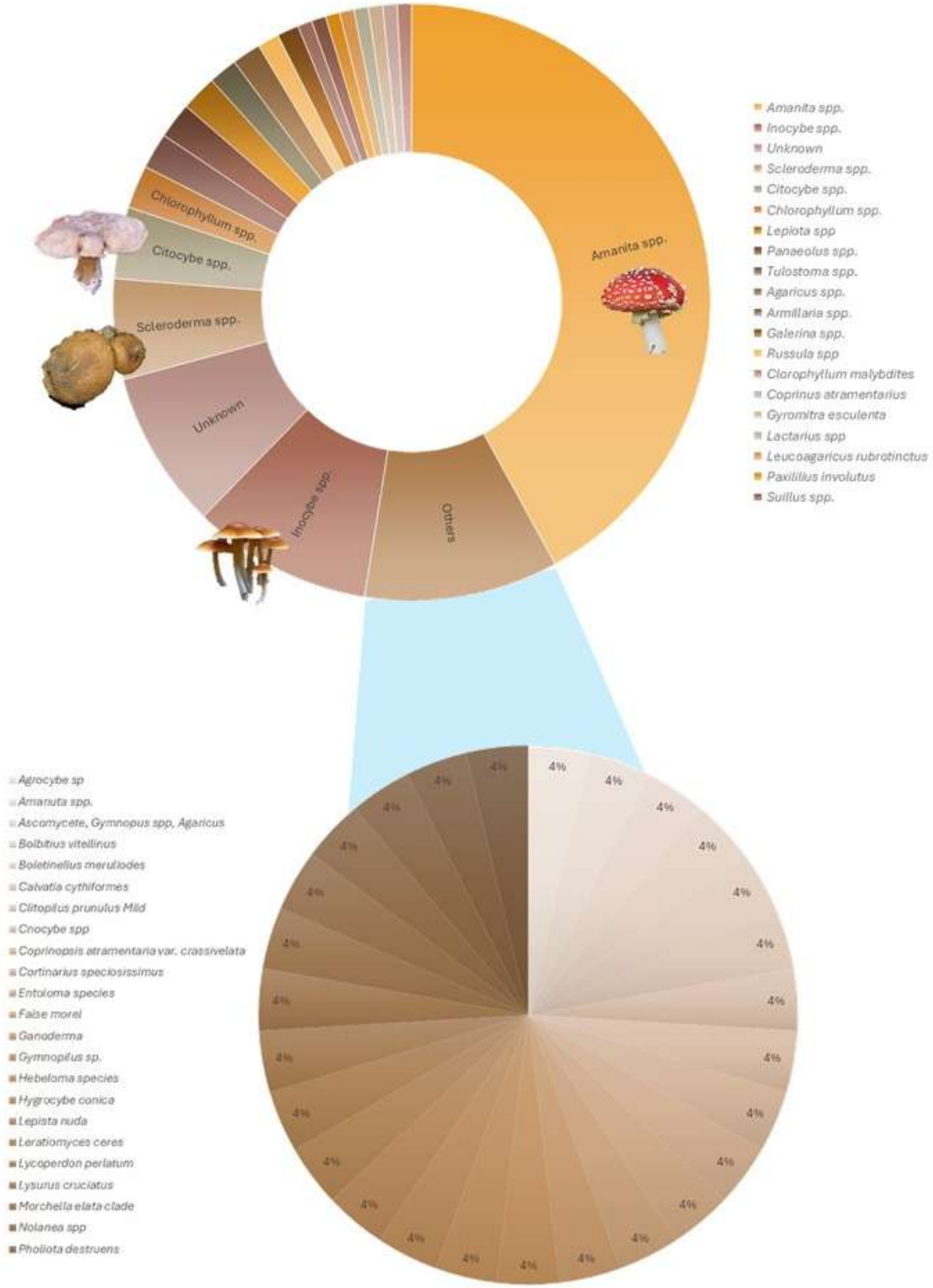

Figure 7. Mushroom species included in animal poisoreported from 1979–2020 are included in this review.

Table 2. Distribution of the mushroom poisoning in dogs by breed, sex, age (Y – years, M– months, W – weeks), species of mushroom, clinical signs, outcome, year, county (NA – Not available).

Breed	Sex	Age	Species mushroom	Clinical signs	Outcome	Year	Country	Ref
Labrador Spaniel	Female	11Y	*Lepiota brunneoincarnata*	Depression, vomiting, diarrhoea	Euthanasia	2017	Spain	[19]
Cocker Spaniel	NA	*4M*	*Amanitta phalloides*	Acute vomiting and icterus	Death	2019	UK	[20]
Labrador Retriever	NA	10M	*Amanita muscaria*	Moderate hypersalivation, dilated pupils, ataxia and severe twitching, drowsy, tachycardia, hallucinations	Recovery	2012–2013	UK	[1]
Mix Breed	NA	NA	*Amanita muscaria*	Asymptomatic	Recovery	2012–2013	UK	[1]
Border collie	NA	8Y	*Armillaria species*	Vomiting, diarrhea	Recovery	2012–2013	UK	[1]
Border collie	NA	4Y	*Armillaria species*	Vomiting, diarrhea	Recovery	2012–2013	UK	[1]
Cocker spaniel	NA	NA	*Clitocybe rivulosa*	Vomiting, hypersalivation, hemorrhagic diarrhoea	Recovery	2012–2013	UK	[1]
Rottweiler	NA	NA	*Clitocybe species*	Behavioral changes (fearful), hallucinations, constricted pupils	Recovery	2012–2013	UK	[1]
Labrador retriever	NA	12W	*Clitocybe species*	Severe hypersalivation, vomiting, diarrhoea	Recovery	2012–2013	UK	[1]
Chihuahua	NA	NA	*Clitocybe rivulosa or Entoloma species*	Vomiting, hypersalivation, nystagmus, severe collapse, bradycardia	Recovery	2012–2013	UK	[1]
Mix Breed	NA	NA	*Clitocybe rivulosa, Mycena epipterygia and Agaricus species*	Hypersalivation, diarrhoea, vomiting	Recovery	2012–2013	UK	[1]
Labradoodle	NA	4Y	*Clitopilus prunulus*	Mild hypersalivation	Recovery	2012–2013	UK	[1]
Terrier	NA	4M	*Coprinus comatus*	Moderate hypersalivation, vomiting, diarrhoea, abdominal pain	Recovery	2012–2013	UK	[1]
English Springer Spaniel	NA	4Y	*Entoloma species*	Vomiting, lethargy, inappetence, hypertension, diarrhoea, constricted pupils, abdominal pain, bradycardia and hypothermia	Recovery	2012–2013	UK	[1]
Border collie	NA	15y	*Hebeloma species*	Vomiting, diarrhoea, severe collapse	Euthanasia	2012–2013	UK	[1]
Labrador retriever,	NA	3M	*Inocybe species (subgenus Inocibium)*	Retching, hypersalivation, vomiting and diarrhoea	Recovery	2012–2013	UK	[1]
Labrador retriever	NA	4Y	*Scleroderma citrinum*	Vomiting and lethargy	Recovery	2012–2013	UK	[1]
Cocker spaniel	NA	10W	*Gyromitra esculenta*	Lethargic, vomit, Fatal hemolytic episode	Dead	1979	USA	[2]

Mixed breed	Female	12M	*Russula spp*	Vomiting, tremors, cardiac arrest	Recovery	2006–2011	USA	[21]
Mixed bred	Male	8Y	Unknown	Ataxia, tremors	Recovery	2006–2011	USA	[21]
Mastiff	Male	13W	Unknown	Vomiting, tremors, hyperesthesia	Euthanasia	2006–2011	USA	[21]
Mix Breed	NA	1Y	*Lysurus cruciatus*	Gastrointestinal syndrome	Unknown	2014	Brazil	[22]
Labrador Retriever	Female	11W	*Amanita spp.*	Lethargy, vomiting and diarrhoea	Recovery	2018	USA	
German Shepherd	Male	2Y	*Amanita spp.*	Acute vomiting	Recovery	2018	USA	[23]
Terrier mix	Male	2W	*Amanita spp.*	Vomiting and lethargy	Recovery	2018	USA	[23]
Golden Retriever	Male	12W	*Amanita phalloides*	Vomiting, lethargy, anorexia	Recovery	2018	USA	[23]
Staffordshire	Male	1Y	Unknown	Paretic, ataxic, ptyalism, vomiting, diarrhoea, abdominal pain	Recovery	2010–2011	UK	[24]
Pug	Female	6Y	Unknown	Stuporous, ptyalism, acute vomiting, acute hemorrhagic, diarrhoea	Recovery	2010–2011	UK	[24]
German wirehaired	Female	7M	Unknown	Ptyalism, acute diarrhoea	Recovery	2010–2011	UK	[24]
Mix Breed	Male	1Y	Unknown	Stuporous, bilateral symmetrical miosis, ptyalism, acute vomiting, acute diarrhoea, abdominal pain	Euthanasia	2010–2011	UK	[24]
German Shepard	Male	2Y	Unknown	Bilateral symmetrical miosis, paretic, ataxic, ptyalism, acute vomiting, diarrhoea	Recovery	2010–2011	UK	[24]
Cocker Spaniel	Unknown	9Y	*Clitocybe rivulosa*	Salivation, vomiting, diarrhoea	Died	2014	UK	[25]
Maltese	Male	10Y	*Inocybe fastigiata*	vomiting, diarrhea, bradycardia and respiratory difficulty,	Recovery	2009	USA	[26]
Golden retriever	NA	NA	*Amanita muscaria*	Listlessness, ataxia, and petit mal seizures	Died	1989	USA	[3]
Labrador Retriever	Female	12W	Unknown	Comatose	Died	1989	USA	[3]
German Shepherd	Female	51W	*Amanita pantherina*	Lethargic, slow to tactile and auditory stimuli, quadriparesis, depressed, left lateral strabismus, miotic pupils, congested mucous membrane	Unknown	1998	South Africa	[27]
Cocker Spaniel	NA	9W	*Amanita phulloides*	Unknown	Death	1993	UK	[28]
Dachshund	Female	9W	*Amanita spp.*	Lethargy	Death	2007	USA	[8]
Labrador Retriever	Male	5Y	*Amanita muscaria*	Vomiting, diarrhoea, tremors, seizures, and somnolence	Death	2019	USA	[9]
English Setter	Male	1Y	*Amanita muscaria var. formosa*	Cluster seizures, diarrhoea	Recovery	2006	USA	[29]
Mixed Breed	Male	4Y	*Amanita muscaria var. formosa*	Somnolence, ptyalism, vomiting, and diarrhoea	Recovery	2006	USA	[29]
Mixed breed	Female	8M	*Inocybe rimosa*	Vomiting, profuse ptyalism, diarrhoea	Recovery	2003	Norway	[30]
Poodle	Female	16M	*Inocybe sp.*	vomiting, tremors, pale mucous membranes, and	recovery	2003	Norway	[30]

				depression				
Bernese Mountain Dog	Male	6Y	*Inocybe sp., Armillaria sp.*	Unknown	Recovery	2003	Norway	[30]
Golden Retriever	Male	13W	*Inocybe sp*	Unknown	Recovery	2003	Norway	[30]
German Shepherd Dog	Male	4M	*Inocybe sp*	Unknown	Recovery	2003	Norway	[30]
4 Mixed Breed	NA	NA	*Amanita ocreata*	Platelets high and abnormal white cells	Unknown	2006	USA	[31]
Mixed Breed	NA	NA	*Amanuta spp.*	Nausea, dehydration, vomit, BUN and Creatin elevated, acute renal failure	Death	2006	USA	[31]
Golden Retriever	NA	NA	*Amanita muscaria*	Unknown	Recovery	2006	USA	[31]
Mixed Breed	NA	NA	*Amanita Pantherina*	Dyspnea, chock	Recovery	2006	USA	[31]
Mixed Breed	NA	8Y	*Clorophyllum molybdiles*	Vomite, ALT elevated	Recovery	2006	USA	[31]
Mixed Breed	Male	6Y	*Clorophyllum malybdites*	Weakness, diarrhea, cramps	Recovery	2006	USA	[31]
Mixed Breed	Female	8W	*Inocyte spp*	Salivation, vomit, weakness, collapse, bradycardia	Recovery	2006	USA	[31]
Mixed Breed	NA	15M	*Inocyte spp*	Vomit, diarrehea, hypersalivation, tremors, lethargy	Recovery	2006	USA	[31]
Mixed Breed	Female	12W	*Inocyte geophyçia V. lilacina*	Hypersalivation, disorientation, vomit, weakness, lacrimation, tremors	Recovery	2006	USA	[31]
Mixed Breed	NA	NA	*Unknown*	Nausea	Recovery	2006	USA	[31]
Mixed Breed	NA	NA	*Unknown*	Unknown	Death	2006	USA	[31]
Mixed Breed	NA	5M	*Amanita muscaria*	Nausea, vomit, ataxia, depression, collapse, spasms	Recovery	2007	USA	[31]
Mixed Breed	NA	20M	*Amanita muscaria*	Salivation, vomiting, nausea, lethargy	Recovery	2007	USA	[31]
Mixed Breed	NA	NA	*Amanita muscaria/pantherina*	Collapse, ataxia, tremors	Recovery	2007	USA	[31]
Mixed Breed	NA	17M	*Coprinus atramentarius*	Tremors	Recovery	2007	USA	[31]
Mixed Breed	NA	<1Y	*Inocybe spp*	Salivation, vomiting, diarrhoea	Recovery	2007	USA	[31]
Mixed Breed	NA	9M	*Paxililius involutus*	Vomit, ALT elevated	Recovery	2007	USA	[31]
Mixed Breed	NA	6M	*Scleroderma cepa group*	Vomit, spacey staggering	Recovery	2007	USA	[31]
5 Greyhound	NA	13Y	*Tulostoma spp*	ALT elevated	Recovery	2007	USA	[31]
2 Mixed Bredd	NA	NA	*Unknown*	ALT elevated	Died	2007	USA	[31]
Mixed Breed	NA	<1Y	*Unkonwn*	Unknown	Died	2007	USA	[31]
Mixed Breed	NA	13Y	*Agarius spp*	Vomit, tremors	Recovery	2008	USA	[31]
Mixed Breed	Female	1/4Y	*Amanita bisporigera*	Vomit, lethargy, liver failure	Recovery	2008	USA	[31]
3 Mixed Breed	NA	1-3Y	*Amanita bisporigera*	Unknown	Died	2008	USA	[31]
Mixed Breed	NA	1.5Y	*Amanita spp*	Vomit, Bloody diarrhea, shock, tremors, seizures	Died	2008	USA	[31]
Mixed Breed	Male	6M	*Amanita muscaria v. guessowii*	Diarrhea, vomit, hypersalivation	Recovery	2008	USA	[31]
2 Mixed Breed	Male, Female	<1Y	*Amanita pantherina*	Incoordination, depressed, seizures, hypothermic, depression,	Euthanized	2008	USA	[31]
Mixed Breed	NA	NA	*Amanita pantherina*	Seizures	Died	2008	USA	[31]

Mixed Breed	NA	2Y	*Citocybe spp*	Vomit, hypersalivation, diarrhea, collapse	Recovery	2008	USA	[31]
Mixed Breed	Female	2Y	*Galerina spp*	Diarrhea, vomit, liver necrosis	Died	2008	USA	[31]
Mixed Breed	NA	NA	*Leratiomyces ceres*	Unknown	Died	2008	USA	[31]
Mixed Breed	Female	3Y	*Scleroderma spp*	Vomit, Diarrhea, spasms, weakness, hypersalivation, tremors	Died	2008	USA	[31]
Mixed Breed	Female	1Y	*Unknown*	Vomit, diarrhea, incontinent, weakness, hypersalivation, foaming mouth	Unknown	2008	USA	[31]
Mixed Breed	NA	<1Y	*Ganoderma spp.*	Liver failure	Died	2008	USA	[31]
Mixed Breed	Female	10Y	*Unknown*	Hypersalivation, vomiting, disorientation, diarrhea	Died	2008	USA	[31]
Mixed Breed	NA	6Y	*Unknown*	Fever, bloody diarrhea, vomiting, tremors, ataxia	Euthanasia	2008	USA	[31]
Mixed Breed	NA	1Y	*Unknown*	Fever, bloody diarrhea, vomiting, tremors, ataxia	Euthanasia	2008	USA	[31]
Mixed Breed	Female	6Y	*Unknown*	Vomit, weakness, diarrhea, tremors	Died	2008	USA	[31]
Mixed Breed	Female	13W	*Amaniya muscarita*	Vomit, urinary incontinent, staggering, lethargic	Recovery	2009	USA	[31]
Mixed Breed	NA	NA	*Amanita muscarita*	Vomit, hypersalivation	Recovery	2009	USA	[31]
Mixed Breed	NA	10M	*Amanita muscarita*	Tremors, weakness, comatose	Unknown	2009	USA	[31]
Mixed Breed	NA	2Y	*Amanita muscarita*	Vomit, hypersalivation, lethargy	Died	2009	USA	[31]
Mixed Breed	NA	15W	*Amanita pantherina*	Convulsion, hypersalivation, hypothermia	Unknown	2009	USA	[31]
Mixed Breed	Female	<1Y	*Calvatia cythiformes*	Lethargic	Recovery	2009	USA	[31]
Mixed Breed	NA	NA	*Chloropyllum molybdites*	Diarrhea, hypersalivation,	Recovery	2009	USA	[31]
Mixed Breed	NA	NA	*Inocybe spp*	Unknown	Died	2009	USA	[31]
Mixed Breed	NA	NA	*Leucoagariuscus naucinus*	Lethargic	Died	2009	USA	[31]
2 Mixed Breed	Female	12W	*Tricholoma terreum*	Hypersalivation, vomit, weakness, diarrhea	Recovery	2009	USA	[31]
Mixed Breed	Female	8W	*Amanatia spp.*	Vomit, Diarrhea	Recovery	2009	USA	[31]
Mixed Breed	NA	NA	*Amanatia spp*	Vomit, lethargic, liver failure	Died	2009	USA	[31]
Mixed Breed	NA	NA	*Agaricus xanthodermus*	Vomit	Recovery	2010	USA	[31]
Mixed Breed	NA	5Y	*Amanita muscaria*	Fever, disorientation, seizures, weakness	Recovery	2010	USA	[31]
Mixed Breed	NA	NA	*Amanita pantherina*	Unknown	Unknown	2010	USA	[31]
Mixed Breed	NA	10W	*Amanita phalloides*	Tremors, weakness, vomit, lethargy	Recovery	2010	USA	[31]
Mixed Breed	NA	6M	*Amanita phalloides*	Diarrhea, vomit, AST elevated	Died	2010	USA	[31]
Mixed Breed	NA	3M	*Amanita phalloides*	Fever, vomiting, diarrhea, weakness	Died	2010	USA	[31]
Mixed Breed	NA	NA	*Amanita subcokeri*	Melena, kidney failure	Recovery	2010	USA	[31]
Mixed Breed	NA	<1Y	*Inocybe spp.*	Vomit, diarrhea	Recovery	2010	USA	[31]
Mixed Breed	NA	3M	*Panaleus foenicecii*	Vomit	Recovery	2010	USA	[31]
Mixed Breed	NA	8M	*Lepiota subincarnata*	Unknown	Died	2010	USA	[31]
Mixed Breed	NA	NA	*Pholiota destruens*	Blood clotting problems	Unknown	2010	USA	[31]
Mixed Breed	NA	4M	*Scleroderma cf cepa*	Vomit	Recovery	2010	USA	[31]
Mixed Breed	NA	NA	*Unknown*	Vomit	Died	2010	USA	[31]
Mixed Breed	Female	9M	*Amanita bisporigea*	Vomit, lethargy, ALT elevated, blood cloths	Died	2011	USA	[31]
Mixed Breed	NA	NA	*Amanita muscaria*	Vomit, diarrhea, hypersalivation, seizures,	Unknown	2011	USA	[31]

				dyspnea				
Mixed Breed	NA	NA	*Amanita muscaria*	Vomit, pancreatic failure, seizures	Unknown	2011	USA	[31]
Mixed Breed	Female	4Y	*Amanita ocreata*	Diarrhea, vomit, spam, seizure, blood not clotting	Died	2011	USA	[31]
Mixed Breed	Female	10Y	*Amanita ocreata*	Vomit, seizures, liver failure, disorientation	Died	2011	USA	[31]
Mixed Breed	Female	8M	*Amanita phalloides*	Vomit, diarrhea, lethargy	Died	2011	USA	[31]
Mixed Breed	Male	14w	*Amanita phalloides*	Vomit, fever, diarrhea, epistaxis	Died	2011	USA	[31]
Mixed Breed	NA	<1Y	*Amanita phalloides*	Unknown	Died	2011	USA	[31]
Chihuahua	NA	8M	*Amanita pantherina*	Hypothermic, bradycardic, apnea, comatose	Died	2011	USA	[31]
Mixed Breed	NA	5M	*Amanita spp.*	Fever, renal failures	Died	2011	USA	[31]
Mixed Breed	Female	2Y	*Chorophyllum molybdites*	Loss of appetite, diarrhea	Recovery	2011	USA	[31]
Mixed Breed	NA	NA	*Cnocybe spp*	Liver damage	Unknown	2011	USA	[31]
Mixed Breed	NA	NA	*Nolanea spp*	Hepatorenal dysfunction	Unknown	2011	USA	[31]
Chihuahua	NA	2Y	*Inocybe mixitilis*	Unknown	Died	2011	USA	[31]
Mixed Breed	NA	NA	*Inpcybe spp*	Vomit	Recovery	2011	USA	[31]
Mixed Breed	NA	<1Y	*Inocybe spp*	Vomit, diarrhea	Recovery	2011	USA	[31]
Mixed Breed	Male	4M	*Inocybe spp*	Vomit, diarrhea	Unknown	2011	USA	[31]
Mixed Breed	NA	NA	*Lepista nuda*	Liver failure	Died	2011	USA	[31]
Mixed Breed	NA	NA	*Leucoagaricus rubrotinctus*	Vomit	Recovery	2011	USA	[31]
Mixed Breed	Male	4Y	*Amanita spp, Inocybe spp*	Vomit blood, hypersalivation	Died	2011	USA	[31]
Mixed Breed	NA	NA	*Amanita spp*	Liver failure	Died	2011	USA	[31]
Mixed Breed	NA	4Y	*Amanita pantherina*	Fever, diarrhea, hypersalivation, weakness, spams	Recovery	2012	USA	[31]
Mixed Breed	NA	13Y	*Amanita muscaria*	Diarrhea, hypersalivation, spasm, disorientation	Died	2012	USA	[31]
Mixed Breed	NA	3M	*Amanita bisporigera*	Vomit, lethargy, clotting abnormalities, liver failure	Died	2012	USA	[31]
Mixed Breed	NA	6M	*Amanita phalloides*	Fever, diarrhea, spasms, hypersalivation, facial swelling, vomiting blood, weakness	Died	2012	USA	[31]
Mixed Breed	NA	4Y	*Amanita phalloides*	Weaknesses, seizures, hypersalivation	Recovery	2012	USA	[31]
Mixed Breed	NA	NA	*Amanita phalloides*	Unknown	Died	2012	USA	[31]
Mixed Breed	NA	10Y	*Amanita phalloides*	Weakness, fever, hypersalivation	Died	2012	USA	[31]
Mixed Breed	NA	4Y	*Amanita phalloides*	Fever, diarrhea, weakness, spasms, vomit, blood cloths, hypoglycemia	Died	2012	USA	[31]
Mixed Breed	NA	2Y	*Amanita phalloides*	Vomit, diarrhea, elevated AST	Recovery	2012	USA	[31]
Mixed Breed	NA	8Y	*Galerina marginata*	Acute liver failure	Died	2012	USA	[31]
Mixed Breed	NA	NA	*Inocyte lilacina*	Vomit, hypersalivation	Recovery	2012	USA	[31]
Pugs	NA	10Y	*Inocyte mixtilis*	Liver failure	Died	2012	USA	[31]
Mixed Breed	NA	NA	*Lycoperdon perlatum*	Lethargic	Recovery	2012	USA	[31]
Mixed Breed	NA	NA	*Scleroderma cf cepa*	Vomit	Recovery	2012	USA	[31]
Mixed Breed	NA	2Y	*Scleroderma cf citrina*	Weakness	Recovery	2012	USA	[31]
Mixed Breed	NA	<1Y	*Scleroderma spp.*	Vomit	Recovery	2012	USA	[31]

Mixed Breed	NA	NA	*Scleroderma spp*	Vomit	Recovery	2012	USA	[31]
Mixed Breed	NA	1Y	*Unknown*	Spasms, hypersalivation, vomit, weakness, seizure	Recovery	2012	USA	[31]
Mixed Breed	NA	3M	*Unknown*	Vomit, diarrhea, pulmonary edema	Died	2012	USA	[31]
Mixed Breed	NA	NA	*Agaricus cf. placomyces.*	Unknown	Unknown	2014	USA	[31]
Mixed Breed	NA	NA	*Agrocybe spp*	Unknown	Recovery	2014	USA	[31]
Mixed Breed	NA	NA	*Amanita cf. Cokeri.*	Diarrhea, vomiting, and drowsiness	Died	2014	USA	[31]
Mixed Breed	NA	NA	*Amanita farinosa*	Diarrhea, salivation, vomiting, and nausea.	Recovery	2014	USA	[31]
Mixed Breed	NA	NA	*Amanita multisquamosa*	Hypersalivation, ataxic respiration, unequal pupil size, and disorientation	Recovery	2014	USA	[31]
Mixed Breed	NA	NA	*Amanita muscaria*	Vomit	Recovery	2014	USA	[31]
2 Mixed breed	NA	NA	*Amanita muscaria*	Hypersalivation, disorientation	Recovery	2014	USA	[31]
Mixed Breed	NA	NA	*Amanita muscaria*	Seizure, ataxia, neurological symptoms	Unknown	2014	USA	[31]
2 Mixed Breed	NA	NA	*Amanita phalloides*	Unknown	Died	2014	USA	[31]
4 Newfoundlands	NA	6Y	*Amanita phalloides*	Hypersalivation, vomiting, nausea, fever, liver failure	Died	2014	USA	[31]
Mixed Breed	NA	9W	*Amanita phalloides*	Diarrhea, vomiting, nausea, weakness, AST elevated, hypoglycemia	Died	2014	USA	[31]
Mixed Breed	NA	<1Y	*Amanita phalloides*	Tremors, vomiting, comatose	Died	2014	USA	[31]
Mixed Breed	NA	9Y	*Amanita phalloides*	Vomit, lethargic, AST elevated	Died	2014	USA	[31]
Mixed Breed	NA	NA	*Chlorophyllum molybdites*	Vomiting, diarrhea	Recovery	2014	USA	[31]
Mixed Breed	NA	<1Y	*Chlorophyllum olivieri*	Vomit	Recovery	2014	USA	[31]
Maltese	NA	NA	*Clitocybe sp.*	Vomiting, bradycardia, and bloody diarrhea.	Recovery	2014	USA	[31]
Mixed Breed	NA	<1Y	*Gymnopilus sp.*	Unknown	Unknown	2014	USA	[31]
Mixed Breed	NA	NA	*Gyromitra esculenta.*	Vomit, diarrhea, dehydrated, fever, painful abdomen, blood in eye, dark mucous membranes, and ataxia	Died	2014	USA	[31]
Cocker Spaniel	NA	NA	*Inocybe sp*	Unknown	Died	2014	USA	[31]
2 Mixed Breed	NA	11y	*Lepiota subincarnata*	Fever, hypersalivation, weakness, intestinal cramps, disorientation, vomit, drowsiness, nausea, blood clotting disorder, and liver failure	Died	2014	USA	[31]
Mixed Breed	NA	NA	*Paxillus involutus*	Vomit and diarrhea	Recovery	2014	USA	[31]
Mixed Breed	NA	NA	*Russula cf. pectinata.*	Fever, vomit, diarrhea	Recovery	2014	USA	[31]
2 Yorkshire terrier	NA	NA	*Scleroderma sp.*	Diarrhea, vomiting, fever, seizures	Died	2014	USA	[31]
Mixed Breed	NA	NA	*Scleroderma sp.*	Diarrhea, vomit	Recovery	2014	USA	[31]
Mixed Breed	NA	NA	*Scleroderma sp.*	Vomit	Recovery	2014	USA	[31]
Mixed Breed	NA	7Y	*Xerula sp*	Diarrhea, vomiting, lethargy	Died	2014	USA	[31]
Mixed Breed	NA	NA	*Agaricus sp*	Unknown	Recovery	2013	USA	[31]
Mixed Breed	NA	NA	*Amanita cf ocreata*	Diarrhea, elevated liver enzymes	Recovery	2013	USA	[31]
Mixed Breed	Male	7Y	*Amanita sec phalloideae*	Vomit, weakness, lethargy	Euthanized	2013	USA	[31]

Mixed Breed	Female	11Y	*Amanita sec phalloideae*	Vomit	Died	2013	USA	[31]
Mixed Breed	NA	NA	*Amanita sec. phalloideae*	Elevated liver enzymes	Unknown	2013	USA	[31]
Mixed Breed	Male	10Y	*Amanita phalloides*	Vomit, liver failure	Died	2013	USA	[31]
Mixed Breed	NA	NA	*Amanita aprica*	Unknown	Unknown	2013	USA	[31]
Mixed Breed	NA	7Y	*Amanita aprica*	Vomit, hypersalivation, tremors, fever, tachycardia	Recovery	2013	USA	[31]
Mixed Breed	NA	7M	*Amanita cf muscaria*	Disoriented, lost balance	Recovery	2013	USA	[31]
Mixed Breed	Female	2Y	*Amanita muscaria*	Vomit, hypersalivation, disorientation,	Recovery	2013	USA	[31]
Mixed Breed	NA	NA	*Amanita muscaria*	Hypersalivation, vomiting, lethargy	Recovery	2013	USA	[31]
Mixed Breed	NA	NA	*Amanita muscaria*	Vomit, diarrhea, coma	Recovery	2013	USA	[31]
Pug	NA	<1Y	*Amanita muscaria*	Vomit	Recovery	2013	USA	[31]
Mixed Breed	NA	NA	*Amanita muscaria var. alba*	Nausea, hypersalivation	Recovery	2013	USA	[31]
Mixed Breed	NA	NA	*Amanita muscaria or pantherina*	Seizures	Recovery	2013	USA	[31]
2 Mixed Breed	NA	14Y	*Amanita pantherina*	Diarrhea, hypersalivation, vomiting, spasms	Died	2013	USA	[31]
Mixed Breed	NA	7Y	*Amanita pantherina*	Diarrhea, vomit	Recovery	2013	USA	[31]
Mixed Breed	Male	5M	*Amanita pantherina*	Hypersalivation, diarrhea, vomiting, nausea, spasms, lethargy	Died	2013	USA	[31]
Mixed Breed	Male	3M	*Bolbitius vitellinus*	Unknown	Unknown	2013	USA	[31]
Mixed Breed	Female	1Y	*Boletinellus meruliodes*	Lethargy, loss of appetite, vomit	Recovery	2013	USA	[31]
Mixed Breed	NA	NA	*Clitocybe irina*	Unknown	Unknown	2013	USA	[31]
Mixed Breed	NA	NA	*Clitocybe sp*	Hypersalivation, spasms, weakness, ataxia, lethargy	Recovery	2013	USA	[31]
Mixed Breed	NA	NA	*Galerina marginata*	Vomit, hypersalivation, melena	Died	2013	USA	[31]
Mixed Breed	NA	NA	*Hygrocybe conica*	Vomit, hypersalivation, disoriented	Recovery	2013	USA	[31]
Mixed Breed	Male	5M	*Inocybe sp*	Unknown	Recovery	2013	USA	[31]
Mixed Breed	NA	NA	*Inocybe sp*	Unknown	Recovery	2013	USA	[31]
Mixed Breed	Male	14Y	*Inocybe fastigiata*	Diarrhea, hypersalivation, vomit, weakness	Recovery	2013	USA	[31]
Mixed Breed	NA	NA	*Inocybe sp*	Vomit	Recovery	2013	USA	[31]
Mixed Breed	NA	NA	*Lactarius sp and Russula sp*	Vomit	Recovery	2013	USA	[31]
Mixed Breed	NA	NA	*Lactarius cf deliciosus*	Vomit, lethargic, elevated liver enzymes, fever	Recovery	2013	USA	[31]
Mixed Breed	NA	NA	*Lepiota cf subincarnata*	Liver failure	Died	2013	USA	[31]
Mixed Breed	NA	NA	*Morchella elata clade*	Unknown	Died	2013	USA	[31]
Mixed Breed	Female	2M	*Russula cf nigricans*	Vomit, tremors, spasms, diarrhea, weakness	Recovery	2013	USA	[31]
Mixed Breed	NA	9Y	*Scleroderma cf cepa*	Vomit	Recovery	2013	USA	[31]
Mixed Breed	Female	8Y	*Suillus albivelatus*	Vomit, diarrhea, hypersalivation, disorientation	Recovery	2013	USA	[31]
Mixed Breed	NA	2M	*Suillus luteus*	Vomit, hypersalivation	Recovery	2013	USA	[31]
Mixed Breed	NA	2M	*Tapinella atrotomentosus*	Vomit	Recovery	2013	USA	[31]

Table 3. Distribution of the mushroom poisoning in cats by breed, sex, age (Y – years, M– months, W – weeks), species mushroom, clinical signs, outcome, year, county (NA – Not available).

Breed	Sex	Age	Species mushroom	Clinical signs	Outcome	Year	Country	Ref
Mix Breed	NA	11M	*Armillaria gallica*	Vomiting	Recovery	2012–2013	UK	[1]
British domestic short hair cat	NA	11.6Y	*Armillaria species*	Severe oral ulceration, polydipsia, renal failure	Recovery, renal problems	2012–2013	UK	[1]
Mixed Breed	NA	1Y	*Pluteus cinereofuscus*	Asymptomatic	Recovery	2012–2013	UK	[1]
Chinchilla	Male	NA	False morel	Anorexia, stagnation, incoordination, watery diarrhea and severe vomiting	Recovery	2020	Turkey	[32]
Domestic shorthair	Female	1Y	*Amanita spp.*	Vomiting, lethargy, and anorexia	Euthanasia	2012	USA	[4]
Bengal	Male	7M	*Amanita spp.*	Lateral recumbency with ptyalism and a history of acute-onset lethargy and vomiting	Died	2012	USA	[4]
Domestic shorthair cat	Male	3Y	*Inocybe and Clitocybe*	Dyspnea, cyanosis, open mouth breathing and drooling.	Recovery	2012	UK	[33]
Mixed Breed	NA	NA	*Unknown*	Blind	Recovery	2008	USA	[31]
Mixed breed	NA	NA	*Coprinopsis atramentaria var. crassivelata*	Vomit	Recovery	2014	USA	[31]
2 Mixed breed	NA	NA	*Amanita cf. muscaria*	Vomit, weakness, disorientation	Recovery	2014	USA	[31]
Mixed Breed	NA	1.5Y	*Amanita ocreata*	Diarrhea, salivation, disorientation, vomiting, nausea, weakness	Died	2014	USA	[31]
Mixed Breed	Female	17Y	*Amanita muscaria*	Unknown	Died	2013	USA	[31]

Table 4. Distribution of the mushroom poisoning in other animals by breed, sex, age (Y – years, M- months, W – weeks), species mushroom, clinical signs, outcome, year, county (NA – Not available).

Animal	Age	Species mushroom	Clinical signs	Outcome	Year	Country	Ref
Miniature Chinese pot-bellied pig	NA	*Scleroderma citrinum*	Unknown	Unknown	1990	USA	[34]
60 Sheep, Dala breed	Adults and juveniles	*Cortinarius speciosissimus*	Depressed and gradually became apathetic.	Died	1979	Norway	[35]
Horse	18Y	*Amanita verna*	Unknown	Died	2000	USA	[36]
2 Beef calves	2-3 M	*Amanita spp*	Unknown	Died	2012	USA	[37]
Horse	NA	*Amanita phalloides*	Acute liver failure	Died	2009	USA	[31]
Horse	<1Y	*Chlorophyllum molybdites*	Colic	Died	2009	USA	[31]
Horse	NA	*Amanita muscaria*	Hallucination	Recovery	2009	USA	[31]
2 Horses	NA	*Ascomycete, Gymnopus spp, Agaricus*	Unknown	Died	2009	USA	[31]
Goat	NA	*Puffballs*	Brain swelling, incoordination, blindness	Died	2010	USA	[31]
3 Rabbits	NA	*Paneolus foenisecii*	Lethargic, ataxic	Recovery	2011	USA	[31]
Horse	9Y	*Chlorophyllum*	Salivation, hallucinations, bloated, stiff joints, weakness. disorientation	Recovery	2012	USA	[31]
Horse	NA	*Panaeolus spp*	Hallucination	Recovery	2014	USA	[31]

4.2. Data on Wild Animals

There hasn´t been a case reported of mushroom poisoning in wild animals to date according to the authors' knowledge. Very little information regarding this theme is available. Many wild animals have evolved in an ability to recognize harmful plants and fungi and they make part of their diet. For example, Cervidae prefer plants such as they offer essential nutrients and minerals that contribute to their overall health. They are particularly important in Winter when the food is scarce. Usually, cervids avoid toxic mushrooms and prefer species such as morels, boletes, waxycaps, brittlegills or ringstalk mushrooms [38,39]. Box Turtles are known to eat poisonous mushrooms and seem to be immune to most toxins [40]. When they eat the poisonous mushroom the toxins are sequestered in their skin, “chelotoxicity”, and the flesh becomes toxic to predators [41]. Also was observed that the Japanese squirrel (*Sciurus lis*) routinely feeds on *Amanita* species that are also poisonous. The mushrooms may facilitate the mutualisms with toxin-resistant squirrels, to disperse viable spores [42]

5. Discussion and Conclusion

Mushroom poisoning in animals represents a significant health concern, particularly in environments where domestic or wild animals may have access to fungal species containing potent toxins. The inadvertent ingestion of toxic mushrooms can lead to a wide range of clinical symptoms, from mild gastrointestinal distress to severe, life-threatening systemic effects [18,30]. The severity of poisoning is influenced by factors such as the species of mushroom ingested, the amount consumed, and the specific physiological responses of the affected animal. Early recognition of symptoms and identification of the ingested mushroom are critical for successful intervention [2,12].

Given the long timeframe of data collection (1979–2020), 309 cases may not be sufficiently large to draw definitive conclusions about the epidemiology of mushroom poisoning in animals. The inclusion of additional cases, especially from underrepresented species, would enhance the study’s robustness. Unfortunately, many of those cases are not well reported or the data is not available to the public. The majority of reported cases originate from North America. This geographical concentration limits the generalizability of the findings to other regions where mushroom species, environmental conditions, and veterinary practices may differ. In many parts of the world, mushroom poisoning cases in animals may be underreported due to a lack of awareness, diagnostic capabilities, or veterinary documentation. The number of cases of animal poisoning associated with toxic mushrooms is probably even higher than the cases that were reported. Differences in reporting standards, diagnostic criteria, and case documentation methods across these studies may introduce inconsistencies. Some cases may lack precise identification of the mushroom species involved, while others may not fully describe clinical symptoms or treatment outcomes. Additionally, the absence of standardized reporting protocols across studies limits the comparability of cases. Also, the ingestion of mushrooms by pets is infrequently observed by owners and may be omitted from the initial history leading to errors in the diagnosis and treatment [3].

This review showed that dogs seem to be the most affected. As dogs are opportunistic scavengers, it is not uncommon for them to ingest mushrooms, many times due to curiosity. Also, they are more prone to contact with this species during walking with their owners [21,43]. The clinical signs are very similar to what was been observed in humans [12]. Regarding the species of mushrooms, it seems that animals, particularly dogs, are more prone to fungi with bright colors [33].

A toxicity prediction model could be introduced based on the collected data, helping veterinarians estimate the likelihood of survival and severity of poisoning based on key parameters such as animal species, age, and weight (since toxicity thresholds vary); fungal species ingested; time from ingestion to symptom onset and observed clinical signs (neurologic vs. gastrointestinal vs. hepatic failure). By using machine learning or statistical modelling techniques, a risk stratification tool could be created to assist veterinarians in decision-making, guiding treatment intensity and prognosis estimation [44]. In the future should be an international database for veterinary toxicology cases, specifically focusing on mushroom poisoning. A centralized reporting system would reduce geographical bias by incorporating more diverse case data, improve early detection of emerging toxic mushroom species affecting animals and facilitate cross-regional comparisons to identify high-risk areas [45].

Current treatment for mushroom poisoning in animals is largely supportive. Future research could explore the potential antidotes or hepatoprotective agents (e.g., silibinin, N-acetylcysteine) and their efficacy in different poisoning scenarios [46]. Application of new therapeutic techniques, such as extracorporeal detoxification methods such as hemodialysis or hemoperfusion for severe cases [47]. Use of probiotic or microbiome-based therapies that could aid in toxin degradation or mitigation [48].

Currently, there is no standardized diagnostic protocol for mushroom poisoning in animals. Given the variability in clinical signs and the difficulty in identifying ingested fungi, the study could propose a structured diagnostic guideline for veterinarians. This could include decision trees or flowcharts based on symptom presentation and time of onset; recommended laboratory tests such as liver enzymes, renal function markers, toxin detection in biological samples; imaging techniques such as ultrasound for hepatotoxic cases or suggested differential diagnoses to rule out other toxic exposures.

Veterinarians and pet owners should be aware of environments where toxic mushrooms are more likely to grow and pose a risk to animals. High-risk areas include forests and woodlands (Amanita spp., Cortinarius spp.), lawn and garden areas (Inocybe spp., Clitocybe spp.), parks and urban green spaces, compost and mulched Areas (Gyromitra spp.). Providing pet owners with a seasonal risk map or visual guide of toxic mushroom species found in different regions would be highly beneficial [2]. The pet owners should regularly inspect yards and outdoor spaces for mushroom growth, especially after rain, train pets to avoid eating wild mushrooms through behavioral reinforcement techniques, keep dogs leashed in high-risk areas such as wooded trails during peak mushroom seasons and dispose of mushrooms safely if found in accessible areas, preventing accidental ingestion [49].

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