

## A survey of diseases in captive bearded dragons: a retrospective study of 529 patients

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**ABSTRACT:** The aim of this clinical retrospective study was to analyse the prevalence of common disorders in 529 captive bearded dragons that were presented to three exotic animal clinics in Central Europe (Austria and Czech Republic) over a period of three years. A diagnosis was made on the basis of the presenting clinical signs and physical examination in 30.8% of the cases, whereas various additional diagnostic tests were performed in the other cases (69.2%). These included diagnostic imaging (radiography, ultrasound and computed tomography), examination of faecal samples for the presence of parasites, a blood-profile analysis, histological, as well as bacteriological and mycological examinations and necropsy. Gastrointestinal diseases (42.67%) like endoparasitism, constipation, sand ingestion, tympany and meteorism were the most common disorders. In 51.92% of the cases of constipation, endoparasites were present, whereas in 38.46% of the cases of constipation, metabolic bone diseases and imbalances in calcium and phosphorus levels were detected. Most of the analysed faecal samples (83.27%) were positive for the presence of endoparasites (48.7% pinworms, 25.39% coccidians and 16.06% flagellates). Dermatological problems (22.4%) contained skin tumours, which were observed in adult lizards (age range from three to eight years) and included spindle cell tumour on the eyelid, as well as spindle cell sarcoma, squamous cell carcinoma and melanoma on the trunk. Osteodystrophy, limb fractures and various types of necrosis on the limbs and tail were frequently observed musculoskeletal disorders (18.93%). Over half of all animals (57.14%) that underwent a blood test, showed a deviation in the calcium-phosphorus ratio, 63.98% showed hypocalcaemia and 26.71% hyperphosphataemia. Diseases of the urogenital system (9.47%) included renal diseases and dystocia. Neoplastic diseases besides skin tumours included two cases of leukaemia in 4-year-old bearded dragons, one of these with lymphoma in kidneys, lungs and liver and one ganglioneuroma in the body cavity of a bearded dragon of unknown age. Orthopaedic surgeries were most frequently performed to amputate the limbs or tail, whereas soft-tissue surgeries most often included the treatment of skin wounds and correction of cloacal prolapse, in addition to ovariectomy, salpingotomy or salpingectomy in female bearded dragons. Similar to the situation in Australia and the USA, infectious as well as non-infectious diseases are common in captive bearded dragons in Central Europe. Due to the high occurrence of endoparasitism, skin diseases and metabolic bone diseases in this present study, regular veterinary controls in bearded dragons including parasitological faecal examinations and optimisation of feeding and housing are necessary to improve the standard of health of bearded dragons kept as pet lizards in Europe.

**Keywords:** agamid lizards; captive reptiles; infectious diseases; metabolic diseases

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Bearded dragons (*Pogona vitticeps* and *Pogona henrylawsoni*) are diurnal, heliothermic and omnivorous agamid lizards native to Australia (Brown 2012) that are well suited to captive conditions. Although bearded dragons are commonly kept as pet reptiles in Europe, the USA (Wright 2008) and Australia (Cannon 2003), analyses of their diseases, except in the overviews published by Stahl (2003) and Raiti (2011), are rare.

A short report dealing with infectious and non-infectious diseases of Australian lizards, including bearded dragons, was published by Carmel and Johnson (2014). These authors classified adenovirus infection and yellow fungus disease (*Chrysosporium* anamorph of *Nannizziopsis vriesii*, CANV) as important infectious diseases of bearded dragons. Most fungal isolates from reptiles were considered to belong to the CANV because of morphological similarities, but they are now seen as a species complex (Sigler et al. 2013). Stchigel et al. (2013) proposed a new family called *Nannizziopsiaceae*. *Devriesea agamarum* (Hellebuyck et al. 2009a; Hellebuyck et al. 2009b; Devloo et al. 2011; Schmidt-Ukaj et al. 2014), a recently discovered bacterial pathogen and *Nannizziopsis* spp. (Bowman et al. 2007; Abarca et al. 2009; Hedley et al. 2010; Van Waeyenberghe et al. 2010; Johnson et al. 2011; Sigler et al. 2013; Stchigel et al. 2013; Cabanes et al. 2014; Schmidt-Ukaj et al. 2014; Schmidt-Ukaj et al. 2016) cause deep skin lesions in bearded dragons. A retrospective study of 99 lizards showed that the most common dermatological disorders in lizards were dysecdysis, mites and stomatitis (White et al. 2011). Reports about adenovirus infections are also common in these agamid lizards (Julian and Durham 1982; Jacobson et al. 1996; Kim et al. 2002; Moormann et al. 2009; Kubiak 2013; Ball et al. 2014; Doneley et al. 2014). The clinical importance of parasitic diseases in captive reptiles, including bearded dragons, was highlighted by Ras-Norynska and Sokol (2015). These authors included 49 bearded dragons in their study, which revealed an internal parasite prevalence of 65.3%. Pinworms (57.1%) and coccidians (40.7%) were the most common endoparasites (Ras-Norynska and Sokol 2015). Metabolic bone disease (MBD), which is a term used to describe a collection of disorders that affect the integrity and function of bones, is mentioned as an important non-infectious disease in captive bearded dragons

(Wright 2008; Raiti 2011; Carmel and Johnson 2014). Hernandez-Divers and Garner (2003) reported the prevalence of non-infectious skin diseases such as skin neoplasia in lizards to be 0.1%, whereas Mauldin and Done (2006) reported skin neoplasms in lizards to be common based on a literature review. Additionally, Heckers et al. (2011) diagnosed 47 out of 100 growths of the skin and oral cavity of bearded dragons to be neoplastic; 46% of these growths were chromatophoromas. The prevalence of neoplasias in lizards in general is between 6% (Hernandez-Divers and Garner 2003) and 8.5% (Garner et al. 2004). Case reports about neoplasias in bearded dragons include descriptions of an intrahepatic cholangiocarcinoma, adenocarcinoma and adenomas of the gallbladder (Jakab et al. 2011), gastric neuroendocrine carcinomas (Ritter et al. 2009; Lyons et al. 2010), multicentric benign peripheral nerve sheath tumours (Lemberger et al. 2005), a periorbital adenocarcinoma (Darrow et al. 2013) and leukaemia (Suedmeyer and Turk 1996; Tocidowski et al. 2001; Garner et al. 2004; Gregory et al. 2004; Jankowski et al. 2011). Neoplasias of the female and male genital tract in bearded dragons were reported by Heckers (2017).

The aim of this clinical, retrospective study was to analyse the prevalence of common disorders in captive bearded dragons that were presented to three specialised exotic animal clinics in Central Europe (Austria and Czech Republic) within a period of three years.

## MATERIAL AND METHODS

The retrospective data were collected from the Clinic for Avian, Reptile and Fish Medicine of the Department for Farm Animals and Veterinary Public Health of the Veterinary University of Vienna (VUW), the Veterinary Clinic Strebersdorf in Vienna (S) and the Avian and Exotic Animal Clinic of the University of Veterinary and Pharmaceutical Sciences Brno (B). Examinations of a total of 529 bearded dragon patients were recorded over a three-year period. Among these 529 bearded dragons, 215 were female and 150 were male; in 164 patients, the sex was not determined. The mean age of the bearded dragon patients was 2.77 years. Two bearded dragons were only seven days old, whereas the age of the oldest patient was 11 years

and 10 months. Most of the bearded dragons were group-housed (77.39%) and fed a mixed diet of insects and greens (88.96%).

A diagnosis was made on the basis of the presenting clinical signs and physical examination in 30.8% of the cases, whereas various additional diagnostic tests were performed in the other cases (69.2%). These included diagnostic imaging (radiography, ultrasound and computed tomography), examination of faecal samples for the presence of parasites, a blood-profile analysis, histological, as well as bacteriological and mycological examinations and necropsy. The standard methods of clinical examination described by Raiti (2011) were used in this study. Blood values were compared with reference values determined by Tamukai et al. (2011).

## RESULTS

The results are categorised according to the organ systems involved (Table 1). The numbers of cases and diagnoses differ because some lizards presented with more than one disease. In 49 cases, a final diagnosis was not made, and the cases were classified as

“unspecified”. The most common diseases in captive bearded dragons involved the gastrointestinal tract and liver (GITL), followed by the skin, musculoskeletal and urogenital systems (Table 1).

One single organ system was affected more often (65.28%) than multiple organ systems (34.72%). The GITL and musculoskeletal system, the skin and the musculoskeletal system as well as the GITL and the skin were commonly affected at the same time.

Diseases of the GITL (42.67%), such as endoparasitic infection, constipation, sand ingestion, tympany and meteorism, were the most common diseases presenting in the captive bearded dragons (Table 2). Faecal samples of 281 animals were examined, and 234 (83.27%) were positive for endoparasites (50.78% nematodes, 0.52% cestodes and 48.7% protozoans). Nematodes were represented mainly by pinworms (48.7%) and most protozoans were coccidians like *Isospora* sp. and flagellates like *Trichomonas* sp. *Choleoeimeria* spp. were diagnosed in the faecal samples of five bearded dragons. In 51.92% of the cases of constipation, endoparasites were present, whereas 38.46% of the cases

Table 1. Types and number of diseases diagnosed in a collection of 529 captive bearded dragon patients, categorised according to the organ systems involved

Organ systems	Clinic			Total <i>n</i> (%)
	B	S	VUW	
Gastrointestinal system and liver (GITL)	38	161	121	320 (42.67)
Skin	11	96	61	168 (22.4)
Musculoskeletal system	14	79	49	142 (18.93)
Urogenital system	6	44	21	71 (9.47)
Ophthalmic system	1	15	9	25 (3.33)
Cloaca	0	8	2	10 (1.33)
Respiratory system	3	4	1	8 (1.07)
Cardiovascular system	0	2	2	4 (0.53)
Nervous system	2	0	0	2 (0.27)
Total	75	409	266	750 (100)

B = Avian and Exotic Animal Clinic, University of Veterinary and Pharmaceutical Sciences Brno; S = Veterinary Hospital Strebersdorf, Vienna; VUW = Clinic for Avian, Reptile and Fish Medicine, University of Veterinary Medicine, Vienna

Table 2. Most common types and number of gastrointestinal and liver (GITL) diseases in a collection of 529 captive bearded dragon patients

Type of disease	Clinic			Total <i>n</i> (%)
	B	S	VUW	
Endoparasites	20	111	58	189 (59.06)
Constipation	2	13	4	19 (5.94)
Endoparasites and constipation	1	10	7	18 (5.63)
Sand/stone ingestion	2	1	9	12 (3.75)
Liver diseases	3	7	2	12 (3.75)
Endoparasites and tympany/meteorism	1	1	8	10 (3.13)
Tympany/meteorism	0	1	6	7 (2.19)
Endoparasites constipation and sand ingestion	0	2	2	4 (1.25)
Endoparasites and liver disease	0	2	2	4 (1.25)
Others (prevalence under 1%)	9	13	23	45 (14.06)
Total	38	161	121	320 (100)

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showed signs of metabolic bone disease or imbalances in the levels of calcium and phosphorus. In 7.85% of the cases of constipation, kidney diseases or follicles and eggs were present and 5.78% of the constipations occurred after deworming. Liver diseases were diagnosed in 8.44% of the cases with gastrointestinal problems.

Skin problems (22.4%) were most often represented by cases of skin wounds, skin necrosis, dysecdysis and dermatitis, which were frequently localised on the tail and limbs (Table 3). Skin tumours (four cases) were observed in adult lizards (aged from three to eight years) and included spindle cell tumour on the eyelid, as well as spindle cell sarcoma, squamous cell carcinoma and melanoma on the trunk. Parasitic mites were present in 12 cases. Overall, 19 bacteriological and mycological examinations were performed, mainly (12/19) from skin samples. Of particular interest were one case of *Devriesea agamarum* and *Chrysosporium*

*guarroi* in a bearded dragon with dysecdysis and chronic skin lesions, and dermatomycosis due to *Chrysosporium chlamydospora* in two bearded dragons from the same owner. No zoonotic pathogens like mycobacteria or salmonella were detected.

Most musculoskeletal disorders (18.93%) were non-infectious in nature, such as osteodystrophy and limb fractures. Various types of necrosis affected the limbs and tail (Table 4). More than half of all animals (57.71%) that underwent a blood test, showed a deviation in the calcium-phosphorus ratio; 63.98% showed hypocalcaemia and 26.71% hyperphosphataemia. Table 5 shows the plasma biochemical values based on sex and season for all bearded dragon patients that underwent a blood test ( $n = 161$ ). Trauma was reported in 27.1% of the cases with dermatological and musculoskeletal diseases. Tables 2–4 only show data with prevalence rates of over 1%.

Table 3. Most common types and numbers of skin diseases in a collection of 529 captive bearded dragon patients

Type of disease	Clinic			Total $n$ (%)
	B	S	VUW	
Skin wound	6	21	6	33 (19.64)
Skin necrosis	1	14	16	31 (18.45)
Dysecdysis	1	18	5	24 (14.29)
Dermatitis	2	11	7	20 (11.9)
Ectoparasites	0	4	6	10 (5.95)
Abscess	0	4	5	9 (5.36)
Missing limbs or/and tails	0	5	4	9 (5.36)
Unspecified skin masses	0	4	3	7 (4.17)
Skin neoplasia	1	0	3	4 (2.38)
Unspecified skin problem	0	0	4	4 (2.38)
Constriction of the tail	0	3	0	3 (1.79)
Dysecdysis and skin necrosis	0	2	1	3 (1.79)
Others (prevalence under 1%)	0	10	1	11 (6.55)
Total	11	96	61	168 (100)

B = Avian and Exotic Animal Clinic, University of Veterinary and Pharmaceutical Sciences Brno; S = Veterinary Hospital Strebersdorf, Vienna; VUW = Clinic for Avian, Reptile and Fish Medicine, University of Veterinary Medicine, Vienna

Table 4. Most common types and numbers of musculoskeletal diseases in a collection of 529 captive bearded dragon patients

Type of disease	Clinic			Total $n$ (%)
	B	S	VUW	
Osteodystrophy	6	11	12	29 (20.42)
Bone fracture	1	13	4	18 (12.68)
Necrosis of tail (bone/muscles)	1	8	9	18 (12.68)
Bone fracture and osteodystrophy	1	7	3	11 (7.75)
Necrosis of limb (bone/muscles)	0	6	4	10 (7.04)
Missing tails and/or limbs	0	5	4	9 (6.34)
Wound	0	7	1	8 (5.63)
Swellings	2	2	3	7 (4.93)
Inflammation	0	2	1	3 (2.11)
Osteolysis	0	2	1	3 (2.11)
Luxation	0	2	0	2 (1.41)
Lameness and osteodystrophy	2	0	0	2 (1.41)
Kink in the tail	0	2	0	2 (1.41)
Lameness and swellings	1	1	0	2 (1.41)
Others (prevalence under 1%)	0	11	7	18 (12.68)
Total	14	79	49	142 (100)

B = Avian and Exotic Animal Clinic, University of Veterinary and Pharmaceutical Sciences Brno; S = Veterinary Hospital Strebersdorf, Vienna; VUW = Clinic for Avian, Reptile and Fish Medicine, University of Veterinary Medicine, Vienna

Table 5. Plasma biochemical values based on sex and season in a collection of 161 bearded dragon patients

Parameter (units)	References (Tamukai et al. 2011)	Present study
Total protein (g/dl)	4.7–6	4.37–5.24
Calcium (mmol/l)	3.1–3.5	2.72–3.36
Phosphorus (mmol/l)	1.36–1.55	1.36–2.15
Calcium : phosphorus (mmol/l)	2.01–2.48 : 1	2.22–3.65 : 1
Uric acid (mg/dl)	4–8.6	3.64–5.29
Alkaline phosphatase (U/l)	314–400	104.5–191
Alanine aminotransferase (U/l)	3–4	17–46
Aspartate aminotransferase (U/l)	7–13	30.93–84
Creatine kinase (U/l)	514–1100	2184–6901.6
Lactate dehydrogenase (U/l)	99–213	206.17–1018
Glutamate dehydrogenase (U/l)	–	3.38–19.85

Diseases of the urogenital system (9.47%) included renal disease and dystocia (Table 6). Organ prolapse from the cloaca was observed in 15 patients. Prolapsed tissue was identified as cloacal tissue (66.67%), intestine (20%) or hemipenis (13.33%).

Neoplastic diseases (three cases) other than skin tumours included one case of leukaemia in a 4-year-old, female bearded dragon, one case of leukaemia and lymphoma in kidneys, lungs and liver in a 4-year-old, male bearded dragon and one ganglioneuroma in the body cavity of a female bearded dragon of unknown age.

Orthopaedic surgeries were most frequently carried out to amputate limbs and tails, whereas soft-tissue surgeries most often included treatment of skin wounds and correction of cloacal prolapse, as well as ovariectomy, salpingotomy or salpingectomy in female bearded dragons (Table 7).

## DISCUSSION

This study has reported the prevalence of common disorders in captive bearded dragons, one

Table 6. Types and number of urogenital diseases in a collection of 529 captive bearded dragon patients

Type of disease	Clinic			Total <i>n</i> (%)
	B	S	VUW	
Urinary system	5	23	8	36 (50.7)
Kidney disease	5	23	8	36 (50.7)
Genital system	0	17	12	29 (40.85)
Dystocia, follicles or eggs	0	14	12	26 (36.62)
Hemipenis prolapse	0	2	0	2 (2.82)
Testicle cyst	0	1	0	1 (1.41)
Kidney disease and dystocia	1	4	1	6 (8.45)
Total	6	44	21	71 (100)

B = Avian and Exotic Animal Clinic, University of Veterinary and Pharmaceutical Sciences Brno; S = Veterinary Hospital Strebersdorf, Vienna; VUW = Clinic for Avian, Reptile and Fish Medicine, University of Veterinary Medicine, Vienna

of the most common reptile patients in Central Europe.

Five hundred and twenty-nine bearded dragon patients from three exotic animal clinics were investigated over a period of three years. Clinical signs and physical examination as well as various diagnostic tests including mainly diagnostic imaging, parasitological faecal examinations and blood analyses were used for diagnoses. The results are in accordance with the most important diseases of bearded dragons described by Stahl (2003) and Raiti (2011). The most common diseases in bearded dragons included in the present study involved the gastrointestinal tract and liver. Gastrointestinal problems (42.67%) in bearded dragons were nearly twice as common as the other categories of diseases investigated. More than 80% of the faecal samples were positive for parasites, especially pinworms, coccidians and flagellates. These results are similar to those published by Papini et al. (2011), Rataj et al. (2011) and Ras-Norynska and Sokol (2015). Endoparasites were present in over 50% of the cases of constipation, whereas metabolic bone diseases or aberrations in calcium and phosphorus levels were present in over one-third of the cases of constipation. These findings support the general opinion that constipation is a common clinical symptom in bearded dragons that suffer from metabolic bone diseases and inadequate husbandry or feed-



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Table 7. Types and numbers of orthopaedic and soft tissue surgeries as well as endoscopies in a collection of 529 bearded dragon patients

Type of surgery	Clinic			Total n (%)
	B	S	VUW	
Limb or toe amputation	2	11	7	20 (20.83)
Tail amputation	1	9	8	18 (18.75)
Skin surgery	3	4	10	17 (17.7)
Organ reposition into cloaca	2	9	2	13 (13.54)
Ovariectomy, salpingectomy, salpingotomy	0	4	8	12 (12.5)
Fracture repair	0	3	3	6 (6.25)
Eye surgery	0	4	0	4 (4.17)
Enterotomy	1	0	0	1 (1.04)
Laparotomy	2	0	0	2 (2.08)
Gastrosocopy	0	0	1	1 (1.04)
Tracheosocopy	1	0	0	1 (1.04)
Hemipenis amputation	0	1	0	1 (1.04)
Total	12	45	39	96 (100)

B = Avian and Exotic Animal Clinic, University of Veterinary and Pharmaceutical Sciences Brno; S = Veterinary Hospital Strebersdorf, Vienna; VUW = Clinic for Avian, Reptile and Fish Medicine, University of Veterinary Medicine, Vienna

ing (Wright 2008). Liver diseases represented only 8.44% of the gastrointestinal problems in this study. This percentage is very low despite the fact that hepatopathies are frequently diagnosed post-mortem in reptiles (Sinn 2004; Hernandez-Divers and Cooper 2006). In hepatic lipidosis, little hepatocellular damage may occur and blood enzyme levels may remain normal (Hernandez-Divers and Cooper 2006). Incorporating bile acids into the routine blood chemistry and ultrasound investigations of the liver may facilitate better clinical diagnosis of liver diseases in the future, but, nevertheless, definitive diagnosis is often only made post-mortem.

Metabolic bone diseases were also common in the present study. This finding is in accordance with that of Klaphake (2010), who reported different types of metabolic diseases. As in the post-mortem study of Sinn (2004), osteodystrophy and trauma were the most common causes of musculoskeletal diseases.

Diseases of the skin were mostly represented by dermatitis, skin wounds, necrosis and dysecdysis

on the tail and limbs that frequently led to amputation. Many skin diseases in reptiles are still primarily caused by inappropriate husbandry and feeding (Pasmans et al. 2010). Emerging skin pathogens in bearded dragons include the bacterium *Devriesea agamarum* (Hellebuyck et al. 2009a; Hellebuyck et al. 2009b; Devloo et al. 2011; Schmidt-Ukaj et al. 2014) and fungi of the family *Nannizziopsiaceae* such as *Nannizziopsis* (*N.*) *chlamydospora*, *N. draconii*, *N. barbata*, *N. guarroi* and *N. vriesii* (Bowman et al. 2007; Abarca et al. 2009; Hedley et al. 2010; Van Waeyenberghe et al. 2010; Johnson et al. 2011; Sigler et al. 2013; Stchigel et al. 2013; Cabanes et al. 2014). This study also included one case of *Devriesea agamarum* und *Chrysosporium guarroi* in a bearded dragon with dysecdysis and chronic skin lesions (Schmidt-Ukaj et al. 2014), and two bearded dragons from the same owner with dermatomycosis caused by *Chrysosporium chlamydospora* (Schmidt-Ukaj et al. 2016).

Heckers et al. (2011) reported that chromatophoromas are frequently encountered in bearded dragons and one case of melanoma was also diagnosed in this present study. Besides skin tumours, one case of leukaemia and one case of leukaemia and lymphoma were included in the present study. The prevalence of neoplasias in lizards in general is between 6% (Hernandez-Divers and Garner 2003) and 8.5% (Garner et al. 2004) and a 1.6% prevalence of lymphomas among agamid lizards has been reported (Garner et al. 2004).

Similar to the situation in Australia and the USA, infectious as well as non-infectious diseases are common in captive bearded dragons in Central Europe. Due to the high occurrence of endoparasitism, skin diseases and metabolic bone diseases in this present study, regular veterinary controls in bearded dragons including parasitological faecal examinations and optimisation of feeding and housing are necessary to improve the standard of health of bearded dragons kept as pet lizards in Europe. Incorporating bile acids into the routine blood chemistry and ultrasound investigations of the liver may facilitate better clinical diagnosis of liver diseases in the future.

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