Seroprävalenz von Salmonellen bei exotischen Haustieren (Reptilien): eine retrospektive Studie von Österreich

DIPLOMARBEIT

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Ute Gaigg

durchgeführt am Institut für Bakteriologie, Mykologie und Hygiene

der Veterinärmedizinischen Universität Wien

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1. Begutachter:

O. Univ.-Prof. Dr.rer.nat. Dr.med.vet.habil. Renate Rosengarten

2. Begutachter:

Univ. Prof. Dr. med.vet. Michael Hess

Betreuung:

Mag. Ewald B. M. Denner

O. Univ.-Prof. Dr.rer.nat. Dr.med.vet.habil. Renate Rosengarten

INHALTSVERZEICHNIS

Fragestellung

Die Haltung und Zucht von exotischen Haustieren, wie z. B. Schlangen, Schildkröten sowie Echsen (Leguane, Agamen, Geckos) wird zunehmend zu einer beliebteren Freizeitgestaltung. Viele dieser Tiere beherbergen jedoch ein breites Spektrum an Krankheitserregern mit zoonotischem Potential, u. a. Salmonellen. In vielen Fällen ist die Besiedelung mit Salmonellen bei den Tieren selbst symptomfrei. Aber besonders Kleinkinder und immunsuppremierte Personen stellen für Reptilien-assoziierte Salmonellosen eine Risikogruppe dar.

Das Ziel dieser retrospektiven Studie ist:

- das Vorkommen von Salmonellen bei verschiedenen Reptilien in Österreich zu ermitteln (Schlangen, Echsen, Schildkröten).
- welche Serotypen von Salmonellen bei Reptilien in Österreich vorkommen.
- die Verteilung der Salmonellen Subspezies zu identifizieren.
- die Möglichkeit der Reptilien als Infektionsquelle für den Menschen zu diskutieren.

Ergebnisse

Zwischen 1997 und 2006 wurden 764 Proben von Reptilien am Institut für Bakteriologie, Mykologie und Hygiene der Veterinärmedizinischen Universität Wien untersucht. Davon wurden bei 173 Proben Salmonellen festgestellt (22,64%) und in der AGES Graz der Serotyp identifiziert.

Echsen (42,26%) und Schlangen (37,63%) hatten nahezu die gleiche Infektionsrate, während Schildkröten (7,80%) eine deutlich niedrigere Seroprävalenz aufwiesen.

Insgesamt wurden 110 verschiedene Serotypen gefunden, wobei alle zur Spezies *Salmonella enterica* gehörten. Die Mehrzahl der Isolate gehörte zur Subspezies *enterica* (n= 86) und *diarizonae* (n= 40). Die restlichen Serovare verteilten sich auf die Subspezies II (n= 16), IIIa (n= 14) und IV (n= 19).

Von 6 Tieren konnten 2 verschiedene Isolate kultiviert werden.

Die am häufigsten vorkommenden Isolate waren *Salmonella* Newport (8 Isolate), *S.* Minnesota und *S.* IIIb 18:l,v:z (jeweils 7 Isolate). Für 2 Isolate konnte nur das O-Antigen festgestellt werden und eine raue Form von Salmonellen wurde gefunden.

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Prevalence of *Salmonella* in reptiles: a retrospective study from Austria

Prevalence of *Salmonella* in reptiles: a retrospective study from Austria

Ute GAIGG, Alexander KNOLL, Renate ROSENGARTEN and Ewald B. M. DENNER*

Institut für Bakteriologie, Mykologie und Hygiene
Veterinärmedizinische Universität Wien, A-1210 Vienna, Austria

*Corresponding author: Ewald B. M. Denner
e-mail: ewald.denner@vu-wien.ac.at
Phone: 43 1 25077 2116; FAX: 43 1 25077 2190

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Abstract

In a retrospective study we evaluated the isolation rate of *Salmonella* from reptile specimens (n=764) of 74 different animals examined between 1997 and 2006. Out of 179 isolated *Salmonellae*, 86 (48,04%) belonged to *Salmonella* enterica subspecies *enterica* I, 40 isolates (22,35%) to subspecies *diarizonae* IIIb, 19 isolates (10,61%) to subspecies *houtenae* IV. In total 110 different *Salmonella* serovars were isolated including some rare serotypes such as *S.* IV 43:z4,z23:-, *S.* Gatuni and *S.* II 4,12:a:-. The most frequently isolated serotypes were *S.* Newport (4,47%), *S.* Minnesota (3,91%) and *S.* IIIb 18:l,v:z (3,91%), *S.* Oranienburg (3,35%) and *S.* IV 1,44:z4,z32:- (3,35%). The percentage of *Salmonella* positive samples was higher for lizards (42,26%) and snakes (37,63%) as compared to turtles (7,80%). 10,06% of the isolates could be assigned to serotypes which had been related to human cases of reptile associated salmonellosis. These serotypes included *S.* Chameleon, *S.* IV 48:g,z51:- (former *S.* Marina), *S.* Infantis, *S.* Java, *S.* Kisarawe, *S.* Minnesota, *S.* Montevideo, S. Pomona, *S.* Poona, *S.* Telekebir and *S.* IIIa 41:z4,z23:-.

Introduction

Keeping and breeding exotic animals such as pet reptiles is increasingly becoming a popular leisure-time activity. In Austria approximately 90.000 households keep reptiles such as turtles, snakes or lizards [13]. This type of animal is known for their zoonotic potential in connection with human salmonellosis. Salmonellosis is the most well-known reptilian zoonosis [24] because cold-blooded vertebrates including snakes, turtles and lizards, harbor *Salmonella* spp. frequently as part of their intestinal flora and excrete the pathogen intermittently.

Salmonella serovars commonly isolated from reptiles are e.g. Java, Stanley, Marina, Poona, Pomona of the subspecies I as well as *S. enterica* subspecies *arizonae* [37], one animal being able to harbor different serovars simultaneously.

Not less than 5.379 cases of human salmonellosis were documented in Austria in 2006, *S.* Enteritidis being the most frequent (78,8%) serotype [4]. The incidence, however, is thought to be much greater than the number of reported and confirmed cases [11]. About 100.000 people are affected in Austria each year [20]. As reported in other studies ~3-5% of all cases of human salmonellosis are directly or indirectly associated with exotic pets [11, 14, 26, 29]. Also the number of human infections with rare and reptile-associated *Salmonella* serotypes has increased in the past 20 years [29].

The aim of the retrospective study presented here was to evaluate the incidence of *Salmonella* in clinical samples of cold-blooded vertebrates (reptiles) sent for routine bacteriological analysis.

Materials and methods

Enrichment and isolation of *Salmonella*

Samples were inoculated into 9 ml Rappaport Vassiliadis enrichment broth (OXOID) and 9 ml selenite cysteine bouillon (OXOID) and incubated at 42°C. After 24h one loop-ful of enrichment cultures was spread onto McConkey agar (OXOID) and xylose lysine desoxycholate agar (OXOID). The plates were incubated at 37°C for 24h.

Identification

Salmonella suspect colonies were subcultivated on blood agar and subjected to serological and biochemical identification. Isolates were typed with DADE Behring *Salmonella* test sera to O and H antigens by slide agglutination. Biochemical identification of *Salmonella* was done by using API20E test strips (bioMerieux). Isolates with typical profile for *Salmonella* spp. were sent to the Austrian Agency for Health and Food Safety - AGES in Graz (Austria) for detailed serotyping.

Results and discussion

Out of 764 reptile samples examined, 173 (22,64%) were *Salmonella* positive (Table 1). Whereas *Salmonellae* were most frequently isolated from lizard (42,26%) and snake samples (37,63%), the *Salmonella* isolation rate for turtles was noticeable lower (7,80%).

As many as 110 different serotypes were found (Table 3), all of them could be assigned to *Salmonella* enterica [18], the majority of the serotypes (n=86) being *Salmonella* enterica subspecies *enterica* I and subspecies *diarizonae* IIIb (n=40). The remaining serovars belonged to *Salmonella* subspecies II (n=16), subspecies IIIa (n=14) and subspecies IV (n=19) (Table 2). From 6 samples two different serotypes were isolated. The most frequently isolated serovar was *Salmonella* Newport (8 isolates) followed by *S.* Minnesota and *S.* IIIb 18:l,v:z (both 7 isolates), *S.* Oranienburg and *S.* IV 1,44:z4,z32:- (both 6 isolates). For two strains only the O-antigen could be determined and one rough form was found. Furthermore, we found the rare serotypes *S.* IV 43:z4,z23:-, *S.* Gatuni and *S.* II 4,12:a:-. The *Salmonella* serotype II 4,12:a:- is a recently isolated novel serotype recently obtained from harbour porpoises (Phocoena phocoena) stranded at the coastline of Scotland [8].

Turtles

7,80% *Salmonella* spp. were isolated from turtels. This low prevalence is in line with the results of Geue, Löschner (2002) and Hassl, Pfleger (2001) [11, 14]. Pasmans et al. (2000) reported that the incidence of *Salmonella* in European tortoises in cavity was over 70%. According to Hidalgo-vila and co-workers (2007) as well as Herka (2003) the incidence of *Salmonella* seems to be much higher in terrestrial tortoises than in aquatic species [15, 16]. This may be explained by the lower persistence of the bacteria in organisms living in aquatic media where they are washed from skin and cloaca, while in terrestrial habitats they persist longer and are directly transmitted among individuals [16]. Another reason for the great difference in prevalence could be the time of year when the samples were collected. In the late autumn the turtles prepare for hibernation and do not feed. This could explain the low percentage of *Salmonella* in some studies [11].

In our study most of the isolates were identified as *Salmonella* enterica subspecies *enterica* (69,70%) or subspecies *salamae* (27,27%). *Salmonella* belonging to subspecies IIIa and IV were not detected. These percentages correspond well to those found in other studies. Higaldo-Vila et al. (2007) described that the isolates belonged to subspecies I or II and Herka (2003) ascertained that *Salmonella* isolates of tortoises belonged to subspecies I while isolates of turtles belonged to subspecies IIIb [15, 16].

In 1943 the first case of turtle-associated salmonellosis in humans was observed and in 1963 the first case occured in a child. *S*. Hartford was found in a 7 month old baby and the same serotype was isolated from the family's pet turtle [26].

Because of the increasing number of turtle-associated salmonellosis in the early 1970's which sometimes proved fatal, a regulation was issued forbidding the sale of turtles not certified to be salmonella-free. In 1975 the interstate shipment of all turtle eggs and live turtles with a carapace length <10,2 cm was banned. The consequence was a 77% reduction of incidence of cases [26].

Another attempt to reduce or eliminate *Salmonella* in turtles was the use of antimicrobials but this was not very successful and led to multi-drug resistance.

At present the *Salmonella* carrier rate among pet turtels in industrialized countries is between 11–12% [34].

Snakes

The *Salmonella* incidence in snakes was 37,63%. Pfleger et al. (2003) found *Salmonella* in 24% of the snakes [29]. Other studies, however, reported higher *Salmonella* isolation rates. For instance Geue and Löschner (2002) isolated *Salmonella* from 73,8% and Herka (2003) from 79,17% of the animals, predominantly subspecies I or IIIb [11, 15].

In our study the majority of isolates belonged to *Salmonella* enterica subspecies IIIb (*diarizonae*, 45,21%) or to subspecies I (*enterica*, 31,51%). The other isolates belonged to subspecies *arizonae* (IIIa, 15,07%), *houtenae* (IV, 6,85%) and *salamae* (II, 1,37%).

Salmonella Typhimurium was found in a python and *Salmonella* Paratyphi B var. Java in a Boa constrictor. Both *Salmonella* serotypes are known for their infectious potential to humans [4, 33].

From faeces of a *Python molurus* we isolated *Salmonella* Gatuni [36]. To our knowledge this rare serotype (6,8:b:e,n,x) was isolated from reptiles for the first time in 2003 by Pfleger and co-workers from faecal samples of vivarium reptiles i.e. bearded dragon (*Pogona vitticeps*) and Hispaniolan giant gecko (*Aristelliger lar*) [29].

Lizards

For this group of reptiles the highest (42,26%) *Salmonella* incidence was found. This outcome is in line with previous studies [11, 15, 28].

Most of the isolates belonged to *Salmonella* enterica subspecies *enterica* (57,97%). The others belonged to subspecies *houtenae* (20,29%), *salamae* and *diarizonae* (both 8,7%) and *arizonae* (4,35%).

In Indiana a 3-week old baby died from a *Salmonella* infection with *S*. Poona from a pet iguana although the baby did not have direct contact with the pet [26]. And in 1999 a 3-week old baby in Great Britain died from meningitis caused by *Salmonella* infection aquired from a lizard [30].

Concluding remarks

It has been estimated that about 90% of reptiles harbor *Salmonellae*, an aspect which emphasises the role of this group of animals as a potential reservoir of *Salmonella* infections.

The animals can excrete *Salmonellae* for a long time (continuously or intermittently) usually without showing any clinical symptoms. Infections only become symptomatic when the animal is stressed by e.g. transportation, crowding, food deprivation and/or a concurrent other disease. *Salmonellae* spp. are able to survive in the environment for long periods of time and can be isolated from faeces-contaminated surfaces. It has been demonstrated that the pathogen can remain virulent for at least 89 days in tap water, 115 days in pond water, 120 days in pasture soil and 280 days in garden soil [24].

The intestine of both wild and domestic, warm-blooded as well as cold-blooded animals and humans are the natural habitat of *Salmonellae* but they can also be found in the environment.

In contrast to mammals and birds, reptiles are considered to be the natural reservoir of nearly all serovars of *Salmonella*. The exception seems to be a limited number of serovars of subspecies *enterica* which are adapted to homeothermic animals and can be routinely isolated from humans [27]. All other *Salmonella* subspecies (especially subsp. III) are frequently found in cold-blooded animals and the environment.

In a retrospective study Hassl and Pfleger (2001) showed that reptiles living in the wild almost exclusively harbour *Salmonella* subspecies *arizonae* (III) while this subspecies is very rare in reptiles living in captivity [14]. But *Salmonella* subspecies *enterica* (humanpathogen serotypes) was isolated in 82% of the animals. The reason for the excretion of these serotypes seems to be a consequence of the close contact between reptiles and humans [14].

According to a recent Austrian report (AGES, 2006) the 10 most common *Salmonella* serotypes responsible for human salmonellosis in Austria were *S.* Enteritidis (78,8%), *S.* Typhimurium (11,7%) as well as (0,7–0,3%) *S.* Infantis, *S.* Hadar, *S.* Newport, *S.* Saintpaul, *S.* Virchow, *S.* Thompson, *S.* Agona, *S.* Bovismorbificans and *S.* Kentucky in the year 2006 [4].

In our study *S.* Typhimurium was only found once, *S.* Infantis three times and *S.* Newport (8 times) was the most frequently isolated serotype. The source of *Salmonella* infection with *S.* Typhimurium is mostly food but it is only rarely found in reptiles [33]. On the other hand *S.* Newport is widespread and frequently reported from reptiles [1, 11, 12].

Keeping exotic animals, especially reptiles, is becoming more and more popular and the number of people owning such a pet is still increasing. But the potential of these pets to transmit infections to their owners is often underestimated. Especially families with children under 5 years, pregnant women or immunodeficient persons should think twice about whether a reptile is the right pet for them. This is because the risk of developing for example salmonellosis is higher for these people in particular. Primarily in young children serious complications, such as meningitis or brain abscesses have occurred, which often proved fatal [26, 30].

Also in our study a number of isolates (n=18), 10,06%, belonged to serotypes (i.e. *S.* Chameleon, *S.* IV 48:g,z51:- (former *S.* Marina), *S.* Infantis, *S.* Java, *S.* Kisarawe, *S.* Minnesota, *S.* Montevideo, *S.* Pomona, *S.* Poona and *S.* Telekebir and *S.* IIIa 41:z4,z23:-) which had been previously related to human cases of reptile associated salmonellosis [e.g. 5, 7, 9, 21, 22, 31, 32, 37].

Proper hygienic measures (washing hands immediately after handling reptiles or their utensils) are imperative. Furthermore reptiles should not be permitted free access throughout the house and in particular they should be kept out of bathrooms and food preparation areas to avoid contamination [2, 3, 34].

TABLE 1. Incidence of *Salmonella* in reptiles

Animal	Number of specimens	Number of *Salmonella* positive specimens	%
Lizards	168	71	42,26
Turtles	410	32	7,80
Snakes	186	70	37,63
Total	764	173	22,64

TABLE 2. Distribution of *Salmonella* subspecies in reptiles

Subsp. / Animal	I	II	IIIa	IIIb	IV
Lizards	40	6	3	6	14
Turtles	23	9	0	1	0
Snakes	23	1	11	33	5
Total	86	16	14	40	19

TABLE 3. *Salmonella* serotypes isolated from reptile species

reptile taxonomy	**number of animals**	**Number of *Salmonella* positive animals**	**Serotype**	**antigenetic formula**	**sample**
<u>Order Squamata Suborder Lacertilia</u> (lizards)	3	1	S. Tornow	45:g,m(s),(t):-	small intestine
Family Agamidae	7	3	S. Koketime	44:z38:-	faeces
			S. II	58:l,z13,z28:z6	
			S. Havana	1,13,23:f,g:-	small intestine, lungs
Chlamydosaurus kingii	1	1	S. Kisaware	11:k:e,n,x	faeces
Hydrosaurus	1	1	S. Infantis	6,7:r:1,5	stomach, spleen, kidney
Pogona vitticeps	32	17	S. II	30:l,z28:z6	liver
			S. Kisaware	11:k:e,n,x	intestine
			S. IV	16:z4,z32:-	intestine
			S. Ealing	35:g,m,s:-	intestine
			S. II	9,12:-:1,7	faeces
			S. Havana	1,13,23:f,g:-	faeces
			S. Pomona	28:y:1,7	faeces
			S. Minnesota	21:b:e,n,x	small intestine, liver
			S. IV	42:z36:-	faeces
			S. IV	48:g,z51:-	faeces
			S. IV	42:z36:-	faeces
			S. Kisarawe	11:k:e,n,x	small intestine, lungs, liver, tongue
			rough form		faeces
			S. IV	1,44:z4,z32:-	small intestine, ovary, mouth swab
			S. IIIa	44:z4,z23:-	small intestine, liver, lungs
			S. Montevideo	6,7:g,m,s:-	small intestine, liver, lungs
			S. Havana	1,13,23:f,g:-	small intestine, liver, lungs, ovary

Physignathus cocincinus	12	6	S. IV	1,44:z4,z32:-	tail abscess
			S. IV	1,44:z4,z32:-	faeces
			S. Fresno	9,46:z38:-	small intestine, liver
			S. IV	1,44:z4,z32:-	large intestine, liver
			S. Kingston	1,4,12,27:g,s,t:-	small intestine, liver, lungs
			S. IIIb	38:k:1,5,7	small intestine, liver, ovary
Uromastyx	6	2	S. Rissen	6,7,14:f,g:-	faeces
			S. Adelaide	35:f,g:-	faeces
Gonocephalus chamaeleontinus	1	1	S. Oslo	6,7:a:e,n,x	intestine
Bronchocela cristatella	1	1	S. IV	43:z4z23:-	ovary
Family Chamaeleonidae	31	10	S. IIIa	13,13:z4,z23,(z32):-	intestine
			S. II	50:b:z6	small intestine, lungs
		one	S. Sanktgeorg	28:r:e,n,z15	small intestine, lungs, liver
		Animal	S. Teshie	1,47:l,z13,z28:e,n,z15	
			S. Nottingham	16:d:e,n,z15	intestine, liver
			S. Lawra	44:k:e,n,z15	small intestine
				6,14,25:-:-	intestine, lungs, liver
			S. IIIb	53:z10:z	small intestine
			S. IIIb	53:k:e,n,x,z15	small intestine, liver
			S. IIIb	53:k:e,n,x,z15	small intestine, liver, lungs
			S. IIIb	53:k:e,n,x,z15	small intestine, liver
Furcifer pardalis	1	0			
Family Iguanidae	16	5	S. Oranienburg	6,7:m,t:-	liver
			S. II	58:1,z13,z28:z6	intestine
			S. IV	11:z4,z23:-	faeces
			S. Urbana	30:b:e,n,x	cloacal swab
			S. IV	16:z4,z32:-	small intestine, liver, lungs
Leiocephalus personatus	1	1	S. IV	42:z36:-	small intestine, liver
Iguana iguana	17	4	S. IIIb	50:k:z	cloakal swab, mouth swab

			S. IV	1,44:z4,z32:-	liver with pus, ovary
			S. Poona	13,22:z:1,6	small intestine, lungs, liver, kidney
			S. II	30:z10:e,n,x,z15	faeces
Cyclura cornuta	13	7	S. Minnesota	21:b:e,n,x	faeces
			S. IV	42:z36:-	faeces
			S. Minnesota	21:b:e,n,x	faeces
			S. Minnesota	21:b:e,n,x	faeces
			S. Minnesota	21:b:e,n,x	faeces
			S. Minnesota	21:b:e,n,x	faeces
			S. Minnesota	21:b:e,n,x	faeces
Basiliskus	1	1	S. Thompson	6,7:k:1,5	small intestine, liver
Family Polychrotidae					
Anolis	1	0			
Family Gekkonidae	6	1	S. IIIa	40:g,z51:-	small intestine, liver
Family Scincidae					
Tiliqua scincoides	2	1	S. Eastbourne	1,9,12:e,h:1,5	
Tiliqua gigas gigas	1	1		1,9,12:-:-	faeces
Eumeces schneideri schneideri	1	0			
Corucia zebrata	1	0			
Family Lacertidae	2	1	S. Ebrie	35:g,m,t:-	intestine
Takydromus sexlineatus	1	1	S. Anatum	3,10:e,h:1,6	skin swab
Family Teeidae	1	0			
Family Varanidae	6	4	S. Onderstepoort	1,6,14,25:e,h:1,5	cloacal swab
			S. Blockey	6,8:k:1,5	stomach, small intestine, lungs
			S. Oranienburg	6,7:m,t:-	small intestine
			S. Pomona	28:y:1,7	
Varanus exanthematicus	2	1	S. Cubana	1,13,23:z29:-	faeces
Suborder Serpentes (Snakes)	52	29	S. Oranienburg	6,7:m,t:-	faeces
			S. IV	1,44:z4,z32:-	intestine, lungs
			S. IIIb	65:z52:z35	lungs, windpipe

			S. Claibornei	1,9,12:k:1,5	lungs, liver
		one Animal	S. IV	43:z4,z32:-	lungs, liver
			S. IIIb	50:k:z	
			S. IIIb	48:k:z35	large intestine
			S. Oranienburg	6,7:m,t:-	faeces
			S. IIIb	48:k:z35	intestine
			S. IIIb	50:r:z	intestine, lungs
			S. IIIb	18:l,v:z	cloacal swab
			S. Georgia	6,7:b:e,n,z15	small intestine, gall bladder
			S. IIIb	50:k:z	small intestine, liver
			S. IIIb	18:l,v:z	small intestine, lungs, liver
			S. Newport	6,8:e,h:1,2	lungs, liver
			S. Lome	9,12:r:z6	faeces
			S. Infantis	6,7:r:1,5	small intestines, lungs
			S. IIIb	57:i:e,n,x,z15	large intestine, liver
			S. IIIb	65:l,v:z53	intestine, lungs, liver
			S. Muenchen	6,8:d:1,2	faeces
			S. IIIb	57:c:z	small intestine
			S. IIIa	44:z4,z24:-	liver
			S. IIIa	44:z4,z23:-	small intestine, liver, heart
			S. IIIb	:z52:z53	small intestine, oesophagus, kidney,
			S. IIIb	48:k:z53	intestine, lungs
			S. IIIb	60:r:e,n,x,z15	intestine, lungs
			S. IIIa	41:z4,z23:-	small intestine
			S. IIIb	18:l,v:z	large intestine, lungs, spleen, oesophagus
			S. IIIb	6,14:z10:z	small intestine, lungs
			S. IIIa	53:z4,z23:-	small intestine, lungs, liver
Familiy Colubridae	2	1	S. IIIb	61:r:z53	liver
Boiga dendrophila	2	0			

Elaphe dione	1	0			
Lampropeltis	4	2	S. Weltevreden	3,10:r:z6	oesophagus
			S. IIIb	18:l,v:z	small intestine, liver, kidney
Lampropeltis triangulum	1	0			
Thamnophis	1	0			
Opheodrys	3	0			
Pantherophis obsoletus	1	1	S. Infantis	6,7:r:1,5	small intestine, liver
Pantherophis guttatus	7	3	S. Oranienburg	6,7:m,t:-	faeces
			S. IIIb	58:r:z53	faeces
			S. IIIb	18:l,v:z	small intestine, lungs, liver
Elaphe schrencki	2	1	S. Newport	6,8:e,h:1,2	large intestine
Family Boidae					
Python	13	3	S. IIIb	50:k:z	small intestine
			S. IIIb	18:l,v:z	skin lesions (swabs)
			S. Typhimurium	1,4,5,12:i:1,2	liver, lungs, intestine
Python regius	13	1	S. IIIb	35:l,v:e,n,x,z15	intestine
Python molurus	16	4	S. Bere	47:z4,z23:-	faeces
			S. IIIa	44:z4,z24:-	lungs
			S. IIIa	44:z4,z24:-	lungs
			S. Gatuni	6,8:b:e,n,x	faeces
Morelia	1	0			
Morelia viridis	6	2	S. IIIb	53:z10:z35	stomach, liver
			S. Oranienburg	6,7:m,t:-	faeces
Liasis	2	0			intestine
Boa constrictor	37	10	S. Paratyphi B var. Java	1,4,5,12:b:1,2	intestine
			S. IIIb	65:l,v:z	cloacal swab
			S. Makoma II	4,12:a:-	intestine, liver
		one Animal {	S. IIIb	18:l,v:z	
			S. IIIb	35:k:z53	
			S. Carrau	6,14,24:y:1,7	faeces

			S. IIIb	65:z10:e,n,x,z15	small intestine, liver, kidney
			S. IIIb	47:z52:1,5,7	liver
			S. IIIa	44:z4,z32:-	lungs
			S. IV	38:z4,z23:-	faeces
			S. IIIa	:z4,z24:-	small intestine, lungs, liver
Epicrates cenchria	3	2	S. IV	38:z4,z23:-	intestine, liver
			S. IV	38:z4,z23:-	small intestine, liver, kidney
Eunectes	1	0			
Family Viperidae					
Crotalus	6	4	S. IIIa	21:g,z51:-	lungs
			S. Newport	6,8:e,h:1,2	intestine
			S. Newport	6,8:e,h:1,2	large intestine
		one Animal {	S. IIIa	40:z4,z23:-	intestine, lungs
			S. IIIb	42:l,v:1,5,7:z76	
Agkistrodon contortrix	3	1	S. IIIa	21:g,z51:-	small intestine, liver
Bothrops	1	0			
Cerastes	4	4	S. Poona	13,22:z:1,6	small intestine, liver, kidney
			S. IIIb	57:i:e,n,x,z15	small intestine, liver
			S. Newport	6,8:e,h:1,2	intestine
			S. IIIb	50:k:z	lungs, liver
Bitis gabonica	1	0			
Bitis arietans	3	2	S. IIIb	38:(k):z55	small intestine
			S. Pomona	28:y:1,7	large intestine
<u>Order Testudines</u> (turtles)	267	20		47:b:-	
			S. Kingabwa	43:y:1,5	small intestine, liver, folikel
		one Animal {	S. Abony	1,4,5,12,27:b:e,n,x	faeces
			S. Sheffield	38:c:1,5	
			S. Bilthoven II	47:a:1,5	faeces
			S. IIIb	50:r:z53	faeces
			S. Richmond	6,7:y:1,2	intestine, lungs, liver

			S. Newport	6,8:e,h:1,2	large intestine, lungs, liver
			S. Alger	38:l,v:1,2	small intestine, lungs, liver
			S. Bareilly	6,7:y:1,5	small intestine
			S. Vanier	28:z:1,5	small intestine, lungs, liver
			S. Lindern	6,14,24:d:e,n,x	small intestine, liver
			S. Kottbus	6,8:e,h:1,5	faeces
			S. II	17:b:e,n,x,z15	faeces
		one Animal {	S. Adamstua	11:e,h:1,6	small intestine, lungs, liver
			S. Salford	16:l,v:e,n,x	
			S. Hermannswerder	28:c:1,5	liver
			S. Telelkebir	13,23:d:e,n,z15	small intestine, lungs, liver
			S. Telelkebir	13,23:e,n,z15	liver
			S. II	47:a:1,5	small intestine, lungs, liver
			S. II	47:a:1,5	small intestine, lungs, liver
			S. II	42:z10:z6	intestine, lungs, liver
Family Testudinidae	56	2	S. Abony	1,4,5,12:b:e,n,x	faeces
			S. Bilthoven II	47:a:1,5	faeces
Testudo horsfieldii	3	0			
Testudo graeca	5	0			
Testudo hermanni	37	6	S. Hillbrow II	17:b:e,n,x,z15	faeces
			S. Hillbrow II	17:b:e,n,x,z15	faeces
			S. Abony	1,4,5,12,27:b:e,n,x	small intestine, lungs, liver
			S. Abony	1,4,5,12,27:b:e,n,x	faeces
			S. II	42:z10:z6	faeces
			S. Richmond	6,7:y:1,2	faeces
Testudo marginata	1	1	S. Abony	1,4,5,12,27:b:e,n,x	faeces
Testudo kleinmanni	1	0			
Dipsochelys hololissa	1	0			
Malacochersus tornieri	1	0			
Geochelone pardalis	3	1	S. Neumünster	1,4,12,27:k:1,6	faeces

Geochelone carbonaria	3	0			
Geochelone denticulata	4	1	S. Newport	6,8:e,h:1,2	
Geochelone elegans	2	0			
Geochelone nigra	2	0			
Geochelone sulcata	2	0			
Family Geomydidae					
Orlitia borneensis	1	0			
Family Chelyridae	1	0			
Family Emydidae					
Trachemys scripta	8	0			
Emys orbicularis	1	0			
Chinemys reevesii	1	1	S. Newport	6,8:e,h:1,2	cloacal swab
Glyptemys	10	0			

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