

Infectious and parasitic diseases of captive reptiles and amphibians, with special emphasis on husbandry practices which prevent or promote diseases

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Summary: Reptiles and amphibians have been maintained in captivity for over one hundred years. The authors review the husbandry practices necessary for the optimal health of these species: for some species these are well known, while such information is lacking for other species. Infectious and parasitic diseases are presented in tabulated form, and a number of references are cited for those seeking more detailed information.

KEYWORDS: Amphibia – Husbandry – Infectious diseases – Parasitic diseases – Reptiles.

REPTILES

Infections introduced from the wild, which are influenced by husbandry practices

Most reptiles in captivity have come directly from the wild. Hence, the assumption appears to be justified that the majority of infectious and parasitic diseases (Tables I and II) have been imported together with the animals. Outbreaks of disease may be prevented only by optimal quarantine and, probably, treatment of reptiles immediately after arrival. Any exposure to stress – due to inadequate transport, overcrowded terraria, temperature variation, insufficient feeding and many other factors – may lead to deterioration in the general condition and may provoke outbreaks of latent infection.

Diseases of concern for interstate or international movements of captive animals

It is of crucial importance to determine the health status of reptiles prior to transportation to a new facility (whether within a given country or across national frontiers). Knowledge on virus infections in reptiles is still limited. Therefore, as a matter of principle, individuals in which virus infection is proven or suspected should not be relocated. In the context of bacterial diseases, particular attention should be paid to detection of *Salmonella* or mycobacterial infections. Whenever inflammatory skin lesions are present in reptiles, mycosis should be considered as a possible cause, and such animals should be excluded from any transport. It is absolutely essential to prevent any spreading of amoebic dysentery, as this disease is almost always fatal to

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TABLE I
The most common infectious diseases of reptiles

Disease/agent	Affected animals	Diagnosis
Viruses		
'Grey patch disease'	Atlantic green turtle (<i>Chelonia mydas</i>)	Necrosis and pustules in epidermis
<i>Herpesvirus</i>	Pacific pond turtle (<i>Clemmys marmorata</i>), painted turtle (<i>Chrysemys picta elegans</i>)	Liver necrosis, oedema, muscular lesions
	Asian cobra (<i>Naja naja</i>), banded krait (<i>Bungarus fasciatus</i>)	Lung and liver necroses, inflammation of venom gland
<i>Paramyxovirus</i>		
Fer-de-Lance virus	Snakes (Serpentes)	Bronchopneumonia
Paramyxoviroid virus	Snakes (Serpentes)	Upper digestive tract, pneumonia, encephalomyelitis, CNS disorders
<i>Oncornavirus</i>		
Viper C-type virus	Russell's viper (<i>Vipera russelli</i>)	Myxofibroma
C-type virus	Boa constrictor (<i>Boa constrictor</i>)	Leukaemia
Corn snake virus	Timber rattlesnake (<i>Crotalus horridus</i>), corn snake (<i>Elaphe guttata</i>)	Virus isolation
<i>Arbovirus</i>		
Western equine encephalitis	Painted turtle (<i>Chrysemys picta elegans</i>)	Antibody detection in up to 89% of the population
Eastern equine encephalitis	Common garter snake (<i>Thamnophis sirtalis</i>)	Antibody detection in up to 89% of the population
	South American snakes	Antibody detection in up to 89% of the population
Japanese B encephalitis	Chinese soft-shelled turtle (<i>Trionyx sinensis</i>)	Antibody detection in up to 89% of the population
St Louis encephalitis		
Powassan virus	Asian cobra (<i>Naja naja</i>)	Antibody detection in up to 89% of the population

Bacteria

Salmonella, sub-genus

I-IV (1,800 types)

Aeromonas hydrophila,

A. liquefaciens,

A. punctata

Pseudomonas aeruginosa

Streptococcus

(including polyinfections)

Mycobacterium marinum,

M. fortuitum, *M. thermophiles*,

M. ulcerans, *M. avium*

Mycoses

Dermatomycoses

Candida albicans

Dematiaceae spp.

Aspergillus spp.

Geotrichum candidum

Fusarium spp.

Mucor spp.

Systemic mycoses

Aspergillus spp.

Mucor spp.

Penicillium spp.

Candida spp.

Paecilomyces spp.

CNS: central nervous system

All reptile species

All reptile species

All reptile species

All reptile species

All reptile species

All reptile species

All reptile species

All reptile species

All reptile species

All reptile species

All reptile species

All reptile species

All reptile species

Tortoises (Testudines)

All reptile species

All reptile species

Systemic inflammatory processes in all organs, above all digestive tract (latent carriers show no clinical signs)
Gastroenteritis, necrotic hepatitis, pneumonia

Inflammatory processes in lung and air sac, granuloma, liver degeneration

Pneumonia with milary foci, serositis

Focal granuloma in lung, liver, kidney, intestinal tract

Carapace necroses, ulcerations in oral cavity

Maxillary abscess, carapace necroses

Ulceration (skin), giant cells, dermal scab, dermatitis

Dermal mycosis, dermal pustules

Dermatitis, granuloma, eye lesions, keratitis

Hyperkeratosis, dermal pustules

Pneumonia, serous granuloma, liver necrosis

Upper digestive tract, ulcerative inflammation

Pneumonia

Lesions in digestive organs

Pneumonia, systemic mycosis

TABLE II
Common parasites of reptiles

Parasite	Affected animals	Diagnosis
Protozoa		
<i>Hexamita parva</i>	Tortoises (Testudines)	Nephritis, enteritis, hepatitis
<i>Entamoeba invadens</i>	All reptile species	Diphtheroid necrotic enteritis (hindmost third of intestinal tract), necrotic hepatitis, gastritis, nephritis
<i>Eimeria</i> spp., <i>Isospora</i> spp.	All reptile species	Jejunitis, hepatitis (coccidiosis)
<i>Cryptosporidia</i> spp.	All reptile species	Gastritis, enteritis
<i>Sarcocystis</i> spp.	All reptile species as intermediate hosts	Muscle infestation
Plathelminthes		
Trematoda	All reptile species	Localised in all organs (many species), digestive organs preferred
Cestoda	All reptile species	Damage to intestinal mucosa, discharge of toxic metabolites
Nemathelminthes		
Trichurioidea (<i>Capillaria</i> spp.)	All reptile species	Skin lesions
Rhabditoidea	All reptile species	Localised in lung and pleural cavity, intestinal tract, catarrhal enteritis
Oxyuroidea (many species)	All reptile species, especially tortoises (Testudines) and lizards (Sauria)	Infestation of colon, constipation
Ascaroidea (fifty species)	All reptile species	Necrotic gastroenteritis; mobility, vision and hearing impaired by migration of larvae
Filaroidea	All reptile species	Macrofilariae: cutaneous and sub-cutaneous defects, necrotic inflammation of organs accompanied by secondary infections
Acanthocephala	All reptile species	Intestinal perforation
Arthropoda		
Mites (Acari)		
<i>Ophionyssus natricis</i>	All reptile species	Anaemia by blood withdrawal
Ixodid ticks (Ixodes)	All reptile species, especially tortoises (Testudines) and lizards (Sauria)	Virus transvectors, tick paralysis, toxicosis
Bugs (Actiniedida)	All reptile species	Larvae only, crater-shaped skin lesions, cutaneous pustules
Insects (Insecta)		
Flesh flies (Calliphoridae)	All reptile species	Myiasis, secondary infection
Pentastomida		
Linguatula	All reptile species	Exudative pneumonia (cephalic hooks in lung tissue)

reptiles, and all individuals suffering from this disease (or even when this is only suspected) must be excluded from transport. If severe parasitisation is established by general examination, transport should not be permitted until de-worming has been accomplished. The same applies to acariosis.

Husbandry practices which are conducive to the spread of disease in a facility

Optimum keeping of reptiles in captivity calls for an understanding of reptile biology. Size and structure of terraria must be adjusted to the species to be accommodated, and overcrowding must be avoided. Temperature and humidity must be properly adapted to the reptiles concerned. Floor heating and radiators must be installed in such a way as to rule out overheating or burns. Running water must not be allowed to flow through several terraria, to avoid spreading pathogens. Turtles may be asymptomatic carriers of virulent amoebae, and may excrete these organisms. Hence, turtles should not be kept together with lizards or snakes. Stringent hygiene is essential in reptile keeping and should include daily cleaning of terraria, if possible, with separate cleaning utensils used for each terrarium. Construction materials chosen for terraria should be easy to disinfect. Drinking containers and bathing pools should be of safe construction to prevent injury.

Appropriate and hygienically-safe transport of reptiles remains a problem. Transportation of 20,000 turtles on one truck is a notorious example (1). Crates were piled on top of each other, stimulating transmission of bacterial infections (e.g. *Salmonella*). When the piles of crates were sprayed with water, faeces were flushed from one crate to another.

Thorough necropsy of deceased individuals is a major element of an optimal reptile-keeping system. This is the only means to ensure early detection and treatment of a stock infection. Wooden terraria should be destroyed after any occurrence of amoebosis, as safe disinfection may not be possible. Optimal feeding is essential to good general condition, and consultation with experts is indispensable. Under no circumstances should imported animals ever be added to existing stock without prior quarantine. Visibly pregnant animals should not be translocated, as egg binding is a great risk to reptiles.

Diseases of other species which may affect Reptilia

Diseases of other animal species rarely cause infection in reptiles. Salmonellosis in turtles and cases of avian tuberculosis are exceptions. To date, no studies have been conducted on disease differences between free-ranging reptiles, on the one hand, and reptiles in captivity, on the other.

Development of infectious diseases not found in free-ranging populations

There are no known examples of captive reptiles being affected by infectious diseases not found in free-ranging populations.

Optimal husbandry practices for Reptilia

A full description of optimum reptile-keeping conditions is beyond the scope of this paper. Distinct conditions are required by each of the following orders: turtles (Pleurodira, Cryptodira), tuataras (*Sphenodon punctatus*), crocodiles (Crocodylia), lizards (Sauria) and snakes (Serpentes). In addition, some species within these five

orders live in water, while others live on land; different species may require different ambient temperatures and feeds. Nevertheless, all these species share the need for stress and overcrowding to be avoided, as well as the demand for optimal temperature and sufficient terrarium space.

Zoonoses of concern in Reptilia

Salmonellosis in reptiles is of particular importance, after sound evidence was produced to the effect that *Salmonella* infections had been transmitted from turtles to human children, which led to legal restrictions on turtle trade in the United States of America.

Amoebic dysentery is of most serious relevance to reptiles. This disease is fatal in almost all cases, and may be transmitted between animals via contaminated drinking water, infected cleaning tools, pathogen shedding by turtles with latent infection, and oral ingestion of pathogens. Incorporation of an amoeba carrier into an existing stock without prior quarantine has been the most common source of introduction. Reptilian amoebosis cannot be transmitted, however, from reptiles to birds or mammals.

Mycobacterial infections are rare in reptiles and should not be considered to be zoonoses. The only – and rare – exception which might threaten other animal species or humans is *Mycobacterium avium*.

AMPHIBIANS

Infections introduced from the wild, which are influenced by husbandry practices

The main husbandry practices in use which may exacerbate infections are as follows:

- inadequate transportation prior to arrival at the facility
- inappropriate housing
- overcrowding
- poor conditions of hygiene
- inanition due to inadequate or unpalatable food.

Such factors may influence infestations by helminths with a direct cycle or by intestinal protozoa, and possibly Lucké virus infection.

Diseases of concern for interstate or international movements of captive animals

Little is known about the spread of diseases which may have consequences for amphibian populations (Tables III and IV) transported to a different state or country. The Lucké virus has definitely been transported to other states and countries. As this virus is almost exclusively confined to the northern leopard frog (*Rana pipiens*), however, it has not caused any major epidemics. To date, exported diseases have caused only isolated deaths. There are no indications whatsoever that the mass mortalities due to either poxvirus or herpesvirus infections in Europe have been caused by imported agents.

Husbandry practices which are conducive to the spread of disease in a facility

Supplying several terraria with water from a single source, and allowing the water to run through successive terraria, may contribute to a serious outbreak of diseases such as tuberculosis, salmonellosis and chlamydiosis, and infestations with intestinal

TABLE III
The most common infectious diseases of amphibians

Disease/agent	Affected animals	Diagnosis
Viruses		
Lucké virus	Northern leopard frog (<i>Rana pipiens</i>)	Renal adenocarcinoma
Erythrocytic virus	Striped frog (<i>Limnodynastes ornatus</i>) Savannah ridged frog (<i>Ptychadena anchietae</i>) Giant marine toad (<i>Bufo marinus</i>)	Erythrocytes affected Anaemia
Poxvirus	Edible frog	Mass mortality, dermal defects
Herpesvirus	Edible frog	Mortality, dermal pustules
Bacteria		
Red-leg disease (<i>Aeromonas hydrophila</i>)	All Amphibia	Generalised infection: – peracute cases: death – (sub)acute cases: local hyperaemia of skin
Tuberculosis (<i>Mycobacterium xenopi</i> , <i>M. marinum</i> , <i>M. ranae</i>)	All Amphibia	Emaciation, death
Flavobacteriosis (<i>Flavobacterium indologenes</i>)	Northern leopard frog	Oedemata, dermal petechiation
Salmonellosis	All Amphibia	Systemic inflammatory processes (of minor importance)
Chlamydiosis (<i>Chlamydia psittaci</i>)	Clawed toad (<i>Xenopus laevis</i>)	Septicaemia
Mycoses		
Dermatomycoses		
<i>Saprolegnia parasitica</i> , <i>Cladiosporum</i> spp. and other opportunistic organisms	All larval and metamorphosed Amphibia Eggs	Whitish mass on skin Dermal ulceration Whitish discolouration
<i>Basidiobolus ranarum</i>	Dwarf clawed frog (<i>Hymenochirus</i> sp.) and other Amphibia	No clinical signs High mortality
Systemic mycoses		
<i>Hormodendrum dermatitidis</i>	Many species of frogs	Generalised infection Granulomata in organs Dermal ulceration
<i>Fonsecaea pedrosoi</i>	Giant marine toad and other species of toads	Generalised infection Granulomata in organs

TABLE IV
Common parasites of amphibians

Parasites	Affected animals	Diagnosis
External protozoa		
<i>Trichodina</i> , <i>Costia</i> , <i>Vorticella</i>	Aquatic Amphibia Larvae of all Amphibia	Irritation, cloudiness of skin, skin produces mucus
<i>Carchesium polysinum</i>	Amphibian larvae	Infection of gills High mortality
<i>Oodinium pillularis</i>	Aquatic Amphibia Larvae of all Amphibia	Irritation, restlessness, death
Internal protozoa		
Sarcomastigophora and Flagellates spp. (indeterminate)	All Amphibia	In case of massive infection, enteritis and death
<i>Ciliophora</i> spp. (ciliates) and <i>Balantidium ranae</i>	All Amphibia	Enteritis and death
<i>Trichodina xenopodos</i>	African clawed frog (<i>Xenopus laevis</i>) and other species of frogs	Infection of urinary bladder
<i>Entamoeba ranae</i>	Frogs	Enteritis, necrotic hepatitis
<i>Eimeria</i> spp. (coccidiosis) and <i>Isopora</i> spp.	All Amphibia	Enteritis, emaciation, diarrhoea, death
<i>Myxobolus hylae</i>	Frogs (several species)	Foci in testicles
<i>Myxobolus ranae</i>	European common frog (<i>Rana temporaria</i>)	Tumor-like growth
<i>Dermocystidium granulosum</i>	All Amphibia	Cysts in the skin
<i>Dermosporidium granulosum</i>	Aquatic Amphibia and European common frog	Granulomata in subcutis
<i>Pleistophora myotrophica</i>	European common toad (<i>Bufo bufo</i>)	Myositis, emaciation
Plathelminthes		
Trematoda		
Monogenea	Larval Amphibia	Dermal infection (rare)
Digenea (many species)	Metamorphosed Amphibia	Localised in all organs (especially in digestive tract and lungs) Metacercaria cause dermalpustulae
Cestoda (many species)		
<i>Spirametra mansoni</i> (tapeworm of the domestic cat)	Giant marine toad (<i>Bufo marinus</i>)	Emaciation

TABLE IV (contd)

Parasites	Affected animals	Diagnosis
Plathelminthes (contd)		
Nematoda		
Rhabditoidea	All Amphibia	Predominantly localised in lungs
Oxyuroidea (many species)	All Amphibia	Predominantly intestinal infections Emaciation, death Occasionally, prolapse of the cloaca
<i>Capillaria</i> spp.	Frogs	Dermal lesions
Leeches	Frogs	Localised dermal lesions
Copepoda		
Fish lice	Larval Amphibia	Minor dermal lesions
<i>Argulus foliaceus</i>	Larval Amphibia	Death
<i>Lernaea cyprinacea</i>	Larval Amphibia	Local dermal inflammation
Acarina		
Trombiculidae (<i>Hannemania dunni</i> , <i>H. penetrans</i>)	Frogs	Dermal vesicles
Arthropoda		
Insects (Insecta)	Toads	Myiasis of the nares, secondary infection
Flesh flies (Calliphoridae) (<i>Lucilia bufonivora</i>)		

protozoa. Inadequate husbandry practices – e.g. overcrowding, overheating, insufficient streaming movement of water supply, and the presence of proteinaceous substances (remains of food) – are essential factors in outbreaks of red-leg disease. Biological filtering systems may be heavily polluted by helminth larvae or eggs (e.g. *Lernaea*). Frequent introduction (without prior quarantine) of new animals obtained from other facilities may result in overcrowding, importation of a new disease, or an explosive outbreak of a subclinical disease.

Diseases of other species which may affect Amphibia

Aquatic Amphibia and larvae may become infected by diseases affecting other species, and especially by parasites of fish. The following parasites are of particular importance:

- protozoa (e.g. *Trichodina* spp., *Costia* spp., *Vorticella* spp., *Oodinium pillularis* and *Dermosporidium granulorum*)
- copepods (e.g. *Argulus foliaceus* and *Lernaea cyprinacea*).

A remarkable instance of infestation with a parasite from a remote host is the occurrence of the domestic cat tapeworm (*Spirametra mansoni*) in the giant marine toad (*Bufo marinus*).

Development of diseases not found in the free-ranging population

Although the Amphibia have evolved over long periods, they are generally considered as a group. There is only sparse information about the occurrence of diseases in the wild. Detailed information is lacking on whether a given disease does or does not occur in a specific species in the wild. It is therefore impossible to speculate on whether or not any disease contracted by captive Amphibia from a different species living in close proximity also exists in the free-ranging amphibian population.

Optimal husbandry for Amphibia

In view of the existence of approximately 4,000 amphibian species, a full description of optimal husbandry practices is beyond the scope of this paper. A distinction should be observed between land-dwelling species and aquatic species. With the exception of ovoviparous species, larval Amphibia are generally aquatic. Some larvae are cannibalistic and should be kept isolated.

In general, Amphibia are maintained at near room temperature ($\pm 20^{\circ}\text{C}$) in an environment with high humidity, and are provided with sufficient shelter and a water basin.

Some species – such as the clawed frog (*Xenopus laevis*) and the axolotl (*Ambystoma mexicanum*) – are well-known laboratory animals. Detailed data about the husbandry of these species are presented in the University Federation for Animal Welfare handbook (see 'Recommended further reading' below). Live modified vaccines are not in use in Amphibia.

Zoonoses of concern in Amphibia

Mycobacterium marinum is known to occur in Amphibia and is a potential zoonotic agent. Intensive contact, especially with human skin soaked by water (e.g. laboratory personnel working with tanks in which aquatic Amphibia are kept) can lead to localised dermal ulceration.

No data are available on the risks of chlamydiosis as a zoonosis.

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LES MALADIES INFECTIEUSES ET PARASITAIRES DES REPTILES ET DES AMPHIBIENS EN CAPTIVITÉ, ET NOTAMMENT LES EFFETS DES MODES D'ÉLEVAGE SUR LA PRÉVENTION OU LE DÉVELOPPEMENT DE CES MALADIES. – R. Ippen et P. Zwart.

Résumé : Reptiles et amphibiens sont élevés en captivité depuis plus d'un siècle. Les auteurs exposent les pratiques d'élevage qui garantissent les meilleures conditions sanitaires, et qui sont connues pour certaines espèces, tandis que pour d'autres, les connaissances en la matière restent incomplètes. Les auteurs présentent les maladies infectieuses et parasitaires des reptiles et des amphibiens sous forme de tableaux, complétés par une bibliographie à l'intention de tous ceux qui recherchent des informations plus détaillées sur ces sujets.

MOTS-CLÉS : Amphibiens – Elevage – Maladies infectieuses – Maladies parasitaires – Reptiles.

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ENFERMEDADES INFECCIOSAS Y PARASITARIAS DE LOS ANFIBIOS Y REPTILES EN CAUTIVIDAD, CON ESPECIAL REFERENCIA A LAS PRÁCTICAS DE CRÍA QUE PREVIENEN O FAVORECEN LA APARICIÓN DE ENFERMEDADES. – R. Ippen y P. Zwart.

***Resumen:** Los reptiles y los anfibios han sido mantenidos en cautividad desde hace más de un siglo. Los autores exponen las prácticas de manejo y cría que garantizan un estado de salud óptimo: para algunas especies, éstas son conocidas, mientras que para otras especies se carece de tal información. Las enfermedades infecciosas y parasitarias son presentadas en forma de cuadros, y se proporciona además un cierto número de referencias bibliográficas para todos aquellos interesados en una información más detallada.*

PALABRAS CLAVE: Amphibia – Cría – Enfermedades infecciosas – Enfermedades parasitarias – Reptiles.

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Recommended further reading

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