

## EMERGING DISEASES ASSOCIATED WITH “NEW COMPANION ANIMALS”: REVIEW IN ZOONOSES TRANSMITTED BY REPTILES

Ioana LUPESCU, Stelian BARAITAREANU

University of Agronomic Sciences and Veterinary Medicine of Bucharest, Veterinary Medicine  
Campus, 105 Splaiul Independentei, District 5, Bucharest, Romania,  
Phone: +4021.411.11.22, Fax: + 4021.401.11.22, Email: doruvet@gmail.com

Corresponding author email: doruvet@gmail.com

### Abstract

Several zoonoses, including rare human diseases, can be transmitted by primates, exotic rodents, lagomorphs and carnivores, marsupials, bats, fish, amphibians and reptiles which are held in households as companion animals. Over the past few years, the interest in wild animals as pets has increased and this interest can also be observed in Romania. The risk of owning wild animals is significant because over 70% of zoonotic emerging infections originate in wildlife. Pathogens can be transmitted to humans through direct contact (e.g. *Salmonella* spp., *Klebsiella* spp., *Enterobacter* spp., *Aspergillus* spp., *Candida* spp., Mites), puncture wounds (e.g. *Aeromonas* spp., *Mycobacterium* spp., Zygomycosis, Phycomycosis, Mucormycosis), ingestion (e.g. *Salmonella* spp., *Aeromonas* spp., *Campylobacter* spp., *Gnathostomiasis*) or inhalation (*Mycobacterium* spp., *Aspergillus* spp., *Candida* spp.).

In this paper, we reviewed zoonoses and zoonotic agents that can be transmitted by reptiles. To identify pathogens frequently involved in zoonoses transmitted by reptiles, we studied official reports of WHO and scientific papers published in the last ten years. The following diseases were analysed: salmonellosis, tuberculosis (*Mycobacterium marinum*), campylobacteriosis, Q-fever, Baker-Rosenbach's erysipeloid, *Edwardsiella tarda* infection and *Aeromonas* infection. The numbers of pathogens that can be transmitted by exotic pets and the severity of diseases that these pathogens cause to humans and other animals can be high. However, reptiles weren't involved in severe zoonoses outbreaks, and the probability of introducing a severe zoonosis in endemic regions seems to be low. Unfortunately, pet owners don't take into consideration the diseases that their animals can transmit, they do not ask for specialists' recommendations and they ignore the preventive measures that should be taken. As a conclusion, the reptile keepers should consider preventive measures, such as: (1) rigorous personal hygiene after contact with an exotic animal; (2) the use of protective equipment, especially when handled animals are showing clinical signs of disease; (3) isolation and treatment of ill animals; (4) periodic cleaning and disinfecting of the accommodation cages.

**Key words:** *Campylobacter fetus*, *Coxiellaburnetii*, *Erysipelothrix rhusopathiae*, *Salmonella*, *Mycobacterium marinum*.

### INTRODUCTION

In many developed countries, more and more exotic animal species are considered as “pets”. Primates, exotic rodents, lagomorphs, carnivores, marsupials, bats, fish, amphibians and reptiles which are held in households can transmit zoonotic agents, including pathogens involved in rare human diseases (Johnson-Delany, 1996; Acha and Szyfres, 1989).

Over the past few years, the interest in wild animals as pets has increased and this interest can also be observed in Romania. Due to human curiosity and eccentricity, more and more species of reptiles are bred as pets nowadays.

However, the reptile owners are less aware of the possibility of contracting infections caused

by zoonotic pathogens hosted by reptiles (Merck, 2014).

The risk of owning wild animals is significant because 71.8% of zoonotic emerging infections originate in wildlife, and are continuously increasing over time (Jones et al., 2008).

Pathogens can be transmitted to humans by the following routes:

- direct contact: *Salmonella* spp., *Klebsiella* spp., *Enterobacter* spp., *Aspergillus* spp., *Candida* spp., Mites;
- puncture wounds: *Aeromonas* spp., *Mycobacterium* spp., *Mucorales* mold infections, *Entomophthorales* mold infections, *Basidiobolus* mold infections;
- ingestion: *Salmonella* spp., *Aeromonas* spp., *Campylobacter* spp., *Gnathostoma* sp. migrating third-stage larvae infestations;
- inhalation: *Mycobacterium* spp., *Aspergillus*

spp., *Candida* spp. (Johnson-Delany, 1996; Acha and Szyfres, 1989).

*Salmonella* spp. infections of humans are characterised by fever, nausea and vomiting, acute gastroenteritis with abdominal pain, bloody mucoid diarrhea, urinary tract infections, meningitis and osteomyelitis (Acha and Szyfres, 1989). *Aeromonas* spp. infections are expressed by fever, gastroenteritis, soft-tissue and muscle infections, septicaemia, and skin diseases (Igbiosa et al., 2012). *Campylobacter* spp. infections were mainly described at young people as acute gastroenteritis with fever, nausea, vomiting, diarrhea and cramps (Johnson-Delany, 1996; Acha and Szyfres, 1989). *Klebsiella* spp. and *Enterobacter* spp. produce urinary tract infections and septicaemia in humans (Acha and Szyfres, 1989). *Yersinia* spp. infections produce acute, painful gastroenteritis, nephritis, arthritis, mesenteric lymphadenitis, terminal ileitis, and septicaemia in humans (Soto et al., 2013). *Mycobacterium* spp. may produce either circumscribed cutaneous granulomatous disease at infection site, or disseminated respiratory disease in immunocompromised individuals (Johnson-Delany, 1996; Acha and Szyfres, 1989). Common manifestations of *Entomophthorales*, *Basidiobolus* or *Mucorales* molds after inhalation, ingestion, or inoculation were pulmonary (30%), rhinocerebral (27%), soft tissue (26%) and disseminated disease (15%) (Skiada et al., 2005). *Aspergillus* spp. produce pulmonary, thyroid, brain and myocardium infections. *Candida* spp. produce white plaques on oral mucosa and skin-fold dermatitis in humans (Godet et al., 2014). *Cryptosporidium* produces persistent diarrhea in immunocompromised patients. *Gnathostoma* spp. migrating third-stage larvae produce nausea, salivation, pruritus, edema, urticaria, and stomach discomfort in humans; also, larvae that migrate to other organs produce local inflammation and/or specific organ diseases. Mites produce papular, vesicular, or bullous lesions with variable pruritus in humans (Johnson-Delany, 1996; Acha and Szyfres, 1989).

In this paper, we reviewed zoonoses and zoonotic agents that can be transmitted by reptiles.

## MATERIALS AND METHODS

To identify pathogens that are frequently involved in zoonoses transmitted by reptiles, we studied official reports of WHO and scientific papers published in last years.

The following diseases were analysed: salmonellosis, tuberculosis (*Mycobacterium marinum*), campylobacteriosis, Q-fever, *Baker-Rosenbach's erysipeloid*, *Edwardsiella tarda* infection and *Aeromonas* infection.

## RESULTS AND DISCUSSIONS

The numbers of pathogens that can be transmitted by exotic pets and the severity of diseases that these pathogens cause to humans and other animals can be high (Johnson-Delany, 1996; Acha and Szyfres, 1989).

### Salmonellosis

Salmonellosis is the most important zoonosis transmitted by reptiles. These unusual companion animals can host *Salmonella* in their digestive tract and excrete it in faeces, without showing any symptoms of disease. (Acha and Szyfres, 1989; Vial, 2001; Mooney, 2002). Due to the increasing number of snakes kept in captivity as pets, the cases of human salmonellosis increased, mainly among children and teenagers. Also, immunosuppressed persons have high risk of infection, developing severe forms of septicaemia and meningitis (Mooney, 2002).

For example, the isolation of *Salmonella enterica* subspecies Houtenae serovar Marina from clinical cases of humans increased from 2 cases in 1989, to 47 cases in 1998, and clinical cases of salmonellosis caused by *Salmonella enterica* subspecies Houtenae serovar Poona, increased from 199 cases in 1989 to 341 cases in 1998 (Schröter et al., 2004).

The main serotypes isolated from patients that contracted *Salmonella* infections from reptiles are:

- *S. enterica* subspecies Biarizonae (IIIb) [rhinoceros viper (*Bitis nasicornis*), eyelash viper (*Bothriechis schlegelii*)]
- *S. enterica* subspecies Houtenae (IV) serovar Chameleon and Marina
- *S. enterica* subspecies Enterica (I) serovars Java, Stanley and Poona (Schröter et al., 2004).

The main routes of transmission from reptiles to humans are fecal-oral and through contact with contaminated surfaces and objects.

In humans, salmonellosis characteristic symptoms are nausea, diarrhea, vomiting, abdominal pain, septicemia, hepatitis, and meningitis (Acha and Szyfres, 1989; Vial, 2001; Mooney, 2002; Cornwell Univ, 2015).

### **Tuberculosis (*Mycobacterium marinum*)**

The bacterial species isolated from reptiles are *M. avium*, *M. ulcerans*, *M. chelonae*, *M. haemophilum*, and *M. marinum*. Bacteria are transmitted to humans by reptile scratches or bites, inhalation or contact with contaminated surfaces (Cornwell Univ, 2015). Mycobacterial infections are commonly associated with wasting syndrome in imported wild reptiles and can be identified as granulomatous lesions at the necropsy examination. Chelonians mainly develop pulmonary infection, while lizards, snakes and crocodylians usually develop visceral granulomas (Merck, 2014). After the infection, humans develop granulomas usually located at the hands or fingers, and respiratory infections (Cornwell Univ, 2015).

### **Campylobacteriosis**

The etiologic agents are *Campylobacter* spp, (Merck, 2014). Reptiles are asymptomatic carriers. Human infection is manifested by diarrhea, abdominal pain, and fever. Bacteria are transmitted by fecal-oral route or by contact with contaminated surfaces or objects (Cornwell Univ, 2015). *Campylobacter fetus* subsp. *fetus* of reptile origin was isolated from the blood of a febrile human patient with precursor T-cell acute lymphoblastic leukemia. Therefore, the bacterium is an opportunistic pathogen that has the ability to produce bacteremia in debilitated hosts (Tu et al., 2004).

### **Q-fever**

Q fever is a zoonosis caused by *Coxiella burnetii*. *C. burnetii* infects various hosts, including humans and reptiles. Humans can acquire infection from reptiles by inhalation or skin contact. The pathogenic agent can be found everywhere, except New Zealand (Cutler et al., 2007). Farmers, laboratory workers and veterinarians have the highest risk of *Coxiella* sp. infection. Clinical signs of Q fever can be

self-limited flu-like syndrome, atypical pneumonia, hepatitis, maculo-papular or purpuric exanthema, pericarditis and/or myocarditis, severe headache, aseptic meningitis and encephalitis (Honarmand, 2012).

### ***Edwardsiella tarda* infection**

*Edwardsiella tarda* is a Gram negative bacterium, similar to *E. coli* (Chomelet al., 2015). It was isolated from reptiles with normal clinical status. The zoonotic nature of the commensal microorganism is an aspect that must be considered when handling or treating reptiles. Trying to eliminate *Edwardsiella tarda* from reptiles and their eggs was unsuccessful and it is not recommended (Merck, 2014). *Edwardsiella tarda* causes gastroenteritis in humans (Chomelet al., 2015).

### ***Baker-Rosenbach's erysipeloid***

Baker-Rosenbach's erysipeloid is produced by *Erysipelothrix rhusiopathiae* (formerly *E. insidiosa*), an occupational pathogen that can produce localized cutaneous lesions, chronic granulomatous cheilitis, septicemia and endocarditis in humans (Koufane, 2010). A study conducted in Australia revealed several serotypes of *E. rhusiopathiae* in snakes (Eamen et al., 1988).

### ***Aeromonas* infection**

The reptiles develop ulcerative stomatitis lesions, sepsis, bleeding, anorexia, pneumonia or may be asymptomatic. Systemic diseases caused by *Aeromonas* spp. in reptiles can be preceded by trauma, local abscesses, parasitism or stress induced by environmental conditions. The bacterium is transmitted by ectoparasites. Death can be sudden or may be the result of a long period of illness. In the last stage of disease, the signs are respiratory failure, convulsions and incoordination. Petechiae and erythema can be observed on the plastron. Sanitation and medical care are important factors in reducing the incidence of disease. Reptiles showing infection should be isolated, and antibiotic therapy initiated (Merck, 2014). It is transmitted to humans by contact of wounded skin with contaminated water, accidental ingestion of contaminated water or tissue, bites or scratches caused by aquatic reptiles (Cornwell Univ, 2015).

Signs of infection in humans are profuse diarrhea, fever, abdominal pain, vomiting, and infected wounds.

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However, reptiles weren't involved in severe zoonoses outbreaks, and the probability of introducing a severe zoonosis in endemic regions seems to be low.

Unfortunately, pet owners don't take into consideration the diseases that their animals can transmit, they do not ask for specialists' recommendations and they ignore the preventive measures that should be taken.

## CONCLUSIONS

The scientific data support the risk of bacteria, moulds and parasites transmission from pet reptiles to humans.

Therefore, reptile keepers should consider preventive measures, such as: (1) rigorous personal hygiene after contact with an exotic animal; (2) the use of protective equipment, especially when handled animals are showing clinical signs of disease; (3) isolation and treatment of ill animals; (4) periodic cleaning and disinfecting of the accommodation cages.

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