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Amphibians and reptiles as a source of Salmonella – a review of Salmonella outbreaks in a period of last ten years

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**Introduction**

Increasing trends of keeping reptiles and amphibians as pets have been observed. These vertebrates can be asymptomatic carriers of *Salmonella* species and can cause infection by transmission of pathogen to humans, especially in infants, young children and people with immunodeficiencies.

**Goal**

The goal of this review is to document the most dangerous outbreaks of salmonellosis caused by contact with amphibians and reptiles that appeared in last ten years. This review is based on the analysis of the available literature.

**Salmonellosis**

*Salmonella* strains isolated from amphibians and reptiles differ genetically from strains isolated from humans. The differences rely mainly on the activation of virulence factors that cause pathogenicity in humans.

**Examples of vertebrates**

- *Pogona vitticeps*
- *Timon lepidus*
- *Alligator mississippiensis*
- *Bufo marinus*
- *Hemidactylus frenatus*
- *Caiman yacare*
- *Anolis carolinensis*

**Table 1:** The most often isolated from amphibians and reptiles *Salmonella* strains causing outbreaks

<table>
<thead>
<tr>
<th>Year of outbreak</th>
<th>Isolated pathogen</th>
<th>Species of vertebrates</th>
<th>Reference</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td><em>S. enterica</em> subsp. <em>arizonae</em></td>
<td><em>Pantherophis guttatus</em></td>
<td>1</td>
<td>France</td>
</tr>
<tr>
<td>2011</td>
<td>*S. Parathyphii B var. L (+)</td>
<td>Small turtles</td>
<td>5</td>
<td>USA</td>
</tr>
<tr>
<td>2012</td>
<td><em>S. Amsterdam, S. Poona, S. Barey</em></td>
<td><em>Naja kaouthia, Hoplobatrachus rugulosus</em></td>
<td>6</td>
<td>Thailand</td>
</tr>
<tr>
<td>2017</td>
<td><em>S. Oranenburg</em></td>
<td><em>Pogona vitticeps</em></td>
<td>7</td>
<td>Czech Republic</td>
</tr>
<tr>
<td>2015</td>
<td><em>S. Weltevreden</em></td>
<td><em>Hemidactylus frenatus</em></td>
<td>11</td>
<td>Costa Rica</td>
</tr>
<tr>
<td>2012</td>
<td><em>S. Tennessee 6,7:t29:</em></td>
<td><em>Pogona vitticeps</em></td>
<td>2</td>
<td>Germany</td>
</tr>
<tr>
<td>2017</td>
<td><em>S. Pomona</em></td>
<td><em>Alligator mississippiensis</em></td>
<td>8</td>
<td>USA</td>
</tr>
<tr>
<td>2016</td>
<td><em>S. enterica subsp. houtenae serovar IV 43::I2::t2:</em></td>
<td><em>Agkistrodon bilineatus taylori</em></td>
<td>9</td>
<td>USA</td>
</tr>
<tr>
<td>2016</td>
<td><em>S. Thompson</em></td>
<td>Pet turtles</td>
<td>10</td>
<td>China</td>
</tr>
<tr>
<td>2014</td>
<td><em>S. Saintpaul, S. Mississippi</em></td>
<td><em>Sphenodon punctatus, Pachypeltis turtur, Oligosoma spp.</em></td>
<td>12</td>
<td>New Zealand</td>
</tr>
<tr>
<td>2012</td>
<td><em>S. Newport 6,8,e:1,2:f6</em></td>
<td><em>Pantherophis guttatus</em></td>
<td>2</td>
<td>Germany</td>
</tr>
<tr>
<td>2014</td>
<td><em>S. Oranenburg</em></td>
<td><em>Anolis carolinensis</em></td>
<td>13</td>
<td>Japan</td>
</tr>
<tr>
<td>2014</td>
<td><em>S. Pomona</em></td>
<td><em>Trachemys scripta elegans</em></td>
<td>14</td>
<td>China</td>
</tr>
<tr>
<td>2011</td>
<td><em>S. Kubisi, S. enterica subsp. salamae serovars 41::I2::t6 and 18::I2::t6</em></td>
<td><em>Timon lepidus</em></td>
<td>15</td>
<td>Spain</td>
</tr>
<tr>
<td>2011</td>
<td><em>S. infantis, S. nottingham</em></td>
<td><em>Caiman yacare, Caiman latirostris</em></td>
<td>16</td>
<td>Argentina</td>
</tr>
<tr>
<td>2013</td>
<td><em>S. Thompson, S. Typhimurium</em></td>
<td><em>Emys orbicularis Trachemys scripta elegans</em></td>
<td>3</td>
<td>Spain</td>
</tr>
<tr>
<td>2013</td>
<td><em>S. Javiana, S. Rubislaw</em></td>
<td><em>Bufo marinus</em></td>
<td>17</td>
<td>Grenada</td>
</tr>
<tr>
<td>2010</td>
<td><em>S. Rubislaw</em></td>
<td><em>Pogona vitticeps</em></td>
<td>4</td>
<td>Australia</td>
</tr>
</tbody>
</table>

**Table 2:** Recommendation of WHO

The World Health Organization (WHO) has made the following recommendations to minimize the risk of salmonellosis, due to RAS salmonellosis (reptile – associated salmonellosis)[18].

- **Clean the amphibians /reptiles’ living area outside the home.**
- **Limit the contact of infants, young children and persons with reduced resistance with reptiles / amphibians.**
- **Avoid keeping reptiles / amphibians in places where meals are prepared or consumed.**
- **Change clothes after each contact with reptiles / amphibians.**
- **Avoid contact with amphibians and reptiles while eating, drinking or smoking.**
- **Don’t kiss or snuggle with reptiles and amphibians.**
- **Wash your hands after each contact with reptiles / amphibians.**

**References**