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Salmonella and *Arizona* Infections of Alimentary and Reproductive Tracts of Panamanian Lizards

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Salmonella and *Arizona* spp. were isolated from various sites of the digestive and reproductive tracts of lizards. The finding that bacteria in the oviducts and in the internal contents of oviductal eggs were of the same serotype raises the possibility that transovarian bacterial transmission in lizards occurs in nature.

The paucity of published information on *Salmonella* infections in wild animals prompted us to investigate the wildlife in rural and jungle areas of Panama (1–4).

In the course of a previous investigation (4), we noted that salmonella organisms of a variety of serotypes are recoverable from several ecologically diverse species of lizards, including species seldom associated with humans. Occasionally, mixed infections caused by organisms of as many as three serotypes were detected in one lizard. This prompted us to determine whether infecting salmonellae localize at multiple anatomical sites of the alimentary and reproductive tracts of lizards. The results of this study are presented below.

Field and laboratory methods used in this study have been previously described (4). Briefly, lizards trapped on a particular day selected at random were used for this study. They were collected in remote rural and forested regions of the country, where prior contact with humans and domestic animals was probably infrequent. To prevent lizards from contaminating one another after capture, we transported them (alive) in individual polyethylene bags to our laboratory in Panama City.

Animals were sacrificed by being intracerebrally injected with pentobarbital sodium; they were then carefully dissected. Selected portions of the digestive and reproductive tracts were transferred aseptically to individual petri dishes, carefully minced with sterile scissors, and transferred to Selenite broth (BBL Microbiology Systems).

The eggs from pregnant females were placed in beakers with 70% alcohol; after 5 min of gentle agitation, the eggs were removed to other beakers and allowed to dry under aseptic conditions. One end of each egg was disinfected with a 7% iodine solution. This area was punctured with a sterile needle, and the internal contents were aspirated with a syringe and inoculated into Selenite broth. All broth cultures were incubated at 37°C, and after 18 h, MacConkey, Salmonella-Shigella, and bismuth sulfite agar plates were inoculated with portions of the broth and incubated overnight. All plates were examined for *Enterobacteriaceae* as previously described (4). *Escherichia coli* isolates were disregarded, and we did not examine the plates for *Yersinia*, *Campylobacter*, or *Vibrio* isolates.

A total of 12 females and 17 males were examined for infection by *Salmonella* spp. and other enterobacterial pathogens. Serotypes of the *Salmonella* and *Arizona* spp. and the species of each lizard from which each organism was isolated are presented in Table 1. The organisms were recovered from multiple areas of the digestive tracts of lizards of both sexes and from the oviducts and eggs of the females. *Salmonella* spp. of similar serotypes were isolated from the eggs, oviducts, and intestines of two pregnant females, whereas in a third pregnant lizard, a *Salmonella* sp. was recovered from an egg and an *Arizona* sp. was recovered from an oviduct. In one female *Ameiva* lizard, *Salmonella rubislaw* and *S. sandiego* were both isolated from the oviduct, and in addition, *S. rubislaw* was recovered from different sites of the digestive tract. In male *Ameiva* lizards, mixed infections caused by salmonellae of as many as three or four serotypes were frequent (Table 1).

Previous studies have shown that infection rates for *Salmonella* and *Arizona* spp. among some lizard species are frequently high and that mixed infections caused by organisms of more than one serotype are quite common (2–4). These organisms may localize at different anatomical sites, or they may show a marked predilection for certain tissues and organs. Perhaps in healthy animals, the infecting organisms remain localized in the digestive tract or in some other

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TABLE 1. *Salmonella* and *Arizona* infections of lizard alimentary and reproductive tracts

Study population[a]	Organism(s) isolated from digestive and reproductive tracts[b]					
	Stomach	Small intestine		Colon	Oviduct	Egg
		Upper	Lower			
Female						
Ameiva ameiva						
Specimen 1	–	–	–	–	–	0
Specimen 2	–	–	–	–	–	–
Specimen 3	–	j	j	a, j	–	0
Specimen 4	–	–	–	k	–	–
Specimen 5	–	–	–	–	–	0
Specimen 6	a	a	a	a	a, b	0
Anolis lionatus	NC	c	–	–	–	–
Anolis pentaprion	NC	–	–	–	–	–
Basiliscus basiliscus	–	–	a	–	a	a
Corytophanes cristatus	NC	NC	–	–	l	a
Polycrus gutturosus	–	–	d	–	d	d
Polycrus gutturosus	NC	–	–	–	–	0
Male						
Ameiva ameiva						
Specimen 7	c, f	e, f	e, f, g	g		
Specimen 8	h, d	e	e, f	e, f		
Specimen 9	–	–	–	–		
Specimen 10	j	–	j	j		
Specimen 11	–	–	–	–		
Specimen 12	–	–	–	–		
Specimen 13	f	–	–	f		
Specimen 14	f	–	e	e, f		
Specimen 15	f	e, f	e, f	e		
Specimen 16	–	–	e	f		
Specimen 17	e	–	f	–		
Specimen 18	e	e	e	e		
Specimen 19	e, f	f	e, f	–		
Specimen 20	a	f, a	f	f		
Anolis frenatus	–	–	–	–		
Iguana iguana	–	i	–	–		
I. iguana	–	–	–	–		

[a] Each species is represented by one lizard, except as noted.

[b] a, *S. rubislaw*; b, *S. sandiego*; c, *S. newport*; d, *S. houten*; e, *S. madelia*; f, *S. miami*; g, *S. bonnaire*; h, *S. carran*; i, *S. wassermaan*; j, *A. hinshawii* (serotype 29:33:31); k, *A. hinshawii* (serotype 26:33:31); l, *A. hinshawii* (serotype 20:23:30). NC, Not cultured; –, negative culture; 0, no eggs in oviducts.

organ system but may, under adverse conditions such as stress, lack of food, or other conditions, pass the lymph-blood barrier and reach the oviducts and eggs. Thus, a natural focus of enteric pathogens can be maintained and the pathogens transmitted by a variety of routes in lizard species in their natural environment.

The finding of bacteria of the same serotype in the oviducts and in the internal contents of eggs of lizard species captured in different localities suggests that the bacteria were present in the oviducts and that the eggs were infected in the early stages of formation in the oviducts. The possibility that this leads to transovarian transmission of salmonellae in lizard species cannot be overlooked. Chicken eggs are known to occasionally harbor pathogenic bacteria. These bacteria reach the interior of the eggs because of a

diseased ovary, an infection of the oviduct, or a contaminating agent penetrating the shell after the egg has been laid, as in the case of *S. pullorum* causing white diarrhea of chicks (5).

Contamination of lizards in their natural environment is a means by which salmonellae and other enteric pathogens can be transmitted in nature, especially through contaminated soil, food, or water. The spread of salmonellae from animal to animal may be directed by way of the food chain. The extensive distribution of lizards and the habits of many species that seem to thrive best in the vicinity of humans underscore the potential role of lizards as incidental carriers and reservoirs of salmonellae (2, 4). Lizards thus offer opportunities for human and domestic animal infection through direct or indirect contact in the rural tropics. This is further compounded by the fact that lizards harbor bacteria of a variety of serotypes in their digestive and reproductive tracts. The isolation of *Salmonella* and *Arizona* spp. from the reproductive systems of the lizards may indicate that transovarian transmission of these organisms takes place in lizard populations in nature. Further studies are required to establish this possibility more precisely.

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