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Authors: EVERARD, C.O.R., TOTA, BRAJIN, BASSETT, DAVID, and ALI, CAMEILLE

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Salmonella IN WILDLIFE FROM TRINIDAD AND GRENADA, W.I.

C.O.R. EVERARD,[1] BRAJIN TOTA,[2] DAVID BASSETT[3] and CAMEILLE ALI[3]

Abstract: Forty-four of 219 animals from Trinidad and Grenada, W.I., yielded 20 serotypes of *Salmonella,* 16 of which are known to have been associated with human infection in the United States in recent years. Toads *(Bufo marinus)* provided the greatest number of isolates. Other carriers were mammals, vultures, lizards, a tree-frog and a cave cockroach.

INTRODUCTION

An outbreak of salmonellosis occurred during April, 1976, at Victory Heights Youth Camp, Arouca (near Arima) in north-central Trinidad, and 75 persons became ill.[8] *Salmonella arechavaleta* was identified and also was isolated from kitchen tap water originating from an open tank, gravity-fed by roof-collected rain water. The possible contamination of this water supply by animal feces was investigated between 12 May and 6 June 1976, by trapping birds, small mammals, reptiles and amphibia, and culturing their intestinal/fecal contents. Fresh bird droppings collected from the catchment area of the roof also were cultured. The results of this study were negative except for one positive isolate from 1 of 3 toads *(Bufo marinus).*

S. arechavaleta has been isolated from humans in the United States 10 times between 1970 and 1976,[5] but is not considered to be common in either man or animals. This paper reports a further attempt to find a wild animal vector and, in the process, to find wildlife hosts of other *Salmonella* serotypes which may have potential significance as human or animal pathogens on Trinidad and Grenada.

MATERIALS AND METHODS

Mammals, reptiles, amphibians, cave cockroaches and land snails were captured alive, but vultures *(Coragyps atratus)* were shot. Vulture feces also were collected. Except for one monkey *(Alouatta seniculus),* from which a rectal swab was taken, the trapped animals were killed in the laboratory with ether or chloroform, and the carcasses bathed in Diversol.[4] The body cavity was opened with sterile instruments and the entire alimentary tract removed aseptically and placed in a sterile glass bottle. In some cases the material was used fresh, but because the majority of the animals had been collected primarily for investigation for leptospires, most of the material was frozen immediately at -20 C and processed for salmonellae when convenient. Standard methods were used in their isolation and the preparation of media.[9,11,12,13,14] Those isolates which conformed with the pathogenic *Salmonella* were further categorized into

[1] U.K. Medical Research Council

[2] Trinidad Public Health Laboratory

[3] PAHO/WHO Caribbean Epidemiology Centre (CAREC)

[4] Diversey Corporation (East Caribbean) Ltd., P.O. Box 315, Port-of-Spain, Trinidad.

Reprint requests: CAREC, 16-18 Jamaica Boulevard, P.O. Box 164, Port-of-Spain, Trinidad, W.I.

groups and serotyped at the Salmonella Reference Laboratory, Colindale, England, or the PAHO/WHO Caribbean Epidemiology Centre (CAREC) in Trinidad.

RESULTS

The results of the investigation are shown in Table 1. None of the common opossums *(Didelphis marsupialis)* was infected, but 4 of 21 smaller murine opossums *(Marmosa mitis)* were harboring four different *Salmonella* serotypes. Three of 23 mongooses *(Herpestes auropunctatus)* from Trinidad and 6 of 11 from Grenada yielded *Salmonella,* but none of the 22 *Glossophaga* bats, from a single roost at Mt. Nesbit Estate in St. John's, Grenada, was positive. The howler monkey *(Alouatta seniculus)* was a newly-caught specimen acquired by the zoo, and gave a negative result, as did all the rodents. All the Trinidad mammals came from the northern half of the island, the majority of the *Rattus* and *Mus* specimens coming from peridomestic localities in Port-of-Spain.

Feces from *C. atratus* were collected from Las Cuevas beach on the north coast of Trinidad where these birds frequently congregate to feed on fish remains discarded by fishermen. None of the feces appeared to be infected. However, many hundreds of vultures frequent the garbage tip (La Basse) on the outskirts of Port-of-Spain, and 1 of 6 of those investigated harbored *Salmonella.*

Two of four ground-dwelling *Ameiva ameiva* lizards (from urban Port-of-Spain) and 1 of 9 *Tupinambis nigropunctatus* were infected. Twenty-five of 60 toads *(Bufo marinus),* which came from several areas including urban Port-of-Spain, were infected, and one of two *Hyla* tree-frogs from Blanchisseuse on the north coast was infected.

Only 1 of 5 freshly-killed cockroaches *(Eublaberus distanti)* was positive for *Salmonella,* and the remaining 10 specimens, which had been frozen, were negative. All originated from Tamana Cave in central Trinidad where they were living in bat guano. None of the three *Strophocheilus* snails from the Caura Valley of the Northern Range was positive.

DISCUSSION

Sixteen of the 20 serotypes encountered in our study have been associated with human infection in the United States since 1970. Commonly reported

TABLE 1. *Salmonella* serotypes isolated from animals from Trinidad and Grenada, W.I.

Host Species	Number Examined	Number Positive	Serotypes	Number Isolated
Trinidad				
Didelphis marsupialis (opossum)	7	0	—	—
Marmosa mitis (opossum)	21	4	*S. glostrup*	1
			S. manhattan	1
			S. miami	1
			S. parera	1
Proechimys guyannensis (forest rodent)	17	0	—	—
Oryzomys capito (forest rodent)	1	0	—	—

TABLE 1. (continued)

Rhipidomys couesi (forest rodent)	1	0	—	—
Mus musculus (peridomestic rodent)	6	0	—	—
Rattus rattus rattus (peridomestic rodent)	2	0	—	—
R. r. alexandrinus (peridomestic rodent)	4	0	—	—
R. r. frugivorus (peridomestic rodent)	4	0	—	—
Herpestes auropunctatus (mongoose)	23	3	*S. corvallis*	1
			S. johannesburg	2
Alouatta seniculus (monkey)	1	0	—	—
Coragyps atratus (vulture)	6	1	*S. typhimurium*	1
Coragyps atratus - feces	—	0	—	—
Ameiva ameiva (lizard)	4	2	*S. agona*	1
			S. typhimurium	1
Tupinambis nigropunctatus (lizard)	9	1	*S. rissen*	1
Hyla minuta (tree frog)	2	1	*S. mendoza*	1
Bufo marinus (toad)	60	25	*S. amherstiana*	1
			S. anatum	3
			S. caracas	1
			S. litchfield	6
			S. london	1
			S. mendoza	1
			S. newport	1
			S. panama	4
			**S. rubislaw*	1
			S. typhimurium	6
Strophocheilus sp. (snail)	3	0	—	—
Eublaberus distanti (cockroach)	15	1	*S. albany*	1
Grenada				
Herpestes auropunctatus (mongoose)	11	6	*S. agona*	1
			S. corvallis	2
			S. panama	1
			S. wernigerode	2
Glossophaga longirostris (bat)	22	0	—	—
Totals	219	44		44

*Single isolate obtained from 1/3 *Bufo marinus* at Victory Heights Youth Camp, Arouca.

were *S. agona, S. anatum, S. litchfield, S. london, S. manhattan, S. newport, S. panama* and *S. typhimurium.* Others reported less frequently include *S. albany, S. caracas, S. corvallis, S. glostrup, S. johannesburg, S. mendoza, S. miami* and *S. rubislaw.*[5] Unpublished data from CAREC in Trinidad show that *S. typhimurium, S. corvallis, S. albany* and *S. agona* were isolated from humans in 1977-78. All the serotypes encountered in our study, except *S. parera,* are from Subgenus 1, which includes the majority of those found in infected or sick animals. Salmonellae probably can be found in nearly all groups of animals and in all parts of the world, the point of importance being the environmental factors which allow easy transmission between these hosts and man or his domestic animals and livestock. The high prevalence of gastroenteritis in Trinidad and Grenada, particularly among infants,[7] reflects the ease with which transmission can occur both from human sources because of poor hygiene, and from animals.

In a review of salmonellae in mammals,[24] Taylor quotes Boycott as isolating one *Salmonella* (in a hedgehog, *Erinaceus europaeus)* from 127 wild rodents and insectivores in Britain. In a different study, *S. typhimurium* was isolated from only 1 of 1,269 (representing 16 species) free-living wild mammals in England, and only *S. dublin* was isolated from seven peridomestic housemice *(Mus musculus).*[15] Peridomestic rats appear to be variable carriers of *Salmonella.* Thus, only 4.4% of 500 *Rattus norvegicus* and none of 279 *R. rattus* in Manchester, England, were found infected,[4] while in another study 22% of rats from a meat by-products factory were infected.[19] *Marmosa* spp. on Trinidad and Grenada usually are arboreal and forest-dwelling, but they sometimes occupy a peridomestic situation comparable to *R. r. frugivorus* or *R. r. alexandrinus.* In a Panamanian survey, 974 wild mammals from forest and rural habitats yielded at least 10 *Salmonella* serotypes, of which 11.8% (12 of 102) were from *Didelphis* and 20.1% (11 of 54) from *Philander* opossums; 1.1% (8 of 704) *Proechimys* also were found infected.[18] Mongooses are found on nearly all the larger Caribbean islands, and as they frequently are forced by territorial restrictions into habitats near domestic premises, *Salmonella* in mongooses may have public health significance in some areas.

Among birds, salmonellae have been found in seagulls and galliform species in particular, and in peridomestic sparrows and starlings. Forty-three of 246 (17%) pigeons in London were infected with *S. typhimurium,*[10] while other workers found 17 of 2,715 wild birds infected with salmonellae, of which 15 strains were *S. typhimurium.*[25]

Lizards and other reptiles have provided an abundance of *Salmonella* isolates.[24] The common African gecko *(Hemidactylus)* and skink *(Mabuya)* are known to have infections,[20] and both of these genera are found in the Caribbean. The African counterpart of the Caribbean *Ameiva ameiva* is *Agama agama,* of which 11.2% were found infected in Ibadan, Nigeria.[6] Many of these reptilian carriers are apparently healthy animals which excrete salmonellae; consequently, they may be potentially hazardous to man. Ground lizards may infect poultry, while geckos are important because of their presence in houses.

Infection in 25 of 60 (42%) toads *(Bufo marinus)* examined in Trinidad is significant, especially since two of the serotypes found, *S. typhimurium* and *S. newport,* are common in human infections. *S. typhimurium* was reported in 7,493 (32.2%) human cases in the United States during 1976, and *S. newport* in 1,336 (5.7%) cases.[5] Other authors suggest that aquarium frogs may be a source of human infection.[2] Frogs and frogs' legs have been found to be infected,[21,22] and this may be of interest in the French Caribbean islands and on Dominica,

where the large frog or "mountain chicken" *(Leptodactylus pentadactylus)* is eaten. Six different *Salmonella* types from 15 of 27 *Bufo* were found in Surinam,[3] while in India 36.7%of 329 toads were found to be intestinal carriers of *Salmonella*.[23] These figures are similar to those reported here and indicate a high prevalence of infection, presumably due to the ingestion of infected material. Our observations indicate that toads will eat a variety of carrion and unlikely items, provided they are of suitable size. Toads and other amphibians probably are the most likely wildlife suspects where *Salmonella* is disseminated between surface water and the terrestrial environment in tropical or sub-tropical areas. *Bufo* is closely associated with both urban and rural dwellings in the southern Caribbean (Trinidad, Grenada and Barbados), and may spread infection to humans via uncooked irrigated vegetables such as lettuce, cress and celery, and through streams, stagnant pools, water storage tanks, or the 200 l. drums commonly used by rural communities.

Although we examined only three *Strophocheilus* snails, and none was positive for *Salmonella,* molluscs have been incriminated as carriers by other workers.[1] Among insects, *Salmonella* is known from flies and cockroaches, and the American cockroach *(Periplaneta americana)* has been shown to act as both a mechanical and developmental vector of *S. typhimurium* in the laboratory.[16] *Salmonella* also has been found to survive in cockroaches after administration of antibiotics.[17] The infection of guano-dwelling cockroaches *(Eublaberus)* with *Salmonella* may be of interest to speleologists and bat workers; and where fresh water streams flow through bat guano deposits in caves, contamination of other water sources may occur.

In an unpublished study by the second author, 39 of 200 (19.5%) swine mesenteric glands from Trinidad abattoirs were infected with *S. agona, S. anatum, S. derby, S. litchfield, S. newport, S. panama* and *S. typhimurium.* Except for *S. derby* these are serotypes also found in Trinidad wildlife. The majority of swine probably are infected through contaminated foodstuffs, but the possibility of infection from wildlife should not be ignored. Equally well, infection in wild animals may derive from domestic animal sources. No animal source was found for *Salmonella arechavaleta* among the specimens tested.

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