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ISOLATION OF ENTERIC PATHOGENS FROM BATS IN TRINIDAD

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ABSTRACT: Bats are one of the most widely distributed mammals in the world, and they are reservoirs or carriers of several zoonoses. Bats were trapped in 27 geographic locations across Trinidad and Tobago, and following euthanasia, gastrointestinal tracts were aseptically removed. Contents were subjected to bacteriologic analysis to detect *Salmonella* spp., *Escherichia coli*, and *Campylobacter* spp. Isolates of *Salmonella* were serotyped, and *E. coli* isolates were screened for O157 strains and antimicrobial sensitivity to eight antimicrobial agents; phenotypic characteristics also were determined. Of 377 tested bats, representing 12 species, four bats (1.1%) were positive for *Samonella* spp, 49 (13.0%) were positive for *E. coli*, and no bats were positive for *E. coli* O157 strain or *Campylobacter* spp. Isolated serotypes of *Salmonella* included Rubislaw and Molade, both from *Noctilio leporinus*, a fish-eating bat, Caracas recovered from *Molossus major*, and *Salmonella* Group I from *Molossus ater*, both insect-eating bats. Of the 49 isolates of *E. coli* tested, 40 (82%) exhibited resistance to one or more antimicrobial agents, and the prevalence of resistant strains was comparatively high to erythromycin (61%) and streptomycin (27%) but lower to gentamycin (0%) and sulphamethozaxole/trimethoprim (2%).

Key words: *Campylobacte*r spp., enteric bacterial pathogens, *Escherichia coli*, Neotropic bats, *Salmonella*, Trinidad.

INTRODUCTION

Bats and other wild animals have been implicated in the epidemiologic cycles of several emerging and re-emerging zoonoses (Meslin, 1997). Bats have also been documented as carriers of pathogenic agents such as vampire-borne rabies (Kobayashi et al., 2006), severe acute respiratory syndrome (SARS) virus, or SARS-like coronaviruses (Li et al., 2005), *Histoplasma capsulatum* (Brown, 1988) and leptospirosis (Smythe et al., 2002), making them important in the epidemiology of bacterial, viral, and mycotic zoonoses.

Bats have varied feeding habits and include species that feed, according to Calisher et al. (2006), on mammalian blood, fruit, insects, and fish. Other species feed on nectar (Voigt et al., 2003). Feeding habits can affect the types and distribution of bacteria in the bat's gastrointestinal tract (Anand and Sripathi, 2004).

Salmonella spp. have been isolated from bats in various countries, although frequency and serotypes vary, and all populations are not infected (Moreno et al., 1975; Everard et al., 1979; Cassel-Beraud and Richard, 1988; Di Bella et al., 2003). Some serotypes recovered from bats are associated with human and livestock disease (Arata et al., 1968; Moreno et al., 1975; Cassel-Beraud and Richard, 1988). Other members of the family Enterobacteriaceae have been recovered from feces or intestinal contents of bats (Pinus and Müller, 1980; Sherley et al., 2000; Anand and Sripathi, 2004).

Resistance to antimicrobial agents among *E. coli* isolates from wildlife has been suggested to be acquired from the foods they consume and from the environment; resistance may also reflect the use of antimicrobials in humans, livestock, and pets (Levy et al., 1981; Rolland et al., 1985). Resistance to antimicrobial agents among *E. coli* strains from bats and other wildlife has been reported (Sherley et al., 2000; Costa et al., 2008). In Trinidad and Tobago, *E. coli* strains have been isolated from wildlife, and some have exhibited resistance to antimicrobial agents (Adesiyun and Downes, 1999; Gopee et al., 2000).

Campylobacter spp. have been isolated from free-flying and domesticated birds,

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and they are generally considered important reservoirs (Waldenström et al., 2007; McCrea et al., 2008). Unlike free-flying birds, there is limited information on this pathogen in bats (Palmer et al., 1983).

Results from the last survey for bacteria in Trinidadian bats were published almost three decades ago (Everard et al., 1979). In the present study we determined the prevalence of *Salmonella* spp., *E. coli,* (including O157 strain), and *Campylobacter* spp. and characterized recovered *E. coli* strains for resistance to antimicrobial agents.

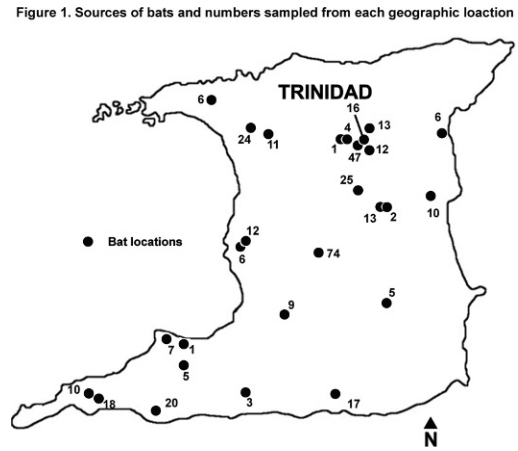


FIGURE 1. Sources of bats and number sampled from each geographic location.

MATERIALS AND METHODS

Between 13 November 2006 and 6 December 2007, bats were randomly captured from their natural habitats at 27 geographic locations across the island of Trinidad and from numerous sites by the Anti-Rabies Unit (ARU) of the Ministry of Agriculture, Land and Marine Resources (Fig. 1). This study was part of a project to determine the frequency of isolation of *Leptospira* serovars from bats and thus required bat euthanasia; kidney tissue was required for *Leptospira* culture. Additional samples for this study were collected from bats (*Desmodus rotundus*) that were trapped and euthanized by the ARU as part of its eradication program for bovine rabies.

Bats were captured with mist nets (36×36 mm mesh) erected between 4 PM and 11 PM. Nets were continuously monitored, and bats were immediately removed and placed in wire mesh cages covered with dark material or cloth bags. Nets, on occasion, were erected between 4 and 7 AM when bats were returning to their roosts. Hand-held mesh nets also were used to capture bats in dwelling houses or other buildings. Live bats were transported in cages to the School of Veterinary Medicine at the Faculty of Medical Sciences, University of the West Indies, where they were taxonomically classified based on morphology (Goodwin and Greenhall, 1961; Carter, 2004, unpubl. data). All collections were done under permits from the Wildlife section of the Ministry of Agriculture, Land and Marine Resources, and the study was approved by the Ethics Committee of the Faculty of Medical Sciences, University of the West Indies.

Bats were euthanized with 2% Bomazine (Bomac Laboratory Limited, Manukau, Aukland, New Zealand) combined with 10% Ketamine (Dutch Farm Veterinary Pharmaceuticals, Loosdrecht, the Netherlands) administered by intraperitoneal injection. The entire gastrointestinal tract was removed and macerated in sterile Petri dishes using a sterile pair of scissors and forceps. Macerated intestines and contents as well as swab samples were either plated on selective media or used to inoculate selective media.

To isolate *E. coli,* swabs samples (intestines or fecal contents) were inoculated on eosin methylene blue agar (Oxoid Ltd, Basingstoke, Hampshire, England) and incubated aerobically for 24 hr at 37 C. Plates were examined for the characteristic appearance of *E. coli* (metallic green sheen), and colonies that exhibited this phenotype were plated on blood agar and incubated aerobically at 37 C for 24 hr. Identification of *E. coli* was done using standard methods (Macfaddin, 1980). Isolates confirmed as *E. coli* were plated on blood agar and MacConkey agar and again incubated overnight at 37 C. On blood agar, phenotypic characteristics (hemolytic and mucoid colonies) were determined; the ability to ferment sorbitol was determined using sorbitol MacConkey media as described previously (March and Ratnam, 1986). Samples of *E. coli* from blood agar were subjected to the slide agglutination test using commercially available *E. coli* O157 antiserum (Oxoid) to determine *E. coli* O157 strain.

To detect *Salmonella* spp., macerated gastrointestinal walls and contents were divided into two portions; each portion was used to inoculate 9 ml of selenite cystine (SC) and tetrathionate (TT) broths. Both were incubated at 42 C and 37 C for 24 hr for selective

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enrichment. The enrichment broths were subcultured onto xylose-lysine-desoxycholate, XLD (Oxoid Ltd., Basingstoke, Hampshire, UK), agar, and brilliant green agar (Oxoid), incubated aerobically at 37 C and examined after 24 hr of incubation. Suspect colonies of *Salmonella,* pink colonies with black centers (XLD) and pink colonies (BGA), were subcultured onto blood agar and incubated overnight at 37 C and subjected to biochemical tests (Macfaddin, 1980). *Salmonella* suspects, which gave typical biochemical reactions, were tested by slide agglutination with a commercially available kit *Salmonella* polyvalent antiserum (A-I & Vi; Difco, Detroit, Michigan, USA). Slide test-positive isolates were sent to the Caribbean Epidemiology Centre (CAREC), Port of Spain, Trinidad and Tobago, the regional typing centre for *Salmonella* for confirmation and serotyping of isolates.

To culture for thermophilic *Campylobacter* spp., swabs of intestinal contents were plated for isolation on *Campylobacter* blood-free agar containing charcoal cefoperazone deoxycholate agar (CCDA, Oxoid) selective supplement. Inoculated plates were incubated at 42 C in 8–10% carbon dioxide in a CO_2 incubator (Forma Scientific, Marietta, Ohio, USA) for 48 hr to detect thermophilic *Campylobacter* as described (Lior, 1984; Adesiyun et al., 1992). Representative colonies on the blood-free agar, which were grayish with a running appearance and nontranslucent, were gram-stained; colonies that were gram-negative with characteristic "slender or seagull" morphology were classified as presumptive *Campylobacter* spp. and identified using standard procedure (Lior, 1984). The disc diffusion method was used to detect the antibiotic sensitivity of strains of *Salmonella* and *E. coli* to eight antimicrobial agents. The following antimicrobial agents and their concentrations (Oxoid) used were as follows: gentamycin (CN,10 μg), sulphamethaxazole/trimethoprim (SXT 1.75 μg/23.25), amoxycillin (AML,10 μg), kanamycin, (K, 30 μg), erythromycin (E 15 μg), nalixidic acid (NA,10 μg), tetracycline (TE, 30 μg), and streptomycin (S, 10 μg). The susceptibility of the isolates to the various antimicrobial agents was read and compared to the National Committee for Clinical Laboratory Standards (NCCLS, 2002) chart for zones of resistance to various antimicrobial agents.

The frequency of isolation of the three pathogens and the frequency of resistance among *E. coli* isolates from the various species of bats were compared and subjected to the chi-squared test (χ^2) and the level of significance determined at an alpha level of 0.05.

RESULTS

Bats were randomly sampled from known roosting sites in the northern ($n=140$), central ($n=142$), and southern ($n=95$) parts of the island of Trinidad. Twelve species were represented, and the samples included 166 males and 197 females (Table 1). Mixed species were captured from 27 locations and from seven different types of roosting sites (houses, buildings, bunkers, trees, bridges, tunnels, and caves).

Of 377 tested bats, four (1.1%) were positive for *Salmonella* spp. Positive cultures originated from *Molossus major* and *Molossus ater,* both insect-feeding species, and *Noctilio leporinus,* a fish-eating species (Table 2). The prevalence of *E. coli* was 13.0% (49 of 377); 11 of 12 (92%) bat species tested were positive for this microorganism. All bats sampled were negative for thermophilic *Campylobacter* spp.

Characteristics of the isolated *Salmonella* spp. and *E. coli* are shown in Table 3. Four of the *Salmonella* isolates belonged to *Salmonella enterica* serovars Rubislaw and Molade isolated (from *Noctilio leporinus*); *Salmonella enterica* serovar Caracas and Salmonella Group I were isolated from *Molossus major* and *Molossus ater,* respectively. Eleven (22%) isolates of *E. coli* were hemolytic, with five (10%) and six (12%) displaying complete and partial hemolysis, respectively. Only one (2%) of 49 isolates of *E. coli* produced mucoid colonies on blood agar plates. Seven (14%) of the isolates were nonsorbitol fermenters, having been detected among *E. coli* isolates from four bat species. All isolates were negative for *E. coli* O157 strain.

The susceptibility of *E. coli* to antimicrobial agents is displayed in Table 4. Overall, 40 (82%) of 49 isolates tested were resistant to one or more antimicrobial agents. Resistance was frequently observed with erythromycin (E, 61%) and streptomycin (S, 27%) but infrequently observed with gentamycin (0%) and

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TABLE 1. Sources and sexes of bats studied.

Species of bats	Geographic location[a]	Site	No. of bats sampled	No. (%) of bats that were:	
				Male	Female
Artebius sp.	Mt. Hope (24)	Building	39	9	30
	Curepe (11)	Tree			
	Manzanilla (3)	Tree			
	Moruga (1)	Tree			
Carollia perspicillata	Wallerfield Ice House (2)	Building	53	25	28
	Wallerfield Cold Storage (2)	Building			
	Tabaquite (1)	Tunnel			
	Cedros (18)	Bunker			
	Arima (2)	House			
	Fyzabad (2)	Tree			
	Princes Town (2)	Unknown			
	Green Hill Cedros (3)	Bunker			
	Manzanilla (1)	Unknown			
	St. Anns (6)	Unknown			
	Nestor Village, Tamana (2)	Bridge			
	Aripo (12)	Building			
Desmodus rotundus	Fyzabad (3)	Tree	41	12	29
	Rousillac (8)	Tree			
	Morne Diablo (3)	Tree			
	Green Hill Cedros (7)	Bunker			
	Erin (20)	Tree			
Diaemus youngi	Princes Town (7)	Unknown	7	4	3
Glossophaga sp.	Tabaquite (16)	Tunnel	30	14	16
	Couva (12)	House			
	Arima (2)	House			
Molossus major	Matura (1)	Building	28	4	24
	Talparo (25)	Building			
	Rio Claro (1)	House			
	Manzanilla (1)	Unknown			
Molossus ater	Matura (5)	Building	9	2	7
	Rio Claro (4)	House			
Mormoops sp.	Wallerfield Ice House (6)	Building	19	9	10
	Tamana (13)	Cave			
Noctilio leporinus	Couva (6)	Tree	11	5	6
	Manzanilla (5)	Unknown			
Phyllostomus hastatus	Wallerfield Ice House (25)	Building	28	27	1
	Wallerfied Cold Storage (2)	Building			
	Tabaquite (1)	Tunnel			
Phyllostomus discolor	Moruga (16)	Tree	16	10	6
Pteronotus parnelli	Wallerfield Ice House (14)	Building	82	45	37
	Wallerfield Cold Storage (12)	Building			
	Tabaquite (56)	Tunnel			
Unknown[b]	Valencia		14		
Total	Not applicable	Not applicable	377	166	197

[a] Number of bats sampled from each geographic location.

[b] Information not provided on the locations and sites from where the bats were sampled by the Anti-Rabies Unit personnel.

sulphamethoxazole (S)/trimethoprim (T, 2%). Overall, 18 (37%) of 49 isolates displayed multiple resistance to antimicrobial agents. The differences in prevalence of resistance to various antimicrobial agents among *E. coli* isolates were statistically significant ($P < 0.05$; χ^2). The predominant antimicrobial resistance pat-

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TABLE 2. Prevalence of *Salmonella* spp., *Escherichia coli*, and *Campylobacter* spp.in bats.

Species of bats	Feeding habits	No. of bats	No. (%) positive for: *Salmonella* spp.	*Escherichia coli*	*Campylobacter* spp.
Artebius sp.	Fruits	39	0 (0)	15 (38.5)	0 (0.0)
Carollia perspicillata	Fruits	53	0 (0)	1 (1.9)	0 (0.0)
Desmodus rotundus	Blood (mammals)	41	0 (0)	2 (4.9)	0 (0.0)
Diaemus youngi	Blood (prefer birds, mammals)	7	0 (0)	2 (28.6)	0 (0.0)
Glossophaga sp.	Nectar	30	0 (0)	3 (10.0)	0 (0.0)
Molossus major	Insects	28	1 (3.6)	2 (7.1)	0 (0.0)
Molossus ater	Insects	9	1 (11.1)	0 (0.0)	0 (0.0)
Mormoops sp.	Insects	19	0 (0)	3 (15.8)	0 (0.0)
Noctilio leporinus	Fish	11	2 (18.2)	2 (18.2)	0 (0.0)
Phyllostomus hastatus	Omnivorous (fruits, insects, occasionally small mammals)	28	0 (0)	6 (21.4)	0 (0.0)
Phyllostomus discolor	Omnivorous (fruits, insects, occasionally small mammals)	16	0 (0)	4 (25.0)	0 (0.0)
Pteronotus parnelli	Insects	82	0 (0)	7 (8.5)	0 (0.0)
Unknown		14	0 (0)	2 (14.3)	0 (0.0)
Total		377	4 (1.1)	49 (13.0)	0 (0.0)

terns were E (41%), S-E (14%), TE-S-E (8%), and TE-E (4%).

The four isolates of *Salmonella* had the following resistance patterns: Caracas (S-E), Salmonella Group I (S), Rubislaw (S-E), and Molade (S-E).

DISCUSSION

In the current study, 12 species of the 34 reported bat species in Trinidad and Tobago were sampled (Wright et al., 2002) from 27 geographic locations. Prevalence of *Salmonella* spp was found to be 1.1%, which is slightly higher than the 0% prevalence reported from bats in Grenada and Italy (Everard et al., 1979; Di Bella et al., 2003) and 0.2% found in Colombian bats (Arata et al., 1968). Higher prevalence estimates for *Salmonella* spp. in bats, ranging from 2.6% to 9.1% have been previously reported from other locations (Moreno et al., 1975; Cassel-Beraud et al., 1988).

Serotypes of *Salmonella* spp. reported from bats in other studies have been similar to those recovered from livestock and humans (Moreno et al., 1975; Cassel-Beraud et al., 1988; CAREC, 2004, 2005, 2006); this may indicate that bats can be locally important in the epidemiology of *Salmonella* infections in human and domestic livestock. The *Salmonella* serotypes (Rubislaw, Molade and Caracas) reported from bats in our study have been recovered from human, food, and animal sources in Trinidad (CAREC, 2004, 2005, 2006).

Several studies have reported isolation of bacteria of the family Enterobacteriaceae from feces and intestinal contents from bats (Pinus and Müller, 1980; Di Bella et al., 2003). It has also been reported that some of these enteric bacteria from bats have atypical characteristics that are related to the types of foods they consume (Cassel-Beraud et al., 1989). In the current study, the prevalence of *E. coli* (13%) was considerably lower than the 29.5–78% reported in other studies (Moreno et al., 1975; Costa et al., 2008). The negative isolation results for *E. coli* O157 strain is consistent with previous negative results from wildlife (mammals [not including bats], birds, and reptiles) sampled in Trinidad. Consistent with this previous study (Adesiyun, 1999), nonsorbitol fermenting (NSF) *E. coli* were recovered (14%). Most strains of

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TABLE 3. Characteristics of *Salmonella* and *Escherichia coli* isolates.

		Salmonella		*Escherichia coli*					
					Hemolysis				
Species of bats	Feeding habits	No. of bats	Serotype of *Salmonella*	No. of isolates	Complete	Partial	Mucoid	NSF[a]	O157 strain[b]
Artebius sp.	Fruits	39	NA[c]	15	2 (13.3)	1 (6.7)	0 (0.0)	1 (6.7)	0 (0.0)
Carollia perspicillata	Fruits	53	NA	1	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)
Desmodus rotundus	Blood (mammals)	41	NA	2	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Diaemus youngi	Blood (prefer birds, mammals)	7	NA	1	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Glossophaga sp.	Nectar	30	NA	3	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Molossus major	Insects	28	Caracas[d]	3	0 (0.0)	0 (0.0)	0 (0.0)	2 (66.7)	0 (0.0)
Molossus ater	Insects	9	Group I[d]	0	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Mormoops sp.	Insects	19	NA	3	0 (0.0)	1 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)
Noctilio leporinus	Fish	11	Molade (1)[e] Rubislaw (1)[e]	2	0 (0.0)	1 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)
Phyllostomus hastatus	Omnivorous (fruits, insects, occasionally small mammals)	28	NA	6	0 (0.0)	0 (0.0)	0 (0.0)	1 (16.7)	0 (0.0)
Phyllostomus discolor	Omnivorous (fruits, insects, occasionally small mammals)	16	NA	4	1 (25.0)	0 (0.0)	1 (25.0)	0 (0.0)	0 (0.0)
Pteronotus parnelli	Insects	82	NA	7	1 (14.3)	1 (14.3)	0 (0.0)	3 (42.9)	0 (0.0)
Unknown		14	NA	2	1 (50.0)	1 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total		377	NA	49	5 (10.2)	6 (12.2)	1 (2.0)	7 (14.3)	0 (0.0)

[a] NSF = Nonsorbitol fermenters.

[b] *E. coli* = O157 strain.

[c] NA = Not applicable.

[d] Isolates recovered from adult male bats.

[e] Isolates recovered from adult female bats.

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TABLE 4. Prevalence of resistance among *E. coli* isolates.

Species of bats positive for *E. coli*	Location	No. of isolates tested	No. (%) resistant[a]	No. (%) of isolates resistant to:						
				E[b]	S	TE	K	AML	NA	SXT
Artebius sp.	Curepe	4	3 (75.0)	2 (50.0)	2 (50.0)	0 (0.0)	1 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Mount Hope	11	9 (81.8)	8 (72.7)	4 (36.4)	1 (9.1)	0 (0.0)	0 (0.0)	1 (9.1)	0 (0.)
Phyllostomus discolor	Moruga	4	4 (100.0)	4 (100.0)	1 (25.0)	1 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Desmodus rotundus	La Brae	2	2 (100.0)	2 (100.0)	1 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Molossus major	Talparo	3	1 (33.3)	1 (33.3)	0 (0.0)	1 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Noctilio leporinus	Couva	2	2 (100.0)	1 (50.0)	0 (0.0)	1 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Phyllostomus hastatus	Wallerfield Ice House	6	5 (83.3)	5 (83.3)	3 (50.0)	2 (33.3)	0 (0.0)	1 (16.6)	1 (16.6)	1 (16.6)
Pteronotus parnelli	Wallerfield Cold Storage	4	4 (100.0)	2 (50.0)	1 (25.0)	0 (0.0)	2 (50.0)	2 (50.0)	0 (0.0)	0 (0.0)
	Tabaquite	3	3 (100.0)	3 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Mormoops sp.	Wallerfield Ice House	3	2 (66.7)	2 (66.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Glossophaga sp.	Tabaquite	3	1 (33.3)	1 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Carollia perspicillata	Princes Town	1	1 (100.0)	1 (00.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Diaemus youngi	Princes Town	1	1 (100.0)	1 (100.0)	1 (100.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Unknown	Unknown	2	2 (100.0)	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total		49	40 (81.6)	35 (71.4)	13 (26.5)	8 (16.3)	3 (6.1)	3 (6.1)	2 (4.1)	1 (2.0)

[a] Resistant to one or more of the eight antimicrobial agents tested.

[b] E = erythromycin, S = strepomycin, TE = tetracycline, K = kanamycin, AML = amoxicillin, NA = nalidixic acid, SXT = sulphamethoxazole/trimethoprim.

E. coli O157 strain are nonsorbitol fermenters (March and Ratnam, 1986). The pathogenic *E. coli* O157 strain has been recovered from various sources in Trinidad, including domestic cattle, goats, sheep, and pigs (Adesiyun and Kaminjolo, 1994) and cows' feces and preprocessed milk (Adesiyun et al., 1997b).

In our study 10% of the *E. coli* strains were hemolytic, a phenotypic characteristic that has been linked to virulence in other animal species (Prader et al., 1991). The findings in the present study compare well with a published report by Moreno et al. (1975), who conducted a bacteriologic study on stools from 100 bats in Brazil and found that hemolytic and nonhemolytic *E. coli* were isolated most frequently (29.5%).

The prevalence of resistance (82%) to antimicrobial agents among *E. coli* strains in the current study is considerably higher than the 57.1% found in fruit-eating bats at the Emperor Valley Zoo in Trinidad (Gopee et al., 2000). The high prevalence of resistance is comparable to results from other studies in other countries (Sherley et al., 2000; Costa et al., 2008). It has also been reported that resistance to antimicrobial agents among wildlife species may vary locally and may be linked to the use of antibiotics in humans and animals (Rolland et al., 1985; Sherley et al., 2000)

The high prevalence of resistance to antimicrobial agents among bat isolates of *E. coli* detected in the current study is comparable to the frequency of resistance reported for *E. coli* isolates from pet dogs, 79.8% (Adesiyun et al., 1997a), and captive and free-ranging wildlife, 95.6–99.6% (Adesiyun and Downes, 1999; Gopee et al., 2000) but considerably lower than resistant rates reported from dairy cows (25.9%) (Adesiyun et al., 1997b) in Trinidad and Tobago. The exchange of *E. coli* strains among bats, livestock, and humans should not be ignored.

To date *Campylobacter* spp. have not been reported from bats (Adesiyun et al., 1998). Palmer et al. (1983) speculated that *Campylobacter* spp. associated with human campylobacteriosis may have been due to the contamination of water by bird or bat feces, but to date a potential bat source has not been identified. *Campylobacter* spp. have been reported from other free-ranging wild mammals, farmed wildlife, free-flying birds, and racing pigeons in Trinidad. Negative results for *Campylobacter* spp. from bats may reflect a lack of exposure due to their diets, habitats, and limited contact with livestock and humans in Trinidad.

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