

## Predators of the tick *Amblyomma variegatum* (Acari: Ixodidae) in Guadeloupe, French West Indies

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### ABSTRACT

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Some vertebrate species in Guadeloupe are predators of free or parasitic stages of *Amblyomma variegatum* (Fabricius). Among birds, 1.9% of the 421 identified animals found in the stomachs of grackles (*Quiscalus lugubris*), 1.6% of the 364 animals found in the stomachs of free-ranging chickens, and 0.3% of the 4642 animals found in the stomach of cattle egrets (*Bubulcus ibis*) were *A. variegatum* ticks. The most efficient predator of ticks was the tropical fire ant, *Solenopsis geminata*, which was observed to only attack engorged stages of ticks. An average of 8% of the 564 individual ticks or batch of ticks released on the ground, mainly in a grass environment, were attacked by this ant species. Mice (*Mus musculus*) and mongooses (*Herpestes auropunctatus*) feed on engorged nymphs and female ticks. None of the 15 strains of entomophagous nematodes, genera *Steinernema* and *Heterorhabditis*, experimentally put in contact with engorged larvae and nymphs were able to parasitize them. In the laboratory, the insects *Megaselia scalaris* (Diptera) and *Tineola* sp. (Lepidoptera) were occasionally found to feed on engorged and unfed ticks, respectively.

### INTRODUCTION

*Amblyomma variegatum* (Fabricius) causes significant economic losses to cattle farmers and small ruminant livestock industries in the Caribbean by its direct pathological effect and from transmission of diseases. *Amblyomma variegatum* transmits *Cowdria ruminantium*, the causative agent of heartwa-

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ter, and is associated with dermatophilosis, a severe skin disease caused by *Dermatophilus congolensis* (Uilenberg et al., 1984). This tick species, introduced from Africa into the Caribbean in the 19th Century, is found extensively throughout Guadeloupe, and represents a threat to livestock in North, Central, and South America (Sutherst and Maywald, 1985; Barré et al., 1987).

Application of an acaricide as sprays for treatment of livestock is the principal method of tick control. However, other methods of tick control such as controlled burning, pasture spelling, and biological control could be used in combination with acaricides (Barré, 1988). In general, there is a lack of information documenting the factors causing natural mortality in tick populations and especially mortality due to parasites and predators. Additional information in this area might lead to more efficient tick-control methods. We present in this article observations made in Guadeloupe over several years on some natural parasites and predators of *A. variegatum*.

## MATERIALS AND METHODS

### *Birds*

Bird predators of *A. variegatum* were identified by collection and examination of their stomach contents. The stomach contents of eight free-ranging chickens, 11 cattle egrets, and 62 Caribbean grackles were examined. Arthropods and animals found in the stomachs were identified to class or order. Ticks found in the stomachs were identified to species and stage. In addition, regurgitated pellets from cattle egrets at roosts were collected from the ground on five dates in 1983 and 1984. These pellets were isolated and the contents identified.

### *Ants*

A total of 564 observations were made on the effect of ants on the survival of engorged *A. variegatum* of different stages over several years and in different environments. Engorged female ticks were released separately and their position in the grass marked with plastic stakes. Engorged larvae and nymphs were released in plastic containers covered with a 1.8-mm-mesh plastic cloth. The large-sized mesh cloth selectively allowed for the entrance of ants and prevented entrance of larger arthropods. All engorged ticks were examined one to seven days after release and the number damaged recorded. Samples of ants present in the vials or feeding on engorged female ticks at one to three days after release were collected and identified to species.

### *Rodents*

We attempted to identify predation of ticks by rodents on the basis of teeth-marks on plastic vials containing ticks released in field survival studies. Teeth imprints were matched with rodent species' feeding habits and abundance.

### *Nematodes*

Fifteen different strains of entomophagous nematodes, collected from soil samples from different areas of Guadeloupe, as well as known strains of entomopathogenic nematodes were used in laboratory studies to determine the infectivity of these organisms for fed or unfed ticks. Two strains and one strain of *Heterorhabditis* nematodes were collected from soils in Guadeloupe and Canada, respectively, and cultured to obtain pure strains for use in these studies. Other nematodes used included *H. bacteriophora*, *H. heliothidis*, *Steinernema anomali*, *S. bibionis*, *S. carpocapsae*, and *S. glaseri*. All strains of nematodes studied were used in attempts to infect all engorged stages and instars of *A. variegatum*, and four strains were also injected in attempts to infect selected engorged *A. variegatum* ticks.

Experiments were conducted in Petri dishes covered with filter paper impregnated with 0.1 ml of a solution containing 1000 infective larval nematodes. In each experiment, five ticks were placed in each of three Petri dishes which contained the infective stages of different strains of nematodes tested. After ticks were introduced, Petri dishes were maintained at 25°C in darkness. Abbott's (1925) formula was used to calculate the mortality of ticks each day. Dead ticks were dissected three days after death in order to verify the penetration and development of the nematodes.

### *Miscellaneous predators*

A colony of ticks has been maintained in the laboratory in Guadeloupe since 1982. During this period of time, a Diptera and a Lepidoptera species has been observed attacking ticks.

## RESULTS AND DISCUSSION

### *Birds*

Active predation of ticks by birds while attached to a host such as cattle was rarely observed on Guadeloupe. However, both the cattle egret and the Caribbean grackle were observed to pull ticks of hosts. Grackles were more often seen perched on the backs of cattle or goats, apparently there to feed on the attached ticks, than were cattle egrets.

Results from the examination of stomach contents from adults of three common birds in Guadeloupe, the cattle egret, Caribbean grackle, and free-ranging chickens, are presented in Tables 1 and 2. A total of 5427 different animals or arthropods were identified in the stomach contents. The main diet of cattle egrets was Orthoptera (33.5%), Diptera (25.6%), Lepidoptera (11.6%), and Anolis lizards (7.8%). Cattle egrets were found to consume large amounts of Diptera larvae, especially those species found around garbage-disposal sites. Lizards were more common in the regurgitated pellets collected from young birds at nesting sites. Coleoptera (33.7%) and Lepidop-

TABLE 1

Animals found in the stomachs or regurgitated pellets of cattle egrets and the stomachs of Caribbean grackles and free-ranging chickens examined in Guadeloupe

Animal <sup>a</sup>	Cattle egret		Caribbean grackle	Chicken	Total
	Pellets (n > 50)	Stomach (n = 11)	Stomach (n = 62)	Stomach (n = 8)	
<b>Annelida</b>					
C. Oligochaeta	13	1	0	0	14
<b>Mollusca</b>					
C. Gastropoda	1	0	3	18	22
<b>Arthropoda</b>					
C. Arachnida					
O. Araneida	182	71	17	0	270
O. Ixodida	86	2	9	6	103
C. Crustacea	11	0	1	0	12
C. Myriapoda	48	13	0	12	73
C. Insecta					
O. Odonata	6	9	0	0	15
O. Dictyoptera	24	15	0	7	46
O. Orthoptera	1270	287	33	3	1593
O. Dermaptera	1	4	0	58	63
O. Coleoptera	167	14	152	153	486
O. Lepidoptera	274	267	137	17	695
O. Diptera	768	420	33	3	1224
O. Hymenoptera	50	43	27	87	207
O. Heteroptera	3	6	6	0	15
<b>Vertebrata</b>					
C. Fish	24	0	0	0	24
C. Amphibia	176	7	0	0	183
C. Reptilia	360	6	3	0	369
C. Mammalia	10	3	0	0	13
<b>Total</b>	<b>3474</b>	<b>1168</b>	<b>421</b>	<b>364</b>	<b>5427</b>

<sup>a</sup>C, Class; O, Order.

tera (36.1%) were the main arthropods found in the stomachs of Caribbean grackles. The predominant species of arthropods found in the stomach contents of free-ranging chickens were Coleoptera (42%) and Hymenoptera (ants; 24%).

In Guadeloupe, cattle egrets, Caribbean grackles, and chickens seem to play a significant role as predators of insects (Table 1). These birds also act as hosts for ticks, and may be involved in the spread of *A. variegatum* in the Caribbean (Alderink and McCauley, 1988; Barré et al., 1988; Barré and Garis, 1990). Their role as predators of *A. variegatum* is limited (Table 2). Of the total animals found in the stomach contents or in the regurgitated pellets collected at the nesting sites, only 103 of them were ticks, and of these, 70%

TABLE 2

Total numbers and stage of ticks found in stomach contents or regurgitated pellets from cattle egrets, Caribbean grackles and free-ranging chickens examined in Guadeloupe

Tick/instar	Cattle egret		Caribbean grackle	Chicken	Total
	Pellets ( <i>n</i> > 50)	Stomach ( <i>n</i> = 11)	Stomach ( <i>n</i> = 62)	Stomach ( <i>n</i> = 8)	
<b><i>B. microplus</i></b>					
Female (Fed)	71	0	1	0	72
<b><i>A. variegatum</i></b>					
Larva (Fed)	0	0	0	1	1
Nymph	1	0	0	2	3
Nymph (Fed)	5	0	0	3	8
Female	0	0	4	0	4
Female (Fed)	9	2	1	0	12
Male	0	0	3	0	3

were engorged females of *B. microplus*. A plausible explanation for the large proportion of *B. microplus* ticks found in the stomach contents examined in this study might be that *Boophilus* ticks have short mouth-parts which do not penetrate into the dermal layer of the skin, whereas *Amblyomma* ticks have long mouth-parts which do penetrate deep into the dermal layer of the skin, thus making removal by cattle egrets more difficult. In addition, *Amblyomma* ticks are mainly found attached to the axillary and udder regions of the animal, areas which are more difficult to reach and which would not be accessible to cattle egrets walking and feeding near cattle.

About 2% of the stomach contents of cattle egrets examined in this survey contained ticks. McKilligan (1984) found 4.5% of the stomach contents of cattle egrets examined in Australia to contain *Boophilus* ticks. In other studies, by Siegfried (1971) and Telfair and Marcy (1984), few ticks were recovered from the stomachs of cattle egrets. Considering the number of cattle egrets in Guadeloupe and the number of animals collected each day as food by cattle egrets (Siegfried, 1971), we speculate that about 1 *Amblyomma* per cow per day is consumed by this bird. This suggests that cattle egrets do not play a significant role in regulating *Amblyomma* tick populations in Guadeloupe. Predation by these birds on ticks appears to be an opportunistic event, and is probably related to the level of infestation of ticks on cattle near where these birds are feeding.

Free-ranging chickens may play an important role as predators of ticks (Newstead, 1910; Bequaert, 1930). These domestic birds are usually associated with cattle and other domestic livestock around farms, and are important protein sources in a traditional farming system in the tropics. In this study, both unfed and engorged ticks were found in the stomachs of these

birds. Morel (1974) observed chickens picking ticks from resting cattle in Africa, and suggested that these birds could easily be used as an additional tick-control method in a traditional livestock production system in the tropics. However in the chickens studied in Guadeloupe, only 1.6% of their total diet was ticks. Therefore, our data for Guadeloupe suggest that chickens would have little effect on tick populations.

### Ants

In all cases, the tropical fire ant, *Solenopsis geminata*, was the only ant found feeding on ticks. In field experiments where ticks were released, no ants were observed to feed on unfed and mobile ticks, but 17.5%, 7.1% and 14.6% of engorged larvae, nymphs, and females, respectively, were attacked by this ant (Table 3).

The attack sequence for all ticks by the *Solenopsis* ant was the same, similar to that described by Colon-Guasp (1985). After locating a tick, the ants cut off its legs, opening an entrance into the inside at or near the coxae. Next, they then penetrate the tick and begin removing the internal contents. This material is returned to the mound. While one group of ants is disassembling the tick, a second group is burying it by removing soil from underneath. Ticks were observed to be attacked by this ant as quickly as within a few hours after release, or as long as up to seven days.

*Solenopsis geminata* are known predators of ticks and have been observed to cause a significant level of mortality in populations of engorged *Boophilus* ticks (Weber, 1948; Butler et al., 1979; Colon-Guasp, 1985). The results presented in this paper report, for the first time, predation by this ant on *A. variegatum*. In our studies, this ant was observed to attack up to 35% of released and engorged larvae in grass environments in Duclos. However, the total rate of predation for all engorged ticks released (only 9.2% were attacked) would suggest that predation by this ant on *A. variegatum* in Guadeloupe would have little effect on populations. Nevertheless, this ant is the most important pre-

TABLE 3

Number of *A. variegatum* released on the ground in grass environments at Gardel and Duclos in Guadeloupe, and the number attacked by *Solenopsis geminata*

Instar released	Gardel		Duclos	
	Released (n)	Attacked (n, (%))	Released (n)	Attacked (n, (%))
Larva (Fed)	20	0 (0)	20	7 (35)
Nymph (Fed)	148	7 (5)	244	21 (9)
Adults	26	0 (0)	29	0 (0)
Female (Fed)	41	6 (15)	36	6 (17)

dator in Guadeloupe, and may have a local or seasonal effect of reducing tick populations in grass environments. Additional research is needed to determine the importance of this predator in regulating tick populations.

### *Rodents*

From the examination of teeth marks, mice (*Mus musculus*) and mongooses (*Herpestes auropunctatus*) were found to tear open specially constructed plastic vials partially covered with cloth, to consume engorged nymphal and female *A. variegatum*. The vials and ticks were released in field plots to determine longevity and survival. Over a two-and-a-half-year period, less than 1% of the 1300 vials of ticks released were attacked by these mammals.

### *Nematodes*

No significant mortalities were observed seven days after contact between the nematodes and various instars of the tick at different stages of engorgement. Nematodes were not infective, even when injected into ticks. Nematodes have no effect on tick populations in Guadeloupe.

### *Miscellaneous predators*

In colony ticks, *Megaselia scalaris* (Diptera) and *Tineola* sp. (Lepidoptera) were found attacking ticks. *Megaselia scalaris* were observed to attack about 5% of vials which contained large numbers of engorged nymphal ticks. We observed that this fly was infecting only those vials which contained dead ticks. Infestations by this fly in the colony has been eliminated by reducing the number of ticks maintained in each vial and by keeping vials clean of dead ticks.

*Megaselia scalaris* has been observed feeding on engorged ticks in the laboratory in Puerto Rico (Garris, 1983). This fly probably only feeds on dead decaying ticks. It has not been observed feeding on ticks released in field studies.

*Tineola* sp. is a small Lepidoptera that was found infesting about 12 vials of unfed and engorged ticks in the laboratory. In an experiment where five immatures of the moth were placed in a vial with 25 unfed nymphs of *A. variegatum*, the moth immatures were observed to capture 24 of the unfed nymphs in webs of silk and then to eat them.

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