THE EFFECT OF HOST SPECIES ON THE ENGORGEMENT, MOLTING SUCCESS, AND MOLTED WEIGHT OF THE GULF COAST TICK

By

HENRY GEORGE KOCH

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1971

Submitted to the Faculty of the Graduate School of
the Oklahoma State University in partial
fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
May, 1974

THE EFFECT OF HOST SPECIES ON THE ENGORGEMENT,

MOLTING SUCCESS, AND MOLTED WEIGHT OF THE

GULF COAST TICK

Thesis Approved:

J. Alexander Hair
Thesis Adviser

Bryan P. Glass

John R. Sauer

D. D. Durham
Dean of the Graduate College

ACKNOWLEDGMENTS

Support was provided by Cooperative Agreement #12-14-100-10,863(33) from the U. S. Department of Agriculture, ARS, Southern Region.

Laboratory facilities were provided by the Oklahoma Agricultural Experiment Station and Dr. Jakie A. Hair who also served as major advisor. Drs. Bryan F. Glass and John R. Sauer at Oklahoma State University served as committee members.

Dr. Ronald W. McNew of the Statistics Department, Oklahoma State University, helped considerably in the statistical analysis of data.

Special appreciation is expressed to my wife, Madeline, who somehow found time from her other research duties to lend support and encouragement during the course of these investigations.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The suitability of animals as hosts of ticks is dependent on many factors. Much of the ecological work done on ticks has emphasized host surveys in which relative numbers of ticks per host species are recorded. These surveys yield a wealth of information concerning host parasite relationships when adequate samples are taken. Host surveys do not, however, provide meaningful data on the relative success of development and molting of ticks after leaving the host. The development and survival of ticks is very important from a pest management standpoint, and is possibly influenced by the type of host utilized for a bloodmeal.

Information on the effects of host species on the development and molting success of hard ticks is very limited. Amin (1969) found that larvae and nymphs of the American dog tick, *Dermacentor variabilis* Say, which had fed on the albino Norway rat, *Rattus norvegicus* (Berkenhout), took greater bloodmeals than those which had fed on the white-footed mouse, *Peromyscus leucopus* (Rafinesque). He believed that the greater imbibition from the less frequently encountered rats would tend to stabilize the tick population through the production of greater numbers of eggs by the larger female ticks.

Sonenshine and Atwood (1967) showed that feeding of both larvae and nymphs of *D. variabilis* was influenced by host species. The meadow vole, Microtus pennsylvanicus (Ord), was fed on more readily than the white-footed mouse or Norway rat when exposed to equal numbers of unfed subadult ticks. No relationship was found between the proportion of subadult ticks which fed on a host or the length of engorgement to the total number of ticks exposed to a host. Also, no relationship between the numbers of ticks attaching to a host and the body size of the host was found.

Sweatman (1970) found that the host species sometimes determined whether Hyalomma aegyptium (L.) was a two-host or three-host tick. The two-host cycle was observed on the Eurasian hedgehog (Erinaceus europaeus L.), laboratory rat, laboratory rabbit, Mediterranean gecko (Hemidactylus turcius) and the starred agama (Agama stellio). A three-host cycle was observed on the laboratory mouse, chicken, barn owl [Tyto alba (Bonaparte)], tortoise (Testudo kleinmanni), chameleon (Chameleo chameleon), and lizard (Lacerata laevis Gray).

Trager (1939) showed that immunity acquired from previous infestations with D. variabilis larvae prevented complete engorgement of ticks of the same species reared on guinea pigs, laboratory rabbits, and white-footed mice. Acquired host resistance has been shown to many other tick species and is associated with skin hypersensitivity to the tick oral secretion (Arthur 1962).

Inherent resistance to attack by ticks has been shown to occur in different cattle breeds. European shorthorn cattle (Bos taurus) were naturally infested with more cattle ticks, Boophilus microplus (Canestrini), than crossbred Zebu (Bos indicus) x Shorthorn in Australian pastures (Riek 1962). Artificially infested shorthorns produced more replete females of slightly greater weight and longer engorgement period than the crossbred cattle. The spread of cattle with *Bos indicus* blood may have reduced the annual economic loss in beef production in Australia (Seebeck et al. 1971).

The present study reports the effect of a variety of naturally occurring vertebrates as hosts on the development, engorgement period, and molting success of immature Gulf Coast ticks, *Amblyomma maculatum* Koch. Immatures of this tick are easily maintained in the laboratory on domestic animals and have a moderately wide host range (Hunter and Hooker 1907; Bishopp 1912; Hooker, Bishopp, and Wood 1912; Robinson 1926; Bishopp and Hixson 1936; Hixson 1940; Cooley and Kohls 1944; Samuel and Trainer 1970; Semtner and Hair 1973). At the time of these studies it was not prevalent in the immediate vicinity of our research laboratory (Stillwater, Oklahoma), and animals trapped in this area presumably would have had a very low level of acquired resistance to Gulf Coast ticks.

CHAPTER II

METHODS AND MATERIALS

Experimental Hosts

All animals were trapped in the field during the summer and fall of 1973 except Bobwhite quail, *Colinus virginianus* (L.), which were obtained from the Oklahoma Department of Wildlife Conservation Game Farm at El Reno, Oklahoma. The hosts included deermouse, *Peromyscus maniculatus* (Wagner); Hispid cotton rat, *Sigmodon hispidus* Say and Ord; Eastern woodrat, *Neotoma floridana* (Ord); blacktail jackrabbit, *Lepus californicus* Gray; raccoon, *Procyon lotor* (L.); and opossum, *Didelphis marsupialis* L.

Infestation Techniques

Unfed adult ticks of similar age (7-8 weeks post molt) were fed on sheep in the laboratory. Detached replete females were placed into 75 ml Nalgene[R] tubes covered with organdy cloth and a 9 mm diam. hole punched in the lid. The tubes were transferred to an incubator at 27°C and 90-98% RH during a 13 hr light:11 hr night photoperiod regimen. After oviposition had ceased, eggs were grouped into five categories and weighed to the nearest 0.01 mg on a Mettler H51 Balance. Groups of 0.01, 0.02, 0.05, 0.08, and 0.10 gms. of eggs were returned to the incubators. After hatching, larvae were aged 30 days and then released with a host into an infestation chamber.

The quail and rodents were infested in Sealright[R] ice cream cartons (0.95 and 1.89 liter sizes) with strips of masking tape securing the lids. Wire mesh cages were used inside those cartons holding rodents to prevent them from chewing out. Jackrabbits, opossum, and raccoon were infested in 20 gal steel barrels (ca. 76 liter) with many small holes cut in the lids to allow for air exchange and ca. 3 cm of dry sand in the bottom to absorb moisture. All animals were held in infestation chambers for 24 hr before being transferred to holding cages at 23 $\pm$ 3°C for the collection of detaching ticks. Holding cages were constructed large enough to allow for host grooming. The same techniques were used to infest animals with nymphs.

Tick Collection Techniques

Holding cages were constructed for the ease of collection and removal of replete ticks that had dropped from the host. Wire mesh bottoms in suspended cages of various sizes allowed passage of ticks into separate collection devices. A strip of masking tape around the rim of the collection device prevented tick escape and sheets of single ply paper toweling placed on the bottom absorbed moisture and facilitated feces removal.

Engorged ticks were collected every 12 hr by examining the collection device and masking tape. After weighing, the replete ticks were transferred to the incubator. When no more ticks dropped or were observed on the host, the hosts were released into the field.

Observations

Twenty-five replete larvae were individually weighed within 24 hr of dropping from the host. The total group of larvae was held in the incubator and 25 of the resulting nymphs were individually weighed 17 days after molting. The nymphs were used to infest different host animals of the same species 14-16 days later.

Engorged nymphs were weighed within 24 hr of dropping from the host and held in the incubator for molting. Adult ticks were weighed 50 days after molting and body measurements, similar to those made by Amin (1969) on developing D. variabilis, were made using an optical micrometer mounted in a dissecting microscope. Measurements of males were maximum length and width of the scutum (including eye spots) and the total body length (including mouth parts). In addition, female body measurements included the maximum width and length of the alloscutum.

Statistical Analyses

Hosts which died before ticks completed engorgement were not used in the analyses. An analysis of variance was performed on the weights and measurements of the ticks from the different hosts. Since the effect of the individual host within a species was found to be significant, the error mean square used in comparing the ticks from different species included this host effect. The t-test was used to compare means after the effect of the host species was found to be significant (F-test). A chi-square analysis was performed on the engorgement times of larvae and nymphs to determine the effect of host species.

CHAPTER III

RESULTS

Engorged Larvae and Molted Nymphs

The average weight of engorged larvae reared on each host species is given in Table I. Larvae reared on the opossum ($\bar{x}$ = 0.058 mg) and deermouse ($\bar{x}$ = 0.060 mg) were lighter than those reared on the other host species. Larvae reared on quail weighed the most ($\bar{x}$ = 0.069 mg). Nearly all ticks dropping from the hosts were dull gray in color and no visual association of host species with engorged tick color could be made.

The length of engorgement and drop-off period is given in Figure 1 and the accumulated drop-off percent is presented in Table II. A significant difference was found between species, with or without the quail or deermouse data included, as determined by the chi-square analysis. Ninety percent of the larvae dropped from the hosts by 144 hrs after exposure of host to ticks. All larvae dropped between 60-180 hrs after exposure of hosts to ticks. Ninety-two percent of the larvae dropping from quail were collected 108 hrs after hosts were exposed to ticks as opposed to only 10 percent dropping from deermice in that same time period. A total of 62% of the larvae dropped from the hosts between 10 PM - 10 AM. The woodrat was the only host species in which a greater number of larvae (58%) dropped from the host between 10 AM - 10 PM.

The percent engorgement of the estimated initial exposure of ticks

TABLE I

MEAN WEIGHTS OF ENGORGED GULF COAST TICK LARVAE
AND MOLTED NYMPHS REARED ON SEVEN
CAGED VERTEBRATE SPECIES

Host Species	Number of Hosts	Engorged Larvae[1/] Mean Weight (mg)	Molted Nymphs[1/] Mean Weight (mg)	Difference (mg)
Didelphis marsupialis	7	0.058a[2/]	0.021a[2/]	0.037a[2/]
Peromyscus maniculatus	8	0.060a	0.023ab	0.037a
Sigmodon hispidus	7	0.065b	0.024ab	0.041ab
Neotoma floridana	7	0.067b	0.024ab	0.043b
Procyon lotor	7	0.067b	0.026b	0.041ab
Lepus californicus	7	0.067b	0.024ab	0.043b
Colinus virginianus	11	0.069b	0.026b	0.043b

1/ Based on a sample of 25 ticks from each host.

2/ Column means followed by the same letter are not significantly different at the 0.05 level of probability.

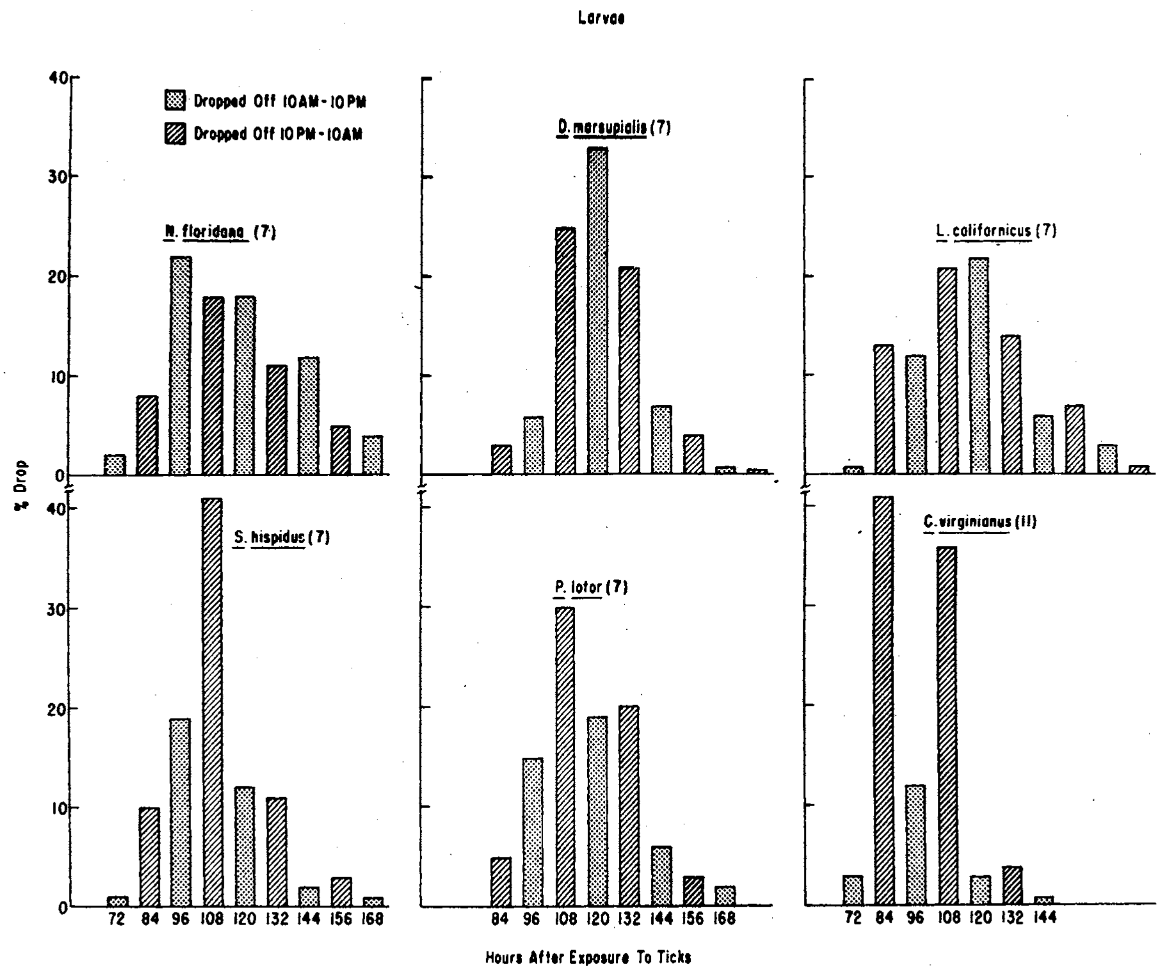

Figure 1. Engorgement time and drop-off period for Gulf Coast tick larvae reared on six caged vertebrate species. Numbers in parentheses equals the number of animals used as hosts.

TABLE II

ACCUMULATED PERCENT DROP IN 12 HR INTERVALS OF
GULF COAST TICK LARVAE REARED ON
SEVEN CAGED VERTEBRATE SPECIES

Hours After Exposure of Host to Ticks	Accumulated Percent Drop of Larvae From Hosts						
	Colinus virginianus (11)[1/]	*Lepus californicus* (7)	*Neotoma floridana* (7)	*Sigmodon hispidus* (7)	*Peromyscus maniculatus* (8)	*Procyon lotor* (7)	*Didelphis marsupialis* (7)
72	3	1	2	1	0	0	0
84	44	14	10	11	0	5	3
96	56	26	32	30	2	20	9
108	92	47	50	71	10	50	34
120	95	69	68	83	25	69	67
132	99	83	79	94	57	89	88
144	100	89	91	96	72	95	95
156	100	96	96	99	93	98	99
168	100	99	100	100	96	100	100
180	100	100	100	100	100	100	100

1/ Number of Animals Used as Hosts

to hosts ranged from 16.65 (opossum) to 85.37 (quail) (Table III). This value when multiplied by the percent molt gives an estimate of the percent molting success of larvae on each of the host species. The percent molt was relatively high in all host species ranging from 91.51 (raccoon) to 99.56 (deermouse). The estimated percent molting success, correspondingly, showed a wide range (14.85 for opossum - 83.56 for quail) and depicts the estimated yield of unfed nymphs from unfed larvae on a particular host species.

Molting of the engorged larvae occurred 11-17 days after dropping from the host. The average weight of molted nymphs and the difference from the engorged larval weights is given in Table I. Ticks reared on the raccoon had the greatest molted nymphal weights ($\overline{x}$ = 0.026 mg) and those reared on the opossum ($\overline{x}$ = 0.021 mg) the least. Differences between the engorged larval weights and the molted nymphal weights were greatest in ticks reared on quail (0.044 mg) and jackrabbit (0.044 mg) and least in ticks reared on deermouse (0.036 mg) and opossum (0.037 mg).

Engorged Nymphs and Molted Adults

Table IV illustrated a comparison of the engorged weights of ticks from the different host species. Nymphs reared on the opossum ($\overline{x}$ = 9.26 mg), raccoon ($\overline{x}$ = 13.89 mg), and quail ($\overline{x}$ = 17.64 mg) were lighter than those reared on the other host species ($\overline{x}$ = 20.01-21.38). The deermouse data were not included due to the small numbers of ticks collected (17 from 8 hosts).

Figure 2 presents the length of engorgement and drop-off period for nymphs and Table V gives the accumulated drop-off percent in 12 hr intervals. A significant difference was found between species, with

TABLE III

ENGORGEMENT AND MOLTING SUCCESS OF GULF COAST TICK LARVAE REARED ON SEVEN CAGED VERTEBRATE SPECIES

Host Species	Number of Hosts	Estimated Tick Exposure Per Host 1/	Number Tick Collected Per Host	Estimated Percent Engorgement	Percent Molt	Estimated Percent Molting Success
Didelphis marsupialis	7	1600	266.43	16.65	95.17	14.85
Procyon lotor	7	2000	413.00	20.65	91.51	18.69
Neotoma floridana	7	400	101.43	25.36	97.28	24.67
Peromyscus maniculatus	8	200	68.13	34.06	99.56	33.91
Sigmodon hispidus	7	400	176.00	44.00	97.00	42.68
Lepus californicus	7	1000	676.71	67.67	95.56	64.67
Colinus virginianus	11	400	341.45	85.37	97.88	83.56

1/ Based on 0.050 mg per egg and 100% hatch

TABLE IV

MEAN WEIGHTS OF ENGORGED GULF COAST TICK NYMPHS
AND MOLTED ADULTS REARED ON SIX CAGED
VERTEBRATE SPECIES

Host Species	Number of Hosts	Nymphs		Molted Adults				Average Difference[2/] (mg)
		N_1[1/]	Mean Weight (mg)	N_2[1/]	Mean Weight Females (mg)	N_3[1/]	Mean Weight Males (mg)	
Didelphis marsupialis	4	64	9.26a[3/]	23	5.36a[3/]	18	3.43a[3/]	4.86a[3/]
Procyon lotor	5	167	13.89b	26	8.48b	20	7.04b	6.13ab
Colinus virginianus	10	277	17.64c	70	8.35b	70	6.44b	10.24c
Sigmodon hispidus	6	152	20.01d	59	9.52c	48	7.57bc	11.46c
Neotoma floridana	5	156	21.23d	48	9.79c	49	8.15c	12.26c
Lepus californicus	5	120	21.38d	54	9.41c	46	7.47bc	12.94c

1/ Number of ticks weighed (N_1 = nymphs; N_2= adult females; N_3 = adult males).

2/ Mean weight engorged nymphs minus mean weight of molted adult ticks.

3/ Column means followed by the same letter are not significantly different at the 0.05 level of probability.

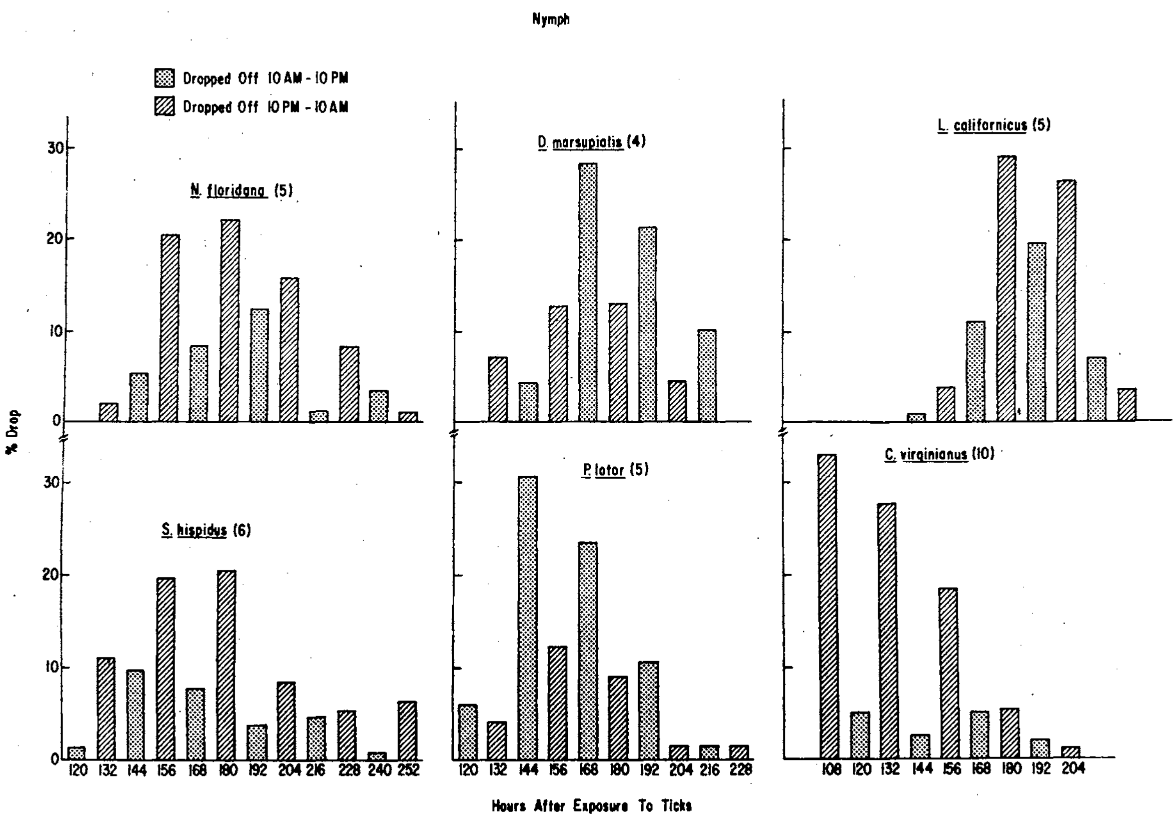

Figure 2. Engorgement time and drop-off period for Gulf Coast tick nymphs reared on six caged vertebrate species. Numbers in parenthesis equal the number of animals used as hosts.

TABLE V

ACCUMULATED PERCENT DROP-OFF PERCENT IN 12 HR INTERVALS OF GULF COAST TICK NYMPHS REARED ON SIX CAGED VERTEBRATE SPECIES

Hours After Exposure of Host to Ticks	Accumulated Percent Drop of Nymphs From Hosts					
	Colinus virginianus (10)[1/]	*Lepus californicus* (5)	*Neotoma floridana* (5)	*Sigmodon hispidus* (6)	*Procyon lotor* (5)	*Didelphis marsupialis* (4)
108	33	0	0	0	0	0
120	38	0	0	1	6	0
132	66	0	2	12	10	7
144	69	1	7	22	41	12
156	87	5	28	42	53	25
168	92	16	36	50	77	53
180	97	45	58	70	86	66
192	99	65	70	74	97	87
204	100	91	86	83	98	91
216	100	98	87	88	99	100
228	100	100	95	93	100	100
240	100	100	99	94	100	100
252	100	100	100	100	100	100

1/ Number of Animals Used as Hosts

or without the quail data, as determined by the chi-square analysis. Ninety percent of the nymphs dropped from the hosts by 204 hrs after exposure of hosts to ticks. All nymphs dropped between 96-252 hrs after exposure of hosts to ticks. Sixty-six percent of the nymphs dropping from quail were collected 132 hrs after hosts were exposed to ticks. During the same time period, no more than 12 percent of the ticks dropping from any of the other host species were collected. A total of 64 percent of the nymphs dropped from the hosts between 10 PM - 10 AM. A greater number of nymphs, however, dropped from the raccoon (73%) and opossum (63%) between 10 AM - 10 PM.

A wide range in the percent engorgement [opossum (17.75) - quail (80.26)] of ticks exposed to hosts was seen (Table VI). The percent molt was greater than 98 in ticks reared on all host species except the raccoon (85.85) and the opossum (85.50). The percent molting success was, therefore, low in ticks reared on the raccoon (18.53) and opossum (8.63) and greatest in quail (79.90).

Molting of the engorged ticks occurred 21-28 days after dropping from the host. The average weight of molted adult female and male ticks and the average difference from the engorged nymphal weights is given in Table IV. Ticks reared on the opossum had the smallest molted weights ($\overline{x}$ = 5.36 mg for females and 3.43 mg for males). Ticks reared on the raccoon and quail were intermediate and the greatest molted adult weights were seen in the cotton rat, woodrat, and jackrabbit. The greatest molted adult weight was seen in ticks reared on the woodrat ($\overline{x}$ = 9.79 mg for females and 8.15 mg for males). Differences between the engorged nymphal weights and the molted adult weights were greatest in ticks reared on the woodrat (12.26 mg) and jackrabbit

TABLE VI

ENGORGEMENT AND MOLTING SUCCESS OF GULF COAST TICK NYMPHS REARED ON SIX CAGED VERTEBRATE SPECIES

Host Species	Number of Hosts	Average Tick Exposure Per Host	Average Number Ticks Collected Per Host	Percent Engorgement	Percent Molt	Percent Molting Success
Didelphis marsupialis	4	176.00	17.75	10.09	85.50	8.63
Procyon lotor	5	204.80	44.20	21.58	85.85	18.53
Sigmodon hispidus	6	50.00	25.17	50.34	100.00	50.34
Lepus californicus	5	132.00	79.00	59.85	99.03	59.27
Neotoma floridana	5	49.60	34.20	68.97	98.29	67.78
Colinus virginianus	10	50.00	41.30	80.26	99.55	79.90

(12.94 mg) and least in ticks reared on opossum (4.86 mg) and raccoon (6.13 mg).

The relationship of molted adult weight with the measured body dimensions for ticks reared on each of the host species is given in Table VII. Differences observed in the body dimensions of male and female adult ticks were not host species dependent when the influence of weight was accounted for. The width of the alloscutum showed the highest correlation ($r = 0.80$) with the weight of the unfed adult female tick. Correlation with adult female tick weight was also high with the length of the alloscutum ($r = 0.78$), total body length ($r = 0.75$), and width of the scutum ($r = 0.72$). A much lower correlation ($r = 0.57$) was found between the length of scutum and adult female tick weight. The total body length, however, showed the highest correlation ($r = 0.91$) with unfed adult male tick body weight. Correlation with adult male tick weight was slightly less but highly significant with the width of the scutum ($r = 0.83$) and length of scutum ($r = 0.86$).

TABLE VII

BODY DIMENSIONS OF MOLTED ADULT GULF COAST TICKS
REARED ON SIX CAGED VERTEBRATE SPECIES

Host Species	Number of Ticks Measured	$\bar{X}$ Tick Weight (mg)[1/]	$\bar{X}$ Scutum (cm)		$\bar{X}$ Total Body Length (cm)	$\bar{X}$ Alloscutum (cm)	
			Length	Width		Length	Width
			Females				
Didelphis marsupialis	23	5.36a[1/]	1.57	1.54	4.69	1.95	2.51
Colinus virginianus	70	8.35b	1.95	1.86	5.49	2.17	3.00
Procyon lotor	26	8.48b	1.83	1.84	5.35	2.25	2.91
Lepus californicus	54	9.41c	1.91	1.93	5.76	2.44	3.05
Sigmodon hispidus	59	9.52c	1.91	1.91	5.74	2.48	3.01
Neotoma floridana	48	9.79c	1.97	1.96	5.76	2.47	3.06
			Males				
Didelphis marsupialis	18	3.43a[1/]	3.09	2.18	4.18		

TABLE VII (CONTINUED)

Colinus virginianus	70	6.44b	3.81	2.59	5.02
Procyon lotor	20	7.04b	3.83	2.76	5.14
Lepus californicus	46	7.47bc	3.96	2.73	5.30
Sigmodon hispidus	48	7.57bc	3.99	2.74	5.21
Neotoma floridana	49	8.15c	4.06	2.50	5.34

1/ Means followed by the same letter are not significantly different at the 0.05 level of probability. Host species did not affect the measurements when the effect of tick weight was accounted for.

CHAPTER IV

DISCUSSION

Engorgement Time and Drop-off Period

Larvae and nymphs reared on quail had much shorter engorgement times than ticks reared on other host species. Ticks attached themselves mainly to the head and neck of quail and mostly on the ears of mammals which may help explain the shorter engorgement period. Observations by Sweatman (1970) indicated that a longer engorgement time in subadult H. aegyptium occurred when ticks attached to the host ears rather than the body. Also, the overall higher temperature of quail may have been a factor in the shorter engorgement time on quail. A greater skin inflammation caused by tick loads that are somewhat larger than field infestations may have accounted for small variations in engorgement time. A longer engorgement period was observed in larval Brown dog ticks, Rhipicephalus sanguineus (Latreille), on mice treated with cortisone which reduced the inflammatory reaction (Ali and Sweatman 1966).

A very distinct drop-off rhythm is seen in the ticks engorging on quail. The vast majority of larvae (81%) and nymphs (86%) dropped from the host between 10 PM - 10 AM. A similar phenomenon was observed by Hixson (1940) using meadow larks under caged conditions as hosts. The drop-off rhythms from other hosts showed the same pattern except nymphs reared on opossum and raccoon and larvae reared on woodrat, in which, the majority dropped from the host between 10 AM - 10 PM. Amin (1970) has shown the maximum drop-off of D. variablis larvae and nymphs occurs at the onset of greatest host activity. If such mechanisms are operating in the Gulf Coast tick: host association, this would partially explain differences observed in Figure 1 and Figure 2.

Engorged Weight vs. Molted Weight

The relatively large amount of variation found between animals of the same species in the analysis of variance of engorged larval weight is responsible for the overall lack of significant differences found. Larger ingested meals by larvae and nymphs resulted in heavier molted ticks within all host species groups.

There is, however, a large variation in the concentration of the ingested meal of Gulf Coast tick larvae and nymphs reared on laboratory rabbits (Koch, H. G., Unpublished Data). The molted weights, therefore, may reflect the quality of the ingested meal. In addition to differences in the amount of hemoglobin ingested per engorged tick weight (concentration), varying levels of nutrients (protein, cholesterol, and sugar) exist within the blood of different host species. Differences in the amino acid composition of blood proteins from different host species is very important in mosquito development (Clements 1963). No conclusive studies on nutrition and development of the hard ticks have been published (Balashov 1968).

The importance of the quality of the ingested meal on molted weight is seen in comparing the engorged nymphal and molted adult weight of ticks reared on raccoon and quail. A heavier molted tick is produced per equal weight of ingested meal when the raccoon is used as a host. A similar trend was also observed in the engorged larvae and molted nymphs. Ticks reared on the opossum were not only light but also had disproportionately smaller molted weight.

Both quantitative and qualitative differences associated with the ingested meal from various wild vertebrate species affected the final molted adult weight. Since the engorged adult female weight is directly proportional to the unfed adult weight, fecundity of the Gulf Coast tick (Drummond and Whetstone 1970), is dependent on the host species of the subadult ticks. The individual host within a species was found to be very important in the development of the ticks, however, the reason for this is not known. Variations between species and individual hosts in body grooming, physiology, nutritional state, captivity behavior, and stress could not be determined. Until a reliable artificial feeding membrane for hard ticks is developed, the specific effect of host nutrition remains speculative.

Engorgement and Molting Success

Of the larger animals, jackrabbits showed a much higher percent engorgement and percent molt than either the raccoon or opossum for larvae and nymphs. The percent molting success for larvae was very similar to that in the nymphs within each of these host groups.

In the smaller animals, larvae and nymphs reared on quail had a very high percent engorgement and molting success. Nymphs reared on the cotton rat and woodrat had a higher percent engorgement and molting success than larvae reared on the same species.

The percent molt was very high in all ticks except nymphs reared on opossum andraccoon. Smaller engorgement weights, particularly in nymphs reared on opossum and raccoon, may have contributed significantly to molting failure.

The greatest limiting factor in the production of adult ticks was the ability of the larvae and nymphs to attach and successfully complete engorgement. The very high molting success of ticks on quail indicates that host grooming was not a significant factor at the level of infestation in the tests. In areas of high tick abundance, this lack of host grooming plus other environmental stresses may significantly effect the well being of the bird unless acquired host resistance mechanisms are operating.

Molted Adult Weight and Dimensions

The host species did not effect the dimensions of the molted adult tick when the influence of weight was accounted for. Differences in the quality of the ingested meal did not, at the sensitivity level of this test, disproportionately effect any of the measured tick dimensions. Therefore, the molted adult weight was just as good as indicator of host species effect as differences in body dimensions.

The reproductive potential of the larger adult female ticks that were reared as immatures on mammals, excluding the unnatural hosts (raccoon and opossum), should be greater in nature. A lower reproductive potential could be expected from ticks parasitizing quail in the subadult stages. However, the occurrence of a marked feeding rhythm, short engorgement period, and overall high percent molting success of the subadult ticks that utilized the avian hosts suggest a greater host: parasite synchronization and, thus, greater epidemiological significance.

LITERATURE CITED

Ali, S. R., and G. K. Sweatman. 1966. Effect of age, sex, and hormone treatment of the mouse on the level of infestation by Rhipicephalus sanguineus larvae. J. Parasitol. 52: 407-12.

Amin, O. M. 1969. Growth of the dog tick Dermacentor variabilis Say (Acarina: Ixodidae). II. The effect of starvation and host species on its growth and fecundity. J. Med. Entomol. 6: 321-6.

____________. 1970. The circadian rhythm of dropping of engorged larvae and nymphs of the American dog tick Dermacentor variabilis Say (Acarina: Ixodidae). J. Med. Entomol. 7: 251-5.

Arthur, D. R. 1962. Ticks and disease. Pergamon Press, Oxford, 445 p.

Balashov, Yu. S. 1968. Bloodsucking ticks (Ixodoidea), vectors of disease of man and animals. Leningrad: Nauka Publisher. (In Russian) (1967). In English: Miscellaneous publication of the Entomological Society of America (1972). 8, 161-376.

Bishopp, F. C. 1912. A new species of Dermacentor and notes on other North American Ixodidae. Proc. Biol. Soc. Wash. 25: 29-38.

Bishopp, F. C., and H. Hixson. 1936. Biology and economic importance of the Gulf Coast tick. J. Econ. Entomol. 29: 1068-76.

Clements, A. N. 1963. The phsiology of mosquitoes. Pergamon Press, Oxford 393 p.

Cooley, R. A. and G. M. Kohls. 1944. The genus Amblyomma (Ixodidae) in the United States. J. Parasitol. 30: 70-111.

Drummond, R. O. and T. M. Whetstone. 1970. Oviposition of the Gulf Coast tick. J. Econ. Entomol. 63: 1547-51.

Hixson, H. 1940. Field biology and environmental relationships of the Gulf Coast tick in southern Georgia. J. Econ. Entomol. 33: 179-89.

Hooker, W. A., F. C. Bishopp, and H. P. Wood. 1912. The life history and bionomics of some North American ticks. USDA Bur. Entomol. Bull. 106, 239 p.

Hunter, W. D., and W. A. Hooker. 1907. Information concerning the North American fever tick, with notes on other species. USDA Bur. Entomol. Bull. 72, 87 p.

Riek, R. F. 1962. Studies on the reactions of animals to infestation with ticks. Austral. J. Agr. Res. 13: 532-50.

Robinson, L. E. 1926. The genus Amblyomma. In Nuttall, G. H. F. and others. Ticks: A monograph of the Ixodoidea. pt. 4, Cambridge, University Press, 53 p.

Samuel, W. M. and D. O. Trainer. 1970. Amblyomma (Acarina: Ixodidae) on white-tailed deer, Odocoileus virginianus (Zimmermann), from South Texas with implications for Theileriasis. J. Med. Ent. 7: 567-74.

Seebeck, R. M., P. H. Springell, and J. C. O'Kelly. 1971. Alterations in host metabolism by the specific and anoretic effects of the cattle tick (Bodphilus microplus) I. Food intake and body weight growth. Aust. J. Biol. Sci. 24: 373-80.

Semtner, P. J. and J. A. Hair. 1973. Distribution, seasonal abundance, and hosts of the Gulf Coast tick in Oklahoma. Ann. Entomol. Soc. Amer. 66: 1264-8.

Sonenshine, D. E. and E. L. Atwood. 1967. Dynamics of feeding of the American dog tick, Dermacentor variabilis (Acarina: Ixodidae). Ann. Entomol. Soc. Amer. 60: 362-73.

Sweatman, G. K. 1970. Temperature control of engorgement by subadult Hyalomma aegyptium ticks. J. Med. Entomol. 7: 71.

Trager, W. 1939. Acquired immunity to ticks. J. Parasitol. 54: 641-56.

VITA

Henry George Koch

Candidate for the Degree of

Master of Science

Thesis: THE EFFECT OF HOST SPECIES ON THE ENGORGEMENT, MOLTING SUCCESS, AND MOLTED WEIGHT OF THE GULF COAST TICK

Major Field: Entomology

Biographical:

Personal Data: Born in Mt. Holly, New Jersey, May 22, 1948, the son of Winfield Rudolph and Eva Virginia Koch.

Education: Graduated from Lenape Regional High School, Medford, New Jersey in 1966; received Bachelor of Science degree from Oklahoma State University in 1971, with a major in Entomology and minor in Chemistry; attended Oregon State University 1971-1972; attended Oklahoma State University and completed requirements for the Master of Science degree in May, 1974.

Professional Experience: Research technician in Insect Physiology, Oklahoma State University, Stillwater, Oklahoma, 1970-1971; National Science Foundation Trainee, Oregon State University, Corvallis, Oregon, 1971-1972; Research Assistant, Oklahoma State University, Stillwater, Oklahoma, Summer 1972; Graduate Research Assistant, Oklahoma State University, Stillwater, Oklahoma, 1972-1974.

Member: Phi Kappa Phi, Entomological Society of America, International Organization of Biological Control.