RESPONSES OF THE LONE STAR TICK, *AMBLYOMMA AMERICANUM* (LINNAEUS), TO CARBON DIOXIDE STIMULATION

By

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CHAPTER I

INTRODUCTION

Much effort in recent years has been spent on attempts to establish the detrimental effects of pesticides to the environment during attempts to control arthropod pests. The ecological impact of these pesticides have possibly been exaggerated, but nevertheless, other methods of arthropod control must be investigated.

A pest which continues to plague man and for which no long-term measures of control are available is the lone star tick [Amblyomma americanum (L.)]. Some pesticides have been employed with a moderate degree of success in restricted areas (Hair and Howell, 1970). Some beneficial insects as well as wildlife however might possibly be destroyed by employing this means of control. It is believed that tourist trade and area utilization are hampered in eastern Oklahoma because of annoyance and bites by ticks.

Attractants may be a beginning toward some means of controlling various arthropods. A few researchers have noted the possibilities of using chemoattractants in taking surveys or as possible control agents in traps for certain species of ticks (Garcia 1962, 1965, 1969; Miles 1968; Neville 1964). Garcia (1965) noted that Dermacentor andersoni moved to a source of CO_2 from as far away as 10 ft.

The present study was undertaken to evaluate the performance of CO_2-baited traps to ticks within different types of habitat, to determine the effect of low temperatures on operation, to ascertain the effective range or collection area of CO_2-baited traps under diurnal and nocturnal conditions, and to compare the seasonal distribution of various tick stages in a meadow, ecotone, and woodlot habitat.

CHAPTER II

LITERATURE REVIEW

Limited data has been published concerning the use of CO_2 as an attractant for ticks. Based on past work, it is now evident that various chemoattractants may play an important role in survey or possible control of certain species of ticks (Garcia 1962, 1965, 1969; Miles 1968; Neville 1964). Garcia (1962) presented data suggesting that an effective tick trap could be constructed. Four species *Dermacentor occidentalis*, *D. andersoni*, *Ornithodoros coriaceus*, and *Ixodes pacificus* were collected by using dry ice as the source of CO_2. As the dry ice sublimed, CO_2 was liberated and stimulated the ticks to move towards the source. Garcia (1965) indicated that *Dermacentor andersoni* moved from vegetation from as far away as 10 ft towards the source of CO_2. Garcia (1962) also noted that tick attraction to CO_2 in dense vegetation extended at least 11 ft. Miles (1968) used a CO_2-baited trap for recovering *Ornithodoros* ticks and fleas from mammalian burrows.

Smittle, et al. (1967) demonstrated that ^{59}Fe labeled ticks traveled up to 75 ft in 72 hr without any apparent chemical stimulation by an attractant. Smith, et al. (1946) indicated that *D. variabilis* was stimulated to move towards a road traveled by a potential host 400 ft away.

Carbon dioxide is well documented as an attractant for species of hematophagous arthropods. Everett and Lancaster (1968) obtained favorable results using CO_2-baited traps in tabanid surveys and control. In Louisiana, horse fly populations on pastured cattle were reduced when CO_2-baited "sticky" traps were placed around the periphery of the animals' pasture (Wilson et al. 1966; Everett and Lancaster 1968; Wilson 1968). There are numerous publications concerning the utilization of CO_2 for trapping species of mosquitoes (Reeves 1951; Bellamy and Reeves 1952; Reeves 1953; Dow, et al. 1957; Newhouse, et al. 1966). Other examples of where CO_2 acts as an attractant for insects include Ceratopogonidae (Nelson 1965, Whitsel and Schoeppner 1965) and Muscidae (Defoliart and Morris 1967). Some species of Simulids are also attracted to CO_2 (Fallis and Smith 1964; Snoddy and Hays 1966).

Other researchers have improved survey techniques with the addition of CO_2 to the basic technique (Newhouse, et al. 1966; Dow, et al. 1957). Newhouse, et al. (1966) employed CO_2 with the CDC miniature light trap and greatly increased the number of mosquitoes caught and also the number of species (20-25%) trapped. Dow, et al. (1957) and Newhouse, et al. (1966) used CO_2 traps as an attractant in disease monitoring studies.

A comparison of animal and dry ice-baited traps for the collection of tabanids was conducted by Everett and Lancaster (1968).

The information available on the limits of CO_2-baited tick traps as a survey tool or control measure is minor and the extent of their effectiveness under varying environmental conditions has not been extensively investigated. However, temperature and relative humidity are known to have a considerable influence on the behavior of various tick species and we recognize that erratic results are frequently obtained when conventional survey techniques are used to monitor the population. A technique that would minimize the influence of the environment on survey effectiveness is, then, highly desirable.

The standard procedure for surveying populations of ticks in the past has been the drag-flag method. Garcia (1965) compared conventional flagging techniques and CO_2 as a means of collecting ticks. His results indicated that the CO_2 method is more effective in surveying for *D. andersoni* than the standard drag-flag method.

Under various environmental conditions, Hair and Howell (1970) have proposed that factors such as temperature, humidity, sun light, ground cover, etc., may play an important part in determining tick activity and behavior. We would therefore expect to find that numbers of ticks collected by the flagging technique would vary with environmental conditions.

CHAPTER III

METHODS AND MATERIALS

Trap Design and Procedures

During the summer of 1970, metal pyramid traps (Wilson, et al. 1972) were employed in various studies in the Cookson Hills Game Refuge, Cherokee County, Oklahoma.

In brief, the functional trap was constructed of 2 major components: (1) a basal portion which contains an insulated reservoir for the dry ice and the trapping portion, or element, of the trap; and (2) a cover which is hinged to the basal portion of the trap and which functions to trap and direct the subliming CO_2 gas towards the basal edge of the trap. The gas is expelled from the device near the soil surface. Masking tape was used as a "trapping substrate" for the pyramidal tick trap. It was noted that the adhesive used on all masking tape tested showed no repellancy properties and was almost 100% effective in trapping lone star nymphs and adults coming in contact with the adhesive.

In all studies, unless otherwise indicated, traps received a 1-kg block of dry ice each day that they were allowed to operate in a given locality. Data was collected from operating traps on a daily basis by removing the trap from the trapping site, transporting it to the laboratory, and then removing the masking tape with attached ticks. Actual counts of numbers of trapped ticks were made.

A styrofoam box trap was also utilized in a study to compare the efficacy of this trap with a metal pyramid trap. This trap consisted of a 12-inch square box constructed of 1-inch thick styrofoam. All seams were sealed with a rubber base glue and subliming gas was forced out of 4 (four) 1/4-inch holes, one of which was drilled 1½ inches from the box bottom on each side. The styrofoam box was centered on a 2 ft x 2 ft piece of ½-inch plywood used to serve as a base. Masking tape 2 inches wide was positioned on the trap base approximately 4 inches from the periphery of the plywood edge. The outer ½ (1 inch) of the tape was turned upward from the plywood base surface at an angle of approximately 30°. The inner ½ of the tape was firmly attached to the plywood base.

An improved trap model was devised in the spring of 1971 (Wilson, et al. 1972). This trap type was fabricated of fiberglass and insulated with polyurethane. The trap shape was similar to the metal pyramid but excluded the large hinged lid and reservoir. This aided in reducing the trap size and bulkiness. Masking tape was also used as a trapping medium with this trap type.

The fiberglass traps were utilized in each of 4 separate studies during the summer of 1971.

1970 Studies

Influence of Temperature on the Response of Nymphs and Adults to CO_2

Several earlier papers elaborated on the problems associated with flagging procedures used to estimate tick populations. For example, Hair and Howell (1970) believed that the daily activity of lone star nymphs and adults were influenced greatly by temperature and, therefore, that flagging surveys made in cooler weather, especially during the early spring months of February and March, showed considerable variation. Preliminary data suggested a fairly uniform response of adult and nymphal lone star ticks to CO_2, even when dispensed under variable environmental conditions (Wilson, et al. 1972).

This study was designed to evaluate the response of nymphal and adult lone star ticks to CO_2 being dispensed from traps under considerable temperature fluctuations (7.2 to 29.4°C) and to determine the practicability of using CO_2-baited traps for tick surveys during a period normally unfavorable for sampling by the flagging method.

Three pyramidal type CO_2-baited traps were utilized in these studies during the summer of 1970 (operational procedures were as previously described). One trap was placed in each of three different vegetative habitat types at approximately 0600 hr and revisited on an hourly basis until 1600 hr in order to record temperatures and ascertain tick activity.

A Model 44 TD YSI Telethermometer® (Yellow Springs Instrument Company, Inc., Yellow Springs, Ohio) was utilized to record the temperatures on the soil litter surface, within litter duff, and at the soil-duff surface.

<u>Migratory Movement of Lone Star Ticks to CO_2 Emitted From Traps During a 72-Hour Period</u>

Metal pyramid traps previously mentioned were utilized in this study during 1970 in an effort to determine the maximum effective distance from the source that ticks could be stimulated to respond to the subliming dry ice.

The study was begun by collecting adult ticks from woodlots with the use of CO_2 traps. Portable vacuum collecting equipment (Hair, et al. 1971) was used to rapidly collect large numbers of adults which were then transferred to the field laboratory for marking with Day-Glo® fluorescent pigments (Switzer Bros., Inc., 9314 East Fern Street, El Monte, California 91733).

Groups of ticks that were later released at specific distances from CO_2-baited traps were marked with one of the following colored pigments: (1) horizon blue; (2) signal green; (3) blaze orange; (4) rocket red; or (5) saturn yellow. Pigments were dissolved in acetone and applied via a 1-gal compressed air sprayer to adult ticks confined in a screen wire cylinder. Care was taken so that an excessive amount of the acetone solution was not applied to the caged ticks. The adults were sprayed with the atomized mist as they moved over the inner surface of the cylindrical cage.

Ticks were counted after marking and a specific number (Table I) were placed in a vial and transported to the study area and released at preselected points at specified distances (6.1 to 24.3 m) from an operating trap.

A steel measuring tape was used to measure distances from the source of CO_2 and neon-marked flags were set in the ground for distance recognition. The meadow and woodlot traps were activated at the same time the ticks were released by placing a 1-kg block of dry ice in the reservoir and applying masking tape at the base of the trap as the entrapping medium.

Twenty-four hr after the CO_2-baited trap was activated, the trap site was revisited and the masking tape was detached and transported

TABLE I

NUMBER OF MARKED ADULT LONE STAR TICKS RECOVERED BY CO_2-BAITED TRAPS AFTER HAVING BEEN RELEASED IN WOODLOTS AT VARIOUS DISTANCES FROM THE TRAP IN COOKSON HILLS GAME REFUGE DURING SUMMER 1970

Release Number	Release Point From Trap (m)	Ticks Released	Number and Percent Ticks Recovered (72 hours)		Ticks Recovered (7 days)	% Total Ticks Recovered
1	6.1	800	39	4.8	3	5.2
	9.4	800	30	3.7	18	6.0
2	9.4	3200	129	3.1	139	8.4
	12.0	3200	43	1.3	51	3.0
3	12.0	1600	26	1.6	38	4.0
	15.5	1600	6	.37	9	.93
4	15.5	1200	3	.25	26	2.4
	18.3	1200	1	.08	5	.37
	21.3	1200	2	.16	1	.25
5	21.3	800	1	.01	0	.01
	24.3	800	0		0	

to the laboratory and placed under an ultraviolet light to help illuminate the marked ticks for counting purposes. After tape from each trap was removed, the traps were retaped and revisited at 24-hr intervals. After 72 hr the traps were collected and final recordings made.

Influence of Habitat Type on CO_2 Trap Efficiency

Nine vegetative habitat types were selected and utilized for this study. The classification scheme was essentially that described by Semtner, et al. (1971). In essence, habitats were classed in 1 of 3 broad categories, depending on amount of overstory (crown cover), understory (brush or grass), and duff (leaf litter). Within these broad categories 3 subdivisions were set up to designate the relative abundance of parameters being measured. Light indicated a coverage of 25% or less, medium coverage varied from 25% to 75% and heavy inferred greater than 75% coverage.

Both pyramidal and the styrofoam box type CO_2 traps were utilized as trapping devices under these varying environmental conditions. Three replicates were run in each habitat type. Trapping procedures involved the random selection of trap placement sites, activation of the trap by placing a 1-kg block of dry ice in the reservoir or box trap and applying masking tape to serve as the entrapping medium. After 24 hr of operation, the tape was removed and counts of adults and nymphs were made.

1971 Studies

Influence of Temperature on the Response of Nymphs and Adults to CO_2

In this study, 2 fiberglass CO_2 traps of the type mentioned earlier were used in 2 different vegetative habitats. Procedures were the same as outlined earlier for the 1970 study and included telethermometer and hygro-thermograph recordings of relative humidity and temperature. Temperature and relative humidity readings were taken every hour as each trap was revisited.

Migratory Movement of Various Stages to CO_2 Emitted From Traps During a 72-Hour Period

Techniques utilized during the 1971 season for adults and nymphs were essentially the same as those employed with adults during 1970. However, larvae were not collected and later released, but rather were located in the field and marked while still on the vegetation with a spray applicator containing Day-Glo pigment dissolved in acetone. A very fine mist was employed and care was taken to avoid excessive coverage of the larvae with the acetone solution. Four CO_2 traps were charged with dry ice and placed at prescribed distances in the 4 cardinal directions from the marked larvae. At 24-hr intervals following marking, collection and examination procedures were the same as described for nymphs and adults.

Nocturnal and Diurnal Movement to CO_2 Under Woodlot Conditions

Procedures for conducting a study on the nocturnal and diurnal movements of the lone star tick involved field collecting or locating of ticks as outlined in the preceding study. All 3 stages were utilized and observed in this study. After the ticks were collected or located in the field, they were marked with pigment as previously described.

Release points were established and marked with neon flags within the vicinity of the traps prior to nighttime releases of the marked ticks. Nocturnal studies were conducted from 9:00 PM until 6:00 AM and were carried out under total darkness. Marked adult and nymphal ticks were taken to the woodlot at 9:00 PM on the release night and released at preselected distances from a CO_2 trap charged with a 1-kg block of dry ice.

At 6:00 AM, the study site was revisited and tapes were removed from the traps and taken to laboratory to be checked for marked ticks.

A diurnal comparison of migratory potential in similar habitats was made employing the same procedures as given for the nocturnal study described above. Trap operation was between 8:00 AM and 4:00 PM.

In both the diurnal and nocturnal migration studies, larvae were marked on vegetation and traps were set at the designated distances from the larval mass.

Seasonal Distribution of Tick Stages in a Meadow, Ecotone, and Woodlot as Indicated by CO_2 Trap Surveys

Fiberglass traps were utilized in this study to determine the response of each stage of the lone star tick to CO_2 being emitted from traps in a meadow, ecotone, and woodlot throughout the summer.

Two areas both having a meadow, ecotone, and woodlot were selected for the study. Nine traps were set up within each area; 3 each in the meadow, ecotone, and woodlot.

Dry ice was placed in the traps at about 10:00 AM in the morning. Approximately 6 hr later, traps were revisited and the number of ticks attached to the tape was recorded. The study was conducted weekly from April through August.

CHAPTER IV

RESULTS AND DISCUSSION

1970 Studies

Influence of Temperature on the Response of Nymphs and Adults to CO_2

During the early spring of 1970, adult and nymphal ticks failed to be attracted to CO_2 until leaf litter surface temperatures reached approximately 10°C (Figure 1). As the temperature increased during the day, the number of ticks responding to CO_2 increased until activity peaked at about 28°C. The activity decreased as the leaf and duff temperatures declined in the afternoon. Activity ceased when the afternoon temperature of the soil cover dropped below 10°C.

Migratory Movement to CO_2 Emitted from Traps During a 72-Hour Period

The maximum effective distance from which lone star tick adults were recovered on CO_2 traps was 21.3 m (Table I).

In general the percentage of marked ticks collected from each release point decreased with an increase in distance from the operating trap. For example, at 6.1 m 4.8% of all released ticks were recaptured 72 hr after release; at 9.4 m an average of 3.4% were recovered and at 12 m about 1.4% were collected. At release distances of 15 m or more only small numbers of marked ticks migrated to traps.

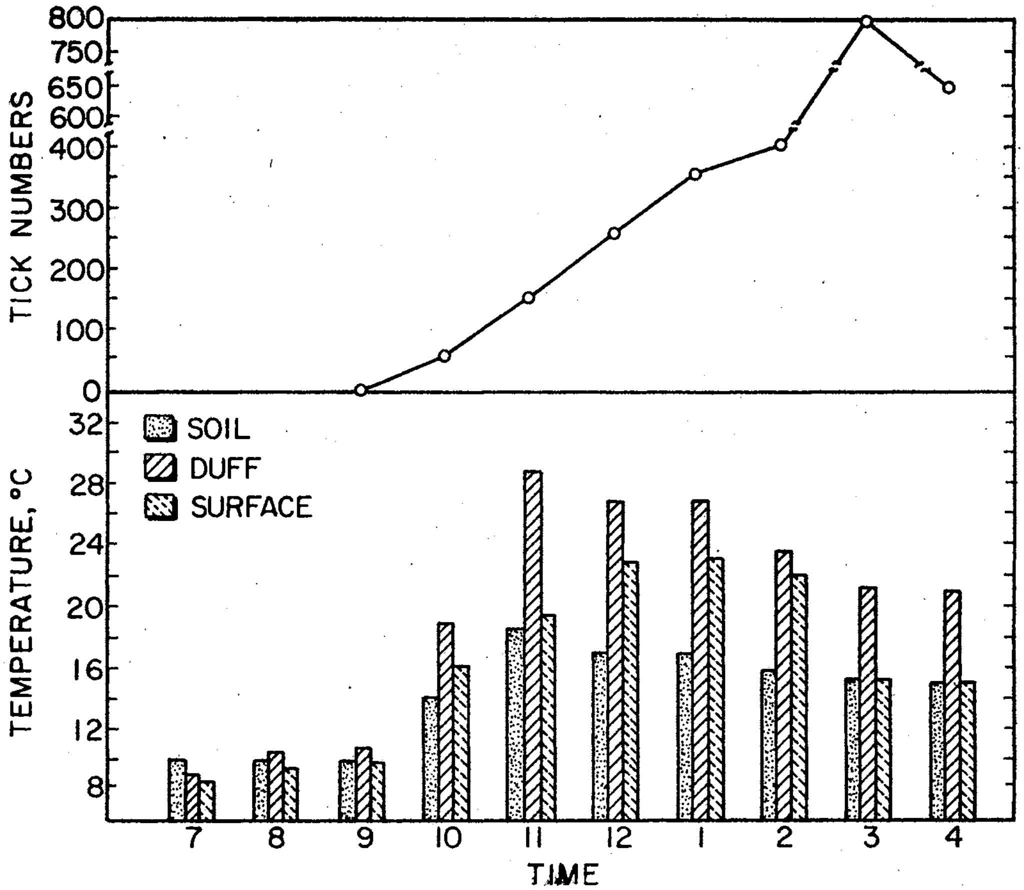

Figure 1. Influence of Temperature on the Response of Lone Star Ticks to CO_2 Traps in the Cookson Hills Game Refuge During 1970.

Follow-up trapping 7 days after the initial release of marked adults increased significantly the total percent of marked adults recaptured (Table I).

Failure to capture large numbers of marked ticks released at distances of 15 m or more from the traps possibly suggested the inability of most adult lone star ticks to detect a low concentration of CO_2 present at that point, or that the concentration of CO_2 was too low to effectively initiate host-seeking behavior.

Influence of Habitat Type on CO_2 Trap Efficiency

When the styrofoam and metal pyramid traps were compared under various woodlot conditions (Table II), differences were noted in the tick sample composition. Significant statistical differences may exist in numbers of ticks collected with the 2 traps. In many instances the numbers collected with the pyramid trap were more than double the numbers collected with the styrofoam model. This difference may have been due to the volume of CO_2 emitted from the 2 types of traps. The metal pyramid traps were perhaps not as well insulated as the styrofoam traps causing a more rapid sublimation of the dry ice and a greater volume of CO_2 emitted per unit of time.

More importantly there was an apparant correlation between habitat type and the numbers of ticks collected from the various habitats. For example, with increased overstory adults and nymphs were more abundant than in habitats with lighter overstory cover. We would normally expect lighter understory and heavy duff to accompany heavy overstory.

TABLE II

THE AVERAGE NUMBER OF NYMPHAL AND ADULT LONE STAR TICKS ATTRACTED TO CO_2 ADMINISTERED VIA TWO TYPES OF TRAPS IN VARIOUS VEGETATIVE HABITATS IN COOKSON HILLS GAME REFUGE DURING SUMMER 1970

Tick Stage	Overstory*			Understory*			Duff*		
	L	M	H	L	M	H	L	M	H
Styrofoam Trap									
o	6	28	35	52	35	24	22	59	4
♀	11	69	66	47	43	59	50	67	9
N**	98	245	361	175	333	212	187	277	173
Replications	5	7	5	5	7	5	11	5	3
Pyramid Trap									
o	46	45	50	64	70	28	34	68	45
♀	18	78	90	115	70	21	17	95	73
N	172	459	790	982	513	144	126	775	511
Replications	12	14	14	11	12	18	15	18	7

*L = Light (0-25% coverage); M = Medium (25-75% coverage); H = Heavy (75-100% coverage).

**N = Nymph

The data in Table II suggest that not only does a correlation exist between certain physical vegetative parameters, but the number of ticks collected can be correlated to habitat type.

1971 Studies

Influence of Temperature on the Response of Nymphs and Adults to CO_2

Observations in 1971 on the tick responses to CO_2 at varying temperatures were similar to those reported for 1970. The threshold temperature for activity appears to be about 9 to 10°C (Figures 2, 3, 4, and 5). At lower temperatures, no adult or nymphal activity was noted. The response of ticks to CO_2 is apparently temperature dependent with increasing activity as temperatures increase.

Migratory Movement of Various Stages to CO_2 Emitted From Traps During a 72-Hour Period

During the summer of 1971, data was collected on the migratory potential of the various stages of the lone star tick in meadows and woodlots. Under woodlot conditions, the maximum distance traveled for adults appeared to be 15.2 m during a 72 hr period (Table III). These data differ somewhat from the 1970 data where 1 adult migrated a distance of 21.3 m. The highest percentage of marked ticks recovered was from within 3 m and 6.1 m.

Adults introduced in unmowed meadows moved a maximum of 3 m during the first 72 hr after release. Apparently there was better dispersion of CO_2 in mowed than unmowed meadows since marked adults were found to migrate up to 6.1 m in the mowed meadows (Table III).

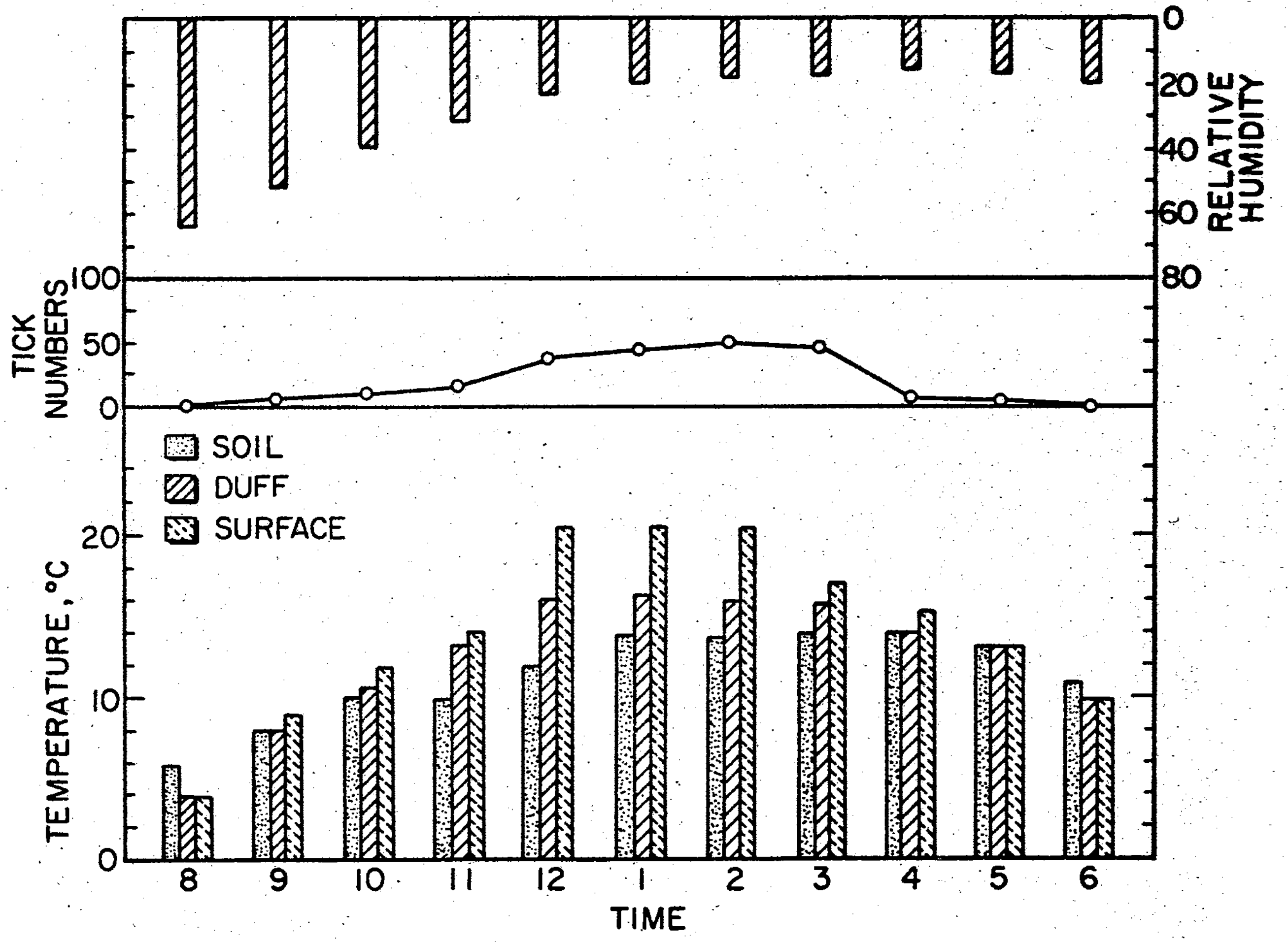

Figure 2. Influence of Temperature on the Response of Nymphal and Adult Lone Star Ticks to CO_2 Traps in the Cookson Hills Game Refuge During 1971.

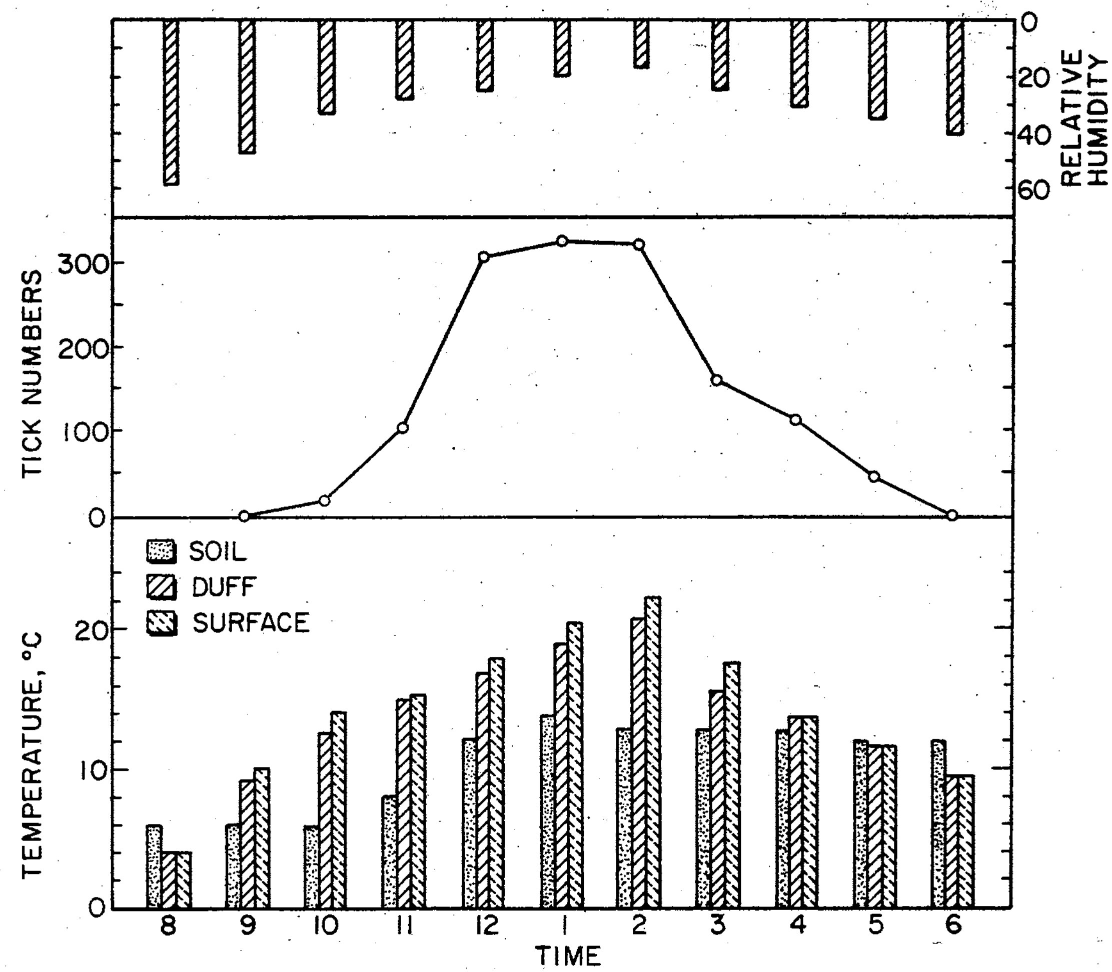

Figure 3. Influence of Temperature on the Response of Nymphal and Adult Lone Star Ticks to CO_2 Traps in the Cookson Hills Game Refuge During 1971.

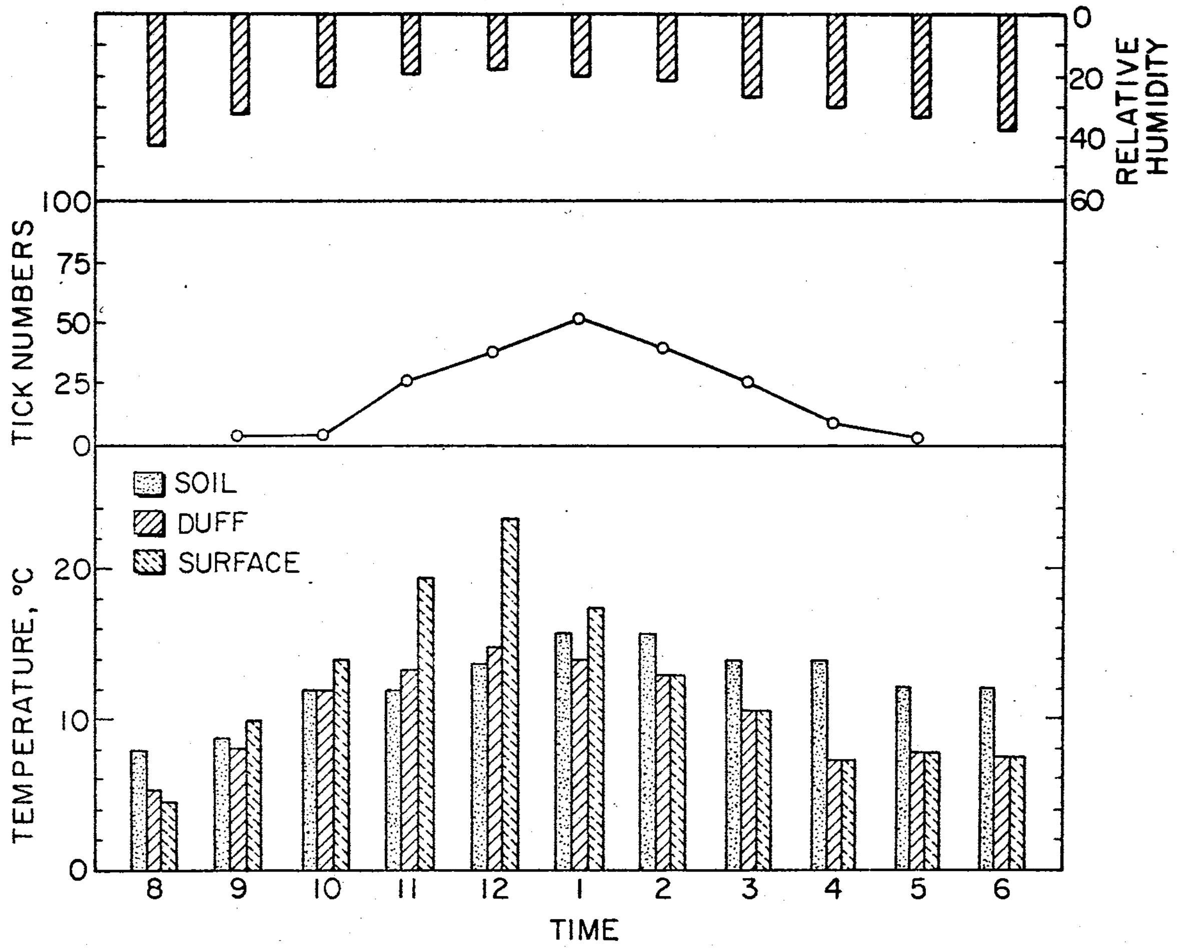

Figure 4. Influence of Temperature on the Response of Nymphal and Adult Lone Star Ticks to CO_2 Traps in the Cookson Hills Game Refuge During 1971.

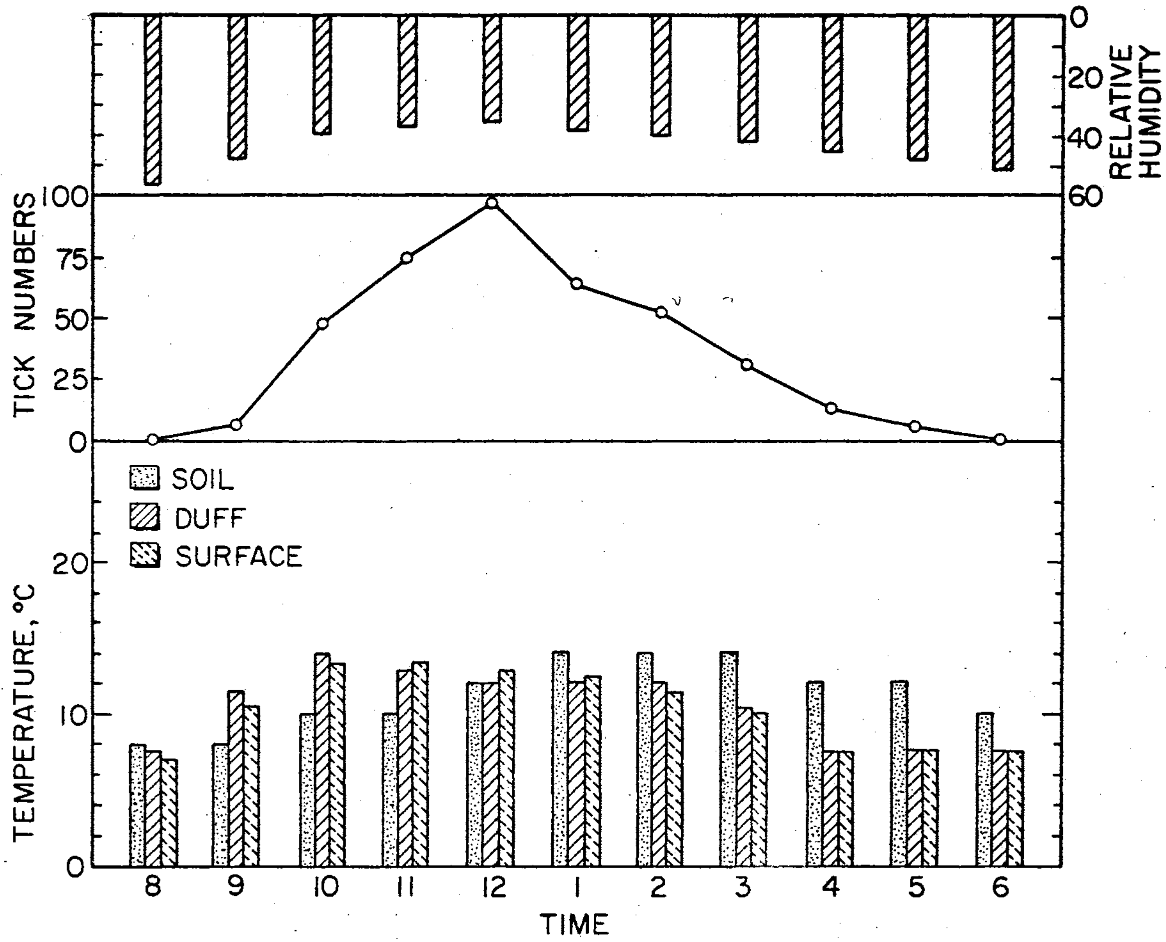

Figure 5. Influence of Temperature on the Response of Nymphal and Adult Lone Star Ticks to CO_2 Traps in the Cookson Hills Game Refuge During 1971.

TABLE III

MIGRATORY MOVEMENT OF ADULT LONE STAR TICKS TO CO_2 TRAPS DURING

A 72-HOUR PERIOD IN THE COOKSON HILLS GAME REFUGE IN 1971

Date	Release Area	Temperature Range; Mean		Release From Trap (m)	Ticks Released	Ticks Recovered (72 hours)	Ticks Recovered (7 days)	% Total Ticks Recovered
May	Meadow	4-24	14	3.0	800	11	0	1.3
				6.1	800	0	0	0
	Woodlot	4-24	14	3.0	800	368	71	54.8
				6.1	800	88	33	15.1
June	Meadow	21-29	25	9.1	400	0	0	0
				12.2	400	0	0	0
				15.2	400	0	0	0
	Woodlot	21-29	25	15.2	800	0	3	.37
				21.3	800	0	2	.24
				27.4	800	0	0	0
June	Meadow	18-33	25	6.1	400	0	0	0
				9.1	400	0	0	0
	Woodlot	18-33	25	9.1	800	31	19	5.5
				12.2	800	2	8	1.2
				15.2	800	1	1	.24
June	Meadow	20-32	26	6.1	400	0	0	0
				9.1	400	0	0	0
	Woodlot	20-32	26	15.2	400	1	2	3
				18.3	400	0	0	0
July	Mowed	19-36	27	6.1	400	2	0	.24
	Meadow			9.1	400	0	0	0
	Woodlot	19-36	27	12.2	400	0	4	1.0
				15.2	400	0	0	0

During the season when the population of nymphs was high movement of up to 9.1 m under woodlot conditions was recorded. The highest recovery rate was approximately 3 m. Adjacent unmowed meadow conditions restricted migration to 1.5 m, whereas in mowed meadows nymphs moved as far as 3 m (Table IV).

Larval movement of up to 3 m was noted in woodlots (Table V) from the original marked cluster on the vegetation to the trap proper. The highest rate of recovery was approximately 1.2 m.

Nocturnal and Diurnal Movement to CO_2 Under Woodlot Conditions

Results from observations on lone star tick movement at nighttime indicated variation between diurnal and nocturnal movements to CO_2.

Each stage observed generally migrated a shorter distance during nocturnal periods than for the same length of time during the day (Tables VI, VII, VIII).

Adults exhibited a maximum migratory movement of up to 3 m during darkness, while for the same number of daytime hours, movement was between 3 m and 4.6 m (Table VI).

Lower nighttime temperatures may have been responsible for the more restricted movement of ticks toward the CO_2 traps at night.

Nymphal responses indicated a maximum movement of 3 m after dusk as opposed to 4.6 m during daylight hr (Table VII).

Larval movement after dark was less than 1 m from the vegetation on which they were marked near the end of the summer. The maximum movement after dark for larvae was .91 m. Movement during the day was a distance of about 1.5 m from the vegetation to the trap (Table VIII).

TABLE IV

MIGRATORY MOVEMENT OF NYMPHAL LONE STAR TICKS TO CO_2 TRAPS DURING A 72-HOUR PERIOD IN THE COOKSON HILLS GAME REFUGE IN 1971

Date	Release Area	Temperature Range; Mean	Release From Trap (m)	Ticks Released	Ticks Recovered (72 hours)	Ticks Recovered (7 days)	% Total Ticks Recovered
July	Mowed	19-36 27	3.0	400	2	0	.50
	Meadow		6.1	400	0	0	0
			9.1	400	0	0	0
	Woodlot	19-36 27	3.0	400	19	20	9.7
			6.1	400	7	4	2.7
			9.1	400	1	0	.25
July	Meadow	16-29 22	1.5	200	2	0	1.0
			4.6	200	0	0	0
			6.1	200	0	0	0
	Woodlot	16-29 22	9.1	200	0	0	0
			12.2	200	0	0	0

TABLE V

MIGRATORY MOVEMENT OF LARVAL LONE STAR TICKS TO CO_2 TRAPS DURING A 72-HOUR PERIOD IN THE COOKSON HILLS GAME REFUGE IN 1971

Date	Release Area	Temperature Range; Mean	Release From Trap (m)	Ticks Released	Ticks Recovered (72 hours)	% Total Ticks Recovered
August	Woodlot	20-30 25	1.2	2000	453	22.6
			1.8	2500	284	11.7
			2.4	2000	60	3.0
			3.0	3000	9	.30
			3.7	2500	0	0

TABLE VI

NOCTURNAL AND DIURNAL MOVEMENT OF ADULT LONE STAR TICKS TO CO_2 TRAPS

DURING THE SUMMER OF 1971 AT COOKSON HILLS GAME REFUGE

Date	Release Time	Temperature Range; Mean		Release From Trap (m)	Number Ticks Released	Number Ticks Recovered	% Total Ticks Recovered
June	Night	22-28	25	3.0	400	0	0
				6.1	400	0	0
	Day	24-30	27	3.0	400	5	1.2
				6.1	400	0	0
June	Night	20-24	22	1.5	200	10	5.0
				3.0	200	3	0
				4.6	200	0	0
	Day	22-32	27	1.5	200	11	5.5
				3.0	200	10	5.0
				4.6	200	1	.50

TABLE VII

NOCTURNAL AND DIURNAL MOVEMENT OF NYMPHAL LONE STAR TICKS TO CO_2 TRAPS

DURING THE SUMMER OF 1971 AT COOKSON HILLS GAME REFUGE

Date	Release Time	Temperature Range; Mean		Release From Trap (m)	Number Ticks Released	Number Ticks Recovered	% Total Ticks Recovered
July	Night	23-25	24	1.5	200	4	2.0
				3.0	200	3	1.5
	Day	22-29	25	1.5	200	10	5.0
				3.0	200	13	6.5
July	Night	20-28	24	4.6	200	0	0
				6.1	200	0	0
	Day	23-30	26	4.6	200	3	1.5
				6.1	200	0	0
July	Night	21-23	22	3.0	200	2	1.0
				4.6	200	0	0
	Day	22-26	24	3.0	200	7	3.5
				4.6	200	0	0

TABLE VIII

NOCTURNAL AND DIURNAL MOVEMENT OF LARVAL LONE STAR TICKS TO CO_2 TRAPS

DURING THE SUMMER OF 1971 AT COOKSON HILLS GAME REFUGE

Date	Release Time	Temperature Range; Mean	Release From Trap (m)	Number Ticks Released	Number Ticks Recovered	% Total Ticks Recovered
August	Night	21-25 23	.30	1000	15	1.5
			.91	1500	7	.46
			1.5	1000	0	0
			2.1	1200	0	0
	Day	22-28 25	.30	1400	57	4.1
			.91	1000	40	4.0
			1.5	1000	32	3.2
			2.1	1200	0	0

As previously indicated, cooler nighttime temperatures may have lowered the metabolism of all stages and, thus, help explain the reduced movements at night. In addition, the rate of sublimation of dry ice after darkness is reduced and therefore less CO_2 gas is expelled during this period.

Seasonal Distribution of Tick Stages in a Meadow, Ecotone, and Woodlot as Indicated by CO_2 Trap Surveys

Adult and nymphal stage numbers remained relatively low during the season in the meadow habitat and there was little fluctuation between either stage (Figure 6). Temperatures corresponded closely with the increase and decrease in tick numbers throughout season. For example, during early May both nymphs and adults increased with a rise in temperature.

Larval activity was noted in the meadow habitats during latter June and their numbers increased in relation to increases in temperature through mid-July (Figure 6).

Activity for each of the three stages was minimal in the meadow during the summer months.

Nymph and adult responses to CO_2 in the ecotone were closely correlated to the temperature trends during April through July. The variation between either stage was slight during this period (Figure 7).

Larval activity began in latter June and increased on through mid-August. Temperatures paralled the numbers of active larvae except for some deviation during early August when the temperature declined when the activity increased (Figure 7).

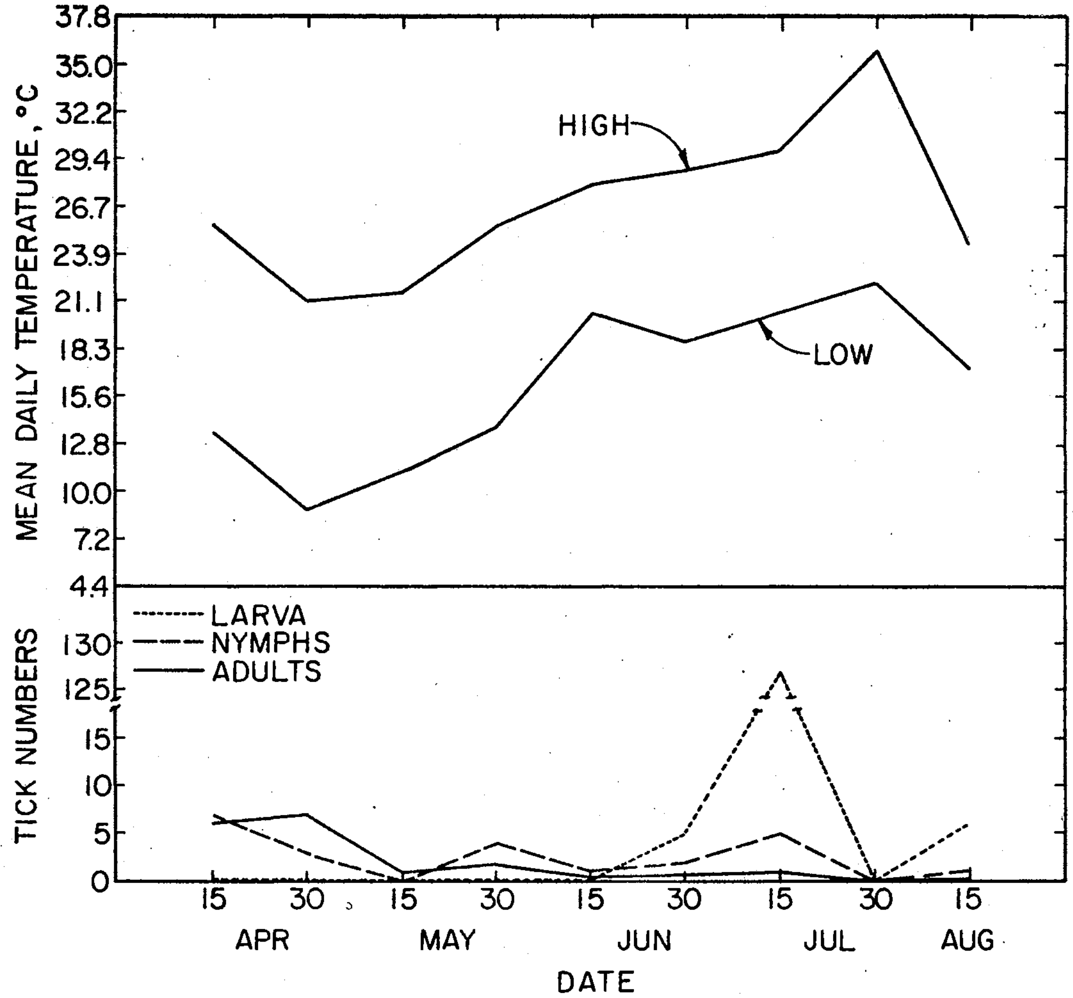

Figure 6. A Seasonal Distribution of Lone Star Tick Stages in a Meadow Habitat Within the Cookson Hills Game Refuge During 1971 as Indicated by CO_2 Trap Surveys.

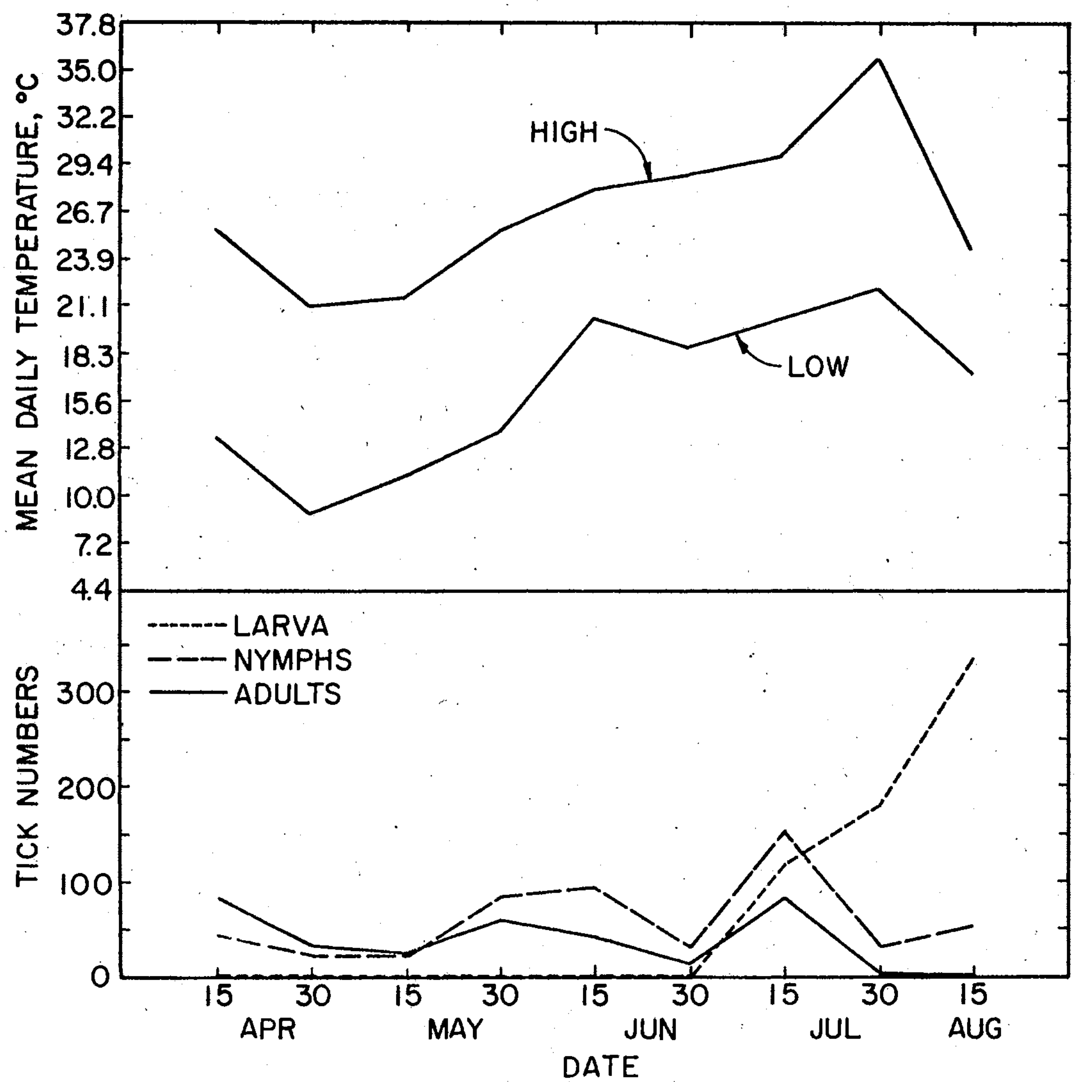

Figure 7. A Seasonal Distribution of Lone Star Tick Stages in an Ecotone Habitat Within the Cookson Hills Game Refuge During 1971 as Indicated by CO_2 Trap Surveys.

Adult and nymph activity in the woodlot declined during latter April and early May before beginning to rise again. Temperatures closely paralleled the rises and declines in tick numbers throughout the season (Figure 8).

Larval activity was noted during mid-June, but declined again during the latter part of month. Larval numbers rose rapidly during July and gradually tapered off in early August with a corresponding decrease in temperature.

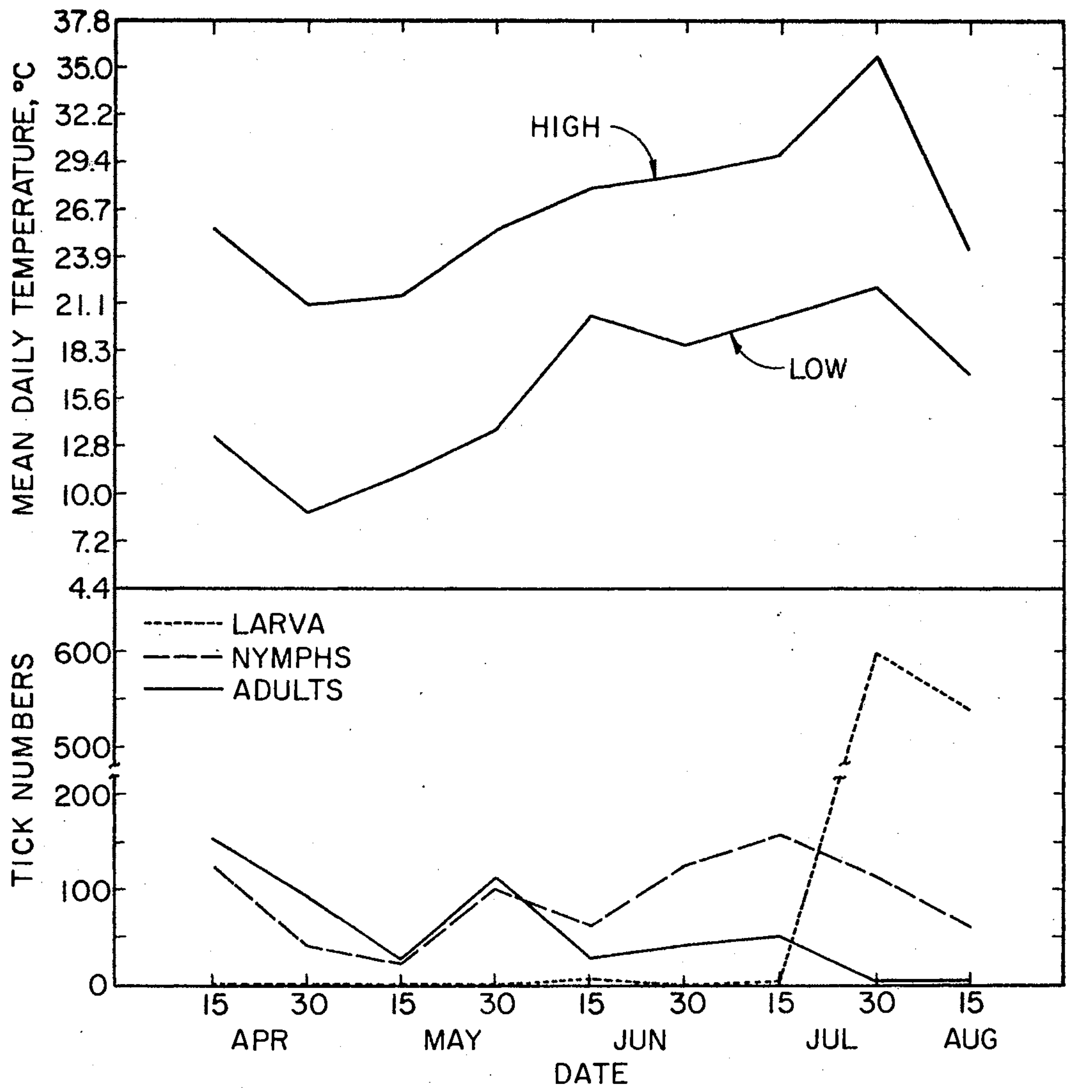

Figure 8. A Seasonal Distribution of Lone Star Tick Stages in a Woodlot Habitat Within the Cookson Hills Game Refuge During 1971 as Indicated by CO_2 Trap Surveys.

CHAPTER V

SUMMARY AND CONCLUSIONS

Early spring threshold studies indicated tick responses to CO_2 stimulation were negative until the temperature reached 9 to 10°C. The performance of the CO_2 traps to a large degree was dependent on the surrounding temperature. As long as the temperature was 9 to 10°C or above, the emission of CO_2 from the traps would stimulate the ticks to activity.

It was noted in migration studies that if the traps remained charged with dry ice, movement or migration of the lone star ticks toward the CO_2 source was from as far away as 21.3 m. Larger numbers were recorded at closer distances to the trap.

Populations of nymphs increased with an increasing in overstory, decreased with increasing understory, and, in general, were higher in heavier duff. Adults followed a similar pattern of distribution. Small numbers of ticks were found in open areas with little overstory.

The nocturnal responses of each stage varied. The adults and nymphs responded from greater distances while the larvae migrated toward the CO_2 source from closer range. When comparing migration potential during nocturnal and diurnal periods, it was noted that the potential was higher during the day.

Results after employing CO_2 traps in meadows, ecotones, and woodlots indicated little activity in the meadows but high populations in the ecotone and woodlot habitats. There were fluctuations in responses with each tick stage throughout the summer which were probably due to variable habitats and alternating temperatures.

Overall data collected from studies employing CO_2 traps indicated much potential for their use in surveying small areas for tick populations, as an aid in collection of large numbers of ticks for lab procedures, and as a tool for limited control of ticks in certain areas.

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