BULLETIN No. 171 FEBRUARY, 1913

ALABAMA

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute

AUBURN

The Biology or Life History of the Cattle Tick as Determined at Auburn, Ala.

BY

H. W. GRAYBILL and W. M. LEWALLEN

Dipping Vats and Dips

BY

C. A. CARY

Opelika, Ala.
Post Publishing Company
1913

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At my request the Bureau of Animal Industry, Zoological Division, under Dr. B. H. Ransom, decided to undertake the investigation of the biology of the Texas fever tick in co-operation with the Veterinary Department of the Alabama Polytechnic Institute at Auburn, Ala. This work was carried on during 1907 and 1908. Mr. H. W. Graybill had direct charge of the work and was assisted by Mr. W. M. Lewallen, both of whom were paid by the Bureau of Animal Industry. The Veterinary Department furnished the place and the material for the work. The agreement between the Bureau and the Veterinary Department of The Alabama Polytechnic Institute was that this co-operative work could be published by both the Bureau of Animal Industry and the Experiment Station of the College. I, therefore, publish this part of the report that will be of value to Alabama farmers in the eradication of the cattle tick. In addition to this report will be found specifications and plans for dipping vats, the arsenical dip and the oil emulsion that is also used in killing ticks. It is anticipated that this bulletin, as a whole, will be of great value to the farmers of Alabama in the work of tick eradication.

The part of this bulletin from page 5 to 21 was written by H. W. Graybill and the remainder by the undersigned.

C. A. CARY.

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STUDIES ON THE BIOLOGY OF THE TEXAS-FEVER TICK.

Introduction.

During 1907-8 the Zoological Division of the Bureau of Animal Industry conducted a year's experiments on the life history of the Texas-fever tick at Auburn, Ala., in cooperation with the veterinary department of the Alabama Polytechnic Institute. The results obtained during the course of those investigations have been published in Bulletin 130 of the Bureau of Animal Industry. The work was continued for another year (1908-9) along the same but somewhat less extensive lines. Mr. W. M. LeWallen, who assisted in the first year's work, had charge of the experiments during the second year.

The second year's work was undertaken for the purpose of obtaining additional data on the nonparasitic periods in the life history of the tick, and to determine what variations might take place in the duration of these as a result of yearly variations in weather conditions.

Methods of Study.

The methods of study employed were the same as those used the first year. The indoor experiments were conducted by the use of incubation tubes, and these were checked by outdoor experiments conducted in field lots representing natural conditions. The incubation tubes used were the vertical type provided with a glass tube inserted at the bottom for the purpose of supplying the sand with moisture, shown in figure 1, Bulletin 130, Bureau of Animal Industry. The field plots were the same as those used in the first year's work (fig. 3, Bulletin 130), being 2 feet square. They were protected from intrusion of small animals by a wire netting fence.

In the indoor experiments the ticks were handled the same as during the first year. Four engorged ticks were collected at the beginning of each month, and each was placed in a dish by itself, where it remained until oviposition was completed. At the end of every 24 hours the eggs were removed from each tick, counted, and placed in an incubation tube marked with the number assigned the tick and the date the eggs were removed. The dates when the eggs in each tube began and completed hatching, and when the first and last larvae died, were recorded, and finally the per cent of eggs that hatched was determined. The indoor experiments were conducted in an unheated room, the windows of which were constantly open.

In the outdoor experiments two sets of plots were run, one located in a place shaded a part of the day and the other in the sun. In each plot 10 engorged females were placed.

PREOVIPOSITION PERIOD.

The minimum preoviposition period noted was 2 days, which occurred in the case of ticks collected in August. Ticks collected in August the first year had a minimum period of 2 days, but the minimum for the year (1 day) was observed in the case of a tick collected in April. The maximum period (29 days) was exhibited by ticks collected December 2, and the maximum for the first year (98 days) was observed in the case of a tick collected November 30.

From the table (last column) it will be noted that the average preoviposition periods increase month by month from the minimum to the maximum, and then decrease again to the minimum. A similar increase and decrease were also shown in the case of averages for the first year's experiments in the horizontal tubes, but in the case of the ticks used for the vertical-tube experiments the averages for April and June were greater than for March.

Preovipisition period—Range and average length of periods

Date ticks were collected	Number of Ticks	Range of preoviposition periods	Average of preoviposition periods	Date ticks were collected	Number of Ticks	Range of preoviposition periods	Average of preoviposition periods
1908		Days	Days	1909		Days	Days
August 5	4	2 to 4	3	January 1	4	22 to 24	23
September 1	4	3 to 5	4	February 4	4	18 to 20	19.3
October 1	4	5 to 11	7.8	March 1	4	9 to 16	11.8
November 2	4	7 to 9	8.3	April 2	4	9 to 10	9.8
December 2	4	17 to 29	25.5	July 2	4	3	3

OVIPOSITION PERIOD.

The longest oviposition period noted was 82 days, observed in the case of a tick which began ovipositing in January. A tick in the first year's experiments which began to lay eggs in January had an oviposition period of 91 days, but the longest period was exhibited by a tick which began ovipositing in November and continued to lay eggs for 152 days. The second year the shortest period (7 days), as well as the longest, occurred in January. The tick giving this period, however, deposited only 305 eggs, an exceptionally small number. The shortest period the first year was 3 days, and this occurred in June. The average oviposition periods for the first year increased month by month from a minimum in June to a maximum in November, and gradually decreased again in the succeeding months. During the second year the same tendency was shown, the periods increasing from a minimum in August to a maximum in November, and then, following a sudden decrease for December, there was an increase for January and February, after which the decrease was regular for the remaining months.

Oviposition period—Range and average length of periods

Month oviposition began	Number of Ticks	Range of ovi-position periods	Average of ovi-position periods	Month oviposition began	Number of Ticks	Range of ovi-position periods	Average of ovi-position periods
1908		Days	Days	1909		Days	Days
August	4	13 to 15	14.3	February	4	37 to 59	46.8
September	4	9 to 18	14.8	March	4	22 to 42	33.3
October	4	13 to 85	25.3	April	4	26 to 32	29
November	4	56 to 63	59.5	May	4	19 to 27	23.8
December	4	30 to 42	34.5	June	4	11 to 19	15.8
				July	4	12 to 17	14.8
1909							
January	4	7 to 82	45.8				

INCUBATION PERIOD.

The range of the incubation periods of the lots of eggs laid by each tick is given in the table in the Appendix. The range of the period for the second year was 18 to 176 days, as compared with 19 to 188 days for the first year. In the table below only the periods from the time the eggs were deposited until the first eggs hatched in each lot have been used, and these are referred to for convenience as the minimum incubation periods. The periods to the hatching of the last eggs in each lot have been included in the table in the Appendix. The longest minimum incubation period for both the first and the second year occurred in the case of lots of eggs deposited during the month of October, being 173 days for the second year and 180 days for the first year. The shortest period for the second year was 18 days and was observed in the case of lots of eggs deposited during the month of June, while the lots deposited during the same month of the first year gave a minimum period of 22 days. The shortest period for the first year (19 days) was furnished by lots of eggs deposited during the months of July and August.

By comparing the averages in the table below it will be observed that they increase from August to October and decrease for the remaining months, except in the case of the average for July, which shows a slight increase. In case of the averages for the first year it is noted that they increase for the months of August to October and decrease for the remaining months without interruption.

Minimum incubation period—Range and average length of periods

Month eggs deposited	Number of lots	Range of periods	Average of periods	Month eggs deposited	Number of lots	Range of periods	Average of periods
1908		Days	Days	1909		Days	Days
August	52	20 to 30	23.1	February	48	82 to 107	95.5
September	49	32 to 70	44.8	March	170	58 to 90	71.5
October	49	141 to 173	158.7	April	141	38 to 65	47.5
November	66	151 to 171	157.5	May	90	26 to 39	30.6
December	21	139 to 158	150.3	June	47	18 to 26	22.9
				July	51	22 to 27	24.5
1909							
January	70	103 to 141	121.6				

HATCHING PERIOD.

The maximum hatching period for the second year was 52 days and for the first year 49 days, and in the case of both years this period belonged to a tick whose eggs began to hatch during the month of October. The shortest hatching period for the second year was 6 days and occurred in the case of a tick whose eggs began to hatch in May, while for the first year the minimum period for the same month was 9 days. The shortest period during the first year (4 days) fell to the month of July. It is noted by referring to the averages in the table below that those for October and February are the same, and for the remaining months, with the exception of the break down shown by May, there is a decrease, month by month, of the averages. In the first year's work the averages increased from that for July to the maximum, which is for the month of October, and decreased for the remaining months, except for a slight increase for the month of June.

Hatching period—Range and average length of periods

Month hatching began	Number of Ticks	Range of hatching periods	Average of hatching periods	Month hatching began	Number of Ticks	Range of hatching periods	Average of hatching periods
1908		Days	Days	1909		Days	Days
August	4	17 to 27	21.5	March	2	33 to 46	39.5
October	4	47 to 52	50	April	4	18 to 21	19.3
				May	20	6 to 21	13.8
1909				June	4	12 to 18	16
February	1	50	50	July	8	11 to 21	14.5

LONGEVITY PERIOD.

The longest and shortest longevity periods obtained for the lots of larvae belonging to each tick are given in the table in the Appendix. The time to the death of the first larvae in each lot is referred to in the table below as the minimum longevity period and that to the death of the last larvae as the maximum longevity period. The longest maximum longevity period for the second year was 249 days, as compared with 234 days for the first year, and both occurred in the case of lots of eggs which began to hatch during the month of October. In referring to the averages it will be noted that there is no regular increase and decrease to and from the maximum, and the same was noted in the case of the first year's experiments. This is no doubt due to the fact that temperature, while it plays some part, is not a controlling factor in the longevity of larvae as it is in the case of the preoviposition, oviposition, hatching and incubation periods. The range of the averages for the months of August to November of the second year is 104.5 to 213.7 days, whereas the range for the same months of the first year is 56.2 to 167.4 days. The range of the averages for the rest of the months of the second year is 63.3 to 77.6 days, as compared with a range of 38.6 to 73.2 for the remaining months of the first year.

Longevity period—Range of maximum and minimum longevity and average of maximum longevity

Month lots began to hatch	Number of lots	Range of minimum longevity periods	Range of maximum longevity periods	Average of maximum longevity periods	Month lots began to hatch	Number of lots	Range of minimum longevity periods	Range of maximum longevity periods	Average of maximum longevity periods
1908		Days	Days	Days	1909		Days	Days	Days
August	6	16 to 36	99 to 192	121.8	April	72	6 to 60	31 to 110	75.3
September	46	6 to 62	50 to 218	104.5	May	355	8 to 87	14 to 119	77.6
October	31	13 to 155	80 to 249	213.7	June	180	7 to 85	25 to 139	66.1
November	18	51 to 146	58 to 223	149.9	July	56	9 to 48	9 to 106	63.3
					August	42	7 to 47	31 to 118	64.6
1909									
March	30	10 to 42	10 to 112	71.6					

ENTIRE TIME OF NONPARASITIC DEVELOPMENT.

The entire time for each individual tick and its progeny, i. e., the time from dropping to the death of all the larvae, is given in the table in the Appendix. The longest entire time during the second year (297 days) was obtained in the case of ticks collected September 1, while the longest period for the first year (288 days) occurred in the case of ticks collected October 1. The shortest period for the second year was 96 days and for the first year 79 days, and both occurred in the case of ticks collected the first part of June. The averages for the first year increase month by month from June to a maximum for October, and then decrease for the remaining months, except that the averages for February and March are the same. The averages for the second year, given in the last column of the table below, do not increase to and decrease from the maximum without deviations, as do those for the first year.

Entire time of parasitic development

Date engorged females were collected	Number of engorged females	Range of entire-time periods	Average of periods	Date engorged females were collected	Number of engorged females	Range of entire-time periods	Average of periods
1908		Days	Days	1909		Days	Days
August 5	4	143 to 254	206.5	January 1	4	202 to 253	235
September 1	4	258 to 297	280	February 4	4	204 to 230	218.5
October 1	3	271 to 280	279.3	March 1	4	185 to 207	198.3
November 2	4	274 to 288	282	April 2	4	139 to 164	154
December 2	4	257 to 268	264.8	May 1 (?)	4	140 to 185	156.5
				June 2 (?)	4	96 to 127	117
				July 2	4	110 to 149	129.5

NUMBER OF EGGS LAID AND PERCENTAGE HATCHED.

During the second year the minimum number of eggs laid by a tick was 305 and the maximum 4,492. The average number of eggs laid by the various lots of ticks ranged from 1,885 to 4,262. The lowest percentage of eggs hatched was 3 per cent and the highest 98 per cent. The percentage of eggs hatched in the case of ticks collected during December, January, and February ranged from 3 to 60 per cent. For the first year the minimum number of eggs laid was 357 and the maximum was 5,105, and the averages ranged from 1,811 to 4,089. The percentage of eggs hatched ranged from 0 to 98 per cent.

Egg laying and hatching—Total and average number of eggs laid and per cent hatched.

Date collected	Number of ticks	Number of eggs deposited	Average number of eggs	Per cent of eggs hatched	Date collected	Number of ticks	Number of eggs deposited	Average Number of eggs	Per cent of eggs hatched
1908					1909				
August 5	4	3,962 to 4,492	4,262	48 to 97	Jan. 1.	4	305 to 3,723	2,615	3 to 60
September 1	4	2,797 to 3,654	3,352	92 to 98	Feb. 4	4	1,993 to 2,970	2,568	11 to 41
October 1	4	1,588 to 3,848	2,768	9 to 61	Mar. 1	4	1,380 to 3,361	2,352	61 to 93
November 2	4	2,215 to 3,329	2,975	52 to 71	April 2	4	1,741 to 3,065	2,476	86 to 95
December 2	4	1,496 to 2,201	1,885	11 to 27	May*1	4	3,181 to 4,178	3,674	69 to 93
					June†2	4	1,640 to 3,003	2,180	60 to 97
					July 2.	4	2,214 to 3,710	2,948	96 to 98

* Ticks were collected May 1 and 2 † Ticks were collected June 2. 3, 4 and 5

COMPARISON OF RESULTS OF INDOOR AND OUTDOOR EXPERIMENTS.

In the next table the dates when the first eggs hatched and when all the larvae were dead in each month's experiments, indoors and outdoors, are given for purposes of comparison. These dates are of much practical importance in eradication work when rotation methods are employed, since the dates when the first eggs hatched are those on which ticky cattle placed on tick-free land on dates corresponding to those on which the experiments were begun will be in danger of reinfestation, and the dates on which all larvae were dead are the dates on which pastures from which all animals have been removed will be free of ticks.

Comparison of records of vertical tubes and field plots, Auburn, Ala., 1908-9

Vertical tubes			Field plots		
Date females were collected	Date first eggs hatched	Date all larvæ were dead	Date females were collected	Date first eggs hatched	Date all larvæ were dead
1908			1908		
August 5	Aug. 30	Apr, 16	August 5-6	Aug. 31	Apr. 3
September 1	Oct: 7	June 25	September 1	Nov. 23	May 22
October 1	Feb. 25	July 8	October 1	Apr. 19	June 23
November 2	Apr. 22	Aug. 17	November 2	May 10	June 23
December 2	May 11	Aug. 27			
1909			1909		
January 1	May 19	Sept. 11	January 1	May 21	July 30
February 4	May 21	Sept. 22	February 1-4	May 20	Aug. 6
March 1	May 24	Sept. 24	March 1-3	May 20	Aug. 25
April 2	May 28	Sept. 13	April 2	May 26	Sept. 11
May 1-2	June 10	Nov. 2	May 1-2	June 12	Sept. 11
June 2-5	July 2	Oct, 7	June 2-5	June 28	Oct. 2
July 2	July 28	Nov. 28	July 1-2	July 26	Nov. 13

In comparing the length of time required for the first eggs to hatch in the indoor and outdoor experiments it was found that for all the months except March, April, June, and July the time was longer in the outdoor than in the indoor experiments, the differences ranging from 1 to 53 days, and for the above-mentioned months the time was shorter, the differences ranging from 1 to 4 days. The longer time obtained in the majority of the outdoor experiments may be due in part to unavoidable errors in observation because of the fact that it is frequently difficult to determine with certainty when the first eggs hatch, since they are scattered and some may be hidden from view. In the first year's experiments practically the same results were obtained. For two of the eight months for which comparisons could be made the time was the same in the indoor and outdoor experiments, and for the remaining months the time was longer in the outdoor experiments, the differences ranging from 1 to 22 days.

In view of the fact that in the two years' experiments the time to the hatching of the first eggs was longer in the outdoor experiments than in the corresponding indoor experiments in all except four instances, in which cases the differences were comparatively small, ranging from 1 to 4 days, it seems safe to assume that indoor experiments, if the temperature is maintained near that on the outside, will be safe to follow in practical work, provided a reasonable margin of safety be allowed to cover slight variations that might occur in the direction of a shorter time for hatching.

In the second year's work, for all months the time required for all the larvae to die was longer in the indoor than in the outdoor experiments, the difference ranging from 2 to 55 days, and the average difference being 28 days. In the first year's experiments similar results were obtained; in all but one case the periods were longer in the indoor than the outdoor experiments, the differences ranging from 5 to 42 days, th average difference being 21 days. It therefore appears that the time obtained indoors, with incubation tubes of the type employed, as a rule will be three to four weeks longer than that occurring under natural conditions. This is what would be expected, since ticks in tubes are not exposed to the wind, and when kept indoors are not subjected to the sun, in consequence of which they will not suffer the loss of body fluids and nourishment that ticks living in the open will. In addition to this, it is likely that the humidity in the tubes as a rule is higher than that of the outside air, which would tend to prolong longevity of the larvae. It is believed that in using tubes such as were employed, the supply of moisture should not be excessive, the sand simply being kept moist. Unless this is done it is likely that the life of the larvae may be prolonged far beyond that occurring under natural conditions. Unduly long periods for the death of all larvae, obtained by using incubation tubes, are safe but uneconomical, requiring the farmer to forego the use of his land longer than is necessary. It is important that the periods be ample, but it is likewise important that they be no more than this, since rotation methods are inconvenient and expensive at best in the majority of instances.

In comparing the time required for all the larvae to die for corresponding months in the indoor experiments for the two years it was found that for all but one month the time was longer the second year, the differences ranging from 3 to 45 days. The average difference was 25 days. A similar comparison of the outdoor experiments for the two years showed that in every instance the time was longer the second year, the differences ranging from 2 to 36 days. The average difference was 17 days.

Individual records of ticks used in experiments.

Number of tick	Date collected	Number of eggs deposited	Preoviposition period	Oviposition period	Hatching period	Incubation period	Minimum longevity	Maximum longevity	Entire time	Per cent hatched
	1908		Days	Days	Days	Days	Days	Days	Days	
1	Aug. 5	4,492	3	15	27	20 to 36	15	116	143	48
2	do	3,962	4	13	17	20 to 30	12	218	254	97
3	do	4,489	3	15	24	21 to 34	17	141	182	61
4	do	4,104	2	14	18	21 to 30	6	207	247	60
5	Sept. 1	3,654	3	16	52	32 to 73	58	249	286	98
6	do	3,604	4	18	51	36 to 75	15	237	279	92
7	do	2,951	4	9	47	31 to 71	21	222	258	93
8	do	2,797	5	16	50	34 to 70	13	249	297	92
9	Oct. 1	1,588	11	13	------	------	------	------	------	------
10	do	3,848	5	35	50	141 to 176	10	100	280	19
11	do	2,730	7	20	33	151 to 174	10	87	271	9
12	do	2,906	8	33	46	146 to 174	7	112	278	61
13	Nov. 2	3,187	7	63	18	151 to 170	11	107	285	52
14	do	3,329	9	56	19	152 to 168	6	98	274	57
15	do	3,167	8	58	19	151 to 170	14	110	281	59
16	do	2,215	9	61	21	143 to 169	18	106	288	71
17	Dec. 2	1,858	28	31	9	114 to 138	18	100	268	27
18	do	1,985	28	35	18	103 to 142	8	97	266	17
19	do	2,201	17	42	16	116 to 144	19	100	268	15
20	do	1,496	29	30	9	115 to 139	8	87	257	11
	1909									
21	Jan. 1	3,723	24	82	21	61 to 119	16	104	243	60
22	do	3,460	24	48	18	73 to 120	16	113	253	18
23	do	2,790	22	46	16	94 to 121	21	103	242	17
24	do	305	22	7	6	111 to 117	49	94	202	3
25	Feb. 4	2.601	19	49	17	53 to 87	17	98	204	33
26	do	2,970	18	42	17	68 to 97	21	114	225	36
27	do	2,706	20	59	14	49 to 87	7	111	230	41
28	do	1,193	20	37	12	70 to 90	23	106	215	11
29	Mar. 1	2,994	9	41	15	45 to 81	25	116	205	79
30	do	1,674	10	28	8	57 to 84	14	107	196	61
31	do	3,361	12	42	14	44 to 77	25	97	185	93
32	do	1.380	16	22	8	55 to 77	25	119	207	62
33	Apr. 2	2,607	9	26	17	36 to 49	20	106	164	94
34	do	3,065	10	32	13	39 to 50	23	95	154	86
35	do	1,741	10	27	14	39 to 51	15	101	159	94
36	do	2,491	10	31	14	35 to 48	11	81	139	95
37	May *1	4,178	--------	27	18	26 to 39	19	118	158	93
38	do	4,040	--------	25	17	27 to 37	17	96	140	73
39	do	3,181	--------	24	17	28 to 36	25	100	143	85
40	do	3,296	--------	19	12	27 to 41	14	139	185	69
41	June †2	2,311	--------	19	13	18 to 27	18	80	114	97
42	do	3,003	--------	11	13	21 to 27	20	95	127	84
43	do	1,765	--------	15	13	22 to 29	20	62	96	60
44	do	1,640	--------	18	11	21 to 27	9	84	117	89
45	July 2	3,452	3	15	16	24 to 27	12	118	149	98
46	do	3,710	3	17	21	22 to 27	13	94	125	98
47	do	2,214	3	12	15	23 to 29	20	81	110	96
48	do	1,416	3	15	14	23 to 28	7	106	134	98

* Ticks were collected May 1 and 2.   † Ticks were collected June 2, 3, 4 and 5.

REASONS FOR ERADICATING THE CATTLE TICK.

There are various kinds or species of ticks occurring on cattle in the Southern States, but the one that chiefly concerns us here is that commonly called the "cattle" or "Texas-fever" tick **(Margaropus annulatus)**. It is the one most frequently found on cattle and is much more abundant than the other species. When the losses occasioned by this parasite are once thoroughly understood by farmers and stockmen there will be little need for arguments in favor of tick eradication. Some of the losses are not directly noticeable and consequently make little impression, while other losses properly chargeable to the tick are frequently attributed to other causes.

It is hardly necessary to emphasize the important fact that the tick is something more than a simple parasite drawing blood from its host, it being the carrier of a dangerous micro-organism or germ, which it transmits to the blood of cattle, thus causing a disease known by many names, among which are Texas fever, tick fever, splenetic fever, and murrain.[a] Without the tick there can be no Texas fever, and it is by preventing the spread of the tick beyond its natural bounds that the fever has been prevented from waging destruction among northern cattle, which are especially susceptible to the disease. In order to restrict the distribution of the tick the National and State governments maintain a quarantine line extending from the Atlantic to the Pacific coast, marking the boundary between the States or Portions of States harboring this pest and those that do not. Cattle of the quarantined area can not be driven across this line, and may be shipped only in accordance with the regulations of the Secretary of Agriculture to prevent the spread of splenetic fever of cattle.

The more important losses for which the tick is responsible are as follows:

1. Deaths from tick fever among native cattle and purebred cattle imported from the North for breeding purposes.
2. Deaths of cattle north of the quarantine line from fever following the occasional accidental introduction of the tick.
3. The temporary and permanent arrest of growth and development resulting from attacks of the fever.
4. The decrease in weight and the lessened rate in putting on flesh in the case of beef cattle, and the decrease in the amount of milk produced by dairy cattle, as the result of the irritation and loss of blood occasioned by great numbers of ticks.
5. The prevention of southern breeders from exhibiting their stock in the north.
6. The decreased price that southern cattle bring on the market on account of the restrictions placed upon them.

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[a]For information as to this disease and how it is transmitted by the ticks the reader is referred to Farmers' Bulletin 258, "Texas or Tick Fever and Its Prevention."

7. The considerable expense incurred each year by the Federal Government and the infested States in establishing quarantine lines and in enforcing regulations to prevent the spread of Texas fever.

Various writers have estimated the annual loss due to the tick at from $40,000,000 to $100,000,000. These figures should be ample argument, even to the most conservative, for the eradication of the tick.

The South needs more and better live stock and a larger and better dairy industry, and these objects would both be greatly promoted by the destruction of the tick. Furthermore, the increased production of live stock, by reason of its important bearing in maintaining and improving the fertility of the soil, would be of distinct benefit in increasing the yield of field crops. An incidental though important advantage of stock raising and dairying would be found in the distribution of the farmer's income throughout the year, enabling him to live on a cash basis. It can thus be seen that the benefits which would accrue to southern agriculture from the extermination of the cattle tick would be very great and far-reaching.

LIFE HISTORY OF THE TICK.

Before methods of eradication can be carried out intelligently and successfully, it is necessary to know the life history of the tick, and the influence of temperature, moisture, and other climatic conditions on the various stages of its existence. These matters will therefore be taken up first, it being understood that whenever the term "tick" or "cattle tick" is used, it refers to the one species or kind, **Margaropus annulatus.**[a]

The usual host for this tick is the cow or ox. Frequently, however, horses, mules, deer, and sometimes even sheep serve as hosts. But none of these latter animals, with the possible exception of deer, are susceptible to tick fever, consequently they suffer from the tick as a simple parasite and not as a transmitter of disease, although they must be considered in plans for eradication.

Only a part of the development of the tick takes place on the host; the rest of the development occurs on the pasture occupied by the host.

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[a]The reader desiring fuller information as to the life history of the cattle tick is referred to Bulletin 72 of the Bureau of Entomology, United States Department of Agriculture, which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 15 cents.

DEVELOPMENT ON THE GROUND.

In tracing the life history of the cattle tick it will be convenient to begin with the large, plump, olive-green female tick, somewhat more than half an inch in length, attached to the skin of the host. During the few preceding days she has increased enormously in size as a consequence of drawing a large supply of blood.

When fully engorged she drops to the ground, and at once, especially if the weather is warm, begins to search for a hiding place on moist earth beneath leaves or any other litter which may serve as a protection from the sun and numerous enemies. The female tick may be devoured by birds or destroyed by ants, or may perish as the result of unfavorable conditions, such as low temperature, absence or excess of moisture, and many other conditions; so that many which fall to the ground are destroyed before they lay eggs.

Egg laying begins during the spring, summer, and fall months in from two to twenty days, and during the winter months in thirteen to ninety-eight days. The eggs are small, elliptical-shaped bodies, at first of a light amber color, later changing to a dark brown, and are about one-fiftieth of an inch in length. As the eggs are laid they are coated with a sticky secretion which causes them to adhere in clusters and no doubt serves the purpose of keeping them from drying out. During egg laying the mother tick gradually shrinks in size and finally is reduced to about one-third or one-fourth her original size. Egg laying is greatly influenced by temperature, being retarded or even arrested by low temperatures. It is completed in from four days in the summer to one hundred and fifty-one days beginning in the fall. During this time the tick may deposit from a few hundred to more than 5,000 eggs. After egg laying is completed the mother tick has fulfilled her purpose and dies in the course of a few days.

After a time, ranging from nineteen days in the summer to one hundred and eighty-eight days during the fall and winter, the eggs begin to hatch. From each egg issues a small, oval, six-legged larva or seed tick, at first amber colored, later changing to a rich brown. The seed tick, after crawling slowly over and about the shell from which it has emerged, usually remains more or less quiescent for several days, after which it shows great activity, especially if the weather is warm, and ascends the nearest vegetation, such as grass, other herbs, and even shrubs.

Since each female lays an enormous mass of eggs at one spot, thousands of larvae will appear in the course of time at the same place and will ascend the near-by vegetation and collect on the leaves. This instinct of the seed ticks to climb upward is a very important adaptation to increase their chances of reaching a host. If the vegetation upon which they rest is disturbed, they become very active and extend their long front legs upward in a divergent position, waving them violently in an attempt to seize hold of a host.

The seed tick during its life on the pasture takes no food and consequently does not increase in size, and unless it reaches a host to take up the parasitic portion of its development, it dies of starvation. The endurance of seed ticks is very great, however, as they have been found to live nearly eight months during the colder part of the year.

DEVELOPMENT ON CATTLE.

The parasitic phase of development begins when the larvae or seed ticks reach a favorable host, such as a cow. They crawl up over the hair of the host and commonly attach themselves to the skin of the escutcheon, the inside of the thighs and flanks, and to the dewlap. They at once begin to draw blood and soon increase in size. In a few days the young tick changes from a brown color to white, and in from five to twelve days sheds its skin. The new form has eight legs instead of six, and is known as a nymph.

In from five to eleven days after the first molt the tick again sheds its skin and becomes sexually mature. It is at this stage that males and females are with certainty distinguishable for the first time. The male emerges from his skin as a brown, oval tick, about one-tenth of an inch in length. He has reached his growth and goes through no further development. He later shows great activity, moving about more or less over the skin of the host. The female at the time of molting is slightly larger than the male. She never shows much activity, seldom moving far from her original point of attachment. She still has to undergo most of her growth. After mating the female increases very rapidly in size, and in from twenty-one to sixty-six days after attaching to a host as a seed tick she becomes fully engorged and drops to the pasture, to repeat the cycle of development.

SUMMARY OF LIFE HISTORY.

To sum up, on the pasture there are found three stages of the tick—the engorged female, the egg, and the larva;

and on the host are found four stages—the larva, the nymph, the sexually mature adult of both sexes, and the engorged condition of the female.

METHODS OF ERADICATION.

In undertaking measures for eradicating the tick it is evident that the pest may be attacked in two locations, namely, on the pasture and on the cattle.

In freeing pastures the method followed may be either a direct or an indirect one. The former consists in excluding all cattle, horses, and mules from pastures until all the ticks have died from starvation. The latter consists in permitting the cattle and other animals to continue on the infested pasture and treating them at regular intervals with oils or other agents destructive to ticks and thus preventing engorged females from dropping and reinfesting the pasture. The larvae on the pasture, or those which hatch from eggs laid by females already there, will all eventually meet death. Such of these as get upon the cattle from time to time will be destroyed by the treatment, while those which fail to find a host will die in the pasture from starvation.

Animals may be freed of ticks in two ways. They may be treated with an agent that will destroy all the ticks present, or they may be rotated at proper intervals on tick-free fields until all the ticks have dropped.

TIME REQUIRED TO KILL TICKS BY ERADICATION.

The time required for the ticks to die out after all animals have been removed from infested fields and pastures varies considerably, depending principally on climatic and weather conditions. The dates when pastures will be free of ticks, beginning during each month of the year, are given in the following table:

Time required to free pastures from ticks by starvation.

Date of removal of all animals from pasture.	Date when pasture will be free from ticks.	Date of removals of all animals from pasture,	Date when pasture will be free from ticks.
July 1	March 1	Dec. 15 to Mar. 15, inclusive	September 1
August 1	May 1	April 1	September 15
September 1	July 1	April 15	October 15
Oct. to Nov. 1, inclusive	August 1	May 1 to June 15, inclusive	November 1
December 1	August 15		

The above table is based on investigations by Hunter and Hooker[a] at Dallas, Tex., and by the writer at Auburn, Ala., under co-operation between the Bureau of Animal Industry and the veterinary department of the Alabama Polytechnic Institute. All the periods obtained by Newell and Dougherty (1906)[b] in work carried on at Baton Rouge, La., which is much farther south, are shorter. The above periods should be found ample for all localities lying no farther north than Dallas, Tex., or Auburn, Ala. The periods necessary to starve out an infestation for many localities in the southern part of the infested region are no doubt somewhat shorter than those given above. In general, moisture and cold prolong and dryness and heat shorten the duration of an infestation. If various portions of the same pasture differ with regard to temperature and moisture, as is frequently the case, some parts become free of ticks before others do. Other things being equal, high, dry, unshaded land becomes tick free sooner than low, damp, shady land.

The simplest and safest plan in most cases, however, will be to follow the foregoing table in the region indicated for it. It is probable that the periods given in the table should be lengthened a little for the northern part of the infested region. The experiments conducted thus far in various places indicate this and it will place the eradication work in that region on the safe side. For example, E. C. Cotton[c] obtained at Knoxville, Tenn., records for September and April somewhat longer than those given above. They are as follows:

Cattle removed April 15; pasture free of ticks November 13.
Cattle removed September 15; pasture free of ticks July 18.

In localities with temperature and other conditions similar to those at Knoxville, Tenn., these periods should be followed.

TIME REQUIRED TO RENDER CATTLE FREE OF TICKS WHEN PLACED ON UNINFESTED FIELDS.

Before discussing plans for rendering farms tick-free, involving the use of the information given in the foregoing table, it will be necessary to indicate how animals may be entirely freed from ticks by placing them on uninfested fields. This is based on the fact that the female tick must

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aBulletin 72, Bureau of Entomology, U. S. Department of Agriculture.

bCircular 10, State Crop Commission of Louisiana.

cBulletin 81, Agricultural Experiment Station of the University of Tennessee.

drop from the host to the ground before eggs can be laid and before young ticks will develop.

The shortest time in which seed ticks will appear after engorged females have been dropped is twenty days. Consequently cattle placed on a tick-free field during the warmer part of the year are not in danger of becoming infested again with young ticks until twenty days have elapsed. The time required for all the ticks to drop after cattle have been placed on uninfested land varies with the temperature. It is much longer during the winter than during the summer. The time required, beginning at various times of the year, is given in the following table:

Time required for all ticks to drop from cattle placed on tick-free land.

When ticky cattle are placed on tick-free land during—	All ticks will have dropped in—	When ticky cattle are placed on tick-free land during—	All ticks will have dropped in—
August	Six weeks	March	Seven weeks
September	do	April	Six weeks
October	Eight weeks	May	do
November	Nine weeks	June	do
January	Ten weeks	July	Five weeks
February	Seven weeks		

FREEING CATTLE OF TICKS BY ROTATION ON TICK-FREE LAND.

The plan of freeing cattle of ticks by rotating them from one lot or field to another is as follows: Beginning at any time of the year from February to September, inclusive, the cattle are removed from the tick-infested pasture they have been occupying to a tick-free lot or field, and continued there for not more than twenty days. During this time a considerable number of ticks will drop. In order to prevent the cattle from becoming reinfested (by seed ticks resulting from eggs laid by females that have dropped), the heard is then changed to a second tick-free inclosure for twenty days longer, and if they are not free of ticks by that time they are placed in a third tick-free inclosure for twenty days more. Should the two changes at intervals of twenty days have been made, sixty days will have elapsed, which is ample time for all ticks to have dropped during the portion of the year indicated, and the animals are ready to be placed on a tick-free pasture or field without danger of becoming reinfested. The periods to free cattle (given in the above table) are believed to be ample. It will, however, be a wise precaution to make a careful examination of the cattle for ticks before placing them in the non-infested field they are to occupy.

During the part of the year from October to January, inclusive, the time required for seed ticks to appear after females have dropped is much longer than the time necessary for all the ticks to drop from cattle. Consequently, if it is desired, the herd may be continued on the same field for the required length of time without danger of becoming reinfested.

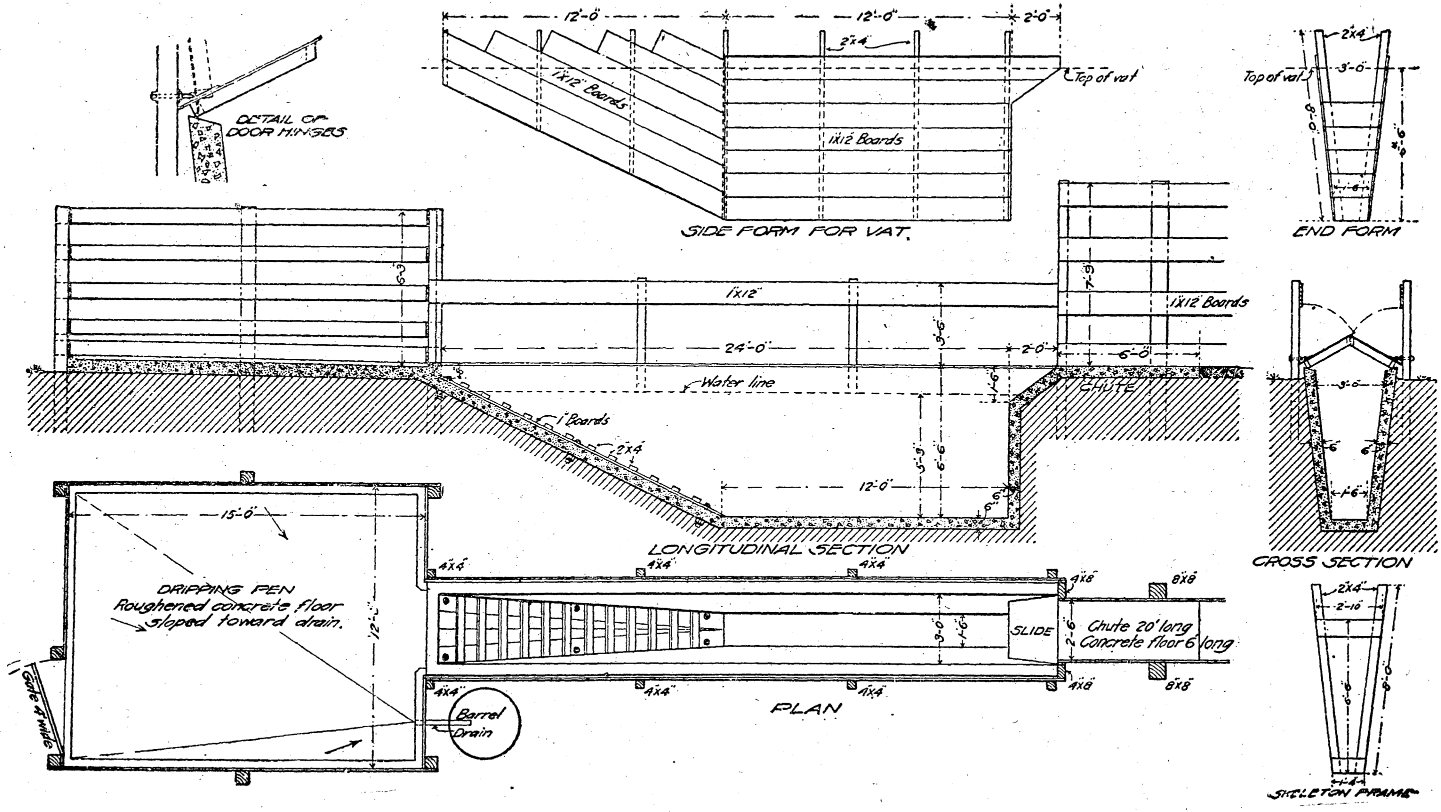
DETAIL OF DOOR HINGES
12'-0"
12'-0"
2'-0"
2"x4"
Top of vat
1"x12" Boards
1"x12" Boards
SIDE FORM FOR VAT
2"x4"
3'-0"
Top of vat
8'-0"
5'-6"
END FORM
6'-3"
1"x12"
7'-9"
1"x12" Boards
24'-0"
3'-6"
2'-0"
6'-0"
Water line
CHUTE
1' Boards
2"x4"
5'-9"
6'-6"
12'-0"
LONGITUDINAL SECTION
3'-0"
1'-6"
CROSS SECTION
15'-0"
DRIPPING PEN
Roughened concrete floor sloped toward drain.
12'-0"
4"x4"
4"x8"
8"x8"
SLIDE
Chute 20' long
Concrete floor 6' long
Barrel
Drain
Gate 4' wide
PLAN
2"x4"
2'-10"
SKELETON FRAME

FIG. 1

DIPPING VATS.

Location.—The vat should be located at a convenient place where the ground is readily drained away from the vat. If the vat is to be a county or public one, locate it near some cross-roads or at a place near a public highway where the cattle from neighboring farms, fields and pastures can reach the vat without being driven over or through private fields or pastures. It is also best to have the long way of the vat run the level way of the ground and never attempt to run the vat up and down the hill or incline of the ground unless the incline be very slight.

The Ground Hole.—The hole should be dug 1 foot longer, 1 foot wider and 6 inches deeper than the respective length, width and depth of the vat to be built. It will be seen by referring to the different outlines of vats in this bulletin that some are only 12 feet long at the bottom. This is 1 to 2 feet too short, since we have found by experience that some cattle may jump off the slide and land in shallow dip on the incline and injure their limbs or feet. This is especially true when the dip gets low in the vat. Hence it is best to have the bottom of the vat 13 to 14 feet long, and this will require the top to be 28 to 30 feet long, not including the length of the slide.

Therefore, the vat should be at least 28 feet long (and 4 feet for the slide) at the top, 14 feet long at the bottom and 36 inches wide at the top; 18 inches wide at the bottom and not less than 6 feet deep in the ground, with 1 to 3 feet above the ground on the sides. For such a vat the hole should be dug 29 feet long (plus 4 feet for the slide) at the top; 15 feet long at the bottom; 4 feet wide at the top and 30 inches wide at the bottom and 6½ feet deep.

Use stakes and lines to lay off the top limits of the hole. Two lines, one on each side, a cross line at each end and a cross line at each end of the 14 feet corresponding to the limits of the bottom. In digging the hole great care should be taken to make the sides smooth and even, and the slide and incline should be even and regular. Irregularities and uneven places in the hole will require more cement, and hence will add to the cost of the vat.

The Forms.—Braces are made of 2x4 as shown in Fig. 2. The braces should be 2 to 3 feet apart and about 8 feet long, 34 inches wide (from outside to outside) at the top of the ground and 16 inches wide at the bottom. Notice in the cut that each brace is nailed to a 2x4—8 feet long, and the ends of this 2x4 are nailed to stakes driven into the ground. This firmly fixes each brace. It will take 5 to 6 long braces for the deep part (14 feet part) and shorter ones will be required for the incline and the slide parts. Braces should not be placed until the cement has been laid in the bottom and on the incline. The braces are then placed and the lower 1x10 or 1x12 planks are cut and placed as shown in Fig 1 above the "side form for vat." The first row of lower planks can be nailed on, but the remaining side planks should be lightly tacked on if they run even and straight. Notice that it is best to make the joints at the 14 foot brace. As a rule, it is best to put on the side and end planks as the grouting or mortar is put in and tamped. This will enable one to see that the concrete is properly tamped, and that the wire is kept in place when it is used to reinforce the sides.

Mixing the Concrete.—It is best to have a mortar box 1 foot deep, 4 feet wide and 6 to 8 feet long. A mortar platform 8 by 10 will do. Accurately measure the cement, sand and gravel or small stones or broken up brick. If the vat is to be reinforced and to be plastered with strong cement after the form is removed, 1 part of cement, 3 parts of sand and 5 parts of gravel or rock may be used. If the vat is not to be plastered, use 1 part of cement, 2½ parts of sand and 5 parts of gravel. Most vats must be plastered.

For each batch of concrete measure out the sand and the cement and mix them thoroughly while dry; then wet and mix and then add the wet gravel or rock; then mix until the gravel is thoroughly coated with cement. For the bottom and incline the concrete should not be too wet. If too wet it will not readily tamp into place and will run down the incline and delay the work. If the sides are to be reinforced it is best to use woven wire fencing 20 to 30 inches wide. Place the first layers along the sides at the bottom, getting it down into the bottom layer of cement. When the tamped concrete is laid to the top of it place the next layer of wire netting and let its lower border slightly overlap the upper border of the previous layer. Keep the wire netting in or near the middle of the six-inch concrete wall. Imbed two bolts at the

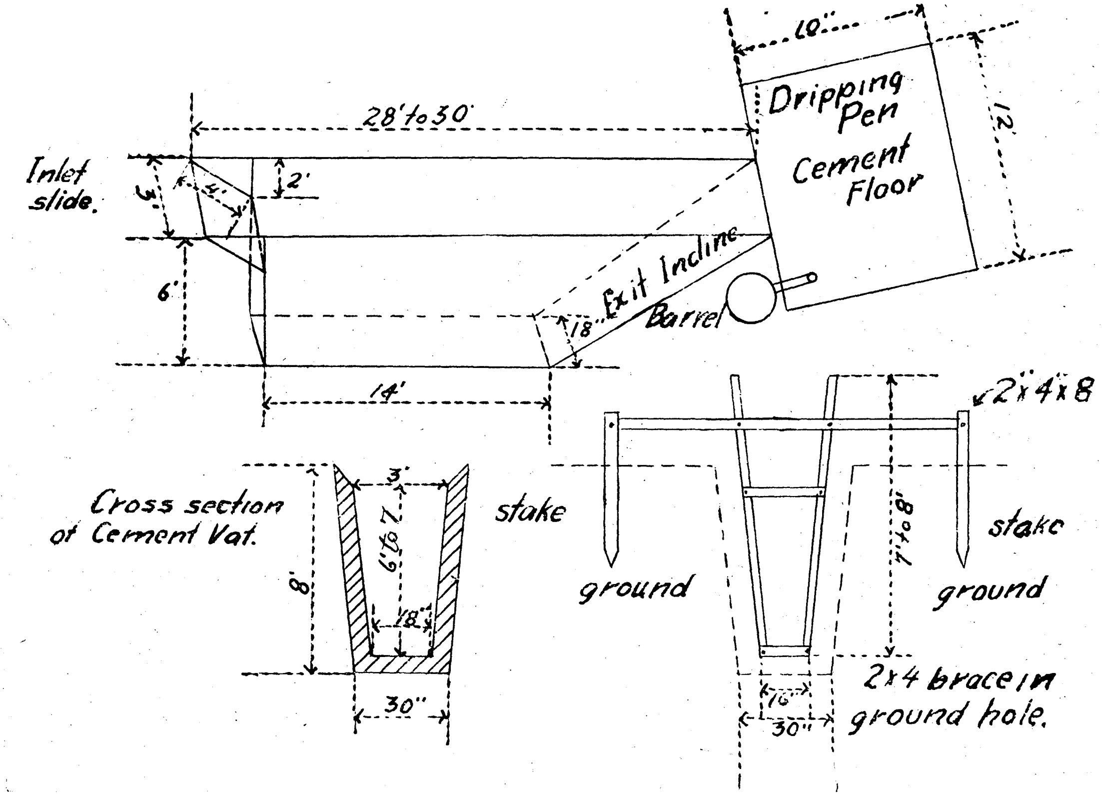
Dripping Pen
Cement Floor
60'
12'
28' to 30'
Inlet slide.
3'
4'
2'
6'
Exit Incline
Barrel
18
14'
Cross section of Cement Vat.
3'
6' to 7
8'
18"
30"
stake
2"x4x8
7' to 8'
stake
ground
ground
2x4 brace in ground hole.
16"
30"

FIG. 2

top and two at the bottom of the incline to hold the incline plank. As a rule, it is best to complete the laying of the concrete at one time, so that all the parts will set together. Some let the concrete in the bottom and incline set for 12 to 24 hours before laying the sides and end. When this is done place the first layer of wire netting and make rough borders of the grouting in the floor and incline. Also let the wire netting extend up all along the incline. If the vat is built 2 to 3 feet above the ground it will be necessary to have outside forms above the ground. These can be made full size and fixed at the bottom by stakes and by top cleats to the braces of the inside forms. The top of the side walls should be beveled—the outside 6 inches higher than the inside. This is especially necessary if the wall stops at the top of the ground and lap splash boards are to be used.

In dry weather the forms may be removed carefully after 24 hours, but in wet weather let the forms remain two to six days.

Plastering Inside.—After the forms are removed dampen bottom, incline, walls and end and plaster the entire inside of the vat with a well mixed mortar made of one part cement and two parts sand. Let this coat be at least one-half inch thick.

If it is desired to waterproof the inside of the vat, paint it over three times a day for three days with a heavy crude petroleum that contains an asphalt base. This can be bought of the big oil companies.

The Incline.—Planks (1 inch thick) are cut the length and form of the incline, and 2x4 cleats are nailed or bolted to these planks, about 10 to 12 inches apart. Then this false plank, cleated floor is put on the incline and held in place by the bolts imbedded in the cement at the top and bottom of the incline. When this wears out it can be replaced by a new one.

The Slide.—Should be 4 feet long, with a 2 foot drop. In some of the plans it will be seen that the slide is 2 to 3 feet long and that is correct for all but milch cows. Cows on short, abrupt slides permit their front feet to slide forward before they jump, and then they slide into the vat on the body, scraping and bruising the udder and teats. The longer and less steep slide prevents this trouble. Making a double slide may also obviate this serious defect. The floor of the slide may be covered with sheet iron.

one-fourth of an inch thick. If the cement is properly laid this iron is not required. It is well to make a sufficient rise in the concrete at the entrance of the slide to prevent surface water from flowing into the vat.

The Dripping Pen—Should be 10x12 feet or 10x15 feet and placed at the end of the incline. Some of the dirt from the hole can be used to level up the ground. This dirt should be well tamped. The concrete should be laid so that the dripping solution from the cattle will all run to a corner next to the vat, where it can run out through a 1½ inch pipe into a barrel in which the solid particles can settle and the top part can be dipped out with a bucket and returned to the vat. The outer borders of the draining pen should be raised 2 to 3 inches to prevent the wasting of the dip. The upper end of the incline should be raised 3 to 4 inches to prevent all material from running back into the vat. The draining pen should be surrounded with a good plank fence not less than 6 feet high. In it must be a good strong outlet gate. The dripping pen should be covered to prevent rain water from flowing into the barrel and tank. It is also essential that the vat be covered to prevent evaporation and keep out rain water.

If the side walls of the vat are not raised 2 to 3 feet above the ground the top of the concrete wall at the ground level should be beveled and posts are then set (2 feet in ground) close up to the wall. Then 1x6 boards are lapped and nailed on the inside of the posts just as siding is put on a house. The lower board laps over the bevel of the concrete wall. These same posts may be high enough to support the roof or the posts may be cut off at the top of the splash boards and other posts may be set some 2 to 3 feet from the side of the tank (6 to 8 feet high) and on these may be placed the roof over the vat. Hinged covers for the vat may be made as suggested in Fig. 1. These hinge covers serve also as splash boards. The objections to the hinge covers are that they are in the way when one wants to get at the vat, and they are difficult to handle and liable to get out of order.

The Chute—Should be 20 or more feet long and 30 inches wide. The boards should be nailed on the inside of the posts. It is also wise to have a good, strong receiving pen connected with the entrance chute and another holding or retaining pen connected with the dripping pen.

MATERIALS FOR VAT.

Portland cement, 36 to 44 sacks.
Sand, 4½ cubic yards.
Gravel, fine broken rock or broken brick, 7 cubic yards.

FOR DRIPPING PEN.

Cement, 8 to 20 sacks.
Sand, 2 to 3 cubic yards.
Gravel or stone, 3 to 4 cubic yards.

In some places "pit-run" gravel, or gravel as it comes from the gravel-pit, is used. This works alright if the sand is good and there is no clay in the mixture and there is a proper amount of gravel. One part of cement is then mixed with six parts of "pit-run" gravel. For the vat and dripping pen it would take 12 to 16 yards of "pit-run" gravel. Never use "pit-run" gravel unless some good authority assures you that it is the proper mixture of sand and gravel.

The vat can be made entirely of cement and sand, but will cost more, since it takes more cement.

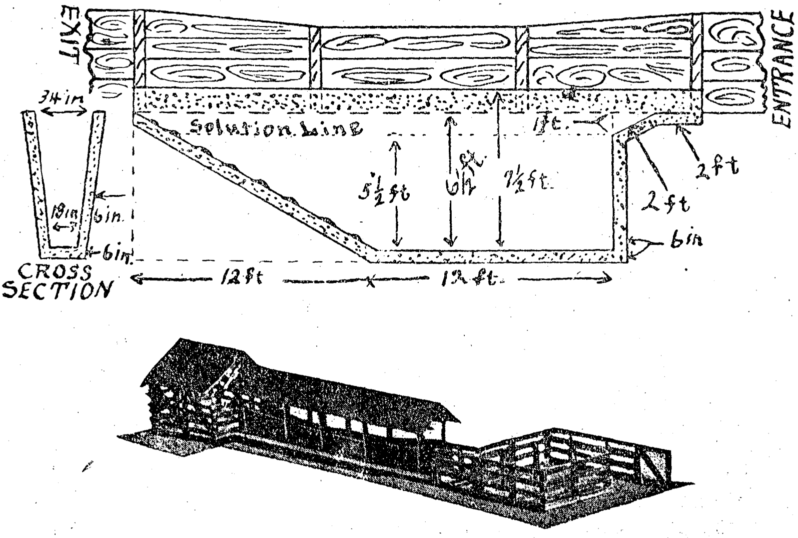

FIG. 3

LUMBER FOR VAT FORMS.

12 to 16 pieces 1x12 inches, 14 feet long, or the equivalent in 1x6, 1x8 or 1x10.

8 to 10 pieces 1x12 inches, 14 feet long, or the equivalent in 1x6, 1x8 or 1x10.

2 pieces 1x12 inches, 9 feet long, or the equivalent in 1x6, 1x8, or 1x10.

2 pieces 1x12 inches, 6 feet long, or the equivalent in 1x6, 1x8, or 1x10.

2 pieces 1x12 inches, 4 feet long, or the equivalent in 1x6, 1x8, or 1x10.

30 pieces 2x4 inches, 8 feet long.

2 pieces 2x4 inches, 7 feet long.

2 pieces 2x4 inches, 6 feet long.

2 pieces 2x4 inches, 4 feet long.

2 pieces 2x4 inches, 2 feet long.

8 to 12 posts, 8 to 10 feet long, will support roof over the vat.

The sheeting and rafters for roof may be made from the 2x4 braces, and the 1-inch plank in the forms and the roof may be covered with galvanized iron, shingles, or tar paper.

6 posts 8 feet long.

2 posts 10 feet long.

1 post 12 feet long.

These will support the roof over the dripping pen.

The rafters may be obtained from the braces and part of the sheeting for the roof from the forms. Cover with galvanized iron, shingles or tar paper.

LUMBER FOR CHUTE.

8 posts, 7 to 8 feet long.

12 pieces, 1x6, 12 feet long.

12 pieces, 1x6, 8 feet long.

Lumber for receiving and retaining pens will vary with the size. The receiving pens can be built with posts, woven wire fence and barb wire.

The Hardware will include nails, 4 bolts ⅝ by 8 to 10 inches long, hinges for dripping pen gate, and

1 piece 1½ inch pipe, 6 inches long.
1—1½ inch elbow.
1 piece 1½ inch pipe, 4 to 8 feet long.
These pipes should have threads on one end or both ends.

ARSENICAL DIP FOR KILLING TICKS ON CATTLE.

Arsenic Trioxide, 1 lb, or for dip. tank 8 lbs.
Sodium Carbonate, 3 lbs., or for dip. tank 24 lbs.
Pine Tar, 1 pint, or for dip tank 1 gallon.
Water, 60 gallons, or for dip. tank 500 gallons.

Dissolve the 3 pounds of carbonate of soda in 4 or 5 gallons of hot water; then add the 1 pound of arsenic and boil and stir for 20 to 30 minutes, remove from the fire; the tar is then warmed and added slowly and stir the dip vigorously at the same time. Next add sufficient hot water to make the entire quantity measure 6 gallons and 1 quart. This is a strong solution and is very poisonous, and should be kept in a well-covered wooden barrel or keg. To get it ready for use take one pint, one quart, or one gallon and add nine pints, nine quarts or nine gallons of hot water to it. In other words, dilute the stock solution by adding nine times as much hot or warm water to it and then it is ready for use.

It may be used by applying it all over the cattle with swab or spray; or it may be used in a dipping vat or tank. In making it for dipping vat dissolve 24 pounds of carbonate of soda in 30 to 40 gallons of hot water, then add 8 pounds of arsenic and stir and boil for 30 minutes; remove the fire from under and around the kettle and let the kettle and its contents cool for 10 to 20 minutes; then add the warm tar and pour it into the dip slowly, stirring it at the same time. This can be placed in dipping vat and sufficient water added to make the entire quantity measure 500 gallons. Make this quantity four times and the tank will contain 2,000 gallons; or five times and it will contain 2,500 gallons. The dipping tank should be measured and marks placed so as to tell how much it will require to fill it, or what it contains at different levels.

Cattle to which this arsenical dip is applied should be placed in a pen or lot where there is no feed or grass, so that the dip will not drip on the feed or grass. The dip is poisonous and should not be handled carelessly.

Some prefer filling the vat with water so that the water in the vat is 5 to 5½ feet deep. The water is measured as it is put into the vat or the number of gallons of water in it determined by adding the length in inches of the vat at the top water line to the length of the vat at the bottom and dividing this product by 2 to get the average length. Now add the width in inches at the top water line and the bottom of the vat and divide by 2 to get the average width in inches. Then multiply the average lengh by the average width and this product by the depth of the water in inches, and this product will be the number of cubic inches of water in the vat. Divide this number of cubic inches of water in the vat by 231 (the number of cubic inches in a gallon) and the result will be the number of gallons of water in the vat. For example:

The top water line may be 26 feet or 312 inches.

The bottom water line may be 14 feet or 168 inches.

312 plus 168 equals 480, divided by 2 equals 240 inches, the average length.

The width at top of water may be 34 inches.

The width at the bottom is 18 inches.

18 plus 34 equals 52, divided by 2 equals 26 inches, the average width.

5½ feet or 66 inches equals the depth of the water in the tank.

240x26x66 equals 421,840 cubic inches of water in the vat.

421,840 divided by 231 equals 1,826 gallons of water in the vat.

By calculation it is found that 1.6 per cent of the number of gallons in the vat will give the number of pounds of arsenic required to make the dip the required strength. Hence, 1,826x.016 equals 29.21 pounds of arsenic trioxide will be required and three times as much sodium carbonate, or 29.21x3 equals 87.63 pounds of commercial sodium carbonate and 3¾ gallons of pine tar.

The arsenic, carbonate of soda and tar may each be divided into three or more equal parts and each batch cooked and mixed as above directed, taking the required gallons of water from the tank to be used in the kettles for that purpose. Be sure to put into the vat the same number of gallons of the concentrated mixture as there were gallons of water removed. If some water is lost in boiling, add sufficient water to make up for the loss.

The dip in the vat will decrease from dipping, and from time to time it should be added to or replenished. This can be done by measuring the water poured into the vat to raise it to the required depth. Then take 1.6 per cent of the number of gallons of water added, and this will be the number of pounds of trioxide of arsenic to add; multiply the number of pounds of arsenic thus obtained by three and this will give the quantity of commercial carbonate of soda needed. Add one pint of pine tar for every one pound of arsenic added.

Approximately the following will suffice:

Water.	Arsenic.	Soda.	Pine tar.
For 60 gallons----------	1 pound	3 pounds	1 pint
For 120 gallons----------	2 pounds	6 pounds	2 pints
For 180 gallons----------	3 pounds	9 pounds	3 pints
For 240 gallons----------	4 pounds	12 pounds	4 pints
For 300 gallons----------	5 pounds	15 pounds	5 pints

When the old dip is to be thrown away and the vat cleaned (this must be done once or twice a year), it should be done with care. The old dip can be run or poured into a large run or brook or creek when the latter is full of running water that will quickly dilute the solution. The sediment in the bottom of the tank should be carefully placed in some hole in the ground away from wells or drinking water. It would be safe to throw it into a creek that has a good flow of water.

Dr. Dalrymple, of Louisiana, has devised a means of neutralizing the arsenic in the old dip before it is thrown away. He says add 6 pounds of slaked lime for each 100 gallons of the old dip. Mix this in the solution in the vat thoroughly and allow it to stand for 2 hours. Then for every 100 gallons of the dip add 6 pounds of commercial sulphate of iron that has just been dissolved in hot water; stir well and allow to stand 10 to 12 hours. The clear fluid on top will contain no arsenic and can be dipped out of the vat and thrown away. The arsenic has united with the iron and sunk to the bottom as an insoluble and harmless sediment. This sediment can be removed and put in a hole or thrown into the creek. The vat is cleaned and refilled with new, freshly made dip.

OIL EMULSION FOR KILLING CATTLE TICKS ON CATTLE.

This is made by using crude petroleum, Beaumont oil or Gulf Refining Oil. *Do not* use the *thick* black oil as it will not emulsify.

(1) Take one pound of hard soap and dissolve it in one gal-

lon of hot, free-stone, or soft, or rain water; then add one gallon of crude petroleum; place in a ten-gallon can or keg and stir vigorously. When thoroughly emulsified add two gallons of hot or warm water and stir. When tepid or milk warm it is ready to apply with a swab, rags or by a spray. This makes a 25 per cent emulsion.

(2) An 80 per cent stock emulsion is made by dissolving one pound of hard soap in one gallon of hot water and then add four gallons of the oil; stir vigorously. To make a 25 per cent solution, take one pint, one quart or one gallon of the 80 per cent stock emulsion and add two and one-fifth times as much warm water to it. This makes a 25 per cent emulsion, but does not contain quite as much soap as when made by the first method.

Always let the animal go into the shade immediately after applying any oil or emulsion, as this will prevent blistering. Also see that the cattle get plenty of good drinking water. *Never apply oil or emulsion to cattle having tick fever or a high temperature.* If the oil is good and the emulsion properly made it will kill all the ticks except the large ones, and they should be picked off and destroyed at the time the emulsion is applied. The emulsion should be thoroughly applied all over every part of the external surface of the body, as often as live ticks are found on the animal—at least every one, two or three weeks. It can be applied by hand, by spray or in a dipping tank. The quantity of the emulsion required to cover an animal will vary from one quart to one gallon depending upon the size of the animal, length of the hair and the way it is applied. The inspectors will tell you where to get spray pumps and how to use them and will tell you how to make dipping vats and how to make and apply emulsions. Your merchant can order for you or sell you the crude petroleum. In order to kill ticks you must watch the cattle and apply the emulsion thoroughly and regularly.

HOW ANY COUNTY IN ALABAMA CAN TAKE UP THE WORK OF TICK ERADICATION.

The law provides that any county in Alabama can begin the work by the County Commissioners or Board of Revenue passing an order to that effect and requesting the State and Federal authorities to co-operate with the county.

The first thing the county should do is to build public dipping vats in all parts of the county in sufficient number to make it convenient for all the cattle of the county to be dipped conveniently once every two weeks during the spring, summer and fall. Some counties furnish all the materials and build the vats. Other counties furnish the cement, sand and gravel and the people build the vats under the direction of an inspector. Other counties furnish only the cement and the people supply the sand, gravel, plank and work to build the vats.

The veterinary inspector in charge of the county is usually paid by the federal or state authorities and the local or beat or district inspectors are paid by the county. The county also furnishes the arsenic, the carbonate of soda and the pine tar to make the arsenical dipping solution to fill the vats. The inspectors mix the ingredients and boil them and fill the vat and conduct the dipping.

THE FIRST YEAR.

Each county should build and fill 70 to 100 different vats. To do that it will take $3,000 to $6,000. It will take 6 to 10 inspectors to make farm to farm inspections and see that all cattle in the country are dipped regularly every two weeks. The government or the State will supply the trained veterinary inspector in charge. The remaining 6 to 10 local inspectors will cost the county $4,000 to $6,000 a year.

Some counties build the vats one year and the next year put on a full force of inspectors and thus clean the county of ticks in two years. Other counties, outside of Alabama, have built the vats and put on a large number of inspectors and cleaned a county of ticks in one year. This is the cheapest method providing the people will co-operate regularly and efficiently. Does it pay? As a rule the cattle ticks destroy every year from 3 to 20 times as much as it costs to eradicate the ticks. It has been proved beyond question that cattle and ticks can not be profitably raised in the South. Hence the cattle industry and indirectly the live stock industry of the South depends upon the eradication of the cattle tick.

Madison County Alabama has eradicated the tick and the United States Government will lift the quarantine on that county and puts its cattle on a world market. This year about 18 counties were cleaned of cattle ticks in Mississippi. Texas, Georgia, South Carolina, Tennessee and Oklahoma have each cleaned from 3 to 5 counties of cattle ticks during 1912. The work is going forward and the federal government will appropriate more money to help the infested states and counties that will co-operate. Every county in Alabama should take up this work at once and make short work of it.

REQUIREMENTS GOVERNING THE SHIPMENTS OF LIVE STOCK INTO ALABAMA.

1. The Regulation Uniform health certificate must be used as issued by the State Veterinarian of Alabama or Bureau of Animal Industry.

2. Every health certificate must be filled out in every detail, otherwise it is void.

3. Horses, mules and asses must be inspected and mallein tested if exposed to glanders and a health certificate issued in duplicate, by a legally qualified veterinarian indorsed by his State Veterinarian All cases of glanders, pneumonia, bronchitis, nasal catarrh, influenza, so called shipping fever and all other infectious and contagious diseases, must not be brought into Alabama. Designate each animal, as mare, gelding, stallion, jack, jennet, horse or mare mule.

4. All cattle over six months old, except those for immediate slaughter, must be tuberculin tested and the temperature records sent to the State Veterinarian. Calves from tuberculcus mothers, or herds, cannot come into Alabama. Feeders may be brought in on affidavit of owner that he will keep them separated from all other cattle during feeding period and then ship them for slaughter. Uniform Certificate issued in duplicate.

5. Hogs must be inspected. Uniform Certificate in duplicate stating no exposure to any infectious or contagious disease, as cholera, swine plague, etc.

6. Sheep—Uniform Health Certificate in duplicate.

7. Dogs—Uniform Health Certificates in duplicate.

8. No ticky horses, mules or cattle can be brought into Alabama.

9. *Who May Inspect.*—Any legally qualified veterinarian who is indorsed by his State Veterinarian, or by the Bureau of Animal Industry. All certificates must be sent to Dr. C. A. Cary, State Veterinarian, Auburn, Alabama—the duplicate by the railroad agent and the original by the inspector.