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TEXAS AGRICULTURAL EXPERIMENT STATION.

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DECEMBER 1892.

THE CATTLE TICK:

BIOLOGY.
PREVENTIVE MEASURES.

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS.

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PREFACE.

For many years there has existed a need for suitable methods and suitable apparatus for practical use on a large scale to control the really serious insect pest known as the common cattle tick. While a few ticks on an animal seem practically without effect, so far as its general health and vigor are concerned, there can be no question that their presence in large numbers, as ordinarily found in this section of the country, is a serious hindrance to the rapid improvement of live stock and a constant menace to the material prosperity of our live stock interests.

Aside from these practical considerations, in which our own stockmen are most intimately concerned, the much argued question of the relation of ticks to so-called "Splenic" or "Texas" Fever among cattle has an economic bearing of equally great importance to the entire country.

Some two years ago practical experiments were begun under the immediate supervision of Dr. M. Francis, Veterinarian of this Station, to find, if possible, some means of preventing the ravages of ticks which might be effectively used with economy and dispatch and thus be of practical benefit, not only to the small farmer who handles at most a few head of cattle, but also to the ranchman who must operate on hundreds at a time.

On consultation with the proper authorities it was deemed best to have prepared for publication at the same time a complete biological discussion of the tick, with drawings and explanatory text, and Dr. Cooper Curtice, formerly with the Bureau of Animal Industry at Washington, D. C., and Author of the very valuable work on "Animal Parasites of Sheep" published by the U. S. Department of Agriculture, was selected to carry out this feature of the proposed investigations. His article is presented under the first sub-head—"Biology". The discussion of the practical side of the question by Dr. M. Francis, follows under the second sub-head—"Preventive Measures for Farm and Range Use".

It is hoped that the information presented in this Bulletin may prove of especial value to the stockmen of the state.

GEO. W. CURTIS,
Prof. Agr. & Director.

Texas Agricultural Experiment Station.

THE CATTLE TICK.

(*Boophilus bovis* Riley sp.)

BIOLOGY.

(COOPER CURTICE, M. D., D. V. S., MORAVIA, N. Y.)

Who does not know those disgusting little leaden colored, bag like affairs that attach themselves to cattle, horses, dogs and man, and are called ticks by everyone. And yet how few know the structure and life history of the arrant pests and that instead of being all alike they belong to many species. Ticks and those other pestiferous insects—the mange insects—belong to the order of mites, *Acarina*, which are at present included with the spiders, *Araneina*, and the Scorpions, *Pedipalpi*, in the Subclass of insects, *Arachnida*. These orders are alike in having the "head and thorax intimately united; no antennae and only one pair of maxillae; no genuine abdominal legs" (Packard's Zoology) While scientists unite these orders the ticks can be easily separated by the one character of having their head, thorax and abdomen united into one bag like piece. To a casual observer an adult tick (Plate I, Figs. 1-4) seems to have the body provided with a small head, but the latter (Plate II, Fig. 7) is really the movable mouth ring and its appendages. There are also four pairs of limbs arranged in the larger ticks on the ventral side and toward the head. In size ticks vary from a minute speck, as the seed ticks, to medium sized beans, the ordinary dog ticks.

In the United States there are at least six species of ticks which have been taken upon cattle viz,: *Boophilus bovis* Riley sp. the common cattle tick; *Ambly omma unipunctata* Packard sp. the lone star tick, occurring on cattle, horses and man; *Dermacentor Americanus* Linn—the common dog tick; *D. occidentalis* Marx—the western deer tick; *Ixodes scapularis* Say—the wood tick, and *Ixodes* sp. from California cattle. Of these the cattle tick and the star tick are those occurring in Texas. These are easily distinguished, the former being the most abundant and without any characteristic markings while the latter always has a bright metallic spot on the head shield of the female, and two bright iridescent lines on each side of the back of the male. It is possible that other species may be found later which will be included by these descriptions but until found it is inconvenient to more closely define them.

On account of its greater economic importance, the cattle tick is the one that will be considered in the remainder of this article unless direct mention of another is made.

To the scientist studying the tick to learn its life history, habits, form and anatomy, the fact that these animals are pests to the stockman throughout the greater part of the year is of very little importance, while the latter cares little about such matters if he can only learn how to rid his cattle of them. Yet it is only by learning the life history that any remedies to prevent them can be applied intelligently and the fact that the knowledge attained is of practical value adds a double interest to their study.

The life history of the cattle tick was first definitely ascertained in the fall of 1889 in the course of laboratory experimentation by the author of this article. The following extracts are taken from the Journal of Comparative Medicine and Veterinary Archives, July 1891 and January 1892, in which this life history was first published:

On October 10th, I placed some of these eggs (Plate II, Fig. 5) in a small glass-covered dish filled with damp mould and set it aside in the incubating room of the laboratory. On November 4th, the young ticks (Plate II, Fig. 6) had begun to emerge and by November 15th the hatching was completed, each egg having produced a young tick.

At this time the ticks were taken to the Bureau Experimental Farm, and put on a calf which was confined in a stable, whose temperature was maintained at summer heat throughout the experiment. A calf with a white abdomen was selected, thrown on its back, sprinkled with ticks directly on its fine silky hairs, and time allowed for them to crawl into the skin. In this proceeding the certainty of the young ticks arriving at the most suitable surroundings was assured.

It is well to state here that the parents of these young ticks were the last seen at the station on any of the cattle, and that the room of experiment and the calf were quite free from ticks before the experiment began. The following table will serve to illustrate the sequence of events in the experiment and present it in rough but compact form:

DATE. 1889.	STAGE OF EXPERIMENT.	TIME CONSUMED IN VARIOUS STAGES.
Oct. 3.	Egg laying begun.	
Oct. 10.	Egg laying finished.	Ovipositing one week.
Nov. 4.	Ticks appeared.	Hatching three and four weeks.
Nov. 15.	Rearing begun.	Unnecessary interval of one week.
Nov. 22.	1st moult, larva to nymph.	Larval stage lasted one week.
Nov. 29.	2d moult, nymph to adult.	Lasted one week.
Dec. 11.	Female 1-2 grown with male.	About two weeks later.
Dec. 16.	Experiment closed.	About one week.
	Experiment endured.	About two and one-half months.

Having briefly reviewed the experiment we may now study its products.

The eggs were laid in a little mass; were subovid, dark brown and opaque and coated with some protective substance. In alcohol they show a thin shell-like covering with a dark opaque mass within. In the latter stages of incubation the form of the young ticks became more and more apparent until they emerged. The exit from the shell seemed to be by the shell rupturing and the imprisoned occupant thrusting it off with its feet. The torn edges afterward rolled inward and produced the appearance of clam shells, so frequently mentioned in writings on this subject.

The anatomical differences of the ticks in their stages will not be discussed further than to point out the gross characters. There are changes which take place in the mouth parts, but these are of such character as to require elaborate drawings and detailed descriptions, and are necessarily omitted.

The young ticks or larvæ when they emerge are whitish, they gradually turn to chestnut brown and resemble minute seeds. Though I have never seen the seed-ticks of the South since I have begun to study them from a standpoint other than to rid myself of them, I think that the young of the cattle tick may form a large portion of them.

The date of the first collection, Nov. 22nd, was a week from the time the young ticks were put on the calf and very fortunately coincided with the time of the first moult. Specimens were taken which showed the tick nearly ready to emerge from the old skin through which they could be seen The larva (Megnin) (Plate II, Fig. 6) is six-footed, possesses no sexual organs and wants the large single stigmata found in later stages. I think it breathes through the six stigmata-like dots I have observed on the sides just behind each pair of limbs, but I have not yet made all the sections and examinations necessary to sustain this point. The digestive, urinary tracts, and cloacal pore are present, and apparently vary little in the successive stages.

The next or nymphal stage as seen through the skin of the larva has added a pair of limbs behind the others and a pair of large stigmata behind them. The additional legs lie along the sides in a loop with its convexity directed caudally. The contents of the three front pairs of legs, have withdrawn until only their white tips remain in the testa about to be moulted. The head itself is withdrawn from the external skin and the mouth parts seem to be entirely disconnected from it.

Moulting in this stage is completed by the testa first splitting along the side in the vicinity of the head, the feet being thrust out through it, and the dorsal and ventral halves torn apart by the force of the limbs. Specimens of the loose valves, and a tick with its feet thrust through the slit near the head, which are now in the Bureau collection, demonstrate this satisfactorily.

In the change from the larval to the nymphal stage there is a complete ecdysis accompanied by the addition of new parts. The change is, therefore, incomparable to the stage of metamorphosis in insects, and the terms *larva* and *nymph* can only be used in a restricted sense as applied to these stages as being analogous, but not homologous with those stages bearing the same names among the insects. The important changes at this moult occur in the locomotory and respiratory organs.

The next specimens were collected a week later on Nov. 29th. The collection contained individuals about to change from the nymphal to the adult stage which, like the others, could also be seen through the testa they were about to shed. I had previously been enabled to study this stage from field collections, but the specimens collected at this time were invaluable in completing the life-history of the ticks as learned from a single brood.

The moulting at this period is complete. The limbs and head are withdrawn a little from the old testa. The valves split along the sides as in the earlier moult. The digestive and respiratory and locomotory organs undergo little, if any, modifications. The greatest change occurs in the reproductive organs which have developed during the nymphal stage and assume their functions immediately after the ecdysis, when the genital orifices appear in the new skin. Beyond this and the more decided adult characters offered in conformation there seem to be no essential changes.

The differences between the ticks destined to become either male or female during their final moult is not marked. The average of the males is smaller, but a small female may not be any larger than an ordinary male. In each the mouth ring and mouth parts, the shield-like head-piece, the breathing pores, the limbs and the body are alike.

After they emerge, however, the males (Plate I, Figs. 1-3) can be quickly chosen by their smaller size, by the absence of a well-defined head shield, by the extension of the shield over entire back, and by the two pairs of triangular chitinous plates, situated on the abdomen, behind and on each side of the anus. The female (Plate I, Figs. 2-4) looks much as in her earlier stage; the head shield is, however, larger and stronger, the lines made by the muscular attachments to the body-walls are stronger and deeper, and the breathing pores are much enlarged. The limbs, in both male and female, are strong and large as compared with their bodies, and fit them for retaining their place on their host until they have gained a new attachment by their mouth or rostrum. The external genitals which appear in the adults are very similar in each sex, and occur between the bases of the second pair of legs. They present little more than an opening situated on the median line of the belly.

Throughout life the male enlarges but little; he becomes a little broader, longer and thicker, but not markedly so. The female, on the contrary, grows to a comparatively immense size (Plate II, Figs. 4, 4a, 4b, 4c) swelling day by day, her body becoming so rotund and replete with the food drawn from her host that she can scarcely be recognized as of the same species as the males. While her body has inflated, however, her head, her legs and breathing pores have not undergone any changes. These remain exactly of the same size as in the beginning, and with the exception of the head shield are but little different from those of the male. The disparity in size between the legs and the body of the fully-gorged female is so marked that the legs and head appear even smaller than at first. The comparatively small size of the male has caused it to be overlooked or, if found, caused it to be classed among the young of this species.

After moulting, the young female again attaches herself to her host, and seems rarely to change her position. While she may be able to do so at first with ease, she becomes so heavy and logy later on that any change would cause her to fall to the ground should she loosen her hold with her beak. The males, however, remain small and light, and it is not impossible for them to change their position, and no doubt do so. After moulting they hunt for mates through the dense growth of cattle hairs and, finding them, attach to their host so that

they can conveniently embrace them belly to belly, and bring their external genitals in apposition. In this position the males may be found with females of all sizes. That the attachment of the male to the host is for food, as well as to facilitate copulation, there can be but little doubt for his long continuance of life, his increase in size, and the tremendous drain upon the little fellow in fertilizing the eggs, demand it.

Ticks live upon the blood of their hosts. The female rapidly increases in size, storing away quantities of the ingested food in an immense convoluted chamber which may be likened to a liver. The rapidity with which she enlarges seems to depend much on temperature; in summer three or four days only are necessary for the production of quite large ticks after the final moult. The blood eaten is stored as a dark colored fluid which coagulates in alcohol. I have seen no blood corpuscles in it.

While ingesting the blood and assimilating it the tick may, and probably does, digest it to some extent. I have not demonstrated a stomach or accessory organs however, not having made necessary microscopic sections.

Underneath the skin of the back of living females can be traced certain tortuous vessels, one on each side, which contain a white fluid substance. This also becomes solid after death in alchol. These vessels are of the excretory system and empty with the intestines at the anus. The presence of this material also demonstrates a digestion of food and a waste product in the living processes of the animal.

Breathing takes place through the two pores (Plate I, Figs. 4-7) with sieve-like plates, (peritremes) situated at each side of the body, just behind and above the last pair of legs. From the main opening the air is distributed by a fascicle of tubular branches (tracheæ), into all parts of the body.

After vegetation the most interesting function in ticks is reproduction. The male places himself in copulation as noted above belly to belly with the female, attaches to the host by his beak and winds his legs around those of the female, thus bringing their external genitals in contact. This is always easily effected, for whatever be the difference in size between them, the distance from the point of the beak to the genital opening in each is nearly equal. The genital opening is about as far behind the mouth-ring as the beak and ring is long.

It is not probable that the male inserts the penis into the female. It is quite likely that each may protrude their organs until they touch. While they touch the semen must pass from the male to the female. From the continued presence of the male by the female one would infer that copulation was not completed at once, but rather through a series of connections more or less remote.

The internal apparatus of the female consists of paired ovaries, uteri, and a single vagina or ovipositor. There are other accessory organs among which is a receptacle for storing semen. The ovaries, of course, supply the eggs which pass into the uteri to become fertilized, take on shells and become otherwise changed. The uteri though comparatively large do not occupy as much of the body cavity as one would think from a glance at the mass of eggs laid; for before the tick loosens her

hold from the cow but few are developed, and during ovipositing, conversion of the stored food and corresponding development of eggs take place with tremendous rapidity.

When fully gorged, when the organs of generation are fully prepared, and either the eggs within fertilized or a sufficient quantity of semen stored in the receptale for their fertilization, the female (Plate II, Fig. 4b) loosens her hold on her host and falls to the ground. She must do this to lay her eggs. Crawling off to some dark corner her work soon begins. Any delay seems to me to be caused by the tick not being prepared to undergo the final act at the time of removal from the cow. The female may, if detached, lay eggs any time after it is half grown. (Plate II, Fig. 4c.) Most ticks under my observation have waited a day or two before commencing ovipositing, and some even more. While the tick prefers to act in quiet she will, if retarded long enough, show her secret method under almost any difficulties.

I must now draw attention to an organ which, though accessory, plays an important role in ovipositing. Between the mouth ring and the head shield, is a space which becomes very marked in the fecund tick; at this point open glands, which are paired, racemose and situated just under and within the head shield. During the last days of the growth of the tick these glands become distended with a viscous fluid substance with which the eggs are to be coated for protection.

The first visible act in ovipositing is the withdrawal of the mouth ring and appendages apparently into the body, thereby leaving a depression or pocket; at the same time the ovipositor protrudes toward the bulging skin at the back of the mouth ring until they touch. The head is now entirely concealed. As soon as the ovipositor touches the opposing organ at the slit which appears in its middle, an egg passes from it and is immediately surrounded by the coating sac. This passage of the egg is difficult to detect but if the passage is interfered with can be made out after a time. The ovipositor then withdraws, the mouth parts appear, and the egg is pushed from its coating sac which recedes from around it. As the mouth parts are commonly known as the head, it appears as though the female passed the eggs over her head and laid them from her neck. A curious affair surely.

The object of coating the egg has been clearly demonstrated by Bertkau, who found that eggs laid after destroying the coating sac and preventing the eggs being covered, dried up and would not hatch, while others newly laid by the same female and coated, hatched in due time. Egg after egg does the little creature lay, her pile growing constantly larger while her body constantly contracts, until, in about a week, little is left but a yellowish, dried up, shriveled skin, whence all life has departed. She dies, having nothing else to live for; her young, when hatched, need neither care nor direction. Sufficient of them will find a cow and live again through all the phases of their life's history, and their posterity be quite sure to pester the future farmer and investigator.

While the cattle tick, *Boophilus bovis*, has an interesting natural history it has also received attention from many writers who have recorded various observations concerning it from time to time.

Boophilus (ox loving), I applied as a generic name for these ticks in a paper on "The Classification of American Ticks" (illustrated), and read before the Washington Biological Society, December 27, 1890. In the proposed genus the *rostrum* and *palpi* are very short; the *capitulum* is wider than the combined width of the *palpi* and *rostrum*; the second and third segments of the *palpi* are nearly equal and *each widest about the middle where the sides project in an angle;* eyes are present. Koch (in Uebersicht des Arachnidens System Zecken), seems to have figured this or nearly related species under his genus *Haemaphysalis*, but so defined the genus that late authorities on the IXODIDÆ include quite other forms of ticks in it. As this species cannot be classified with forms having the *posterior border of the second joint* projected laterally, I have created a new genus.

Prof. C. V. Riley, in 1869, Govt. Rept. Diseases of Cattle by Gamgee, was the first to furnish a good, unmistakable description and figures, excepting the male, of this species. There is a possibility, however, that his description may have been antedated by Koch (1844), who described *Hæmaphysalis rosea*, from Cuba, and by Say (1820), who described *Ixodes annulatus*, from Florida. *Boophilus bovis* is the only species in this country that I have so far met with to which the characters of *Ixodes annulatus* apply. The above descriptions of Koch and Say are so imperfect that it seemed preferable to adopt the later description.

More lately, Megnin, in his volume on parasites (1883), has described a tick from Algerian cattle as *Ixodes Dugesii* which seems to be our *Boophilus bovis*. I have, through the great courtesy of Prof. A. Raillet, of Alfort, received, among other parasites, specimens of ticks from Egyptian cattle. I cannot find a specific difference between the specimens of males and females received from Egypt, and specimens of our *Boophilus bovis*, on direct comparison.

Prof. Riley described the cattle tick in the government publication just cited in the following terms:

"*Ixodes bovis,* Riley. A reddish, coriaceous, flattened species, with the body oblong-oval, contracted just behind the middle, and with two longitudinal compressions above this contraction, and three below it, more especially visible in the dried specimen. Head short and broad, not spined behind, with two deep, round pits. Palpi and beak together unusually short, the palpi being slender. Labium short and broad, densely spined beneath. Mandibles smooth above with terminal hooks. Thoracic shield distinct, one-third longer than wide, smooth and polished; convex, with the lyrate medial convexity very distinct. Legs long and slender, pale, testaceous red; coxae not spined. Length of body 0.15 of an inch; width 0.09 of an inch.

"Several hundred specimens in different stages of growth have also been received from Pulvon, west coast of Nicaraugua, taken from the horned cattle * * * by Mr. J. McNeil. They preserve the elongated flattened form, with the body contracted behind the middle by which this species may easily be identified. The largest specimens measure 0.5 by 0.3 of an inch. When gorged with blood they are nearly as thick through as they are broad. In the freshly hatched hexapodous young, and the young in the next stage of growth, the

thoracic shield is one-third the size of the whole body which is pale yellowish, with very distinct crenulations on the hinder edge. The fourth pair of legs is added apparently at the first moult."

The above description was evidently drawn from alcoholic specimens, thus giving the discolorations due to the alcohol rather than the colors of life. In describing the head, the mouth ring and appendages are meant.

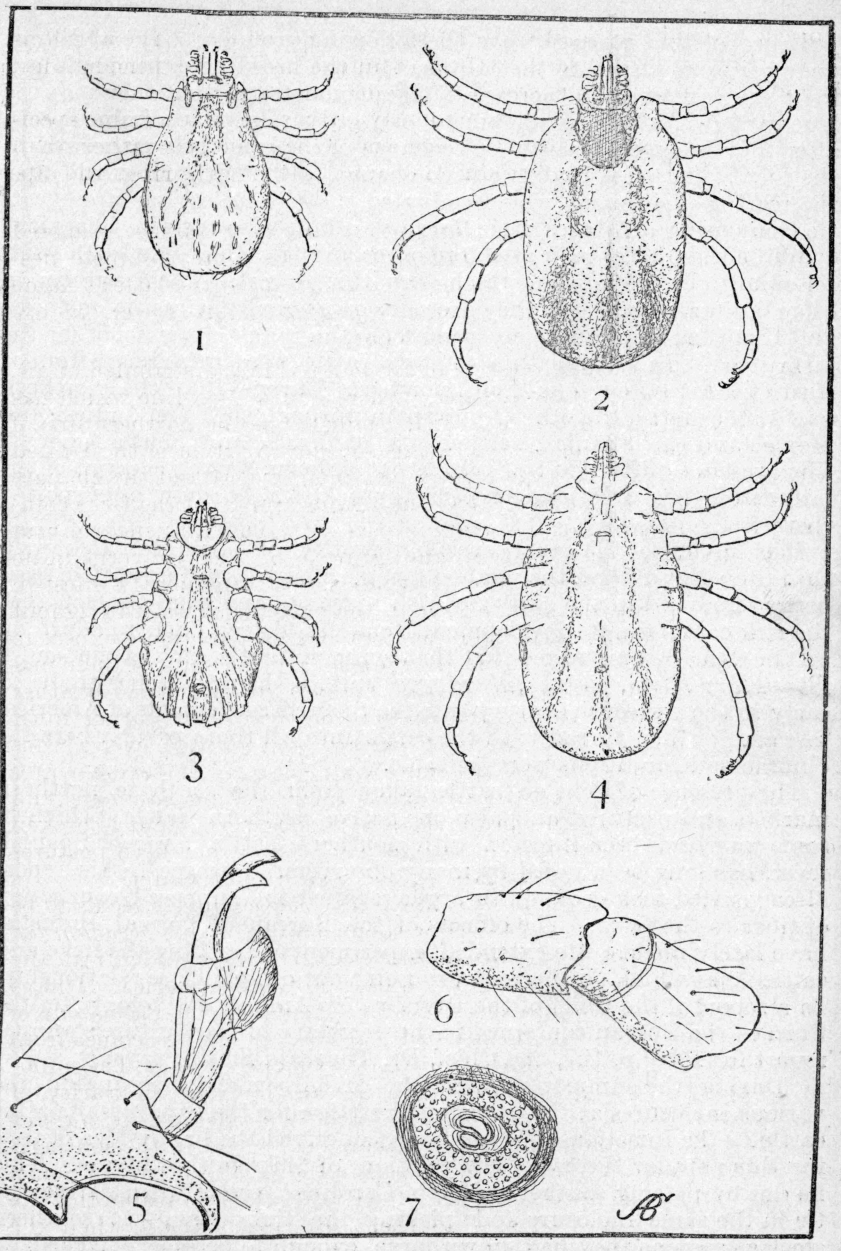
On the same page with this description Professor Gamgee proposed for the tick the name *Ixodes indentatus*. The more complete description of Professor Riley seems to have secured the latter's name *boris*, for Professor Gamgee's name *indentatus* has never, to my knowledge, been used outside of his report.

The cattle tick seems to be one of the most widely distributed of all. In the United States it occurs everywhere south of a line which has been drawn by the Bureau of Animal Industry as the northern line of the southern cattle fever area. In this southern portion of the United States the ticks or their eggs seem to be able to withstand the changes of climate. It is well known that the disappearance of the ticks coincides with the coming of the winter frosts. * The influence of heat or cold upon the propagation and growth of ticks governs in no slight degree their presence, even in those states permanently infested, during early spring and late fall, or in the extreme south, throughout the winter. In some warm open winters one may therefore expect to find the ticks in southern Texas all winter. On account of their inability to actively migrate and of the changes in severity of weather from winter to winter the northern limit of their distribution must also vary. Thus the line sweeps backward and forward over a considerable area, being pushed far southward in a single severe winter only to advance slowly northward again in succeeding summers and milder winters. The line proposed as the northern limit is broken every summer by the shipment of infected cattle to northern pastures and markets, to be restored again by the severities of winter.

The distribution of *Boophilus boris* in other countries seems to be tolerably certain. It is in Mexico without doubt. In his *Arachniden* C. L. Koch describes and illustrates species which seem identical, the originals having been collected in Cuba and South America. I have also received Cuban specimens from Dr. Francesco de Balmaseda of Havana. The specimens mentioned earlier as having come from Egypt through Professor Raillet prove its existence there. The probable occurrence on Algerian cattle is indicated by the similarity of our species with that described by Professor Megnin as *Ixodes Dugesii*. The distribution seems, therefore, to be in the southern part of the United States of America, in the northern part of South America and in the northern part of Africa. It is probable that we may find it in certain parts of southern Europe as Spain, when the knowledge concerning this most important tick has accumulated.

The original home of these ticks was probably northern Africa.

* Professor Geo. W. Curtis, Director of the Texas Experiment Station, comments on this statement as follows: "With us, ticks seem to suffer very little loss in winter except in long continued and quite severe cold. 'Frost,' I think, has no effect whatever."



1- Male seen from above. 2- Female seen from above. 3- Male seen from below. 4- Female seen from below. 5- Claw and pulvillus. 6- Lower surface of 1st. 2nd, 3rd, segments of leg. 7- Spiracle or peritreme.

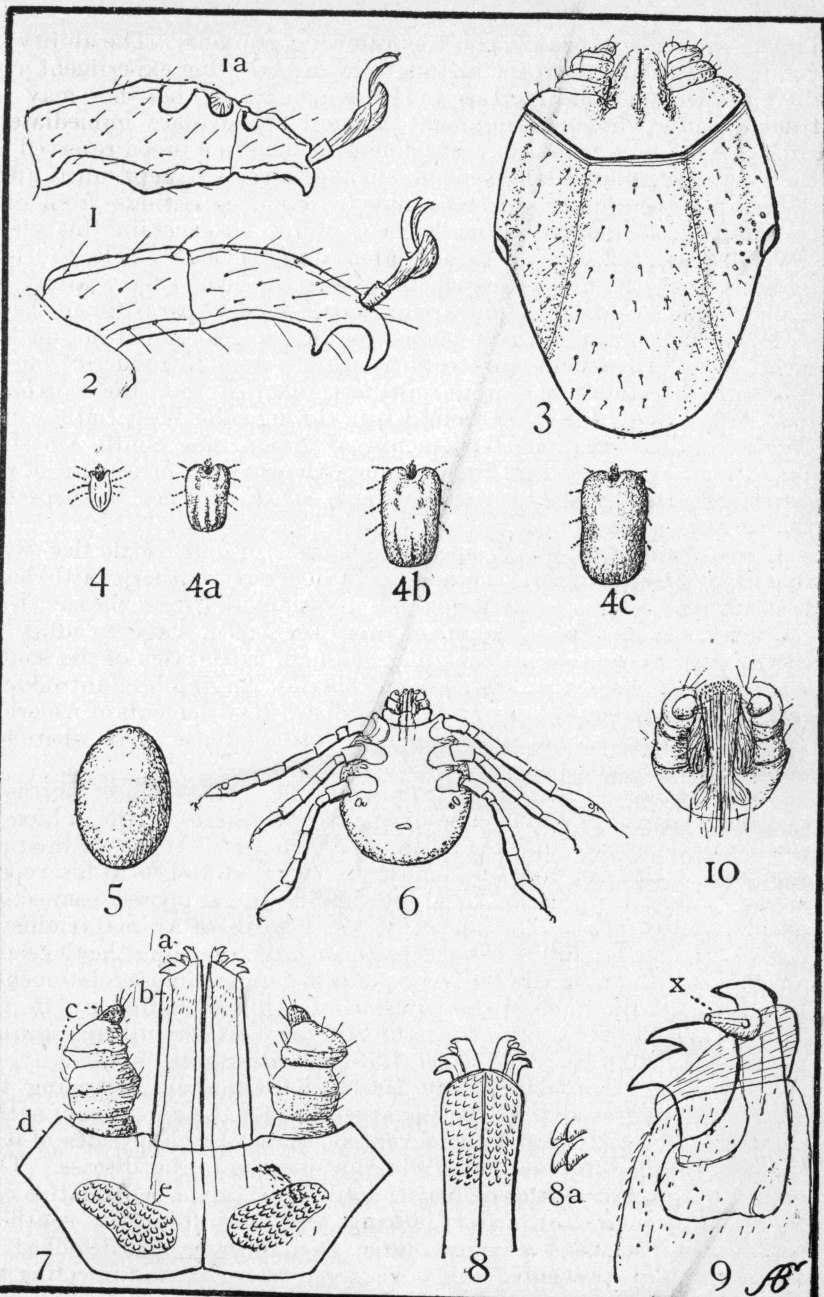
This proposition is based upon the following grounds: The ability of young ticks to attach to the calf used in the breeding experiment and their subsequent rapid increase in size demonstrates that they may be true parasites, whose development can only take place immediately after they become parasitic. Specimens of the same brood reserved in the incubating glass underwent no change, although kept until after the rearing experiment was terminated. Field collections from cattle comprising all stages from larva to adult, also sustain this view.

While these ticks may attach to other animals than cattle, the latter seem to be the host on which they thrive best. Their scarcity on other animals indicates they are only occasionally parasitic on them, and that they would scarcely persist on the ranges were it not for the farm stock. In settling this country cattle were introduced from at least two directions, one from northern Europe into the northern half of the states; the other from Spain through the West Indies into Mexico and the Spanish settlements of North and South America. The presence of the tick in Spain is not known, but on account of the latter's old-time relations with northern Africa, it may be suspected there.

It is in view of the exact specific identity of our cattle tick with that from Egypt, and the method by which our southern cattle have been introduced in the early Spanish invasion, and from the fact that the tick completes its development from six-footed stage to adult on cattle, that it seems to me that the common cattle tick of the south, *Boophilus bovis*, is an *introduced* species, having been introduced early in the sixteenth century into the Spanish settlements of America. The species then spread with the cattle into all those parts where the climate and conditions were suitable.

The presence of ticks on cattle taken from the south to northern markets and pastures, and also on native northern cattle, which in some way have been infected with southern cattle fever or Spanish fever, has long been noted by many observers. Gamgee in his report already cited took occasion to argue against the supposed connection of ticks to the fever. The officers of the Bureau of Animal Industry have lately made quite extended experiments regarding the ticks and cattle fever which on the contrary point out quite a close relationship. In a report of the Chief of the Division of Animal Pathology to the Chief of the Bureau contained in the Secretary of Agriculture's annual report for 1890, p. 107, the Chief, Dr. Theobald Smith, says:

"During the summer of 1889 Dr. F. Kilborne, in arranging the various inclosures at the experiment station for the exposure of native cattle to the infection of Texas fever, conceived the happy idea of testing this popular theory of the relation of ticks to the disease. This he did by placing southern (North Carolina) cattle with native cattle in the same inclosure and picking the ticks from the southern stock as soon as they had grown large enough to become detached on the skin. This prevented any ticks from maturing and infecting the pastures with the eggs, and hence prevented any ticks from infesting native cattle subsequently. At the same time, in another inclosure, the ticks were left on the southern cattle. The natives in the latter



1- Front foot showing single spur. 1a- Supposed sense organs. 2. Hind foot showing double spur. 3- Head of female. 4, 4a, 4b, 4c- Female ticks natural size, shown at different stages of feeding. 5- Egg. 6- Young tick. 7- Dorsal surface of the mouth parts of female, a- mandible, b- labrum, c- palpus, d- mouth ring, e- spots covered with papillae. 8- Labium and mandibles. 8a- Papillae enlarged. 9- Mandible-X-Busk's organ, use unknown. 10- Mouth parts of young tick.

field died of Texas fever, while those in the former did not show any signs of the disease.

"Another experiment was made in September in the same manner by preparing three fields: one with southern cattle and ticks; a second with southern cattle from which the ticks were removed, and a third over which only adult ticks had been scattered. The result was equally positive. In the first field no natives died, but careful examination of the blood by the writer showed Texas fever in an unmistakable manner. In the "tick" field one animal died of Texas fever and the examination of the blood showed that most other natives in the field were sick. In the third field containing southern cattle without ticks no disease could be detected."

In 1890 other experiments confirmatory of the above were tried. The most interesting of these is as follows: "Eggs laid by ticks sent from North Carolina were placed on dried leaves in a dish partly filled with moist soil and kept in the laboratory until the young emerged from the eggs. These ticks were placed on four different animals of different ages kept from any infected inclosures. Two were placed in stalls, one of them on an adjoining farm, and two were allowed to stay in a patch of woodland with healthy cattle. Of these four, two died of Texas fever as determined by a careful *post mortem* examination. One of them was in the stall away from the station; the other in the patch of woodland. The other two became very ill; one of them never recovered but had to be killed later on; the other recovered. In all of them the germs were discovered in the blood. The disease possessed the same characters as those observed in cattle in the infected pastures during the summer."

In concluding Dr. Smith writes that "while the nature of Texas fever is by no means made clear as yet, we are able to affirm that ticks can produce it. Whether the disease can be transmitted by any other agency must be determined by future investigations. Meanwhile the evidence accumulated thus far seems to favor very strongly the dictum: 'No ticks, no Texas fever.'"

Until more conclusive evidence is given us, we must believe that the tick in question is a dangerous parasite in transmitting(?) or producing(?) a disease which costs the country annual losses, and against which there have been passed strict quarantine regulations.

Many people living south of the southern cattle fever line do not know of this disease except as they have read of it. It is variously named "Spanish fever," "Texas fever," "Murrain," "Splenic fever" and "Acclimatization fever." While unknown to many, others who have been engaged in importing high grade stock or full bloods for the improvement of their range stock have known the disease only to their cost.

The extermination of cattle ticks will be undertaken by men in the future who have different ends to attain.

Some with few cattle will remove them for the sake of appearances. Others will find that while a few ticks do no apparent harm, many seem by their multitudes to make it ill. These they will remove for economy's sake in endeavoring to improve the health of the animal by their remedies.

A still broader application of preventive remedies is to the cattle in transit across the southern cattle fever line from south to north. In this lies the highest value, for by cleansing the cattle, if the experiments of the Bureau hold true in all cases, they may be transported to northern markets and pastures without danger to northern cattle.

It is quite impossible to free the southern ranges from the ticks. There are localities, however, which may be freed and kept entirely so. Such ranges are those near the line where the severe frosts of a winter may kill them. These may therefore be kept safe by turning only the tickless cattle upon them. It is possible to exterminate the ticks from fenced inclosures further south. It has already been stated that the ticks develop from the eggs in the pastures and do not seem to grow any until after they attach to cattle. Experiment showed that they were capable of retaining vitality for some weeks in the six-legged stage. If a herd of cattle are turned on to a fenced inclosure and periodically cleansed, say once or twice a week, oftener if need be, and no new adult ticks are brought on to the pasture, the ticks would be exterminated after a time. The proceeding is laborious, requires time and patience, but should succeed.

Milch cattle are confined of a night time in stalls, yards or corrals. Often cattle as steers or bulls are constantly confined for one or another purpose. Such places, after the cattle become infested, constantly furnish new ticks; also any place to which cattle constantly return as mid-day resting places, for the ticks dropping from them in these places, lay their eggs there and the young hatching await the return of the cattle. Such places are then sources of the greatest amount of ticks and killing the adults and half grown ticks and removing them will keep these places free. Spraying the yards with emulsion or treating with lime would also help.

Half grown ticks will lay eggs although not as many as the full grown ticks. But a half grown tick is not as liable to detach itself from the cow voluntarily as a full grown one would for the purpose of egg laying, for it would wait until its development is complete.

It would seem then that spraying should be undertaken each time before any of the ticks become adult.

While it is quite likely that the preparation used would kill all the ticks it is safer to try and destroy all those that drop to the ground for fear that they would only be temporarily poisoned and that they would perform their egg laying functions later. Treating the cattle on a floor or in a shute with a shallow tank would be preferable for the ticks could then be easily collected and destroyed.

If cattle are treated persistently the owner should soon see the benefit in the lessened number of ticks which the cattle bring back with them from the fenced in ranges. Whether or not it would pay him for the ordinary range cattle is for the future to decide.

The points of interest in the above are:

1. That the ticks were probably brought with the cattle either from southern Europe or northern Africa.

2. That the life-history of ticks is 1st an egg; 2nd, a six legged seed tick; 3rd, an eight legged asexual nymph; 4th, an eight legged adult.

3. That ticks dropping off where cattle are confined or spend the most time, more especially in their resting places, cause these places to be most infested with the young.

4. That ticks are associated with a disease attacking cattle and that their removal has prevented the disease being communicated.

5. That by taking advantage of the climate and the use of remedies cattle and certain pastures may be freed from the ticks.

6. That all cattle intended for transportation to northern fields and markets should be freed from ticks.

The prevention of Southern cattle fever by the removal of ticks is based entirely on the work of the Bureau of Animal Industry.

No mention has been made of the remedies or their use. This phase, the practical one, being discussed by Dr. M. Francis.

The two plates with twenty figures of the cattle ticks prepared especially for this bulletin have been executed so finely that they deserve especial mention. Since they bring out certain details of anatomy not touched upon in the text, detailed explanations which can not be entered into in the plate descriptions are here given.

The drawings are all original and the work of one of the foremost of America's women entomologists, Mrs. Anna B. Comstock. Mrs. Comstock is the wife of Professor J. H. Comstock Professor of Entomology in Cornell University of Ithaca, New York, and the Leland Stanford Jr. University of Palo Alto, California, and formerly the Chief Entomologist of the United States Department of Agriculture. The execution of this work speaks for itself, bearing every evidence of a master hand.

The features brought out in these drawings have been worked up by the artist as original work. Being unable to be present at Ithaca I have had no hand in directing the drawings further than general suggestions.

Having directed the drawing of previous figures while engaged in the Bureau of Animal Industry I am able to say that there are many new features, some demonstrated by each of us independently, while others, as the spurs on the tarsi (Plate II, Figs. 1, 2.) are entirely Mrs. Comstocks.

The limbs as drawn show seven segments with a line across the tarsi indicating another. As this interpretation may be doubted by some I wish here to unqualifiedly endorse it as being an interpretation that Mr. Haines, artist of the Bureau, and myself arrived at. I regard morever that the proximal segment does not belong to the limb but is an essential part of the sternal plates. This would make the small joint the second of the series.

The termination of the tarsi of the first pair of limbs Mrs. Comstock figures as a single spur while in the posterior pair she figures a double spur. This feature she regards as specific. Without other species of this genus to compare with we cannot arrive at any definite conclusion regarding this.

The two claws and pulvillus are shown in Plate I, Fig. 5. The drawing was from an alcoholic specimen, Mrs. Comstock not having had the privilege of studying a living specimen. This fact influences

the appearance of the pulvillus which looks stiff in the figure. In living specimens the affair is more bell shaped and flaring.

In Plate II, Fig. 6, are indicated the three pairs of stigmata of the hexapod stage. Mrs. Comstock adds a small dot by the side of each of the caudal pair. I have never made these out distinctly but do not doubt their being there. The interpretation of these dots remains to be learned.

In the same figure and also as shown enlarged—Plate II, Figs. 1, 1a, is an organ whose function is problematic. Somewhere I have read argument to the theory that these were hearing or auditory organs. As this first pair of limbs corresponds to the antennæ of insects in position and apparently by function in the living tick, they may have to do with either feeling or hearing, I prefer to believe the former.

Regarding the first pair of limbs as homologues of antennæ, the larval hexapod has left two pairs of limbs to compare with those of similar stages in hexapod insects.

In the text the head has been described as joined immovably to the body. In Plate II, Fig. 3, it is shown separated. In this, the head shield, the mouth ring, the labrum and the palpi are depicted. The head shield shows three portions—a median and two lateral: at the lateral corner of each side area there are two dots which in the tick are amber colored. Most students of the *Ixodidae* have regarded these as eyes. The mouth ring of Fig. 3 shows it to have been taken from a male for the two dotted areas shown in Fig. 7 are absent. The mouth ring as shown in figures 7 and 3 of Plate II, bears the organs of mastication. These are beginning from without:

The *palpi* are composed of four joints each the proximal joint is sunk well into the mouth ring; the distal is quite minute provided with bristles and situated on the ventral side of the third segment; the inside of these palpi is covered by a thin membrane and is slightly concave for fitting against the mandibles. Their functions are evidently protective. From my examinations of the living and a study of the terminal segment they also seem to be true palpi acting as organs of touch.

The *labrum* is apparently a thin prolongation of the ring bearing shagreen dots upon the upper surface and closely investing the mandibles.

The *labium* is a symmetrically bilateral elongate extension of the ventrum of the mouth ring; it carries on it eight rows of retrorse spines, figures 8 and 8a. The functions of these seem to be from structural reasons for the secure attachment of the tick to its host, the shagreen and the retrorse teeth fulfilling their purpose admirably.

The *mandibles* (Plate II, Figs. 7 and 9) are two cylindrical rods surmounted by a rather complex apparatus. The rods are apparently of two parts as indicated by a transverse line at about their middle, not shown in the figures; figure 9 shows the shagreen envelope of one of these, the left; at the top of either cylinder are two bright, shiny, chitinous claws or chelæ; the longer has the larger base and into its side the shorter, stronger and broader is set; around both is a thin membranous appendage; this membrane indicates a third segment to the mandibles. The longer of the two is single pointed. The broader

is double pointed. These move laterally and the points are directed outward; they are first class cutting implements and enable the tick to enter its mouth into the host's tissues. Mrs. Comstock has figured an organ X on the longer jaw; it is apparently conical, hollow, and situated on the upper side. While I have seen hitherto that there was some organ here I have never seen it so plainly as she. In an old publication of an English microscopical society I once found a similar drawing by Mr. Busk. He had received ticks and eggs from South America. The tick-eggs hatched out on the voyage and Mr. Busk drew the young. He thought that he had *Ixodes Americanus* L., but we may well believe that he had our common cattle tick, as his specimens were taken from cattle originally. Mr. Busk ventured the theory that the ticks sucked blood through these organs. I am inclined to believe that these organs are the openings of poison glands the poison being secreted to promote the flow of blood and to prevent the healing of the wound made in the host.

There seem to be no *Maxillæ*. It would seem as if the character of the food of these parasites had rendered the use of the *maxillæ* so unimportant that they had disappeared entirely. As rudimentary as these appendages of the mouth ring are, differing but little as compared to other insects from the ambulatory appendages, they seem to serve their purpose admirably. They enable the tick to pierce the hide and hold itself there. The food needs no mastication.

The meaning of the two dotted areas on the dorsum of the mouth ring so well developed in the female and so rudimentary in the male, is not evident. They seem to be a sexual character, but until some one makes sections of them their nature can not be determined. The peritreme or stigmatal plate is well shown at Plate I, Fig. 7. The tracheae open at the clear spaces indicated in the center.

Beyond the head the proximal segments of the limbs in the male and female, the dorsum and the four abdominal plates in the male, these ticks have retained but little of the chitinous skeleton they may have had earlier in their history. The great capacity of the female for sucking blood and stretching seems to have done away with the necessity for hard parts and put the stretching powers of the coriaceous skin to the test.

PREVENTIVE MEASURES FOR FARM OR RANGE USE.

(M. FRANCIS, D. V. M.)

The life history of the common cattle tick has been described in the preceding pages by Dr. Cooper Curtice, the distinguished scientist, of Moravia, N. Y. I shall now present those means that have been employed by us to prevent and destroy this annoying pest. It may be well to discuss briefly those conditions under which ticks are abundant.

They prevail the entire year in this climate. They appear in great numbers about July and continue as a rule until about December. They are a great deal more abundant during hot, dry seasons when grass is scarce.

Ticks are no exception to the general rule that parasites attack the poor and weak. It is often noticed that when stock begin to fatten, the ticks leave them and do not molest them so long as they remain fat. There seems to be no satisfactory reason why they should prefer one breed of cattle to another. It is true that they greatly prefer the Durham to any other. Their presence on those parts of the body where the skin is thin would seem to indicate a reason, but if we compare the softness and delicacy of the skin of the Durham with Jerseys', for instance, the verdict seems to be in favor of the latter, yet the ticks greatly prefer the former. This preference for Durham is a very serious obstacle to raising animals of that breed in this state.

Recent investigations seem to indicate that ticks are in some way associated with Texas fever, and it is a matter of observation that this disease is more fatal to this breed than any other. This may be due to the preference of the tick.

The prevalence of ticks varies greatly with the character of the pasture in which cattle are kept. This is especially noticeable in cases where they have access to thickly wooded pastures, or where underbrush and decaying vegetable matter prevail. On the contrary, in pastures that have been under cultivation and where rotation of crops is practised, ticks are practically unknown.

The influence of ticks on their host is certainly two-fold. The irritation or annoyance, I am inclined to believe is comparatively mild, that is, compared with the irritation produced by other cutaneous parasites. This is perhaps due to the character of the skin of cattle, for when we observe the same species, or those closely allied to it, in the ears of horses or dogs, the irritation is certainly very great.

We never notice in cattle affected with ticks that intense discomfort manifested when horses have the mange, or are covered with chicken lice, or sheep with scab or ticks (*Melophagus*), or dogs with fleas. They are still less annoying than other parasites of cattle—flies and lice (*Trichodectes and haematopinus*). I have not seen cattle affected with mange and cannot speak in reference to it.

The extraction of nutriment (blood) from their host constitutes the main damage done by ticks. Who has not been astonished at the rapidity with which they engorge themselves? In a single day or a single night they seem as abundant and as large as when their predecessors were removed twelve hours before. When we calculate their number, the rapidity of their development, and the quantity of nutriment necessary, not only for the adult, but also for the proper development of the hundreds of eggs within the females, can we be surprised to find the cattle poor and weak? The wonder is that they are able to endure the strain.

I believe a comparison with another species of ticks (*Argas*) on chickens, which occurs in some portions of the state, and which I am informed, killed considerable number of the young fowls by exhaustion in a single night, will support this view.

MEASURES TO PREVENT THE TICKS.

As indicated above, the keeping of cattle away from thickly wooded pastures during the summer and fall, and substituting pastures that have recently been in cultivation, will prevent a great many. We have adopted the plan of keeping sulphur and salt before our cattle during the summer. I believe the plan a good one, and that it prevents the ticks to a considerable extent. Weed of Mississippi, called attention to this some time ago (Am. Naturalist.) Our experience is that sometimes cattle consume too much , or for some other reason become "sulphur sick" and will not consume it again in any quantity.

The use of applications to those parts of the body attacked has not given us satisfactory results in preventing the attack of the ticks.

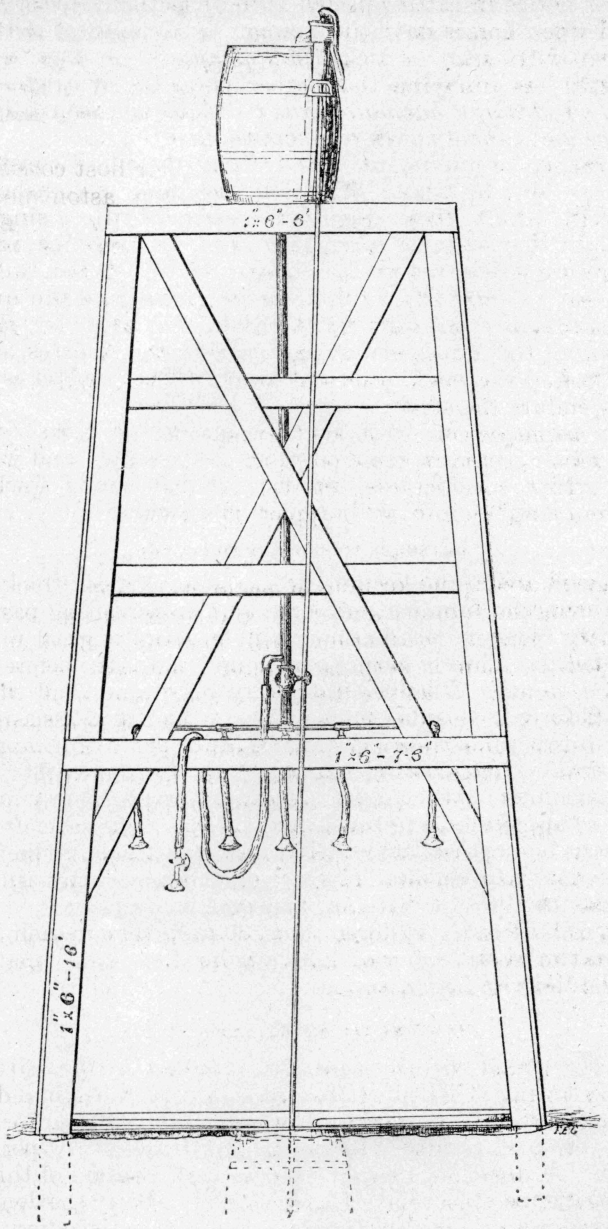
I made some experiments during the summer with sulphur and salt to cause the ticks to abandon their host.

A Durham bull badly affected, consumed one pound each of sulphur and salt, in two weeks. I was not able to determine that this influenced the ticks in any manner.

MEASURES TO DESTROY THE TICKS.

Almost any greasy or oily substance applied to the parts affected will destroy them. I failed with a decoction of tobacco and also with crude petroleum. A combination of lard and sulphur or lard and kerosene gives good results. Kerosene emulsion of 10 per cent. does fairly well. At one time I entertained a high opinion of this preparation but later experiences have failed to fully satisfy the demands.

We have found nothing that gives so general satisfaction as several brands of Sheep Dip that are on the market. These were applied at 2 per cent. strength in water. The ones employed by us were Cannon's, Hayward's and Little's. There are others perhaps of equal value. The qualities that these possess, are, efficiency, cheapness, ease of application, miscible with water, non-poisonous, non-irritating


1"x6"-6'
1"x6"-7'6"
1"x6"-16'

or injurious to eyes, skin, or hair, stability, uniformity of strength, non-corrosive to apparatus for application, and no heating required.

MODE OF APPLICATION.

The treatment of a few dairy cows is an easy affair.

The substance can be applied with sponges, brushes, mops, or syringes. We use in such cases a brass hand syringe with spray nozzle intended for gardeners use I believe.

With range cattle it is quite different and involves time, labor and expense. This has led us to devise an apparatus for the purpose. (See cut.) This consists of a derrick 16 feet high on which is a barrel. From the barrel there comes a pipe that divides into five smaller pipes 18 inches apart on each of which is a piece of hose 12 inches long and to the end of each hose a tin rose, such as are used on garden watering pots is fixed.

There also comes from the main down pipe another hose 15-20 feet long for hand use. This is also provided with a rose and also a stop cock.

The derrick is built directly on a platform 5 by 8 feet made of flooring and so slanted as to drain to one side so the substance used can be collected by a trough and poured into a lower barrel sunk in the ground. From the lower barrel is a pipe to the upper barrel provided with a pump.

There is also a narrow chute leading to the derrick tnrough which the cattle pass. Our method of operating is as follows :

The dip is mixed in the lower barrel and then is pumped into the upper one. An animal is driven on the platform and the dip allowed to play on it for one minute, while so doing the hand hose is used between the thighs and on the brisket and lower parts of the body. The others are treated in a similar manner.

That which runs off the animal is caught in the lower barrel and pumped up, thus preventing much waste.

Trash must be kept out or it will clog the nozzle. This is happily accomplished by using a cloth strainer on the upper barrel. A flour sack answers very well. With the arrangements as here described and illustrated, we are able to treat about 30 animals per hour, at a cost, including material and labor of 5 cts. per head.

The small ticks will soon be found dead and the large ones will be dead in a few hours.

The above has been found satisfactory in every respect.