

T H E S I S

THE IMMATURE STAGES
OF THE TICKS
OF THE UNITED STATES

Submitted by

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In partial fulfillment of the requirements
for the Degree of Master of Science
Colorado Agricultural College
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Fort Collins, Colorado

December 1, 1925.

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THIS THESIS HAS BEEN APPROVED AND RECOMMENDED FOR
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Introduction

The publication in 1893 of the fact that a tick Margaropus annulatus Say) is the carrier of Splenetic or Texas fever of cattle gave a decided stimulus to the study of this interesting and important group of animals. Although many years prior to this discovery numerous species of ticks had been described, practically nothing was known of their life histories, habits, and relations to man and animals. Six diseases of man and ten or eleven distinct disease of domestic animals and fowls have been demonstrated to be carried, principally or solely by ticks. At least sixteen species of ticks are known to be concerned in the spread of these diseases in nature.

In the case of most of these maladies the tick has a very definite and inseparable relationship to the causative organism of the disease. In several of the diseases the organism has been found to pass from the parent tick to the offspring through the egg. In some of the maladies the immature stages (larvae and nymphs) of the ticks act as carriers of the disease to domestic animals or man, in other cases they carry the disease from one susceptible wild animal to another, while in still others the immature stages are not infestive but pass the disease organism on to the adults.

There is little doubt that other species of ticks will be found to be vectors of disease and that the group, even now, assumes its supreme economic importance on account of its connection with disease

transmission; however, aside from this the ticks as parasites are of no little importance.

A considerable number of scientists have devoted time to a study of the ticks systematically and others have undertaken investigations of their life histories and habits. These latter investigators and others, principally veterinarians, have done much work upon methods of control. The purely economic work, however, has been confined to a very few species, that is, those which are of paramount importance to man. The life history work has included a greater number of species but it, too, has been largely limited to species of known economic importance. The systematists have studied available material but little attention has been given to other work than the describing of new forms and the classification of the group based principally upon morphological characters. In the United States the geography of all species but the cattle tick was very imperfectly known until the recent investigations of the Bureau of Entomology. The host relations of the various species were very poorly worked out. This was especially true in regard to the hosts of immature stages, the cattle tick being the only species at all well understood in this particular.

As has been stated, the systematists have given little attention to the study or description of the immature stages of ticks, despite the fact that all economic work depends so largely upon our ability to correctly determine the species of tick in the immature stages or to breed them to adults. Moreover, many of the descriptions published are not sufficient to identify the species.

The importance of being able to correctly identify ticks when not mature may be well illustrated by experience had by the Bureau of Entomology during its investigations of the Rocky Mountain spotted fever problem in the Northwest. In order to work out satisfactory means of control and to gain information on the possible reservoirs of the disease among the native wild animals it was necessary, of course, to make collections of large numbers of all of the different native mammals. Over one thousand animals were examined and a large percentage of them were found to be infested with ticks belonging to six or seven different species. Since identification could not be made in the immature stages it became necessary to breed each lot to adults. The larvae must be engorged twice and molt as many times. During the breeding of these ticks many died without reaching the adult stage, others were lost and much time was consumed in the process of breeding.

It was hoped that in the study of the immature ticks some of the questions of doubtful species might be cleared up. Although this work still has some promise, the characters in the larvae do not appear to be sufficiently marked to be dependable in separating closely allied species. The nymphs are more likely to aid in giving the proper status to doubtful species. None of these cases have as yet been carefully studied.

It was not until comparatively very recently that systematists recognized the difference between nymphs and adults, hence a number of species were described and in several cases synonyms made by an author describing an immature tick. It is now known that the immature stages

can readily be separated from the adults by the presence or absence of the genital orifice. The males of the Ixodidae can be distinguished readily from the nymphs by the presence of a large scutum which covers almost the entire dorsum. The females in this family always have the porose areas, whereas the nymphs never have these organs. In practically all of the ticks of the genera *Amblyomma*, *Aponomma* and *Dermacentor* the adults have white markings on the scutums. The nymphs are only very rarely ornate and the larvae never are. In the family Argasidae the nymphs can readily be separated from the adults by the absence of the genital openings in the former. Since the scutum does not occur in this family, and the females have no porose areas, these characters can not be utilized. The comparatively small size of the nymphs in both families of ticks may aid in separating them from adults, but this is not reliable. In many of the argasid ticks there are two or more nymphal instars; these cannot easily be distinguished. The larvae of all ticks can always be separated from other stages by their possession of only six-legs. They are also much smaller in size than the subsequent stages.

As is generally known the ticks offer rather fewer reliable characters for purposes of classification than do insects. This is due in a considerable measure to the large part of the body, especially in the females, which is not strongly chitinized. This is equally true among the larvae and nymphs. The variation in the color and size owing to the state of engorgement and character of food taken causes little reliance to be placed on the parts which are not highly chitin-

ized. The variation in these highly chitinated parts is considerable, but it has been found that by studying a series of specimens and defining the variations they are not serious obstacles to identification. For the most part, the same structures which are of most value in the classification of the adults have been found of equal value in the immature stages. The mouth parts and scutum offer many important characters as do also the legs and coxae, but in a less degree. Considering any single structure the stigmal plates probably provide the most reliable characters in the nymphal stage for separating species.

Technique

In the study of the immature stages of ticks it has been found imperative that they be bred from accurately determined adults. Living or freshly killed specimens have been found far more desirable than old material. While specimens mounted in balsam have been found of value in studying certain structures, it has been determined that the specimens are often distorted and many structures can not be seen as in fresh or alcoholic material. All of the drawings have been made, therefore from unmounted specimens.

In preparing balsam mounts it has been found necessary to vary the technique according to the material in hand, and the structures to be studied. In engorged specimens a slit should be made through the tip of the abdomen and the specimens then soaked in 5 or 10 per cent caustic potash for from 1 to 24 hours. The soft contents can then be readily teased out and after a thorough washing the specimens are passed through the alcohols and xylol into balsam.

With unengorged material the use of caustic potash is not essential. The specimens may sometimes be mounted uncleaned or they may be

soaked in clove oil or some other clearing agent for a few hours prior to being placed in xylol and balsam. Care must always be exercised in order to prevent the introduction of air into the specimens when transferring them to the balsam.

If living material is available it is best to kill the specimens in hot water so as to cause the legs to be straightened out and render the stigmal plates and coxae readily visible. The legs of dried specimens will often be extended if the specimens be placed in boiling water for a few minutes.

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SUPERFAMILY IXODOIDEA

The immature stages as well as the adult ticks may be separated into two families as follows.

Scutum present, palpi relatively rigid, pulvilli well developed	
.....	Ixodidae
Scutum absent, palpi flexible, pulvilli absent or rudimentary	
.....	Argasidae

FAMILY ARGASIDAE

The two genera in this family are rather easily differentiated especially in the nymphal stages.

Margins of body rounded, integument on edges similar to that of the

rest of the body. Usually no discs on body, if present, not symmetrically arranged.....Argas

Margins of body thin, and in nymphs the integument along the edges differs in structure from that of the rest of the body. Symmetrically arranged discs present in nymphs.....Ornithodoros

GENUS ARGAS Latreille

The distinguishing character of the larvae and nymphs of this genus is the thin edges of the body - even when engorged this character is not entirely lost. In the nymphs, the difference in structure of the body edge from that of the remainder of the body integument, also the presence of areas of smooth integument known as discs in symmetrical radial arrangement on the dorsum and venter, is diagnostic.

But a single authentic species of this genus occurs in the United States, namely the fowl tick, Argas miniatus Koch.

ARGAS MINIATUS Koch

Nymph, first stage, unengorged. Capitulum yellowish, inferior; length ventrally about 608 μ m.; basis capituli somewhat rectangular, greatest width 320 μ m., transversely wrinkled and practically straight on its posterior border; a transverse row of four bristle-like hairs near the base of the hypostome; palpi nearly twice the length of the hypostome, flexible, bending ventrally; article I short, article II distinctly longer than the subsequent articles and widest apically, article III nearly cylindrical, article IV tapering to a blunt tip; each article has a few pale hairs, several at the tip of article IV; hypostome spatulate, broadly rounded at the tip, two rows of teeth on each side, about 6 teeth per row, becoming smaller basally.

Legs and coxae yellowish, of moderate length and stoutness; all tarsi gradually tapering apically except I which is rather abruptly narrowed; pulvilli distinct, slightly broader than long, claws

well developed; leg I, length, trochanter 176 mm., femur 400 mm., tibia 272 mm., tarsus 592 mm. (basal portion to false segment 272 mm.); all coxae slightly wrinkled, arranged in an arc, well removed from the lateral sides of the tick, the coxal row being somewhat more widely separated posteriorly than anteriorly; all coxae rather pointed internally, IV being the broadest.

Body brownish yellow, 2 by 1.25 mm to 2.5 by 1.5 mm., ovate, widest slightly behind coxae IV, broadly rounded behind and considerably narrowed anteriorly; the anterior tip often shows a slight ridge; the margin sharply defined; surface coarsely striate, discs distinct, arranged radially, 3 to 5 per row the larger ones toward the center of the body; a slight fold in the integument at the base of the capitulum; coxal grooves present but not well defined; anus oval about 144 mm by 112 mm wide.

Size, unengorged, as given under body; engorged, 3 mm. by 2 mm. by 1 mm to 4 by 3 by 1 mm.

Nymph, second stage, unengorged. Similar to first stage nymph in most respects; greatest width usually a little farther anteriorly than in the first stage and anterior ends rather less narrowed; discs somewhat larger and more clearly defined.

Size, unengorged, 3 mm. long by 2 mm. wide to 4 by 2.75 mm.; engorged, (premales) 5 by 3.5 by 2 mm. to 7 by 4 by 2 mm., (pre-females) 6 by 4 by 2 mm. to 8.5 by 5 by 2.5 mm.

Larva, unengorged. Dirty yellow; hypostome sub-terminal, somewhat triangular, broader than long; ventrally, rectangular, narrowed basally, widest at base of palpi; palpi long and comparatively slender, articles nearly equal in length, bearing a number of pennate hairs; hypostome about two-thirds the length of the palpi, sides nearly parallel, tip broadly rounded; three rows of teeth apically and two dorsally, the outer row the largest and consisting of about 10 teeth; the next row distinctly smaller and containing about 9 teeth, ^{inner} row of 4 small teeth; sometimes a few extra teeth are present near the apex, giving the appearance of four rows.

Legs and coxae yellowish, long and moderately stout, thickly beset with pennate hairs, all tarsi tapering toward the tip, tarsi I rather abruptly; claws well developed and widely separated at base, pulvilli distinct, broader than long; coxae diverging slightly toward posterior, internal ends rather pointed.

Body pale yellow, length 680 to 770 mm.; nearly spherical in outline, usually the greatest width slightly behind the middle and the anterior end rather more narrowly rounded than the

posterior; surface minutely striate, a number of pennate hairs on both the dorsum and venter, longest posteriorly; anus slightly oval, located just posteriorly from the center.

Size length, unengorged, (including capitulum) 0.8 mm., width 0.6 mm.; engorged, 2.2 by 1.5 mm. to 2.5 by 2 mm.

Hosts: the immature stages as well as the adults attack various domestic fowls including chickens, turkeys, ducks and geese; also reported as attacking canaries and ostriches. They have been collected on a few wild birds including quail, wild turkey and turkey vulture. Experimentally they have been engorged on rats and mice.

GENUS ORNITHODOROS Koch

The immature ticks of this genus are distinguishable from those of other genera by the absence of a scutum, the rounded margins of the body upon which the integument is the same as that of the rest of the body; discs may be present or absent but they are never arranged radially.

There are four species of this genus recorded from the United States. The larval and nymphal stages of two of these are described herein. These are readily distinguished as follows:

Larva. Integument of body striate, a constriction behind coxae III; when engorged, body pear shaped, very thick in proportion to width.....megnini

Integument mammillate, body oval in outline, never greatly distorted by thickening when engorged.....turicata

Nymph. Integument of body well covered with spine-like bristles, body constricted at posterior third.....megnini

Integument mammillate, body oval, not constricted.....turicata

ORNITHODOROS MEGNINI Duges

Nymph, unengorged. Capitulum sub-terminal before feeding, becoming inferior as engorgement proceeds, length to tips of palpi 576 μ m.; base, width 392 μ m., rectangular with median portion somewhat elevated in triangular shape, leaving distinct shoulders

where palpi attach. Ventrally base is distinctly longer than broad. Palpi moderately stout, tapering slightly toward apex; length on dorsal side: article I 80 mm., article II 112 mm., article III 80 mm., article IV 72 mm. Hypostome nearly as long as palpi, sides nearly parallel, tip moderately rounded, teeth acute, 3 to 5 rows on each side, from 5 to 7 teeth per row.

Legs pale yellowish, stout and rather long; coxae short, broad at distal end, set almost on the body margin. Leg joints cylindrical with scattered hairs; tarsi abruptly narrowed near apexes; pulvilli absent or represented only by a slight protuberance; claws strong and decidedly curved, darker colored toward ends; length, leg 1-femur 640 mm., tibia 480 mm., metatarsi 472 mm., tarsi 496 mm.

Body somewhat oval but with a marked constriction just behind middle, the posterior position being much narrower than the anterior. When first mottled, white tinged with blood red later they become reddish brown, changing to bluish brown as engorgement becomes complete; dorsally the anterior half thickly set with stout spines directed posteriorly, the posterior portion bearing spine-like hairs; ventrally the spines extend back to near the anus and hairs posterior from this line; as engorgement proceeds the spines become more separated and the integument between appears glossy.

Spiracles dorsal from the space between coxae III and IV, tubular and rather prominent.

Size: unengorged, length, not including capitulum, 2.25 to 3 mm.; width 1.5 to 2 mm.; engorged, length 7 to 8 mm.; width 4 to 5 mm., thickness about 0.3 mm.

Larva unengorged. Capitulum terminal, length 304 mm.; width base 160 mm., base sub-triangular, lateral angles rather narrowly rounded, anterior angle broadly rounded and posterior border slightly convex; a distinct shoulder below the level of the central portion of the base, for the reception of the palpi. Ventrally, base is elongate oval without irregularities; palpi slender, slightly longer than the hypostome; length, article I 33 mm., article II 75 mm., article III 70 mm., article IV 36 mm., last is slightly tapering and curved downward at the tip; hypostome spatulate, teeth acute, 2 rows on each side, about 9 in inner and 13 in outer rows.

Legs and coxae. Coxae rather broad and rounded, trochanters large and narrowed toward apex especially in II and III, trochanter I largest, femurs with basal part very narrow, tarsi with a distinct hump dorsally about the middle, very slender toward tip. Pulvilli small with long slender basal stalk, claws slender and strongly curved. Length, leg I: trochanter 72 mm., femur 152 mm., tibia

96 mm., tarsus 208 mm., pulvillus 80 mm., claws 48 mm. All legs bear a number of strong, slightly barbed hairs.

Body length about 450 mm., width 360 mm., finely striate, widest about the middle, antero-lateral angles prominent and project anteriorly beyond central portion, considerably narrowed behind legs III; anus small, about one-fourth of length of body from posterior border, a few scattered hairs both dorsally and ventrally. When engorged color varies from pale pink to dirty white. Body is pear-shaped but often considerably extended thus making the legs and mouth parts appear like diminutive appendages on a large sac, narrowing of the body posteriorly is less conspicuous than in unfed specimens. The decided distention of the body in front of the anterior legs is noteworthy.

Size, unengorged: length - (including capitulum 0.55 to 0.72 mm. wide 0.2 to 0.37 mm. Engorged length (including capitulum) 3 to 4 mm. width 2 to 3. mm.

Hosts. The hosts for the immature stages are the same as for the adults. Those recorded are: Cattle, horse, ass, mule, goat, sheep, hog, dog, rabbit and man. They are practically always attached in the ear in the folds of the concha.

ORNITHODOROS TURICATA Duges

Nymph. First stage. Capitulum yellowish, sub-terminal; length 192 mm., width of basis capituli 160 mm., triangular; palpi distinctly longer than hypostome, curved ventrally, articles slightly tapering toward the tip except article II which is rather wider distally; article II bears a long slightly barbed bristle toward its apical internal angle; article III has a similar bristle slightly in front of the middle; article IV about 80 mm. long and bearing a number of minute hairs at its apex. Ventrally, basis capituli elongate oval, narrowed toward the base and bearing 2 long hairs near the base of the hypostome; hypostome, sub-lanceolate, with four files of teeth, 5 teeth per row, first tooth of each row apically is small, second and third large, especially in outer row; basal teeth reduced to scales.

Legs and coxae pale yellowish, legs of moderate size, anterior pair distinctly longer than the second pair, which is the shortest of all; coxae rather large, decreasing in size from front to rear, slightly divergent posteriorly, minutely roughened; tarsi tapering toward tip; pulvilli narrow but quite long; claws long and slender; leg I, length tarsus 240 mm., metatarsus 160 mm., tibia 112 mm., femur 160 mm., trochanter 120 mm.; a few small hairs on each leg joint.

Body dirty brown, length (not including capitulum) 1.09 mm.,

width .71 mm., irregularly oval; anteriorly, below super-coxal fold is a rather broad projection which partially covers the capitulum; sides nearly parallel broadly rounded behind and a slight prominence laterally at the anterior third of the length of the body; margin of body thickened leaving an irregular sub-marginal depressed area, especially anteriorly; entire surface of body well covered with small mammillae between which are minute granules; mammillae are largest posteriorly and on the margin. Venter: anteriorly the mammellae very minute, posteriorly, large and shiny; anus transversely oval, 48 mmm. by 88 mmm.; super-coxal and coxal fold distinct; though the latter only reach to the space between coxae II and III; median post-anal groove widened at each end; pre-anal groove extending from the dorsal side of the body margin around in front of the anus; post-anal groove almost parallel to it, and about mid-way between the anus and posterior margin.

Nymph, Second Stage unengorged. Very similar in general appearance to first stage but size is increased, length about 2 mm., width about 1.6 mm.; mammillae somewhat larger; hood on anterior end of body, over capitulum more pronounced; coxae and anal grooves deeper.

Larva, unengorged. Capitulum apical, milky white, translucent; length to tip of palpi 176 mmm., width of base 144 mmm., base approximately rectangular, distinctly broader than long, central portion elevated between palpal attachments. Ventrally, base is longer than broad with slight transverse depressed line across the middle. Hypostome reaching slightly beyond the distal end of the third palpal joint, lanceolate, two rows of teeth, outer row with four large teeth and 3 or 4 minute bases ones; inner row with one large apical and 3 minute basal ones; palps rather large, article I compressed laterally on the dorsal side making it narrower than article II, article III and IV tapering toward the tip; ventrally, the palps taper toward the tip; on the dorsal side, article II bears a strong spine toward its internal distal angle; article III has 3 dorsal spines, the inner one of these is very strong and located slightly in front of the middle of the article, slightly laterally from this is a similar spine near the distal end of the segment and a minute lateral spine from this article IV bears a few small hairs at its apex; length, article I 32 mmm., article II 4.0 mmm., article III 40 mmm., article IV 56 mmm.

Legs and Coxae translucent, long and moderately stout; length of femur 160 mmm., tibia 128 mmm., metatarsus 128 mmm., tarsus 224 mmm.; pulvillus slender, oval; claws rather long and slender; leg joints cylindrical except tarsi which are compressed laterally; each provided with a few hairs; tarsi I on all legs tapering gradually to tip; coxae moderate size and somewhat pointed at their internal extremities; coxae I slightly broader than long.

Body, Length (not including capitulum) 576 to 656 mmm., greatest width about the middle, 488 to 512 mmm.; broadly oval, yellowish

with only slight marginal irregularity; margins thick, rounded; dorsal surface finely roughened the ridges being less conspicuous on the mid-dorsal region; a slight suggestion of a sub-marginal groove anteriorly; the end of the ventral furrows show dorsally as slight notches, in the 3 median of these notches on each side is a strong spine-like hair, and there is also a sub-marginal row of 6 similar hairs on each side of the dorsum and 3 on the margin on each side on the anterior half of the tick. Venter slightly roughened especially posteriorly; anus of moderate size, about one-fourth of the length of the tick from the posterior margin; pre-anal groove fairly distinct reaching from the margin to the posterior edge of coxae IV, the 2 anterior ends approximating each other but not visibly joined; post-anal grooves sub-parallel extending two-thirds of the way from the posterior border to the anus where they fade out; there is also a fairly distinct median groove extending from the margin almost to the anus where it is slightly forked; a few scattered hairs between the coxae and toward the posterior end.

Size, unengorged. Length to tip of palpi 744 to 784 mm., width 488 to 512 mm.

FAMILY IXODIDAE Murray

The members of this family are easily distinguished either in the larval or nymphal stages by the presence of a scutum. The palpi are relatively rigid.

The five genera may be differentiated in the larval or nymphal stages by the following characters:

1. Anal groove running around in front of anusIxodes
Anal groove not running anterior to anus, it has the form of
a medial groove behind anus with a fork at anterior end.....2
2. Palpi with article II produced into a lateral ridge...Haemaphysalis
Palpi with article II not so produced.....3
3. Body nearly circular, rudimentary, palpi short.....Aponomma
Body oval, eyes distinct, palpi long or short.....4
4. Body narrowed behind, palpi short, articles somewhat bead-like
.....Margaropus
Body not narrowed behind, palpi not bead-like.....5

5. Scutum shaped like an arch key, narrow end forward, eyes at posterior fourth.....Rhiciphalus

Scutum not so shaped, longer behind eyes.....6

6. Scutum broadly oval, except maculatum which has but a single spur on coxae I, stigmal plates with goblets of equal size.....Amblyomma

Scutum elongate, coxae I with 2 spurs, stigmal plates circular or slightly produced dorso-posteriorly, with 3 to 8 large and many small goblets.....Dermacentor

GENUS IXODES Latreille

Nymphs. Usually pale when unengorged; anal grooves running around in front of anus, eyes absent, no festoons, stigmal plates circular or oval.

Larvae. Characters as in nymphs, except for the stigmal plates which are absent.

IXODES RICINUS SCAPULARIS Say

Nymph, unengorged. Capitulum smoky brown, length 273 to 379 mm.; basis capituli triangular, width 172 to 205 mm., postero-lateral angles slightly prominent; postero-dorsal edge slight concave; palpi long (136 to 144 mm.) and slender; article I short; article II one and a half times as long as article III, which is nearly twice as long as broad; neck of capitulum long, especially ventrally, where it extends backward in a rectangular projection; on each side, ventrally about the middle of the long axis of the basis capituli and opposite the palpi is a distinct spur; hypostome spatulate with 6 files of teeth on the apical half and 4 files on the basal half, lateral files of teeth largest.

Scutum uniform in outline, slightly longer than wide; widest about middle, length from 517 to 660 mm. width from 416 to 517 mm.; capitular emargination shallow; cervical grooves distinct, rather close together at anterior third, diverging behind this and reaching back two-thirds of the length of the scutum; lateral carinae strong, running back of widest portion of scutum; small punctures and hairs scattered over scutum.

Legs and coxae dark smoky brown, moderately long and strong; coxae I with a short but prominent spine on the postero-internal angle; coxae II, III and IV with a small subapical spine; tarsi tapering rather abruptly at ends, tarsus I nearly three times as long as metatarsus; pulvilli large, claws long and slender.

Body yellowish brown, oval, finely striate and with a number of

long pale hairs scattered over it; marginal groove deep anteriorly; genital groove deep, running forward close to the coxae to a point opposite coxae III.

Stigmal plates longitudinally oval, convex; projecting slightly from the body; 182 mm. long by 161 mm. wide; macula oval, slightly antero-ventrally from the center of the plate; about five rows of goblets at the widest point between macula and margin, and four rows at narrowest point.

IXODES COOKEI Packard

Nymph, partially engorged. Capitulum reddish brown, length 360 mm., width of base 328 mm., base triangular, posterior margin nearly straight, cornua strong and moderately sharp; palpi broad, club shaped, article III as broad as long, length article I 24 mm., article II 144 mm., article III 104 mm.; article I, ventrally, with a blade-like process. Ventrally, basis capituli bears a prominent flattened tubercle at base of palpi; posterior margin rounded; hypostome spatulate, heavy and moderately long, four files of teeth of about 7 each, a few small teeth forming a third row apically.

Scutum reddish brown, length 560 mm., width 672 mm., greatest width slightly before middle; sides convex anteriorly, almost straight posteriorly, apex broadly rounded; scapular angles rounded, emargination shallow, cervical grooves deep, converging for a short distance then diverging and reaching nearly to posterior margin, lateral carinae strong, incurved posteriorly and reaching to the border slightly behind the widest part of scutum, a pronounced depression medad from these carinae.

Legs and coxae reddish brown, legs long and moderately stout; tarsi rather abruptly narrowed at tip, pulvilli moderate; coxae I to IV with a short, rather broad, subapical spine or tubercle, article I with a long sharp spine on its inner angle, article II and III with the inner posterior angle slightly produced, but not forming a spine; coxae II, III and IV rather pointed at their medial ends.

Body oval, striate, pale hairs scattered over both sides; anal groove pronounced, sides sub-parallel, not quite meeting in front of anus; genital grooves running from margin to opposite the space between coxae III and IV but not joining anteriorly.

Stigmal plates transversely oval, 168 mm. by 136 mm., macula located slightly antero-ventrally from center.

Larva similar to nymph except for the absence of stigmal plates, armature of coxae less developed and carinae on basis capituli less incurved.

IXODES KINGI Bishopp

Nymph, partially engorged. Capitulum length 362 mm., width base 272 mm., base approaching triangular in shape; cornua strong, basal margin straight; palpi heavy, article III as broad at base as long; length (along outer margin) article I 24 mm., article II 204 mm., article III 96 mm., article I is cupped out to receive article II and the inner edge is produced into a heavy blade which extends forward along the base of article II; on the ventral side article I bears a strong blade like protuberance. Ventrally base is curved along its posterior border and below the base of the palpi is a short transverse ridge which is produced at its middle into a tubercle; behind this ridge the base is narrowed; hypostome stout, spatulate, four files of teeth, about 6 teeth per row, largest in outer row.

Scutum reddish brown, average length 660 mm., average width 680 mm., widest slightly in front of middle; scapular angles blunt; emargination very shallow, antero-lateral margins slightly convex, postero-lateral margins concave; apex rather narrowly rounded; cervical grooves distinct, in form of regular curves diverging at both anterior and posterior ends and reaching nearly to posterior border; lateral carinae present curved and reaching border behind widest point of scutum; a slight depression medad of carinae; a few punctures scattered over scutum.

Legs and coxae brownish yellow, legs of moderate size, all tarsi abruptly narrowed near tip, pulvilli broadly oval; coxae I to IV with an apical tubercle on the posterior border; coxae I with a moderately long and heavy spine on its inner posterior angle; coxae III rectangular in outline, the inner posterior angle being very slightly produced; leg I, length, tarsus 320 mm., metatarsus 192 mm., tibia 168 mm., femur 200 mm.

Body oval, finely striate, a few short yellow hairs on dorsum and venter; anus transversely oval 80 by 64 mm., anal groove deep sub-parallel, sides slightly diverging posteriorly, not united in front of anus; genital groove distinct, converging from posterior margin to opposite coxae III.

Stigmal plates small, slightly oval transversely, from 59 by 64 to 66 by 80 mm.; about 47 goblets in 2 to 3 rows.

Larva, unengorged, pale yellow, translucent, oval; similar in most characters to nymph but scutum has furrows less distinct. Capitulum 190 mm. length; scutum 277 mm. long by 335 mm. wide.

IXODES ANGUSTUS Neumann

Nymph, unengorged. Capitulum brownish yellow, length 272 mm.; basis capituli triangular, width 224 mm., cornua strong, pointing slightly outward; ventrally the base bears two large spines projecting latero-ventrally from the base of the palpi, also a ridge-like tubercle medad from this spine; palpi of moderate length, rather stout, article I with the inner angle produced into a short tooth; article II one and one half times the length of article III; hypostome, spatulate, with four rows of teeth, about 7 teeth to the inner and 9 to the outer rows.

Scutum brownish yellow, length 480 mm., width 464 mm., greatest width at middle, somewhat diamond shape, sides converging anteriorly and posteriorly, tip moderately rounded; scapular angles acute, emargination shallow; cervical grooves shallow, diverging slightly and disappearing about middle of length of scutum; lateral carinae strong, running nearly parallel to margin of scutum from the scapular angles nearly to margin behind widest part of shield, curved slightly medad at posterior end; a few short pale hairs on scutum laterally.

Legs and coxae yellowish of moderate length, tarsi abruptly narrowed near apex; coxae I with two large spurs on posterior margin, coxae II to IV with a sub-apical spur diminishing slightly in size from II to IV; coxae II with a slight tubercle at its postero-internal angle; coxae II and IV with a suggestion of a tubercle similarly placed.

Body oval, yellowish brown, length 960 mm., width 784 mm.; marginal groove deep, running from scutum to end of genital groove the tip of which runs over margin and is visible on posterior side, as is also the tips of the genital groove; anal groove broadly oval in front of anus, posteriorly, sides nearly parallel; sides of genital groove running nearly parallel from opposite middle of coxae I to opposite coxae III then diverging to margin; a number of short pale hairs scattered over body.

Stigmal plates, oval of moderate size, goblets medium size set close together.

Larva unengorged. Capitulum yellow, length 160 mm.; basis capituli triangular, 176 mm., spine on ventral side as in nymph; palpi rather short, article I with its inner angle distinctly produced; hypostome spatulate, 4 rows of teeth of 6 or 7 teeth each.

Scutum shaped as in nymph but lateral carinae not present; cervical grooves run about two-thirds of the length of scutum in form of an arc.

Legs and coxae yellowish, rather stout, coxae I with a moderate spur on its inner posterior angle, coxae II and III with a trace of a tubercle sub-apically.

Body oval, genital groove visible posteriorly, divergent; anal groove nearly closed in front of anus, sides sub-parallel.

Hosts. The immature stages of this tick have been collected on pine squirrel, wood rat (*Neotoma*) and chipmunk.

IXODES TEXANUS Banks

Nymph, partially engorged. Capitulum yellowish brown, length 240 mm.; basis capituli, width 224 mm., dorsal surface triangular, widened somewhat at base of palpi; cornua distinct, but short, palpi broad, slightly rugose, length 224 mm., article I about 32^{mm}, article II 96 mm., article III 96 mm., broadest at apical end of article II; outer margin of palpi almost straight, inner margin regularly curved; ventrally, article I with a broad but pronounced tooth; ventral side of base with broad tubercle below base of palpi, behind this constricted into a neck, posterior margin rounded; hypostome spatulate four files of rather large teeth.

Scutum yellowish brown, length 440 mm., width 464 mm., greatest width at anterior third; scapular angles broadly rounded, emargination very shallow, sides curved anteriorly, posteriorly nearly straight to tip which is narrowly rounded; cervical grooves converging for a short distance then diverging and reaching nearly to posterior border; trace of lateral carinae anteriorly; surface reticulate, somewhat rugose laterally.

Legs and coxae yellow, legs rather short and stout; all tarsi narrowed rather abruptly at tip, tarsi I with a slight hump; leg I, length, trochanter 80 mm., femur 160 mm., tibia 160 mm., metatarsi 144 mm., tarsi 256 mm. Coxa I with a distinct but short tooth at the inner posterior angle and a slight prominence at the apical angle posteriorly, coxae II with a similar tubercle, other coxae unarmed.

Body brownish yellow, striate, numerous short hairs; anal groove narrowly rounded in front of anus, sides nearly parallel; genital groove joined opposite space between coxae II and III, nearly parallel anteriorly, diverging to the rear and reaching the posterior margin; anus, length 96 mm., width 64 mm.

Stigmal plates small, nearly circular, greatest diameter 64 mm.; macula central, goblets few and small, wide marginal rim.

Larva, unengorged. Capitulum pale yellow, length 173 mm.;

basis capituli with basal outline nearly rectangular, width 161 mm., posterior dorsal edge nearly straight, no projecting post-lateral angles, surface slightly rugose, especially just medad of palpal attachments, neck moderate. Ventrally, basis capituli is long, appears slightly rugose, the neck extending well down between coxae I; a slight ridge extends backward and toward the median line from near the base of each palpus, ending at the neck constriction, behind this constriction the neck is slightly widened, broadly rounded posteriorly; a long, pale hair extends forward from near the base of hypostome; palpi short and broad, total length about 128 mm., width 69 mm.; articles I and II about equal in length, article III distinctly narrowed dorsally, article II broad and thick at base, this and article III rugose; ventrally, article I is produced into a round blade-like edge, article II is narrowed at base, article IV is rather short, in the shape of a broadly truncated cone; hypostome slightly spatulate, rather blunt with four files of teeth, inner rows with 4 minute teeth each, outer rows with 5 rather large teeth each, slightly recurved at tips, a few exceedingly minute teeth at apex.

Scutum very pale yellowish, translucent, only slightly darker in color than body; much broader than long, 311 by 365 mm., another 311 by 360 mm.; emargination shallow, posterior lateral margins almost straight to near apex which is rather narrowly rounded; cervical grooves distinct, slightly converging, then diverging posteriorly, the posterior tips reach nearly to the post-lateral margin of scutum; surface covered with minutely depressed lines which form irregularly hexagonal areas; about 4 short pale hairs on central area between cervical grooves.

Legs and coxae pale yellowish, translucent, moderately long and stout; tarsi I rather gradually narrowed at tip, others, especially III narrowed more abruptly, one to several pale hairs on each article of legs; Leg I, length, tarsus 204 mm., pulvillus 43 mm., metatarsus 118 mm., tibia 123 mm., femur 123 mm.; pulvilli almost circular, the claws slender and well separated at attachment. All coxae without spines, coxae I with a slightly pronounced internal posterior angle, coxae II rather long, approaching rectangular in shape, the sides being almost parallel.

Body very pale yellowish, broadly oval, finely striate and with a row of pale hairs extending around the margin, also a divergent row running from medad of coxae II back nearly to the anterior end of anal groove and a few other scattered hairs; the genital groove is moderately distinct, broad, reaching forward from a point opposite anus nearly to posterior end of coxae III where a straight transverse portion joins the lateral sides; anal groove joining in front of anus but this portion indistinct; the sides slightly curved; anus longer than broad with a hair on each valve; posterior margin of anus slightly less than one-fifth of length of body from posterior margin.

Hosts. Larvae and nymphs have been taken on racoon, rock squirrel, gray squirrel and armadillo.

GENUS HAEMAPHYSALIS Koch

The larvae and nymph of this genus are characterized by the presence of a Y shaped anal groove behind anus, conical palpi, the base of article II being distinctly produced laterally, eyes absent.

The two North American species are distinguished as follows:

Basis capituli rectangular; not produced laterally..leporis-palustris

Basis capituli pentagonal; laterally produced into rather acute angles.....chordeilis

HAEMAPHYSALIS LEPORIS-PALUSTRIS Packard

Nymph, unengorged. Capitulum brown, length 201 to 248 mm.; basis capitulum, width 200 mm., approaching rectangular with width twice the length, cornuae strongly produced; ventrally, basis capituli has two distinct backward projecting teeth at its posterior border on each side; width of palpi, closed, 258 to 300 mm., total length 158 to 177 mm., article II 96 mm. long, article III 64 mm. long, article II rather strongly projected around its base this projection appears from a dorsal or ventral view ^{as} a slightly up-curved ridge; palpi rather conical in outline with an indistinct suture between articles II and III; article III has, on its ventral side at the edge of the excavation for article IV, a rather strong broad retrograde tooth; article II bears along its median edge pectinate bristles and article III has a single smaller one near the tooth, the inner margin of article II is produced to a considerable extent out over the hypostome; hypostome spatulate, rather broad at base, teeth, two rows on each side about 10 or 11 teeth per row, the teeth gradually get larger from the apex to the 5th tooth which is quite large, the ones basally from this ~~one~~ much smaller, running into mere scales at the base.

Scutum reddish brown, length from 402 to 512 mm., width from 416 to 504 mm.; oval, usually narrowed at tip but some are rather broad; the latter are usually slightly broader than long; in unfed specimens the edge of the body extends beyond the scutum laterally and interiorly; scapular angles rounded, capitular excavation rather

deep; cervical grooves deep, fairly broad and extending back two-thirds to three-fourths of the length of the scutum; they first converge then diverge posteriorly, most specimens show a trace of a marginal groove in the form of an elongate depression opposite the tip of the cervical groove.

Legs brownish, of moderate size; coxae I with internal angle produced into a short rounded spur; coxae II to IV each with a spur on the posterior margin toward the inner edge; the inner side of these spurs extend anteriorly reaching the inner margin of the coxae; the spur on coxae II prominent and rather broad, the size diminishes on the posterior coxae; trochanter I has a rather strong triangular blade-like spine dorso-posteriorly, and a slight tubercle at its distal end, ventrally; the other trochanters also show minute tubercles similarly placed; tarsi I narrowed rather abruptly at apex, other tarsi tapering at tips, claws and pads rather small; leg I, length, trochanter 152 mm., femur 208 mm., tibia 192 mm., metatarsus 132 mm., tarsus 256 mm.; leg IV length (another tick) trochanter 144 mm., femur 208 mm., tibia 208 mm., metatarsus 144 mm., tarsus 240.

Body broadly oval; length 950 to 955 mm.; width 631 to 739 mm., widest about the middle; marginal groove very distinct, completely circling the body from the scutum; festoons distinct, grooves not deep, but color set them off. Ventrally, body with a few small hairs; anal groove Y-shaped, deep and joins the genital groove just above the anus; genital groove deep, narrowly rounded at its anterior end, which is opposite the space between coxae III and IV; posteriorly, diverging to the point where it joins the tips of anal groove, then bending outwardly even more sharply; a distinct groove also runs just medially from the coxae and practically joins anteriorly in the form of a broadly rounded loop opposite the space between coxae I and II; this groove is not discernable in engorged specimens. Color, engorged, dark bluish gray to almost black.

Stigmal Plates transversely oval, slightly flattened posteriorly and with a slight dorso-posterior projection; dimensions of 3 run 80 by 120 mm., 80 by 107 mm., and 88 by 112 mm.

Size, unengorged, length (including capitulum) 1.15 to 1.18 mm.; width .63 to .74 mm.; engorged, 2.5 by 1.75 mm.

Larva, unengorged. Capitulum smoky brown, length 108 to 160 mm.; chelicerel sheaths rather coarsely roughened dorsally; basis capituli 128 mm. wide, with distinct, but blunt cornua, posterior border somewhat concave, sides convex; palpi conical, length 96 mm., article II broad at base and with the outer angle of the base moderately produced; article II has a distinct tooth at its apex projecting ventrally; the base bears, ventrally, on each side toward the postero-lateral margin, a rather sharp tooth, anterior to this on the side of the base is a slight ridge; hypostome spatulate,

tip moderately sharp; teeth rather small, two rows on each side, outer row with 7 and inner with 6 teeth, in addition to a few small ones apically.

Scutum smoky brown, lighter toward center; length 244 to 280 mm., width 287 to 384 mm., scapular angles rounded; tip of scutum broadly rounded, postero-lateral margins very slightly concave; cervical grooves rather deep, curving slightly medially, then spreading and extending back more than two-thirds of the length of the scutum.

Legs brown, of moderate build; coxae I with posterior-medial tip slightly produced and strongly chitinized though rounded; coxae II with a broad spine on its posterior border slightly medial from the center; coxae III with a similarly placed, but slightly smaller spine; tarsi I rather abruptly narrowed some distance from the tip; the claws on this leg scarcely longer than the oval pulvillus; length of leg I, trochanter 80 mm., femur 128 mm., tibia 112 mm., metatarsus 64 mm., tarsus 80 mm., legs III and IV with tarsus tapering toward point, claws longer in proportion to pad than in leg I; length, leg IV, trochanter 88 mm., femur 104 mm., tibia 126 mm., metatarsus 92 mm., tarsus 160 mm.

Body smoky brown, broadly oval, festoons distinct, marginal groove suggested in unfed specimens; anus circular; no anal groove visible. Color, engorged, dark brown to black, some specimens with a pink tinge for some time after engorgement.

Size, unengorged, length (including capitulum) .60 to .65 mm.; width .43 to .47 mm.; engorged, 1.33 by 0.88 mm.

Hosts. Although the adults are essentially rabbit parasites the larvae and nymphs have been collected on the pine squirrel, and on a number of birds especially those which are largely ground frequenting. The following have been recorded: Quail, meadowlark (eastern and western), bluejay, chapparel cock, Brewer's blackbird, jackdaw, thrush, magpie, groove-billed ani, and a species of sparrow.

HAEMAPHYSALIS CHORDEILIS Packard

Nymph, unengorged. Capitulum yellowish brown, length (from tips of cornua) 201 to 256 mm., width of base 246 to 267 mm., width across palpi 256 to 288 mm.; basis capituli with slight cornua and considerably produced laterally, forming on each side a distinct angle; ventrally it bears two small teeth at its posterior lateral angles; hypostome spatulate, teeth, two rows on each side, about 8 teeth in each row, these very small at tip and base; rows set very close to the median line; palpi, 158 to 172 mm. long; article I with base distinctly produced, forming a slightly up-curved angle laterally; articles II and III not distinctly divided, outer contour being practically straight; inner edge of article II distinctly produced

medially at its distal end; ventrally, article III with a distinct retrograde spine just posterior to the excavation, which receives article IV; also bearing 4 broad plumose spines on its inner margin.

Scutum yellowish brown, slightly darker at scapular angles, which are rounded; excavation not very deep; scutum length 430 to 502 mm., width 416 to 502 mm., outline regular, oval; cervical grooves deep comparatively straight, running back three-fourths of length of scutum, no lateral grooves or carinae, a few medium sized punctures scattered over scutum.

Legs yellowish brown, of moderate length and stoutness, coxae with a spine on the posterior margin toward the inner angle; coxae II and III with a single spine almost at the middle of the length, but the inner border runs to the edge of the coxae near the internal anterior angle; teeth broader and longer on coxae II than on I and they diminish in size slightly on coxae III and IV; trochanter I with a strong, rather sharp spine at its outer posterior angle; tarsi I tapering rather abruptly, less abrupt in other tarsi; length; leg I, tarsus 113 mm., metatarsus 67 mm., tibia 73 mm., femur 100 mm., trochanter 67 mm.; leg IV, tarsus 100 mm., tibia 77 mm., metatarsus 60 mm., femur 87 mm., trochanter 60 mm.; some specimens have legs decidedly smaller than this, but proportions are practically the same.

Body elongate oval, greatest width usually about the middle; numerous punctations and a few minute hairs; marginal groove deep, extending completely around the body, farthest from the margins laterally; festoons fairly distinct, emphasized by darker color along grooves; anus rather large; anal groove deep, Y-shaped and anterior ends curving outward to meet the genital groove which is pointed at its anterior end opposite coxae III, and diverges rapidly posteriorly; coxal groove fairly deep and rounded anteriorly opposite the anterior end of coxae II. Color, engorged, dark bluish gray.

Stigmal plates, greatest diameter 168 mm., smallest 136 mm.; irregularly ovoid with a distinct postero-dorsal projection; macula small, located toward the ventro-anterior side, surrounding this is a slightly depressed circular area; plates with 33 to 44 rather large goblets and these surrounded by small cells, marginal cells set close together and somewhat lengthened, in the direction of the diameter of the plate.

Size, unengorged, length including capitulum 1 to .4 mm.; width .65 to .72 mm.; engorged from 2.2 by 1.7 mm to 2.7 by 1.8 mm.

Larva, unengorged. Capitulum yellowish brown, length 125 to 140 mm., basis capituli 152 mm. wide, laterally produced into sharp angles; very slight coruna, posterior edge of base slightly concave; ventrally, base has a distinct tooth on each side near its posterior margin; length

of palpi 79 to 86 mm.; basal edge of article II produced into a moderately prominent ridge; suture between articles II and III scarcely discernable; article III with a small broad retrograde tooth at its apex, ventrally; width across palpi when closed 158 to 168 mm.; hypostome spatulate, two rows of teeth on each side, about 7 or 8 teeth per row.

Scutum dark brown, almost black toward tip; length 232 to 244 mm., width 269 to 290 mm.; scapular angles rounded, emargination rather deep, outline very regular, the apex being broadly rounded cervical grooves rather deep and extend back with slight divergence just beyond the middle of the scutum.

Legs yellowish brown of moderate size; coxae I with a broad spur at its inner posterior angle; coxae II with a broad spur on the posterior border about the middle; coxae III with a similar though smaller tubercle; tarsi I with a slight hump before the declivity which tapers to the tip; other tarsi taper more gradually; leg I, length, pad 84 mm., tarsus 176 mm., metatarsus 96 mm., tibia 112 mm., femur 128 mm., trochanter 80 mm.; leg IV, length, pad 50 mm., tarsus 168 mm., metatarsus 88 mm., tibia 112 mm., femur 120 mm., trochanter 80 mm.

Body yellowish brown, ovoid, broadest at posterior third; festoons distinct, anus rather large; anal groove indistinct; genital groove indistinct, broadly rounded at its anterior which is between coxae III and IV, diverging slightly for half its length then widely diverging and reaching almost to body margin near the middle of the second festoon. Color, engorged, slate.

Size, unengorged, length (including capitulum) 0.55 to 0.57 mm., width 402 to 430 mm.; engorged from 1.4 to 0.8 by 6.6 mm. to 1.5 by 1 by 0.6 mm.

Hosts. The immature stage, as the adults, are found commonly on a number of species of birds, including the quail, meadow-lark, jackdaw, red-winged blackbird, marsh-hawk and domestic turkey.

GENUS DERMACENTOR Koch

The morphology of the immature stages indicated that there are two rather widely divergent types included in the genus. This is also in line with adult characters and life histories and indicates that the genus should be split. D. venustus, occidentalis, parumapertus and variabilis in one section and D. albipictus, nigrolineatus and

nitens in the other. These divergent types make a characterization of the genus in its present conception rather difficult.

The principal generic characters of the immature stages are:
Anal groove Y shaped behind anus; eyes present; stigmal plates circular or oval, in the latter case with a dorso-posterior projection, with few to many comparatively large goblets.

The nymphs of the species of the genus occurring in the United States may be distinguished as follows:

1. Basis capituli acutely angular laterally.....2
2. Basis capituli rounded laterally.....5
- Basis capituli without a sharp spine on the posterior margin, ventrally.....variabilis
- Basis capituli with such a spine on either side behind base of palpi.....3
3. Stigmal plates acutely pointed laterally, with 4 or 5 large goblets..... occidentalis
- Stigmal plates rounded with seven or more smaller goblets.....4
4. Stigmal plates circular or nearly so. Article II of palpi 3 times as long as broad.....venustus
- Stigmal plates oval. Article II of palpi twice as long as broad.....parumapertus marginatus
5. Hypostome with 6 files of teeth. Each stigmal plate with 4 or 5 exceedingly large goblets.....nitens
- Hypostome with 4 files of teeth. Each stigmal plate with at least 7 goblets of smaller size.....6
6. Scutum as long as broad, not constricted behind the eyes, the posterior tip rather acute.....nigrolineatus
- Scutum broader than long, constricted behind the eyes, the posterior tip broadly rounded.....albipictus

DERMACENTOR VARIABILIS Say

Nymph, unengorged. Capitulum yellow, length 287 mm., to tip of hypostome which does not quite reach the ends of the palpi; basis capituli, width 323 mm., lateral angles prominent; palpi slender, total length 215 mm., article II slightly more than twice the length of article III which is one and one-half times as long as broad; article II three times as long as broad, article I very short; one long hair on inner angle, two on outer and one on inner margin of article II, 5 hairs on outer margin of article III and several on the apex of article IV. Ventrally the basis capituli is broadly rounded behind, with a longer body than in venustus and occidentalis, the lateral angles are rather long and slender; slight tubercles (not spines as in D. venustus and D. occidentalis) on margin behind palpi; hypostome spatulate with 4 files of teeth, about 10 teeth each, teeth very small and scale like toward base, longer and more pointed toward apex, except on extreme end where there are a few small ones, the two rows on either side converge toward base and diverge from median line.

Scutum yellowish brown, reddish brown near eyes which are oval and not prominent; 552 mm. in length by 576 mm. in width, greatest width at eyes which are much behind middle; cervical grooves fairly deep, in the form of regular curves running back to a point opposite eyes; a slight longitudinal depression occurs laterally and posteriorly from end of cervical grooves; a few shallow punctures near posterior margin opposite ends of cervical grooves, also a few along anterior-lateral margins in front of eyes; a few pale hairs on scapular angles and four or five toward tip of scutum; scapular angles rounded.

Legs and coxae reddish brown, divergent well separated; coxae I with a short, postero-internal, rounded spur and a long, blunt, subapical spur, coxae II and III with a broad, subapical tubercle, coxa IV unarmed, two hairs on each coxa.

Body reddish brown, finely striate with a few punctures; length (without capitulum) from 1.00 mm to 1.16 mm.; width, from 0.69 to 0.83 mm.; marginal groove and festoons distinct; venter reddish brown with a few pale hairs; genital groove distinct, divergent posteriorly from a point opposite coxae III; anus transversely oval, 86 by 75 mm., prominent, 3 short yellow hairs on each valve; post-anal groove indistinct, Y-shaped behind anus, festoons distinct. Color, engorged, slate-gray.

Stigmal plates longitudinally oval with a short, broad posterior-lateral prolongation, dimensions 139 by 113 mm.; cells over entire surface, except narrow margin, these very small, growing larger toward aperture where the last concentric row consists of about 10 moderately large cells (goblets); these are much smaller than the goblets on the stigmal plates of the nymphs of venustus and occidentalis; about ten rows of cells at widest point between macula and border, three

at narrowest; macula area depressed.

Size, length, including capitulum, 1.33 to 1.41 mm.; width 0.69 to 0.77 mm.; engorged, 3.5 by 2 by 1 mm. to 4 by 3 by 2 mm.

Larva similar to nymph in important characters. Capitulum yellowish, length 115 to 143 mm.; palpi rather long and slender; length 100 to 115; hypostome, spatulate, with 4 files of teeth.

Legs and coxae yellow, of moderate size.

Scutum yellowish, length 251 to 273 width 273 to 358 mm.

Body yellowish, ovoid; length .57 mm. to .6 mm., width .35 mm. to .43 mm. greatest width just behind coxae III. Color engorged dull gray.

Size, length including capitulum .69 mm. to .74 mm., width, .35 mm. to .43 mm.

Hosts. No larvae of this species have been collected in nature; nymphs have been taken on fox squirrel and swamp rabbit.

DERMACENTOR OCCIDENTALIS Neumann

Nymph, unengorged. Capitulum brown, length 275 to 358 mm.; basis capituli nearly triangular, lateral angles acute and rather long, width to extreme angles 287 to 308 mm.; palpi 201 mm. long, rather slender; article I slightly prominent at inner corner, ventrally; article II broadest apically, one and three fourths times longer than article III; a pale hair on inner margin of article II and two toward outer margin; article III widest apically with three hairs on inner margin; article IV not prominent, small in diameter and deeply set in article III; several bristles on its apex; hypostome and palpi about equal in length; hypostome broadly rounded at tip with four rows of teeth, these more angular forward and rounded on basal portion, basally rows diverge from center and become smaller; about 12 teeth in outer and 10 in inner row. Ventrally, basis capituli rounded on postero-ventral margin, with a prominent blunt tooth on each side near the margin, these teeth as broad as the external spurs on coxae I but somewhat shorter.

Legs and coxae brown, moderately long and strong, a few yellow hairs on each segment; coxae I with two spurs on the posterior margin, the inner distinct but rather short, the outer stout and rather long,

set about the middle of the posterior margin; coxae II with a short, broad, subapical spur, shorter than corresponding spur on coxae I; coxae III with a still shorter and broader apical spur; coxae IV rounded, unarmed.

Scutum 474 to 502 mm. long by 545 to 574 mm. wide, greatest width at eyes which are large and oval; scutum red around eyes, reddish yellow on scapular angles, pale yellow toward tip; scapular angles bluntly rounded, emargination shallow, scutum broadly rounded behind, outline regular, except a slight constriction anterior of eyes and another opposite posterior ends of cervical grooves; cervical grooves deep anteriorly, disappearing a short distance from margin posteriorly, in form of regular curves, nearest together at the anterior third of their length.

Body: Abdomen dorsally brownish yellow, striate; size from .99 mm. long by .7 mm. wide to 1.11 mm. long by .80 mm. wide; marginal grooves shallow, running from near eyes to second festoon groove; accessory grooves fairly distinct, running from near tip of shield to third festoon groove; poster-median groove distinct, broad, beginning further behind scutum than accessory grooves and running to festoons, festoons fairly prominent. Color, engorged, steel gray.

Stigmal plates 966 mm. by 756 mm. conical with base rounded, apex pointing dorsally; macula ventro-anteriorly from center; about 54 cells (four rows in widest and one in narrowest place between macula and margin, four large goblets around macula; plates located a considerable distance behind coxae IV.

Size, unengorged (including capitulum) 1.13 mm. long by .63 mm. wide to 1.41 mm. long by .80 mm. wide; engorged 2.98 mm. long by 2.1 mm. wide by 1.14 mm. thick to 3.10 by 2.16 by 1.11 mm.

Larva, unengorged, similar in most important respects to nymph. Capitulum reddish brown, length 129 to 143 mm.; basis capituli, width 158 mm.; palpi, length 717 to 861 mm.

Legs and coxae yellowish, of moderate size.

Scutum, reddish brown, length 230 mm., width 330 to 344 mm.

Body reddish brown, ovoid, 511 to 513 mm. long by 402 to 459 mm. wide.

Size, length (including capitulum) 631 to 653 mm., width as given under body.

Hosts. Little is known of the host of the immature stages; they probably engorge on small, wild rodents. Experimentally they have been

reared on guinea pigs, rabbits and cattle.

DERMACENTER VENUSTUS Banks

Nymph, unengorged. Capitulum reddish brown, angles and spines darker; length 258 to 311 mm. basis capituli, width 316 to 348 mm., nearly triangular, lateral angles prominent and sharp; posterior-margin projected backward into a blade-like edge or flange; palpi rather long and slender, total length dorsally, 215 to 258 mm.; length (along inner margin) article II 155 mm., article III 70 mm.; ventrally, article I bears a long bristle which extends forward from the inner margin of the article; article IV small, subconical, set in the tuncate end of the article III; it bears several bristle-like hairs; basis capituli with a broad blunt tooth on its posterior margin, on each side; opposite the internal angle of coxae I; the posterior margin between these teeth is slightly convex; hypostome rather blunt apically, narrowed toward the base; with two files of teeth on each side; teeth largest toward tip smaller and scale-like toward base, where they gradually disappear; about 11 teeth in each row.

Scutum reddish brown, darkest near eyes and along posterior border 531 mm. long by 495 mm. wide to 560 by 567 mm., widest at eyes which are somewhat behind middle, eyes oval, distinct; shield broadly rounded behind, postero-lateral borders slightly concave, concavity opposite beginning of marginal groove on body; three or four moderate sized punctures medad of eyes and several along the borders, from the eyes to scapulae; scapulae rounded, not very broad; cervical grooves deep anteriorly and extending back to opposite posterior end of eyes, these form fairly perfect arcs, nearest together slightly in front of their middle where they are slightly angular.

Coxae and legs, reddish brown, coxae I with two posterior spurs, inner rather short and broad, the apical one more than twice as long and bluntly pointed; coxae II with a small but distinct apical tooth and coxae IV with a very minute one; all coxae with two hairs, one near the center at basal third and the other near leg attachment on posterior border.

Body, reddish brown, length 1.05 to 1.15 mm., (not including capitulum), width 0.65 to 0.84 mm., ~~yellowish-brown~~; marginal furrows distinct, running from shield to festoons which are distinct and traceable around posterior margin; posterior sub-median groove fairly distinct, same for accessory grooves which begin farther forward than posterior median; scattered short yellow hairs on body; coecal system usually plainly visible as brownish black bands; anus nearly circular 85 $\frac{1}{2}$ mm. long by 91 mm. wide; four hairs on each valve; genital grooves distinct, running to opposite leg III; anal groove

not very distinct; festoons clearly marked; a few short pale hairs scattered over venter. Color when engorged dark bluish gray.

Stigmal plates rather large, 129 by 123 mm., the greatest diameter at right angles to body axis; nearly circular with a slight flattening along the antero-internal margin and a slight prominence on the external side; with eight large goblets near macula, usually six or seven in oval arrangement around opening which is small and oval and one smaller goblet toward external margin; macula slightly antero-ventrally from center; about 112 small cells on plate, close together. Stigmal plates of a nymph from Riverside, Oregon, measured 113 by 102 mm. This plate as well as several others showed seven or eight large goblets. These plates have little or no flattening on antero-internal border and have a distinct prominence on the outer side.

Size, unengorged, length (including capitulum) 1.36 to 1.54 mm., width 0.65 to 0.8 mm.; engorged, from 3 by 2.1 by 1.3 mm. to 4.8 by 3.3 by 2 mm.

Larva. Capitulum yellow, average length, 139 mm., basis capituli average width 169 mm.; broadly triangular, lateral angles acute; palpi shorter in proportion than in the nymph, average length 99 mm.; hypostome spatulate 4 files of teeth, 7 to 8 teeth each.

Scutum yellow, average length 241 mm., average width 350 mm. shape similar to that of the nymph, cervical groove deep and reach nearly to posterior border.

Legs and coxae yellow or moderate size, all tarsi, especially tarsi I, rather abruptly narrowed near tip; leg I, length, trochanter 56 mm., femur 128 mm., tibia 128, metatarsus 99 mm., tarsus 20 mm.; coxae I with a single heavy spur on its inner posterior angle, a slight tubercle at apex posteriorly, coxae II and III with a broad tubercle subapically, smallest on coxae III.

Body, pale yellow, ovate broadest at posterior fourth, marginal and festoon grooves distinct anus small. Color, engorged, slate-blue.

Size, average length (including capitulum) 688 mm. average width 429 mm.; engorged, average length 1.36 mm., average width .83 mm., average thickness .60 mm.

Hosts. The immature stages of this tick are to be found on all small rodents in the region where the species is abundant. They have been taken on seventeen different species ranging from small meadow mice to the woodchuck and snowshoe rabbit. Ground squirrels are probably the most important host.

DERMACENTOR PARUMAPERTUS VAR. MARGINATUS Banks

Nymph, unengorged. Capitulum light reddish brown, lateral and posterior flange darker; length 193 mm., basis capituli with lateral angles prominent, but obtusely rounded; width 316 mm.; palpi moderately stout, length (along inner margin) article II 113 mm., article III 80 mm., extreme length of palpi (along outer margin) 209 mm., article I of moderate length on ventral side. Ventrally, basis capituli rather heavy, lateral angles sharp but not long; two short spines a short distance from margin, below and internally from base of palpi hypostome lanceolate with four rows of teeth, slightly diverging posteriorly from median line; basal teeth very minute, about twelve in outer rows and nine in inner ones.

Scutum dark reddish brown, slightly broader than long, 596 by 574 mm.; greatest width at eyes which are slightly behind middle, eyes oval, prominent; scapular angles broadly rounded, emargination moderate; cervical grooves rather deep anteriorly, extending backward with a slight curve about one half length of scutum where they become broader and shallow, thus forming a broad depression running nearly to margin of scutum; the lateral portion of the shield very convex, this convexity running practically to posterior margin, a few distinct punctures, on median portion, others extending along border from eyes to scapular angles, a few short pale hairs scattered over scutum usually corresponding to punctures.

Legs and coxae reddish brown, coxae I short with a large subapical, posterior spine and a slight trace of a rounded spine on posterior internal angle; coxae II, III and IV with distinct subapical spines, largest on coxae II and smallest on coxae IV; a pale hair on each coxa posteriorly; all coxae much out out at interior apical margin where trochanters articulate.

Body 1.04 mm. long by .65 mm. wide, widest just behind eyes; another had a length of 1.01 mm. and a width of .62 mm.; genital grooves distinct converging anteriorly to a point about opposite coxae III, where they nearly meet.

Stigmal plates transversely ovate, the smaller end pointing postero-dorsally; rather small, with a wide margin; about 36 to 40 small cells, four rows at widest point, the cell in the outer row larger along the ventral side of the plate; about seven large goblets around the aperture which is small, these large goblets vary somewhat in size, the largest being about 14 mm. in diameter; they have distinct central openings, greatest diameter of the stigmal plate 91 mm. width 80 mm. Another plate measured 86 mm. by 96 mm. and showed seven

large goblets.

Size, unengorged (including capitulum) 1.23 by .79 mm. to 1.19 by .62 mm.; engorged 3 by 21 by 1.2 mm. to 3.9 by 2.8 by 1.6 mm. Color when engorged slate to almost black.

Larva unengorged. Capitulum brownish yellow, length 144 to 158 mm., basis capituli, width 158 to 165 mm., broadly triangular, lateral angles acute; palpi moderately stout, length 96 to 100 mm.; capitulum spatulate with four rows of small teeth, about 4 teeth per row with 3 or 4 scale like ones at the base.

Scutum, brownish yellow, length 251 to 280 mm. width 330 to 368 mm. shape much as in nymph; cervical grooves as in nymph.

Legs and coxae, dark yellowish, of moderate size; all tarsi tapering towards tip, I rather abruptly; coxae I with a small tubercle at its inner posterior angle. Coxae II and III with a similarly placed though smaller tubercle, each of the coxae have a minute sub-apical tubercle also.

Body, pale yellowish, ovate, length 592 to 624 mm., width 445 to 504 mm., greatest width at posterior third; marginal grooves distinct close to margin; festoons sharply defined; anus transversely over 334 by 400 mm.; ventral groove indistinct. Color, engorged, dark gray.

Size length (including capitulum) 0.69 to 0.88 mm.; engorged 1.3 by 0.8 by 0.7 to 1.5 by 0.9 by 0.8 mm.

Hosts. Very few immature stages have been collected but it appears that rabbits (cotton tails and jack rabbits) are their normal hosts as with the adults. Experimentally they have been reared on fox squirrel, guinea pig and bovines as well as on rabbits.

DERMACENTOR ALBIPICTUS Packard

Nymph, unengorged. Capitulum translucent yellow, edges darker; length 263 mm.; ^{base}Capituli 273 mm. wide, very thick, approaching rectangular in shape, slight lateral angles, which are broadly rounded, formed by the posterolateral flange; this extended edge or flange not noticeable along median portion of base; the basal edge slightly concave, well separated from the neck which is depressed below the body of the basis capituli; hypostome and palpi about equal in length; palpi rather short and heavy; length of palpi about 150 mm.; article I slightly

visible dorsally on outside, article II with a raised body and narrowed neck at base; length 85 mm., length of article III 70 mm., width of each palpus 96 mm., ventrally, article I of the palpi is long and with a slight prominence at the internal distal corner; article II with a slight edge separating the raised distal portion from constricted basal portion; article II rather broad; article III short, along internal margin, and truncated; article IV truncate conical, fairly prominent, bending ventrally; a number of hairs around the apical portion; cheliceral sheaths rather broad, finely roughened on dorsal surface nearly to base. Ventrally, the capitulum is yellow, base rather long, median portion convex, neck rather long, rounded at attachment to body; postero-ventral edge broadly rounded with a slight carina which is strongest at sides; in the center the edge is not strongly divided from the neck; sides diverging gradually to base of palpi; hypostome slightly spatulate, with 4 rows of teeth, the inner rows with 6 and outer with 7 teeth; rows diverge from the median line and the 2 rows on each side converge, the teeth become very small basally.

Scutum pale yellow to brownish yellow; length 531 mm. width 588 mm., greatest width at eyes which are not prominent; emargination moderate, scapular angles rather broadly rounded; cervical grooves distinct anteriorly, not deep, curving inward then diverging and gradually broadening and becoming shallow, so as not to be traceable behind eyes, a broad depressed area, extends from ends of grooves proper to postero-lateral margin of scutum; posterior end of scutum rather narrowly rounded, regular in outline; a few short pale hairs on scutum, also a few shallow punctures.

Legs and coxae pale yellow to yellow brown, coxae rather broad, well separated, coxae I with a stout, rather short subapical spur, and a broad, slightly raised keel at its postero-internal angle; coxae II, III and IV with very small subapical spur. Legs rather long and moderately stout; tarsi II, III and IV constricted somewhat at false segment; leg I with oval pulvillus, length of pad 91 mm., entire pulvillus length 139 mm.; greatest length of tarsus I 257 mm., metatarsus I 161 mm., tibia I 111 mm., greatest width of tarsus I 107 mm.; a few hairs on each joint of legs, more numerous on ventral sides of tarsi.

Body reddish yellow, elongate oval, proportionately longer than in any other Dermacentor; from 1.25 mm. long by .55 mm. wide to 1.50 mm. long by .67 mm. wide; marginal groove indistinct though traceable, festoons visible but not pronounced; accessory grooves diverge from near shield to festoons; post-median groove indistinct, beginning some distance behind tip of scutum; a few hairs on the body, rather more numerous on the lateral edges. Ventrally, genital groove distinct, converging anteriorly to a point opposite the space between coxae III and IV where the sides meet; anus transversely oval about 86 by 107 mm.; post-anal groove indistinct; festoons visible but not prominent; a few scattered pale hairs. Color when engorged almost white to bluish gray.

Stigmal plates broadly oval, greatest diameter antero-ventrally by dorso-posteriorly. One nymph has a left plate which measures 139 by 118 mm. with 7 large goblets arranged in an approximate circle about the center; the right plate has 11 goblets and measure 145 by 118 mm.; the largest goblets on the right plate are 21 mm. in diameter, the largest on the left plate 27 mm.; apertures in goblets distinct; macula slightly oval, located just antero-ventrally from center of plate. Another nymph has the right stigmal plate 182 by 145 mm. with 9 large goblets, 2 rows in one place at posterior side; greatest diameter of plate parallel with body axis; macula antero-ventrally from center. A third nymph has a right stigmal plate 182 x 155 mm. with 14 large goblets; aperture located ventro-anteriorly from center; greatest diameter ventro-posteriorly by dorso-anteriorly the left plate measured 182 x 145 mm. and has 12 or 13 goblets, greatest diameter as on left plate. In a fourth nymph the left plate measures 214 by 230 mm. and showed 20 goblets, 3 deep from margin in some place; the right plate on this nymph shows 16 goblets, size of plate about the same as left. Still another nymph has a left plate measuring 150 by 182 mm. with 14 goblets, the largest being 21 mm. in diameter.

Size, unengorged (including capitulum) 1.44 mm. long by .55 mm. wide to 1.61 mm. long by .67 wide; engorged, 5.4 mm. long by 3.9 mm. wide by 1.5 mm. thick to 2.8 by 1.7 by .9 mm. A thickness of 1.9 mm. has by noted in some individuals.

Larva, unengorged. Capitulum pale yellow, length 112 mm.; basis capituli width 128 mm., approaching rectangular with practically no lateral projection, posterior edge straight. Ventrally basis capituli rounded along its posterior border, without teeth. Palpi short and broad, articles II and III about equal in length, article IV cylindrical bending ventrally about 33.3 mm. in length by 16.6 mm. wide; hypostome short, broadly spatulate, 4 rows of small teeth, about 5 or 6 teeth per row.

Scutum yellowish, reticulated, length 248 mm., width 352 mm., greatest width in middle, scapular angles rounded, emargination broad and moderately deep; cervical grooves broad and extending back half the length of the scutum; sides anteriorly slightly convex diverging rapidly posteriorly; posterior margin broadly and evenly rounded.

Legs and coxae yellow, of moderate size, all tarsi tapering at tips; pulvilli broad; coxae I with a slightly prominent postero-internal angle; coxae II and III with a minute tubercle subapically on the posterior border; length, leg I, tarsus 224 mm., metatarsus 96 mm., tibia 112 mm., femur 128 mm., trochanter 96 mm.; several yellow hairs on each of leg joints.

Body oval, striate, brownish yellow, length 576 mm., width 416 mm., greatest width slightly behind middle, dorsum convex without grooves except marginal which is pronounced, running from scutum around

posterior margin; anus slightly oval transversely; post-anal groove indistinct, genital grooves converge from posterior margin to slight-in front of anus where they fade out; a few yellow hairs scattered over body. Color, unengorged, gray, tho many are whitish or pinkish.

Size. length 672 *mm.*, width 416 *mm.*

Hosts. Since this species remains on one host for its entire development, the hosts of the immature stages must be the same as those of the adults. The species has been found most abundantly and in all stages on horses, cattle, and elk. The moose, deer and beaver have also been recorded as hosts. Experimentally the larvae and nymphs have been engorged on guinea pigs, and rabbits.

DERMACENTOR NIGROLINEATUS Packard

Nymph, unengorged. Capitulum yellow, edges darker; length from 263 to 273 *mm.*; basis capituli width 268 to 278 *mm.* sub-rectangular, lateral sides rounded posterior and postero-lateral edge with a considerable flange, posterior edge slightly concave; length of palpi along inner margin 150 *mm.*, article II 85.8 *mm.*, article III 53.6 *mm.*; width of each palpus from 85 to 96 *mm.*; article I of palpi distinct ventrally, article IV sub-conical with several hairs on its sides and apex. Ventrally, basis capituli with a convex central portion which is bounded quite definitely posteriorly where the base is constricted into a short neck; this convex area is less distinctly defined anteriorly, the declivity to the base of the hypostome being gradual though considerable; no armature ventrally; hypostome slightly spatulate, with two rows of rather strong, backward projecting teeth on each side, about ten teeth in the outer and eight in the inner rows; basally these teeth gradually become smaller and the rows diverge slightly from the median line.

Scutum from 474 *mm.* long by 445 *mm.* wide to 617 *mm.* long by 517 *mm.* wide; pale yellow; eyes paler than scutum, projecting slightly beyond edge; posterior margin of scutum much as in the adult female; the posterior end rather acutely rounded, the posterior lateral margins are almost perfect arcs behind the eyes; scapular angles moderately broad, gradually rounded into emargination which is not deep; cervical grooves shallow, in form of regular curves extending back to a point opposite the anterior end of the eyes; a few short pale hairs along antero-lateral margin, and on postero-central portion.

Legs and coxae yellowish brown; length of tarsi I 220 *mm.*; length of metatarsi I 113 *mm.*; tarsi I very broad, other segments rather so; tarsi II, III and IV less broad and more gradually narrowed at tips, though all end rather abruptly; coxae I bearing two spines the inner short and rounded; the outer which is at about the middle of the posterior border of the coxa is stout, rather more pointed and of considerable length; coxae II with a medium sized subapical spine; coxae III with a distinct though broad and short subapical spine; coxae IV with a small subapical tubercle; pulvilli small, oval; claws short; a number of hairs on all segments of legs; trochanter I with a moderately sharp, dorso-posterior, subapical blade.

Body elongate oval; usually widest opposite the tip of the scutum; length (not including capitulum) 1.15 mm., width .69 mm.; the postero-lateral margins have a tendency to roll upward in the region of the stigmal plates; postero-median grooves fairly distinct and broad, beginning one-third of the distance from tip of scutum to posterior end of body; accessory grooves distinct, beginning near posterior end of scutum and diverging slightly backward; marginal grooves and festoons scarcely visible; many pale hairs on body, thickest and longest on lateral margins near stigmal plates. Ventrally, festoons indistinct, genital grooves converging anteriorly where they meet opposite coxae III; anal grooves not very distinct; anus transversely oval about 97 by 75 mm., (not including marginal rim), a considerable amount of pale hair as on dorsum. When engorged color varies from almost white to slate, sides are often sub-parallel, greatest width at anterior end about opposite space between coxae II and III.

Stigmal plates irregularly oval, the greatest diameter usually with the axis of the body; somewhat flattened on the posterior end; margin moderately wide; plate projecting slightly from body; size of plates from 193 by 161 mm. to 204 by 171 mm.; each plate with from 6 to 12 large goblets (smaller than in D. Nitens) set close together around macula; area not covered with goblets, filled with small cells; largest goblets about 37 mm. in diameter; the apertures in some of these, about 16 mm. in diameter.

Size, unengorged, length (including capitulum) about 1.4 mm., width about .7 mm. Engorged 3.45 by 3.28 by 2 mm. to 3.95 by 3.72 by 2.27 mm.

Larva, unengorged. Capitulum yellowish brown, length 130 mm., width 130 mm., shape as in nymph; palpi length 72 mm.; hypostome spatulate with 4 rows of teeth.

Body yellowish brown, length 576 mm., width 480 mm., greatest width at posterior third; marginal grooves and festoons fairly distinct, a few rather long hairs scattered over body; anus nearly circular 40 mm. in diameter.

Scutum yellowish brown, length 272 mm., width 352 mm., greatest width about middle; sides anteriorly curved, posteriorly slightly convex; tip broadly rounded; scapular angle broadly rounded; cervical grooves as in nymph.

Legs and coxae brownish yellow; tarsi I rather abruptly narrowed at tip, others tapered; coxae unarmed.

Hosts. The immature stages have the same hosts as the adults since this species does not leave the animals to molt. They occur commonly on the cattle and deer, occasionally on horses.

DERMACENTOR NITENS Neumann

Nymph, unengorged. Capitulum pale yellow, except posterior edge which is reddish, length to tip of hypostome, 287 to 359 mm., basis capituli rectangular; no lateral angles; basal edge not flanged; posterior edge almost straight slight convex in middle, lateral corners rounded, width 265 to 354 mm.; palpi rather short, 316 mm. (along outer edge); shape somewhat as in the adult; article II 107 mm. in length (along internal border); article III 69.8 mm. long; article IV distinctly inclined ventrally; ventrally, articles appear cylindrical, article I wedge shaped with narrow angle medially; article III made very short by large excavation to receive article IV which is sub-conical; ventrally, the capitulum is pale yellow, basis capituli rectangular with broadly rounded posterior edge; no spines; hypostome slightly capulate with three rows of teeth on either side, inner row with 12, middle with 12 and outer with 13 teeth, the three rows converging basally where the teeth are very minute and scale-like; the three rows on each side diverge from center line.

Scutum yellowish, length 517 to 589 mm., greatest width 603 to 689 mm. at eyes; eyes small, slightly in front of middle; shield narrowly rounded behind; scapulae broadly pointed anteriorly, emargination rather deep; cervical grooves short, not reaching to anterior ends of eyes, slightly convergent posteriorly; scutum usually broadly depressed from posterior ends of cervical grooves to posterior margin; a few scattered punctures and yellow hairs.

Coxae and legs, pale yellow, margins of coxae and spurs slightly reddish; all coxae rather narrow; coxae I with a medium sized, blunt spur subapically and a slightly raised, rounded prominence near the postero-internal angle; coxae II, III and IV with a distinct subapical spur diminishing in size on the posterior coxae; leg I, length along dorsal side, pulvillus (pad only) 80 mm., tarsus 241 mm. metatarsus 150 mm., tibia 182 mm., femur 182 mm.

Body light reddish brown, length from 95 mm. to 1.13 mm. width from .74 mm. to .90 mm.; the lateral margins of the body behind the scutum usually roll upward; leaving the central portion much depressed; the accessory grooves appear as broad depressions reaching nearly to scutum; the posterior, median and marginal grooves are seldom distinguishable; festoons very indistinct, some being indistinguishable; body surface finely striate and with scattered punctures. Venter, pale yellow anteriorly, darker posteriorly and at posterior end reddish brown; genital groove distinct but somewhat interrupted back of coxae IV; anteriorly genital groove is rounded, the sides meeting opposite posterior angle of coxae III; anus transversely oval, 102 by 113 mm.; three hairs on each valve; considerable hair posteriorly especially around spiracles, where it is longest and forms a fringe around the spiracles; color when engorged dark gray.

Stigmal plates opposite anus, broadly oval, the largest diameter antero-dorsally by postero-ventrally; the margin is rather wide and slightly raised; plates bear three to four large goblets which are distinctly convex on the surface, these are surrounded by many small cells placed close together. One stigmal plate measuring 247 by 182 mm. has three large goblets, the largest 80 mm. in diameter, with a aperture (in goblet) 21 mm. in diameter; the other plate on this specimen has three goblets. Another tick has three goblets on each plate; one of these plates measuring 225 by 203 mm., bears 3 goblets; another measuring 275 by 225 mm., has four. Still another tick has four goblets on each plate, the largest goblet measuring 75 mm. and the largest aperture 18 mm.; this plate measured 236 by 204 mm.

Size, unengorged, length (including capitulum) 1.33 mm., width 0.9 mm.; engorged, 2.9 by 1.8 by 1 mm. to 3.5 by 2.2 by 1.3 mm.

Larva, unengorged. Capitulum reddish brown, length 132 to 205 mm.; basis capituli, 143 to 158 mm. wide, short-posterior margin nearly straight, no cornua, laterally rounded, sides not prominent. Palpi yellowish, rather stout, length on lateral margin dorsally 100 to 115 mm., article I very short, article II nearly $1\frac{1}{2}$ times the length of article III, article IV extended antero-ventrally; hypostome spatulate, with two rows of teeth of about 8 or 9 teeth per row, these very small basally. Ventrally, base is broad and without prominences, posterior border rounded.

Scutum brownish yellow, length 273 to 308 mm., width 366 to 387 mm., widest slightly behind middle; sides anteriorly distinctly convex, posteriorly, slightly concave; scapular angles rounded, emargination moderate; cervical grooves moderately strong, extending back slightly behind middle of scutum.

Legs and coxae yellowish brown, moderate in size, pulvilli rather broad, all tarsi tapering at tips; coxae I with a very short, broad spur on its internal posterior margin, coxae II and III with a distinct subapical tubercle; length, leg I, tarsus 192 mm., metatarsus 112 mm., tibia 128 mm., femur 136 mm.

Body brownish yellow, ovoid, length (not including capitulum) 720 mm., width 464 mm., greatest width at posterior third; marginal groove rather distinct, extending from scutum around posterior border; festoons well marked; anus transversely oval, 40 by 53 mm. Color, engorged, steel gray.

Size, length (including capitulum) 682 to 738 mm., width 459 to 474 mm.

Hosts. Since this species molts on the host the immature stages are to be found on the same hosts as the adults. Collections have been made from horse, mule, ass, goat, and cattle. They usually occur within the outer ear.

GENUS MARGAROPUS Karsch

There is, in the United States, but a single species of this genus, the Texas fever tick M. annulatus. The nymph is easily recognized by the short, bead-like palpi, the very short hypostome and the constriction of the body behind the posterior legs. The larvae are more easily confused with other forms, but palpal characters, short hypostome, and the shape of the scutum serve to differentiate them.

MARGAROPUS ANNULATUS Say

Nymph, unengorged. Capitulum yellowish, length 230 to 287 mmm., basis capituli, width 373 to 448, very short in comparison with width, posterior margin straight, a trace of cornua, laterally produced into a rather acute angle on each side, ventrally, this angle is ridged along its center this ridge extending medad for some distance on the base, outline of basis capituli similar ventral and dorsally; palpi very short, length 108 to 115 mm., article I very short, inconspicuous, article II 72 mm. long, with a ridge along its base, running from the inner dorsal margin to the inner ventral margin most developed ventrally and approaching the middle of the length of the segment, article III much shorter than article II with a similar ridge; article IV short, conical, broad at base; a few short hairs on each segment; hypostome short, broadly spatulate, broad at tip with 6 rows of 6 to 8 teeth each.

Scutum yellow, length 430 to 432 mmm.; width 430 to 432 mmm., greatest width at eyes which are slightly in front of middle, emargination rather deep, scapular angles very broad at base, rounded at apex; sides, anterior of eyes, converging only slightly toward scapulae, posteriorly nearly straight, apex narrowly rounded, cervical grooves represented by a broad shallow depression running from anterior end to postero-lateral margin; lateral portions of scutum slightly raised.

Legs and coxae yellowish; legs short, leg I, length, trochanter 112 mmm., femur 120 mmm., tibia 104 mmm., metatarsus 96 mmm., tarsus 176 mmm.; tarsi rather abruptly narrowed near end; pulvilli broad at contact base; coxae I to IV each with a broad subapical flattened tubercle.

Body brownish yellow, semi-translucent elongate oval with a dis-

inct lateral constriction behind coxae IV; festoons moderately distinct; anal groove Y shaped behind anus, short posteriorly; anus nearly circular, diameter 72 mm. a few short hairs on both sides. Color, engorged, grayish blue.

Stigmal plates nearly circular, slightly longer dorso-ventrally, dimensions 128 by 118 mm.; margin slightly raised, macula slightly antero-ventrally from center, about 15 moderate sized goblets.

Size unengorged 1.11 by 0.55 mm to 1.5 by 0.6 mm..; engorged, about 3 by 2.8 by 0.8 mm.

Larva, unengorged. Capitulum reddish brown, length 115 to 136 mm., basis capituli 129 to 158 mm wide, approaching rectangular in outline the sides are slightly produced laterally into a broad, rounded angle. Cornua but a trace; ventrally base is rounded on its posterior border; palpi short and rather broad, length 72 to 100 mm., usually shorter than hypostome, article II slightly longer than article III, article IV minute with several long apical hairs, hypostome broadly spatulate with 4 files of teeth, 5 teeth per row, chelicerae often extended beyond end of hypostome.

Scutum reddish brown, length 280 to 301 mm. width 330 to 358 mm., greatest width at eyes which are about at middle; scapular angles broad, emargination rather deep; sides anteriorly and posteriorly convex, broadly rounded; cervical grooves deep and short, converging and extending back one-fifth of the length of scutum.

Legs and coxae yellowish brown, of moderate length and size; all tarsi tapering rather gradually at tip; pulvilli large, claws small and slender, coxae I with a broad but short tooth on its inner posterior angle; coxae II and III unarmed.

Body pale yellow, translucent, greatest width slightly behind middle; festoons indistinct and other grooves ill defined. Color, engorged, light yellowish gray.

Size, unengorged, (including capitulum) 488 by 395 mm. to 574 by 430 mm., engorged, about 1.5 by 0.75 mm.

Hosts. Since this species passes its molts on the hosts the immature stages are found on the animals as well as the adult. They have been collected on cattle, horses, deer, hogs, and collared peccaries.

GENUS RHIPICEPHALUS Koch

This genus is characterized in the immature stages by the scutum

being shaped like an arch key, i.e. the greatest width near the apical end and the sides converging to the scapular angles, also by the pentagonal shape of the basis capituli. This is somewhat like that of *Margaropus* but in that genus the palpi and hypostome are much shorter.

The only representative of this genus in the United States is the brown dog-tick, *R. sanguineus*.

RHIPICEPHALUS SANGUINEUS Latreille

Nymph. Capitulum yellowish brown, length to tip of hypostome 224 mm.; basis capituli somewhat hexagonal in outline, width 320 mm., laterally produced into rather sharp angles, the latero-posterior portions being distinctly flanged, posterior border practically straight on its central third; palpi rather short and broad, length (along outer margin), article I 9 mm., article II 69 mm., article III 58 mm., article II nearly as broad at its distal end as long. Ventrally, base is comparatively short, a distinct blunt spine is located on each side two-thirds of the length of the base from the attachment of the palpi; hypostome short, spatulate, with four files of rather small teeth, about 6 teeth in the outer and 5 in the inner rows.

Scutum yellowish brown, darkest around eyes, shape of an arch key; length 452 to 464 mm., width 462 to 480 mm., greatest width at eyes which are at posterior fourth; scapular angles rounded, emargination moderate; sides back to eyes practically straight, posterior end broadly rounded; cervical grooves deep anteriorly, rather distinct and converging backward one-third of the length of the scutum then blending into a broad depression which extends to the posterior margin; laterally the scutum has a broad ridge running from the scapular angles to the posterior margin behind the eyes.

Legs and coxae legs brownish yellow, of moderate size; coxa I with two posterior spines the inner short and rather blunt, the outer long and sharp; coxa II, III and IV with a subapical spine diminishing in size posteriorly so that on coxae IV it is but a tubercle; tarsi tapering at tip; pulvilli of moderate size, claws slender; length leg I trochanter 112 mm., femur 224 mm., tibia 192 mm., metatarsus 152 mm., tarsus 312 mm.

Body reddish brown, size about 0.94 by 0.57 mm., ovoid, greatest width opposite coxae IV, finely striate; festoons rather distinct; anal groove distinct, Y shaped at anterior end, prongs disappearing opposite

middle of anus; genital groove distinct; converging from margin to a point in front of anus where it is markedly constricted, then proceeding forward with sides sub-parallel, to the space between coxae II and III where the sides unite.

Stigmal plates ovoid with the pointed and postero-dorsally, 86.7 mm. by 70 mm., macula near ventral end.

Larva, unengorged. Capitulum yellowish, margin darker; length 152 mm.; basis of capituli, short and broad, width 152 mm., lateral angles only slightly produced, posteriorly border convex; ventrally, basis capituli short and broad, posterior border somewhat convex; palpi much shorter than hypostome, length 80 mm.; articles I and II apparently fused, article I with a slight lateral prominence at its base; article III tapering slightly toward tip; article IV visible dorsally; a number of rather large hairs along edges; ventrally, palpi are conical in outline, very strong spines arise from the internal basal angle of article II; hypostome broadly spatulate with four rows of teeth, the outer row with about 7 teeth and inner with 6; these very small basally.

Scutum yellowish brown, minutely reticulate; length 224 mm., width 360 mm.; scapular angles rather broad; emargination moderate, greatest width at posterior fourth, the sides anteriorly are slightly rounded and very divergent; behind the eyes the border is uniformly convex; cervical grooves deep anteriorly, first converging then diverging and becoming superficial a short distance behind the middle, eyes rather large oval.

Legs and coxae, legs yellowish, of moderate length and stoutness, coxae I with an indication of a spine on the posterior border, internally, this is hardly more than a thickened edge; coxae II with a broad and very short subapical tubercle, coxae III with a similar, but even smaller tubercle; all tarsi tapering at tip; leg I, length, trochanter 70 mm., femur 133 mm., tibia 113 mm., metatarsus 100 mm., tarsus 196 mm.; pulvillus (including base) 67 mm.

Body brownish yellow, finely striate, ovoid; length (not including capitulum) 457 mm. to 496 mm., width 328 to 432 mm.; marginal groove distinct to the fourth festoons, festoons distinct; venter somewhat shiny, bearing a number of pale hairs; anus transversely oval, 26.6 by 33.3 mm.; anal groove indistinct. Color, engorged, dark gray.

Hosts. The only host upon which this species has been taken in extensive collections in the United States, is the dog. In other parts of the world it has been recorded as attacking fox, cat, horse ox, hare, dromidary, camel, sheep, goat, birds and reptiles.

GENUS AMBLYOMMA Koch

The immature stages of this genus are distinguished by the long palpi, rectangular basis capituli, oval body, well developed eyes and more or less comma shaped stigmal plates. The form, A. maculatum is an exception in two of these particulars. It has a triangular basis capituli and elongate body, but the palpal, coxal scutal, and stigmal plate characters readily distinguish it from some of the Dermacentors with which it is most likely to be confused.

The nymphs of the five species of Amblyomma found in the United States may be distinguished as follows:

1. A single spur on coxae I, scutum as long as broad.....maculatum
Two spurs on coxae I, scutum distinctly broader than long2
2. Hypostome with six files of teeth3
Hypostome with four files of teeth.....4
3. Scutum with white pattern, large species, stigmal plate with only a crescent-shaped area covered with goblets.....tuberculatum
Scutum without white markings, smaller species, surface of stigmal plates, except a marginal boss, covered with goblets
.....dissimile
4. Scutum broadly rounded at tip, outer spur on coxae I as broad at base as long, stigmal plates with distinct dorso-posterior projection and boss.....cajennense
Scutum more narrowly rounded at tip, outer spine on coxae I much longer than broad at base, stigmal plates with but a trace of a projection and no boss.....americanum

Key to the larvae of the nearctic species of Amblyomma.

1. Coxae I with a single spur, basis capituli with sharp lateral angles.....maculatum

- Coxae I with two spurs, basis capituli with sides rounded.....2
2. Posterior margin of basis capituli convex.....3
- Posterior margin of basis capituli straight or slightly concave...4
3. Coxae I with rather sharp spurs, cervical grooves short and straight, normal sized species.....dissimile
- Cervical grooves extending past the middle of scutum, coxae I with spurs rounded, large species.....tuberculatum
4. Coxal spurs rather acute, as long as broad at base, scutum moderately extended behind the eyes, tip rather narrowly rounded.....americanum
- Coxal spurs short and rounded, scutum extended but little posterior to the eyes, making tip very broadly rounded...cajennense

AMBLYOMMA MACULATUM Koch

Nymph, unengorged. Capitulum yellow, length 358 to 416 mm.; basis capituli triangular, width 230 to 301 mm., long in comparison with width, posterior border of base straight, no cornua, lateral angles fairly acute; ventrally, there are two large spurs near the base of the palpi; palpi long and slender, length 237 to 273 mm.; article I small, article II 161 mm., broadest apically, article III 75 mm.; ventrally, article III is shortened and truncated to receive article IV, also slightly produced at its inner apical angle; each article bears a few hairs; hypostome broadly lanceolate, rather long; four files of teeth, 11 or 12 teeth in the outer and 10 or 11 in the inner rows.

Legs and coxae yellowish, legs of moderate length and stoutness; tarsi rather bluntly narrowed at tips; pulvilli large, oval; claws slender, equal in length to the pulvilli; coxae nearly parallel increasing in size from I to IV, coxae I with a large spur near its middle posteriorly, coxae II with a slight tubercle similarly placed, coxae III and IV with just a trace of a subapical tubercle.

Scutum yellowish brown, darkest at eyes; length 603 to 617 mm., width 588 to 603 mm., widest at eyes which are well behind middle; eyes large and rather prominent; scapular angles broad, emargination moderate; sides are curved medially from the eyes forward; posterolaterally, sides almost straight, apex rather narrowly rounded; cervical grooves deep and sub-parallel, diverging slightly posteriorly; laterally carinae extend from near the scapular angles almost to the border

behind eyes, slightly incurved posteriorly; shield depressed medad from carinae, especially posteriorly; sides distinctly elevated especially in region of scapular angles.

Body brownish, elongate oval, 1 by .75 mm., greatest width about middle, striate and thickly punctate; median and accessory grooves distinct, marginal groove well defined extending around posteriorly from scutum; festoons distinct; ventrally, marginal groove well defined as are also anal and genital grooves, the sides of the latter join anteriorly opposite coxae II; anal groove Y-shaped, the basal portion short, extending to the marginal groove. Color, engorged, bluish gray, shining. Some nymph are dirty white due to engorgement with lymph.

Stigmal plates somewhat oval, slightly produced postero-dorsally; size 172 by 129 mm. to 172 by 147 mm.; no marginal cells, goblets very small and uniform in size, 6 to 11 rows between macula and margin; macula located antero-ventrally from the center.

Size length (including capitulum), unengorged, 1.56 mm. to 1.68 mm., width .66 mm. to .75 mm.; engorged about 4.5 by 3 by 2 mm.

Larva, unengorged. Capitulum length 143 mm.; basis capituli 170 mm. wide, no postero-lateral projection, posterior border in middle nearly straight, antero-lateral sides slightly convex, practically hiding the first article of the palpi; lateral angles sharp and considerably produced; ventrally base is without projections and is somewhat convex; palpi rather short and fairly stout; length dorsally (on out side) total 107 mm., article II 53 mm., article III 40 mm., article IV usually rather broad and not extended anteriorly beyond the dorsal border of article III; article II rather narrowed and raised toward the base, suture between articles II and III not sharply defined; ventrally, article I is somewhat elevated medially; hypostome slightly spatulate rather narrow, tip entire, teeth rather small and fairly sharp, two rows on each side, outer row with 7 teeth and basal scales, inner 5 teeth and a few basal scales; at tip a number of minute teeth.

Scutum brown; length 215 to 244 mm. width 316 to 344 mm., greatest width distinctly behind middle; scapular angles well produced and narrowly rounded; anterior lateral sides nearly straight, postero-lateral sides slightly concave, apex broadly rounded; cervical grooves deep, extending back about one-third the length of the scutum; marginal grooves rather deep and short, extending backward from opposite the end of cervical grooves nearly to the posterior border; anterior-lateral areas of scutum distinctly convex.

Legs moderate in length and stoutness, all tarsi tapering to end but tarsus I is rather abrupt; length, leg I, trochanter, 80 mm., femur 128 mm., tibia 120 mm., metatarsus 106 mm., tarsus 200 mm.,

length of joints, ~~Leg IV (from body out) (not end tarsus)~~ trochanter 96 mm., femur 112 mm., tibia 104 mm., metatarsus 96 mm., tarsus 144 mm.; coxae I with a single broad blade-like internal projection on its posterior angle; coxae II with a broad but short posterior spur, coxae III with a minute, broad, posterior tubercle.

Body brown, broadly oval; festoons fairly distinct, anal and genatal grooves scarcely visible; anus nearly circular and located rather far toward posterior border.

Size, unengorged, length (including capitulum) 0.62 to 0.63 mm., width, 0.4 to 0.42; engorged 1.5 by 0.9 by .49 to 1.66 by 1 by 5 mm. Color, engorged, dark gray, some are pink, others pale yellowish.

Hosts. The host relations of the nymphs of this species are rather wide, including a number of birds. No larvae have been positively identified from any host in nature. The following hosts have been recorded for the nymphs: quail, meadow-lark, brewer's blackbird, red-winged blackbird, jack rabbit and fox.

AMBLYOMMA DISSIMILE Koch

Nymph, unengorged. Capitulum reddish brown, length 497 mm.; ^{base}capituli, width 400 mm., rectangular, no cornua, but the postero-lateral angles slightly prominent; Ventrally, bulged and with posterior margin convex; palpi 386 mm. long, rather slender; article II being about twice the length of article III; article II somewhat compressed laterally at its base, forming a short median ridge; article I short dorsally, but rather long and rectangular in outline ventrally, a longitudinal ridge medad from the center; article IV very small and sub-conical; hypostome spatulate, blunt at tip, with 6 files of teeth, about 12 in the outer and 7 in the inner rows, those at the base very minute.

Scutum brown, 737 mm. long by 983 mm. wide, greatest width at the eyes which are located at the middle of the length of the scutum; eyes flat and not prominent; sides anteriorly convex, posteriorly distinctly concave opposite the ends of the cervical grooves, the tip moderately rounded; scapular angles rather acute; emargination deep; cervical grooves deep anteriorly, rather broad posteriorly, becoming superficial slightly behind the eyes; surface rather uniformly covered with punctures of irregular size.

Legs and coxae reddish brown, of moderate length and stoutness; all tarsi taper rather gradually toward tip; coxae I, with two spurs on its posterior margin, the outer being distinctly larger; coxae II and III with a spur slightly larger than the inner one on coxae I located

near the middle of the posterior margin; coxae IV with a slightly smaller subapical spur.

Body dark brown, broadly ovoid, greatest width at posterior third; festoons distinct; anal groove Y-shaped, the upper ends of the Y being curved and equally as long as the basal portion.

Stigmal plates, comma shaped, the narrow end projecting posterodorsally and truncate of tip, greatest length about 280 mm., other diameter about 210 mm.; surface closely covered with cells of uniform size; margin rather narrow except at anterior side of tip, where there is a distinct boss; macula small depressed, located toward the antero-ventral border. Color, engorged, light gray or yellowish brown.

Size, unengorged, length 2 mm., width 1.1 mm. Engorged, from 4.5 mm. long by 3 mm. wide by 2 mm. thick to 5 by 3.25 by 2 mm.

Larva, unengorged. Capitulum yellowish brown, length 204 to 258 mm.; basis capituli, width 170 to 193 mm., sub-triangular with antero-lateral margins convex, no postero-lateral angles, but posterior edge slightly produced; ventrally, base is almost pentagonal in outline with surface practically smooth; palpi rather slender, total length dorsally 143 to 201 mm., length article I 20 mm., article II 67 mm., article III 56 mm., sloping ventrally at tip; ventrally, palpi slightly prominent, longitudinal ridge on article I; articles II and III only slightly excavated to receive hypostome; hypostome spatulate, rather broad distally and narrow at base, tip emarginate medially; dentition two rows on each side, outer row of 6 teeth, inner 5 teeth with a few small basal ones and several small ones set irregularly on apex; outer portion of chelicerae with 2 large basal and a small apical tooth, inner portion with a single moderate sized tooth.

Scutum pale brown, 357 to 425 mm. long by 510 to 561 mm. wide, surface finely reticulate, greatest width slightly in front of middle; scapular angles rather broadly rounded; postero-lateral borders distinctly concave; cervical grooves rather deep and practically straight, reaching back about one-third of distance to margin; some specimens show slight trace of broad depression from the tips of the cervical grooves almost to posterior border.

Legs and coxae brown, of moderate length, all tarsi tapering at tips; claws slightly shorter than bodies of pulvilli; length, tarsus I 204 to 258 mm.; metatarsus I 100 to 115 mm.; coxae well separated and slightly divergent posteriorly; coxae I with two moderate spines, the outer the larger; coxae II and III each with an external spine, slightly smaller than the outer spine on coxae I; median end of coxae III is quite narrow.

Body yellowish brown, striate with very few minute hairs, broadly

rounded posteriorly, greatest width at posterior third; trace of marginal grooves anteriorly; festoons distinct; anal frame, width 49 mm., length 46 mm.; anus nearly circular with a minute hair on each valve; genital and anal grooves not well defined. Color, engorged, gray to brownish yellow.

Size, length, unengorged 0.87 to 0.96 mm., width 0.58 to 0.62 mm.; engorged 2 by 1.15 mm.

Hosts. The adults confine their attacks to cold blooded animals but the immature stages probably engorge on warm blooded animals since they have been successfully fed upon bovine. In nature they have been collected on toads and iguanas.

AMBLYOMMA TUBERCULATUM Marx

Nymph, unengorged. Capitulum yellowish brown, length 860 to 932 mm.; basis capituli 588 to 600 mm. wide, sub-triangular in outline, lateral angles broadly rounded, not produced; posterior border slightly convex; ventrally, slightly constricted below base of palpi, posterior border convex; palpi long and moderately stout, length 617 mm., article II nearly twice as long as article III; article II slightly compressed laterally on the dorsal side forming a broad median ridge at the base. Ventrally article II has two oblique depressed lines running from the central portion of the base to the margins; article I rather long ventrally and with a median longitudinal ridge; article IV very small, sub-conical, crowned with a number of very small hairs; hypostome spatulate, 6 files of teeth, outer row with 11 or 12, inner row with 8 or 9 teeth, the basal ones very minute.

Scutum yellowish brown with a considerable silvery white area on each side, but usually not reaching to the anterior lateral margins; the brownish central portion is somewhat V-shaped and the margin from the scapular angles to slightly behind the eyes is also without white markings; 1.2 mm. long by 1.6 mm. wide to 1.5 mm. long by 1.2 mm. wide; somewhat cordate in outline; greatest width distinctly in front of middle; scapular angles broadly rounded; sides, anteriorly, strongly convex; posteriorly, slightly so, the tip being rather narrowly rounded, in front of the middle of the length of the scutum; cervical grooves rather deep diverging for a short distance then converging to a point opposite the eyes and again diverging posteriorly, becoming superficial a short distance behind the middle of the scutum; surface with unequal punctures, those between the eyes and the cervical grooves being numerous and very large; eyes rather small sometimes not reaching to margin of scutum, especially posteriorly.

Legs and coxae legs brownish, long and rather slender in compari-

son with the size of the tick; all tarsi rather blunt at tip, but tapering rather gradually farther back, except I which is narrowed abruptly on both the dorsal and ventral sides; pulvilli small and slender, claws of medium length and slender, nearly parallel; all segments of legs bear some pale hairs; those on the ventral side, especially on the metatarsi being spine-like; coxae I with two broad spurs toward the posterior margin, the outer being much the larger, and slightly broader at base than long; coxae II, III and IV each with a broad spur near the central portion of the posterior margin; these spurs about equal in length but that on coxae IV is the broadest.

Body reddish brown, broadly oval, greatest width about middle; marginal, accessory and median grooves distinct, the latter reaching about two-thirds of the way from marginal groove to the scutum; festoons well defined; anal groove rather deep, Y-shaped anteriorly, the anterior tips of the groove hardly attaining the middle of the anus; a number of punctures on the dorsal surface especially along the borders anteriorly. Color, engorged, dark gray.

Stigmal plates rather irregular in outline, greatest length dorso-ventrally, 250 mm.; margin unusually wide, cellular area covering only about one-half of the surface and being in the shape of a crescent; macula large elongate oval.

Size, unengorged, 2.25 by 1.5 mm. to 4 by 2.5 mm. Engorged, 7 by 5 by 2.5 mm. to 10 by 6.5 by 4 mm.

Larva, unengorged. Capitulum yellowish brown, length 316 to 320 mm., basis capituli, 208 to 212 mm. wide, approaching triangular, posterior edge convex and without cornua; lateral angles rounded and produced but little ventrally, base is rounded posteriorly and without roughness; palpi of moderate size, somewhat compressed laterally, length total 200 mm., article I 20 mm., article II 100 mm., article III 80 mm.; article III bends distinctly ventrally and article IV usually points medio-ventrally; hypostome slightly spatulate with tip rounded; teeth rather small, two rows on each side, outer row of about 7 and inner row of about 5 with a few basal scales and a few small teeth toward tip.

Scutum brown, 430 mm. long by 545 mm. wide to 444 mm. long by 576 mm. wide, greatest width at about the middle of the length; scapular angles slightly produced and narrowly rounded, antero-lateral sides convex, postero-lateral sides very slightly concave; eyes rather prominent; cervical grooves deep anteriorly and extending back with first a slight outward curve, then a slight inward curve and again spreading slightly as they become shallow and disappear slightly behind the middle of the scutum; no lateral grooves or carinae.

Legs and coxae yellowish brown, of moderate proportions but

appear small on the large engorged larvae; coxae I with 2 broadly rounded tubercles rather close together near the inner posterior border, the inner is slightly shorter and narrower; coxae II with a distinct blunt spur near the middle of its posterior margin; coxae III with a similar spur, but slightly smaller; leg I, length, trochanter 130 mm., femur 192 mm., tibia 192 mm., metatarsus 160 mm., tarsus 288 mm.; leg IV, length, trochanter 144 mm., femur 176 mm., tibia 180 mm., metatarsus 156 mm., tarsus 250 mm.; all tarsi taper at the tips but tarsus I is rather abrupt, this article shows a tendency toward two pseudo-segments, and the occurrence of a pseudo-suture at the basal third of tibia IV is noteworthy.

Body broadly oval, greatest width slightly behind the middle; festoons distinct, anal and genital grooves scarcely visible; a few scattered short hairs on both dorsum and venter.

Size, unengorged, length (including capitulum) 1.03 mm.; width 0.76 mm.; engorged, 3.8 by 2.7 by 1.75 mm. to 3.96 by 3 by 1.5 mm. Color, engorged, deep gray with a purple cast, after being engorged for some time becoming bluish brown.

Hosts. The nymphs are abundant on the gopher tortoise and have been reared on bovines. The larvae are found on dogs and rabbits and in smaller numbers on cattle, a few have been taken on an owl and a hawk. These may have been accidental infestations derived from mammals devoured by these birds.

AMBLYOMMA AMERICANUM Linnaeus

Nymph, unengorged. Capitulum yellowish brown, length 343 mm.; basis capituli 257 mm. wide, rhomboidal, slightly narrowed at attachment of palpi; no carina but with a slight marginal flange; posterior margin straight. Ventrally, base is rounded posteriorly and the surface convex; palpi long and slender, length 252 mm. (along outer margin); article I, length (along outer margin), 21 mm., very short internally; length, article II, (along inner line), 139 mm., article III 97 mm.; article II compressed laterally at its base, making a slight longitudinal carina near its median line. Ventrally, article I bears a long bristle on its inner margin. All of the articles bear a few scattered hairs; article IV very small, conical; hypostome with four files of teeth, 10 in the outer and 9 in the inner rows; teeth strong and sharp subapically, more rounded basally.

Scutum yellowish brown, length 397 mm., width 579 mm., greatest width at the eyes which are oval and prominent, and located distinctly in front of the middle; scapular angles broadly rounded; sides anteriorly convex, posteriorly nearly straight, tip being rather narrow

and rounded; cervical grooves distinct, moderately broad, first converging for a short distance, then diverging and becoming more shallow, almost attaining posterior border; entire scutum with numerous rather large punctures and short hairs.

Legs and coxae reddish brown; legs of moderate size tapering at tips; trochanter I with a broadly rounded postero-dorsal, blade-like process; length, tarsi IV 258 mm.; coxae set some distance from edge of body; coxae I with a short, but distinct, spur on the postero-internal angle, and a moderately long stout spur on the mid-posterior border; coxae II, III and IV with a subapical spur.

Body brownish gray, broadly oval, size 1.19 by 1.01 mm. to 1.46 by 1.16 mm., greatest width slightly behind middle; integument finely striate and rather thickly punctate, postero-median and accessory grooves distinct, reaching nearly to the end of the scutum anteriorly and to the festoons posteriorly; festoons distinct both dorsally and ventrally; genital groove fairly distinct running from a point opposite coxae III to the marginal groove; anal groove deep, Y-shaped, the forks of the Y reaching forward opposite the anterior edge of the anal ring; anal ring broadly, transversely oval, 86 to 75 mm., venter without punctures. Color, engorged, dark gray.

Stigmal plates rather large, oval-rectangular in outline with a short, broad, dorso-posterior prolongation; size 155 by 182 mm. to 161 by 187 mm., macula located near internal anterior corner; surface, except for the macula and a rather wide margin, covered uniformly with small, closely set cells.

Size, unengorged 1.5 mm. long by 1.25 mm. wide; engorged, 3 by 2 mm. to 4 by 2.5 mm.

Larva, unengorged. Capitulum reddish brown, length 166 to 187 mm.; basis capituli, width 155 to 161 mm.; central elevated portion almost triangular; laterally, produced into a rounded angle; ventrally, smooth, slightly bulging, posterior margin convex; palpi rather slender, length 116 to 117 mm.; article I 10 mm., article II 60 mm., article III 46 mm., article IV short, slender, conical a number of short hairs at tip; hypostome spatulate, two rows of teeth on each side, outer row 8 to 9 teeth, inner row 6 to 7 teeth, basal ones very small; chelicerae sheaths nearly as long as hypostome.

Scutum yellowish, darker at eyes which are rather large, pale and prominent; length 230 to 257 mm., width 316 to 375 mm., greatest width distinctly in front of middle; sides anteriorly convex, posteriorly nearly straight or slightly concave; scapular angles broadly rounded emargination moderate, cervical grooves distinct, diverging posteriorly and disappearing slightly behind middle.

Legs and coxae yellow, tarsi I rather abruptly narrowed by two

declivities some distance before apex, other tarsi tapering, claws rather long and slender; leg I, length, trochanter 76 mm., femur 112 mm., tibia 112 mm., metatarsus 107 mm., tarsus 203 mm.; coxae I with 2 rather broad spurs on the posterior margin the one on the inner angle considerably the smaller, coxae II and III each with a single spur, somewhat nearer the inner than the outer angle, these spurs are about the same size as the outer spur on coxae I.

Body pale yellow to brown, broadly ovoid, length 504 to 640 mm.; width 472 to 510 mm., greatest width slightly behind middle; festoons and marginal groove fairly distinct; anus nearly circular about 45 mm. in diameter, anal groove rather broad, reaching from marginal groove to anus where it is forked; a few rather long pale hairs on body. Color, engorged, dark bluish brown, shining.

Size, engorged, about 1.5 by 1 mm.

Hosts. The larvae and nymphs appear to attach to almost any mammal host with which they come in contact, they have been taken also on wild turkey and chaparral cock. The mammal list includes the horse, ox, sheep, goat, hog, dog, cat, wolf, fox, skunk, peccary, badger, and squirrel.

AMBLIOMMA CAJENNENSE Fabricius

Nymph, unengorged. Capitulum yellowish brown, length 332 to 374 mm.; basis capituli rectangular, width 263 to 279 mm., posterior margin almost straight, no cornua, corners rounded; ventrally, convex, rounded and unarmed; palpi length 242 to 258 mm., length article I 19 to 22 mm., article II 124 to 129 mm., article III 100 to 102 mm., article I constricted laterally along its ventral side so as to form a longitudinal ridge; article II constricted laterally at its base, both dorsally and ventrally; the ridge thus formed on the ventral side joining the end of the ridge on article I; palpi slightly constricted between articles II and III, articles III usually bent toward each other making an angle with rest of palpi; article IV small, projecting ventro-medially as well as anteriorly, conical, with a number of rather short hairs apically; a few moderately long hairs along the margins of articles II and III; cheliceral sheath finely roughened nearly to its base dorsally; hypostome spatulate bluntly rounded at apex with four files of teeth, about 11 teeth in each file, rather large and acutely pointed toward apex, becoming very small and rounded basally.

Scutum brownish yellow, length 531 to 585 mm., width 717 to 817 mm.; emargination rather deep, cervical angles narrow, posterior end broadly rounded, almost straight, or rarely slightly concave before rounding the posterior tip; greatest width at eyes which are rather large, prominent and rounded; cervical grooves rather deep anteriorly, first converging then diverging, more shallow and broader

where divergence begins, reaching nearly to posterior margin; a few medium sized punctures scattered over scutum.

Legs and coxae, legs brownish yellow, fairly long and strong; all tarsi tapering at tip; tarsi I from 386 to 418 mm. in length; pulvilli oval, largest on tarsi I (about 107 mm. long) claws long and slender; trochanter I with a postero-dorsal, broad blade, tibia I from 273 to 311 mm. long, metatarsus I from 193 to 219 mm. long; legs with a number of rather long pale hairs, most numerous on tarsi I; coxae I with a small internal and a large subapical spur, the latter as long as broad at base but not sharp, coxae II with a distinct though short and broad subapical spur, coxae III and IV with similar spurs to coxae II, but a trifle longer especially on coxae IV.

Body dark brown, finely striate, thickly punctate, regularly oval, broadest near middle; length from 1.2 to 1.4 mm., width from .9 to 1.2 mm.; median groove distinct rather narrow, and sometimes interrupted in front of its center, accessory grooves fairly distinct, usually interrupted near middle; festoons strong; genital grooves distinct, usually interrupted just in front of anus; anal grooves deep, uniformly crescent shaped behind anus, the tip of the crescent extending forward to points about even with anterior end of anus; a very few, exceedingly short hairs on body; anus slightly wider than long measuring from 86 by 97 mm. to 93 by 100 mm. wide; valves convex with three hairs along each near median line.

Stigmal plates broadly oval with distinct postero-lateral prolongation; greatest length from 204 to 225 mm., greatest width from 150 to 193 mm.; rim fairly wide especially on each side of prolongation, a boss being formed in the inner angle of the prolongation; surface closely set with small circular cells of uniform size; macula oval, small, about 33 mm. long, situated rather near to the antero-internal margin, a slight depression surrounding the macula.

Larva, unengorged. Capitulum length 187 to 215 mm., basis capituli 151 to 160 mm. width, broadly triangular, external angles rounded but rather prominent, no postero-lateral extensions; palpi, length 129 to 143 mm., moderate in size; length of article I 14 mm., article II 67 mm., article III 49 mm.; hypostome spatulate two rows of teeth on each side, teeth rather broad, outer row with 6 distinct teeth and several scale-like ones at base, inner row about 4 teeth and several scale-like ones; ventrally basis capituli smooth, broadly rounded posteriorly.

Scutum reddish brown, length 244 to 251 mm. width 358 to 387 mm., surface reticulate; scapular angles broadly rounded; tip broadly rounded, postero-lateral sides only slightly concave; cervical grooves moderately deep and extending back about two-thirds the distance to the posterior border, slightly divergent posteriorly.

Legs of moderate length and stoutness; article I with two rather distinct declivities as it narrows toward tip; article II and III rather abruptly narrowed dorsally near tip; length, leg IV, trochanter 96 mm., femur 102 mm., tibia 128 mm., metatarsus 96 mm., tarsus 320 mm.; coxae I with two broad blunt spines or tubercles, the outer slightly the more prominent; coxae II and III each with a rather broad tubercle on the posterior margin.

Body reddish brown, broadly oval, greatest width slightly behind middle; festoons distinct; anus nearly circular, anal and genital grooves indistinct; a few scattered hairs ventrally and even less dorsally.

Size, unengorged, length (including capitulum) .62 to .7 mm.; width, .46 to .5 mm.; engorged, 1.4 by .8 by .56 to 1.5 by 1.1 by .8 mm. Color, engorged, dark gray, a few pink or whitish.

Hosts. The immature stages of this tick attack the same hosts as do the adults. The larvae and nymphs are very troublesome to man. They have been collected on cattle, horses, goats, dogs, peccary and deer. They probably engorge on many other warm blooded hosts.

GENUS APONOMMA Neumann

This genus is closely, related to Amblyomma, in fact, by some it is considered only a subgenus. The characters distinguishing the immature stages of it from those of Amblyomma are not striking.

The palpi are shorter, body rather more nearly circular in outline, eyes rudimentary, and article I of the palpi bearing a spur at its inner angle.

A single species, A. inornata Banks, occurs in the United States.

APONOMMA INORNATA Banks

Nymph, partially engorged. Capitulum yellow, length 208 mm., basis capitulum short and broad, width 192 mm., no cornua, rounded laterally, posterior margin practically straight; palpi short and rather broad, article I scarcely visible, article II 48 mm. long, broadest dis-

tally, article III 80 *mm.* in length, slightly broader than article II. Ventrally, base is short and very broad, posterior margin practically straight, the postero-lateral angles being slightly prominent but not toothed; hypostome short, spatulate, four files or rather small teeth, 7 or 8 per row, the basal of these being mere scales.

Scutum yellow, length 416 *mm.*, width 368 *mm.* greatest width at middle; scapulae broadly rounded, emargination shallow and broad, sides, anteriorly rounded, posteriorly slightly convex, apex broadly rounded; cervical grooves far apart, distinct, extending back about two thirds the length of the scutum, first converging slightly, then diverging in gentle curves; a very few minute punctures.

Legs and coxae yellow, of moderate size; coxa I with two spurs posteriorly, the inner being very short, the outer about one half the length of the coxa, coxae II to IV each with a moderate subapical spur decreasing in length on the posterior coxae; tarsi rather abruptly narrowed at tips.

Body broadly oval, greatest width slightly behind middle; festoons distinct; genital groove distinct, from the point of union of the two sides opposite space between coxae II and III, diverging and extending practically in a straight line to the posterior border; anal groove distinct, extending from the posterior border to the anus where it is forked.

Stigmal plates longest with axis of body, 112 *mm.*, width 64 *mm.*, with pronounced dorso-posterior projection and a boss anterior to this; covered uniformly with moderate small cells.

Larva, unengorged. Capitulum light brown, length to tip of hypostome 128 *mm.*; basis capituli comparatively short, width 140 *mm.*, sides produced somewhat to form a blunt angle; palpi short and broad, slightly longer than hypostome, length article I 7 *mm.*, article II 40 *mm.*, article III 40 *mm.*; article I with a slight internal projection; hypostome short, spatulate, four files of teeth of about 6 each, diminishing in size posteriorly.

Scutum brownish yellow, darkest in eye region; shape as in nymph, length 260 *mm.*, width 368 *mm.*; cervical grooves extend back about one-half the length of scutum.

Legs and coxae yellow, size moderate, coxae as in nymph; the spine on coxae III is well developed, but not long; tarsi all rather abruptly tapering at ends; pulvilli large, claws moderate; length, leg I, tarsus 168 *mm.*, metatarsus 80 *mm.*, tibia 120 *mm.*, femur 96 *mm.*

Body broadly ovoid, marginal groove distinct, beginning at

scutum; festoons distinct; anus circular; a number of pale hairs on venter.

Size. length (including capitulum) 640 mm., width 480 mm., widest at third coxae.

Hosts. Little is known of the host relationships of this species, nymphs have been collected on meadow lark and Brewer's black-bird.

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