75th Congress, 1st Session - - - - - House Document No. 296

U. S. TREASURY DEPARTMENT
PUBLIC HEALTH SERVICE

National Institute of Health Bulletin No. 171
(Continuation of Hygienic Laboratory Bulletin Series)
December, 1938

THE GENERA *DERMACENTOR* AND *OTOCENTOR* (IXODIDAE) IN THE UNITED STATES, WITH STUDIES IN VARIATION

By

R. A. COOLEY, Entomologist
Rocky Mountain Laboratory
United States Public Health Service

Contributions from the National Institute of Health
Rocky Mountain Laboratory
United States Public Health Service
Hamilton, Mont.

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1938

CONTENTS

THE GENERA *DERMACENTOR* AND *OTOCENTOR* (IXODIDAE) IN THE UNITED STATES, WITH STUDIES IN VARIATION[1]

By R. A. Cooley, *Entomologist, Rocky Mountain Laboratory, United States Public Health Service*

INTRODUCTION

The incrimination of ticks in disease transmission just before the opening of the present century aroused a world-wide interest in the Ixodidae. This interest has been enhanced by a growing appreciation of the economic importance of ticks as parasites and by frequent announcements of new relationships between ticks and diseases of man and animals. These findings have been paralleled by an increasing realization that need exists for a broad knowledge of the structure, biology, geographical occurrence, and taxonomy of this group of parasites. The entomological studies which have thus been stimulated have resulted in many valuable contributions by numerous workers in various parts of the world. However, the progress that has been made has but served to emphasize the vast amount of research which still remains to be done. This is particularly true in the field of classification because of the basic importance of accurate specific determinations.

L. G. Neumann, in France, perhaps even earlier than G. H. F. Nuttall in England, saw the potential value of a world-wide study, and the publications of both have become of classic importance. The monograph by Nuttall and Warburton and their associates, the publication of which was begun in 1908, is the most comprehensive and useful taxonomic work that has yet been attempted. Of the many useful features of their work, one of the most valuable has been their elucidation of synonomy and of specific relationships. It is to be hoped that these careful students of the Ixodoidea may continue their studies until all the genera have been covered.

Most publications on the taxonomy of ticks, however, have dealt with the fauna of relatively small geographic units, such as countries or parts of countries, and many portions of the world are thus represented in the literature. With respect to the ixodid fauna of the United States, there are two publications which have been of outstanding value: A Revision of the Ixodoidea, or Ticks of the United States, by Nathan Banks, 1908, and The Life History and Bionomics of Some North American Ticks, by W. A. Hooker, F. C.

[1] Submitted for publication May, 1937.

Bishopp, and H. P. Wood, 1912. With the abundance of materials now available in many species, it has become evident that the finer details of the structure of the spiracular plates are of less taxonomic value than was believed by Stiles (1910). Other morphological and color characters are found to be more available and more readily applied.

As a result of taxonomic researches many new species have been described, until now there are over 400 known species classified into numerous genera and subgenera. Activity in the systematic field seems to be particularly marked at the present time, but it is notable that biological studies have not kept pace. It is important that variation and biological data should be given more consideration. Unfortunately there has been, and still exists, a tendency in some instances for too hasty publication of new genera, subgenera, and species, based on insufficient material or material representing a too restricted area. The correct specific determination of ticks is a primary essential, whether in biological studies, epidemiological surveys, or other research, and misidentifications, even more than lack of identification, tend only to encumber both entomological, medical, and associated literatures.

As has been intimated above, the chief factor which has stimulated interest in ticks is their great importance as transmitters of disease. One of the important genera from this standpoint is *Dermacentor*. Species of this genus occur in Europe, Asia, Oceania, Africa, and North and Central America. Very little is known of the species of Asia and Oceania, and no species have been reported from South America.

In a recent publication of the Rocky Mountain Laboratory, one of our United States species, *D. andersoni*, has been referred to as a "veritable Pandora's box of disease-producing agents." This species is known to transmit Rocky Mountain spotted fever, tularaemia, Colorado tick fever, and to produce tick paralysis. There have been isolated also from this tick a number of bacteria and at least one filter passing agent, the relationships of which to human or animal disease are still undetermined. Experimentally it will also transmit equine encephalomyelitis and bovine anaplasmosis. Of the other United States species, *D. variabilis* is also a natural vector of Rocky Mountain spotted fever and tularaemia, and like *andersoni* will transmit experimental bovine anaplasmosis; *D. occidentalis* is a known carrier of tularaemia and a suspected one of Rocky Mountain spotted fever; *D. parumapertus* is a possible vector of spotted fever among its reservoirs in nature; and *D. albipictus* also can carry this infection experimentally, but there is a reasonable doubt that it does so under natural conditions. Besides these maladies known to be

due to specific agents, the bites of *D. andersoni*, *D. variabilis*, and *D. occidentalis* frequently result in local lesions, of which a considerable variety have been noted, and which are sometimes accompanied by constitutional symptoms. Heavy losses sometimes occur in tick-infested domestic animals and the larger game animals, and infestations with *D. andersoni* or *D. albipictus* sometimes cause a serious exsanguination anemia, due, apparently, to the rapid withdrawal of blood by engorging females.

The present paper on the species of *Dermacentor* in the United States has been prepared in an effort to elucidate and simplify the specific determination not only of the adults but also of the larvae and nymphs. Incident thereto, it has been necessary to make an intensive study of variation within species limits.

The known species of *Dermacentor* found in the United States belong to a natural or homogeneous group which also includes the genotype *D. reticulatus*, as well as others occurring in Europe and Asia. This group seems to be confined to the Nearctic and Palearctic regions. The other species of the genus fall into other rather definite groups which perhaps are typical of certain geographic divisions; e. g., *D. imitans* Warburton and *D. dispar* Cooley, from Central America. Lack of adequate material, however, as well as other considerations, have made it necessary to limit this paper to the United States species, and generic and specific characters discussed represent only this group of species. The taxonomic study involved has concerned variation within species, and the opinions thus reached have been extensively checked by biometric measurements, distribution records, and biological data. A considerable number of crossing experiments also have been made.

It was found, as others have found, that definite results from studies of variations may be elusive. Tenable opinions may be reached, however, without final conclusions. Only parts of the variation and biometric data have been included in the text. Such data were found to be of limited value, but certain measurements which represent long series of specimens from different localities were made, and were computed in percentages of another dimension of the tick. The studies on variation are mainly represented by photographs which speak for themselves. In some instances better photographs could have been made if living or freshly killed specimens had been available. In the majority of cases only alcoholic specimens were at hand, and the color markings were often obscured. Unavoidable highlights, which are easily confused with the pattern colors, are a detriment. Biological data, particularly those of host and seasonal relationships, have been of confirmatory value. Most of these data could not be included. Species distribution maps,

based on published data and the records available at the Rocky Mountain Laboratory, will be found in the text. Some of the maps have shaded areas covering the approximate known limits of distribution, while small black circles represent the definitely known records near the limits of distribution as given in prior publications, and the more recent records of the Rocky Mountain Laboratory and other institutions.

The species heretofore known as *Dermacentor nitens* was found to be generically distinct, and has been made the genotype of a new genus, *Otocentor*.

The author is deeply grateful to associates at the Rocky Mountain Laboratory for advice and assistance in the preparation of the manuscript, and especially to Dr. R. R. Parker, director, and Dr. Cornelius B. Philip. The paintings for the colored plates and the line drawings were made by the artist, Thomas Moore.

DEFINITION OF TERMS

[See plate I also]

ANUS: The posterior opening of the alimentary tract situated caudally on the median line, formed by two movable valves surrounded by a more or less circular chitinous ring. This may not be the true anus in the accepted meaning.

ARTICLE: A natural division of a jointed appendage—a "segment", "joint", or "metamere."

ARTICULATION: The movable or immovable junction between parts of the exoskeleton.

BASAL SPURS: Found in the nymphs of *Dermacentor*. Paired horns or excrescences at the lateral posterior edges of the ventral surface of the basis capituli.

BASE COLOR: In ornate ticks—the dark color of the chitin, usually warm, dark earth-colors on which the color pattern is superimposed.

BASIS CAPITULI (sometimes abbreviated to "basis"): The basal portion of the capitulum, spoken of as the "basal ring" by some authors. The basis capituli is movably attached to the anterior part of the scutum and lies partly within the emargination.

CAPITULUM: The anterior portion of a tick which bears the mouth parts, sometimes spoken of by various authors as the "false head", "head", or "rostrum." It consists of a proximal portion, the basis capituli, and the palpi, hypostome, and chelicerae.

CERVICAL GROOVES: The pair of grooves in the scutum of both sexes that run posteriorly from a little behind the emargination.

CHELICERA (pl. chelicerae): Paired mouth parts lying dorsally on the hypostome and completing the cylindrical mouth parts that are inserted when the tick bites.

COLOR PATTERN: The pattern or design of color which is superimposed over the base color.

CORNU (pl. cornua): Caudad projection extending from the lateral posterior dorsal angles of the basis capituli.

COXA (pl. coxae): The coxae are the ventral plates of the body on which the legs are movably attached. Beginning anteriorly they are designated as I, II, III, and IV.

COXAL SPURS: Small or large, long or short, mostly spurlike projections from the posterior surface, or from the posterior margin of the coxae.

DENTICLES: The recurved teeth on the ventral side of the hypostome.

DORSAL HORN: Retrograde process on the dorsal surface of trochanter I.

DORSAL PROLONGATION: The posterodorsal extension of the spiracular plate. In *Dermacentor* this prolongation may be long as in the males of *D. hunteri*, or short or absent as in *D. albipictus*. In some genera, as in *Amblyomma*, the prolongation may be extremely long.

DORSAL RIDGE: In some ticks, the posterior transverse ridge or definite edge on the basis capituli, between the cornua (if present).

DORSUM: The whole upper surface of the body.

EMARGINATION: That rectangular emargination in the anterior portion of the scutum for receiving the basis capituli.

FESTOONS: Uniform, more or less rectangular areas separated by grooves, along the posterior margin of the dorsum in both sexes. There may be ventral plates corresponding with the festoons on the dorsum, called ventral festoons.

FOVEA (pl. foveae): Paired, nearly circular structures in the chitin of the dorsal surface situated a little posterior to the scutum in females and to the pseudoscutum in males.

FRAME: The elevated chitinous periphery of the spiracular plate. When the thickness of the frame is described, reference is made to the transverse thickness.

GENITAL GROOVES: Paired grooves starting at the genital orifice and continuing caudad between the coxae and often attaining the festoons or posterior margin.

GENITAL ORIFICE: The sexual opening situated on the median line between the coxae.

GOBLETS: Internal structures about the same in number as the small pores seen on the surface. The spiracular plate, when mounted in balsam and examined under a compound microscope, is too thick to be seen in one focal plane, and the goblets are the largest rings that can be brought into focus. See plate I, figure 4.

HYPOSTOME: The ventral mouth part, distally with recurved teeth or denticles arranged in longtiudinal rows. Proximally it is immovably attached to the ventral wall of the basis capituli.

LATERAL GROOVES: Grooves at the sides of the scutum in both sexes of Ixodidae and running more or less parallel with the edge of the body. Absent in female *Dermacentor*. In males they may limit one or more festoons on each side.

MACULA: In adult ticks the term used for the heavily chitinized hollow structure of the spiracular plate showing externally as a heavily chitinized area through which is the principal respiratory opening. In the nymphal tick no true macula is present, and in descriptions the term "spiracular opening" is used.

MACULA RING: The lateral walls of the macula which with its external and internal surfaces form a cavity or cell which is opened and closed by a valve in the internal surface.

MARGINAL FOLD: A fold of the body external to the scutum. Present in some genera (*Ixodes*) but absent in *Dermacentor*. Fully fed males of *Dermacentor* may show a pseudomarginal fold.

MARGINAL GROOVES: A term used only in describing females. Grooves which follow the sides of the body backward from posterolateral margin of the scutum and may limit part or all of the festoons.

MEAN: Is the quotient obtained by dividing the sum of a series (of measurements) by the number included in the series, or

$$\overline{X}=\frac{\Sigma X}{N}$$

in which $\overline{X}$=mean, Σ=summation, X=value of individual measurement, and N=number of individuals in the series.

ORNAMENTATION: Ixodidae are either ornate or inornate. Inornate ticks have only the color of the chitin. This is the base color of ornate ticks. Ornate ticks, including dermacentors, have patterns of color superimposed over the base color. Pattern color refers only to the color of the pattern.

Color pattern refers only to the pattern. The base color varies with the age of living specimens, and changes in 70 percent alcohol. While the fundamental color pattern is the same in all the United States species of *Dermacentor*, details differ and within any species there is variation. The colors are influenced by the visceral organs showing through the dorsal wall, particularly in specimens in which the wall is translucent or transparent. The dark brown or black intestinal diverticulae showing through the scutum may influence or dominate the colors of the tick. The base color in *Dermacentor* in the United States may vary from a mixture of yellow ocher and burnt-sienna to burnt-umber, but because of the different color of living, dead, and preserved specimens, an exact designation is of little value for descriptive use. Similarly, the pattern color, usually spoken of as "white" or "gray" varies and different workers would hardly agree as to the shade of "gray." It might be called yellow-gray or green-gray but it is never pure white. In this paper, the base color is usually called amber-brown or brown, and the pattern color is called gray, which is approximately the same as silver of other authors.

PALPAL SETA (pl. setae) : A series of setae arising from the median edge of the ventral surface of the palpus and directed diagonally forward toward the hypostome.

PALPUS (pl. palpi) : The appendage attached to the basis capituli anteriorly on either side of the hypostome and shields of the chelicerae. They are excavated (grooved) on their median faces in *Dermacentor* and when apposed they protect the hypostome and chelicerae. The palpi are "open" when spread apart as in feeding. The palpus is movably articulated to the basis capituli. The articles, beginning proximally are designated as 1 to 4. In *Dermacentor* articles 1, 2, and 3 are immovably articulated, article 4 is movable, and 1 and 4 are visible only on the ventral side. In some genera, articles 1 and 2 are movably articulated. In the Ixodidae, article 4 is reduced to a small papilla lying in a depression on the antero-ventral surface of article 3.

PATTERN: The pattern of color superimposed on the base color.

PATTERN COLOR: The color of the pattern. (See also Ornamentation.)

POROSE AREAS: Two more or less depressed areas, finely pitted, on the dorsal surface of the female basis capituli, often without sharp boundary.

POSTANAL GROOVE: A curved, transverse groove immediately posterior to the anus.

POSTERODORSAL RIDGE: On article 2 of the palpus, a dorsal elevation coming to an angle at the base of the article.

POSTEROVENTRAL RIDGE: The definite posterior edge of the ventral surface of the basis capituli. It may be slightly elevated or salient.

POSTSCUTAL AREA: The area posterior to the scutum in females.

PSEUDOSCUTUM: That anterior portion of the male scutum that is homologous with the scutum in the female. In *Dermacentor* it is usually distinguishable by an obvious difference in color pattern and by the limitation of the lateral groove.

PULVILLUS: The soft pad terminally attached to the distal end of the tarsus and making it possible for the tick to walk on smooth surfaces.

PUNCTATIONS: Pits in the exoskeleton. Punctations of two definite sizes are found on the scuta in *Dermacentor* and the difference in size (disparity) may be pronounced, moderate or slight. The smaller punctations may be much more easily seen when they lie within the pattern.

SALIENCE: A definite edge which projects slightly.

SCAPULA (pl. scapulae) : The anterior angles of the scutum in both sexes on either side of the emargination.

SCUTUM (pl. scuta) : The "dorsal shield" of some authors. In males it includes the entire dorsal surface of the body, exclusive of the appendages. In the females the scutum is the "shield" situated posterior to the capitulum.

SPIRACULAR PLATES: Paired respiratory organs situated caudo-laterally, posterior to coxae IV. The "peritreme" or "stigma" of various authors.

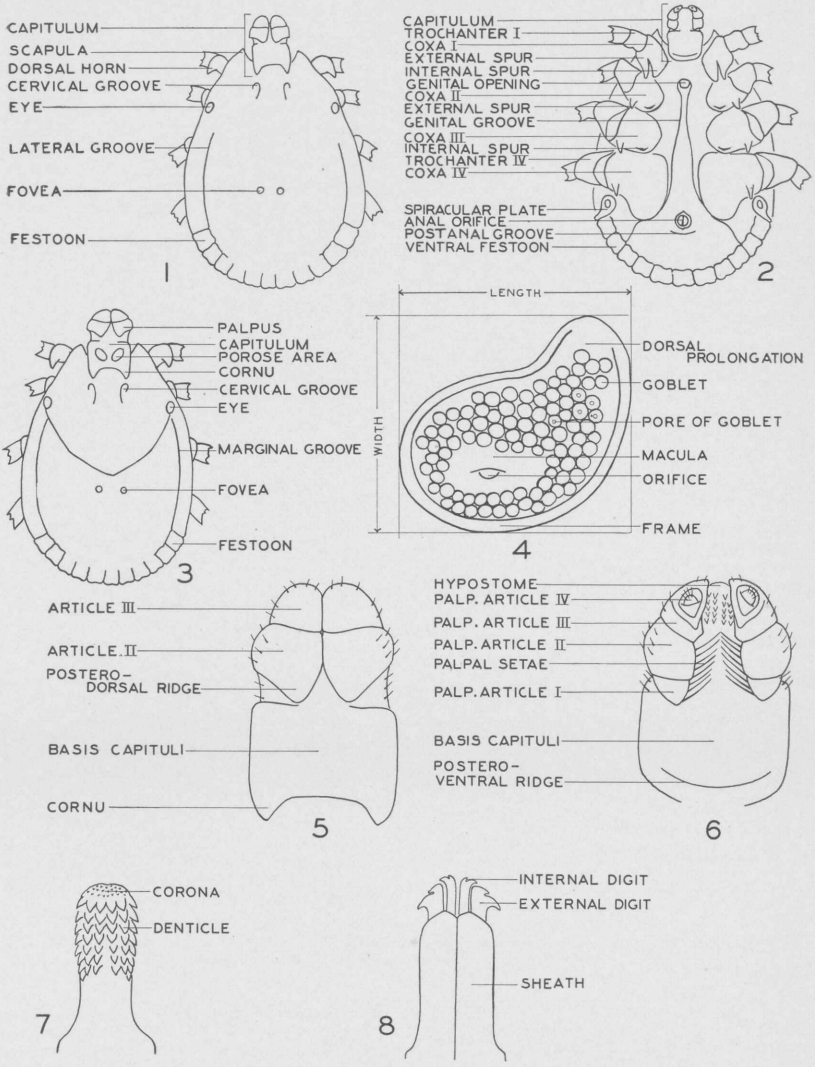
STALK OF THE PULVILLUS: The stalk which joins the tarsus with the pulvillus.

STANDARD DEVIATION: Is the value obtained by extracting the square root of the sum of the squared deviations from the mean divided by the number in the series, or

$$\sigma = \sqrt{\frac{\Sigma(x-\bar{x})^2}{N}}$$

TARSUS: The distal article of the leg.

VENTER: The whole ventral surface of the body.



1. MALE, DORSAL 4. SPIRACULAR PLATE 7. HYPOSTOME
2. MALE, VENTRAL 5. CAPITULUM, DORSAL 8. CHELICERAE
3. FEMALE, DORSAL 6. CAPITULUM, VENTRAL

CHARACTERS IN DERMACENTOR.

MEASUREMENTS OF TICKS

PLATE I

[All measurements in this paper are in millimeters.]

Length of tick—from the cephalic points of the scapulae to the caudal margin.

Width of tick—distance across the tick at the point of greatest width.

Length of scutum, female—from the cephalic points of the scapulae to the posterior margin of the scutum.

Width of scutum, female—width of scutum as obtained by measurement of the distance between outer edges of the eyes.

Length of scutum, male—same as in the length of tick in the male.

Width of scutum, male—same as the width of tick in the male.

Length of capitulum (dorsal)—the measurement between two transverse lines, one touching the most anterior points of the palpi, the other the most posterior points on the cornua.[1]

Length of basis capituli (dorsal)—from the depressed lines posterior to the proximal ends of the second articles of the palps to the posterior points of the cornua.

Width of basis capituli (dorsal)—distance across the widest portion.

Total length of palpus (dorsal)—from the anterior margin of the basis capituli to the most anterior point of article 3.

Width of palpus—the greatest distance across the palpus at right angles to the axis of the member.

Length of palpus article 2 (dorsal)—from the median end of the suture separating articles 2 and 3 to the depressed line across the posterior end of article 2.

Length of palpus article 3 (dorsal)—from the median end of the suture separating articles 2 and 3 to the anterior margin of the palpus.

Total length of leg I and leg IV—from the proximal limit of the trochanter to the distal end of tarsus, not including the stalk of the pulvillus.

---

[1] Measurements of the true length of the capitulum should be from the apex of the hypostome to the posterior ends of the cornua, and this is often possible in other genera. In *Dermacentor*, however, the hypostome is generally covered dorsally by the palpi or chelicerae, making it impossible to see the apex of the hypostome. A measurement from the ends of the palpi provides a useful character and is reasonably dependable.

Length of femur (ventral)—from the distal end of the trochanter to the distal end of the article.

Length of tibia (ventral)—from the distal end of the femur to the distal end of the article.

Width of femur or tibia (dorsoventral direction)—measurement across the widest part of the article not including any projecting ventral spurs.

Length of metatarsus (ventral)—from the proximal end of the metatarsus to the distal end of the article.

Length of tarsus (ventral)—from the proximal end of the tarsus to distal end of the article, not including the stalk of the pulvillus.

SPIRACULAR PLATES IN DERMACENTOR

ADULTS

A study of numerous spiracular plates of both sexes of all the species of *Dermacentor* in the United States has led to clearer understanding of the range of variation, and also makes clear what points are of taxonomic value. These studies show the following to be more or less useful.

Shape.—In very few species is it possible to identify them by this character alone, though in *nitens*, now segregated in the new genus *Otocentor*, the plate is so different as to be diagnostic. Of the other species, some show much variation, as in *andersoni*, *variabilis*, and *albipictus*, while there is very little in *hunteri* and *halli*. These latter species, however, are restricted both as to hosts and locality and but few lots were available for study.

Size.—Size alone is of little value, even if stated as a percentage of some other dimension of the same tick. Shape, however, does tend to correlate with size, and the small spiracular plates of small specimens tend to have a shape that is different from those in large specimens. The very small specimens are generally not of vigorous or normal stock. For example, refer to plate XXVI, figures 1 and 2. These adult ticks were collected as fully fed nymphs from chipmunks near Burns, Oreg., and as specimens were difficult to identify. They were lighter in base color and almost lacking in pattern color. As stated elsewhere in this paper, they were reared on laboratory animals and the adults of the next generation were the same in morphology and coloration as normal sized adults collected in the same locality.

Frame.—The frame determines the shape and is of some value as a character because of the variation in width of certain parts. This refers principally to that portion of the frame which encloses the dorsal prolongation.

Dorsal prolongation.—Previous writers on *Dermacentor* have made use of the dorsal prolongation especially mentioning, in some cases, the direction in which it is pointed. As a character, the direction is of small value and the degree of variation in different species is not great, as may be seen by referring to the numerous figures on plates XXV to XXX. That the direction of the prolongation is not very dependable is shown in the figures of *D. variabilis* on plates XXVI and XXVII.

Number and size of goblets.—Though the goblets vary in size and number within species limits, they are nevertheless of much value in distinguishing between certain species. In most cases, however, this character must be considered in combination with other major points. For example, *D. variabilis* and *D. andersoni* can be separated by a glance at the spiracular plates, while in *variabilis*, *halli*, and *reticulatus* (Europe) the plates are quite similar but the species are easily separable if other characters also are considered.

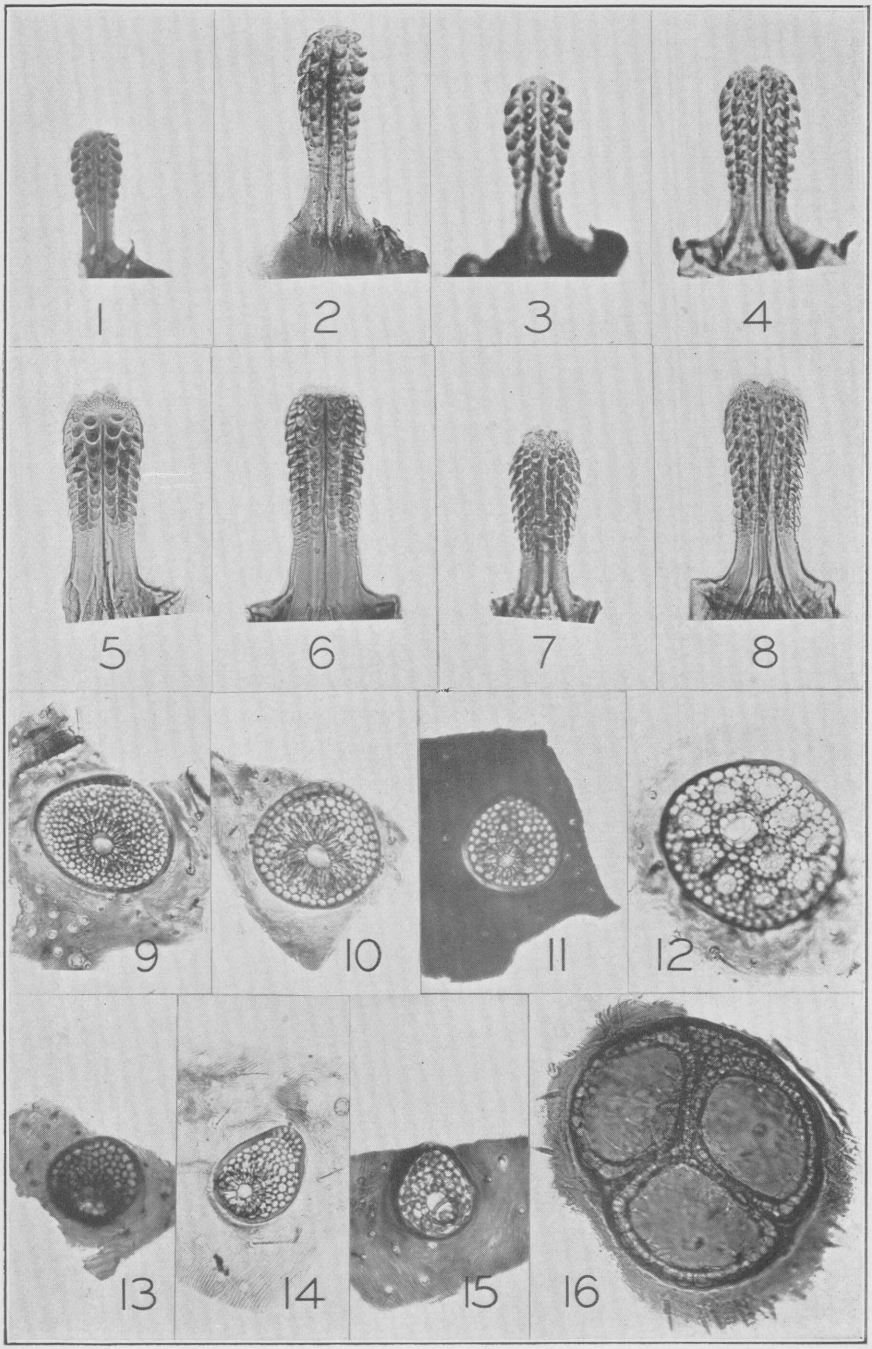
In presenting in this manuscript the numerous figures of spiracular plates, it should be explained that some difficulty was experienced in obtaining satisfactory photographs. These photographs were taken through a microscope, usually with objective 16 millimeters and ocular 6x, and at this magnification the depth of sharp focus is very limited. In most instances the focal plane in the photographs is at a depth which shows best the size and number of goblets, and at this level the macular frame often appears as a shadow limiting the macula. It will be observed that in some instances the focus is at the outer surface and in these the pores of the goblets are better shown. For example, see plate XXVI, numbers 17 and 19, and plate XXVII, number 1.

NYMPHS AND LARVAE

PLATE II, NOS. 9 TO 16

It will be seen by reference to plate II that size, shape, and number of goblets are of value in separating the nymphs of *Dermacentor*. This is particularly evident when one compares those of *andersoni* and *occidentalis*, two species that are rather closely related. The macula is absent in the spiracular plates of the nymphs and the dorsal prolongation may be only suggested.

In the larva the spiracular plate is missing, respiration taking place through at least three pairs of spiracles. Discernible spiracles are caudad to coxae I, II, and III, and lead directly into the tracheae. A fourth pair, if present, has not been observed in cleared and mounted specimens. A fourth spiracle is present in the larval *Otocentor nitens;* it is larger than the others and is placed caudo-laterad of no. III. See plate XIX, no. 5.



DERMACENTOR AND OTOCENTOR.

Hypostomes and spiracular plates.

Plate II

No.

1. Hypostome, larva of *Dermacentor andersoni.* ×200.
2. Hypostome, nymph of *D. andersoni.* ×100.
3. Hypostome, larva of *Otocentor nitens.* ×200.
4. Hypostome, nymph of *O. nitens.* ×100.
5. Hypostome, male of *Dermacentor andersoni.* ×57.
6. Hypostome, female of *D. andersoni.* ×57.
7. Hypostome, male of *Otocentor nitens.* ×57.
8. Hypostome, female of *O. nitens.* ×57.
9. Spiracular plate, nymph of *Dermacentor variabilis.* ×125.
10. Spiracular plate, nymph of *Dermacentor andersoni.* ×125.
11. Spiracular plate, nymph of *Dermacentor parumapertus.* ×125.
12. Spiracular plate, nymph of *Dermacentor albipictus.* ×125.
13. Spiracular plate, nymph of *Dermacentor halli.* ×125.
14. Spiracular plate, nymph of *Dermacentor hunteri.* ×125.
15. Spiracular plate, nymph of *Dermacentor occidentalis.* ×125.
16. Spiracular plate, nymph of *Otocentor nitens.* ×125.

GENUS DERMACENTOR C. L. KOCH, 1844

1844. *Dermacentor* Koch, original description, p. 235.
1901. *Dermacentor* Koch: Salmon and Stiles, p. 447.
1908. *Dermacentor* Koch: Banks, p. 42.
1911. *Dermacentor* Koch: Neumann, p. 98.
1911. *Dermacentor* Koch: Nuttall and Warburton, Part II, p. 120.
1929. *Cynorhaestes* Hermann, 1804: Schulze discussed status of *Dermacentor*, *Cynorhaestes*, and *Crotonus*, and adopted the view that *Dermacentor* and *Crotonus* should be treated as synonyms of *Cynorhaestes*, p. 735–754.
1931. *Dermacentor* Koch: Schulze recommends that the genus name be retained, p. 52.
1933. *Dermacentor* (Koch) s. l. *Indocentor* n. g.: Schulze states that *reticulatus* Fabricius (genotype) is not a valid species, with his reasons, p. 424; original description of *Indocentor* n. g., p. 417.

Ornate; with eyes; festoons 11 in number. Basis capituli quadrangular dorsally. Hypostome with three rows of denticles on each side of the median line. Palpi short, broad or moderate in width, and with a posterodorsal elevation present; article 1 fused (not movably attached) with article 2. Coxae I to IV increase in size progressively; coxa I bifid. Spiracles suboval or comma-shaped. Postanal groove present. Male with no ventral plates or shields.

Type species *I. reticulatus* (Fabricius, 1794).

The genus *Dermacentor* was described by C. L. Koch in 1844, and *reticulatus* (Fabricius, 1794) was established as genotype by subsequent designation of Salmon and Stiles in 1901. The International Commission of Zoological Nomenclature has placed *Dermacentor* with *reticulatus* Fabricius of Europe as genotype in the Official List of Generic Names. (See Opinion 73.) This was accepted by all writers on this genus until Schulze (1929) rejected the name, as well as the species *reticulatus* Fabricius, though this author (Schulze, 1933) later continued to use *Dermacentor*. Explanation of this resumption was elicited in correspondence with Dr. Schulze, in April 1936, and he pointed out that *Dermacentor reticulatus* Fabricius had been given status as nomen conservandum (Nomina conservanda: Sitz. Ber. naturf. Freunde, Berlin 1915; S. 148), and also that in 1931 he had recommended that the name *Dermacentor* be retained. (See p. 52, Einige neue Chinesische Ixodiden: Sitz. Ber. u Abh. naturf. Ges. Rostock; 3.) This would appear to have removed all question of the status of *Dermacentor* as a genus, and of *reticulatus* Fabricius as a species. However, in the 1933 publication of this author, in a footnote on page 425, appears the following: "Der

Name *reticulatus* ist nicht anwandbar. Fabricius' Art ist ein *Ixodes*. Dagegen ist *Ixodes reticulatus* Latr. 1804 (Genera Crust. et. Ins. 1, Nr. 3, 157) ein *Dermacentor* und zwar wahrscheinlich *marginatus* oder *pictus*. *Crotonus variegatus* Dumeril 1829 aus Afrika (Dict. Sci. Nat. *54*, 402, Planches, Rhinapteres figure 6) gehort ebenfalls in diese Gattung (*variegatus* Neum. u. Marx 1897 muss daher aus Grunden der Homonymie fallen, er heisse *varius* n. n.). Offenbar handelt es sich nach Besehreibung und Abbildung nicht um *lacteolus*. Vielleich leight eine bisher ubekannte Art aus Nord-afrika vor." ["The name *reticulatus* is not valid. Fabricius' species is an *Ixodes*. In place of it is *Ixodes reticulatus* Latr. 1804 (Genera Crust. et. Ins. 1, no. 3, 157), a *Dermacentor* and that probably is *marginatus* or *pictus*. *Crotonus variegatus* Dumeril 1829 from Africa (Dict. Sci. Nat. 54, 402, Planches, Rhinapteres, fig. 6) belongs likewise in this genus (*variegatus* Neum. and Marx 1897 must therefore fall on the basis of the homonym, it may be called *varius* n. n.). It is evident from the description and figure that it is not *lacteolus*. Perhaps it is an unrecognized species from North Africa."]

The type specimens are not available and the writer finds himself in doubt as to the precise significance of Schulze's language as quoted above. The generic name *Dermacentor* Koch and the name *reticulatus* Fabricius as the genotype, are being retained since any change now would involve ambiguity and would not be in accord with the important principle laid down in Opinion 107 of the International Commission of Zoological Nomenclature "* * * that a name in current use is not to be supplanted by an earlier but rarely adopted or an unadopted name unless the argument is unambiguous and unless the premises are not subject to difference of opinion, * * *."

SPECIFIC CHARACTERS OF DERMACENTOR

The following discussion is limited to specific characters as occurring in the genotype (*reticulatus*) and in the species of the United States.

Both sexes are oval and are narrowed anteriorly. The males are generally somewhat contracted at the vicinity of the eyes. Viewed laterally the profile of the dorsum in the United States species is convex, whereas in *D. dispar* Cooley, 1937, and *D. imitans* Warburton, 1933, found in Central America, it is straight. The scutum is emarginated anteriorly and has the scapular projections pronounced. The caudal margin is broadly rounded. Eyes are present, flat or a little convex, and in the female are situated at the lateral margins of the scutum at or near the point where the scutum joins the

postscutal region on the dorsum, and in the male at the lateral margin of the pseudoscutum. Foveae are present. The genital opening is between or near coxae II and is placed more anteriorly in the males. The anal opening is posterior to coxae IV. The postanal groove is present but often indistinct. The spiracular plates are placed caudo-laterad of coxae IV, closer to coxa IV in males than in females, and with the frame abruptly raised above the surface of the body wall. They are suboval in outline and in most species have a dorsal prolongation which is usually broader in the female.

Punctations of two sizes are present on the scuta of both sexes, with the number of each kind and the disparity of sizes showing specific differences. The large punctations often have a short hair, which is of different nature from those on the legs. The smaller punctations are usually very faint, unless within the field of the gray of the pattern.[2] Similar punctations often occur on the basis capituli, palpi, and legs and may or may not have a short hair.

The basis capituli is quadrangular and the lateral edges rounded both dorsally and ventrally in most species. The dorsal surface may be flattened, convex, or concave, and is usually wider than long in the female, and usually longer than wide in the male. The porose areas are oval, depressed, and with their longer axes either in one transverse line or with the two axes converging posteriorly; the distance separating the porose areas varies within the same species. A dorsal ridge is absent. The ventral surface is quadrangular with the surface convex; a central ridge may be present or absent. The cornua are present in all species and are longer in the male, sometimes very short in the female.

The palpi in dorsal view are bluntly rounded anteriorly, and contiguous at articles 2 and 3 when closed. They are sometimes longer than the basis capituli. The median surfaces of articles 2 and 3 are excavated along the long axis and cover dorsally the sheaths of the chelicerae. Article 1 is scarcely visible and article 4 never visible; article 2 has an elevated triangular ridge which may be drawn out into a retrograde process (*reticulatus*); the articulation between articles 1 and 2 is fused. The ventral surfaces of the palpi are irregular, flattened transversely and curved downward anteriorly; the flattened edges of the two palpi do not meet on the median line but leave the hypostome visible or obscured only by the palpal setae. The median edges have long, strong palpal setae directed forward diagonally over the hypostome; article 1 is a sub-

[2] The smaller punctations are morphological in character and are not due to absence of color. This may be demonstrated by putting a living male of *Dermacentor* momentarily on a very hot plate. This causes the tick to inflate and when examined under a binocular microscope, the color is obliterated and with oblique light the small punctations are seen to be definite pits with raised edges.

triangular, slightly elevated plate which in some species has the caudal point drawn out into a mild retrograde process. The ventral surface of article 3 has an oval excavation for the reception of the short protrusible article 4 which has a few short hairs.

The hypostome is spatulate or with subparallel sides with three rows of denticles on each side of the median line, and with a corona at the cephalic end; hypostome broader in the female than in the male: the chelicerae have all the terminal processes short.

Coxae I to IV progressively increase in size posteriorily, except in *reticulatus* in which the very large spurs on coxa I make this plate larger than II. The posterior coxae are larger in the male than in the female. Coxa IV in males of *andersoni* and *albipictus* shows a remarkable variation in size. There appears to be no correlation between large size of coxa IV and heavier hind legs. The two spurs on coxa I are much larger and stronger than those on II, III, and IV, with the internal spur generally subtriangular, and the external spur tapering and either straight or curved. The external spurs on coxae II, III, and IV are similar in form to that on coxa I, but are progressively smaller posteriorly. The internal spurs on coxae II and III are different in shape from that on coxa I, being short, flat, rounded or pointed and are also progressively smaller posteriorly. In some species the internal spur on IV is sometimes present. If present it is very small and similar in shape to those on II and III. The two spurs on coxa I may be in contact, close together, or divergent, those on II, III, and IV are distant. All coxal spurs on females are smaller than those on the males. All coxae in *reticulatus* and in the United States species have sparse, tapering, usually long hairs. In a recently described species from Guatemala (*D. dispar* Cooley) these hairs are reduced to one on coxa I.

Leg I has on the trochanter a dorso-distal retrograde spur, the dorsal horn. On the ventral side of the legs there are tapering hairs of moderate and varying length, and on the dorsal surface similar but shorter hairs. Either large or small punctations, or both, may be present on the dorsal surfaces. On the ventral side of the legs there are short spurs, sometimes in pairs (ventral leg spurs), and on each leg at the distal end of the tarsus a terminal spur which is in contact in walking. The length of the ventral leg spurs varies considerably even in different populations of the same species. Just proximal and dorsal of the terminal spur is attached the movable stalk (stalk of the pulvillus) which connects with the pulvillus. The latter bears two fine curved hooks. The length of the stalk and the size of the pulvillus differ slightly in the species. In Dermacentor the gray coloring of the pattern persists on the legs even in specimens which have the color much reduced.

There is a recognizable characteristic basic color pattern or design in the North American *Dermacentor*, and an effort has been made to set up a terminology of the color spots as has been done by Nuttall in *Amblyomma*. This did not prove practical, however, since there is a marked variation in the color pattern within any particular species, and while a system of terms might be usable in some species it would be more confusing than useful in others, and quite unnecessary in still others.

KEY TO THE ADULTS

1. Spurs on coxa I widely divergent 2
   Spurs on coxa I with proximal edges parallel or only a little divergent 3
2. Scuta with deep, large punctations ..... *parumapertus* (p. 49) no.
   Scuta with the larger punctations shallow and moderate in size (known from peccary in southern Texas) ..... *halli* (p. 55)
3. Spiracular plate oval, without dorsal prolongation and with goblets few and large ..... *albipictus* (p. 59)
   Spiracular plates oval, with dorsal prolongations, and with goblets many or of moderate numbers 4
4. Cornua long ..... *occidentalis* (p. 39)
   Cornua short or of moderate length 5
5. Spiracular plate with goblets very numerous and small ..... *variabilis* (p. 23)
   Spiracular plate with goblets moderate in size and number 6
6. The larger punctations of the scuta very large and deep ..... *andersoni* (p. 31)
   The larger punctations on the scuta moderate in size and depth (known from Rocky Mountain sheep in southern Arizona) ..... *hunteri* (p. 45)

DISCUSSION ON KEY TO IMMATURE STAGES

A key to the nymphs and larvae of *Dermacentor* has been desirable for some years and some attention has been given by the writer to a study of these early stages of the United States species. All species have been reared on laboratory animals, many times in some species, and there has been available an abundance of both reared and field material.

The larvae of *Rhipicephalus*, *Haemaphysalis*, *Amblyomma* and *Ixodes* are, in most cases, readily recognized as belonging to these genera. The larvae of some *Ixodes* are easily confused with those of *Dermacentor*.

In *Dermacentor* variation in morphology of the larvae and nymphs reduces the value of some points that otherwise would be very useful as characters. The dorsal posterior border of the nymphal basis capituli would be of much value if constant, as would be also the contour of the posterior border of the scutum.

In our studies, specimens of all species were treated in sodium hydroxide, washed, cleared, and mounted in balsam, and in many cases the specimens were stained before mounting. Others were

examined when alive or freshly killed in hot water, and it was found to be better to have for study both mounted and unmounted specimens. The spiracular plates of the nymphs were dissected out for mounting. Such mounted plates are of value in identification, but some of the characters are seen as well in living or freshly killed specimens. The measurements given are of some value, but here again there is a considerable variation. The percentage of the width over the length of the entire tick (larva or nymph) is not always dependable.

In identifying the larvae there are distinguishing points available in most cases but a key is omitted from this manuscript because a workable and dependable key has not been made. However, on purely geographical and seasonal grounds the worker will be able to limit the number of species brought into question. Larvae of *albipictus* are easily recognized on morphological grounds as the basis capituli is not definitely pointed at the sides.

Because of various circumstances, larvae or nymphs collected in the field cannot always be definitely determined on the basis of morphological characters, and it then becomes desirable to rear them to adults or at least hold the well engorged larvae and nymphs for ecdysis. Engorged nymphs will emerge into adults which can be easily identified, but nymphs emerging from fed larvae, if they still cannot be determined, should be fed on laboratory animals and then held for ecdysis. Many workers, however, lack the facilities for rearing ticks. As an aid to identification, therefore, attention should be given both to locality and date of collection. In many instances identification is simplified by the fact that in most sections of the country the genus is represented by only one or two species. Also, in most localities only one species of *Dermacentor* feeds during the late fall and winter months. This species, *albipictus*, while widely distributed is very spotted in its occurrence. A larva or nymph taken in western Montana has to be, on geographical grounds, either *andersoni* or *albipictus*, and if taken in the summer months it has to be *andersoni*. In areas of overlapping distribution, as between *andersoni*, *variabilis*, and *albipictus* east of the Rocky Mountain region, if immature stage ticks are taken in the winter months the species is almost sure to be *albipictus*, and some indication between *andersoni* and *variabilis* may be obtained by the fact that in this latter species the dog is the most common host of the adults and, naturally, the larvae and nymphs would be more commonly found in locations where the fully fed females are dropped from dogs. Information on the host relationships of *D. variabilis* is very incomplete. In the midwestern States the occasional abundance of this species in bushy areas along streams where domestic animals other than dogs are

often present, naturally suggests the possibility that such animals serve as the hosts of the adults and also that there may be present unknown hosts of the immature stages in the same area. In California where *occidentalis*, *andersoni*, *variabilis*, *parumapertus* and *albipictus* may all be present, the recognition of immature stages is more difficult than in any other part of the country, but here again, if taken in the winter months *albipictus* is very probable and if taken on rabbits, *parumapertus* is suggested. Fortunately, *andersoni* and *occidentalis* are readily separated on their spiracular plates.

A wide variation in sizes in the several species occurs and also in the shape in some. Measurements given are of unfed larvae or nymphs in all cases and represent the average dimension of alcoholic specimens.

In using the key to the nymphs and in studying the larvae, a binocular microscope with high powers and good lighting is essential. A small electric light on a stand, easily movable, so that the direction of light may be changed, has been found to be most useful.

KEY TO THE NYMPHS

1. With no spurs on coxa IV 2
   With one external spur on coxa IV 5
2. Spiracular plate subcircular or elliptical, spiracular opening eccentric 3
   Spiracular plate ovoid, distinctly broader on lower end, with spiracular opening in the broader end 4
3. Spiracular plate larger and with goblets very numerous ..... *variabilis* (p. 25)
   Spiracular plate smaller, with goblets of about same size as in *variabilis* but fewer in number (adults known from southern Texas) ..... *halli* (p. 57)
4. Basal spurs narrow, pointed; on rodents on Pacific Coast ..... *occidentalis* (p. 41)
   Basal spurs broad, rounded. Adults (on Rocky Mountain sheep) in southwestern Arizona ..... *hunteri* (p. 47)
5. Spiracular plate large, circular, goblets about ten in number. On large herbivora in fall and winter ..... *albipictus* (p. 63)
   Spiracular plate circular or subcircular, goblets numerous and small 6
6. Spiracular plate subcircular with spiracular opening subcentral ..... *andersoni* (p. 33)
   Spiracular plate short, oval, with spiracular opening eccentric in the broad end ..... *parumapertus* (p. 52)

THOMAS J. MOORE, DEL.

Lith. A. Hoen & Co., Inc.

DERMACENTOR VARIABILIS SAY.

Female (top) and male.

DERMACENTOR VARIABILIS (SAY) 1821

PLATE III

1821. *Ixodes variabilis* Say, original description, p. 77.
1844. *Dermacentor electus* Koch, p. 235.
1847. *Dermacentor electus* Koch, p. 109.
1901. *Dermacentor electus* (Koch 1844) : Salmon and Stiles, synonym, p. 455.
1908. *Dermacentor variabilis* (Say 1821) : Banks, p. 49.
1911. *Ixodes albipictus* (Packard 1869) : Neumann, as synonym in error, p. 101.
1911. *Ixodes quinquestriatus* + *Ixodes robertsoni* (Fitch 1872) : Neumann, as synonym, p. 101.
1911. *Dermacentor americanus* (Linnaeus) : Neumann, as synonym, p. 101.
1912. *Dermacentor variabilis* (Say 1821) : Hooker, Bishopp and Wood. Extended and valuable information, including host relationships and seasonal history, with figures, p. 190–197.

Say's types of this species have not been available, and the writer has followed Banks in accepting *variabilis* Say as the valid name.

The base color is dark brown; pattern color, gray.

MALE[1]

	Minimum	Maximum	Mean	Standard deviation
Length	2. 3	4. 4	**3. 6**	0. 67
Width	1. 6	2. 9	**2. 4**	. 42
Percentage, width of length	64	77	**68**	2. 7

[1] 25 males in 5 lots from Minnesota, Texas, and Massachusetts.

DORSAL VIEW

PLATE IV, No. 1; PLATE XXI

Capitulum—Basis capituli.—Wider than long; median longitudinal area slightly depressed; punctate and usually with pattern color present; hairs absent; cornua moderate, each about as long as the width at base, and with the apex rounded. *Palpi:* Punctations and a few short hairs present; pattern color present or absent; posterodorsal ridges moderate.

Scutum.—Cervical grooves deep, short; lateral grooves present but shallow and emphasized by having in them a row of large punctations; festoons not limited by the lateral grooves; both large and small punctations present, moderately numerous, and with marked disparity in size. This species shows much variation in the orna-

mentation and in some specimens the gray is dim.[1] The pattern is usually less extensive than the base color, with which it becomes confluent more often than in *andersoni* and *occidentalis;* both pattern color and base color present outside the lateral grooves; festoons usually edged with gray laterally.

Legs (both sexes).—Pattern color and short hairs present. Dorsal spur on trochanter I well developed, subacute, and with some pattern color present.

VENTRAL VIEW

PLATE IV, No. 3; PLATES XXVI AND XXVII

Capitulum—Basis capituli.—Posteroventral ridge present, curved; punctations and hairs absent. *Palpi:* A few punctations and hairs present.

Coxae (both sexes).—Coxa I with the spurs very well developed, about equal in length, not acute at the apex; external spur slightly curved, its inner edge nearly parallel with external edge of the triangular internal spur; external spurs on II, III, and IV each about as long as the width at the base, with apices rounded; internal spurs on coxae II and III broad, flat, and with rounded ends; internal spur lacking on coxa IV.

Spiracular plates (both sexes).—Large and with the dorsal prolongation broad; goblets very small and very numerous.

FEMALE[1]

	Minimum	Maximum	Mean	Standard deviation
Length	2. 7	5. 2	3. 8	0. 55
Width	2. 2	3. 0	2. 5	. 21
Percentage, width of length	61	83	67	5. 3

[1] 25 males in 5 lots from Minnesota, Texas, and Massachusetts.

DORSAL VIEW

PLATE IV, No. 2; PLATE XXI

Capitulum—Basis capituli.—Much wider than long; hairs absent; a few punctations present in some specimens. Cornu shorter than its width at the base; rounded at the apex. *Palpi*: Posterodorsal

[1] Numerous specimens of this species from Liberty County in southeastern Texas, received since the preparation of this manuscript, are consistently devoid or almost devoid of the gray of the pattern color, and it is notable that numerous specimens from southern Texas, only some two hundred and fifty miles away, are abundantly ornamented with the gray.

ridge moderate; a few punctations and short hairs present; pattern color usually absent but traces of the gray sometimes present.

Scutum.—Length and width about equal; posterior border behind the eyes subangulate. The pattern color of gray usually prevailing over the base color. In many specimens base color present in the median longitudinal area, at cervical grooves, in spots near eyes, at sides back of eyes, and in two parallel, diagonal marks on each side of median line in area between eyes. Cervical grooves deep, three to four times as long as wide, converging posteriorly. The median, longitudinal area mildly elevated. Punctations, large and small, showing much disparity in sizes, both distributed generally over surface and with smaller ones more numerous.

Postscutal area.—Marginal grooves distinct and limiting the first three festoons on each side, the remaining festoons usually less definitely limited.

For descriptions of female spiracular plate, coxae, and legs, see under male. All female ventral characters essentially the same as in the male.

D. variabilis, because of superficial resemblance, is easily confused with *D. andersoni*, but is readily distinguished by the spiracular plates in *variabilis* which have very numerous, small goblets.

NYMPH

PLATE IV. NOS. 6 AND 7; PLATE II, NO. 9

Length, 0.9 mm; width, 0.78 mm. Oval, narrowed anteriorly.

Basis capituli.—Dorsally triangulate, arcuate on posterior margin, and with the sides drawn out into sharp points. Basal spurs as salient edges, not pointed.

Scutum.—Length, 0.57 mm; width, 0.48 mm. Cervical grooves moderate, short, and extended posteriorly into two subparallel depressed areas. Posterior margin broadly curved, with some tendency to be pointed at the extremity.

Festoons distinct.

Coxae.—Coxa I with internal and external spurs definite; II and III with the external spurs only; IV with no spurs.

Spiracular plate.—Suboval, with the longer axis about parallel with median axis of the tick, and with the spiracular opening slightly eccentric. Length, 0.134 mm; width, 0.1337 mm. Goblets numerous and small.

LARVA

PLATE IV, NOS. 4 AND 5

Length, 0.62 mm; width, 0.42 mm. Length of scutum, 0.27 mm; width, 0.32 mm. Basis capituli moderately drawn out into points

at the sides. Coxae II and III about equal in size. All coxae with spurs as shown in plate III, no. 5, that on coxa I definitely pointed and extended beyond the edge of the coxa.

HOSTS

The hosts of the type and the type locality are not known. Salmon and Stiles (1902) writing of it under its synonym, *D. electus*, state that the species has been taken from man, cattle, dogs, horses, panther, rabbits, and "elan." The "elan" may refer to eland, that name having been applied in earlier years to both moose and elk in America. Stiles (1910) adds the wildcat. Hooker, Bishopp, and Wood (1912) list additional hosts, as follows: Fox squirrel, raccoon, opossum, badger, coyote, skunk, deer, wolf, ass, Mexican lion (*Felis hippolestes aztecus*), fox, hog, and weasel. McIntosh (1931) reports that ticks collected by Dr. Maurice C. Hall from *Pecari angulatus angulatus* from Kingsville, Tex., included specimens of *D. variabilis*.

In reporting on a survey for ectoparasites of *Citellus tridecemlineatus*, *C. franklini*, *C. richardsoni*, in Manitoba, Canada, J. A. McLeod recorded *Dermacentor venustus* from these rodents. The specimens were reviewed by the writer and were found to be *D. variabilis*.

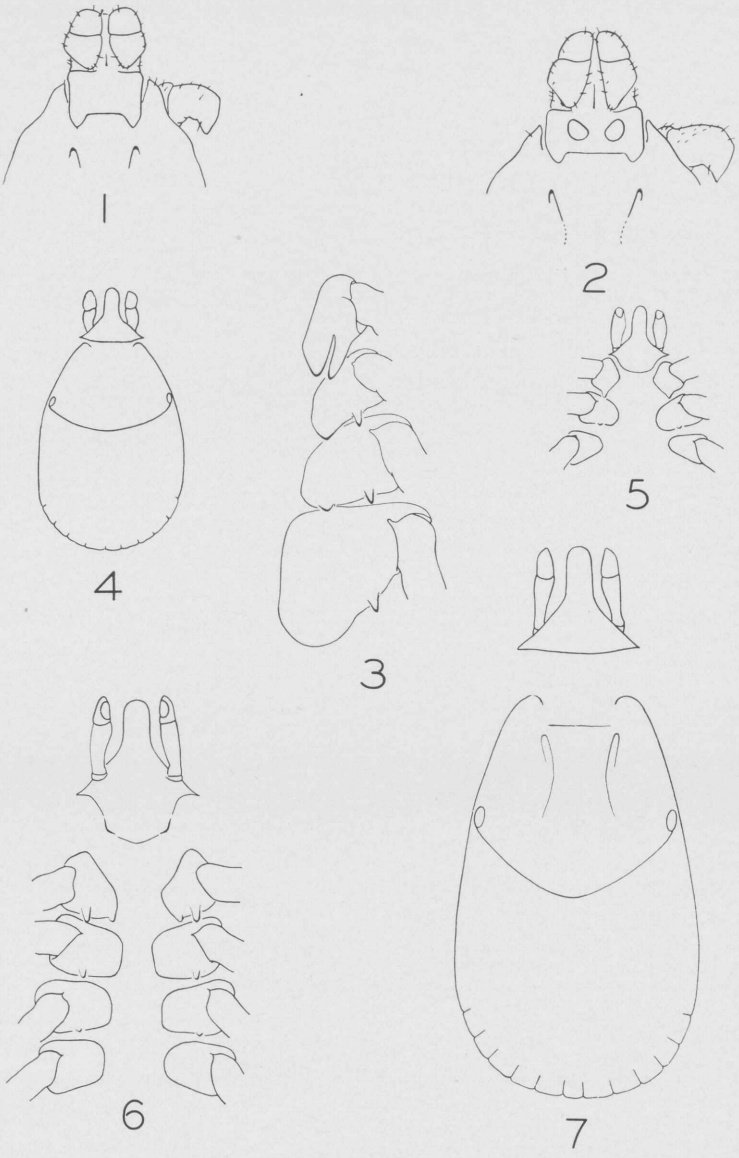
From the numerous records of the Rocky Mountain Laboratory can be added as hosts of adults the following: From sheep, Halsey, Nebr., April 17, 1933 (L. G. Baumhofer); 2 males and 1 female from a woodchuck, Iowa City, Iowa, 1934 (L. O. Nolf); from a civet cat, Oklahoma, March 11, 1929 (Professor C. E. Sanborn).

The dog is the principal host of the adults.

Mr. F. C. Bishopp has kindly furnished a manuscript copy of a paper by himself and C. N. Smith, read before the American Society of Parasitologists at Atlantic City in December 1936, and to appear as a circular of the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture.

To the hosts of adults listed above are to be added from Bishopp and Smith the following: Cat, leopard cat, mountain lion, and mule.

Although this species was described over a hundred years ago, we have had no information on the hosts of the immature stages until quite recently. Hooker, Bishopp, and Wood (1912) record that nymphs have been taken from the fox squirrel and the swamp rabbit, *Lepus aquaticus*, (= *Sylvilagus aquaticus*). Larrousse, King, and Wolbach (1928) report the common field mouse, *Microtus pennsylvanicus pennsylvanicus*, as the host of larvae and nymphs. Bishopp and Smith (1936) record the taking of immature forms of



DERMACENTOR VARIABILIS SAY.

1. Capitulum and part of scutum, male.
2. Same, female.
3. Coxae and spurs, male.
4. Larva, dorsal view.
5. Larva, ventral view.
6. Nymph, ventral view.
7. Nymph, dorsal view.

this species on the gray rat, and the jumping mouse (*Zapus hudsonius*), and on sheep in Massachusetts.

Below is quoted from Bishopp and Smith.

> The following is a list of the collections of immature stages contained in the accession catalogue. The number of times nymphs and larvae have been taken on the respective hosts is as follows: White-footed mice (*Peromyscus*) : larvae 68, nymphs, 18; meadow mice (*Microtus*) : 12, 13; Pine mice (*Pitymys*) : 4, 8; house mouse (*Mus domesticus*) : 3, 0; kangaroo mouse (*Zapus*) : 1, 1; mouse, species in doubt: 5, 5; cottontail rabbit: 3, 8; swamp rabbit: 2, 1; cotton rat (*Sigmodon hispidus*) : 3, 1; Norway rat: 2, 1; wood rat (*Neotoma*) : 0, 1; squirrels: 0, 7; cat: 0, 2; shrew (*Blarina brevicauda*) : 2, 1; sheep: 0, 1 (un-(engorged) ; cattle: 0, 1 (engorged) ; mole (*Scalopus acquaticus machrinus*) : 1 (unengorged), 0.
>
> The larger number of collections of ticks from *Peromyscus* as compared with those from *Microtus* was due to the much larger number of *Peromyscus* collected.
>
> While we have made no collections of nymphs or larvae attached to man and such occurrences are certainly unusual, statements of residents on islands south of Cape Cod convince us that nymphs occasionally attach to man.

The quotation includes some hosts previously published but is quoted complete because of the data on relative importance of hosts of immature stages.

DISTRIBUTION

FIGURE 1

The published records of Say (1821), Stiles (1910), and Hooker, Bishopp, and Wood (1912), as well as the unpublished records at the Rocky Mountain Laboratory, show that this species is present in the Eastern and Central States and in western California. There are a few reports of sporadic occurrences in the intermediate region, and two records from Oregon.

In the accompanying map, the black circles indicate the marginal records of Hooker, Bishopp, and Wood (1912), those of the Rocky Mountain Laboratory and others. Workers from the above laboratory have collected extensively in Oregon, and in the full length of California, and have not met with this tick east of the Cascade and Sierra Nevada Mountains. The laboratory's many records from central and southwestern Oregon, made since 1924, include numerous negative records from dogs, and the apparent absence of this species there now may indicate a reduction in the abundance since the Bureau of Entomology publication. The black circle in Oregon is from the latter.

Eastern Montana.—East of the Rocky Mountains the ranges of *D. andersoni* and *D. variabilis* overlap in a north and south zone. On the north, in eastern Montana and western North Dakota, this

zone is over a hundred miles wide. Available data show that it extends southward at least into Nebraska. *D. variabilis* is not abundant in eastern Montana, but a few definite records in the Rocky Mountain Laboratory show its presence in Big Horn and Sheridan Counties, and the absence of records made westward, where very numerous collections were made from 1910 to 1927, indicates that this species is not there.

Western Nebraska.—No. 11204, 1 male and 1 female, July 15, 1935 (host not given), Fort Robinson, Nebraska. These specimens were sent in by Dr. R. L. Ivins, Contract Surgeon, U. S. Army, Fort Robinson, Nebraska. The species is reported by residents to be common.

Eastern Colorado.—The eastern edge of this State is in doubtful

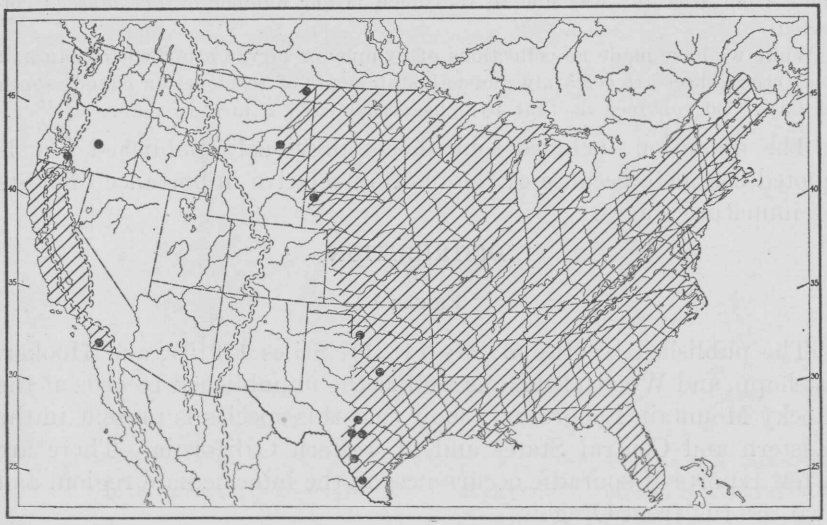


FIGURE 1.—Distribution of *Dermacentor variabilis.*

area and field work there has not definitely shown either this species or *andersoni* to be present. However, residents have reported that ticks are abundant in some localities in Sedgwick County, and the laboratory has two authentic records of local cases of Rocky Mountain spotted fever. Under the circumstances, since *andersoni* is absent or very rare this far east, we may accept Sedgwick County as positive for *variabilis.*

Oklahoma.—The inclusion of most of the State of Oklahoma is supported by numerous specimens loaned to the writer by Prof. C. E. Sanborn, as well as by the records in Hooker, Bishopp, and Wood (1912).

Texas.—The eastern part of Texas is shown to have this tick present by Hooker, Bishopp, and Wood (1912), as well as by the records of this laboratory.

It is possible that there are sporadic occurrences in western Texas, New Mexico, Colorado, and Arizona, though there are no definite records.

D. variabilis has been reported in Alaska, "Marx 1932, Alognakig Alaska", quoted from Stiles (1910). This tick is present in Canada as far west as Aweme, Manitoba, as shown by Hadwen (1913). Although the laboratory has no records from Mexico, Hooker, Bishopp, and Wood (1912) mention one without giving the locality, and it is also probable that the species is present near the Pacific Ocean on the west and near the Gulf on the east of that country.

THOMAS J. MOORE, DEL.

Lith. A. Hoen & Co., Inc.

DERMACENTOR ANDERSONI STILES.

Female (top) and male.

DERMACENTOR ANDERSONI STILES, 1908

PLATE V

1908. *Dermacentor venustus* Banks, original description, p. 46.
1908. *Dermacentor andersoni* Stiles: differentiates from *occidentalis*, *parumapertus* and "*D. venustus* of Texas."
1910. *Dermacentor andersoni* Stiles, full description with figures, p. 36.
1910. *Dermacentor venustus* Marx: Stiles, full description with figures, p. 43.
1911. *Dermacentor venustus* Banks: Cooley, information on host relationships and seasonal history.
1912. *Dermacentor venustus* Banks: Hooker, Bishop, and Wood, extensive and valuable information, including host relationships and seasonal history.
1932. *Dermacentor andersoni* Stiles: Cooley, extended review, including new information.

The writer has had opportunity to examine the available types, and has found that *venustus* Marx, *venustus* Banks, and *andersoni* Stiles are all specimens of one and the same species. In retaining *andersoni* Stiles as the name of this important vector of diseases, instead of returning to *venustus* Banks, the writer has been influenced by the desire to avoid, as far as possible, further confusion in the literature of human and veterinary medicine and entomology.

Base color brown; pattern color gray.

MALE[1]

	Minimum	Maximum	Mean	Standard deviation
Length	2. 5	6. 1	**3. 79**	1. 1
Width	1. 6	4. 1	**2. 52**	. 66
Percentage, width of length	60	73	**66. 84**	4. 94

[1] 25 males in 6 lots from Washington, Oregon, Idaho, and Montana.

DORSAL VIEW

PLATE VI, NO. 1; PLATE XX; PLATE XXI

Capitulum—Basis capituli.—Wider than long; median area of the surface a little depressed, punctate; some pattern color usually present; cornua of moderate length, with the ends rounded. *Palpi:* Posterodorsal elevation moderate; general surface slightly irregular, some pattern color usually present; small punctations present and with short hairs at the sides.

Scutum.—Cervical grooves deep, about three times as long as wide. Lateral grooves distinct and emphasized by large punctations, the grooves terminating at the anterior festoons. Punctations with marked disparity of sizes, the small ones more numerous, usually not visible in the definite spots of the base color of the caudal area; large punctations present in the marginal areas outside of the lateral grooves. In the area posterior to the pseudoscutum, if the base color becomes more extensive or confluent, the punctations may occur within the areas of base color. The gray of the color pattern may be either more or less extensive than the base color, and the spots of the base color may be either separated or confluent; pattern color and base color present in the marginal area outside of lateral grooves; lateral margins of festoons of the pattern color; pseudoscutum in well-colored specimens clearly indicated by the color pattern. Eyes distinct, marginated by large punctations.

Legs (both sexes).—Pattern color and hairs present. Dorsal spur on trochanter I well developed, triangular, subacute, and with some pattern color usually present.

VENTRAL VIEW

PLATE VI, No. 3; PLATE XXV; PLATE XXVI

Capitulum—Basis capituli.—With posteroventral ridge usually present only as a limiting edge at the posterior border, convex; a very few small punctations usually present. *Palpi:* With punctations few in number, and with a few short hairs at the sides and on the anterior margins.

Coxae (both sexes).—Spurs on coxa I well developed, with proximal edges parallel or slightly divergent, not acute terminally; external spurs on II, III, and IV about as long as the width at the base; internal spurs on II and III short, broad, and with ends rounded; internal spur on IV absent.

Spiracular plates (both sexes).—Moderate in size and variable in shape; dorsal prolongation always definite, variable in length and width; goblets moderate in size and number.

FEMALE[1]

	Minimum	Maximum	Mean	Standard deviation
Length	2. 8	5. 4	3. 75	0. 8
Width	1. 9	3. 7	2. 51	. 52
Percentage, width of length	57	73	66. 7	5. 53

[1] 25 females in 7 lots from Washington, Oregon, Idaho, and Montana.

DORSAL VIEW

PLATE VI, No. 2; PLATE XX; PLATE XXI

Capitulum—Basis capituli.—Distinctly broader than long; the dorsal surface a little depressed in the posterior portion between the bases of the cornua; a few small punctations often present at the sides; some pattern color usually present; cornua of moderate length, with the points rounded. *Palpi:* Posterodorsal elevation moderate; general surface slightly irregular and with small punctations scattered over the surface; a few short hairs at the side and on anterior margins, and with some pattern color usually present.

Scutum.—Length and width about equal; portion posterior to the eyes, with the margin subangulate. Cervical grooves deep, three to four times as long as wide, converging posteriorly. The area posterior to the cervical grooves raised medially and with two lateral, diverging, shallow depressions reaching nearly to the posterolateral margin of the scutum. Punctations with disparity of sizes marked; the small ones more numerous; the large punctations more numerous at the side, and the humeral areas sometimes with a few arranged in diagonal rows. The pattern color of gray usually more extensive than the base color, but specimens in some localities have very little gray present. In most specimens, the base color present at the cervical grooves in ocular spots, at the sides back of the eyes, and in two parallel, diagonal bars on each side of the median line in the area between the eyes. Eyes distinct, bordered with large punctations.

Postscutal area.—Marginal grooves pronounced in unfed specimens and limiting all the festoons. Large punctations often visible.

For descriptions of female spiracular plates, coxae, and legs, see under male. All female ventral characters essentially the same as in the male.

D. andersoni Stiles, in general appearance, closely resemble *D. variabilis* (Say), but the two are easily separated by the spiracular plates, those of *andersoni* having fewer and larger goblets, whereas those of *variabilis* have small and very many goblets. *D. andersoni* is easily distinguished from *D. occidentalis* Marx by the longer cornua in *occidentalis*, and usually by the wide disparity of the sizes of the punctations in *andersoni*.

NYMPH

PLATE VI, NOS. 6 AND 7; PLATE II, No. 10

Length, 1.26 mm; width, 0.81 mm. Oval, narrowed anteriorly.

Basis capituli.—Dorsally subtriangulate, laterally drawn out into sharp points; the posterior dorsal margin made up of three arcs.

Ventral view with the short basal spurs, small, narrow, though distinct.

Scutum.—Length, 0.63 mm; width, 0.60 mm. Cervical grooves distinct, moderately deep, followed posteriorly by broad, shallow depressions, which first converge and then diverge, and extend about three-fourths of the length of the scutum. Posterior margin of the scutum evenly arcuate with no tendency to become pointed posteriorly.

Festoons distinct.

Coxae.—Coxa I with both internal and external spurs distinct, internal spur pointed; coxae II, III, and IV with only external spurs present, that on IV being faint.

Spiracular plate.—Nearly circular, with the spiracular opening near the center. In some specimens the plate shows tendency to become pointed dorsally. Goblets numerous and small. Length, 0.147 mm; width, 0.138 mm.

LARVA

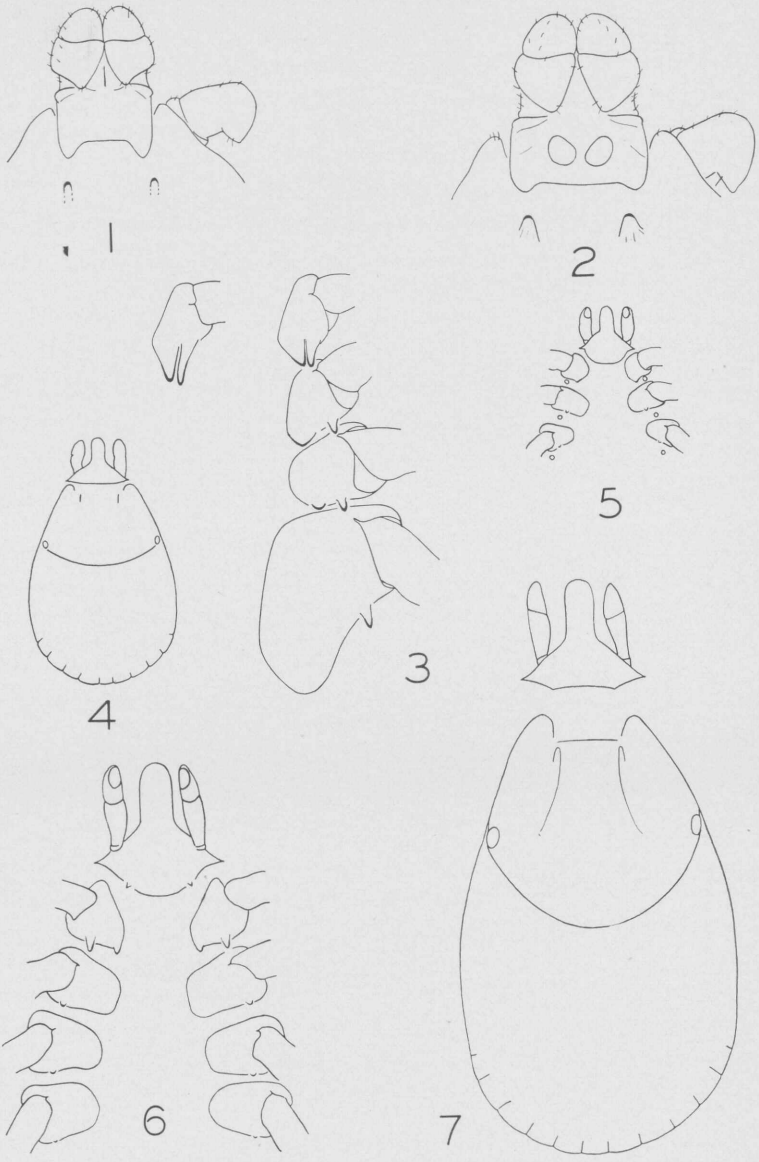
PLATE VI, NOS. 4 AND 5

Length, 0.57 mm; width, 0.45 mm. Length of scutum, 0.24 mm; width, 0.36 mm. Basis capituli laterally produced into sharp points. Coxa II a little larger than III. Coxa I with a definite small internal spur; coxae II and III with external spurs only, that on III being faint.

HOSTS

The earliest host records of the adults of *D. andersoni* are those on the labels in the "Marx collection", and are *Ovis aries* and "mountain goat" (almost certainly the Rocky Mountain goat, *Oreamnos americanus*). In the following lists, host animals included in earlier publications are omitted. In Stiles (1910) are added man, horse (*Equus caballus*), cattle (*Bos taurus*), and *Lepus* sp.; and in Cooley (1911) the dog, badger (*Taxidea taxus*), snowshoe rabbit (*Lepus bairdi*), and woodchuck (*Marmota flaviventris*). Henshaw and Birdseye (1911) recorded bear and coyote. Hooker, Bishopp, and Wood (1912) added mule, ass, hog, goat, and wildcat.

From the records at the Rocky Mountain Laboratory, including the records of the Montana State entomologist and Montana State Board of Entomology, there are the following added hosts: Deer in Colorado (*Odocoileus hemionus*), elk (*Cervus canadensis*), antelope (*Antilocapra americana*), grizzly bear in western Montana (*Ursus horribilis*), porcupine (*Erethizon epixanthum*), prairie dog (*Cynomys ludovicianus*), black-tailed jack rabbit in Idaho, white-tailed jack rabbit, and cottontail rabbit (*Sylvilagus nuttalli*). Rocky



DERMACENTOR ANDERSONI STILES.

1. Capitulum and part of scutum, male.
2. Same, female.
3. Coxae and spurs, male.
4. Larva, dorsal view.
5. Larva, ventral view.
6. Nymph, ventral view.
7. Nymph, dorsal view.

Mountain Laboratory A. P. 1543 and A. P. 9051B, record one male "dead in the feathers" on ruffed grouse and 2 adults on turkey, respectively.

The hosts of the immature stages of this tick, as recorded by Cooley (1911), are Columbian ground squirrel (*Citellus columbianus*), pine squirrel (*Sciurus hudsonicus richardsoni*), wood rat (*Neotoma cinerea*), cottontail rabbit (*S. nuttalli*), side-stripe squirrel or Say's ground squirrel in Montana (*Callospermophilus lateralis cinerascens*), woodchuck (*M. flaviventris*), and yellow-bellied chipmunk (*Eutamias amoenus vallicola*). Henshaw and Birdseye (1911) listed "mice" as hosts, and Hunter and Bishopp (1911) added the snowshoe rabbit (*L. bairdi*), white-footed mouse (*Peromyscus maniculatus artemisiae*), white-bellied chipmunk (*Eutamias ruficaudus ruficaudus*), large meadow mouse (*Microtus modestus*), jumping mouse (*Zapus princeps*), pika (*Ochotona princeps*), and pocket gopher (*Thomomys fuscus*).

Parker and Wells (1916) found the following animals to be larval and nymphal hosts in eastern Montana: Porcupine (*E. epixanthum*), prairie dog (*Cynomys ludovicianus*), jack rabbit (*Lepus townsendii campanius*), cottontail rabbit (*Sylvilagus nuttalli grangeri*), striped spermophile (*Citellus tridecemlineatus pallidus*), kangaroo rat (*Peripodus montanus richardsoni*), upland meadow mouse (*Microtus ochrogaster haydeni*), grasshopper mouse (*Onychomys leucogaster missouriensis*), deer mouse (*Peromyscus maniculatus osgoodi*), and pale chipmunk (*Eutamias pallidus*). The same authors in 1917 added the Richardson ground squirrel (*Citellus richardsonii*).

From unpublished laboratory records may be added: The flying squirrel (*Glaucomys sabrinus*), Say's ground squirrel in Colorado (*Callospermophilus lateralis lateralis*), Montana hoary marmot (*Marmota caligata nivaria*), pigmy rabbit (*Brachylagus idahoensis*), weasel (*Mustela cicognani cicognani*), and Abert squirrel (*Sciurus aberti aberti*).

It is very apparent that *D. andersoni*, in all stages is far from host specific. Almost any mammal that is available is used, and host lists in various localities naturally differ. Animals about the size of woodchucks, rabbits, and porcupines may be considered as representing a dividing line between the hosts of immature and adult ticks. It is likely that there are but few of the rodents and smaller carnivores, indigenous to the *andersoni* range, that do not serve, at least occasionally, as hosts of the larvae or nymphs.

HYBRIDIZATION WITH DERMACENTOR OCCIDENTALIS

D. andersoni and *D. occidentalis*, though distinct species, are probably more closely related than any of the others discussed in this paper.

In a series of crossing experiments conducted, 1932 to 1934, definite hybridization was secured between females of *andersoni* and males of *occidentalis*. It is of interest that both the first and second generation hybrids were fertile. Crossing combinations of and with other species have been attempted but have thus far proved negative.

The chief value of the successful crossings of *andersoni* and *occidentalis* is its possible bearing on the validity of crossings as a criterion of specificity, but the hybrids are also of value in showing the influence of hybridization on the morphological and color characters. Some such studies have already been made, but publication is being withheld pending further observations.

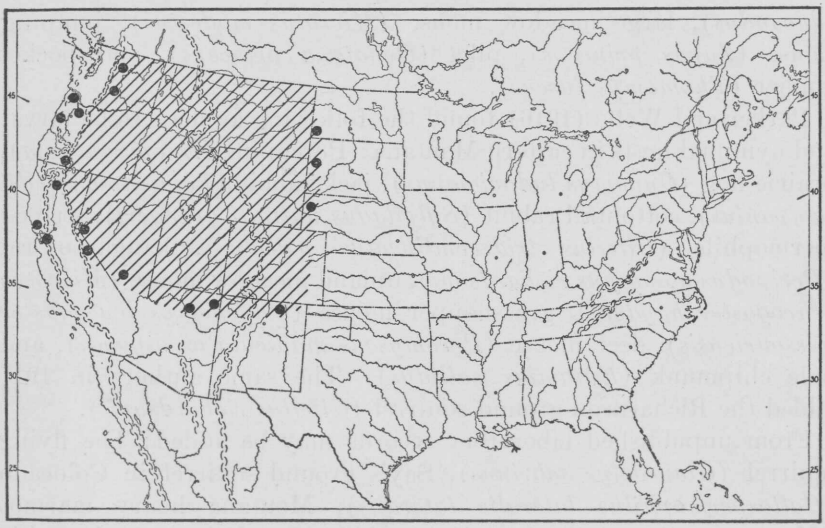


FIGURE 2.—Distribution of *Dermacentor andersoni*.

DISTRIBUTION

FIGURE 2

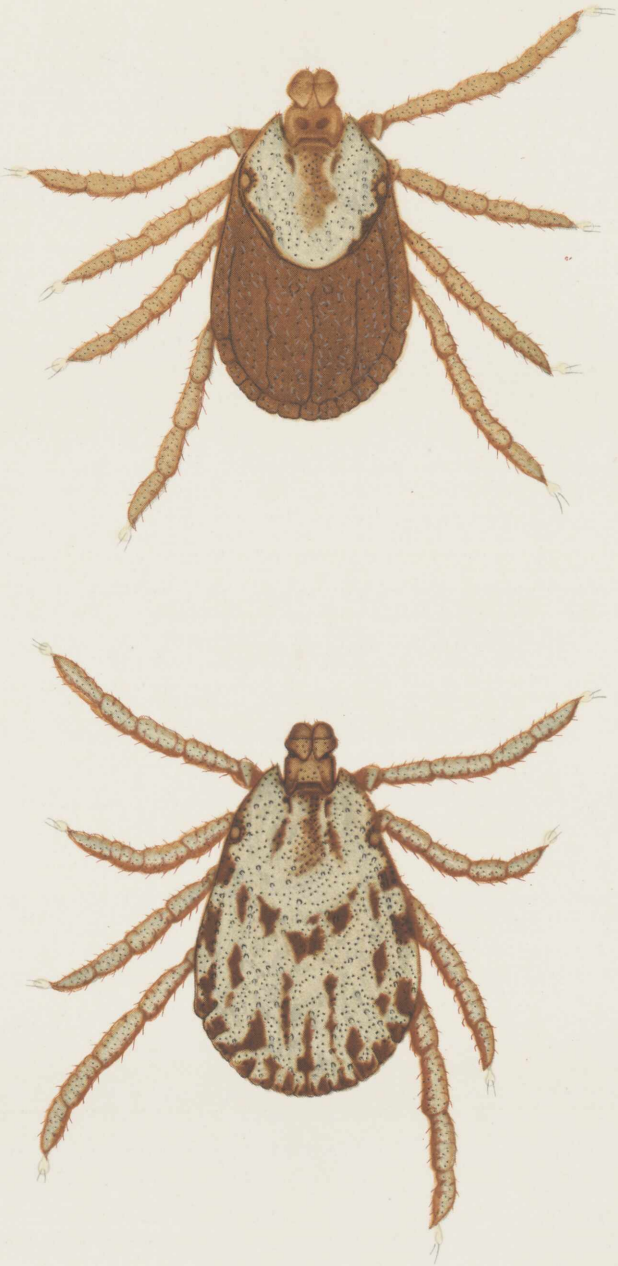
D. andersoni has been collected in 14 Western States and is found also in the southern parts of British Columbia, Alberta, and Saskatchewan in western Canada.

The black spots in eastern Montana, western North Dakota, western South Dakota, and western Nebraska represent relatively recent records. This tick is prevalent in Colorado, as shown by many laboratory collections, but is absent or rare east of the mountains, though we have one definite record from western Nebraska. The laboratory has a few records from northern New Mexico and northern Arizona, and a recent note by Bishopp (1936) records its occurrence in northeastern Arizona. Collections by Mr. Glen M. Kohls, of the labora-

tory, in 1936, show this tick to be present in Alpine and Inyo Counties in the eastern edge of California, as indicated on the map. There is only a single record in Shasta County in northern California, although considerable collecting has been done in this region. The same is true in southwestern Oregon, where hundreds of records have shown only one positive record, namely, at Pinehurst, Klamath County, on the eastern slope of the Cascades.

The spots on the map showing the presence of *D. andersoni* in western Washington just east of the Cascade Mountains are based on Hooker, Bishopp, and Wood (1912). The map shows positive records south of Portland, the specimens having come from Prof. Don C. Mote and Dr. W. J. Chamberlin, of the Oregon Agricultural College, and near San Francisco from specimens sent by Dr. Charles M. Wheeler.

The species is not abundant west of the Cascade and Sierra Nevada Mountains in western Oregon and California, and its presence in small numbers may be due to introductions made incident to the movements of domestic animals.



THOMAS J. MOORE, DEL.

Lith. A. Hoen & Co., Inc.

DERMACENTOR OCCIDENTALIS MARX.

Female (top) and male.

DERMACENTOR OCCIDENTALIS MARX, 1892

PLATE VII

1892. *Dermacentor occidentalis* Marx in Curtice, original description, p. 226.
1897. *Dermacentor occidentalis* Marx: Neumann, as synonym of *reticulatus*, in error, p. 365.
1899. *Dermacentor occidentalis* Marx: Morgan, p. 134.
1905. *Dermacentor reticulatus occidentalis* Marx: Neumann, as a variety of *reticulatus*, p. 235.
1907. *Dermacentor occidentalis* Marx: Banks, p. 608.
1908. *Dermacentor occidentalis* Marx: Banks, p. 47.
1910. *Dermacentor occidentalis* Marx: Stiles, p. 32.
1912. *Dermacentor occidentalis* Marx: Hooker, Bishopp, and Wood, biology and distribution, p. 181.

Marx is accepted as the author of *occidentalis* in keeping with Banks (1908) and Stiles (1910), although Curtice in 1892, in referring to "*Dermacentor occidentalis* Marx MS.", pointed out differences between this and some other species and gave diagnostic points which are scarcely sufficient to distinguish this species.

The base color is dark brown; pattern color gray with greenish cast. Living specimens often show a waxy bloom over the scuta.

MALE[1]

	Minimum	Maximum	Mean	Standard deviation
Length	2. 6	3. 9	3. 4	0. 34
Width	1. 7	2. 6	2. 3	. 2
Percentage, width of length	64	75	67	2. 4

[1] 25 males in 6 lots from Oregon and California.

DORSAL VIEW

PLATE VIII, No. 1; PLATE XXII

Capitulum—Basis capituli.—Length, including the cornua, greater than width, and a little wider anteriorly; median longitudinal area depressed and with a few punctations present; cornu long, broad, and rounded apically; some pattern color usually present. *Palpi:* Posterodorsal ridges moderate; a few punctations and pattern color present; short hairs present on the lateral and distal edges.

Scutum.—Cervical grooves deep, short, scarcely more than pits; lateral grooves absent but usually having in their positions more or less definite rows of punctations which suggest grooves; punctations very numerous and with the disparity of sizes moderate. The color pattern always more extensive than the base color, and in a connected pattern leaving the base color in separate spots; pesudoscutum usually well marked off by its more complete gray pattern; numerous specimens from southwestern Oregon have the gray uniformly less brilliant than in specimens from middle and southern California. In both sexes the antero-lateral margin anterior to the eyes reddish yellow in color.

Legs (both sexes).—The legs covered with the pattern color both dorsally and ventrally, and with numerous distinct punctations; dorsally the numerous hairs, short and inconspicuous, ventrally, long; dorsal spur on trochanter I long, pointed, and with pattern color present.

VENTRAL VIEW

PLATE VIII, No. 3; PLATE XXVI

Capitulum—Basis capituli.—Posteroventral ridge a salience limiting the posterior side, convex caudally; punctations and hairs absent. *Palpi:* Punctations absent but with surface irregular.

Coxae (both sexes).—In some specimens the coxae surprisingly show presence of the pattern color of the dorsum. Coxa I with two strong, long, subequal spurs with the proximal edges subparallel; the external spur is often a little curved. External spurs on II, III, and IV equal to or longer than the width at the base; some specimens have the external spur on IV very small; internal spurs on II and III short, flat, and with rounded ends, often scarcely more than saliences; internal spur on IV absent.

Spiracular plates (both sexes).—Dorsal prolongation definite and pronounced; goblets numerous and of moderate size.

FEMALE[1]

	Minimum	Maximum	Mean	Standard deviation
Length	2. 9	3. 8	3. 5	0. 22
Width	1. 8	2. 5	2. 2	. 17
Percentage, width of length	60	72	64. 7	2. 8

[1] 25 females in 5 lots from Oregon and California.

DORSAL VIEW

PLATE VIII, No. 2; PLATE XXII

Capitulum—Basis capituli.—About twice as broad as long, surface posterior to porose areas depressed; punctations and hairs absent; some pattern color usually present. Cornu about as long as wide, narrowly rounded apically. *Palpi:* A few punctations and irregular depressions present and with a few hairs on the anterior and lateral sides; some pattern color present; posterodorsal ridge moderate.

Scutum.—Length and width about equal; the posterior margin, posterior to the eyes, subangulate. Cervical grooves deep and short. Punctations numerous and usually with only moderate disparity of sizes. The pattern color is more extensive than the base color. The base color is usually present at the cervical grooves, in the lateral margins back of the eyes, and in the ocular spots. The two parallel diagonal marks on each side in the median area back of the eyes, which are seen in related species, may be absent or faint in *occidentalis*.

Postscutal area.—Lateral grooves distinct, limiting either all the festoons or only the more anterior ones.

For descriptions of female spiracular plate, coxae and legs, see under male. All female ventral characters essentially the same as in the male.

Distinguishable from *andersoni* by the longer cornua, and the numerous small punctations which do not differ greatly in size from the larger punctations.

NYMPH

PLATE VIII, NOS. 6 AND 7; PLATE II, No. 15

Length, 1.05 mm; width 0.81 mm. Oval.

Basis capituli.—Dorsally triangulate, arcuate on the posterior margin and extended laterally into sharp points. Ventral surface showing lateral horns distinct, subacute.

Scutum.—Length, 0.39 mm; width, 0.57 mm. Cervical grooves small and short. Posterior margin arcuate and with no tendency to be pointed at the extremity.

Festoons moderately distinct.

Coxae.—Coxa I with two spurs; external spur on coxa II moderate, on coxa III faint, and on coxa IV absent.

Spiracular plate.—Broad, oval, with the dorsal end showing some tendency to become pointed; spiracular opening eccentric, placed nearer the broader end. Goblets fewer in number and of about the

same size as in *parumapertus*. Greatest length, 0.092 mm; width, .0777 mm. The plate of *occidentalis* resembles that of *parumapertus* from which it is distinguished by being smaller.

LARVA

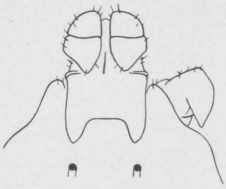
PLATE VIII, NOS. 4 AND 5

Length, 0.57 mm; width, 0.48 mm. Length of scutum, 0.23 mm; width, 0.33 mm. Basis capituli laterally extended into moderate points. Coxa II somewhat larger than coxa III; coxa I with a definite pointed internal spur; II with a faint, rounded external spur; III with no spur.

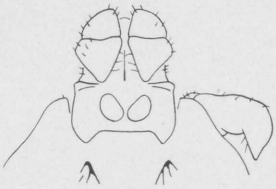
HOSTS

In his original discussions Marx (1892), in connection with the original description, gives the cow (*Bos taurus*), horse (*Equus caballus*), deer, dog, and man, as hosts of the adults. Hooker, Bishopp, and Wood (1912) add the mule, ass, rabbit, and sheep. The very numerous records of collections from this laboratory have not added to this list. Wherry and Wellman (1909) report this species from *Citellus beecheyi* but do not state the stage.

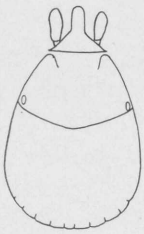
Kohls (1937) gives the following host records for the immature stages. Both larvae and nymphs were taken on the California ground squirrel (*C. beecheyi*), Douglas ground squirrel (*Citellus douglasii*), wood rats (*Neotoma lepida* and *fuscipes*), chipmunk (*Eutamias* sp.), brush rabbit (*Sylvilagus bachmani*), cottontail rabbit (*Sylvilagus auduboni*), jack rabbit (*Lepus californicus*), deer mouse (*Peromyscus* sp.), pocket mouse (*Perognathus* sp.), kangaroo rat (*Dipodomys* sp.), and spotted skunk (*Spilogale gracilis*). Larvae alone were recorded on a mouse, and the chickaree (*Sciurus douglasii*). Nymphs alone were taken on the gray squirrel (*Sciurus griseus*), house mouse (*Mus musculus*), golden mantled ground squirrel (*Callospermophilus chrysodeirus*), horse (*E. caballus*), coyote (*Canis* sp.), and man. Species of animals which were collected only in small numbers, and on which no larvae and nymphs were recorded, were the following: Harvest mouse (*Reithrodontomys* sp.), field mouse (*Microtus californicus*), antelope ground squirrel (*Ammospermophilus leucurus*), shrew (*Sorex* sp.), and dog (*Canis familiaris*). The occurrence of the immature stage on cattle has been reported by Herms and Howell (1936).



1

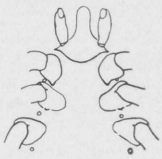


2

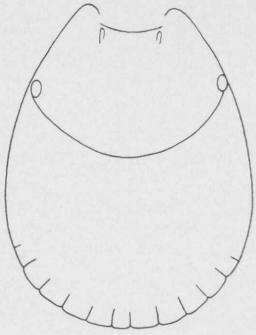


4

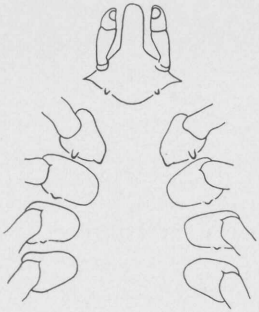
3



5



7



6

DERMACENTOR OCCIDENTALIS MARX.

1. Capitulum and part of scutum, male.
2. Same, female.
3. Coxae and spurs, male.
4. Larva, dorsal view.
5. Larva, ventral view.
6. Nymph, ventral view.
7. Nymph, dorsal view.

DISTRIBUTION

FIGURE 3

A recent intensive survey made by the Rocky Mountain Laboratory has shown *D. occidentalis* to be very abundant in southwestern Oregon. It is less numerous farther north and rare or absent north of

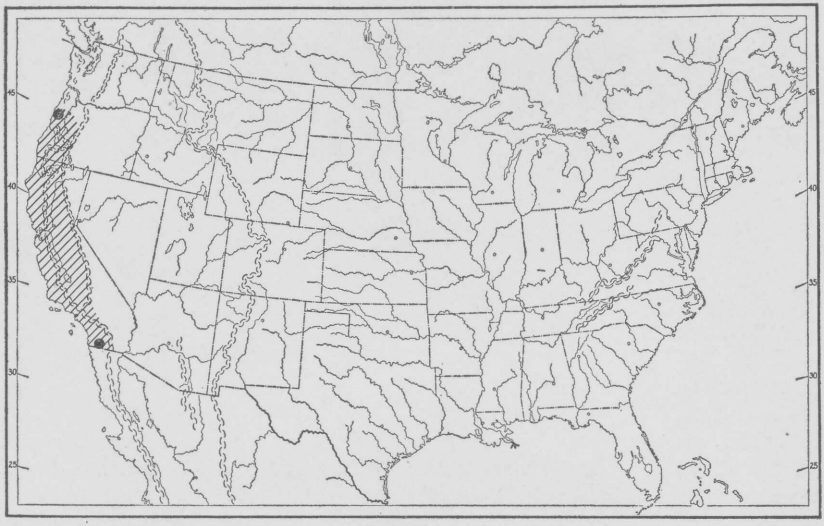


FIGURE 3.—Distribution of *Dermacentor occidentalis*.

Yachats, Lincoln County, where, in the map, the black circle records a recent collection made by Dr. W. J. Chamberlin, Oregon Agricultural College, Corvallis, Oreg. The record in southern California is from Hooker, Bishopp, and Wood (1912).

3012—38——4

THOMAS J. MOORE, DEL.

Lith. A. Hoen & Co., Inc.

DERMACENTOR HUNTERI BISHOPP.

Female (top) and male.

DERMACENTOR HUNTERI BISHOPP, 1912

PLATE IX

1912. *Dermacentor hunteri* Bishopp, original description, p. 33.
1913. *Dermacentor hunteri* Bishopp: Bishopp and Wood, biology and distribution, p. 155.

The types are in the U. S. National Museum, Cat. no. 14575.

Base color brown; pattern color gray.

MALE[1]

	Minimum	Maximum	Mean	Standard deviation
Length	3.9	4.6	4.3	0.20
Width	2.6	3.1	2.8	.41
Percentage, width of length	60	72	66	2.6

[1] 25 males in 3 lots from Arizona.

DORSAL VIEW

PLATE X, No. 1; PLATE XXII

Capitulum—Basis capituli.—Width greater than the length; posterior area between the cornua depressed; cornu about as long as the width at the base, subacute; punctations, both large and small, and some pattern color present. *Palpi*: Posterodorsal ridge moderate, rounded; some pattern color and a few punctations present; a few short hairs present at the sides and anterior ends.

Scutum.—Cervical grooves deep, smooth, and short; lateral grooves of moderate depth, emphasized by large punctations, and terminating at the festoons; large punctations few, and small ones moderate in number and present in both the median areas and in the marginal areas outside the marginal grooves; disparity of sizes moderate. Color pattern notably definite, confluent, and leaving the base color spots isolated. Pattern color outside of the lateral grooves and across the festoons in a more or less continuous, narrow stripe. Specimens from Libertad, Mexico, have the pattern color less extensive, causing the base color spots to be confluent in the lateral areas.

Legs (both sexes).—Glabrous, with punctations few and small; pattern color present dorsally (in specimens from Libertad, Mexico, the pattern color is reduced to terminal spots on the leg articles).

Dorsal spur on trochanter I well developed, pointed, and with pattern color present.

VENTRAL VIEW

PLATE X, No. 3; PLATE XXVIII

Capitulum—Basis capituli.—Posteroventral ridge a salience which may be curved or with a broken contour; a few small punctations and a few short hairs sometimes present. *Palpi*: Small punctation usually present; a few short hairs present at the sides.

Coxae (both sexes).—Spurs on coxa I with the proximal edges nearly parallel and apically rounded; external spurs on II, III, and IV a little longer than the width at the base; internal spurs on II and III short, broad, elevated, and with rounded ends; internal spur on IV absent.

Spiracular plates (both sexes).—Dorsal prolongation very definite, and, in the male, attenuated; goblets moderate in number and in size (larger and fewer than in *andersoni* and *occidentalis*).

FEMALE[1]

	Minimum	Maximum	Mean	Standard deviation
Length	3. 5	4. 3	3. 9	0. 33
Width	2. 2	2. 9	2. 6	. 23
Percentage, width of length	62	68	66	2. 5

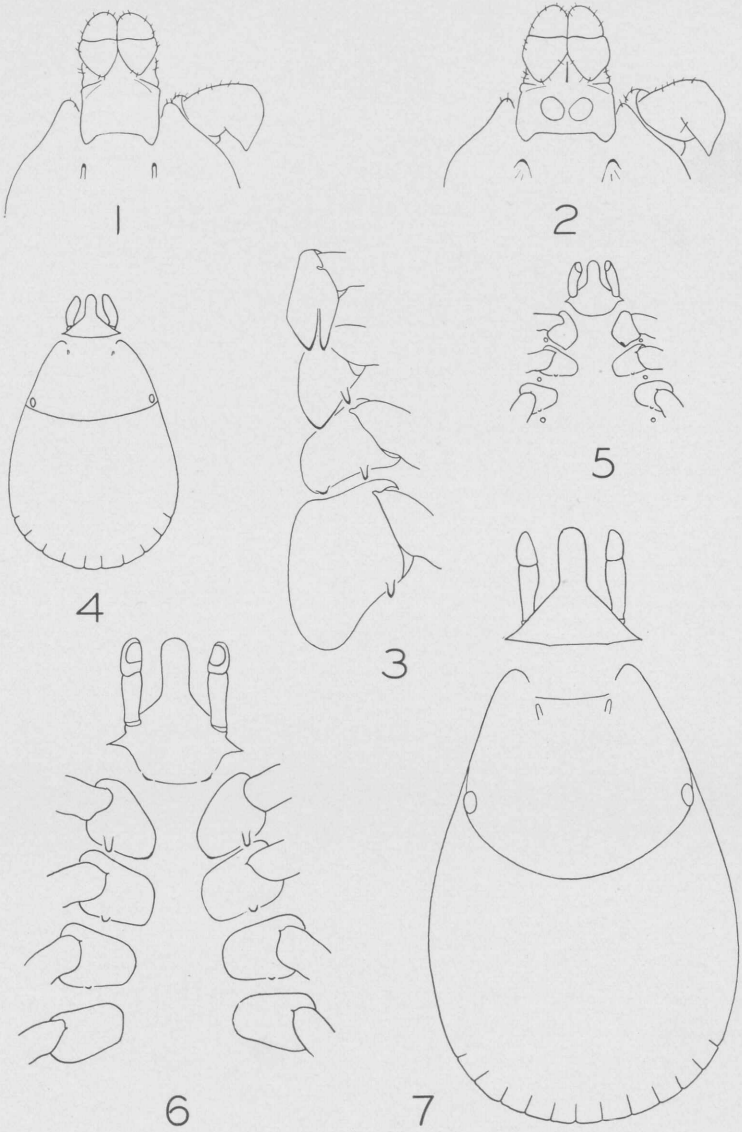
[1] 6 females in 2 lots from Arizona.

DORSAL VIEW

PLATE X, No. 2; PLATE XXII

Capitulum—Basis capituli.—Much wider than long, flat, or slightly convex; cornua short, and with the ends rounded; some pattern color present. *Palpi:* Posterodorsal ridge moderate, surface smooth and with a very few small punctations present; a few short hairs present on the sides. Some pattern color present.

Scutum.—Length and width about equal, with the posterior margin faintly subangulate. Cervical grooves deep and short. Small punctations moderate and large ones few in number; disparity of sizes moderate. The gray of the pattern is more extensive than the base color, the latter being present posterior to the emargination, in the cervical grooves, in the ocular spots, on the margins, both anterior and posterior to the eyes, and in two parallel, diagonal marks in the median area posterior to the eyes. Eyes with punctations on their edges.



DERMACENTOR HUNTERI BISHOPP.

1. Capitulum and part of scutum, male.
2. Same, female.
3. Coxae and spurs, male.
4. Larva, dorsal view.
5. Larva, ventral view.
6. Nymph, ventral view.
7. Nymph, dorsal view.

Postscutal area.—Marginal grooves pronounced and limiting about three festoons on each side.

For descriptions of female spiracular plate, coxae, and legs, see under male. All female ventral characters are essentially the same as in the male.

Numerous specimens of this species have been reared on guinea pigs at the laboratory. Fully engorged females are notably dark blue-gray and glabrous, differing markedly from the lighter green-gray color in *andersoni*, and the still lighter tan-gray in *halli*.

The male of this species is readily distinguished from other United States species by the definite, confluent, color pattern, and by the long, narrow, dorsal prolongation of the spiracular plate.

NYMPH

PLATE X, NOS. 6 AND 7; PLATE II, NO. 14

Length, 1.26 mm; width, 0.87 mm. Oval, narrowed anteriorly.

Basis capituli.—Subtriangulate, extended laterally into sharp points, and with the posterior margin made up of three nearly straight lines. Ventral view showing lateral horns broad, flat, and salient.

Scutum.—Length, 0.62 mm; width, 0.66 mm. Cervical grooves distinct, short. Posterior margin of the scutum evenly curved without tendency to become pointed.

Festoons distinct.

Coxae.—Coxa I with the external spur distinct and the internal spur broad, flat, and rounded apically; coxae II and III with external spurs short, coxa IV without spurs.

Spiracular plate.—Small, broad oval, and with the eccentric spiracular opening in the broader end. Goblets moderate in size and number. The spiracular plate of *hunteri* resembles both *parumapertus* and *occidentalis*, but can be separated by the more eccentric position of the opening in *hunteri*. Greatest length, 0.103 mm; width, 0.0912 mm.

LARVA

PLATE X, NOS. 4 AND 5

Length, 0.69 mm; width, 0.54 mm. Length of scutum, 0.24 mm; width, 0.42 mm. Basis capituli moderately extended laterally into points. Coxa II longer than coxa III; coxa I with a salient internal spur; coxae II and III with faint external spurs.

HOSTS

Bishopp (1912), in describing *D. hunteri*, gave as host Rocky Mountain sheep (*Ovis canadensis gaillardi*), and all subsequent cap-

tures of this tick have been from the same animal. The immature stages have not been taken in nature. Bishopp has reared the ticks on guinea pigs, and the Rocky Mountain Laboratory has reared them in abundance.

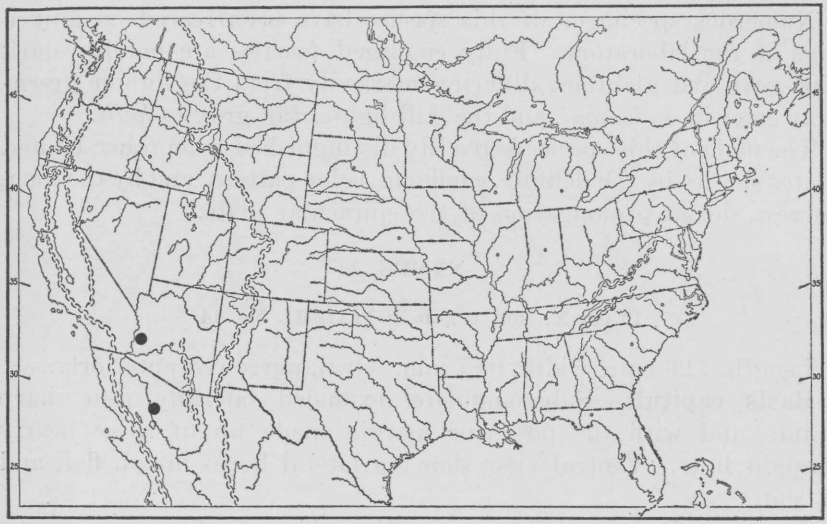


FIGURE 4.—Distribution of *Dermacentor hunteri.*

DISTRIBUTION

FIGURE 4

D. hunteri has been collected in the United States only at, or near, the type locality in southwestern Arizona, though it would not be surprising if it were to be found on Rocky Mountain sheep anywhere in the southwestern United States, and particularly in the eastern part of southern California where this host animal is still to be found near Death Valley, high up in the mountains. It is evident that the distributional range of this tick extends southward into Mexico, for we have received specimens collected at Libertad, from Prof. Charles T. Vorhies, University of Arizona, Tucson, Ariz. The spot in the accompanying map refers to these specimens.

THOMAS J. MOORE, DEL.

Lith. A. Hoen & Co., Inc.

DERMACENTOR PARUMAPERTUS NEUMANN.

Female (top) and male.

DERMACENTOR PARUMAPERTUS NEUMANN, 1901

PLATE XI

1901. *Dermacentor parumapertus* Neumann, original description, p. 267–268.
1905. *Dermacentor electus parumapertus* Neumann, in error, p. 236.
1908. *Dermacentor parumapertus marginatus* Banks, in original description of *marginatus* as variety of *parumapertus*, p. 45.
1910. *Dermacentor parumapertus* Neumann and *D. parumapertus marginatus* Banks: Stiles p. 46–48.
1911. *Dermacentor variabilis parumapertus* Neumann: Neumann, as variety of *variabilis* Say, in error, p. 101.
1912. *Dermacentor parumapertus marginatus* Banks: Hooker, Bishopp and Wood, biological data, p. 159.

Neumann's type specimens, "Taken on a man and in a chicken house", came from Lakeside, Calif., and are deposited in the United States National Museum.

The writer knows of no valid reason for retaining *marginatus* Banks, as a variety of *parumapertus* Neumann. There are present in nature variants ranging from complete absence of the gray on the scuta and legs to the degree of ornamentation shown in plate XXIV, nos. 6 to 12. In 1932 a field party from this laboratory did extensive collecting in Ada and Elmore Counties, Idaho, and collected numerous specimens of this tick, almost all of which were devoid of the gray. A very few specimens showed, when collected, the faintest trace of the gray on the posterior margin of the female scutum. Selected specimens showing none of the gray were reared in the laboratory and this stock has been continuously reared up to the present (1937), and now, in about the seventh generation, this stock shows much of the gray in both sexes. In the rearing, the amount of gray has progressively increased. Specimens from both the northern and southern ranges of distribution of this tick have been reared and no biological differences have been detected.

The color markings of the United States species of *Dermacentor* show a very distinct tendency to variation. This is true of all species. *D. parumapertus marginatus* is not even a persistent race.

Base color red-brown; pattern color gray.

MALE[1]

	Minimum	Maximum	Mean	Standard deviation
Length	2. 4	3. 1	2. 8	0. 18
Width	1. 6	2. 0	1. 8	. 11
Percentage, width of length	64	75	69	3. 0

[1] 25 males in 6 lots from California, Idaho, and Utah.

DORSAL VIEW

PLATE XII, No. 1; PLATE XXIV

Capitulum—Basis capituli.—Width greater than the length; nearly flat and usually punctate; cornua with the length shorter than the width at the base, apex rounded; gray of the pattern color and hairs absent. *Palpi:* Longer and narrower than in related species; posterodorsal ridge well developed, with edges rounded; a few punctations present; gray of pattern color absent.

Scutum.—Cervical grooves deep, parallel, about three times as long as wide; lateral grooves distinct, emphasized by large punctations, and terminating at the festoons; large punctations conspicuous, moderate in number; small punctations visible more easily within the field of the gray, moderate in number, much smaller than the large punctations; punctations of both sizes are present outside of the lateral grooves, but few in number. Color pattern notably variable in specimens from different localities, variants showing anything from absence to an extensive pattern. (See particularly plate XXIV, nos. 6 and 7.) Some of the gray appears on the legs even with the appearance of the least amount on the scutum.

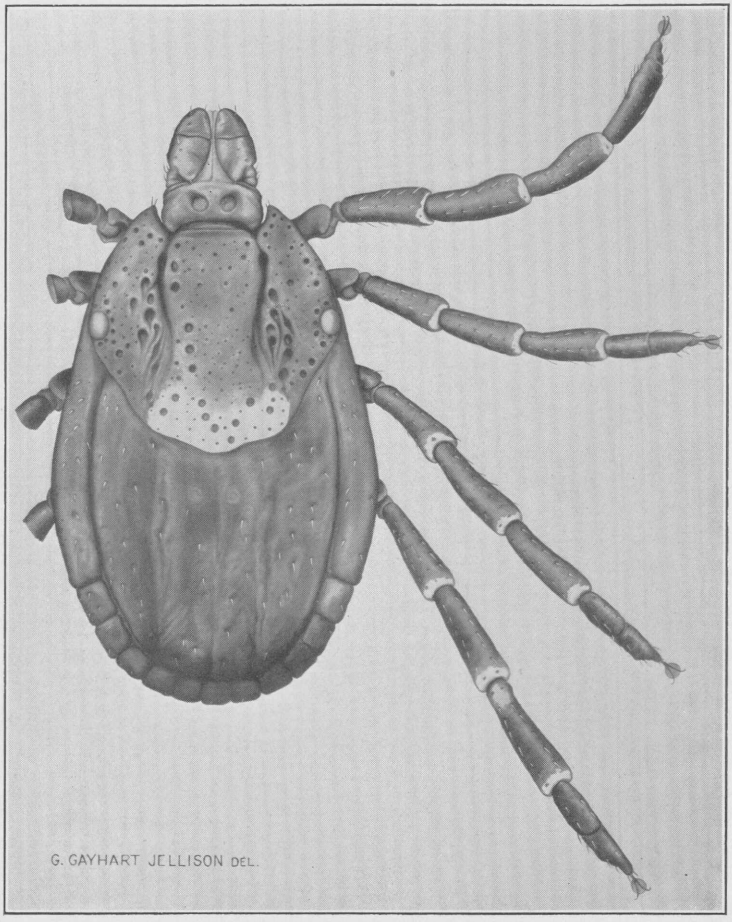
Legs (both sexes).—Notably longer than in the other United States species; a few punctations present; pattern color present only on distal ends of the articles. Dorsal spur on trochanter I well developed, pointed, and with pattern color present.

VENTRAL VIEW

PLATE XII, No. 3; PLATE XXVIII

Capitulum—Basis capituli.—Posteroventral ridge a curved salience, a very few small punctations, and short hairs present or absent. *Palpi:* Small punctations few in number or absent; short hairs few in number or absent.

Coxae (both sexes).—Spurs on coxa I divergent, with the internal spur shorter, and both spurs apically rounded; coxae II, III, and IV with the external spurs about as long as the width at the base; inter-



DERMACENTOR PARUMAPERTUS.

Dorsal view of female.

nal spurs on II and III broad, short, rounded, and slightly elevated, that on IV absent.

Spiracular plates (both sexes).—Dorsal prolongation very definite and only moderately broad, and in the male somewhat attenuated; goblets moderate in number and size.

FEMALE[1]

	Minimum	Maximum	Mean	Standard deviation
Length	2. 2	3. 4	**2. 9**	0. 28
Width	1. 6	2. 5	**2. 1**	. 22
Percentage, width of length	57	82	**70**	4. 9

[1] 25 females in 6 lots from California, Idaho, and Arizona.

DORSAL VIEW

PLATE XII, No. 2; PLATE XXIV

Capitulum—Basis capituli.—About twice as long as wide; surface flat and with the porose areas large and deep; punctations scarce or absent; gray of pattern color absent; cornua short and rounded apically. *Palpi:* Posterodorsal ridge moderate with rounded edges; small punctations faint or absent; a few short hairs present laterally and apically; pattern color absent.

Scutum.—Length and width about equal; the posterior margin subangulate. Cervical grooves deep and narrow anteriorly, and with their posterior extensions broad, shallow, and punctate or rugopunctate; median edges definite, lateral sides indefinite; the grooves disappearing near the posterolateral margin of the scutum. The scutum is elevated in the median longitudinal area and in the areas at the sides laterad of the grooves. In possessing these characteristic grooves *D. parumapertus* differs from all known United States species. The large punctations conspicuous and deep; small punctations easily seen only when within the fields of the gray pattern color. The pattern color, if present at all, is seen at the posterior apical margin of the scutum; specimens that have more pattern show it in the broad portions of the cervical groove, and others which have the maximum amount that the writer has observed, have the gray in much of the surface but not in the median and lateral areas. The base color near the eyes, and extending posteriorly from this region, is dark brown.

Postscutal area.—Lateral grooves pronounced and limiting a part or all of the festoons.

For descriptions of female spiracular plate, coxae, and legs, see under male. All female ventral characters are essentially the same as in the male.

Females are easily distinguishable from other species by the scutum, which has the long rugo-punctate cervical grooves, and the gray spot at the apex if any gray at all is present. Males show at least one or two gray spots in the posterolateral regions, if any pattern color is present, or if no gray is present the large deep punctations, with the small punctations not conspicuous, indicate this species. Specimens of both sexes from southeastern New Mexico show much gray in the patterns.

NYMPH

PLATE XII, NOS. 6 AND 7; PLATE II, NO. 11

Length, 1.05 mm; width, 0.75 mm. Wide oval, narrowed anteriorly.

Basis capituli.—Subtriangulate, laterally extended into shape points; the posterior margin straight in the median portion and with the sides slightly curved. The ventral view shows the lateral horns distinct but small.

Scutum.—Length, 0.54 mm; width, 0.60 mm. Cervical grooves distinct, but moderately deep anteriorly. Posterior margin of scutum broadly rounded without tendency to become pointed posteriorly.

Festoons distinct.

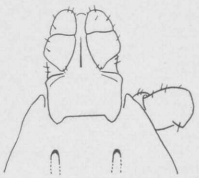
Coxae.—Coxa I with the external spur well developed, and with in internal spur broad, flat, and rounded. (In *andersoni* the internal spur is pointed.) On coxae II, III, and IV the external spurs are distinct but small; internal spurs are absent on II, III, and IV.

Spiracular plate.—Broad oval with some tendency to become pointed dorsally; spiracular opening near the broader end. Goblets moderate in size and number. Greatest length of the plate, 0.132 mm; greatest width, 0.1212 mm.

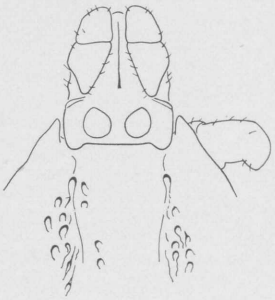
LARVA

PLATE XII, NOS. 4 AND 5

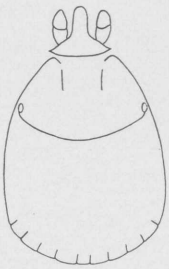
Length, 0.60 mm; width, 0.48 mm. Length of scutum, 0.24 mm; width, 0.39 mm. Basis capituli subtriangulate, moderately pointed at the sides. Coxa II a little larger than coxa III. Coxa I with small internal spur present; coxae II and III with only external spurs which are distinct but small.



1

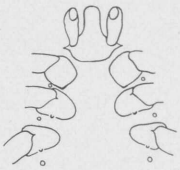


2

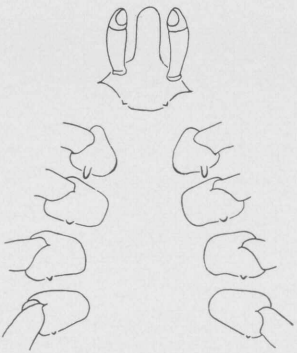


4

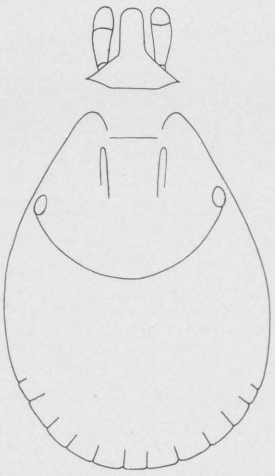
3



5



6



7

DERMACENTOR PARUMAPERTUS NEUMANN.

1. Capitulum and part of scutum, male.
2. Same, female.
3. Coxae and spurs, male.
4. Larva, dorsal view.
5. Larva, ventral view.
6. Nymph, ventral view.
7. Nymph, dorsal view.

HOSTS

Neumann's type specimens were from "man and in a chicken house", from Lakeside, Calif. Banks (1908), when describing *D. parumapertus marginatus*, had several specimens from a jack rabbit from Mesa City, Ariz.

The numerous laboratory records show that the tick is very abundant on various species of rabbits, including jack, cottontail, and pigmy rabbits, and it seems probable that this tick will use as hosts any species of rabbit available.

Boynton (1933) records *D. parumapertus* on deer. A letter addressed to him for further information was referred to Dr. Charles M. Wheeler, who had made the identification. Dr. Wheeler kindly sent me the specimens and they are of this species. With these ticks were included several specimens of both sexes from a coyote taken at Plymouth, Calif. The ticks were attached on both the deer and the coyote.

The only known hosts of the immature stages are rabbits.

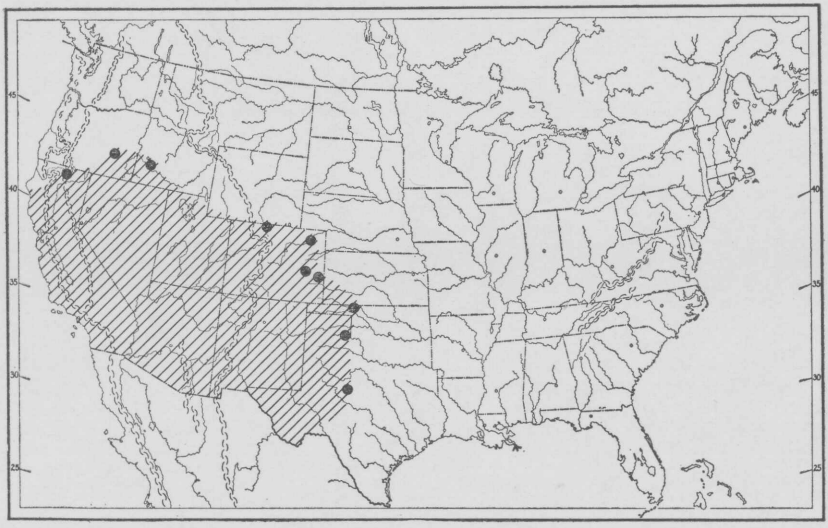


FIGURE 5.—Distribution of *Dermacentor parumapertus*.

DISTRIBUTION

FIGURE 5

The species has been collected in 11 States in southwestern United States, as shown in the accompanying map. The shaded portion of the map indicates the areas where the species is present, and the black spots represent definite collections which in some cases extend the known area of distribution.

The spot in northern California represents numerous specimens from Shasta. We have one record from near Burns, east-central Oregon, and very numerous specimens from near Grandview, Idaho. The records in Colorado are from McCampbell (1926), who had specimens from the counties of Jackson, Morgan, Lincoln, and Kiowa. One definite laboratory record from Harper County in northern Oklahoma verifies the spot in that locality, and western Texas is included from laboratory records from Hedley, Donley County. The black circle in west-central Texas refers to a record of Hooker, Bishopp and Wood (1912).

THOMAS J. MOORE, DEL.

Lith. A. Hoen & Co.,

DERMACENTOR HALLI MCINTOSH.

Female (top) and male.

DERMACENTOR HALLI McINTOSH, 1931

PLATE XIII

1931. *Dermacentor halli* McIntosh, original brief description, p. 124.
1932. *Dermacentor halli* McIntosh, full description with figures, p. 1–6.

Holotype, allotype, and paratypes are in the U. S. National Museum, nos. 31500, 31501, and 31502.

Base color yellow-brown; pattern color gray.

MALE[1]

	Minimum	Maximum	Mean	Standard deviation
Length	3. 4	4. 4	**3. 9**	0. 36
Width	2. 2	2. 9	**2. 6**	. 23
Percentage, width of length	63	67	**65. 6**	1. 5

[1] 14 males in 1 lot from Texas.

DORSAL VIEW

PLATE XIV, NO. 1; PLATE XXII

Capitulum—Basis capituli.—Slightly wider than long, surface flat or a little convex, a few punctations present, and with pattern color present but faint; hairs absent; cornua as long as wide, terminally rounded. *Palpi:* Posterodorsal ridge moderately developed, with the elevated edges forming a wider angle than in other species: General surface slightly irregular, with few punctations and with a tinge of pattern color present or absent; a few short hairs present on the lateral and anterior margins.

Scutum.—Viewed dorsally the scutum is seen to be slightly elevated at the sides, causing the median area to be depressed, and when viewed in lateral profile the dorsum from anterior to posterior extremities, is nearly straight. All other known species of *Dermacentor* in the United States have the dorsum convex. Cervical grooves deep, short, scarcely more than pits; lateral grooves shallow and including a few punctations, terminating at the festoons; short grooves between the festoons deeper than the lateral grooves; large punctations not distinct, except those in the lateral grooves, and in the marginal areas laterad of the grooves and in the humeral regions,

where they are deep; small punctations moderate in number and seen clearly only in the areas of the pattern color. Pattern color less extensive than the base color and tending to be continuous, but often interrupted by the punctations; pattern color present in a continuous marginal stripe outside the lateral grooves; a spot or crossbar of the pattern color is usually present on the festoons.

Legs (both sexes).—Pattern color present dorsally, and with punctations and a few very short hairs present; dorsal spur on trochanter I well developed, triangular, subacute apically.

VENTRAL VIEW

PLATE XIV, No. 3; PLATE XXVII

Capitulum—Basis capituli.—Posteroventral ridge very well developed as an overhanging edge, medially straight, laterally curved; punctations and hairs absent; a few short hairs at the sides and on the anterior ends. *Palpi*: Punctations absent; a few short hairs present at the sides and on the anterior end.

Coxae (both sexes).—Spurs on coxa I shorter than in related species, divergent, and apically rounded; external spurs on II, III, and IV with sides nearly parallel, a little longer than the width at the base, and apically rounded; internal spurs on II and III broad, flat, and with the apically rounded ends salient; internal spur on IV absent.

Spiracular plates (both sexes).—Dorsal prolongation broad, and with the goblets numerous and small. The plates of *halli* resemble those of *variabilis*.

FEMALE[1]

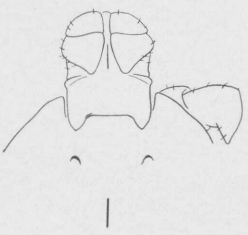
	Minimum	Maximum	Mean	Standard deviation
Length	3. 72	5. 71	4. 3	0. 671
Width	2. 16	3. 21	2. 55	. 36
Percentage, width of length	53	65	59. 5	4. 19

[1] 6 females in 2 lots from Texas, including allotype.

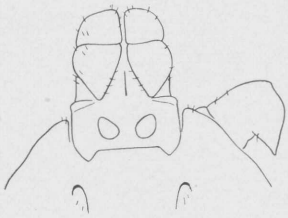
DORSAL VIEW

PLATE XIV, No. 2; PLATE XXII

Capitulum—Basis capituli.—Much wider than long; punctations and hairs absent; pattern color very faint or absent; cornu shorter than the width at the base, rounded apically. *Palpi:* Posterodorsal ridge moderate; punctations faint or absent; a few short hairs present; pattern color faint or absent.

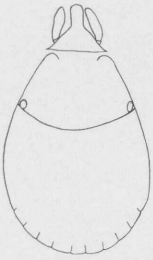


1

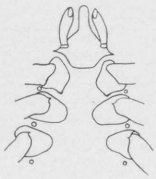


2

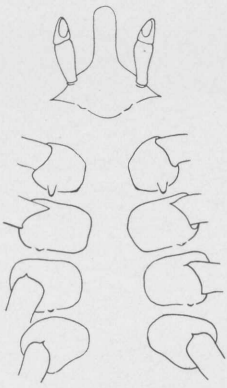
3



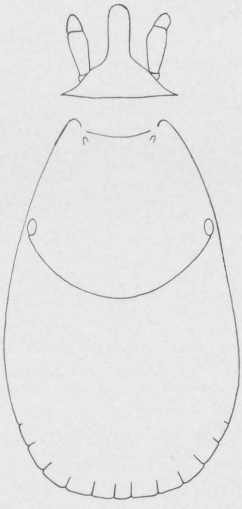
4



5



6



7

DERMACENTOR HALLI MCINTOSH.

1. Capitulum and part of scutum, male.
2. Same, female.
3. Coxae and spurs, male.
4. Larva, dorsal view.
5. Larva, ventral view.
6. Nymph, ventral view.
7. Nymph, dorsal view.

Scutum.—Length and width about equal; posterior border behind the eyes nearly a semicircle; cervical grooves deep, short; punctations with moderate disparity of sizes, the smaller ones evenly distributed, and the larger ones present only in the lateral areas. Pattern color usually more extensive than the base color, the latter always present in the median longitudinal area, in the cervical grooves, in the ocular spots, in the margin back of the eyes, and in one diagonal bar on each side caudo-mesad from the eyes.

Postscutal area.—Marginal grooves distinct, limiting some or all of the festoons.

For descriptions of female spiracular plate, coxae, and legs, see under male. All female ventral characters are essentially the same as in the male.

D. halli is readily distinguished from all other United States species of the genus by the broadly forked spurs on coxa I of both sexes, and the flat dorsal profile in lateral view, as well as the presence of the larger punctations only in peripheral areas in the male.

NYMPH

PLATE XIV, NOS. 6 AND 7; PLATE II, NO. 13

Length, 1.05 mm; width, 0.60 mm. Oval, narrowed anteriorly.

Basis capituli.—Dorsally subtriangulate, and laterally extended into sharp points, posterior margin straight medially and slightly curved at the sides. Ventral surface of the basis capituli with the basal spurs very small, short, and rounded.

Scutum.—Length, 0.45 mm; width, 0.48 mm. Cervical grooves very small or absent; posterior margin evenly rounded, with no tendency to become pointed at the extremity.

Coxae.—Coxae I, II, and III with internal spurs small, faint, and rounded apically; with external spurs distinct and apically rounded; coxa IV with no spurs.

Spiracular plate.—Short, oval; spiracular opening eccentric. Goblets moderate in size and number; length, 0.108 mm; width, 0.0938 mm.

LARVA

PLATE XIV, NOS. 4 AND 5

Length, 0.54 mm; width, 0.42 mm. Length of scutum, 0.24 mm; width, 0.36 mm. Basis capituli laterally extended into points. Coxa I with a faint internal pointed spur. Spurs absent on coxae II and III.

HOSTS

The 12 type specimens were taken from the peccary (*Pecari angulatus angulatus*). Prof. Clyde T. Reed, Texas College of Arts and

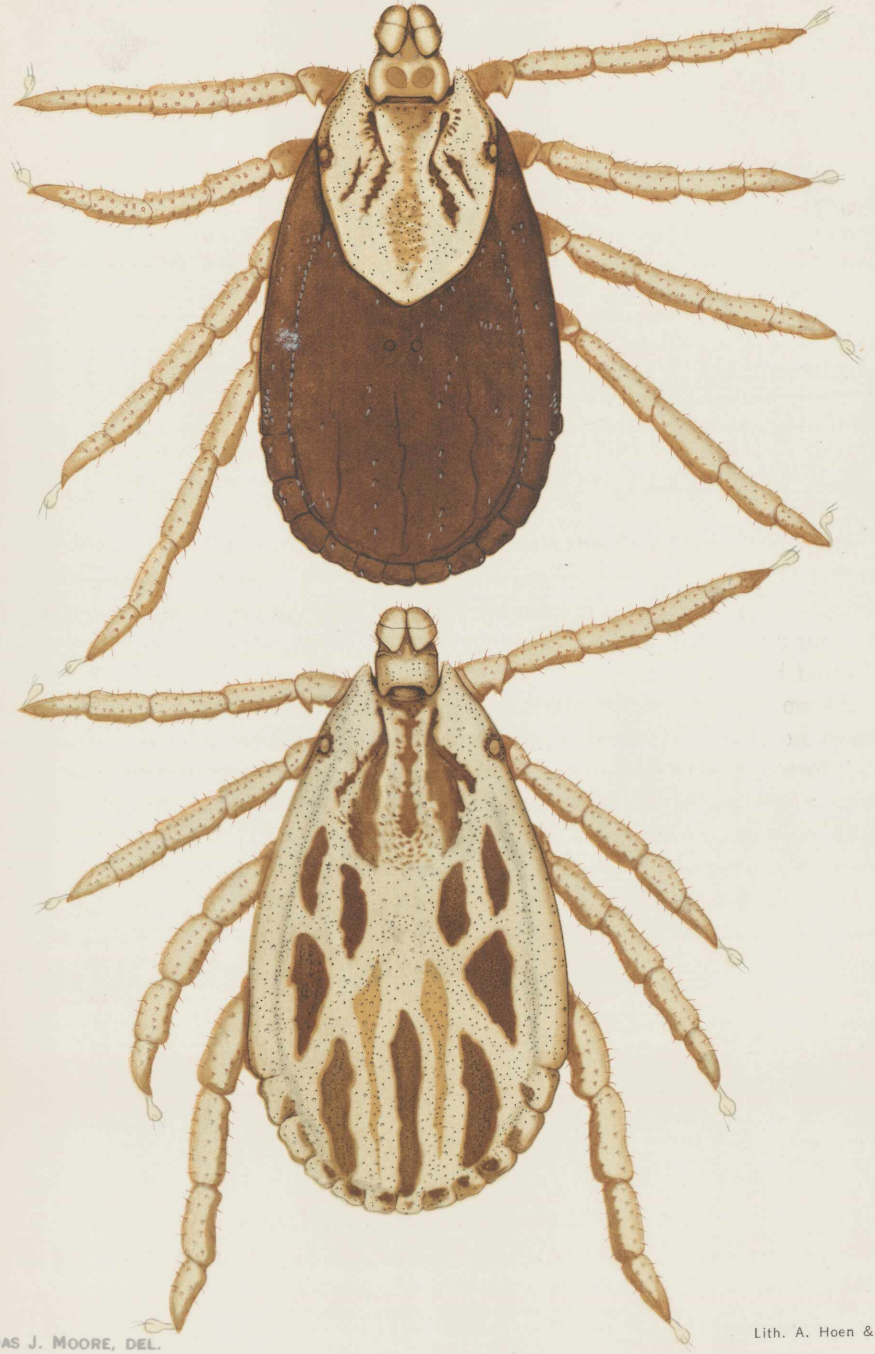
Industries, Kingsville, Tex., reports that he also has specimens from peccary. In correspondence dated September 21, 1935, he stated, "I took several this summer from skunk which added another host for the tick." On October 16, 1935, workers from the Rocky Mountain Laboratory took 28 males and 8 females from two peccaries at Kingsville, and from these specimens a stock was reared on laboratory animals.

FIGURE 6.—Distribution of *Dermacentor halli.*

DISTRIBUTION

FIGURE 6

Up to the present time *D. halli* has been collected in the United States only in southern Texas. One female from Chichen-Itza, Yucatan (host and date not given), has been received from Dr. Joseph Bequaert.



THOMAS J. MOORE, DEL.

Lith. A. Hoen & Co., Inc.

DERMACENTOR ALBIPICTUS PACKARD.

Female (top) and male.

DERMACENTOR ALBIPICTUS (PACKARD), 1869

PLATES XV AND XVI

1869. *Ixodes albipictus* Packard, original description, p. 65–66.
1869. *Ixodes nigrolineatus* Packard, original description, p. 66.
1897. *Dermacentor variegatus* Marx and Neumann, in Neumann, p. 367–370.
1901. *Dermacentor variegatus* Marx and Neumann: Salmon and Stiles, p. 452–454.
1901. *Dermacentor reticulatus* Fabricius: Salmon and Stiles, p. 448–452.
1908. *Dermacentor albipictus* Packard: Banks, p. 44–45.
1908. *Dermacentor nigrolineatus* Packard: Banks, p. 48–49.
1910. *Dermacentor nigrolineatus* Packard: Stiles, p. 51–55.
1910. *Dermacentor albipictus* Packard: Stiles, p. 60–63.
1910. *Dermacentor salmoni* Stiles, original description, p. 55–60.
1913. *Dermacentor albipictus* Packard: Bishopp and Wood, p. 161–174.
1913. *Dermacentor nigrolineatus* Packard: Bishopp and Wood, p. 180–186.

In 1869 Packard described *Ixodes albipictus* and *Ixodes nigrolineatus* in the same publication, and both have continued as accepted species to the present time. The types of both, in the Museum of Comparative Zoology, Cambridge, Mass., have been studied by the author.

As an abundance of material has continued to accumulate from many hosts and localities, and especially on receipt of specimens from California and western New Mexico, it became impossible to maintain *albipictus* and *nigrolineatus* as distinct species. Intergrades in both color and morphology were particularly evident among specimens from the above localities. Measurements and computations of a long series from different localities were made, but when the results were compared it was found that the means of the measurements in each of the sixteen measurements, and in their percentages of other measurements of other parts in the same tick showed no significant differences.

As previously stated, the biological differences between species of *Dermacentor*, including the host relationships and seasonal histories, are corroborative. *D. albipictus* is a one-host tick, and the larvae and nymphs feed on the same large animals as the adults, and do not drop for ecdysis. This is true also of "*nigrolineatus*." In part at least, both forms occur on the same host animals at the same time of the year. The writer knows of no biological differences between them.

Doubtless "*nigrolineatus*" was named and described as a distinct species because of black or dark "lines" visible in dorsal view, and caused by the diverticulae showing through the transparent dorsal wall usually present in this form. The writer considers this variant to be a weakened strain of the species. It would be of interest to know the reason for the transparency of the chitin, a condition which also occurs in exceptional specimens in other species. It appears to be caused by physical factors. Both forms have been collected in the same geographical regions in several instances. Furthermore, it will be observed by reference to the accompanying map that both forms have been taken, generally, all over the United States, but that the form "*nigrolineatus*" has been recorded more frequently in the more southern States.

The writer knows of no valid reason for retaining both names, and since *albipictus* has page priority over "*nigrolineatus*" in the same publication (Packard, 1869), the latter is made a synonym. *D. albipictus* is, therefore, very easy to identify. However, colored drawings and photographs of both forms are included, as well as photographs of the spiracular plates. This affords a better understanding of the species.

Base color brown; pattern color gray, some well ornamented specimens showing iridescence.

MALE[1]

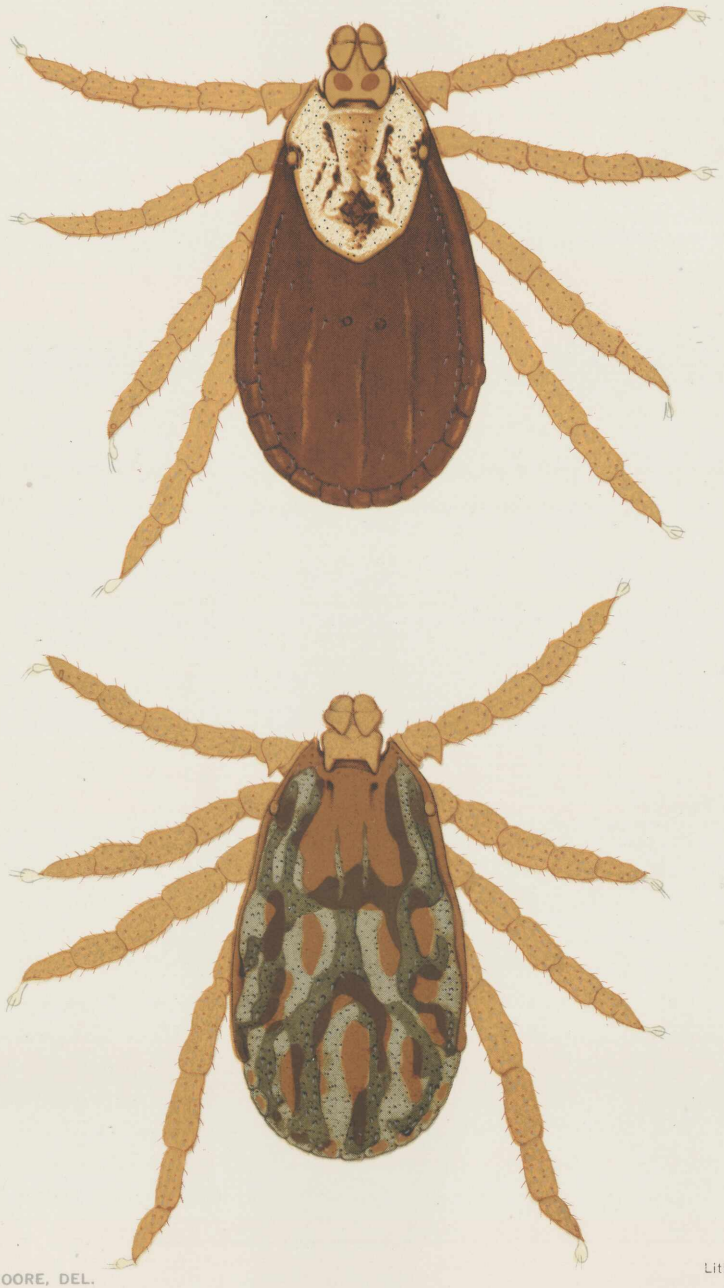
	Minimum	Maximum	Mean	Standard deviation
albipictus:[1]				
Length	3. 1	6. 1	**4. 656**	0. 95
Width	1. 8	3. 9	**2. 972**	. 60
Percentage, width of length	47	74	**64. 08**	5. 61
"*nigrolineatus*":[2]				
Length	2. 8	4. 4	**3. 4**	. 38
Width	1. 7	2. 6	**2. 1**	. 26
Percentage, width of length	58	70	**62. 7**	3. 4
Combined figures for *albipictus* and "*nigrolineatus*":				
Length	2. 8	6. 1	**3. 99**	
Width	1. 7	3. 9	**2. 509**	
Percentage, width of length	47	74	**63. 34**	

[1] 23 males in 9 lots from Montana, Yellowstone National Park, and Minnesota.
[2] 26 males in 3 lots from Arizona.

DORSAL VIEW

PLATE XVII, No. 1; PLATES XXIII AND XXIV

Capitulum—Basis capituli.—Wider than long, surface depressed between the bases of the cornua; punctations distinct, faint, or ab-



THOMAS J. MOORE, DEL.

Lith. A. Hoen & Co., Inc.

DERMACENTOR ALBIPICTUS PACKARD (''NIGROLINEATUS'' FORM).

Female (top) and male.

sent; pattern color distinct or, in "*nigrolineatus*", faint. Cornua well developed, notably variable in length in both forms, subacute or rounded. In the descriptions of this species, the term "form" is used to indicate a variant, not in a taxonomic sense. *Palpi:* Short, broad distally; posterodorsal elevation short and rounded caudally; a few punctations usually present, and with hairs on the lateral and anterior margins; pattern color present in well-ornamented specimens.

Scutum.—Cervical grooves short and shallow. Lateral grooves absent or visible only for a short distance anterior to the festoons; their positions indicated by broken rows of punctations. Punctations, with distinct but moderate disparity of sizes, distributed over entire surface of the scutum; small hairs often visible in the large punctations; smaller punctations more visible within the areas of the pattern color. Pattern color continuous, when easily visible, base color in spots, and both variable in extent and definition. In well-ornamented specimens, the pseudoscutum is clearly indicated in the pattern; pattern color continuous along the lateral margins; base color in distinct elongate spots in the median area and often in small spots on the festoons.

Legs (both sexes).—The hairs on the dorsal surface of the legs are large and numerous, and the pattern color is extensive in well-colored specimens. Dorsal spur on trochanter I long, attenuated, subacute, and usually with some pattern color present.

VENTRAL VIEW

PLATE XVII, No. 3; PLATES XXIX AND XXX

Capitulum—Basis capituli.—The posteroventral ridge a curved salience limiting the ventral surface posteriorly; a few small punctations often present; small lateral hairs present. *Palpi:* With ventral surfaces mildly irregular; lateral hairs present; punctations absent.

Coxae (both sexes).—Spurs on coxa I in both forms variable in length, contiguous at their bases, with their proximal edges parallel or mildly divergent, and rounded terminally; coxae II, III, and IV, with the external spurs well developed, about twice as long as the width at the base, attenuated (narrow), subacute; internal spurs on II and III short, broad, and with some tendency to be pointed terminally; internal spur on IV absent.

Spiracular plates (both sexes).—Notably variable in shape but always having the goblets large and moderate in number. The dorsal prolongation is never definitely present and may be only indicated or absent. In "nigrolineatus" the plates are smaller and, in the males, more elongated posteriorly.

FEMALE[1]

	Minimum	Maximum	Mean	Standard deviation
albipictus: [1]				
Length	3. 7	5. 5	**4. 7**	0. 56
Width	2. 0	3. 5	**2. 795**	. 38
Percentage, width of length	50	66	**59. 61**	3. 59
"*nigrolineatus*:" [2]				
Length	2. 8	3. 9	**3. 4**	. 31
Width	1. 6	2. 2	**1. 9**	. 17
Percentage, width of length	46	64	**57**	4. 4
Combined figures for *albipictus* and "*nigrolineatus*":				
Length	2. 8	5. 5	**4. 02**	
Width	1. 6	3. 5	**2. 329**	
Percentage, width of length	46	66	**58. 25**	

[1] 23 females in 8 lots from Montana and Yellowstone National Park.
[2] 25 females in 3 lots from Arizona.

DORSAL VIEW

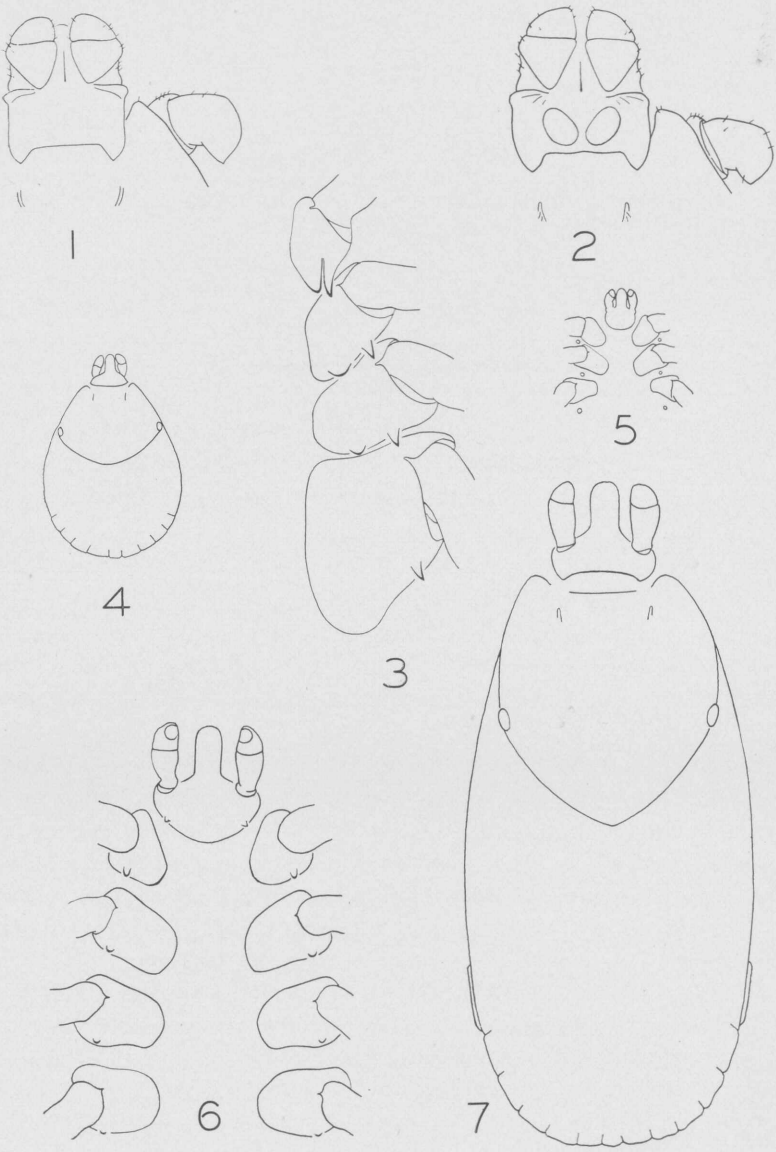
PLATE XVII, No. 2: PLATES XXIII AND XXIV

Capitulum—Basis capituli.—Nearly twice as broad as long; porose areas large, moderately depressed; punctations and hairs absent; pattern color present on well-colored specimens. Cornua variable in length, shorter than in the male, apically subacute or rounded. *Palpi:* Short, apically rounded; posterodorsal ridge moderate, with edges rounded; punctations faint or absent; short hairs present on the sides and anterior margin; pattern color present on well ornamented specimens.

Scutum.—Longer than wide, with the portion posterior to the eyes narrower than in the other United States species, usually subangulate laterally, and always with the posterior margin rounded. Cervical grooves shallow and usually short, but in some specimens they extend caudad in narrow, shallow grooves that first converge and then diverge and terminate before reaching the posterolateral margins of the scutum. Punctations with little disparity of sizes, the larger ones more numerous in the lateral areas and the smaller ones present over the entire surface and more visible when the pattern color is present. Well-ornamented specimens have the pattern color predominant, but in such specimens the base color is present in the cervical grooves and in the positions of their posterior extensions described above. Base color is often present in ocular spots, and as two divergent bars parallel and lateral to the markings just described.

Postscutal area.—Marginal grooves distinct, and limiting the first two festoons on each side.

For descriptions of female spiracular plate, coxae, and legs, see under male. All female ventral characters essentially the same as in the male.



DERMACENTOR ALBIPICTUS PACKARD.

1. Capitulum and part of scutum, male.
2. Same, female.
3. Coxae and spurs, male.
4. Larva, dorsal view.
5. Larva, ventral view.
6. Nymph, ventral view.
7. Nymph, dorsal view.

D. albipictus is easily distinguished from other United States species by its more elongate shape, and its rounded or oval spiracular plates with large goblets. Excepting *D. occidentalis* in California and southern Oregon, and *Otocentor nitens* in the southern point of Texas, it is the only United States species active on horses, cattle, and large game animals during the fall and winter months.

NYMPH

PLATE XVII, NOS. 6 AND 7; PLATE II, NO. 12

Length, 1.5 mm; width, 0.84 mm. Long oval. In dorsal view, unfed nymphs of *albipictus* are notably elongated and narrow, and when fed the elongated shape becomes even more apparent.

Basis capituli.—Subquadrate in dorsal profile and lacking the lateral points found in other species. Cornua are shown in some specimens and the excavated posterior margin is concave in profile. Ventral surface showing faintly the basal spurs which are narrow, scarcely more than saliences.

Scutum.—Length, 0.60 mm; width, 0.57 mm. Cervical grooves absent or very faint; posterior margin with a distinct tendency to become pointed.

Festoons faint.

Coxae.—Coxa I with the external spur well developed, rounded apically; internal spur small, pointed, faint; external spurs on II and III distinct but small, that on IV faint or absent. Internal spurs on II and III faint or absent; that on IV absent.

Spiracular plate.—Nearly circular, with goblets large and few in numbers; spiracular opening eccentric; length, 0.222 mm; width, 0.1781 mm.

LARVA

PLATE XVII, NOS. 4 AND 5

Length, 0.59 mm; width, 0.54 mm. Length of scutum, 0.24 mm; width 0.32 mm. Basis capituli not definitely extended laterally into points. Coxa II larger than III. Coxal spurs absent.

HOSTS

Packard (1869) described *albipictus* from specimens on moose shipped from Nova Scotia. The ticks were removed in New York where the animals were examined in transit to Europe (Hays 1868). The same author described *nigrolineatus* from a deer (*Cervus virginianus*), northern New York. Stiles (1910) records *albipictus* from moose and beaver (?), as *nigrolineatus* from deer and horse, and as *salmoni* on horse and cattle. Bishopp and Wood (1913) under

the name *albipictus* add the elk (*Cervus canadensis*), mule deer (*Odocoileus hemionus*), and deer (*Odocoileus virginianus texanus*). From the records of the Rocky Mountain Laboratory are to be added antelope (*Antilocapra americana americana*) and Rocky Mountain sheep (*Ovis canadensis*).

DISTRIBUTION

FIGURE 7

The records shown on the map are from Banks (1908), Bishopp and Wood (1913), and from the records of the Montana State Board of Entomology and the Rocky Mountain Laboratory.

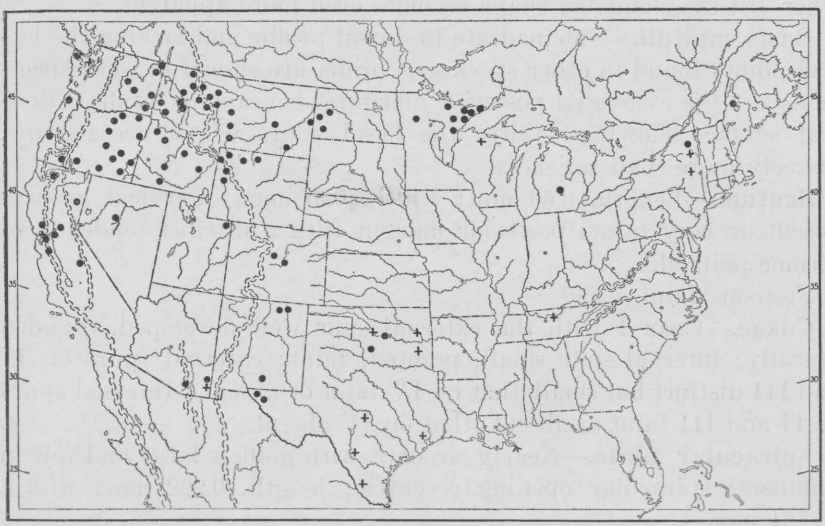
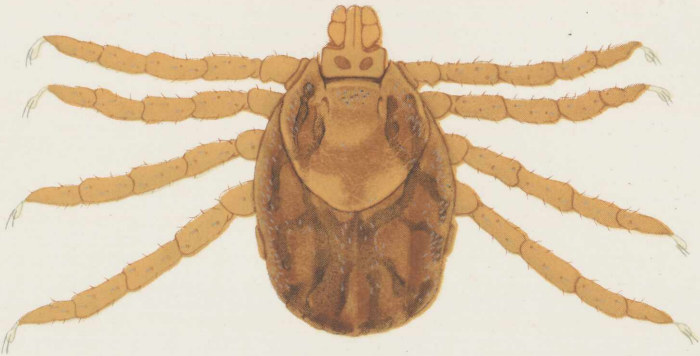


FIGURE 7.—Distribution of *Dermacentor albipictus*.

The black circles represent records of *albipictus* and the crosses, those of *nigrolineatus*. The records of the two forms are kept separate on the map in support of the statement on a previous page that the occurrences are intermingled and that *nigrolineatus* is relatively more abundant in the Southern States and warmer climates. Not all of the available records are shown, the main purpose being to show the extent of the distribution rather than the abundance of the species in any region.



THOMAS J. MOORE, DEL.

Lith. A. Hoen & Co.

OTOCENTOR NITENS (NEUMANN).

Female (top) and male.

OTOCENTOR—NEW GENUS

Inornate Ixodidae without ventral plates or shields; postanal grooves present but faint. Basis capituli rectangular dorsally. Coxa I bifid in both sexes. Palpi short, moderate in width, and when closed not covering the chelicerae and hypostome dorsally; palpus article 1 fused (not movably attached) with article 2; denticles arranged in four rows on each side of the median line; eyes present (obsolescent). Festoons, seven in number. Lateral grooves absent in the male; marginal grooves absent in the female.

Otocentor becomes a monotypic genus with *Dermacentor nitens* Neumann the type species.

OTOCENTOR NITENS (NEUMANN, 1897)

PLATE XVIII

1897. *Dermacentor nitens* Neumann, original description, p. 376–378.
1908. *Dermacentor nitens* Neumann: Banks, p. 50–51.
1910. *Dermacentor nitens* Neumann: Stiles, p. 63.
1911. *Dermacentor nitens* Neumann, p. 103.
1912. *Dermacentor nitens* Neumann: Hooker, Bishopp, and Wood, p. 197–204.

Inornate, yellow-brown in color.

MALE[1]

	Minimum	Maximum	Mean	Standard deviation
Length	2.3	2.9	2.7	0.14
Width	1.7	2.1	1.9	.9
Percentage, width of length	66	75	72	2.1

[1] 25 males in 3 lots from southern Texas.

DORSAL VIEW

PLATE XIX, No. 1; PLATE XXII

Capitulum—Basis capituli.—Wider than long, punctate, without hairs. Cornua short, and apically rounded. *Palpi:* Shorter than the hypostome, longer than wide, with the sides straight and with the anterior ends blunt. Dorsal surface swollen (tumescent) basally, and with hairs present at the sides and on the anterior end.

Scutum.—Convex, with the posterior region especially declivitous; lateral margins contracted in the vicinity of the spiracular plates, leaving portions of the dorsal wall not covered, but having numerous hairs which are visible also on the anterior lateral edges of the body; festoons seven in number, with the dividing grooves of irregular lengths. Surface smooth and with numerous punctations which are more apparent in the anterior areas, especially just caudad of the emargination; hairs are present, more apparent in the lateral and posterior areas. Cervical grooves shallow, narrow, and variable in length, usually a few times longer than wide. Lateral grooves absent. Eyes small, obsolescent.

Legs (both sexes).—Numerous hairs present, similar to those on the body; dorsal spur on trochanter I moderately developed, short and terminally rounded.

VENTRAL VIEW

PLATE XIX, No. 3; PLATE XXVII

Capitulum—Basis capituli.—Convex and with the posteroventral ridge and punctations absent; a few short hairs present at the sides. *Palpi*—Ventral surface is irregular; hairs are present at the sides; punctations absent.

Coxae (both sexes).—Smaller than in *Dermacentor* and with long hairs present, especially in the median areas. Coxa I with divergent, strong, short spurs, apically rounded and elevated. External spurs on II, III, and IV about as long as the width at the base, subtriangular, flattened and apically rounded and elevated; internal spurs on II and III broad, short, apically rounded and extending slightly beyond the margin of the coxae. In the female only, similar internal spurs are present but faint on coxae IV.

Spiracular plates (both sexes).—Oval in shape and with no dorsal prolongation in either sex; goblets few in number and notably large. The plate is prominently raised above the surface of the body.

FEMALE[1]

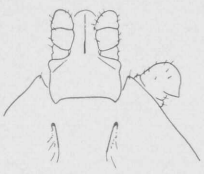
	Minimum	Maximum	Mean	Standard deviation
Length	2. 6	3. 1	**2. 9**	0. 12
Width	1. 8	2. 3	**2. 0**	. 11
Percentage, width of length	65	76	**70**	2. 6

[1] 25 females in 3 lots from southern Texas.

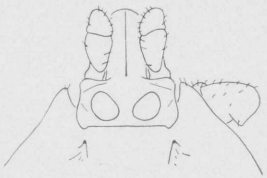
DORSAL VIEW

PLATE XIX, No. 2; PLATE XXII

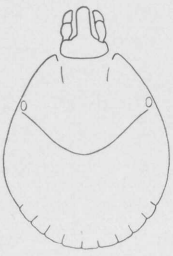
Capitulum—Basis capituli.—Twice as broad as long; porose areas oval, convex, and with their longer axes divergent anteriorly; puncta-



1

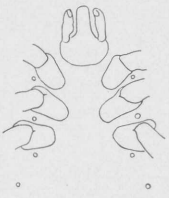


2

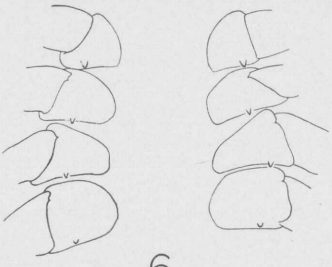


4

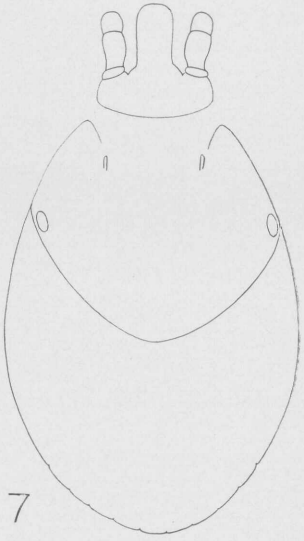
3



5



6



7

OCENTOR NITENS NEUMANN.

1. Capitulum, and part of scutum, male.
2. Same, female.
3. Coxae and spurs, male.
4. Larva, dorsal view.
5. Larva, ventral view.
6. Nymph, ventral view.
7. Nymph, dorsal view

tions and hairs absent; cornua absent (sometimes faintly indicated). *Palpi:* as in the male.

Scutum.—Length and width about equal. Posterior margin rounded. Cervical grooves shallow and narrow, sometimes faint or absent. Punctations more numerous and deeper in the cervical and humeral areas, where short hairs are usually present in the punctations. Eyes obsolescent.

Postscutal area.—The dorsal surface is narrowed in the vicinity of the spiracular plates and the latter are often visible; numerous hairs present in the lateral areas near the spiracular plates. Lateral grooves absent; seven festoons present, faintly delineated.

For descriptions of female spiracular plate, coxae, and legs, see under male. All female ventral characters essentially the same as in the male.

NYMPH

PLATE XIX, NOS. 6 AND 7; PLATE II, NO. 16

Length, 1.11 mm; width, 0.78 mm. The larvae and nymphs, compared with the adults, are proportionately larger than in *Dermacentor.*

Basis capituli.—In both dorsal and ventral profile, the basis capituli is subquadrate whereas in most species of *Dermacentor* it is subtriangulate. Posterior margin of the basis capituli, both dorsally and ventrally, broadly rounded. Basal spurs are absent. Hypostome with three rows of about nine denticles on each side of the median line.

Scutum.—Length, 0.54 mm; width, 0.60 mm. A little wider than long, rounded on the posterior margin with only a slight tendency to become pointed. Numerous and conspicuous hairs are present in the vicinity of the spiracular plates, visible from both dorsal and ventral views.

Festoons very faint or absent.

Coxae.—External spurs I, II, III, and IV definite but small; internal spur on I very small, indefinite; those on II, III, and IV absent.

Spiracular plates.—Remarkable for their large size; subcircular, with the spiracular opening near the center. Goblets very large and only three to eight in number. Length, 0.258 mm; width, 0.221 mm.

LARVA

PLATE XIX, NOS. 4 AND 5

Length, 0.54 mm; width, 0.45 mm. Length of scutum, 0.26 mm; width, 0.39 mm. Basis capituli subquadrate dorsally. Coxa II longer than III. No coxal spurs visible.

HOSTS

Neumann's (1897) type host was the horse. Hooker, Bishopp, and Wood (1912) report the species from the mule, ass, goat, and ox.

It is quite clear that the horse and related animals are the principal hosts. The Rocky Mountain Laboratory has records of numerous specimens taken from the horse, and a few from the goat (Brownsville, Tex).

DISTRIBUTION

FIGURE 8

Otocentor nitens was originally described by Neumann from specimens from Jamaica and Santo Domingo. The species probably occurs in the United States only in the southern point of Texas as shown in the map.

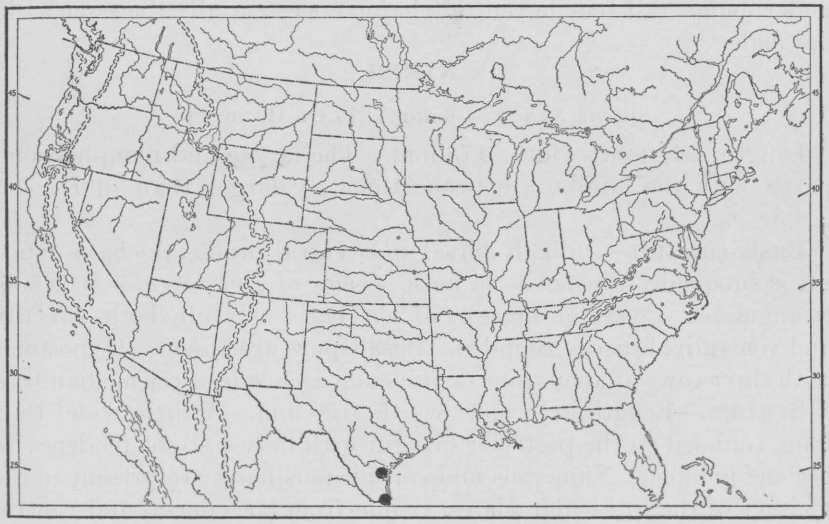
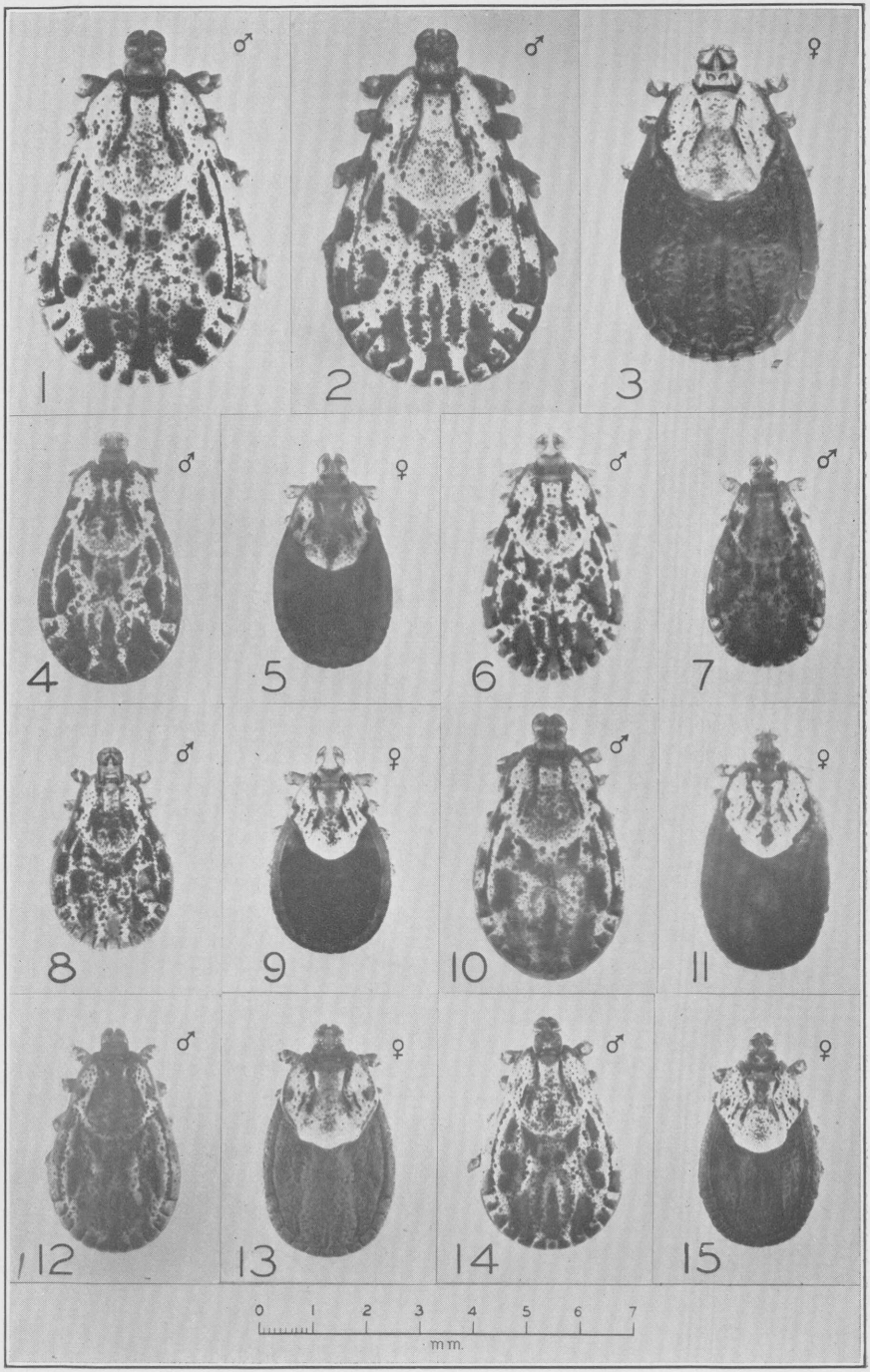


FIGURE 8.—Distribution of *Otocentor nitens*.

Banks (1908) reported the tick from Fort Bowie, southern Arizona, but this location is now in question, as recent correspondence from Prof. Charles T. Vorhies, Tucson, Ariz., states he feels sure that the species does not occur in that State. It seems probable that the specimens mentioned by Banks (1908, p. 51) as coming from Fort Bowie, Ariz., were taken from horses or pack animals from Mexico. Hooker, Bishopp, and Wood (1912) report the tick in Mexico, Guatemala, Panama, Costa Rica, Cuba, Haiti, and Trinidad. The Rocky Mountain Laboratory has a record from Bogota, Colombia.



MALES AND FEMALES.

Studies in variation.

STUDIES IN VARIATION—MALES AND FEMALES

PLATE XX

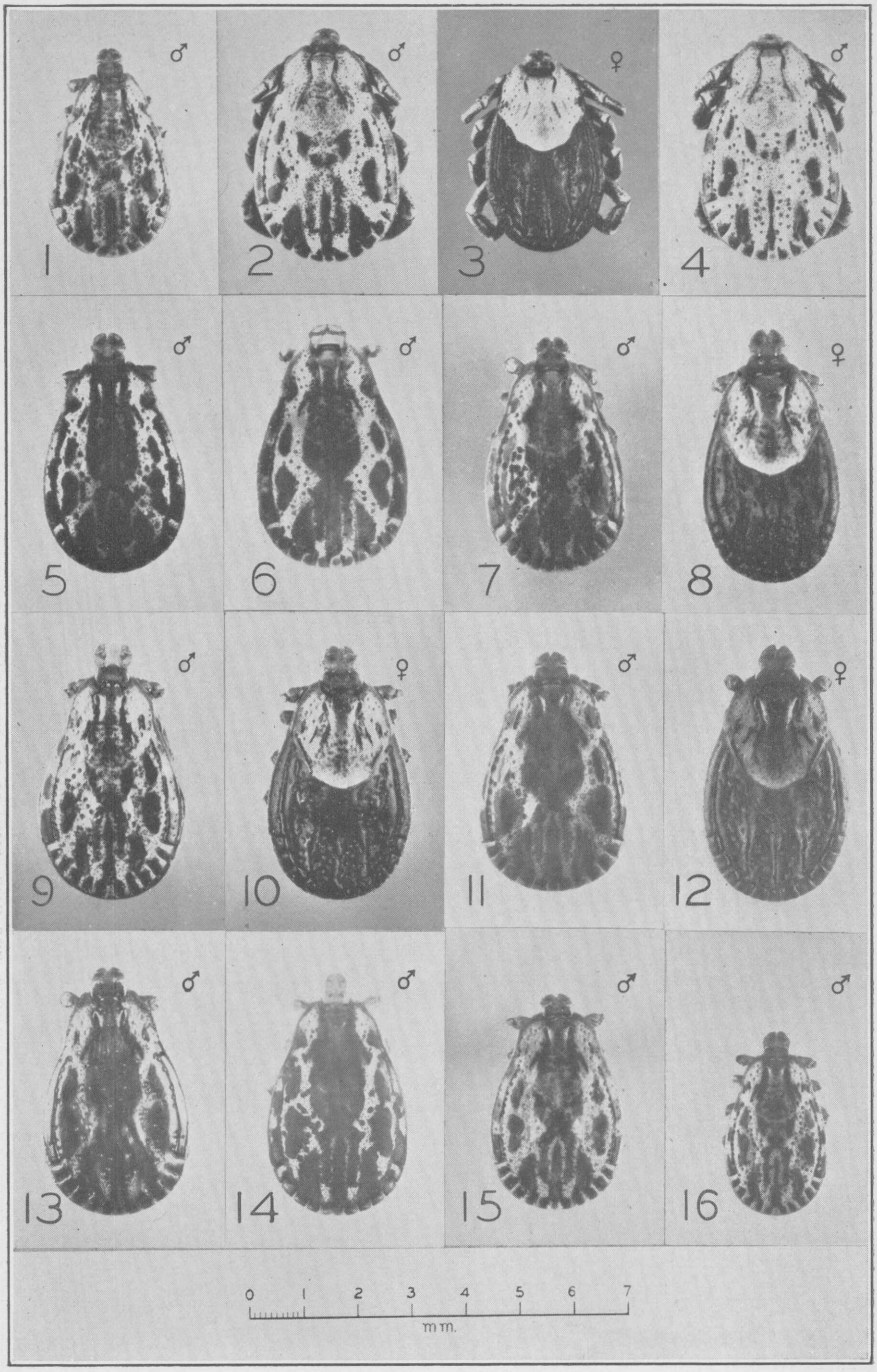
No.

1. *Dermacentor andersoni*, male, unusually large specimen, "drag" tick, Ravalli County, Mont.
2. *D. andersoni*, male, unusually large specimen, "drag" tick, Ravalli County, Mont.
3. *D. andersoni*, female, same source as no. 2.
4. *D. andersoni*, male, Antonito, Colo., porcupine.
5. *D. andersoni*, female, same source as no. 4.
6. *D. andersoni*, male, Cimarron, Colo.
7. *D. andersoni*, male, Antonito, Colo., deer.
8. *D. andersoni*, male, Lander, Wyo., ground squirrel (reared).
9. *D. andersoni*, female, same source as no. 8.
10. *D. andersoni*, male, Modoc County, Calif., porcupine.
11. *D. andersoni*, female, same source as no. 10.
12. *D. andersoni*, male (reared), "stock" tick.
13. *D. andersoni*, female, same source as no. 12.
14. *D. andersoni*, male (reared), "stock" tick.
15. *D. andersoni*, female, same source as no. 14.

PLATE XXI

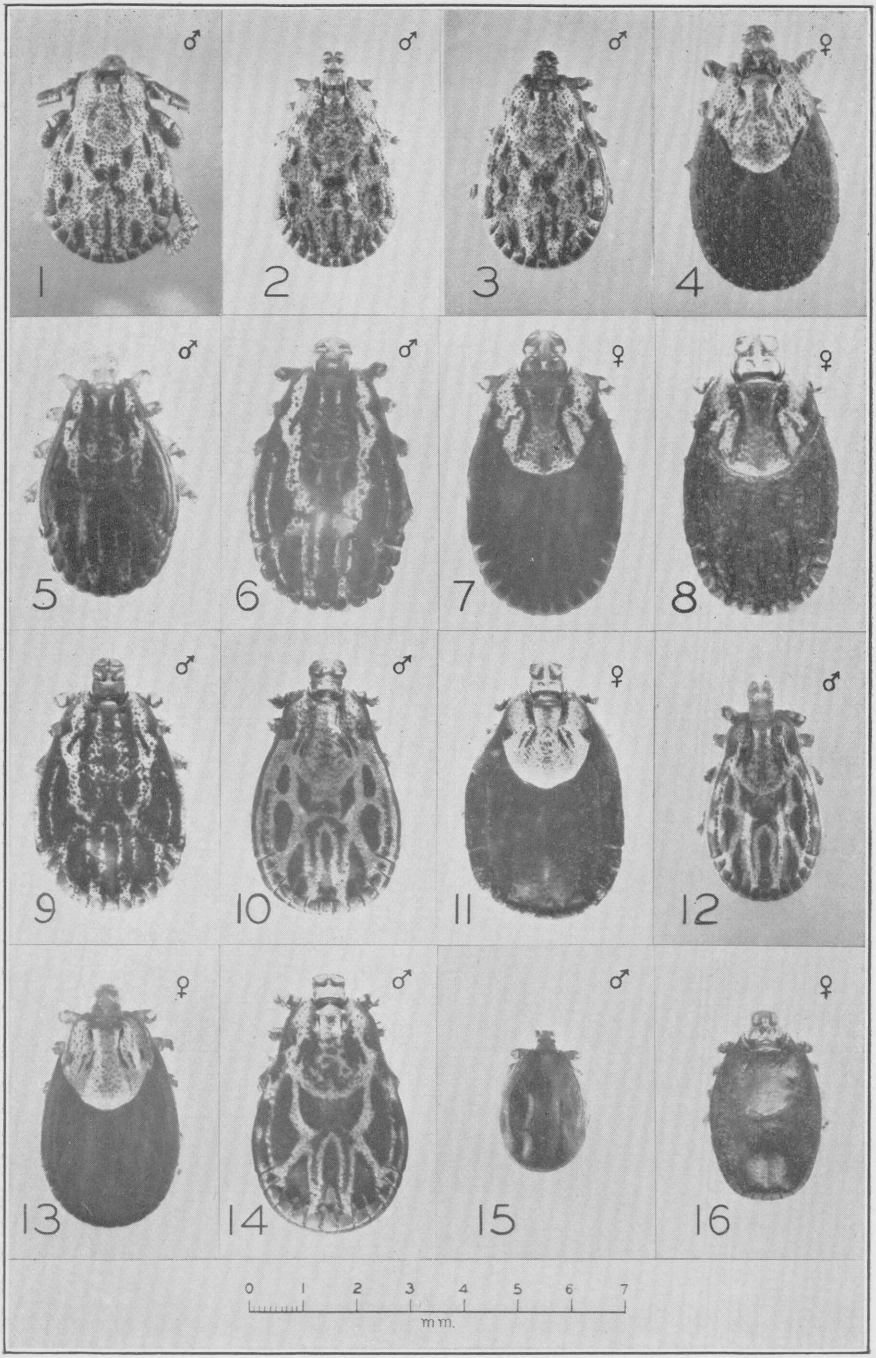
No.

1. *Dermacentor andersoni*, male (reared), "stock" tick.
2. *D. andersoni*, male, "drag" tick, Ravalli County, Mont.
3. *D. andersoni*, female, same source as no. 2.
4. *D. andersoni*, male, same source as no. 2.
5. *Dermacentor variabilis*, male, Minnesota.
6. *D. variabilis*, male, Kernville, Calif., dog.
7. *D. variabilis*, male, Naushon Island, Mass.
8. *D. variabilis*, female, same source as no. 7.
9. *D. variabilis*, male, Brownsville, Tex., horse.
10. *D. variabilis*, female, same source as no. 9.
11. *D. variabilis*, male, Minnesota.
12. *D. variabilis*, female, same source as no. 11.
13. *D. variabilis*, male, same source as no. 11.
14. *D. variabilis*, male, Halsey, Nebr.
15. *D. variabilis*, male, Catarina, Tex.
16. *D. variabilis*, male, Kingsville, Tex., peccary.



MALES AND FEMALES.

Studies in variation.



MALES AND FEMALES.

Studies in variation.

PLATE XXII

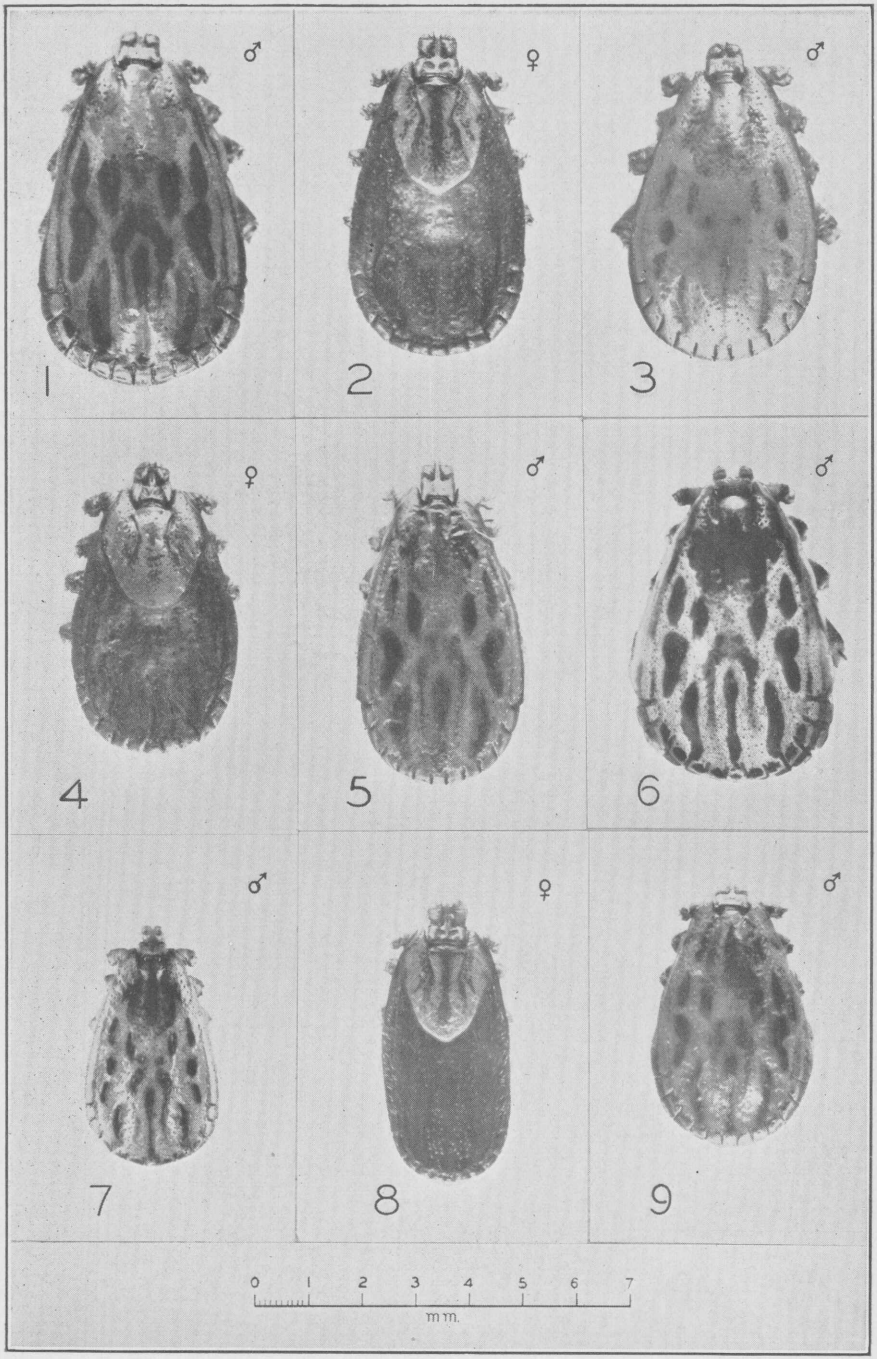
No.

1. *Dermacentor occidentalis*, male, reared stock from California.
2. *D. occidentalis*, male, Riverside County, Calif., California ground squirrel (reared).
3. *D. occidentalis*, male, emerged from nymphs from ground squirrels near Grants Pass, Oreg.
4. *D. occidentalis*, female, same source as no. 3.
5. *Dermacentor halli*, male, reared from specimens taken from peccary, Kingsville, Tex.
6. *D. halli*, male, Kingsville, Tex., peccary.
7. *D. halli*, female, same source as no. 6.
8. *D. halli*, female, same source as no. 6.
9. *D. halli*, male, same source as no. 5.
10. *Dermacentor hunteri*, male, Quartzsite, Ariz., Rocky Mountain sheep.
11. *D. hunteri*, female, same source as no. 10.
12. *D. hunteri*, male, reared from specimens taken at Quartzsite, Ariz., Rocky Mountain sheep.
13. *D. hunteri*, female, same source as no. 12.
14. *D. hunteri*, male, Libertad, Mexico, Rocky Mountain sheep.
15. *Otocentor nitens*, male, Brownsville, Tex., donkey.
16. *O. nitens*, female, same source as no. 15.

PLATE XXIII

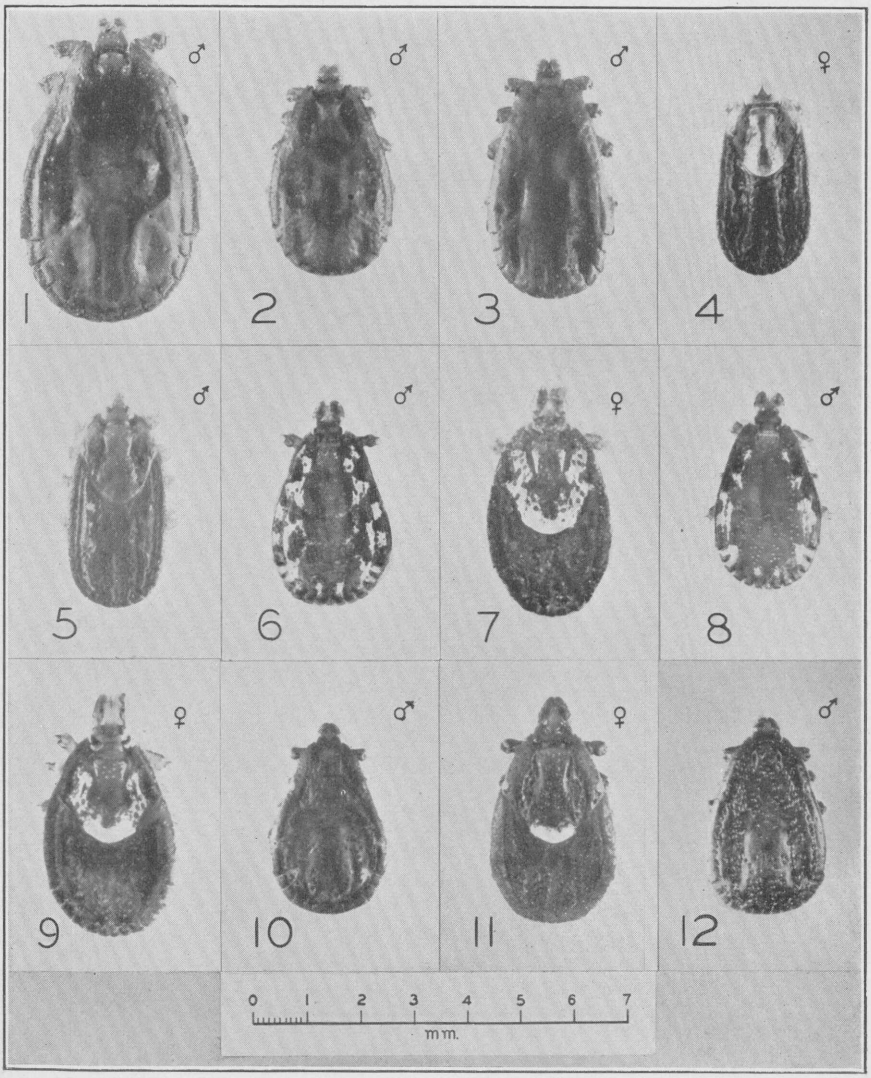
No.

1. *Dermacentor albipictus*, male, Ely, Minn., moose.
2. *D. albipictus*, female, same source as no. 1.
3. *D. albipictus*, male, Ravalli County, Mont., Rocky Mountain goat.
4. *D. albipictus*, female, same source as no. 3.
5. *D. albipictus*, male, Ravalli County, Mont., deer.
6. *D. albipictus*, male, Yellowstone National Park, Wyo., elk calf.
7. *D. albipictus*, male, Yellowstone National Park, Wyo., elk.
8. *D. albipictus*, female, Boise, Idaho.
9. *D. albipictus*, male, Mayfield, Idaho, horse.



MALES AND FEMALES.

Studies in variation.



MALES AND FEMALES.

Studies in variation.

Plate XXIV

No.

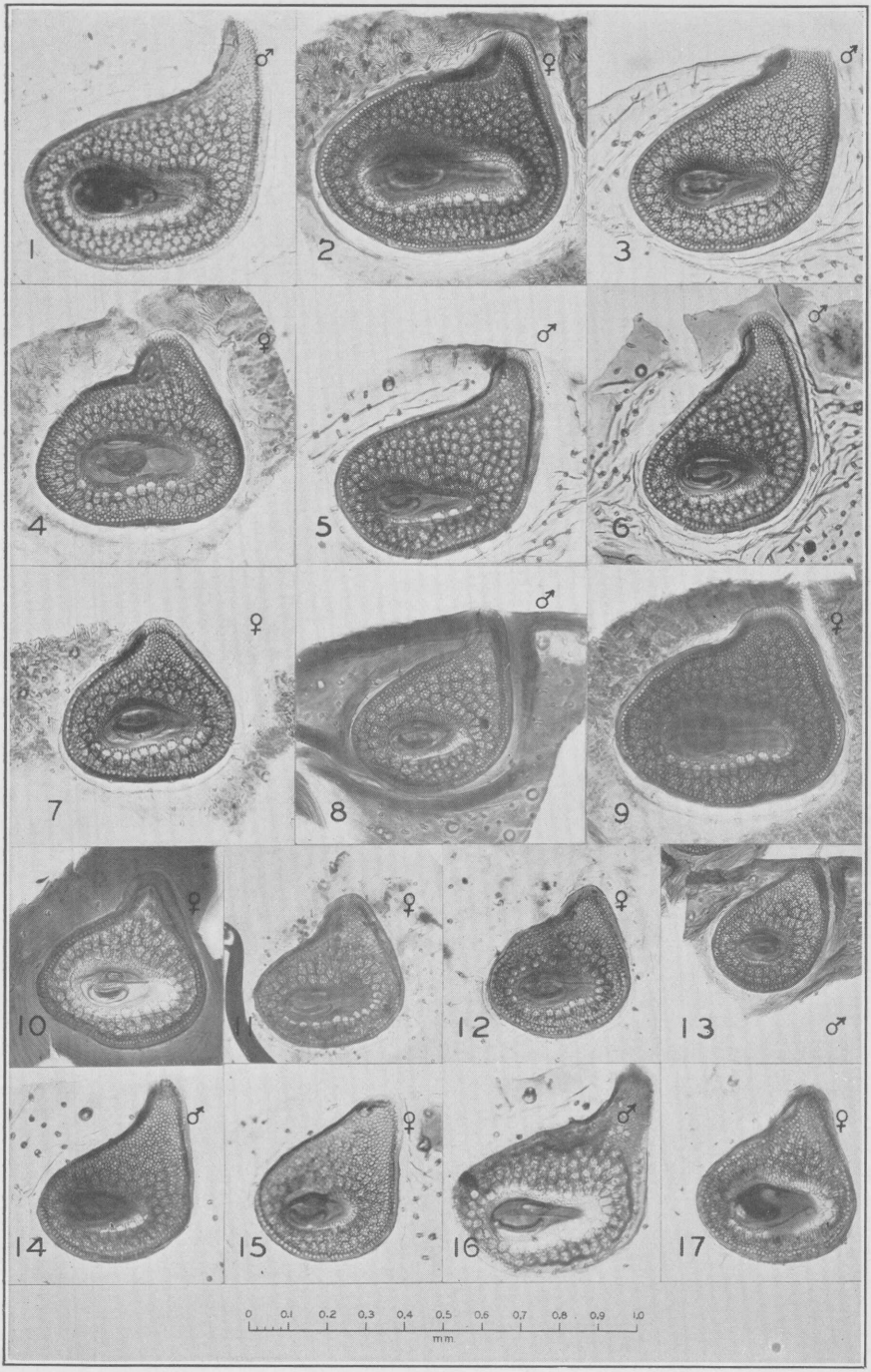
1. *Dermacentor albipictus* ("nigrolineatus"), male, Gila National Forest, N. Mex., deer.
2. *D. albipictus* ("nigrolineatus"), male, Mexico, deer.
3. *D. albipictus* ("nigrolineatus"), male, Dos Cabezos, Ariz., cow.
4. *D. albipictus* ("nigrolineatus"), female, same source as no. 3.
5. *D. albipictus* ("nigrolineatus"), female, same source as no. 2.
6. *Dermacentor parumapertus*, male, Hope, N. Mex., jack rabbit.
7. *D. parumapertus*, female, same source as no. 6.
8. *D. parumapertus*, male, Hope, N. Mex., jack rabbit.
9. *D. parumapertus*, female, same source as no. 8.
10. *D. parumapertus*, male, Idaho "stock."
11. *D. parumapertus*, female, same source as no. 10.
12. *D. parumapertus*, male (reared), "stock", Mayfield, Idaho.

STUDIES IN VARIATION—SPIRACULAR PLATES

PLATE XXV

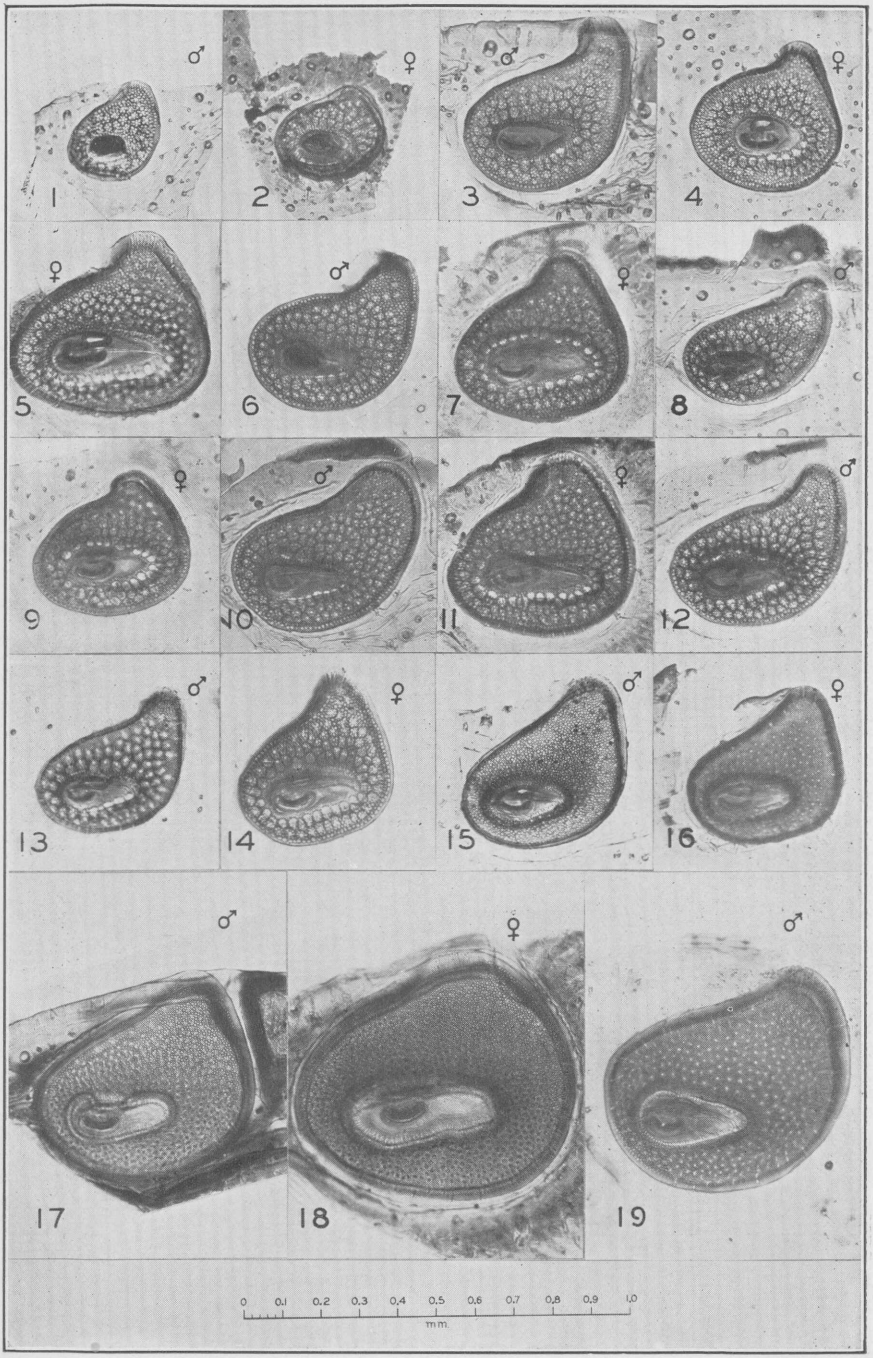
No.

1. *Dermacentor andersoni*, male, very large "drag" tick, Ravalli County, Mont.
2. *D. andersoni*, female, same source as no. 1.
3. *D. andersoni*, male (reared), "stock" tick.
4. *D. andersoni*, female, same source as no. 3.
5. *D. andersoni*, male, hybrid (*D. andersoni* and *D. occidentalis*).
6. *D. andersoni*, male, reared "stock" from Montana.
7. *D. andersoni*, female, same source as no. 6.
8. *D. andersoni*, male, Det. Banks, Dallas no. 727.
9. *D. andersoni*, female, hybrid, third generation (*D. andersoni* and *D. occidentalis*).
10. *D. andersoni*, female, Det. Banks, Dallas no. 723.
11. *D. andersoni*, female, Burns, Oreg., chipmunk.
12. *D. andersoni*, female, Conejos Canyon, Colo., porcupine.
13. *D. andersoni*, male (reared), "stock" tick, Ravalli County, Mont.
14. *D. andersoni*, male, Conejos Canyon, Colo., porcupine.
15. *D. andersoni*, female, same source as no. 14.
16. *D. andersoni*, male, same source as no. 14.
17. *D. andersoni*, female, same source as no. 14.



SPIRACULAR PLATES.

Studies in variation.



SPIRACULAR PLATES.

Studies in variation

PLATE XXVI

No.

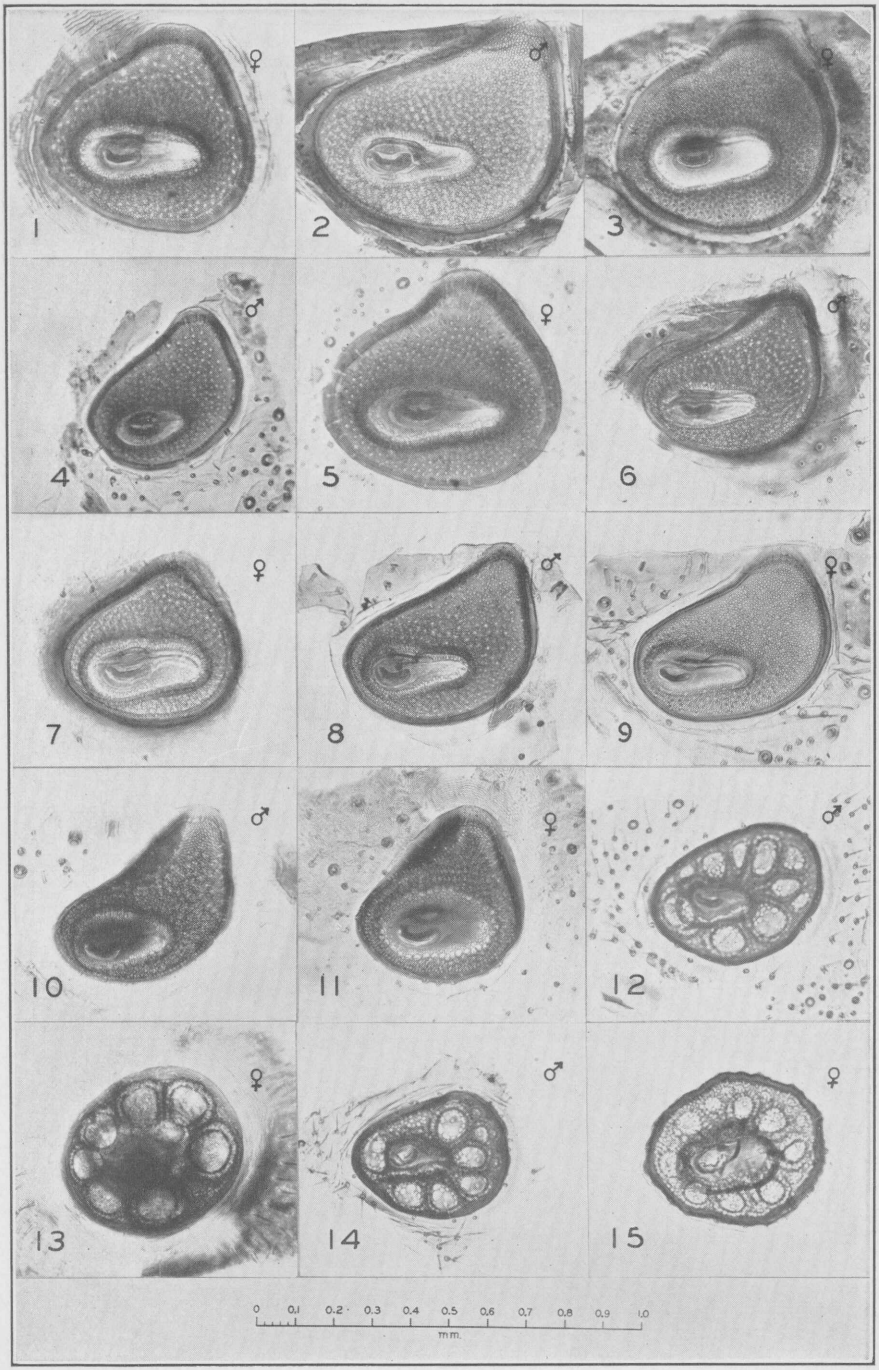
1. *Dermacentor andersoni*, male, Burns, Oreg., chipmunk.
2. *D. andersoni*, female, same source as no. 1.
3. *D. andersoni*, male, Fox Creek, Colo., jack rabbit.
4. *D. andersoni*, female, same source as no. 3.
5. *D. andersoni*, female, same source as no. 3.
6. *Dermacentor occidentalis*, male, Douglas County, Oreg., ground squirrel.
7. *D. occidentalis*, female, same source as no. 6.
8. *D. occidentalis*, male, Cayucas, Calif., cattle, Bishopp no. 1790.
9. *D. occidentalis*, female, same source as no. 8.
10. *D. occidentalis*, male (reared), "stock" tick.
11. *D. occidentalis*, female, same source as no. 10.
12. *D. occidentalis*, male, Bass Lake, Calif.
13. *D. occidentalis*, male, Seven Oaks, Calif., horse.
14. *D. occidentalis*, female, same source as no. 13.
15. *Dermacentor variabilis*, male, Catarina, Tex., peccary.
16. *D. variabilis*, female, same source as no. 15.
17. *D. variabilis*, male, Naushon Island, Mass.
18. *D. variabilis*, female, same source as no. 17.
19. *D. variabilis*, male, Osceola, Iowa.

3012—38——6

Plate XXVII

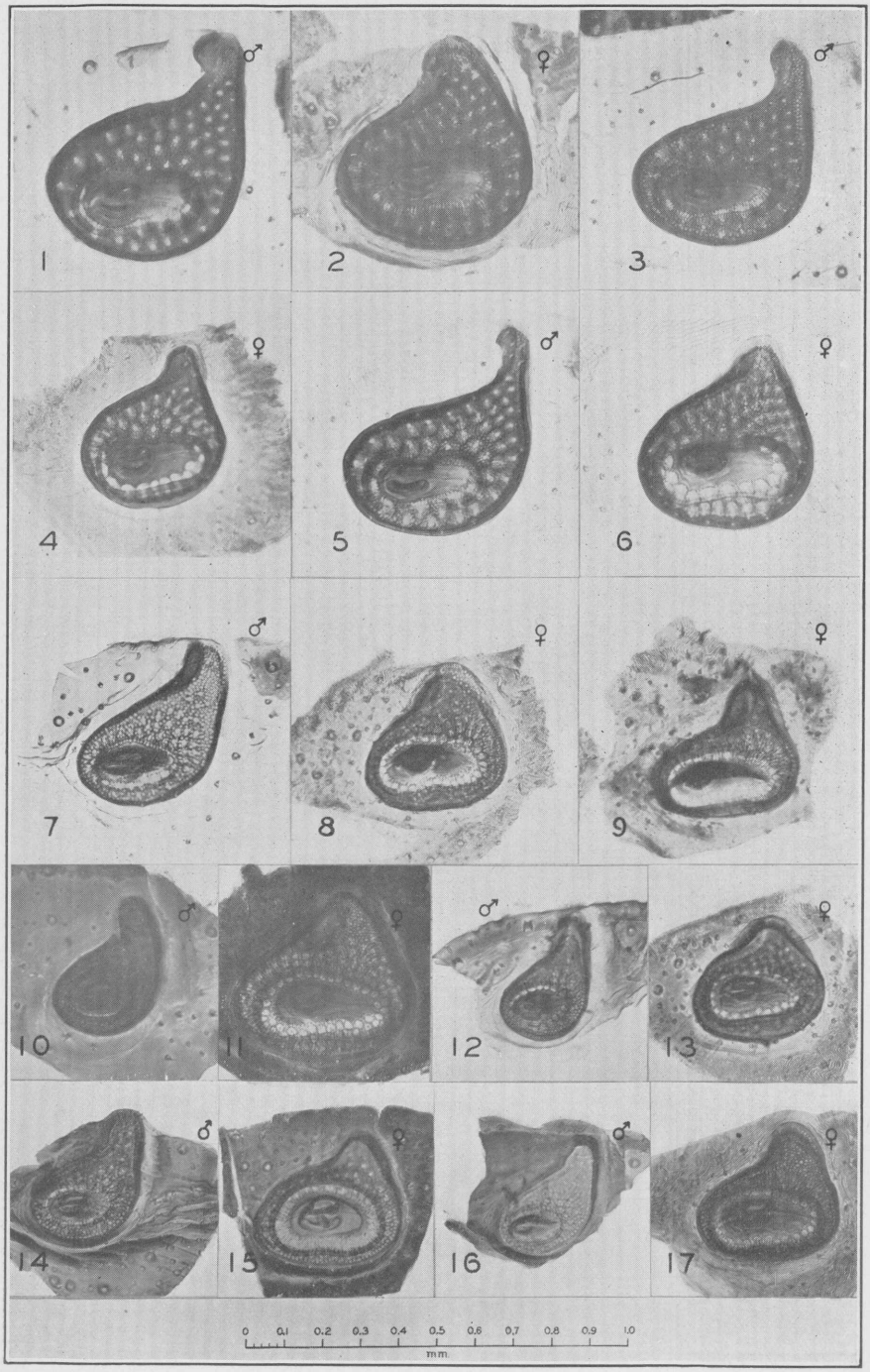
No.

1. *Dermacentor variabilis*, female, Osceola, Iowa.
2. *D. variabilis*, male, Minnesota.
3. *D. variabilis*, female, same source as no. 2.
4. *D. variabilis*, male, Stillwater, Okla., cow.
5. *D. variabilis*, female, same source as no. 4.
6. *D. variabilis*, male, Brownsville, Tex., dog.
7. *D. variabilis*, female, same source as no. 6.
8. *D. variabilis*, male, Kingsville, Tex., peccary.
9. *D. variabilis*, female, same source as no. 8.
10. *Dermacentor halli*, male, Kingsville, Tex., peccary.
11. *D. halli*, female, same source as no. 10.
12. *Otocentor nitens*, male, Brownsville, Tex., horse.
13. *O. nitens*, female, same source as no. 12.
14. *O. nitens*, male, Parker's collection, horse.
15. *O. nitens*, female, same source as no. 14.



SPIRACULAR PLATES.

Studies in variation.



SPIRACULAR PLATES.

Studies in variation.

Plate XXVIII

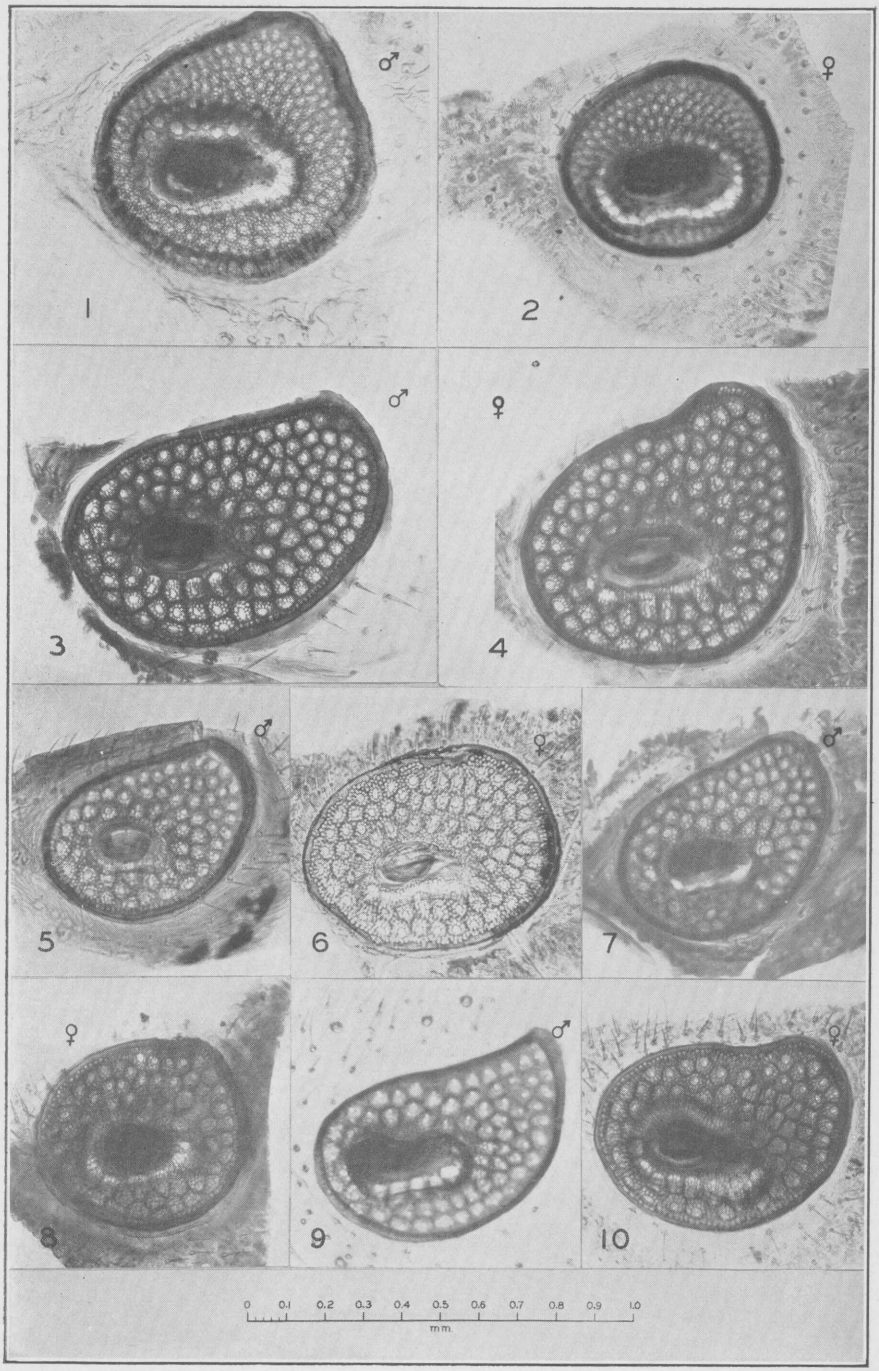
No.

1. *Dermacentor hunteri*, male, Libertad, Mexico, Rocky Mountain sheep.
2. *D. hunteri*, female, same source as no. 1.
3. *D. hunteri*, male, Quartzsite, Ariz., Rocky Mountain sheep.
4. *D. hunteri*, female, same source as no. 3.
5. *D. hunteri*, male, same source as no. 3.
6. *D. hunteri*, female, same source as no. 3.
7. *Dermacentor parumapertus*, male, Grandview, Idaho, "stock."
8. *D. parumapertus*, female, same source as no. 7.
9. *D. parumapertus*, female, Tucson, Ariz., *Lepus alleni*.
10. *D. parumapertus*, male, Hope, N. Mex., jack rabbit.
11. *D. parumapertus*, female, same source as no. 10.
12. *D. parumapertus*, male, Banning, Calif., jack rabbit.
13. *D. parumapertus*, female, same source as no. 12.
14. *D. parumapertus*, male, Grandview, Idaho, jack rabbit.
15. *D. parumapertus*, female, same source as no. 14.
16. *D. parumapertus*, male, Beaver, Utah, jack rabbit.
17. *D. parumapertus*, female, same source as no. 16.

Plate XXIX

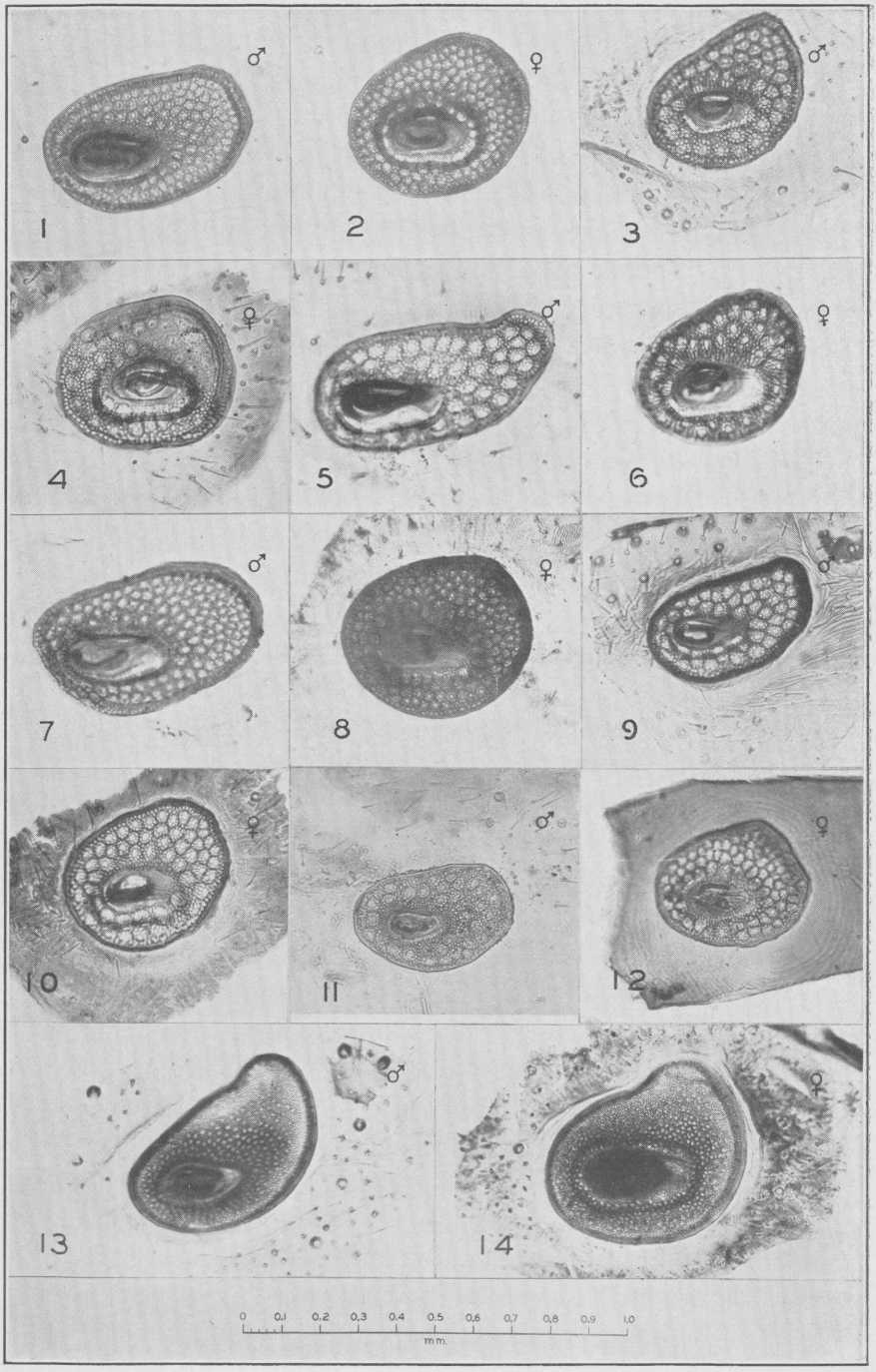
No.

1. *Dermacentor albipictus*, male, Blodgett Canyon, Ravalli County, Mont., Rocky Mountain goat.
2. *D. albipictus*, female, same source as no. 1.
3. *D. albipictus*, male, Ely, Minn., moose.
4. *D. albipictus*, female, same source as no. 3.
5. *D. albipictus*, male, Libby, Mont., white-tailed deer.
6. *D. albipictus*, female, same source as no. 5.
7. *D. albipictus*, male, Mayfield, Idaho, horse.
8. *D. albipictus*, female, same source as no. 7.
9. *D. albipictus*, male, Ravalli County, Mont., horse.
10. *D. albipictus*, female, same source as no. 9.



SPIRACULAR PLATES.

Studies in variation.



SPIRACULAR PLATES.

Studies in variation.

Plate XXX

No.

1. *Dermacentor albipictus* ("nigrolineatus"), male, Oakland, Calif., horse.
2. *D. albipictus* ("nigrolineatus"), female, same source as no. 1.
3. *D. albipictus* ("nigrolineatus"), male, Dos Cabezos, Ariz., cow.
4. *D. albipictus* ("nigrolineatus"), female, same source as no. 3.
5. *D. albipictus* ("nigrolineatus"), male, Gila National Forest, N. Mex., black-tailed deer.
6. *D. albipictus* ("nigrolineatus"), female, same source as no. 5.
7. *D. albipictus* ("nigrolineatus"), male, same source as no. 1.
8. *D. albipictus* ("nigrolineatus"), female, same source as no. 1.
9. *D. albipictus* ("nigrolineatus"), male, Dos Cabezos, Ariz., cow.
10. *D. albipictus* ("nigrolineatus"), female, same source as no. 9.
11. *D. albipictus* ("nigrolineatus"), male, Mississippi, Bishopp no. 2758.
12. *D. albipictus* ("nigrolineatus"), female, same source as no. 11.
13. *Dermacentor reticulatus*, male, France, Dr. E. Brumpt.
14. *D. reticulatus*, female, same source as no. 13.

ADDENDUM

Dermacentor albipictus (Packard)

Since the preparation of the paper to which this addendum is attached, there have been received other lots of ticks, which make desirable further comments on the old "*nigrolineatus*." The following discussion mainly concerns these lots and the previously mentioned ones from California, New Mexico, and Arizona.

Early in November 1937 a letter was received from Dr. W. A. Riley of the University of Minnesota, accompanied by ticks collected on cattle October 10–28, 1937 by a correspondent at Tamarack, Aitkin County, Minn. The lot contained 16 females, 5 males and 35 nymphs, and the adults were notable in being of about average size for *albipictus*, devoid of color pattern, and heavily sclerotized.

At about the same time a few specimens were received from Prof. C. E. Sanborn, Stillwater, Okla. These were taken from deer, November 6, 1937, at Dusty, N. Mex., and were smaller than the average northern specimens of *albipictus*. Like the Riley specimens they were heavily sclerotized and had no color pattern.

These two new lots and ones received earlier from California and New Mexico show the same variable morphological characters found in *albipictus* and *nigrolineatus* and all are well or heavily sclerotized. Those from California and the earlier lot from New Mexico had the color pattern moderate, while those from Dr. Riley and Professor Sanborn had the color pattern absent. On the other hand, the specimens from Dos Cabezos, Ariz., the fifth lot, were lightly sclerotized and had the color pattern faint or absent. Detailed discussion follows.

The reader's attention is now directed to plates XXIII, XXIV, XXIX, and XXX in the main paper for variation in size, shape, and coloration in the males and females and in the spiracular plates of both sexes. The specimens (pl. XXX, 1 and 2) from near Berkeley, Calif., sent in by Dr. C. M. Wheeler, then of the University of California, and those from Gila National Forest (pl. XXIV, 1), sent by A. C. Pickins, Silver City, N. Mex., were of about average size, had the color pattern moderately distinct, and were heavily sclerotized. The presence in these specimens of a distinct color pattern, the heavy sclerotization, as well as the variable morphological characters of both *albipictus* and *nigrolineatus* left no criteria for specific differentiation.

As to *albipictus*, as heretofore understood, the species was quite variable in size, always well sclerotized, and had the color pattern brilliant or moderate.

In the light of the fuller information on specific identity and variation of the species of *Dermacentor* now available, Packard's descriptions of *albipictus* and *nigrolineatus*, published in 1869 are of little value. Banks (1908) redescribed both of the Packard species and in doing so pointed out characters that were supposed to be of diagnostic value.

In the description of the male of *nigrolineatus*, Banks points out the following:

> No white markings, but the black caecal marks show through in most specimens as several irregular lines behind; capitulum small and narrow, its posterior angles produced into long spines; dorsum slender, about one and two-thirds times as long as broad; with many short hairs; stigmal plate large, elliptical without dorsal prolongation.

Banks gives 3.5 mm as the length of the *nigrolineatus* male and of the male *albipictus* as 4.0 mm. Female,

> shield without marks; capitulum scarcely twice as broad as long; hind angles distinctly prolonged behind; porose areas large, oval, and distinctly separated; shield, tapering and almost pointed behind; stigmal plate elliptical, of same shape as in male, no dorsal prolongation; length of female shield, 1.2 mm. [For the length of female shield of *albipictus* he gives 2.0–2.2 mm.] It is allied to *D. albipictus*, but differs in shape of stigmal plate, more distinctly separated porose areas, sharper hind angles to the capitulum, shield more pointed behind.

Stiles (1910) also redescribed *nigrolineatus* and in doing so covered practically the same characters as found in the Banks description which bore an earlier dating.

Both Banks and Stiles mentioned as characters various other points which now, in the light of fuller information on the structures which the various species of *Dermacentor* have in common, are of little or no recognized value. However, Stiles' paper (1910) is of particular interest because of his thorough study of the spiracular plates, but he had before him only a very few specimens and could not include significant information on variation.

Referring now to the points set up by Banks, above, in the light of the study of an abundance of *albipictus* and *nigrolineatus* it is possible more thoroughly to evaluate the Banks characters.

The average size of *albipictus* and *nigrolineatus* is about the same. The lots of *nigrolineatus* from California and New Mexico are larger than *albipictus* on deer and domestic animals in the Northern States. The largest specimens observed and having a distinct, brilliant color pattern, come from the Rocky Mountain goat in Ravalli County, Mont., and from moose, at Ely, northern Min-

nesota. Thus, the Riley specimens from cattle at Tamarack, Minn., and those from moose at Ely, Minn., originate from two localities which are only some 50 miles apart. Our long series of biometric measurements have shown no significant differences between *albipictus* and *nigrolineatus*.

Banks states that no white markings occur in *nigrolineatus* and that "black caecal markings" are present. Our studies have shown that living and alcoholic specimens from Arizona, which show the caecal markings very plainly, do have the color pattern distinctly present in some individuals and absent in others. In these same ticks the spiracular plates are much as described by Banks, but when the range of variation in all of the supposed diagnostic characters in these and other specimens is considered, the specimens are indistinguishable from *albipictus*.

Similarly, the specimens from California and New Mexico have the color pattern almost brilliant, are well sclerotized, and have spiracular plates similar to both those from Arizona and from Tamarack, Minn. In size these specimens are intermediate.

In both *albipictus* and *nigrolineatus* the size and width of the basis capituli and the length of the cornua are particularly variable in both sexes and it is impossible to separate the two on these structures.

In both *albipictus* and *nigrolineatus* the width, in proportion to the length, in the adults and in the nymphs, is very variable. We have noted this particularly in *albipictus* in Ravalli County, Mont., and in *nigrolineatus* from Arizona.

Referring to hairs on *nigrolineatus*, they are present also on *albipictus*. They vary in both forms, and in some lots they are much more in evidence. The specimens from California have in the males the longer spiracular plate and a well-marked color pattern, and yet these specimens have a very few short hairs, as in many specimens of *albipictus*.

The spiracular plates are of particular interest. Banks points out that in *nigrolineatus* they are large, elliptical, and without dorsal prolongation. In his redescription of *albipictus* he mentions of the male plates, "elliptical, without distinct dorsal prolongation," and of the female, "large, semi-elliptical, without distinct dorsal prolongation." Survey of a considerable number of these structures in both *albipictus* and *nigrolineatus*, only a part of which were included in the plates of the publication to which this is attached, showed the spiracular plates to be quite variable. The Riley specimens show the plates to be intermediate in size and in shape and fall in between northern *albipictus* and *nigrolineatus* from Dos Cabezos, Ariz.

The porose areas in both forms are very variable in size, and the size, in part at least, governs the width, or the interval, between the two areas. The writer has found it impossible to consider the character to be of diagnostic value.

Banks states that the shield (scutum) is almost pointed behind. The shape of the scutum varies considerably and the character has not been found to be dependable.

In the writer's opinion if there is any tenable morphological character which would distinguish between the two forms under discussion, it might possibly be found in the spiracular plates. This will be better understood through a study of the figures in plates XXIX and XXX.

We are largely lacking in knowledge that would explain the variation in the coloration and the sclerotization in ticks. If we had such a knowledge it might be of value in both the taxonomic and biological fields. It is recognized that some groups of Ixodidae are "ornate" or "ornamented" and that others are "inornate." Ticks of the genus *Dermacentor*, and probably all other "ornate" ticks, have the extent of the pattern variable. In *Dermacentor* the pattern color may be very distinct, mild, faint, or absent.

In the main paper attention was directed to *D. parumapertus*, collected in southern Idaho, which was without pattern color and yet when this stock was reared through several generations in the laboratory the color pattern appeared. Numerous fully engorged nymphs of *D. andersoni*, taken from chipmunks near Burns, Oreg., emerged as adults which were surprisingly small, showed little or no pattern color, and had spiracular plates (pl. XXVI, 1 and 2) that were modified in shape. This stock, reared through only one generation in the laboratory, emerged as adults having the usual morphology and the full color pattern of the ticks prevailing in that area. During the summer of 1937 many ticks of various species were collected in Liberty County, Tex. Among these were numerous specimens of *D. variabilis*. On morphological grounds these specimens could be none other than this species and yet all were wholly without pattern color. All other specimens of *variabilis* from the Southern States, of which there are many in our collections, are moderately or very well marked. Numerous specimens from Dimmit and Cameron Counties, southern Texas, have the color pattern brilliant.

From these three instances it becomes apparent that in *Dermacentor* (and perhaps in other genera) the color pattern, while usually present, may be suppressed because some ecological or physiological factors are present or absent.

Again, it would be interesting to know the cause or causes for the reduction in the sclerotin in some specimens of *Dermacentor*. The writer has not observed a change of degree of sclerotization in rearing ticks from one generation to another. The facilities available at the Rocky Mountain laboratory have not permitted such a rearing of *albipictus* on large animals. Is it not possible that in *nigrolineatus* the thin sclerotization as evidenced in Banks' redescription and in the Dos Cabezos specimens was due to the presence or absence of some ecological or physiological factor?

It has been stated elsewhere that we know of no significant difference between the biologies of *albipictus* and *nigrolineatus*. A thorough study of the biology of *albipictus* is very desirable and this study should include some of the old "*nigrolineatus*," both from the North and the South, and also studies of all stages in controlled thermal cabinets as well as of the host relationships and the feeding, emerging, and waiting or resting periods. Both are one-host winter ticks using, in part at least, the same host animals. In both, the host animals probably pick up their infestations of larval ticks year after year in the same winter bedding places and pastures. Both have localized occurrence.

BIBLIOGRAPHY

This bibliography contains only those papers of value from a systematic standpoint.

Banks, Nathan:

1901. Acarina; *in.* (Some spiders and other Arachnida from southern Arizona.) Proc. U. S. Nat. Museum, v. 23, p. 590.

1907. Note on a new classification of ticks (summary of paper). Proc. Entomol. Soc. Washington, v. 8, p. 62.

1908. A revision of the Ixodoidea, or ticks, of the United States. Tech. ser. no. 15, Bur. Entomol., U. S. Dept. Agric. 60 pp.

1910. The scientific name of the spotted fever tick. J. A. M. A., v. 55, Oct. 29, p. 1574.

Bishopp, F. C.:

1912. A new species of *Dermacentor* and notes on other North American Ixodidae. Proc. Biol. Soc. Washington, v. 25, p. 29–37.

1936. Rocky Mountain spotted fever ticks, Insect Pest Survey Bull., U. S. Dept. Agric., v. 16, no. 10, Summary for 1936, p. 534.

Bishopp, F. C., and Smith, C. N.:

1936. American Dog Tick (*Dermacentor variabilis* Say). Insect Pest Survey Bull., U. S. Dept. Agric., v. 16, no. 5, July 1, p. 210.

Bishopp, F. C., and Wood, H. P.:

1913. The biology of some North American ticks of the genus *Dermacentor*. Parasitology, v. 6, p. 153–187.

Boynton, W. H.:

1933. Deer as carriers of anaplasmosis. Science, v. 78, Dec. 15, p. 559–560.

Cockerell, T. D. A.:

1924. The name of the spotted fever tick. Science, v. 59, Mar. 21, p. 277.

Cooley, R. A.:

1911. Tick control in relation to the Rocky Mountain spotted fever. Montana Agric. Exper. Station, Bull. No. 85, 29 pp.

1932. The Rocky Mountain wood tick. Montana Agric. Exper. Sta. Bull. No. 268, 58 pp.

1937. Two new *Dermacentors* from Central America. J. Parasitology, v. 23, p. 259–264.

Curtice, C.:

1892. About cattle ticks. J. Comp. Med. & Vet. Arch., v. 13, p. 1–7.

Fitch, A.:

1872. Fourteenth report on the noxious, beneficial, and other insects of the State of New York. Trans. N. Y. State Agric. Soc. for the year 1870, v. 30, p. 355–381.

Hadwen, Seymour:

1913. The life-history of *Dermacentor variabilis*. Parasitology, v. 5, Jan., p. 234.

Hays, W. J.:

1868. The moose tick. American Naturalist, v. 2, Dec., p. 559.

Henshaw, Henry W., and Birdseye, Clarence:

1911. The mammals of Bitter Root Valley, Mont., in their relation to spotted fever. Circular No. 82, Bur. Biol. Survey, U. S. Dept. Agric.

Herms, W. B., and Howell, D. E.:
1936. The western dog tick, *Dermacentor occidentalis* Neum., a vector of bovine anaplasmosis in California. J. Parasitology, v. 22, no. 3, June, p. 283.
Hooker, W. A., Bishopp, F. C., and Wood, H. P.:
1912. The life-history and bionomics of some North American ticks. Bull. 106, Bur. Entomol., U. S. Dept. Agric., 239 pp.
Hunter, W. D., and Bishopp, F. C.:
1911. The Rocky Mountain spotted fever tick. Bull. No. 105, Bur. Entomol., U. S. Dept. Agric., 47 pp.
Koch, C. L.:
1844. Systematische Übersicht über die Ordnung der Zecken. Arch. f. Naturgeschichte, Berlin, Jahrg. 10, Bd., 1, p. 217–239.
1847. Übersicht des Arachnidensystems. Nürnberg. Heft 4, 136 pp.
Kohls, Glen M.:
1937. Hosts of the immature stages of the Pacific Coast tick *Dermacentor occidentalis* Neum. (Ixodidae). Pub. Health Rep., v. 52, no. 16, April 16, p. 490.
Larrousse, F., King, Arthur G., and Wolbach, S. B.:
1928. The overwintering in Massachusetts of *Ixodiphagus caucurtei*. Science, v. 67, Mar. 30, p. 351.
Marx, G.:
1892. *In Curtice* (Parasites), J. Comp. Med. & Vet. Arch., v. 13, p. 223.
Morgan, H. A.:
1899. Ticks and Texas fever. Bull. no. 56, ser. 2, Louisiana Agric. Exper. Station, p. 128–141.
McCampbell, Sam C.:
1926. Notes on some parasites of the jack rabbits of eastern Colorado. Jack rabbits of eastern Colorado, pt. II, Circular 52, Colorado Agric. College.
McIntosh, Allen:
1931. A new species of tick from the Texas peccary. Abstract of paper. J. Parasitology, v. 18, p. 124.
1932. Description of a tick, *Dermacentor halli* from the Texas peccary, with a key to the North American species of *Dermacentor*. Proc. U. S. Nat. Museum, no. 2945, v. 82, art. 4, p. 1.
McLeod, J. A.:
1933. A parasitological survey of the genus *Citellus* in Manitoba. Canadian J. Research, v. 9, p. 108–127.
Neumann, L. G.:
1897. Revision de la famille des Ixodidés (2e memoire), Mem. Soc. Zool. de France, v. 10, p. 324–420.
1901. Revision de la Ixodidés. Extr. des Mem. Soc. Zool. de France. Original description.
1905. Notes sur les Ixodidés III. Arch. de parasitol., v. 9, p. 225–241.
1911. Ixodidae. Das Tierreich; *im* Auftrage der Königl. Preuss. Akad. d. Wissenschr. zu Berlin. 169 pp.
Nuttall, G. H. F., and Warburton, C.:
1911. Ticks. A monograph of the Ixodoidea, part II, Cambridge Univ. Press, p. 120.

Packard, A. S., Jr.:
1869. List of hymenopterous and lepidopterous insects collected by the Smithsonian expedition to South America, under Prof. James Orton. Appendix to report on Articulates. Ann. Rep. Peabody Acad. Science, v. 1, p. 56–69.
Parker, R. R., and Wells, R. W.:
1916. Some facts of importance concerning the Rocky Mountain spotted fever tick (*Dermacentor venustus* Banks) in eastern Montana. Montana State Bd. Entomol., Second biennial rep., 1915–1916, p. 45.
Parker, R. R., Philip, Cornelius B., Davis, Gordon E., and Cooley, R. A.:
1937. Ticks of the United States in relation to disease in man. J. Econom. Entomol., v. 30, Feb. 2, p. 51–69.
Pierce, W. D., editor:
1921. Sanitary Entomology. Gorham Press, Boston. 518 pp.
Salmon, D. E., and Stiles, C. W.:
1901. The cattle ticks (Ixodoidea) of the United States. Seventh Annual Rep., Bur. Animal Industry. For the year 1900. U. S. Dept. Agric., p. 380–491.
Say, T.:
1821. An account of the Arachnides of the United States. J. Acad. Nat. Sci., Phila., v. 2, pt. I, p. 59–82.
Schulze, Paul:
1929. Die heutige Verbreitung einzelner Tierarten im Lichte der erdgeschichtlichen Vergangenheit (Besonders der Zecken *Dermacentor reticulatus* Auct. u. *Hyalomma marginatum* Koch). Zeitschr. f. Morph. u. Ökologie der Tiere, 15 Band, 4 Heft, Nov., p. 735–754.
1931. Einige neue chinesische Ixodiden. Sitz.-Ber. u. Abhandl. Nat. Gesell. Rostock 3 F. Band 3, p. 59.
1933. Die Arten der Zeckengattung *Dermacentor* s. 1. aus Europa, Asien und Neu-Guinea. Ztschr. f. Parasitenkunde. 6 Band, 3 Heft, p. 416–431.
Stanford, J. S.:
1934. Some ectoparasites of Utah birds and mammals, Proc. Utah Acad. Sciences, Arts, and Letters. v. 11, p. 247.
Stiles, C. W.:
1908. The common tick (*Dermacentor andersoni*) of the Bitter Root Valley. Pub. Health Rep., v. 23, no. 27, p. 949.
1910. The taxonomic value of the microscopic structure of the stigmal plates in the tick genus *Dermacentor*. Hygienic Lab., Bull. no. 62. 67 pp.
1910. The correct name of the Rocky Mountain spotted fever tick. J. A. M. A., v. 55, no. 22, Nov. 26, p. 1909.
Vorhies, C. T., and Taylor, W. P.:
1933. The life histories and ecology of jack rabbits, *Lepus alleni* and *Lepus californicus* ssp., in relation to grazing in Arizona. Tech. Bull. no. 49, Arizona Agric. Exper. Station.
Ward, J. W.:
1934. A study of some parasites of rabbits of central Oklahoma. Proc. Oklahoma Acad. Science, v. 14, p. 31.
Wherry, William B., and Wellman, F. Crieghton:
1909. Ticks on the California ground squirrel. Entomol. News and Proc. Entomol. Section, Academy of Natural Sciences, Phila. v. 20, Nov., p. 377.

○