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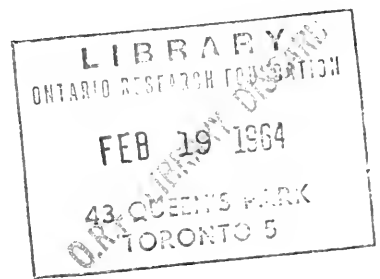
ON THE GENERA

DERMACENTOR, ANOCENTOR, COSMIOMMA
BOOPHILUS & MARGAROPUS

BY

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FOREWORD

More than half a century ago when the late G. H. F. Nuttall and his co-workers were studying piroplasmiasis their work was seriously hampered by lack of co-ordinated knowledge of ticks which transmitted the disease. Not only was there comparatively little reliable information on the morphology, taxonomy, geographical distribution, ecology and biology of ticks in relation to diseases of man and other animals, but such information as was available was scattered in many journals throughout the world and much of it was not readily accessible. Nuttall believed that a much more detailed knowledge of ticks, a sound basis for the taxonomy of these organisms and the collection of the information scattered throughout the literature in a concise and easily accessible form were an urgent prerequisite for future work on the diseases transmitted by ticks. It was with this object in mind that Nuttall, with C. Warburton, W. F. Cooper and L. E. Robinson, planned a comprehensive work entitled *Ticks: A Monograph of the Ixodoidea*.

It was first intended to publish this work in one complete volume but, in 1908, it was decided to issue the part dealing with the *Argasidae* separately and to follow it with other parts. The optimism of the authors is shown by the fact that in the prefatory note to the first part they expressed the hope that the whole work would be ready in about a year. In fact, vol. I of the Monograph appeared in three parts over the next seven years. These were: part I, *The Argasidae*, by G. H. F. Nuttall, C. Warburton, W. F. Cooper and L. E. Robinson (1908); part II, *The Ixodidae*, by G. H. F. Nuttall and C. Warburton (1911); part III, *The Genus Haemaphysalis*, by G. H. F. Nuttall and C. Warburton (1915). The First World War (1914–18) interrupted the work and the next part, which began vol. II of the Monograph, did not appear until 1926, when part IV, *The Genus Amblyomma*, by L. E. Robinson, was published. The completion of the remaining parts of the monograph remained an earnest wish of Nuttall and he looked forward to resuming work himself on the remaining genera when he would be free of academic duties on his retirement, in 1931, from the Quick Professorship of Biology in Cambridge. He had already begun to arrange his notes and to review the literature for the next part of the monograph when his sudden death in 1937 put an end to work on the project for many years.

Although those parts of the monograph which were published were highly appreciated by parasitologists throughout the world and were soon recognised as standard works on the subject, it has proved very difficult to arrange for work to be resumed on the remaining genera. Indeed, twice authors undertook to complete one of the missing parts but in each case the project had to be abandoned owing to changing circumstances. The suggestion was, therefore, made to Dr D. R. Arthur that he should undertake the onerous task of producing part V of the Monograph which, as

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originally planned, was intended to deal only with the genus *Dermacentor*. With commendable courage and at the cost of considerable self-sacrifice as regards time and energy, Dr Arthur undertook this difficult task and he has now completed part v of the Monograph and included in it the genera *Dermacentor*, *Anocentor*, *Cosmiomma*, *Boophilus* and *Margaropus*. All parasitologists will be grateful to him for having accomplished this work. Dr Arthur's many papers on the morphology, taxonomy and biology of ticks are a guarantee of his competence for such work and the fact that so many of his publications have appeared in *Parasitology* has brought him into close and harmonious association with the editors of that journal at the Molteno Institute for many years past. Although fifty years have passed since part I of the monograph appeared, I am confident that Dr Arthur has maintained the same high standard that has been manifest in previous parts and that fifty years hence part v will have been accepted as a standard work on *Dermacentor* and the closely allied genera. It is with great pleasure that I write this foreword and, in conclusion, I should like to express my congratulations to Dr Arthur for accomplishing this formidable task so admirably in a comparatively short time. I am sure that all those interested in ticks will welcome the appearance of this work.

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(Director)

MOLTENO INSTITUTE
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17 May 1958

CHAPTER I

INTRODUCTION

The family IXODIDAE Murray 1877 consists of the scutate ticks which possess a terminal, protruding capitulum and spiracles placed behind the fourth pair of coxae. Two areas of pores are present on the dorsal surface of the basis capituli of the female. Sexual dimorphism is marked, the males being almost entirely covered dorsally by a shield or scutum, whereas in the female the scutum is small and located anterodorsally on the opisthosoma. If eyes are present they are placed laterally on the shield in both sexes. The post-scutal region of the female, unlike that of the male, is capable of a remarkable degree of distension during feeding.

The family Ixodidae is divided into the PROSTRIATA and the METASTRIATA. Members of the former section have anal grooves surrounding the anus in front but in the Metastriata the anal grooves contour the anus behind. The Metastriata are subdivided into (1) the BREVIROSTRATA which includes the following genera, *Haemaphysalis*, *Dermacentor*, *Anocentor*, *Cosmiomma*, *Amblyocentor*, *Rhipicentor*, *Rhipicephalus* and (2) the LONGIROSTRATA comprised of *Hyalomma*, *Aponomma* and *Amblyomma*. *Boophilus* and *Margaropus* are clearly attributable to the BREVIROSTRATA by their general structure although the anal groove is faint or obsolete.

The present volume deals very largely with the genera *Dermacentor*, *Anocentor* and *Cosmiomma*. *Dermacentor* has representative species in Asia, Europe, Africa, North and Central America; *Anocentor* is reported from Central America, the West Indies, Colombia and the Argentine whilst *Cosmiomma* is exclusively an African genus.

Various species of *Dermacentor* are of immense medical and economic importance to both man and his domestic stock, being recognised as vectors and reservoirs of bacilli, piroplasms, theilerias, viruses and rickettsiae among others. Accordingly a number of species, particularly in the United States, have been treated as first priorities in disease control schemes. Our knowledge of the morphology and biology of these American species has been the result of extensive work, both in the field and laboratory, by such workers as Cooley, Kohls, Hooker, Bishopp and Smith to mention but a few. In Canada the importance of *D. andersoni* as the causal agent of paralysis in both man and cattle provided the stimulus for Gregson's untiring pioneer work in this field and represents a wonderful example of scientific patience, exactitude and initiative.

The situation in Europe and Asia is less well defined, but much credit is due to Černý and his colleagues for their excellent contributions to our knowledge of *D. reticulatus* and *D. marginatus*. Possibly one of the major obstacles in the general evaluation of tick problems in Russia and the Far East has been the language difficulty.

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Fortunately this barrier has now been partially overcome by the recent efforts of Anastos and his collaborators in the United States in providing translations and sources of reference to the main Russian literature.

In preparing the section on *Dermacentor* I have drawn freely from these sources, particularly where a species is known only from the type specimens or where supplies of specimens have been inadequate or not obtainable, for example *D. taiwanensis* and *D. coreus* from Japan. The genus *Cosmiomma*, represented by one species in Africa has been treated in some detail as previous descriptions have been inadequate and its distribution is far wider than was formerly believed. Similar treatment has been accorded to *Dermacentor circumguttatus* and *D. rhinocerinus*.

The approach in the present volume differs somewhat from that of earlier volumes in that the first section deals with the morphology and physiology of representatives of the genus as a general background to systematic studies. Each species considered under the heading of systematics is further subdivided into a review of the literature and cognate remarks, followed by specific descriptions and figures which in turn are followed by a summary of the biology, under both laboratory and field conditions. The section is concluded by a brief reference to the diseases transmitted by each species.

ACKNOWLEDGEMENTS

This work was initiated during the tenure of a Leverhulme Research Award and elaborated under a Colonial Office Welfare and Development award by which I was permitted to visit Africa in 1956. A travelling grant from the Royal Society also enabled me to examine the collections of ticks in the Danish Museum, Copenhagen. The Agricultural Research Council and Wellcome Trust grant for scientific publications (Royal Society) have each contributed £150 towards the expenses of publishing this work. To all these organisations I am deeply grateful for their financial assistance.

I am especially indebted to a large number of institutions and people for the loan of material, for supplying me with literature and for checking the sources of literature as well as for assistance in translating foreign scientific papers and for some assistance with figures. In particular, I should like to record my thanks to Mr Harry Hoogstraal, Mr J. D. Gregson, Mr G. M. Kohls, Dr D. M. Allred, Mr A. Wiley, Dr A. McIntosh, Dr G. Owen Evans, Mr E. Browning, Dr V. Černý, Miss Jane Walker, Dr Reznik, Dr Gertrude Theiler, and Mr G. B. Thompson for help with literature and specimens; to Dr Pollak of King's College for her ever willing and ready assistance in translating German papers, Dr E. Barnard for his great help with the Russian literature, Mr Pascoe for the Japanese translations of *Dermacentor coreus* and *D. taiwanensis*, and the Librarian of Tokyo University for providing me with the relevant papers. Mr Peter Davies assisted me with the drawings of Figs. 201-10, Figs. 370-80, and my research assistant, Mr J. G. M. Sullivan, has rendered me yeoman service in this connection. It is also a pleasure to acknowledge the services of Miss Dilys G. Thomas of the administrative staff of King's College for her careful typing of the manuscript in its numerous preliminary drafts, as well as in the final form.

INTRODUCTION

It gives me the greatest pleasure to record my gratitude to Professor D. Keilin, F.R.S., and Dr P. Tate for their ever ready assistance and encouragement and for permission to study the late Professor Nuttall's notes on matters pertinent to the genera considered in the present volume. I also wish to thank the publishing staff of the University Press for the kind consideration they have shown me, and the printers for the care they have taken in the production of this monograph.

EXPLANATION OF TERMS USED

Anus. The posterior opening of the alimentary tract, which is surrounded by a circular chitinous ring within which are two laterally moving valves.

Anal grooves. In the METASTRIATA round the anus behind, and in the majority of cases run forward and outward towards the genital grooves, which they may attain. Sometimes the anal groove is continuous with an antero-posterior median groove from which they fork anteriorly.

Article. See under *Palp*.

Basal spurs. Paired protuberances or horns at the postero-lateral edges of the ventral surface of the *basis capituli*.

Basis capituli or shortly, *basis* or '*kragen*' of some authors, is the basal portion of the capitulum. The posterior border may have protruding angles which we term the *cornua*.

Capitulum (= 'rostrum', 'head' or 'false head' of various authors). This bears the mouth parts and consists of the *basis capituli* proximally and the *palpi*, *hypostome* and *chelicerae* distally.

Cervical grooves. The term commonly applied to a pair of grooves running backwards from the inner angles of the scapulae of the *scutum*. These grooves are present in both sexes.

Chelicera(e). Paired structures lying dorsally to the hypostome, and consisting of a movable shaft extending through the *basis capituli* and bearing a cutting digit apically. This consists of (1) an *internal article*, bearing a *dorsal process* which is a non-articulating portion of it, and (2) an *external article* which articulates with the internal article on its outer margin.

Colour pattern. The pattern or design of enamel colour which overlies the base colour (see also under *Ornamentation*).

Cornua. See *Basis capituli*.

Coxa(e). The proximal, immovable segment of the leg upon which the other segments are articulated. They are designated antero-posteriorly as coxae I, II, III, IV.

Coxal spurs. Spur-like or spine-like projections from the posterior surface or from the posterior margin of the coxae. When coxae are described as bifid or bidentate they bear two spurs and are deeply incised; when described as trenchant they have sharp posterior margin.

Denticles (or teeth). The recurved teeth on the ventral surface of the hypostome. The dentition is indicated by figures on either side of a vertical line; thus as in *Dermacentor*, 3/3 means three rows of denticles on each side of the median line. When the hypostome is described as having a *corona*, the tip bears a number of very minute denticles.

Dorsal horn. A variably developed retrograde process on the upper surface of the *trochanter*.

Dorsal prolongation (= *dorsal outgrowth* of some authors). A postero-dorsal extension of the *spiracular plate*. The degree of development of this structure varies from genus to genus and from species to species (for example, in *Dermacentor hunteri* males it is long, in *D. albipictus* it is short or even wanting).

Dorsal ridge. A transverse elevated postero-dorsal margin of the basis from which the *cornua* arise.

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Emargination. The portion of the *scutum* between the *scapulae*, which is hollowed out to receive the capitulum.

Festoons. Uniform rectangular regions, separated by grooves, into which the dorsal and posterior margin of the body of both sexes is divided. These festoons frequently have distinct chitinous plates on their ventral surface when they are referred to as *ventral festoons*.

Foveae (= *submedian dorsal porose areas* (Salmon & Stiles)). Paired circular areas often seen near the middle of the scutum in the male and posterior to the scutum in the female.

Genital alae. Wing-like outgrowths on either side of the genital opening.

Genital apron (= *apron*). A lightly sclerotised flap originating in front of the sexual opening which it covers.

Genital grooves. Grooves which start at the genital orifice, pass backward mesial of the coxae and then externally to the anal grooves towards the posterior margin of the body.

Goblets. Internal structures of the spiracular plate about the same in number as seen on the surface: they are the largest circles which can be brought into focus when the spiracular plate is viewed from above.

Hypostome. A median, ventral anterior extension of the basis, which is grooved dorsally, and armed with longitudinal rows of denticles ventrally.

Lateral grooves. Grooves running along the sides of the scutum in males, when they may delimit one or more festoons. 'Complete' if they are continuous along the anterior border of the festoons. Lacking in females of *Dermacentor*.

Macula. A more or less centrally placed, heavily sclerotised hollow structure of the spiracular plate showing externally as a heavily sclerotised area. Lacking in the nymphs.

Marginal fold. A body fold external to the scutum. Represented in fully-fed males of *Dermacentor* as a *pseudomarginal* fold.

Marginal grooves. Grooves which commence at the postero-lateral scutal border of females and run along the sides of the body (= *lateral grooves* of the male). The marginal grooves may delimit one or more festoons or they may be 'complete' (see under *Lateral grooves*).

Ornamentation. Refers to the enamel-like colour pattern (= pattern) which may be present on the capitulum, scutum and legs. Ornate ticks have the pattern colour (= colour of pattern) superimposed on the base colour. The fundamental colour pattern is the same for most species of *Dermacentor*, but there are intraspecific differences in detail. Frequently the colours may be influenced or obscured in some specimens which have translucent integuments whereby the colour of the contents of the gut diverticulae become dominant. Preserving specimens in alcohol may frequently be a cause for a change in colour tone, as is also the age of living specimens.

Palpal seta(e). A row of strong, spinose setae originating from the median edge of the ventral surface of the *palp* and extending meso-anteriorly across the hypostome.

Palp(i). Appendages articulating antero-laterally upon the basis capituli, and when apposed protecting the upper surface of the hypostome and the chelicerae. Each palp consists of four segments or articles, numbered from the proximal to the distal end as 1, 2, 3 and 4. In *Dermacentor* articles 1, 2 and 3 are incapable of articulation one against the other; article 4 is, however, movable. Articles 1 and 4 are visible only from below in *Dermacentor* ticks.

Pattern colour. See *Ornamentation*.

Pattern. See *Ornamentation*.

Porose area(s). Two more or less depressed areas on the dorsum of the basis capituli of the female; they are finely punctate and often lack distinct boundaries.

Postero-dorsal ridge. A dorsal elevation coming at an angle at the base of article 2.

EXPLANATION OF TERMS

Postero-ventral ridge. The posterior edge of the ventral surface of the basis which may be elevated or salient.

Pseudoscutum. That portion of the male scutum which corresponds in shape and position with the female scutum; it is sometimes demarcated by a ridge, punctations or hairs, without being a definite structure.

Pulvillus. A soft pad or 'sucker' attached to the distal end of the tarsus, whereby the tick can walk on smooth surfaces.

Punctations. Circular depressions dotting the integument and frequently bearing hairs. Punctations of two sizes occur on the scuta of *Dermacentor*, and the differences in size may be marked, moderate or slight. They are referred to as finely or coarsely punctate, etc.

Scapula. The anterior angles of the scutum projecting forward on either side of the basis capituli.

Scutum (=the *dorsal shield*, '*kopfschild*', etc. of some authors). In males it includes the entire dorsal surface of the body excluding the capitulum; in females the shield does not cover the dorsum and is located posterior to the capitulum. The size is stated by giving the length first (including the scapulae), then the greatest width (including the eyes, if protruding).

Spiracular plate (= *peritreme*, or *stigmatal plate*, etc. of various authors). Paired respiratory plates situated ventro-laterally and posterior to coxa IV. The plates may be circular, oval or comma-shaped (see under *Dorsal prolongation*). The punctate surface is enclosed in a broad sclerotised 'frame' which in comma-shaped spiracles is incomplete dorsally. The shape of the plate as a single diagnostic character in species separation has limited application.

Tarsus. The distal segment of the leg.

Tarsal spurs. Spurs which are present on the ventral surface of the leg and are of some diagnostic value in separating Eurasian forms.

Tibia. The penultimate segment of the leg.

Tibial spurs. Similar to tarsal spurs and also of diagnostic value.

Trochanter. The second proximal segment of the leg.

Trochanter spurs. Present on the ventral surface of the trochanter (cf. *Dorsal horn*) and which are variable in form.

CHAPTER II

THE GENUS *DERMACENTOR*: 1. GENERAL

DIAGNOSTIC CHARACTERS

Usually ornate; anal groove contouring the anus behind; basis capituli broader than long, rectangular dorsally; palpi short, thick, of moderate width, with an elevated postero-dorsal eminence on the proximal part of palpal article 2; article 1 immovably attached with article 2; hypostome spatulate or subparallel with usually three rows of denticles on either side of the median line, corona present; eyes on the scutum usually present and distinct, in *Dermacentor dissimilis* Cooley the eyes may be absent, obsolescent and difficult to find, but in other respects show an undoubted affinity with other *Dermacentors*; coxae I-IV increase progressively in size (except in *D. reticulatus* Fabricius in which the large spurs on coxa I make this plate larger than coxa II), coxa I bidentate in both sexes and these spurs are much larger and stronger than those on coxae II-IV, internal spurs on coxa I usually subtriangular, external spurs tapering and either straight or curved; internal spurs on coxae II and III short, flat, rounded or pointed, progressively smaller backwards; internal spurs (if present) on coxa IV very small and comparable in form to those of coxae II and III; coxa IV of the male is much the largest; a dorsal, distal retrograde spur of variable development on the trochanter of leg 1; spiracles suboval or comma-shaped, but the shape is of little diagnostic value because of the great degree of intraspecific variation; ventral surfaces of males lacking ventral plates; dorsal and posterior margins with festoons.

Type species: *Ixodes reticulatus* (Fabricius, 1794) but the genus *Dermacentor* was erected by Koch (1844) with *reticulatus* (Fabricius, 1794) recognised as the genotype by the designation of Salmon & Stiles (1901).

SYNONYMY AND LITERATURE

- 1844 *Dermacentor* Koch, original description.
- 1847 *Dermacentor* Koch; Koch, p. 24.
- 1882 *Pseudoixodes* Haller, p. 311.
- 1897 *Dermacentor* Koch; Neumann, p. 360.
- 1901 *Dermacentor* Koch; Salmon & Stiles, p. 447.
- 1908 *Dermacentor* Koch; Banks, p. 42.
- 1911 *Dermacentor* Koch; Neumann, p. 98.
- 1911 *Dermacentor* Koch; Nuttall & Warburton; Cooper & Robinson, Part 11, p. 120.
- 1927^A *Dermacentor* Koch; Olenev, p. 222.
- 1928 *Dermacentor* Koch; Sharif, pp. 291-7.
- 1929 *Cynorhaestes* Hermann, 1804; Schulze, pp. 735-54. Schulze discussed the validity of the status of *Dermacentor* and considered that both *Dermacentor* and *Crotonus* should be sunk in synonymy with *Cynorhaestes*.

SYNONYMY AND LITERATURE

- 1931 *Dermacentor* Koch; Schulze (1931), p. 52. A recommendation that the generic name be retained.
- 1931 *Dermacentorites*, Olenev, pp. 88-90. The establishment of a subgenus to include *Dermacentor reticulatus* Fabr.
- 1932 *Amblyocentor*, Schulze, p. 463. Establishment of *Amblyocentor* as an independent genus for African species.
- 1933 *Dermacentor* Koch; Schulze, p. 424. Considered that the name *reticulatus* is invalid and that Fabricius's specimen was an *Ixodes* nymph; establishment of *Indocentor* as a new genus, p. 417.
- 1938 *Dermacentor* Koch; Cooley (1938), pp. 15-16. 'The generic name *Dermacentor* Koch and the name *reticulatus* Fabricius as the genotype are 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.' Cooley, p. 16.
- 1950 *Dermacentor* Koch; Anastos, p. 51. *Indocentor* Schulze regarded as a synonym of *Dermacentor*.
- 1950 *Indocentor* Schulze; Kohls, pp. 20-1. Expresses doubt as to the number of species in addition to *auratus* that should be recognised in this genus.
- 1950 *Dermacentor* Koch; Pomerantzev, p. 131. Pomerantzev does not recognise Schulze's division of the genus *Dermacentor* into three independent genera, viz. *Dermacentor*, *Indocentor* and *Amblyocentor* (with subgenera *Amblyocentor* s.str. and *Puncticentor*), but considers them as subgenera whilst retaining Schulze's nomenclature, p. 134. He does not consider that the subgenus *Dermacentorites* of Olenev is sufficiently well defined to merit subgeneric status.

MORPHOLOGY

General features

The body of the unfed *Dermacentor* tick (pl. I, figs. 1, 2) is ovate in outline, flattened dorso-ventrally and indented on the anterior margin for the reception of the capitulum. The posterior margin is broadly rounded and subdivided into a number of quadrate divisions or festoons which are separated one from the other by grooves. Ventral plates corresponding with the dorsal festoons which are referred to as the ventral festoons may be present. Females are readily distinguishable from males by a dorsal shield or scutum which covers only the front part of the body. The male lacks a dorsal shield or, as it is said, the shield covers his entire back.

Laterally and dorsally, and associated with the scutum, are a pair of ocellar eyes. These are small, colourless, convex lenses, formed by a hyaline portion of the integument overlying a typical hypodermal layer. In section the lens is simple but without any structure or pigmentation, although Bonnet (1906) described the lens as having perpendicular striae accentuated by black pigment and said that the hypodermal layer was prolonged to form a vitreous body. At one side of the lens there is a group of nerve cells whose fibres lead to the brain and it is possible that these ocelli function as photoreceptors. In *D. dissimilis* eyes may be present, absent or difficult to find. Paired, nearly circular clear areas or foveae are located posterior to the scutum in the female,

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and posterior to the pseudoscutum in the male; these foveae are larger in the female than in the male. Each fovea has a small central body bristling with minute peg-like processes, which are presumably sensory in function.

Integument

The integument bears setae and a very large number of cuticular pores which are the outlets of the dermal glands. Histologically two main layers can be recognised in the integument, an inner endocuticle and an outer epicuticle. The endocuticle of the legs, capitulum, spiracle and scutum is rigid, highly sclerotised and ornate in the female, while in the alloscutum it is soft, colourless and extensible. The outer layer, or epicuticle, is little more than 1μ in thickness and in unfed ticks is thrown into deep folds when seen in section. It is these wrinkles or folds which appear as fine, closely set parallel striations running in zig-zag bands over the surface of the integument. Lees (1946) has shown that the epicuticle of *D. andersoni* is brown or chocolate-coloured and, by analogy with insects, it appears that the darkening of the epicuticle which takes place after moulting is due to a tanning process. This tanning also occurs in *Rhipicephalus sanguineus* and *Amblyomma maculatus*, but not in *Ixodes canisuga* nor in *I. hexagonus*. Cuticular striations are not visible in the males.

The ducts of the dermal glands are continuous with the epicuticular lining and open freely on to its surface, while their internal open ends lie against the hypodermal cells. Pore canals are also readily visible in sections of the integument, where they appear as fine striae extending from the endocuticle to the epicuticle. Lees suggested that these pore canals in *Ixodes* contain cytoplasm as there is reason to believe that, as the tick imbibes blood, further cuticular material synthesised by the epidermal cells is transported along the pore canals. The integument of the male is very rigid but there are extensible areas on the ventral surface, the lateral margins and between the large coxae. The male scutum is heavily sclerotised. In ornate ticks, such as the *Dermacentors*, superimposition of pattern colour over the base colour (i.e. the chitin) is a noticeable feature. The base colour will vary with the age of living material and also when preserved in various fluids. The base colour, in living specimens, varies from yellow ochre to dark brown and similarly the pattern colour ranges from white to grey or silver of some authors. The scutal pattern is a *fairly* safe guide to diagnosis, but light markings are often more or less obsolete after preservation in some solutions. Fortunately the punctations are a characteristic greatly affecting the pattern, which remain when the coloration is obliterated. In some cases the punctations are very numerous and fine and of fairly equal size, for example, as in *D. albipictus* and *D. occidentalis*; in others the punctations fall into two distinct categories, many excessively minute and others very much larger, as in *D. andersoni* and *D. variabilis*, with hairs frequently arising from the latter. A convenient criterion for comparison of punctation size is furnished by the foveae which are fairly constant in size. Punctations equal in diameter to the foveae are referred to as 'large'. Now these large punctations, usually brown in colour, greatly interrupt the light markings, so that while in *D. albipictus*,

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for instance, the reticulate pattern seems to be painted on with a bold clear line, in *D. andersoni* the light lines are ragged, their borders being notched by the large brown punctations.

Capitulum—external structure

The capitulum of the female, as illustrated by *D. parumapertus*, consists of a median ventral hypostome flanked on each side by a four-segmented palp arising from the broad basis capituli. A pair of long cylindrical shafts, the chelicerae, overlies the hypostome dorsally and passes back through the body of the basis. Dorsally (fig. 1) the latter is broader than long, this ratio being as 3.2:1.4. The lateral margins are straight, converging strongly to the base of the cheliceral sheaths antero-laterally. The postero-lateral margins are broadly rounded to form the cornua: the width at the base of the latter is greater than the length and the apex is rounded. The surface is generally flattened except behind the porose areas where it is undulate, and punctations are scarce or absent; the lateral and posterior margins are more deeply pigmented than the rest of the dorsum. The large pear-shaped porose areas are strongly depressed, with their axes set obliquely to the long axis of the body. The interporose distance is variable, being less than half the width of one of the porose areas in most specimens. The dorsal ridge is salient and strong. Ventrally the basis is broad (fig. 2), with a prominent curved postero-ventral ridge, and in front of this the surface is flat nearly to the hypostomal base where it passes into a crescentic depression. The basis behind the ridge slopes down quite strongly to its posterior margin. Both surfaces, when seen in side view (fig. 3), converge distally, the upper surface sloping more acutely than the lower. Vento-laterally the basis bears three or four short, sharp, pointed hairs.

The palpi are longer and narrower in *D. parumapertus* than in related species. Palpal articles 1 and 4 are visible only from the ventral surface; the inner edge of article 2, when seen from above, is straight and in the non-feeding female lies obliquely to the long axis of the body. Article 3, similarly, has a straight inner profile which lies parallel to the long axis of the body. The apex of article 3 is subangular towards the mid-line, becoming broadly convex laterally. Article 2 is widest apically, before passing back obliquely at about one-third of the distance from the distal end, to form a moderate postero-dorsal ridge with rounded edges. Small faint punctations may be present on the palp, but in some specimens these are absent. A few short hairs are present laterally and apically. Article 1, seen only from the ventral surface, is a triangular plate with a salient postero-ventral margin. Ventrally article 2 is longer than broad, and somewhat swollen near its apex; article 3 is, however, broader than long. Meso-ventrally article 3 forms a triangular, flattened area which extends back beyond half the length of this article. The apical margin of article 3 is rounded at its junction with article 4, the articulating membrane between these articles being extensive. The apex of article 4 bears half-a-dozen sensillae, which have rounded tips, and three to four moderately long pointed hairs peripherally. A series of curved, palpal setae arises from the mesial border of the ventral surface of articles 1 and 2,

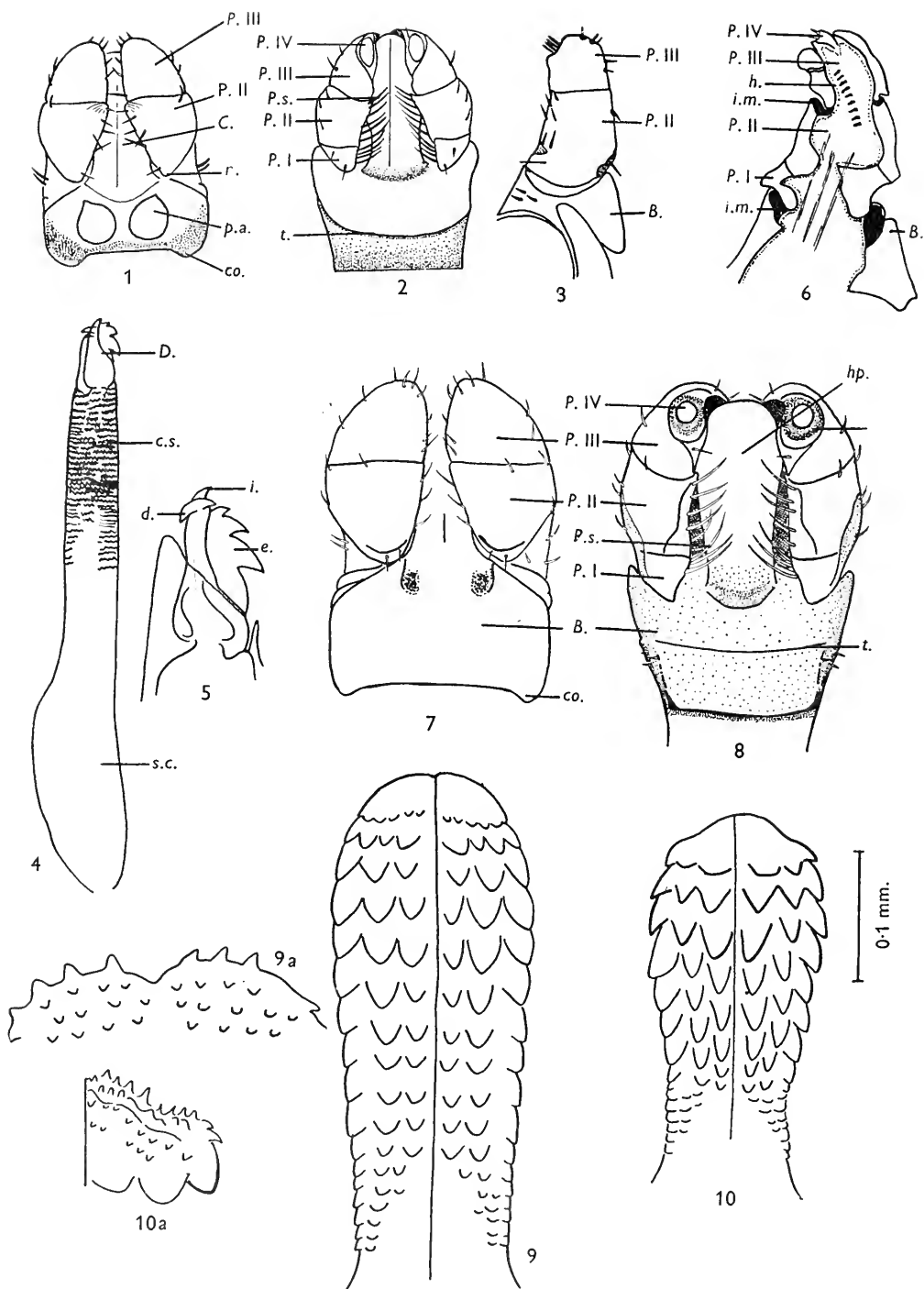


Fig. 1-10a. For legend see facing page.

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these being longer and thicker than the other hairs and bristles of the palp. Four palpal setae arise from article 1 and six similar setae from article 2 of the female; they pass diagonally forward but do not usually reach the mid-ventral line of the hypostome. These palpal setae are less well developed in *D. parumapertus* than in species such as *D. circumguttatus* Neumann, 1897, and *D. rhinocerinus* (Denny, 1843). In *D. parumapertus*, as in other species of this genus, articles 1, 2 and 3 do not move on each other.

When the tick is sucking blood, the palps move outwards at an articulation between the base of article 1 and the basis capituli (fig. 6), and at this connection there is a prominent fold of intersegmental membrane. The walls of the palp show much variation in thickness; the upper wall of article 1 and the lower basal wall of article 2 are stout and along the mid-line of the palp the walls become so thickened that the palpal cavity is reduced to a relatively narrow connection which becomes wider peripherally. Distally the walls of article 2 are thinner, becoming more so laterally in article 3. Between articles 1 and 2 there is no intersegmental membrane, the division between them being indicated by a suture line. The intersegmental membrane between articles 2 and 3 is much reduced on the upper surface but is readily distinguishable on the lower surface. The internal faces of the second and third segments are concave; the palp is broader on its ventral surface than on its dorsal surface but the overlap is greater on the upper surface. When apposed during the non-feeding period the inner margins of the palps partially protect the hypostome and the chelicerae.

Figs. 1-10a, *Dermacentor parumapertus*. 1, basis capituli of female, dorsal view; 2, basis capituli of female, ventral view; 3, basis capituli of female, lateral view; 4, cheliceral shaft of female; 5, digit of female; 6, longitudinal section through the palp along the median line; 7, basis capituli of male, dorsal view; 8, basis capituli of male, ventral view; 9, hypostome of female; 9a, tip of hypostome enlarged; 10, hypostome of male; 10a, half tip of hypostome enlarged. (From Arthur, *Parasitology*, 1957.)

The following abbreviations are used in figs. 1-34:

<i>a.</i>	wing plate or alar plate	<i>m.d.</i>	dilator muscles
<i>B.</i>	basis capituli	<i>m.p.</i>	palpal muscle
<i>b.c.</i>	body cavity	<i>o.s.</i>	outer cheliceral sheath
<i>C.</i>	chelicerae	<i>P.</i>	palp
<i>c.s.</i>	cheliceral shaft	<i>P. I-IV</i>	palpal articles I-IV
<i>ch.</i>	hypostomal channel	<i>P.s.</i>	palpal setae
<i>co.</i>	cornua	<i>p.a.</i>	porose areas
<i>D.</i>	digit	<i>px.</i>	pharynx
<i>d.</i>	dorsal process	<i>px.l.</i>	pharyngeal lumen
<i>e.</i>	external article	<i>Q.</i>	pharyngeal struts
<i>g.</i>	hypostomal groove	<i>q.</i>	denticle
<i>h.</i>	epithelium	<i>r.</i>	postero-dorsal extension of article 2
<i>hp.</i>	hypostome	<i>s.</i>	salivarium
<i>h.s.</i>	more heavily sclerotised part of cheliceral shaft	<i>s.c.</i>	membranous part of cheliceral shaft
<i>i.</i>	internal article	<i>s.d.</i>	salivary duct
<i>i.m.</i>	intersegmental membrane	<i>s.s.</i>	subsalivarial cavity (=forward continuation of body cavity)
<i>i.s.</i>	internal cheliceral sheath	<i>T.</i>	tectum
<i>l.m.</i>	labrum	<i>t.</i>	transverse ridge
<i>M.</i>	vertical wall between palp and the mesial portion of the basis	<i>t.s.</i>	tertiary cheliceral sheath
<i>m.c.</i>	constrictor muscles	<i>y.</i>	subcheliceral plate

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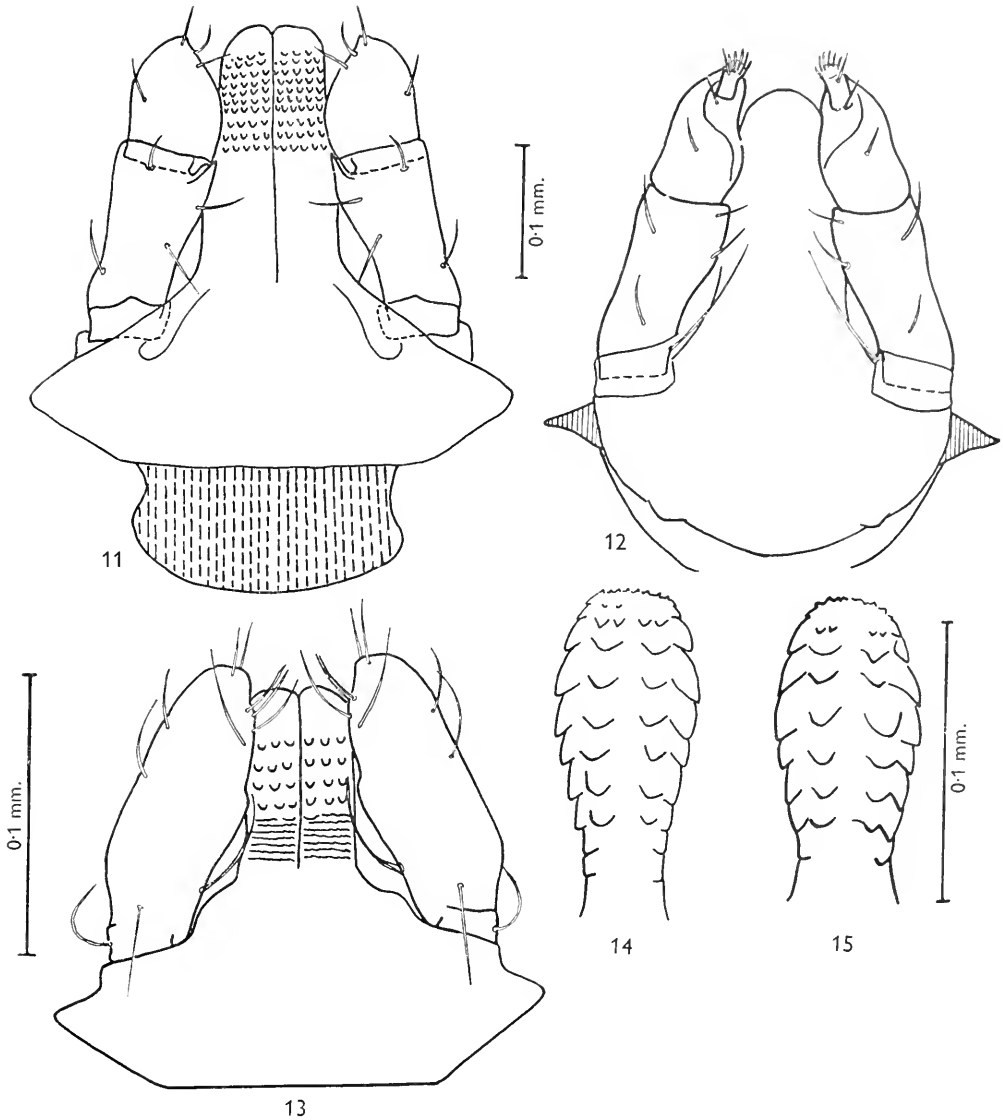
The ventral wall of the capitulum extends forward between the palps to form a spatulate-shaped hypostome. This structure is generally rounded at the tip with a slight indentation in the mid-line. A corona, consisting of three rows of small projecting pointed teeth, is located subapically (fig. 9*a*) and behind the corona there are 16-17 rows of lateral teeth. The transverse row immediately behind the cornua bears 4/4 files of teeth but the remaining teeth are arranged in 3/3 files. Basally the teeth are replaced by crenulations which thin out to the basal margins. The length of the hypostome is about 0.43 mm.

The chelicerae of the female are broad and strong, measuring about 1.0 mm. in length, being swollen proximally for about one-third of the total shaft length (fig. 4). The surface of the distal part of the shaft is reticulately patterned but becomes smooth proximally. The chelicerae emerge anteriorly through the capitular foramen and posteriorly through the occipital foramen. Each is enclosed within an outer sheath and partially within an inner sheath (see later), both of which are the results of folding of the body cuticle. Protrusion of the chelicerae under normal conditions is presumably effected by contraction of the dorso-ventral somatic muscles, the resulting pressure within the body cavity forcing the shafts out through their sheaths. Retractor muscles, inserted on the cheliceral bases, pass postero-dorsally, having their attachment on the lower surface of the posterior margin of the scutum. Movement of the chelicerae in a horizontal plane is prevented by the close apposition of their basal positions and of internal guiding channels formed by the cheliceral sheaths, to be described later.

Each cheliceral shaft bears an apical denticulate digit which moves by the action of antagonistic muscles arising within the shaft. The cavity of the expanded proximal portion of the shaft is completely filled by these flexor and extensor muscles. Tendons of these muscles pass forwards through the distal portion of the shaft to their points of insertion on the apical digit. The digit conforms to the chelate type found in arachnids, but the usual pincer-like organ has been modified to form a cutting surface. It consists of a triangular plate drawn out into a point. It is attached by its expanded base to the extremity of the cheliceral shaft which forms a broad articular surface on which the entire digit moves in a meso-lateral plane. The external article is broad and consists of three sharp teeth. On the outer side of the internal article and flexibly attached to it is the movable bifid dorsal article. It does not, however, articulate with the internal article. In all stages the outer cheliceral sheath is produced forwards to form a reticulately sculptured hood-like protective lobe on the mesial side of the digit. This hood does not enfold the digit when the chelicera is extruded (fig. 5).

The basis capituli of the male, like that of the female, is rectangular, the sides being straight or more rarely gently curved, thence passing back into rounded cornua which are about as broad as long (fig. 7). The surface of the basis is flat. The palps of the male are relatively shorter than are those of the female, and the postero-dorsal ridge is well developed. The postero-ventral ridge is elevated and salient, passing back to a declivitous posterior margin. The ventral surface, divided into anterior and posterior

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Figs. 11-15, *Dermacentor parumapertus*. 11, basis capituli of nymph, dorsal view; 12, basis capituli of nymph, ventral view; 13, basis capituli of larva, dorsal view; 14, hypostome of nymph; 15, hypostome of larva. (From Arthur, *Parasitology*, 1957.)

portions by a shallow transverse groove, is flat and slopes gently towards the base of the hypostome. There are a few scattered punctations. In other respects it agrees essentially with that of the female. The hypostome (fig. 10) is about 0.28 mm. long and the apex consists of a median lobe which undulates to the margins and bears three to four rows of short pointed teeth, which project anteriorly (fig. 10a). Nine to ten rows of $\frac{3}{3}$ files of sharp equal teeth occupy most of the hypostomal surface but

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towards the base pass marginally where they are supplanted by crenulations, similar to those of the female. The cheliceral structures of the male agree essentially with those of the female.

The basis capituli of the nymph is more than twice as broad as it is long, the mean ratio of fifty specimens being as 3.25:1.5. The posterior margin is straight, becoming convex postero-laterally and extended laterally to form prominent pointed projections. The anterior edges of the lateral extensions are continuous with the straight antero-lateral margins of the basis and converge to the outer cheliceral sheaths. The surface of the basis is generally flattened except for a slight curvature to the pointed lateral extensions. Ventrally the basis is broad and the postero-ventral ridge, which is more heavily sclerotised than the rest of the basis, is broadly rounded. Postero-laterally this ridge is drawn out into small projections, and towards the lateral extremity a single hair of moderate length arises on each side (fig. 12). Palpal article 1 is only partially visible from above, being overlapped by antero-lateral extensions of the basis. Palpal article 2, which is narrow basally, attains its greatest width just behind its distal extremity. The outer margin of the palp is undulate and near its base is a single curved hair. The inner margin is asymmetrically convex, with one or two long hairs directed towards the mid-line. Article 3 is considerably shorter than article 2 and, when seen from above, is cone-shaped. One hair is borne laterally and three or four similar hairs arise near the apex. The lengths of palpal articles 2 and 3 are 0.14 and 0.09 mm. respectively. The outer cheliceral sheath is smooth for about half its distance forward from the tectum, but in front it is covered with transverse rows of small backwardly pointed elevations. The cheliceral shafts closely resemble those of the adults and are about 0.41 mm. in length. The hypostome is spatulate (fig. 14), a corona is present and the dentition of the visible rows from apex to base consist of one row of $\frac{3}{3}$ files and five to six rows of $\frac{2}{2}$ files. Basally there are two lateral crenulations. The length of the hypostome is 0.11 mm.

The basis of the larva is similar to that of the nymph in all essential features (fig. 13). Such differences as do exist relate to the palp. The hairs on the latter are long and thin, being relatively longer than in the succeeding stages. No suture line is evident between palpal articles 2 and 3; the combined length of articles 2 and 3 is about 0.11 mm. The hypostome is spatulate; the dentition consists of six to seven rows of $\frac{2}{2}$ teeth surmounted by an apical corona.

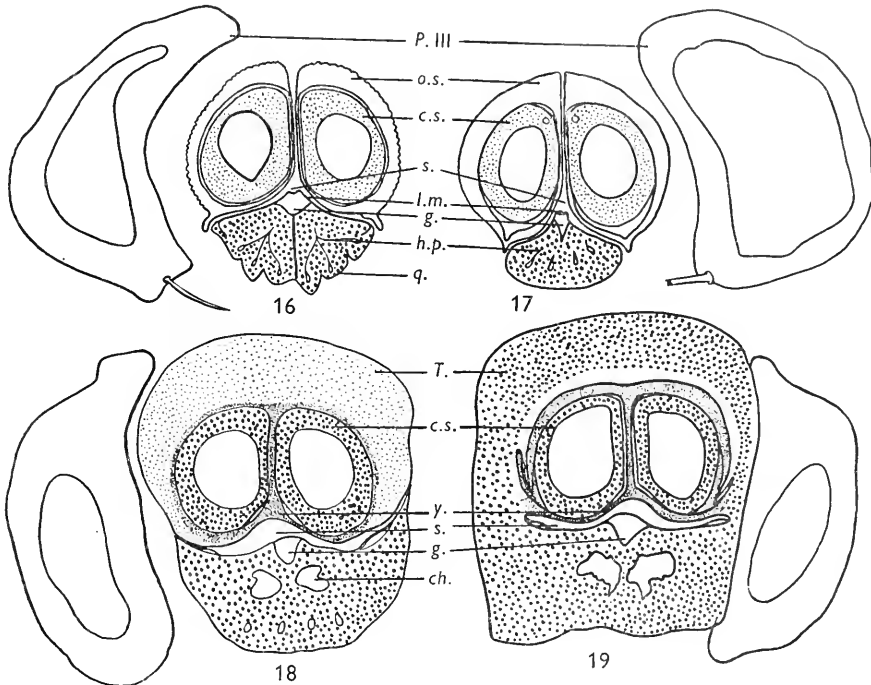
Capitulum—internal structure and feeding mechanism

Internally the capitulum is divisible into (i) an extra-basis or pre-oral region consisting of the hypostome, the distal ends of the chelicerae and the palps, and (ii) the basis capituli, where partial or complete morphological union of these parts has taken place.

When the tick is not feeding, the palps are closely apposed and partially overlap the chelicerae and the hypostome thus protecting a salivary channel and a food groove developed in association with the hypostome. The latter, when seen in section, is

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broader than deep at the apex and is divided into two halves by a vertical suture line. The upper surface is indented along the mid-dorsal line to form a V-shaped depression, the hypostomal groove (fig. 16). Lateral to this groove the upper surface of the hypostome slopes downwards and outwards to its greatest width, before sloping inwards to the mid-ventral line where it bears three or four denticles on each side. An elevated membrane, or labrum, which overlies the hypostomal groove is continued laterally and appears to be fused with the lateral edges of the hypostome. The chelicerae



Figs. 16-19, *Dermacentor parumapertus*. 16-18, transverse sections of the extra-basis region showing only one palp in each case; 19, transverse section through the region of fusion of the tectum with the hypostome. (From Arthur, *Parasitology*, 1957.)

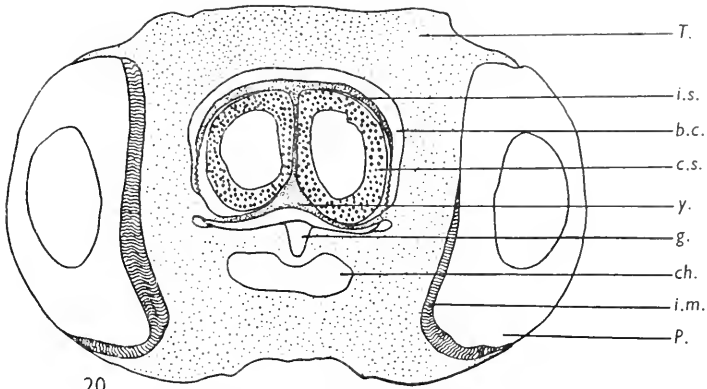
lie above the hypostome. On their inner surface the sides of the shafts are straight, being broadly rounded ventrally and mesially but their dorso-mesial profile is more angular. At this level no inner cheliceral sheath can be found. The dorsal and lateral margins of the outer cheliceral sheath are thick and thrown into pronounced ridges and ventro-laterally it is drawn out into a small lobe which overlaps the side of the hypostome. Ventrally and between the shafts this sheath is thin and non-ridged. Sections through this extra-basis region in feeding ticks show that there is a close fit between the lower surfaces of the chelicerae and the upper marginal surfaces of the hypostome (figs. 16-18). The salivary channel is a triangular lumen (figs. 16, 17) which lies above the labrum and between the lower and inner rounded margins of the

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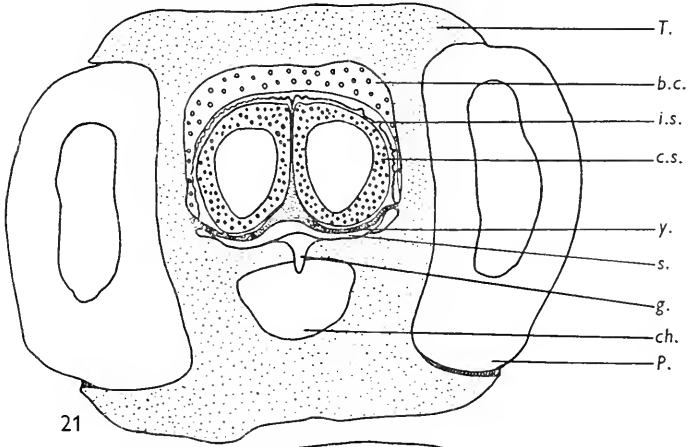
cheliceral sheaths. As a consequence of this the salivary channel opens at the tip of the hypostome above the labrum when the chelicerae are fully protruded. This pattern is typical of the whole length of the extra-basis region, except that nearer the basis the depression beneath the hypostomal membrane becomes narrower and the membrane becomes secondarily elevated, but nevertheless appears to be quite rigid. About 10μ further back the lateral margins of the hypostomal depression are elevated above the general hypostomal surface, which is concave on each side of the former. The ventral convex faces of the chelicerae and their associated sheaths fit snugly into these lateral hypostomal concavities (fig. 17). Channels run through the hypostome on each side of the median suture line. At this level the hypostome is still free from the overlying cheliceral complex and the ensheathing palps.

The basis of the capitulum is formed by (1) the fusion of the much thickened outer cheliceral sheaths to form the roof (or tectum), (2) the fusion of the median margins of these same sheaths to form a vertical plate arising from a subcheliceral plate (= the ventral portion of the cheliceral sheath) and (3) the fusion of the lower lateral borders of the outer cheliceral sheaths with the upper lateral margins of the hypostome to produce the sides of the basis (fig. 19). As a result of this latter fusion a transverse space is left between the subcheliceral plate and the upper surface of the hypostome. This space is, in fact, the much widened backward continuation of the salivary channel already noted in the extra-basis region.

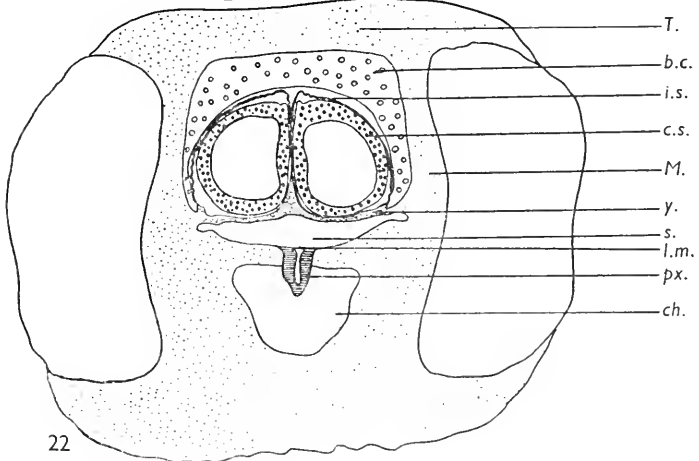
The tectum becomes progressively thicker proximally and three 'layers' are recognisable by the use of appropriate stains. The outermost, and thickest, layer stains deepest and is of a granular consistency; an intermediate layer does not stain as deeply and an inner, moderately thick, regular, deeply staining layer becomes the inner cheliceral sheath. The latter is soon separated from the rest of the tectum for most of its length by a space, narrow at first, but becoming broader posteriorly. This space is a forward continuation of the body cavity. The inner cheliceral sheath arises ventrolaterally from the lateral walls of the tectum (fig. 20 *et seq.*) as a thin, much folded membrane which stains blue with Mallory's stain. At the distal end of the basis this membrane is short, continuing into more heavily sclerotised dorso-lateral and dorsal portions. Posteriorly the inner sheath gradually becomes entirely membranous and much folded (figs. 21-5). Between the tectum and the inner cheliceral sheath the cavity is lined with an epithelium layer which is limited to the sides and above the inner cheliceral sheaths. Eventually, however, it is continued upwards as a median layer which ultimately joins with the epithelium underlying the tectum (figs. 24, 25). The transverse space of the salivary channel between the subcheliceral plate and the upper surface of the 'hypostome' becomes deeper within the basis (fig. 22). The lateral extremities of this channel are rounded and divided into upper and lower cavities by a membrane which appears to be a lateral extension of that of the labrum (fig. 21). The function of these cavities at the rounded extremities is at present not known. Below the hypostomal groove there is a rectangular space formed by the fusion of the two channels already noted in the extra-basis region of the hypostome.



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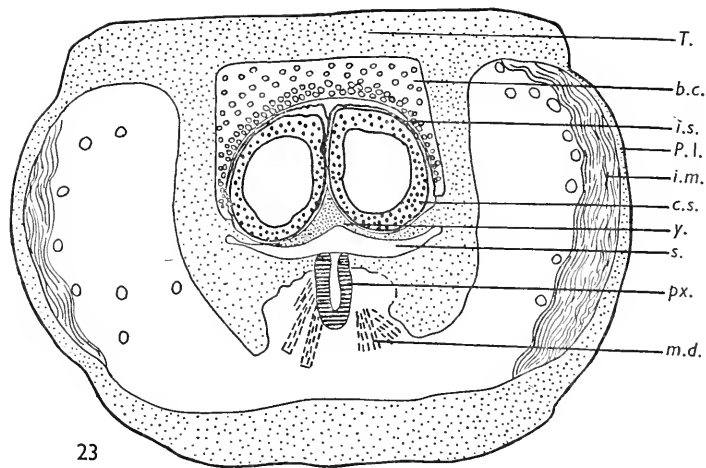


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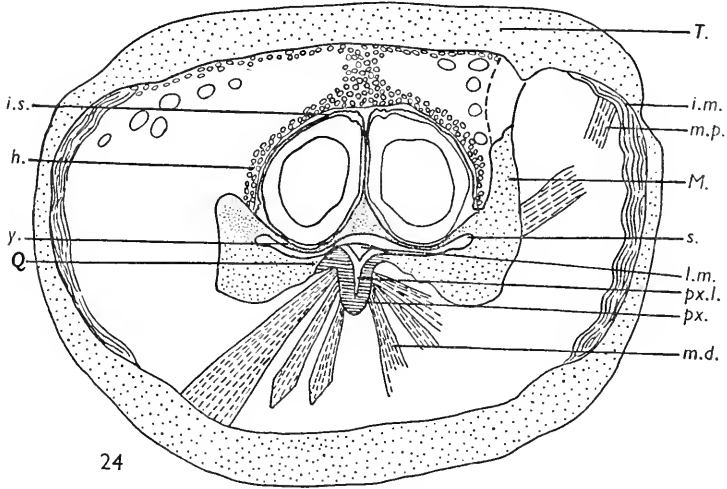


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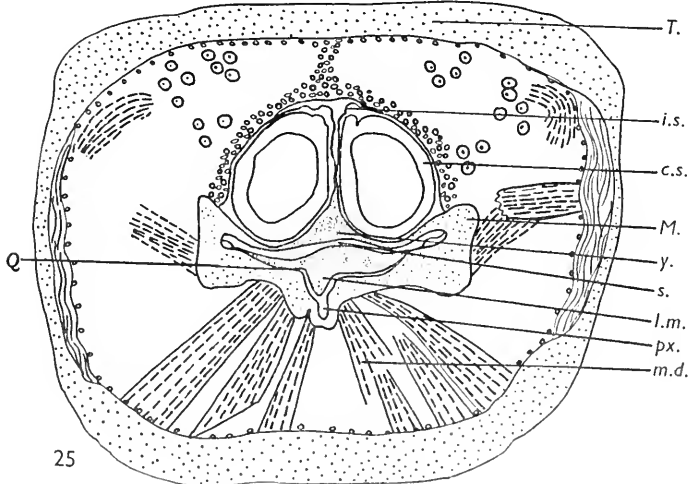
Figs. 20-2, *Dermacentor parumapertus*. Transverse sections through the basis to just beyond the incorporation of the palps with the basis. For explanation see text. (From Arthur, *Parasitology*, 1957.)



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Figs. 23-5, *Dermacentor parumapertus*. Transverse sections through the basis beyond the incorporation of the palps with the basis. For explanation see text. (From Arthur, *Parasitology*, 1957.)

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Posteriorly this cavity increases in size in all directions and is a forward extension of the body cavity (figs. 20-5).

The palpal base articulates with the basis by softer cuticle (fig. 20) before the palp becomes solidly incorporated into the body of the basis (figs. 21, 22). At this level the palpal base is separated from the cheliceral complex and the hypostomal groove by a vertical wall about 6-10 μ long (figs. 21, 22). In subsequent sections this vertical plate loses its connection with the floor of the basis (fig. 23 *et seq.*) and passes obliquely upwards, thereby making the cavity of the palpal base continuous with that of the very much enlarged subpharyngeal cavity. The subpharyngeal cavity is so named at this level (fig. 23) because of the presence of dilator muscles attached to the wall of what is functionally the pharynx. With the disappearance of the lower portions of the vertical plates the cheliceral complex and the pharynx become supported by the dorsal portions of the vertical plates and of transverse pharyngeal struts (fig. 23). The V-shaped pharynx is here supplied with three sets of oblique dilator muscles on each side which have their origin on the ventral and ventro-lateral walls of the basis (fig. 24). No constrictor muscles are present on the fore part of the V-shaped pharynx, and it would appear that the closure of the lumen is effected by the elasticity of the pharyngeal walls. The labrum is here thickened to form a broad 'wedge' partially fitting into the upper part of the lumen. At the opening of the pharynx the wedge is a median thickening of the membrane but farther back the lateral portions of the membrane thicken to form a transverse sclerotised bar which passes outwards to unite laterally with the pharyngeal struts (figs. 24, 25). Slightly behind the opening of the pharynx the dorsal portions of the vertical plates lose their connection with the upper wall of the basis and its upper margin passes backwards and obliquely downwards (figs. 24, 25). Accordingly, the only sclerotised supporting elements in the rest of the basis are the subcheliceral plate and underlying transverse bars associated with the pharynx. Three pairs of powerful muscles are inserted on the lateral walls of the pharynx and these have their origin on the ventral wall of the basis. Some 8-10 μ further back the floor of the salivarium is separated from the transverse pharyngeal struts by a forward 'outgrowth' of the body cavity (fig. 26). The 'wedge' then becomes tripartite so that its median projection fits into the lumen of the pharynx, whilst its lateral projections lie close against the upraised margins of the cleft. The cavity beneath the salivarium floor becomes wider and deeper more posteriorly, and is accordingly flanked by a wing plate or ala which, as seen in section, passes outward and downward from the sub-salivarial sclerotisation and then inward and upward (fig. 27) to merge with supporting struts of the now narrower and deeper three-pronged wedge. Some 20 μ behind this level the wing plate loses its connection with the overlying sclerotised structures (figs. 28, 29) and now forms a backwardly projecting wing which in transverse section appears in the form of a horizontal S-shaped plate. A similar separation from the supporting struts of the pharynx occurs a little further back, so that in section the sclerotisation appears to lie free within the posterior part of the basis (fig. 30). Muscles arise from the inner face of the elbow of the flanking wall and cross to the floor of the

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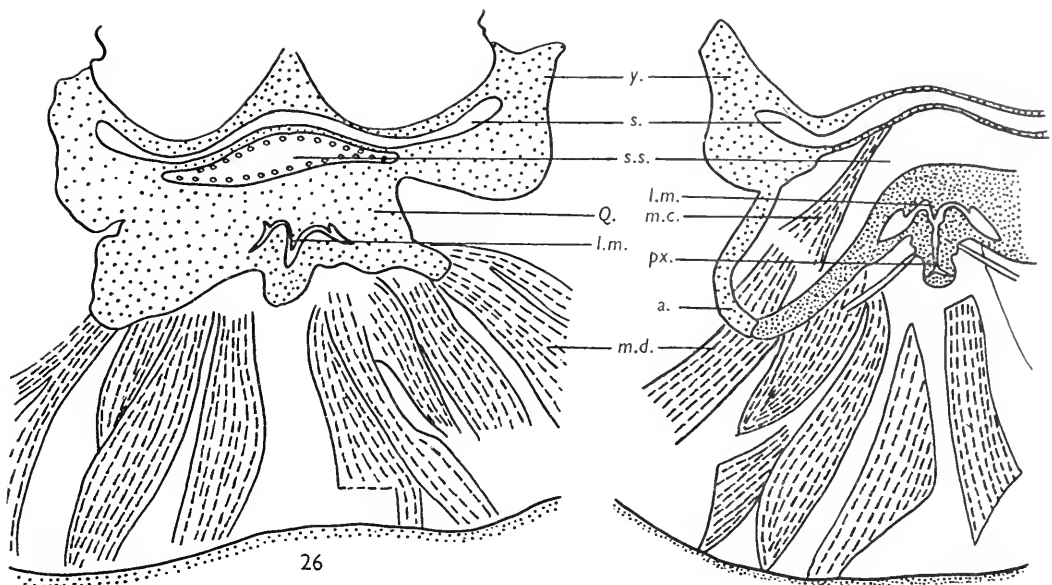
salivarium. Antagonistic muscles are inserted on the outer wall of the elbow and pass obliquely backwards to the ventral and ventro-lateral walls of the basis. These muscles I refer to as the elevator and depressor muscles respectively of the wing plate or ala. Five or six bands of dilator muscles are inserted on the pharynx and pharyngeal struts at this level, in addition to two pharyngeal ligaments which pass out laterally. Similar elevator and depressor muscles arise from the flanking wall further back even when connection with the subcheliceral sclerotisations is no longer evident; in other words, the salivarium-alar muscles pass obliquely forwards. The posterior end of the salivarium is now evident as a narrow elongate oval space embedded within the thick subcheliceral plate. The salivary ducts entering into the salivarium are also incorporated into the subcheliceral plate for a short distance. The pharynx becomes bifid ventrally and supplied with vertical dilator muscles (fig. 29) and this level corresponds with the proximal swelling of the chelicerae, where the upper and lateral parts of the shaft are much thinner and consist of two layers of 'blue'-staining cuticle (with Mallory's stain) (fig. 32). The outer layer is thin (tertiary sheath) and very much folded, and the inner layer is about three times as thick and lacks the pronounced foldings of the outer layer. Entire chelicerae, when seen from the side, show that this region consists of a short semilunar area of less heavily sclerotised tissue. This less heavily sclerotised region may possibly permit flexure of the chelicerae during penetration of tissue.

When the wedge (of the labrum) overlying the V-shaped pharynx separates from the wall of the wing plate it becomes the dorsal wall of the pharynx (cf. figs. 29, 30).

Dilator muscles originate on the subcheliceral plate and are inserted on to the apices of these dorsal pharyngeal arms. Similar muscles supply the ventral arms, and broad dilator muscle bands are inserted on the sides of the pharynx passing horizontally to the wall of the basis.

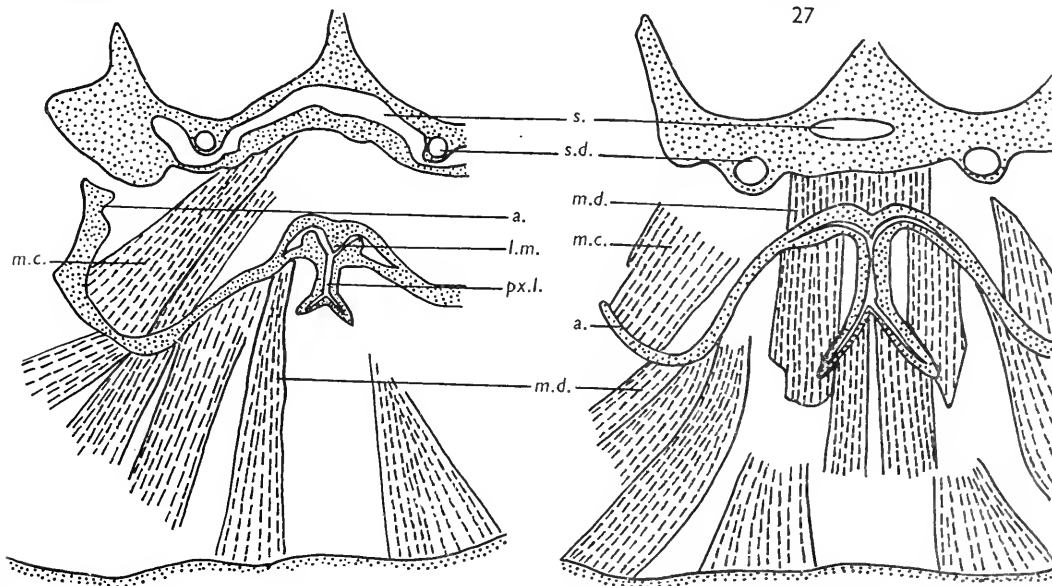
Alimentary tract and associated structures

The pharynx is a powerful suctorial organ, approximately 0.5 mm. long, and is pisiform in shape. The walls consist of heavily sclerotised plates, connected by flexible membrane, arranged in the form of two Y's placed with their bases together. The sides consist of a pair of large concave plates and the dorsal and ventral surfaces of two pairs of smaller plates. In the absence of constrictor muscles at the anterior end of the pharynx, the active movements are those of opening by the contraction of the dilator muscles and closure by a recoil of the pharyngeal walls which occlude the opening. The 'wedge', in view of its shortness, would at this level seem to exert only a limited valvular action. Further back at the level of the alae the closing and opening mechanism appears to be reinforced by the subsalivarial-alar muscles (figs. 27-9). By their contraction they would tend to draw the 'elbow of the ala' upwards and depress the wedge into the pharyngeal lumen. Conversely, the ventral basis-alar muscles would depress the elbow, thus elevating the wedge. All the muscles attached to the alar processes



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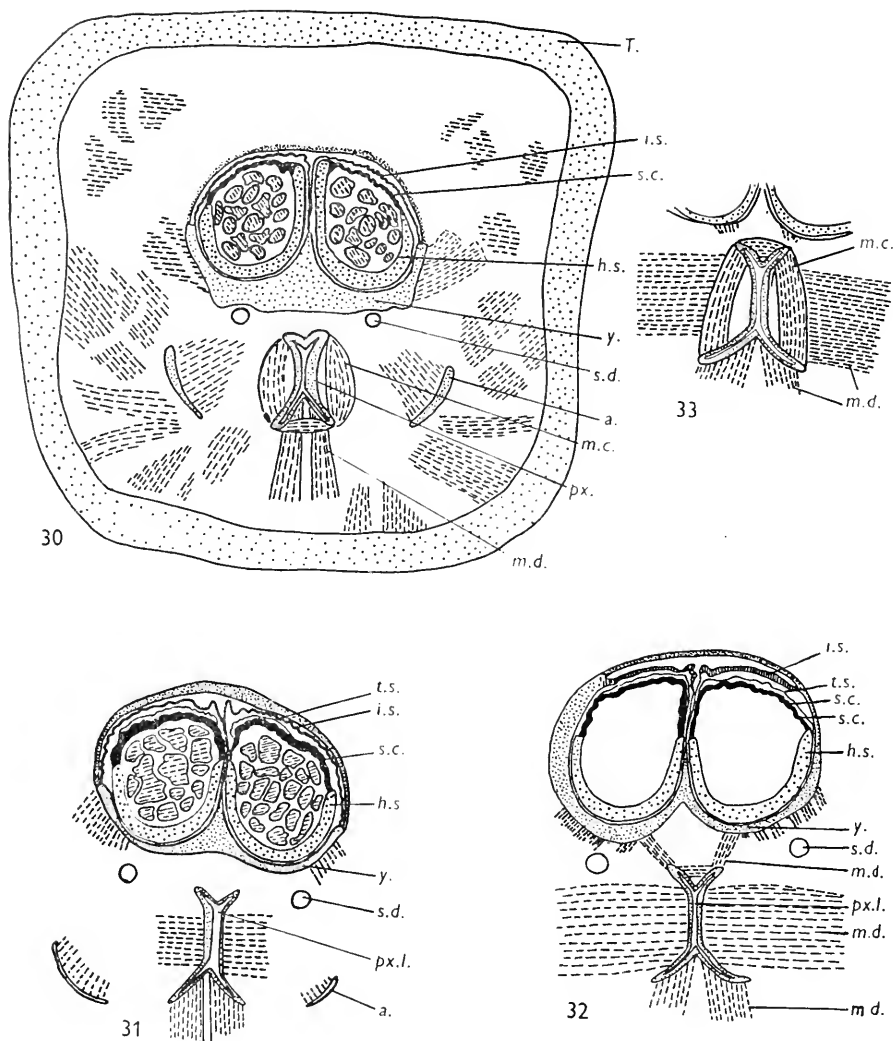


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Figs. 26-9, *Dermacentor parumapertus*. High-power drawings based on transverse sections through the region immediately below the subchelicerai plate to show the origin of the wing plates and their associated musculature. For explanation see text. (From Arthur, *Parasitology*, 1957.)

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Figs. 30-3, *Dermacentor parumapertus*. 30, transverse section through the basis showing constrictor muscles around the pharynx, the posterior extension of the wing plates, and the membranous dorsal and dorso-lateral portions of the chelicerae; 31-3, transverse sections through the chelicerae and pharynx at their posterior limits. (From Arthur, *Parasitology*, 1957.)

pass obliquely forwards. When the pharynx is completely separated from the alar plates posteriorly the muscles consist of the following: (i) the lateral dilators, which are large and have their insertion on the lateral pharyngeal plates and their origin on the lateral wall of the basis; (ii) ventral dilators, which consist of two groups arising from the ventral wall of the basis and these are inserted on to the ventral walls of the pharynx; (iii) the dorsal dilators, two relatively small muscle bands arising from

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the dorsal pharyngeal arms and which have their origin on the subcheliceral plate; (iv) the four constrictor muscle bands are arranged so that they connect the arms of the pharynx and alternate with the dilator bands. These constrictor muscles make their first appearance behind the posterior limit of the alae. The oesophagus arises from the pharynx as a narrow tube, which bends sharply downwards as it nears the brain. It enters the brain ventrally and passes through it at an angle of 45° and

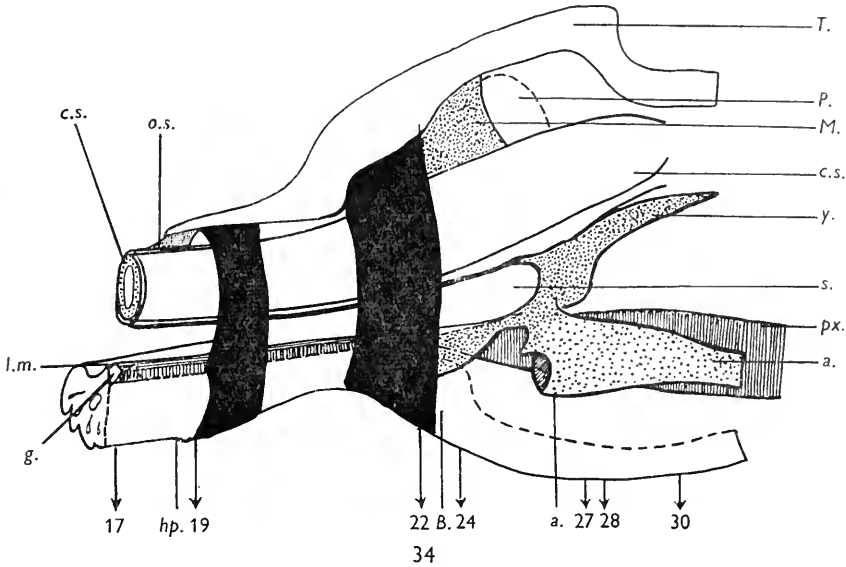


Fig. 34, *Dermacentor parumapertus*. Sagittal half of the female capitulum, reconstructed. The solid black portions represent the vertical wall between the mesial part of the basis and the palps before they fuse. The numbers refer to sectional levels, for which illustrations are given earlier in the text. (From Arthur, *Parasitology*, 1957.)

emerges dorsally from it at two-thirds the distance towards its posterior end. From here the oesophagus flattens out and enters the stomach as the proventricular fold. Histologically the cells lining the oesophagus are large, irregular and somewhat angled and rest on a thin basement membrane. The nuclei are of moderate size and irregular in shape. Overlying these cells and bounding the lumen of the cavity is a very thin chitinous layer which is continuous with the walls of the pharynx.

The salivary ducts pass for some distance beyond the end of the salivarium in the substance of the subcheliceral plate, and on emerging diverge in the direction of the scapulae of the scutum. The ducts open into the salivary glands, which in unfed ticks extend from the level of the scapular angles to the level of the stigmal plates. Each gland consists of a mass of spherical alveoli of approximately 0.02–0.04 mm. in diameter. These alveoli are of two different types. The first type of alveolus is limited to the anterior third of the gland and consists of an indefinite peripheral cellular structure with fibrils radiating in the direction of the lumen and, as far as can be

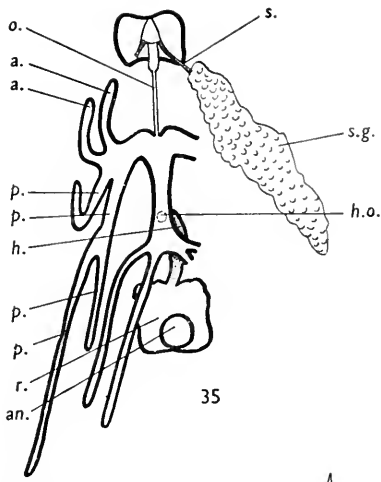
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ascertained, they end freely. The nuclei are small and appear to be near the lumen. The second type of alveolus forms the bulk of the gland; the cells are relatively large, with large basal nuclei and they may contain ferment granules or appear as pale reticulate cells devoid of granules.

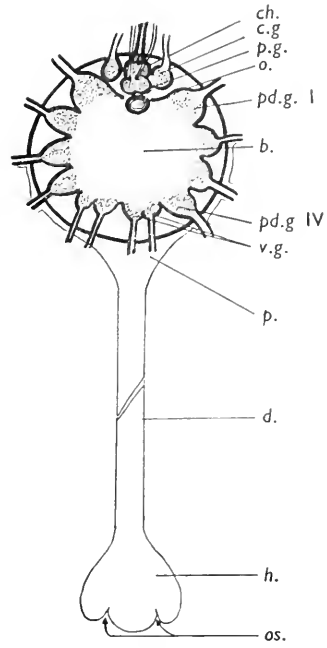
The oesophagus leads to the midgut (fig. 35) which forms an elongate tube-like structure from which arise a number of diverticula. The most posterior of these curve under the other abdominal viscera running in a median cephalad direction. The epithelial cells of the midgut vary in shape, some are irregular, others cuboidal, clavate or pyramidal; the nuclei being large, spherical, and centrally placed. These epithelial cells in *Dermacentor andersoni* (Douglas, 1943) almost always contain black granules arranged along the periphery of the cell wall. Cell inclusions have also been seen in engorging ticks which are always confined to the epithelium of the mid-gut diverticula (Gregson, 1938) but in larval ticks the gut cells are devoid of such inclusion granules. After the tick has imbibed blood, assimilative changes in the gut are accompanied by the presence of large numbers of minute colourless non-motile globules, being most abundant in the cytoplasm at the free end of the cells and decreasing in numbers to the base of the cell. As assimilation continues these globules increase in size and ultimately the epithelium cells are packed with them. The gut cells in the fully-fed female become distended with globules and increase their size enormously. Eventually the cells are detached, and float in the fluid of the gut lumen (Gregson, *loc. cit.*). The globules differ from volutin bodies in their capacity to resist heat (80° C.) for over five minutes, are gram positive and are unstained by dilute solutions of neutral red in the living cell. They are not destroyed by acid fixatives nor with janus green, i.e. they are neither mitochondria nor rickettsiae. The cells of the rectal tube at its junction with the mid-gut are similar to those already described. Further back, however, the cells become flattened and the lumen narrows. The rectal sac, on the other hand, is a large membranous sac of irregular form lying directly over the anal aperture. Physiologically it serves for the reabsorption of water and as a receptacle for waste products. The paired Malpighian tubules open on to the floor of the rectal sac and from here they curve posteriorly, before curving forward to run above the viscera to the anterior gut diverticula. Thence they pass to the postero-lateral border of the body, curve anteriorly again beneath the viscera as far forwards as the level of the brain. The lumen of the Malpighian tubule usually contains numerous small, spherical highly refractive excretory granules and is bounded by cuboidal cells with centrally placed nuclei.

Nervous and sensory systems

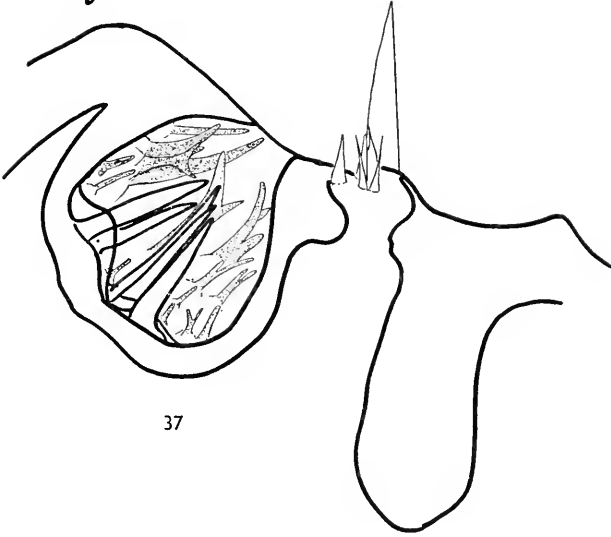
The nervous system of *Dermacentor* ticks is, as in other ticks, concentrated into a single mass, the brain (fig. 36) which is perforated obliquely by the oesophagus and lies immediately above the genital orifice. It is a creamy spheroidal mass which is slightly flattened dorso-ventrally. The nature and distribution of the nerves arising from it suggest that the dorsal portion is derived from four pairs of ganglia and the



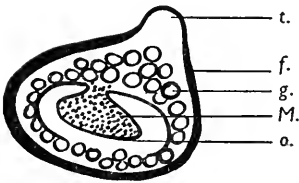
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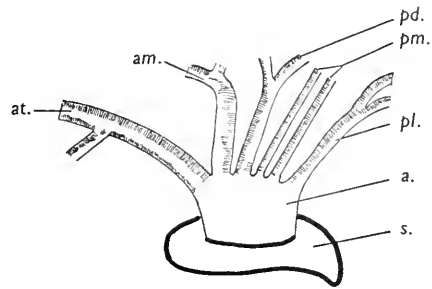
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Fig. 35, the alimentary tract of *Dermacentor*. *o.*, oesophagus; *s.*, salivary duct; *s.g.* salivary gland; *a.*, anterior lobes of mid-gut; *p.*, posterior lobes of same; *h.*, hind-gut; *h.o.* opening of mid-gut into hind-gut; *r.*, rectal sac; *an.*, anal opening.

Fig. 36, brain and nervous system of *Dermacentor*. *ch.*, cheliceral ganglion; *c.g.* cerebral ganglion; *p.g.* palpal ganglion; *o.*, oesophagus; *b.*, brain; *pd.g.* I-IV, pedal ganglion I-IV; *v.g.* visceral ganglion; *d.*, dorsal aorta; *h.*, heart; *os.*, ostium; *P.*, periganglionic sinus.

Fig. 37, Haller's organ of *Dermacentor* seen from the side.

Fig. 38, surface view of a spiracle of a species of *Dermacentor*. *t.*, dorsal prolongation; *f.*, frame; *g.*, goblet; *M.*, macula; *o.*, ostium.

Fig. 39, diagram of the internal structures associated with the spiracular plate. *a.*, atrium; *s.*, spiracular plate; *at.*, anterior tracheal trunk; *am.*, anterior median tracheal trunk; *pd.*, postero-dorsal tracheal trunk; *pm.*, postero-median tracheal trunk; *pl.*, postero-lateral tracheal trunk.

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ventral portion from six ganglionic pairs. Nerves supplying the palps, chelicerae and pharynx arise from the upper portion, while from the ventral portion the four anterior nerves innervate the legs, and the two posterior ones supply the viscera (fig. 36). Histologically there is an inner mass of interwoven fibres, the neuropile, surrounded by a layer of ganglionic cells which stain deeply and indicate the limits of the various components. The whole is ensheathed by a thin neurilemma which persists over the nerve trunks and, according to Douglas (1943), is reflected around the oesophagus as it passes through the brain. From the dorsal ganglion the paired cheliceral nerves pass forwards dividing to innervate the cheliceral shaft and the retractor muscles. The palpal nerves originate as a pair but fuse to form a single trunk immediately above the oesophagus before dividing near the posterior extremity of the pharynx to pass into each palp. Paired nerves arise from the lateral ganglionic component and, after dividing, lead to the porose areas and the eye. The pharyngeal nerves divide several times beyond their origin and supply the pharyngeal and adjacent areas of the capitulum. The peripheral nerves supplying the legs are the largest, and pass directly into the coxal cavities; the two pairs of visceral trunks divide repeatedly and innervate the opisthosomatic structures.

The sensory structures in *Dermacentor* are thick-walled bristles on the legs, often slightly curved and terminating in fine points, usually becoming more spinose from the first to fourth legs and confined to the ventral surfaces. By appropriate staining methods a fine sensory process can be detected at the end of a canal penetrating the cuticle, and in some species of *Dermacentor* one or more nuclei lie at the base. In *D. andersoni* (Douglas, 1943) the sensory cells and their nuclei may be found in the canal itself. Other integumentary structures with alleged sensory functions are duct-like with frequently a complicated shape. These sensillae have been subdivided by Schulze (1942) into 'trichoid' sensilla and 'Krobylophores' or 'Schöpforgane'. The former are believed to act as proprioceptors responding to cuticular strains, the latter to have a chemical and mechanical function as well as being secretory. 'Krobylophores' (=sensilla hastiforma) occur in *D. andersoni*, but do not appear to be innervated; nevertheless Douglas noted that they more closely resembled chemoreceptors than glandular structures. Other Krobylophores to be found in *Dermacentor* consist of solid cuticular bodies attached by a thin membrane and lying in a deep depression of the integument. These cone-like bodies have connections with a sensory cell. Lees (1948) has also described two types of integumental glands in *Dermacentor*, both of which were considered as dermal glands. These, whilst indistinguishable in the unfed female, hypertrophy on engorgement and subsequently degenerate, yielding a yellow end-product which passes up the duct on to the cuticular surface. The porose areas, present only in the female, constitute a compact group of ducts which are alleged by some workers to be innervated by the oculoporose nerve from the dorsal ganglionic portion of the brain in the case of *D. andersoni*. The dorsal foveae are morphologically similar to the areae porosae and have been considered by Schulze (1942) and Douglas (1943) as sense organs. The scutal eyes are generally small, colourless convex lenses

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comprising an hyaline portion of the integument superimposed over the hypodermis. No structure or pigmentation has been observed, although Douglas has asserted that it is innervated by a branch of the oculoporosa nerve and he suggested that it is probably a photoreceptor.

Haller's organ, first described in an *Ixodes* species by Haller (1881), is universal in all tick genera although there are many differences in detail from genus to genus. Haller's organ in *Dermacentor* (fig. 37) consists of a capsule and a trough. The shape of the capsule may be subtriangular, ovate or round and it contains five or six sensillae which taper distally. In *D. andersoni* and *D. parumapertus* the sensillae are quite broad proximally and all point to the antero-dorsal aperture. Accessory cuticular outgrowths are also found, and these may be short, narrow, unbranched projections or larger broad dichotomously branched extensions, all of which are devoid of a nervous supply (fig. 37). The presence of these accessory structures in the capsule suggests an affinity with the Rhipicephalid ticks. It has not been found possible to use these capsule characters for the separation of the various *Dermacentor* species, as the accessory structures appear to vary much in detail from species to species. The trough likewise suggests affinities with *Rhipicephalus*, *Haemaphysalis* and *Amblyomma* in that all the sensillae open into a common basal canal. In *Dermacentor andersoni* and *D. parumapertus* there is one type I sensilla (Arthur, 1956), two type II sensillae, two type III sensillae and one type IV sensilla. In contrast, *Anocentor nitens* (previously *Dermacentor nitens*) has a capsule without cuticular outgrowths, and in this resembles the genus *Ixodes*, while in the trough there is an extra sensilla of type IV.

Circulatory system

The heart is located at about two-thirds the body length and lies under the dorsal foveae with which it has no apparent connection. It is supported by five extrinsic muscles, two pairs of which are inserted laterally and one pair posteriorly between the ostia (fig. 36). The contraction of these extrinsic muscles results in the diastole. Systole is achieved by contraction of a network of intrinsic musculature in the wall of the heart. Douglas has stated that in *D. andersoni* the pulse rate varies from 20-128 pulsations per minute but there is a frequent cessation of heart beat for several seconds. Leading forwards from the heart is a non-muscular dorsal aorta which, in the region of the brain, enlarges to produce the periganglionic sinus, and which completely invests the former, to continue forwards then as the perioesophageal sinus around the capitular nerves and oesophagus where it opens on the same level as the posterior end of the pharynx. The blood has been described as a slightly turbid fluid in which numerous amoeboid corpuscles float. Granular aggregations are also apparent in both the nuclei and the cytoplasm. Strongly eosinophilic spherical elements have been observed in these corpuscles and it has been suggested that they are phagocytosed material since they occur freely in the plasma.

Respiratory system

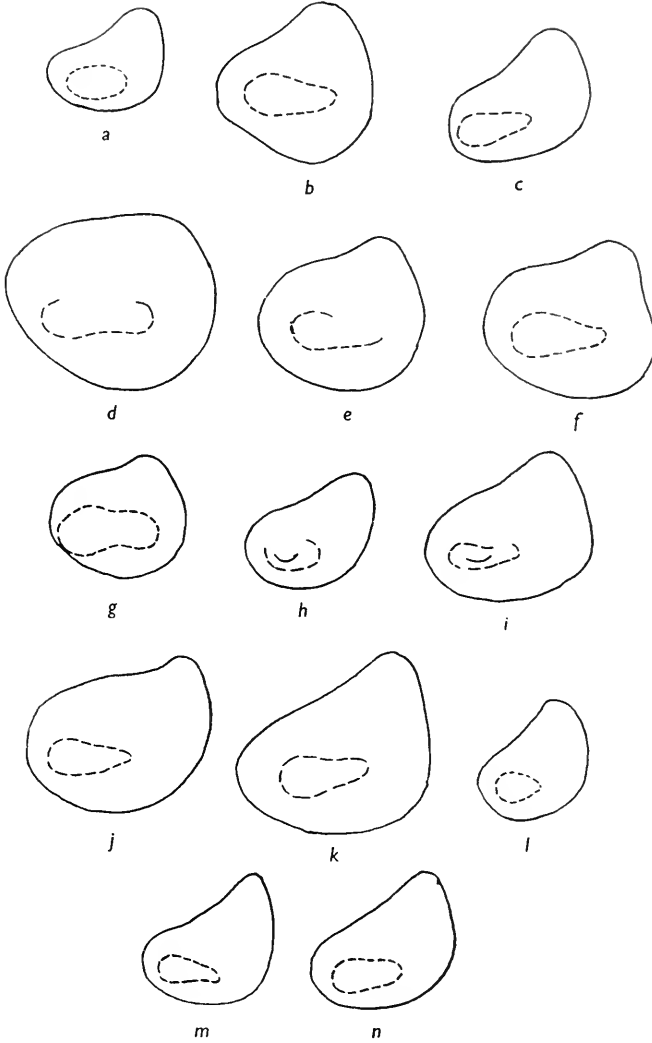
The respiratory systems of the nymphs and adults consist of paired spiracular plates on the ventral surface of the body near the lateral margins and slightly posterior to coxa IV. The plate is normally comma-shaped with a distinct 'tail' or dorsal process. This 'tail' may be quite absent or slight and blunt or well marked and narrow. Centrally there is a heavily pigmented region, the macula, which constitutes the upper lip of the frequently crescentic ostium. Granulations of various sizes are found around the macula, the larger ones being the goblets of Stiles. The plate itself is bounded by a thickened ridge of chitin, the frame, which in some species is elevated above the general level of the post-scutal area. Earlier writers, as pointed out by Cooley (1938), have utilised the dorsal prolongation as a diagnostic character, especially the direction in which it is pointing. This is not a dependable feature as shown in the outlines of plates from various specimens of *D. variabilis* (fig. 40). Some species show much more variation in the outline of the spiracular plate than do others; thus *Anocentor nitens* has oval plates with no dorsal spur, *Dermacentor hunteri* and *D. halli* reveal little variation but *D. andersoni*, *D. variabilis* and *D. albipictus* show quite a considerable degree of intraspecific variation. Size alone is of little diagnostic value and tends to be closely linked with shape; thus small ticks have spiracular plates which differ in outline from those of large ticks of the same species. The number, size and distribution of goblets, whilst they vary to a limited extent intra-specifically, are of some value in species determination, more particularly when considered along with some other characters. In *Anocentor nitens* the goblets are very large, forming a single layer of about six goblets around the macula; in *Dermacentor albipictus* the goblets are large and distributed over the whole spiracle which appears coarsely granular all over; in *D. andersoni*, *D. parumapertus*, *D. hunteri* and *D. occidentalis* the goblets are fairly large and clustered around the macula, the coarsely granular area being quite distinctly separated from the smooth peripheral region; in *D. variabilis* and all the Old World forms at present known, with one exception, they are so small and so little differentiated from the finer granulations that at magnifications of twenty diameters they are barely resolved and the entire surface looks glossy and almost smooth.

From an investigation of the structure of the spiracular plate of *Dermacentor* it is apparent that it is similar in all essential respects to that of the genus *Ixodes*. The spiracular plate consists of three layers and their relationship can only be adequately interpreted from serial sections. The spiracle is here described under the following headings: (a) the spiracular plate, (b) the subostial space, (c) the atrial chamber, and (d) the tracheae.

(a) *The spiracular plate* (fig. 38). Beyond the limits of the macula the plate consists of an outer non-extensible cuticular layer, characterised by being alternately thick and thin. The thinner portion overlies the goblets as seen in fig. 43 and the thicker portions, occupying the spaces between successive goblets, are formed by the coalescing ends of underlying rods or pedicels which merge around the periphery of the goblets.

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1.0 mm.



40

Fig. 40, variation in the outline of the spiracular plates of *D. variabilis* (after Cooley, 1938).
a-g, FEMALE; h-n, MALE.

This produces the effect of a reticulate pattern when the plate is observed from the surface. The aforementioned pedicels are not septa but columns, so that there is a continuous space between the goblets. Each pedicel is a diamond-shape in cross section, and their somewhat swollen proximal ends fuse with the thick inner cuticular layer. The pedicels are hollow and continuous with tubular extensions which pass through the inner cuticular layer, where their open ends abut against the epithelial

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cells. These pedicellar ducts do not appear to penetrate through the superficial layer of the plate, but cease abruptly about midway through it, nor is there evidence that cytoplasmic extensions from the hypodermal cells continue into these ducts.

The inner cuticular layer underlying the goblets is structurally uniform, being concave at the bases of the goblets, into which narrow ducts open. Each duct then passes inwards through the cuticle, widening about midway along, where there is a stellate cuticular thickening. Cytoplasm from the underlying epithelium extends into the wider proximal portion, but does not penetrate into the finer distal end. Norden-skiold (1908) ascribed a glandular function to these ducts, Nuttall, Cooper & Robinson (1908) considered them to be sense organs and Falke (1931) referred to them as 'Champagner-Propforgane'. The underlying epithelium in this region is thicker here than elsewhere but the repeated failure to identify anything analogous to nervous elements or to nervous connections prompts me to consider them as tegumental glands as originally suggested by Lees (1948).

Previous workers have given little consideration to the relationship existing between the macula, the upper and lower lips and the ostium. Nuttall *et al.* (1908) described the position thus: 'The portion of the spiracle beneath the macula . . . is occupied by a columnar mass of connective tissue and muscle fibres (the columella) running up from the soft structures underlying the spiracle.' I propose to give the term 'columella' to that portion of the macula which constitutes the upper lip and, as will be seen later, its connection to the inner cuticular layer will be referred to as the 'stalk'. The peripheral region of the macula differs from the alternating thick and thin cuticle of the rest of the superficial plate in that it is a thick cuticular layer (figs. 45, 46). Towards the centre of the macula and in approximate line with the long axis of the ostium this cuticular layer becomes thickened into a wedge-like projection (figs. 41, 45). Here pedicels arise from the walls of the subostial cavity and pass directly into this thickened macula. These pedicels differ from those associated with the goblets in that they pass individually into the macula without terminal fusion into groups; nevertheless they are still tubular. These pedicels are, moreover, very much stouter and longer than those of the goblet region. The apex of the wedge increases in length in the direction of the ostium and projects inwards into a subostial cavity (figs. 41, 42) whereby the bulk of the wedge goes to form the upper lip. Meanwhile, the lengthened apex of the wedge fuses with the deep-seated cuticular layer, producing in section a stalk-like effect (cf. figs. 41, 42 and 45). The lower lip is smaller and consists of an intucking of the free end of the 'split' macula (fig. 42). The 'stalk' of the 'columella' attains its greatest thickness about halfway along the ostium and thereafter narrows to its posterior edge with the elimination of the softer tissues within the columella, but the columella and its stalk do not lose their identity for some 30-40 μ beyond the actual edge of the opening (fig. 44). After this the columella and its associated stalk pass gradually into the wedge-shaped form (fig. 45) which in turn becomes the uniformly thick macula (fig. 46). Nuttall *et al.* (1908) imply that in *Haemaphysalis* this columella stalk is cylindrical but as seen from their figures and from the present series of sections, it is

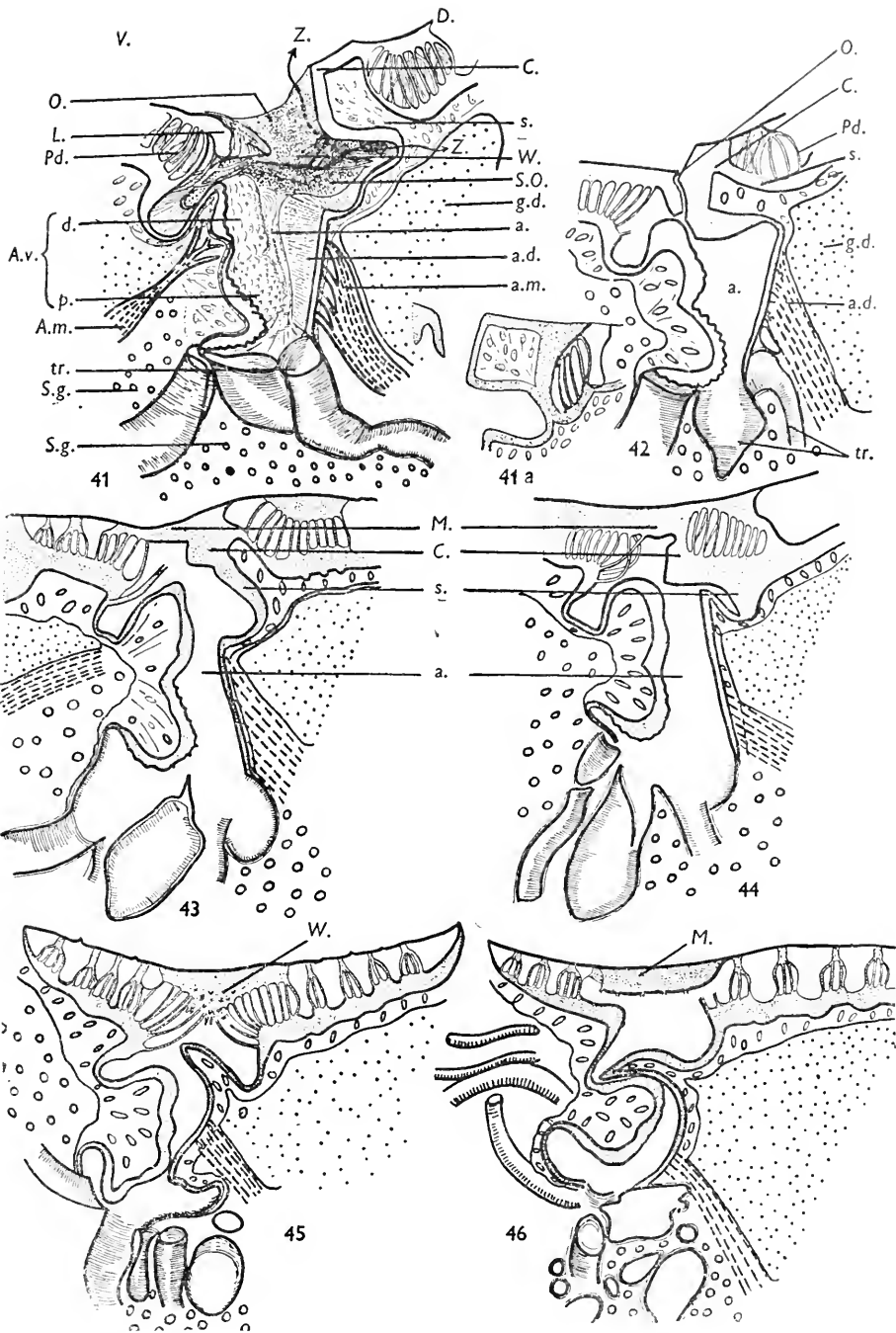


Fig. 41, reconstruction of half spiracle, looking anteriorly.

Figs. 42-6, sections through the spiracle to show the relationships between the columella and the macula. *O*, ostium; *L*, lower lip of ostium; *Pd*, pedicel; *A.v.* ventral and ventro-lateral walls of atrium; *d*, distal portion, *p*, proximal portion; *A.m.* muscle of ventral atrial wall; *tr*, tracheal trunk; *S.g.* salivary gland; *a.m.* muscle of dorsal atrial wall; *a.d.* dorsal wall of atrium; *a*, atrium; *g.d.* gut diverticulum; *S.O.* substomial space; *V*, ventral; *W*, wedge of macula; *s*, stalk of columella; *C*, columella; *D*, dorsal; *M*, macula; *ZZ*, level of section depicted in Fig. 41a. (From Arthur, *Parasitology*, 1956.)

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a septum of varying thickness which extends along the length of the ostium and is continuous anteriorly and posteriorly with the cuticle of the macula. For the greater part of its length within the limits of the ostium the columella and its stalk are hollowed and lined with the epithelium. Towards the periphery (fig. 42) the stalk becomes solid, but there is an apparent radiation of the epithelial tissue into the columella (fig. 42). This epithelium does not extend to any great degree into the macula.

(b) *The subostial space.* In *Haemaphysalis punctata*, as described by Nuttall *et al.* (1908), a distinct clear space (pericolumellar space) surrounds the lower portion of the columella. The space lying above the pericolumellar septum (i.e. truly dorsal to it) in *Dermacentor* is crossed by pedicels (figs. 44, 45), some of which may arise from the columellar septum. Hence the space beneath the ostium communicates directly with a dorsal pedicellar space in this species *on each side* of the septum beyond the disappearance of the 'stalk', i.e. outside the anterior and posterior limits of the aperture. For convenience I refer to the clear space as the subostial space (though in fact its limits extend well beyond the ostium in all directions). This space, when seen in horizontal section, is elongate and lies along the long axis of the tick's body, widening appreciably in the vicinity of the ostium. For the most part it is shallow, becoming more so towards its posterior limit, the whole being asymmetrically arranged relative to the ostium.

(c) *The atrial chamber.* The subostial space leads into a narrower inner atrial chamber which is short and tube-like when viewed *in situ*.

The dorsal and dorso-lateral walls of the atrium are uniformly smooth and flat, whilst the ventral and ventro-lateral walls are thrown into a conspicuous broad lobe, as also shown by Douglas (1943) in *D. andersoni*, whose long axis is transverse to the length of the atrium. In the mid-line the lobe is indented, thus dividing it into proximal (*p*) and distal (*d*) portions (fig. 41). Towards both the anterior and posterior ends of the atrium these indentations fade out so that the folds appear as a single lobe, becoming progressively smaller towards the extremities where they merge into the antero-dorsal and postero-dorsal walls respectively. In these regions the outer dorsal wall and the corresponding lateral areas curve and come to lie between the atrium and the subostial space (fig. 46); ultimately this wall at its most posterior limits joins with the base of the ventral lobe so that on the extreme anterior and posterior extensions the atrium is separated from the subostial space. The walls of the ventral lobe are much thicker than are those of the dorsal surface, and are of a brownish hue rather than of the yellow colour of the latter. The cuticle is also thrown into folds which are not as fine and deep as are those of the epicuticle of the body wall. The surface lacks the taenidia which are so characteristic of the trachea.

Gaseous exchange is regulated by the movement of the atrial walls, which are governed by the following muscles. (i) A single muscle band originates from the ventro-lateral body wall just below the spiracle and passes to the ventral lobes of the atrial chamber at or about its mid-ventral line (fig. 41), but on entering into the folds it divides into fine fibrillar bundles. (ii) A series of broad muscle bands arise from the

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dorsal surface of the body and pass out obliquely to be inserted along the length of the smooth dorsal and dorso-lateral wall of the atrium. Before passing into the cuticular substance of the latter they become fasciated. Mid-dorsally they are attached along the length of the atrial wall, but peripherally they are limited to the inner extremity (cf. figs. 41, 43 and 44, 46). (iii) A third muscle band is evident in *D. variabilis* which arises from the base of the latero-ventral infolding of the body integument and is inserted on the post-scutal area immediately below the ventral margin of the spiracular plate.

No direct occluding muscles have been observed in the spiracles of *Dermacentor*, and earlier workers on other tick genera have suggested that the constriction of the lumen of the atrium is effected by the ventral lobe being squeezed against the dorsal wall. This appears to be highly probable, and under such an influence the folds of the ventral lobe become flattened and thus come to lie close against the opposite wall. It has been stated that compression is due to the contraction of the dorso-ventral body muscles, which raises the problem of the efficiency of these muscles for this purpose. In the unfed female these muscles are folded, and would therefore be inadequate for contractile purposes. On the other hand, with the rapid ingestion of blood the gut contents and the body wall become distended rapidly to a remarkable degree. Removal of the water from the blood mass soon turns the ingested blood into a semi-solid sticky mass, which ultimately becomes so highly concentrated that churning movements of the gut are impossible (Lees, 1952), and under these conditions it seems likely that the contraction of the dorso-ventral body muscles will be inhibited to a very large extent. The pressure of the much distended gut will obviously exert a pressure on the atrial walls and the dorsal and ventral atrial muscles will contract and maintain the lumen of the chamber.

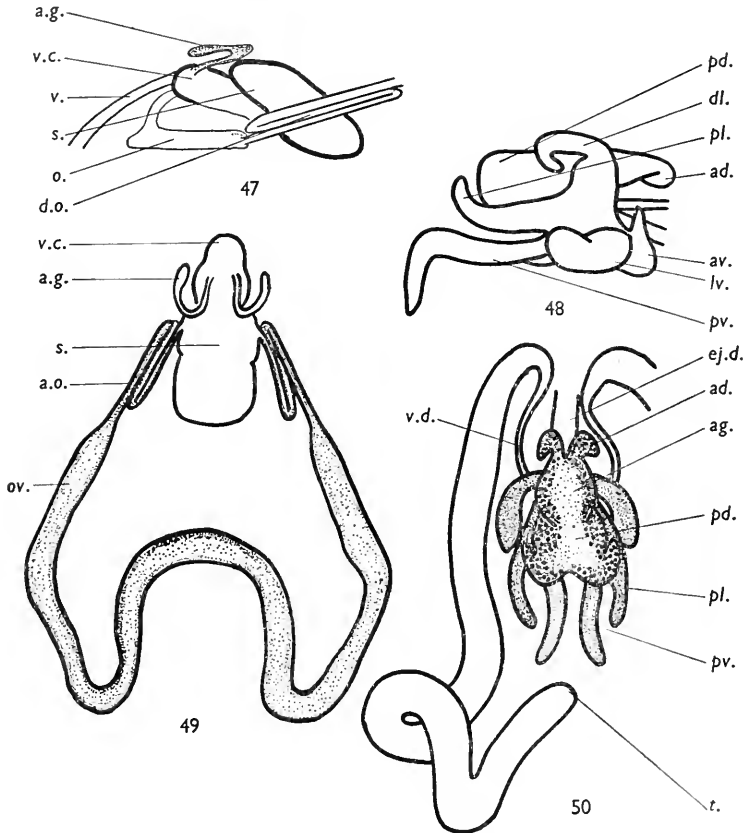
(d) *The tracheae.* From the atrium of each spiracle the following tracheal trunks (fig. 39) arise: (a) an anterior trunk which passes along the antero-lateral margins of the opisthosoma, dividing to send branches to each leg, to the brain, the prosomatic appendages and the prosoma generally; (b) the median anterior trunk which passes in the direction of the mid-line before becoming longitudinal and thence supplies the salivary glands and the proximal parts of the genital system; (c) the postero-dorsal trunk yielding tracheation for portions of the mid-gut, the posterior parts of both the salivary glands and reproductive system; (d) two smaller trunks, the postero-medians, which, along with (e) the postero-lateral trunk, supply the posterior viscera in general. It is not without significance that the female has a more extensive tracheal system than the male.

Reproductive system

The testes of the male are paired lobes (fig. 50) which extend laterally from the level of the brain to about the posterior margin of coxa IV where they loop upon themselves mesially. Structurally they consist of large subtriangular cells containing spermatogonia which, bounded by a thin epithelial sheath, enclose a small lumen. Outwardly

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the large cells are also covered with a thin sheath of epithelial tissue possessing scattered nuclei. The anterior end of the testes is continued forwards as a much narrowed vas deferens which is reflected on itself before merging with the ejaculatory duct. The accessory glands open at the junction of the vas deferens and the ejaculatory duct and the expanded posterior portion of the latter is thought to be a seminal vesicle in

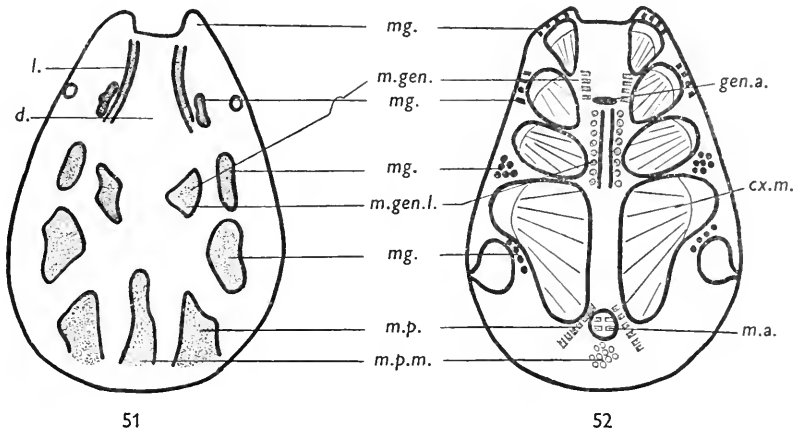


Figs. 47-50, 47 and 49, female reproductive system; 47, side view; *a.g.* dorsal accessory gland; *v.c.* vagina, cervical portion; *v.* vestibular portion of vagina; *s.* seminal receptacle; *o.* expanded common oviduct; *d.o.* dorsal oviduct; 49, dorsal view; *ov.* ovary; 48 and 50 male system: 48, side view to show the accessory glands, *pd.* postero-dorsal lobe; *dl.* dorso-lateral lobe; *pl.* postero-lateral lobe; *ad.* antero-dorsal lobe; *av.* antero-ventral lobe; *lv.* latero-ventral lobe; *pv.* postero-ventral lobe; 50, dorsal view; *v.d.* vas deferens; *ej.d.* ejaculatory duct; *t.* testes. (Adapted from Douglas, 1943.)

D. andersoni (Douglas, 1943). The ejaculatory duct is lined with a chitinous intima, which rests on a single layer of small cells resting on a thin basement membrane. In transverse section this duct is oval and becomes broader posteriorly. Antero-dorsal and postero-dorsal lobes of an accessory gland empty their contents into the hinder extremity of this ejaculatory duct (fig. 48). The other accessory glands consist of antero-ventral, postero-ventral and latero-ventral lobes; there are also unpaired

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median and ventral lobes. The three former paired lobes consist histologically of large, loosely aggregated cells with large, ovoid, basophilic nuclei, but nearer the lumen they tend to become columnar in shape with ellipsoidal nuclei. The rest of the gland is granular in nature, comprised exclusively of columnar cells with ellipsoid nuclei, and nearer the lumen granular elements are readily distinguishable. Occasionally the lumen may be filled with these elements. Gregson (1938) has observed inclusion bodies in the nucleoplasm of developing sperms, which vary in size from dimensions near the limits of visibility with the oil immersion lens to 2μ in diameter. Within the limits of a single section they may vary in size and number, but in more mature spermatozoa they appear to have increased in number but decreased in size. All these



Figs. 51 and 52. 51, principal unpigmented areas with the muscles attached to them: *l.*, levator muscles of capitulum; *d.*, depressor capitular muscles; *mg.*, marginal dorso-ventral body muscles; *m.gen.*, anterior genital muscles; *m.gen.l.*, posterior genital muscles; *m.p.*, postero-accessory dorso-ventral body muscles; *m.p.m.*, postero-median dorso-ventral body muscles; *m.a.*, anal muscles; *cx.m.*, coxal muscles; *gen.a.*, genital aperture; 52, schematic drawing of the floor of the body cavity showing attachment of principal muscles. (After Douglas, 1943.)

inclusions appear to be without internal structure. The ovaries in the female are continuous, extending well back posteriorly before looping forward mesially in front of the rectal sac (fig. 49). Initially the ovary is of a creamy smooth texture, and prior to pressure of other organs during engorgement is almost circular in cross-section. It consists of two cellular layers when seen in section, the outer consisting of potential ova and the inner of epithelial cells. Dense masses of uniform small globules (1μ diameter) have been observed within the nuclei of the eggs of certain engorging females of *D. andersoni* (Gregson, 1938) and they appear to be aggregated in certain regions of the nucleoplasm. Outside the membrane of ova containing such globules and in the surrounding haemolymph there are occasional larger globules ($4-12\mu$ diameter) which are reminiscent of the inclusion bodies of the gut epithelium. In more advanced ova there are cytoplasmic groups of inclusion bodies, which assume the form of loosely packed tortuous globular threads (Gregson, 1938) of very small

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size (0.2μ diameter). The nuclei of the epithelial layer are large and commonly thicker than the cellular layer itself. The oviducts extend forwards to the hind margin of the vagina where they are reflected on themselves almost as far back as the beginning of the ovary, before opening into a median expanded common oviduct beneath the vagina and thence to the antero-ventral portion of the vagina. The lumen of the oviduct is bounded by columnar epithelial cells which project into the cavity, and outwardly these cells are surrounded by a layer of muscle fibres and an epithelial layer. The seminal vesicle is a large median unpaired sac situated in the mid-line between the mid-gut and the ventral integument. Anteriorly it is produced around the cervical portion of the vagina, and the inner surface, consisting of columnar cells, is thrown into deep folds. Douglas has suggested that its size and form may be associated with spermatophore storage. The vagina is divisible into a barrel-shaped posterior part and the anterior vestibular portion consisting of a simple dorso-ventral tubular organ. Internally, the cervical region is similar to that of the seminal vesicle but is less strongly folded than the latter. The walls of this portion of the vagina have a heavy layer of circular muscle fibre, undoubtedly correlated with the extrusion of the egg. A strong band of muscle is also inserted on this organ on its antero-dorsal aspect, and which has its origin on the ventral body wall slightly in front of the genital opening. The wall of the vestibular region is again folded to allow for distension during egg laying; the hinder end of this wall projects slightly into the cervical portion and the walls of both gradually blend together. The accessory glands of the female system consist of a pair of short sausage-shaped tubes which enter the cervical portion of the vagina antero-dorsally. The internal limiting layer consists of columnar-shaped cells with large conical nuclei which circumvent a very narrow lumen. It has been suggested by Douglas (1943) that these glands in *D. andersoni* produce a lubricant fluid to facilitate the passage of the egg through the vagina.

Musculature

During egg laying the egg is passed from the protruded vagina to the arms of the bidigitate glistening sac of Gené's organ, whence it is transferred, after manipulation by the 'arms' of this organ, to the dorsum. There appears to be no intrinsic musculature whereby the organ can be extruded; presumably this is effected by differences of internal body pressure initiated by contraction of the dorso-ventral somatic muscles. Attached to the posterior end of each lobe of the organ is a bundle of longitudinal muscles which originate on the postero-ventral surface of the scutum and undoubtedly serve as retractors.

The leg muscles arise as a pair, a tensor and a flexor, in each segment. The coxae are immovably fixed to the body wall and the flexors and tensors originating therein are inserted on the trochanter whereby rotary movement is effected. The musculature of the other segments permits movement in a vertical plane only. Similarly the muscles of the tarsus are attached to tendons which are inserted on the basal articulation of the pulvillus and enable the claw to move up and down. The other somatic

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muscles are readily divisible into three series all of which are dorso-ventrally disposed (fig. 52).

Peripherally the muscles are arranged in four groups laterad of the coxae, whence they extend obliquely inwards to the dorsal surface. In *D. andersoni* the anterior group have their origin outside the anterior portion of the cervical groove of the scutum; the remaining three groups on each side lie beneath 'unsilvered' spots on the dorsum in the male, and in roughly comparable situations in the female. The second series of muscles are inserted in the vicinity of the anus; a pair obliquely placed relative to the long axis of the body on either side of the anus (the postero-accessory muscles of Douglas) with their insertion on the postero-lateral unsilvered region; a single group behind the anus, the postero-median muscles, which 'pass in a direction dorso-posterior to their origins between the origins of the postero-accessory muscles'. The third group are the muscles around the rectal sac which serve primarily to force nitrogenous waste material into the anal canal and out of the body. The fourth series of muscles are those associated with the reproductive structures and are divisible into anterior and posterior groups. The former, located on either side of the genital opening, are directed dorsally and postero-laterally to their points of origin slightly behind the arms of the cervical grooves. The posterior group is similarly arranged and originates laterad of the dorsal foveae; this group of muscles lies behind the orifice and outside the accessory glands in the male, or the receptacle and cervix of the vagina in the female. The primary function of these muscles in the male would appear to be the extrusion of the spermatophore, and in the female to assist the outward passage of the eggs. It has also been suggested that they may be complementary to marginal muscles.

CHAPTER III

THE GENUS *DERMACENTOR*:

2. AMERICAN SPECIES

Key to the males

- | | | |
|----|--|------------------------|
| 1 | Widely divergent spurs on coxa I. | 2 |
| | Spurs on coxa I with either parallel inner edges or only slightly divergent. | 5 |
| 2 | Ventral festoons produced into chitinous tubercles. | <i>D. imitans</i> |
| | Ventral festoons not produced into chitinous tubercles. | 3 |
| 3 | Palpi long and narrow, postero-dorsal ridge well developed; cervical grooves deep, parallel, three times as long as broad. | <i>D. parumapertus</i> |
| | Palpi short and broad, postero-dorsal ridge moderately developed; cervical grooves as deep pits. | 4 |
| 4 | Lateral grooves shallow; short grooves between festoons deeper than lateral grooves. | <i>D. halli</i> |
| | Lateral grooves lacking; festoons coalesced in groups of three, two and one, latter median in position. | <i>D. dispar</i> |
| 5 | Spiracular plate oval to suboval without a definite dorsal prolongation; goblets large, few to moderate in number. | 6 |
| | Spiracular plate oval with a dorsal prolongation, goblets many or of moderate numbers. | 7 |
| 6 | Hypostomal dentition 3/3; internal spurs present on coxae II and III. | <i>D. albipictus</i> |
| | Hypostomal dentition variable, 4/4, 3/4, 4/3, 3/3. Internal spurs lacking on coxae II and III. | <i>D. dissimilis</i> |
| 7 | Cornua long. | <i>D. occidentalis</i> |
| | Cornua short or of moderate length. | 8 |
| 8 | Spiracular plate with goblets small and numerous. | 9 |
| | Spiracular plate with goblets moderate in size and number. | 10 |
| 9 | External and internal spurs of coxa I about equal in length. | <i>D. variabilis</i> |
| | Internal spur on coxa I much longer than external spur. | <i>D. latus</i> |
| 10 | Spiracular plate with dorsal prolongation variable in length and width; larger punctations on scutum very large and deep. | <i>D. andersoni</i> |
| | Spiracular plate with long narrow tail, larger scutal punctations of moderate size and depth. | <i>D. hunteri</i> |

Key to the females. (Female of *D. latus* not known)

- | | | |
|---|---|----------------------|
| 1 | Hypostome with dentition in most specimens of 4/4, less frequently 3/4, 4/3, 3½/3½. | |
| | Hypostome with dentition of 3/3. | <i>D. dissimilis</i> |
| 2 | External spurs on coxa I widely divergent. | 2 |
| | External spurs on coxa I with either parallel inner edges or, if not, only slightly divergent. | 3 |
| 3 | Coxae II, III, IV with their external spurs about as long as their basal widths or only slightly indicated. | 4 |
| | Coxae II, III, IV with external spurs distinctly longer than the basal width. | 5 |

KEYS TO SPECIES

- | | | |
|---|---|------------------------|
| 4 | Legs strong and thick; blunt, diverging, large cornua; cervical grooves as small oval pits set well apart; scutal surface smooth. | <i>D. imitans</i> |
| | Legs much longer than in other American species; cornua not divergent; cervical grooves deep and narrow in front with their posterior continuations broad and shallow, surface punctate or rugo-punctate. | <i>D. parumapertus</i> |
| 5 | Internal spurs on coxae II and III broad and flat with rounded extremities salient; external spurs on coxae II to IV with sides nearly parallel and a little longer than their basal widths. | <i>D. halli</i> |
| | Internal spurs lacking on coxae II and III; external spurs on coxae II to IV long and narrow, those on coxae II and III being much longer than their basal widths. | <i>D. dispar</i> |
| 6 | Spiracular plates variable in shape but lacking dorsal extension, goblets large, few in number. | <i>D. albipictus</i> |
| | Spiracular plates oval, with dorsal prolongation defined, goblets moderate to large in number. | 7 |
| 7 | Cornua short or moderate in length. | 8 |
| | Cornua long. | <i>D. occidentalis</i> |
| 8 | Spiracular plate with goblets of moderate size and number. | 9 |
| | Spiracular plate with very numerous small goblets. | <i>D. variabilis</i> |
| 9 | Very deep large punctations on the scuta. | <i>D. andersoni</i> |
| | Larger punctations of the scutum only of moderate depth and size. | <i>D. hunteri</i> |

Immature stages

(Larva of *D. dissimilis*, and all the immature stages of *D. latus*, *D. dispar* and *D. imitans* are not known.)

The use of a key for the immature stages of *Dermacentor* is fraught with risk because identification cannot always be incontestably determined on morphological characters alone. Hence it may be necessary to breed them out to the adult stages. Should this be impossible, attention should then be directed to the locality data and to the time of the year when collections are made. This method has an advantage in that representatives of this genus in most regions of America are referable to one or two species. Thus on geographical grounds *D. occidentalis* is very abundant in south-west Oregon whilst *D. andersoni*, with its wide distribution in the western states, is known only from sporadic individuals in south-west Oregon. Where, as in the regions east of the Rocky Mountains, three species overlap in their distribution, namely *D. variabilis*, *andersoni*, and *albipictus*, the timing of the occurrence of the immature stages during the year together with host data does give an indication of the species involved. (See under biology of these species.) No dependable key has yet been produced for larvae but Cooley (1938) prepared a key for the North American nymphal stages upon which the following is based.

Key to the nymphs

- | | | |
|---|--|----------------------|
| 1 | Basis capituli pointed at the sides. | 3 |
| | Basis capituli not pointed at the sides. | 2 |
| 2 | Hypostomal dentition 2/2; scutum with distinct tendency to become pointed posteriorly. Ventral cornua present. | <i>D. albipictus</i> |

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	Hypostomal dentition 3/3; scutum broadly rounded posteriorly. Ventral cornua absent.	<i>D. dissimilis</i>	
3	Spurs lacking on coxa IV.		4
	External spur present on coxa IV.		7
4	Spiracular plate subcircular or elliptical, ostium not centrally placed.		5
	Spiracular plate ovoid and broader on the ventral side where the ostium is situated.		6
5	Very numerous goblets. Basal spurs as salient edges, not pointed.	<i>D. variabilis</i>	
	Spiracular plate smaller than in <i>variabilis</i> but with goblets of about the same size but fewer in number. Basal spurs very small, short and rounded.	<i>D. halli</i>	
6	Basal spurs as distinct, narrow pointed projections; scutum very much broader than long.	<i>D. occidentalis</i>	
	Basal spurs as broad, flat salient lateral horns; scutum only slightly broader than long.	<i>D. hunteri</i>	
7	Spiracular plate subcircular with ostium subcentral.	<i>D. andersoni</i>	
	Spiracular plate short, oval, with ostium eccentric in the broad end.	<i>D. parumapertus</i>	

Dermacentor variabilis Say (American dog tick)

Figs. 53-74

LIT., SYN. AND ICON.

Ixodes variabilis Say, 1821, p. 77: original description of an apparent *Dermacentor* tick from the United States of America. Oudemans (1936) stated that this species, along with *Ixodes punctulatus*, was described without stating the country of origin. Bequaert (1946), on the contrary, has pointed out that the title of Say's paper stated that the specimens he described came from the United States; he is of the opinion that Say's description of *I. variabilis* and *I. punctulatus* is reasonably certain to appertain to the male and female of *Dermacentor variabilis*. Say's description of *Ixodes variabilis* is as follows: 'Body oblong-ovate, gradually attenuated before; sides hardly arquated; a few remote deeply impressed punctures not more numerous behind; posterior margin with about twelve impressed abbreviated lines; a lateral, impressed, punctured submarginal line, obsolete behind; two deeply indented, abbreviated lines before; head, hind edge rectilinear, angles abruptly and a little extended backward, acute, rostrum rather short; palpi ovate; colour reddish or ferruginous, varied with white; incisures of the feet white; white of the back is more or less reticulated and the feet are white above or only at their joints.'

Ixodes punctulatus Say, 1821 (no sex, but apparently female, no host): 'Body oblong-ovate, gradually attenuated before, sides hardly arquated, crowded with impressed, confluent punctures; thorax destitute of punctures, but with two impressed undulated lines; abbreviated lines of the posterior margin not deeply impressed, almost obsolete; lateral submarginal line deeply impressed; obsolete behind; head, hind edge rectilinear, angles abruptly a little projected backward, acute; rostrum rather short; palpi oval; eyes distinct, impressed; colour ferruginous, thorax white lineated or varied with ferruginous; incisures of feet white. Considerably like the preceding (*I. variabilis*).'

The possibility that this tick may have been *Acarus lineatus* Fabricius (1775) was suggested by Say. Fabricius's description reads: 'Acarus ovatus, ferrugineus; lineis duabus undatis albis. Corpus punctatum, obscure ferrugineum, lineis duabus longitudinalibus, valde undatis, albis. Puncta duo parva supra anum. Pedes geniculis albis. Magnitudo praecedentis (*Ixodes iguanae*).' *A. lineatus* was placed in the genus

D. VARIABILIS

Amblyonma by Koch, but whether he saw it or not is doubtful, whereas Oudemans (1929, 1936) has expressed the opinion that it is *A. oblongoguttatum*.

Ixodes cinctus Fabricius (1805) came from North America where only a *Dermacentor* species appears to correspond with the description, possibly drawn from a female as Oudemans (1936) suggested. The original description is 'I. oblongus ferrugineus albus, scutelli margine thoraceque antice albis. Reliquis magis oblongus. Caput ferrugineum. Scutellum triangulum ferrugineum: margine albo. Thorax et abdomen ferruginea, antice cerea, scutellum late alba. Pedes ferruginei.'

Adoption of this name for *D. variabilis* is unsafe until the type material is re-examined.

Dermacentor electus Koch, 1844, p. 235.

Dermacentor electus Koch, 1847, p. 109, Pl. 31, figs. 83, 84.

Description of *D. electus* based on Say's description of *variabilis* and *punctulatus*.

Ixodes albipictus Packard, 1869 (pro parte: female without host, Hill near Washington, D.C.).

Ixodes quinquestriatus Fitch, 1872, p. 366: no sex but strong suggestion of it being the female of *Dermacentor variabilis*. Original description: 'Five-lined tick, *Ixodes quinquestriatus*. Ovate, rust coloured; thorax and scutellum white, with irregular rust-coloured spots and punctures: abdomen with punctures and five impressed longitudinal lines; the outer one of each side being submarginal; legs paler, joints white. 0.20 inches long.' Locality: Virginia and Tallahassee, Oklahoma. No host.

Ixodes robertsonii Fitch, 1872, p. 366: sex unspecified. Original description: 'Oval, punctured, rust-coloured, above marbled with tallow white on the head, thorax and abdomen, with rust-coloured punctures; abdomen with a submarginal impressed line, between which and the edge are deeply impressed equidistant, transverse lines with white interstices; joints of legs white. 0.16 inches long.' Without question a male, locality data Tallahassee, Oklahoma. No host specified.

Ixodes bovis Lintner 1874 (from Bequaert, 1946): according to the figures this was *Dermacentor variabilis*, not *Ixodes bovis* 'Riley', Packard, 1869.

Dermacentor americanus Neumann, 1897, p. 365: not *Acarus americanus* Linnaeus 1758 nor *Ixodes albipictus* Packard, 1869, p. 65, as stated by Neumann, 1897, p. 366; 1911, p. 101.

Dermacentor electus Koch: Neumann, 1901, p. 265. *Dermacentor electus* Koch: Salmon & Stiles, 1901, p. 455 (a translation of Neumann, 1897, p. 365). Not related to *D. electus parumapertus* Neumann, 1905, p. 236, originally described as *D. parumapertus* Neumann, 1901, p. 267, and now recognised as a good species.

Dermacentor variabilis Banks, 1908a, p. 49, 1908b; Jarvis, 1910; Stiles, 1910; Neumann, 1911 as *D. variabilis variabilis* where recognition of *D. americanus* as a synonym is made; Hooker, Bishopp & Wood, 1912, extended and valuable information including host relationships and seasonal history; Hadwen, 1913a, p. 234; Weiss, 1915, p. 150; Miller, 1925, p. 126; Zebrowski, 1926, p. 331; Larrouse, King & Wolbach, 1928, p. 352; Shipley, 1932, p. 86; Parker, Philip & Jellison, 1933, p. 348; Hertig & Smiley, 1937; Clarke, 1937, p. 99; Bishopp & Smith, 1938; Cooley, 1938, pp. 23-9, pl. II, fig. 9, pl. III, pl. IV, fig. 107, pl. XXI, figs. 5-16, pl. XXVI, figs. 15-19, pl. XXVII, figs. 1-9 (full description of female, nymph and larva); Hearle, 1938, p. 353; Headlee, 1938, p. 290; Trager, 1939, p. 233; MacCreary, 1939, p. 29; Headlee, 1940; Friedman, 1940, p. 887; Katz, 1941, p. 467; Smith & Cole, 1941; Cobb, 1942; Bell & Chalgren, 1943, p. 275; Wilson, 1943; Eddy & Joyce 1944; Koutz, 1944, p. 29; MacCreary, 1945, p. 126; Bishopp & Trembley, 1945, p. 22; Bequaert, 1946, pp. 164-72; Gregson, 1956, pp. 30-1.

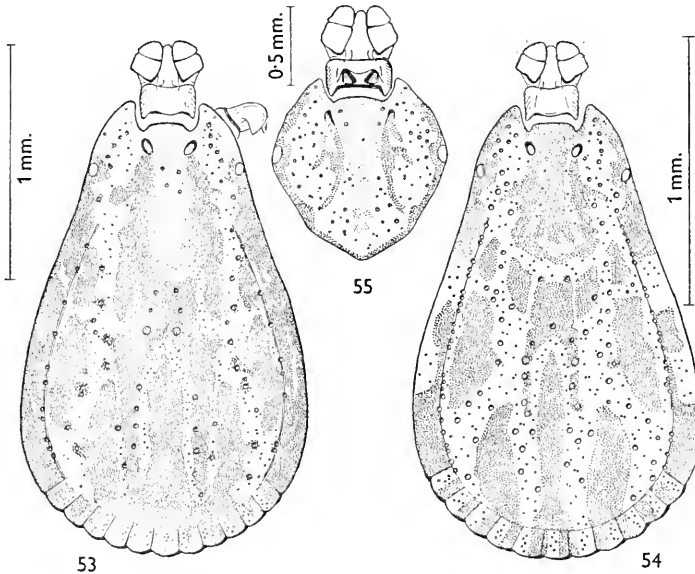
AMERICAN SPECIES OF *DERMACENTOR*

Dermacentor venustus McLeod, 1933, pp. 111 and 124 (nec Banks (1908)) see Cooley, 1938, p. 26.

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

MALE. Variably ornate: base colour pale brown and in the specimens examined the grey colour pattern is less extensive than the base colour with which it frequently merges.

Capitulum. Basis capituli more or less rectangular (figs. 53 and 56), broader than long; posterior border nearly straight; cornua moderately developed, each about as long as the basal width, widest at base tapering to rounded apex. Surface of basis



Figs. 53-5, *Dermacentor variabilis*. 53, male specimen from Oregon; 54, male specimen from Texas; 55, female, capitulum and scutum.

mildly concave between two slight elevations extending from inner margins of cornua to mid-line of base of article 1; punctate and usually with colour pattern present, hairs absent from dorsum. Palpi short and broad, length of article 2 from postero-dorsal ridge to distal end about 0.22 mm., greatest breadth in front of ridge, about 0.35 mm., pentagonal in form and traversed by a shallow oblique transverse process; article 3, 0.22 mm., long, subtriangular, breadth across base 0.3 mm. Ventrally, basis capituli broad and short (fig. 57), posterior and postero-lateral margins rounded, basis crossed by a transverse groove, surface flat to the hypostomal base where there is a semi-circular depression; palpal article 2 humped along outer margin whilst that of article 3 broadly convex. Surface of palpal articles ridged, particularly on inner side. Hairs short except for the strong palpal setae. Article 1 projects postero-ventrally to form

D. VARIABILIS

a distinct spur. Hypostome: 0.2 mm. long; spatulate in form; large corona, dentition 3/3 files for about 12 rows, teeth equal in all files, basally teeth become crenulations and thin off obliquely to the base.

Scutum. Length about 1.43 mm., breadth about 1.01 mm., narrowing appreciably anteriorly; greatest width behind the middle. Cervical grooves deep, short, oval depressions; lateral grooves distinctly indicated by a row of deep, large punctations. Punctations very unequal in size, many being large (as large or larger than the foveae) and the others extremely small, moderately numerous. Short hairs sunk into large deep pits. Festoons long, not limited by lateral grooves, frequently edged with grey or a silver hue; scapular angles moderate.

Hooker, Bishopp & Wood (1912) recognise two forms as regards coloration, the Texas form (fig. 54) and the Oregon form (fig. 53). Cooley (1938) commented on the high degree of variability in ornamentation; while in some specimens the grey is dim, other specimens from south-eastern Texas are either completely or almost completely without the pattern colour. Specimens from southern Texas (fig. 54) on the other hand are well and clearly patterned with grey overmarkings.

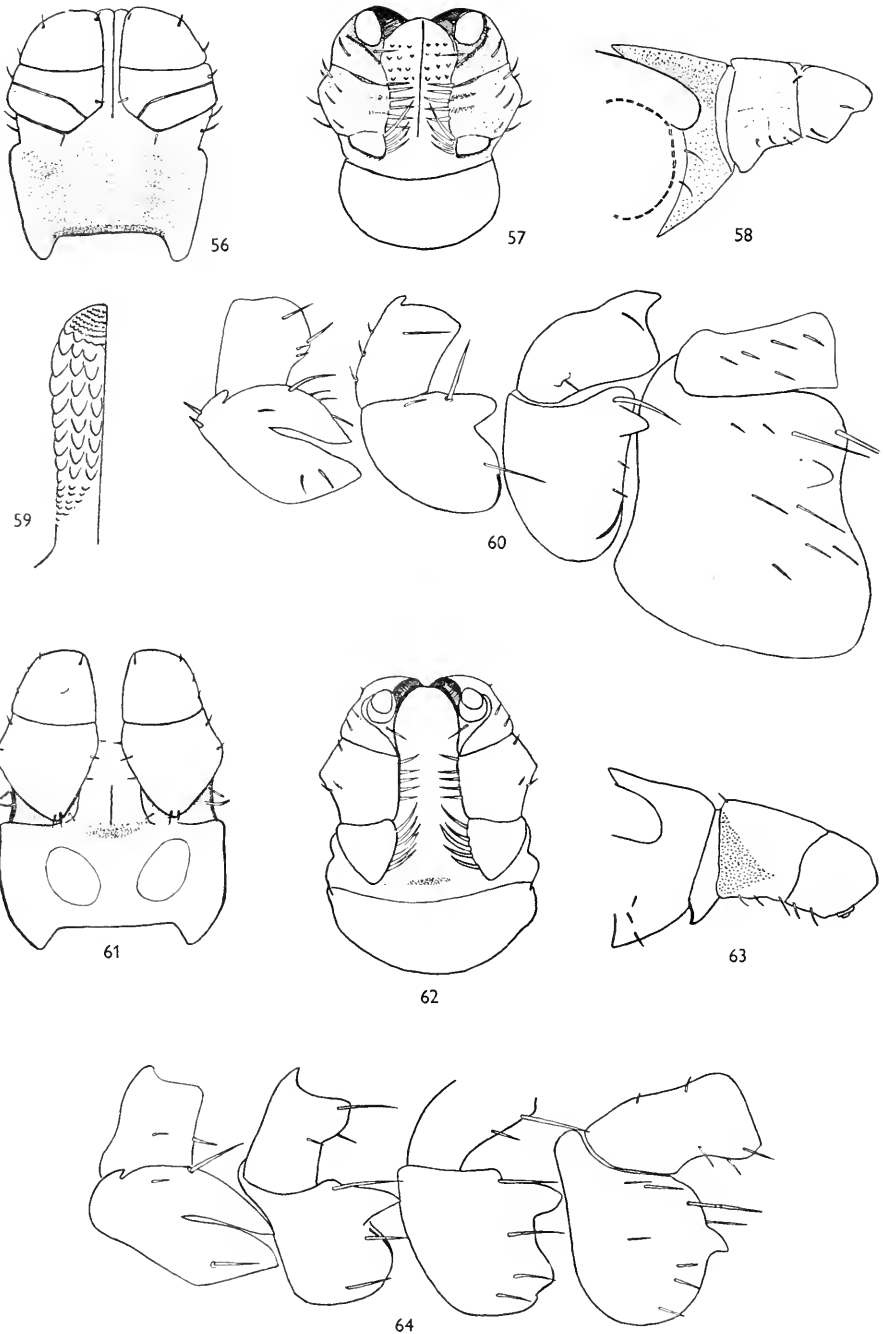
Legs. Variably ornate, short hairs present. Coxa I (fig. 60) with very well developed spurs, internal spur slightly longer than external spur, posterior margin of external spur gently convex, anterior margin more or less parallel with that of internal spur; internal spur triangular. External spurs on coxae II-IV of about equal size, rounded at the tips. Internal spurs on coxae II and III flat and broad, and equivalent to a marginal salience; internal spur lacking on coxa IV. Width of coxa IV nearest the mid-line about equal to the length. Surface of coxae I-III moderately convex, that of coxa IV flattened. Dorsal trochanter spur on leg I subacute, well developed, variable amount of pattern colour present.

Spiracular plate. Large, and with broad dorsal prolongation; surface finely granular, goblets very small and numerous. Subject to much variation in form (fig. 40), thus the dorsal process is very slight in the Oregon form, but fairly well marked in the Texas form.

Dimensions. 3.6 ± 0.67 mm. long; 2.4 ± 0.42 mm. broad.

FEMALE

Capitulum. Basis capituli about twice as broad as long (figs. 61, 62); hairs generally absent except for three or four short hairs ventro-laterally. Posterior margin straight, postero-lateral margins broadly rounded. Cornua shorter than their basal width, rounded apically. Surface generally flat, except near the base of rostrum which is slightly sunken. Porose areas suboval, separated by an interval about equal to their smallest diameter. Ventrally basis capituli short, postero-ventral ridge broadly rounded, salient; transverse groove strongly defined. Generally flat with a small depression at the hypostomal base. Palpi longer, narrower and more rounded distally than in male: length of palpal article 2 about 0.35 mm., breadth of palpal article 2 about 0.34 mm.; length of palpal article 3 about 0.28 mm., breadth of palpal article 3 about 0.30 mm.

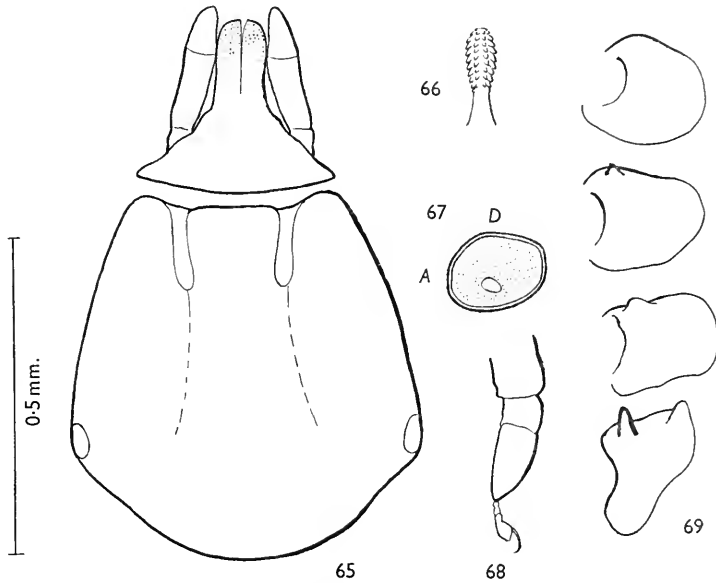


Figs. 56-64, *Dermacentor variabilis*. 56-60, MALE: 56, capitulum, dorsal; 57, capitulum, ventral; 58, capitulum, side view; 59, left half of hypostome; 60, coxae and trochanters I-IV. 61-4, FEMALE: 61, capitulum, dorsal; 62, capitulum, ventral; 63, capitulum from the side; 64, coxae I-IV.

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Postero-dorsal ridge moderate; few punctations and short hairs present. Ventral palpal setae strong. Palpal article I produced ventrally into a moderately strong flattened spur.

Scutum (fig. 55). About as long as broad, greatest width at the level of the straw-coloured eyes (in alcohol-preserved specimens): more angular in outline than *D. reticulatus* which it resembles in ornamentation. Colour pattern of a silvery hue usually prevailing over the basic brown colour; latter predominates in the cervical grooves, in spots near the eyes and along the scutal margin; base colour paler between the cervical grooves. Cervical grooves roughly hour-glass shaped: at the base of the scapulae the grooves are shallow and relatively broad, thence by deep gorge-like



Figs. 65-9, *D. variabilis*. NYMPH: 65, capitulum and scutum; 66, hypostome; 67, spiracle; 68, tarsus IV; 69, coxae I-IV.

indentations for a short distance, before becoming wide and relatively broad, not reaching postero-lateral margins. About thirty moderate and numerous very small punctations, generally distributed over the surface. Fine short hairs arise from the larger of these.

Post-scutal region. Distinct marginal grooves delimiting the first three festoons on each side, remaining festoons usually less definitely demarcated.

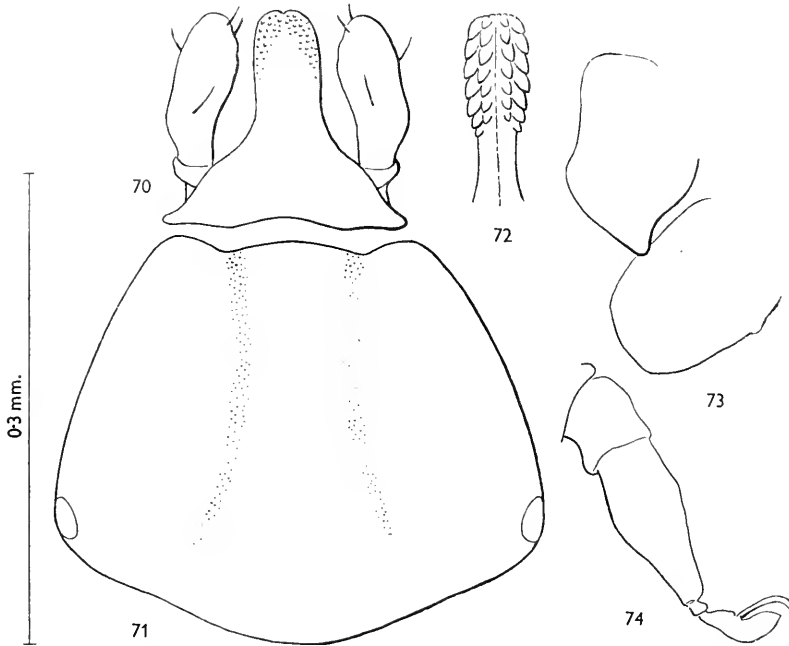
Legs (fig. 64). Coxal spurs present externally on legs I-IV, very large triangular internal spur on coxa I, smaller and more broadly rounded on coxae II and III, absent on coxa IV. External spur on coxa I well developed, about equal in length to internal spur. Coxa IV only slightly larger than coxa III, with a smaller external spur. Trochanter spur prominent, tapering.

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Spiracular plate. Broad, with blunt dorsal process, surface very finely granular, goblets very small and numerous.

Dimensions. Length 3.8 ± 0.55 mm., breadth 2.5 ± 0.21 mm. Replete female may reach 15 mm. in length by 10 mm. in breadth.

NYMPH. Length 0.9 mm., width 0.79 mm. Elongate oval, narrowed slightly in front and somewhat indented postero-laterally. Un-engorged specimens are pale yellowish brown with hind border of scutum dark, peripherally brick red, gut diverticula visible through the integument.



Figs. 70-4, *D. variabilis*. LARVA: 70, capitulum, dorsal; 71, scutum, dorsal; 72, hypostome; 73, coxae I and II; 74, tarsus I.

Capitulum. Basis capituli triangular in outline, posterior margin as a broad arc, drawn out to points laterally (fig. 65). Palpi relatively long and narrow, article 2 longer than article 3 as 5.0:3.5. Ventrally the basal spurs as short broad rounded lobes. Hypostome with apical corona followed by $2/2$ teeth (fig. 66).

Scutum. Length 0.54-0.58 mm., breadth 0.48-0.54 mm. (fig. 65), broadest nearer the posterior margin, antero-lateral margins almost rectilinear, postero-lateral and posterior margins broadly rounded, according to Cooley (1938) with some tendency to be pointed at the extremity. Fестоons distinct but not delimited by a lateral groove.

Legs. Coxa I with internal and external spurs definite, former larger than latter, II and III with external spurs only, becoming progressively smaller; IV lacking spurs.

Spiracular plate. Suboval with longer axis parallel with corresponding axis of

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body: goblets numerous and small. Spiracular opening antero-ventrally placed. Length 0.134 mm., width 0.134 mm.

LARVA. Body colour of un-engorged larvae pale yellow, brick red markings on the scutal margins. Length about 0.59–0.64 mm., breadth 0.39–0.44 mm.

Capitulum. Basis capituli triangular in shape when viewed dorsally, posterior margin either arcuate or sinuous, drawn out to moderate points postero-laterally (fig. 70). Hypostome short, with 7 rows of $2\frac{1}{2}$ files of teeth.

Scutum. Greatest width of 0.31–0.32 mm., posteriorly, length 0.27–0.30 mm. Cervical grooves distinct but not reaching postero-lateral borders (fig. 71).

Legs. Coxa I with definitely pointed internal spur extended beyond the posterior edge of the coxae, coxae II and III of similar size with small but nevertheless distinct external spurs.

RELATED SPECIES

In having spurs on coxa I with the proximal edges parallel or only slightly diverging *D. variabilis* agrees with *D. occidentalis*, *D. andersoni* and *D. hunteri* of the American forms, but is recognisable from *D. occidentalis* in having cornua of only moderate length. It is most readily separated from *D. andersoni* and *D. hunteri* by virtue of its spiracular plate with very numerous and small goblets, in contrast to the latter two species where the goblets are moderate both in size and number.

DISTRIBUTION AND BIOLOGY

D. variabilis is widely distributed east of the Rocky Mountains in the United States, in parts of California and Mexico. Gregson (1956) observed that it replaces *D. andersoni* in eastern Saskatchewan and is found east as far as Nova Scotia. During feeding the adult female increases considerably in size, attaining dimensions of 15 mm. long by 10 mm. wide.

Unfed females of *D. variabilis* may, under suitable conditions of temperature and humidity, survive for more than two years and frequently up to nearly three years. Prior to feeding the adults climb on to the vegetation and await the passage of a suitable host. They cling to the vegetation by the hinder three pairs of legs and wave the first pair in a manner reminiscent of insectan antennae. After both sexes have fed for some days mating takes place on the host. According to Smith, Cole & Gouck (1946) the males continue to feed and mate for an indefinite period whereas the females become fully fed between 7–27 days, the average period being 10.5 days. Having fed, the females detach themselves and fall to the ground where, according to experimental work, subsequent movement is indiscriminate. The preoviposition period under field conditions is extremely variable and, like this process in other ticks, is undoubtedly influenced by humidity and temperature. Bishopp & Smith (1938) established the range of this period as 3–24 days, but extended observations by Smith *et al.* (1946) gave a range of 6–58 days out of doors.

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The eggs are laid in masses which are bound together by a viscid secretion from Gené's organ and the number of eggs laid by a female in 14-32 days is 4000-6500 and, if *D. variabilis* compares with other ticks in this respect, the oviposition rate is much influenced by external weather conditions. The shortest incubation period noted by Smith *et al.* under outdoor conditions, when the average temperature was 71.1° F., was 36 days. Sometimes the eggs overwinter and under these conditions the longest incubation period hitherto recorded was 303 days, but the resultant larvae were abnormal. The longest period of egg development yielding normal larvae was 57 days when mean temperatures were 65.2° F.

Unlike the adults, larvae issuing from eggs are unable to withstand long periods of fasting. Under normal conditions larvae can survive up to about 540 days and the experimental data of Smith *et al.* showed that five lots survived '500 days, 20 lots 400 days, 14 lots 300 days, 2 lots 200 days and 7 lots for about 100 days'. The larvae are apparently never taken by dragging the vegetation, probably remaining in masses on the soil or on low-growing vegetation while awaiting a host, and generally associated with mice 'runs'. They appear to be more active in warm than cool weather and survive long periods in an aquatic medium. Having found a suitable host, usually meadow mice, the larvae continue to feed for 3-13 days (the average time is about 4 days). It is the larvae of over 5 days old which make up the bulk of a feeding larval population, and the sites of predilection chosen for feeding on small mammals are mainly on the neck and shoulders. When fully engorged the larvae detach themselves from the host and seek a protected niche for metamorphosis, becoming quiescent in a few hours to 2 days depending on the temperature. The shortest period observed from dropping of the larvae to the moulting to nymphs was 6 days when the ticks were maintained at 80° F. For larvae dropped under outdoor conditions this period was 10 days (for those dropped in July and August) and 247 days for those which fed in autumn and overwintered as fully fed larvae.

Nymphs select hosts similar to those of larvae but are capable of surviving longer without feeding (274-309 days). The newly moulted nymphs are relatively inactive for 1-4 days but when they do partake of a meal it lasts from 3-12 days with an optimum feeding period of about 6 days. The behaviour during the pre-moulting phase is similar to that of the larvae, and the shortest period for moulting as observed under outdoor conditions was 24 days and the longest period of 291 days for nymphs dropped in October. Throughout the life-history the periodicity of these various phases is dependent on temperature and humidity as both Bishopp & Smith (1938) and Smith *et al.* (1946) have clearly indicated.

Seasonal incidence. The following hosts of the immature stages of this tick species are known: white-footed mouse (*Peromyscus*); meadow mouse (*Microtus*); pine mouse (*Pitymys*); jumping mouse (*Zapus hudsonius*); cotton rat (*Sigmodon hispidus*); cottontail rabbit; swamp rabbit; muskrat; Norway rat; squirrel; cat and short-tailed shrew. Larvae alone are known from jack rabbit; house mouse (*Mus domesticus*) and mole (*Scalopus aquaticus machrinus*) and nymphs alone from wood rat, sheep, cattle and

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dog. The adults, on the other hand, prefer larger mammals and these include the most preferred dog, man, cattle, opossum, coyote, hog, horse, racoon, wild cat, squirrel, sheep, badger, wolf, skunk, deer, fox, cat, peccary, weasel, ass, leopard, mountain lion, Mexican lion, mule, rabbit, Norway rat, 'Eland', ground squirrel, civet, woodchuck. In view of the habits of larvae and nymphs, dragging of grassland yielded negative results and the seasonal activity was determined by Smith *et al.* by trapping rodents and examining the living ones for ticks over a four-year period. From their data it is apparent that there is a major peak of larval activity, representing activity of overwintering, unfed larvae, which commenced about the end of March and continued at varying amplitudes until the end of June and July. In two of the four years the spring activity of these ticks was followed by a less intense autumn peak of activity. The reason for this is obscure and from the available data does not appear to be correlated with either mice population or rainfall. The nymphal periodicity starts at about the same time as that of the larvae, and the initial populations are undoubtedly the products of overwintering larvae and nymphs emerging from hibernation. This development towards moulting progresses very slowly at low temperatures but with the advent of increased temperatures in the spring the ticks that had engorged in the late autumn would moult during a comparatively short time. Nymphal activity predominates from June to early September and this population would appear to be derived from the large numbers of larvae which engorged in April to June. The length of day appears to be an important factor in controlling their seasonal activity (Smith & Cole, 1941). The indications are that the nymphs attach fairly quickly after moulting. The picture of adult activity as determined by the dragging method is a fairer indication of tick activity than the collection from hosts, which may be complicated by changes in the host populations and habits. The general picture is that adults become active about mid-April, and the populations rise steadily through May to their highest levels in June, thereafter declining to mid-August and remaining at a low level to September. There appears to be no relation between the seasonal abundance of the nymphs and adults, and this may be attributed to the fact that the latter are delayed longer in finding a host—'a conclusion strengthened by their greater potential longevity, almost three years compared with a little over one year for larvae and nymphs' (Smith *et al.*, 1946).

ECONOMIC IMPORTANCE

Dermacentor variabilis has been reported by Maver (1911) to be capable of the experimental transmission of the western strain of Rocky Mountain Spotted Fever. Early in 1931 Rumreich, Dyer & Badger, after identifying this fever in the eastern United States reported its experimental transmission by *D. variabilis* (Dyer, Badger & Rumreich, 1931) while a year later Badger demonstrated the presence of the causal virus in a tick found in nature (Badger, 1932). The larva, nymph, adult male and female have been proved efficient intermediaries for the parasite (*Rickettsia rickettsii*) which has also been demonstrated to be a transovarial transmission. After feeding on

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infected blood the invasion period lasts 12 days during which period the rickettsias multiply, and the virus is converted into 'tick virus'. Natural tularaemia infections have also been shown in this tick (Green, 1931), and Philip & Jellison (1934) have secured experimental transmission with this species. Experimental anaplasmosis of cattle has been reported by Rees (1932).

Dermacentor parumapertus Neumann, 1901

Pl. II, figs. 1, 2; Figs. 1-2, 7-8, 9-10, 11-15, 75-84

SYN., LIT. AND ICON.

- 1901 *Dermacentor parumapertus* Neumann, original description pp. 267-8.
 1905 *Dermacentor electus parumapertus* Neumann, p. 236 (in error).
 1908a *Dermacentor parumapertus* Neumann: Banks, p. 45 (pl. VII, figs. 8, 10). Banks remarks: 'After describing this species Neumann later made it a variety of *D. electus* (= *variabilis*), but it differs in many important characters from that species and the granulations of the stigmal plate are much larger.'
 1908a *Dermacentor parumapertus* var. *marginatus* Banks, p. 46 (pl. VIII, fig. 6).
 1910 *Dermacentor parumapertus* Neumann and *D. parumapertus* var. *marginatus* Banks: Stiles, pp. 46-8.
 1912 *Dermacentor parumapertus* var. *marginatus* Banks: Hooker, Bishopp & Wood, p. 159, pl. XIII, figs. 1-5 (very small photographs).
 The variety *marginatus* is alleged by these authors to resemble the type in all essential respects, but the punctations are more clearly divided into large and small, and some scutal ornamentation is present in both sexes. The most persistent white markings in the male scutum are a small oblique patch behind the eye, a longitudinal patch along each lateral groove and a small patch defining the sides of the extreme festoon. All are peripheral. The posterior border of the female scutum is white and there are irregular white markings at some distance behind the eye and immediately outside the cervical grooves.
 1911 *Dermacentor variabilis parumapertus* Neumann, as a variety of *variabilis* Say, in error, p. 101.
 1938 *Dermacentor parumapertus* Neumann: Cooley, pp. 49-54. Cooley remarked that he knew of no valid reason for the retention of the variety of *marginatus*. Specimens range in colour from a complete absence of grey on the legs and scuta to a variable degree of ornamentation. Breeding experiments of specimens almost devoid of grey showed that in the progeny the amount of grey in both sexes had increased. Cooley has asserted that '*D. parumapertus* var. *marginatus* is not even a persistent race'.

MALE. Base colour red brown: pattern colour grey. Only very slightly ornate; distal ends of femora II-IV have grey spots, and there are sometimes a few peripheral grey markings on the scutum, but these are more often obsolete.

Capitulum. Basis capituli rectangular, sides straight or very gently curved (fig. 7); rounded angles; surface flat, usually punctate; cornua rounded, basal breadths exceed their lengths. Palpi narrower and longer than in related species, distinctly longer than basis, widest near the base of article 2; postero-dorsal ridge well developed: few punctations present, absence of pattern colour. Ventrally, surface of basis divided

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into anterior and posterior portions by shallow transverse groove, flat, slopes to hypostomal base (fig. 8). Postero-ventral ridge as a curved salience; few small punctations; short hairs present laterally. Hairs on palp few and short (further details are given on p. 12). Details of hypostome on p. 13.

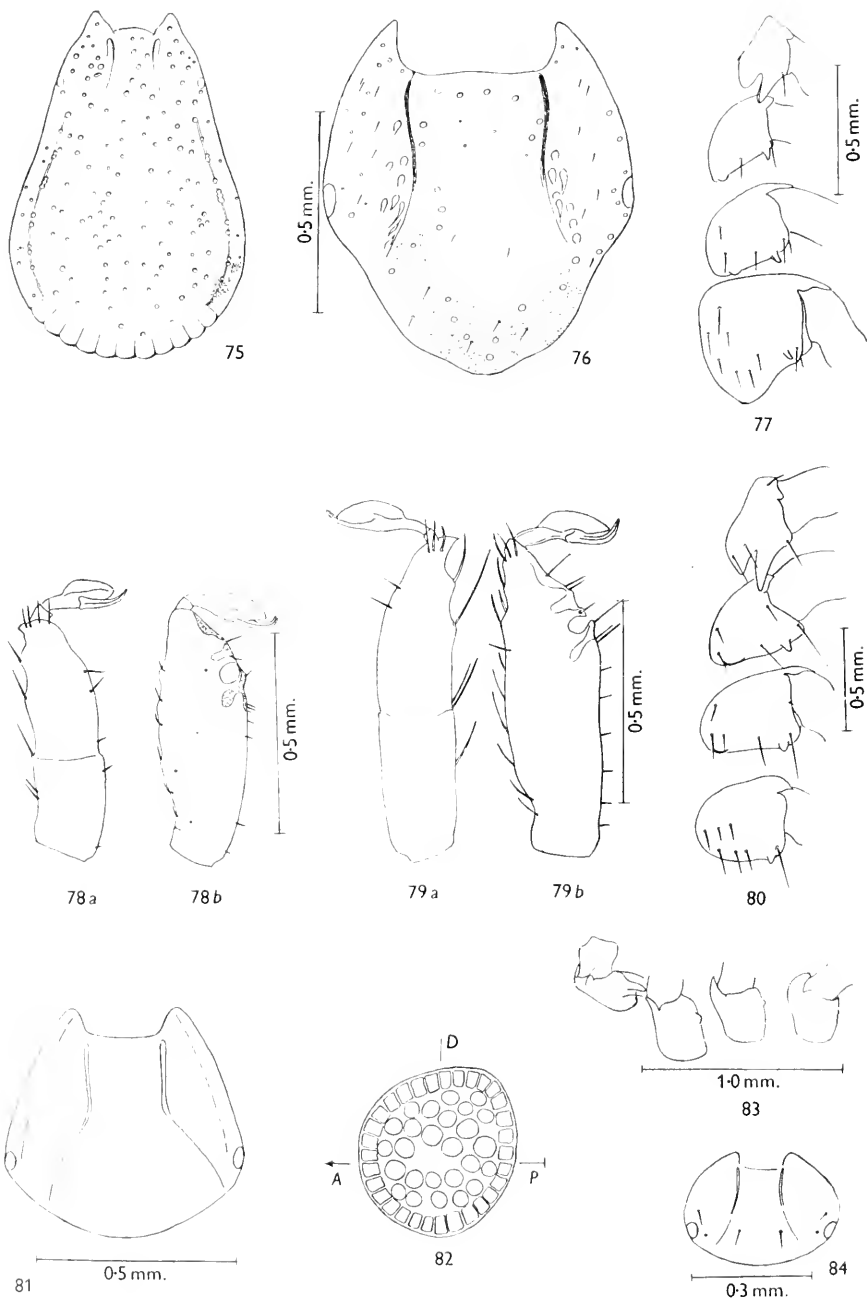
Scutum. Length 2.83 ± 0.11 mm., breadth 1.75 ± 0.13 mm. (based on twenty-five specimens from California), wider behind the middle (fig. 75). Punctations large, about the size of the foveae which are rather large and posteriorly placed; few small punctations more easily visible in the grey field: punctations of both sizes are present outside the lateral grooves where they are few in number. Colour pattern extremely variable in specimens from different localities, ranging from complete absence (when they are light to dark brown) to extensive ornamentation. Surface generally flat but antero-laterally it is slightly elevated above the general surface. Cervical grooves short, deep, parallel, rectilinear depressions followed by diverging shallow impressions. Lateral grooves well marked behind the level of the eye and extending to the anterior festoons. Latter clearly defined, separated from rest of scutum by slight furrow. Scapular angles blunt, emargination well defined.

Legs (fig. 77). Rather longer than in other species from the New World. External spur of coxa I broad and tapering, longer than internal spur which is apically rounded. Internal spurs on coxae II and III broad, short and rounded. External spurs of coxae II and III about as long as their basal widths, external spur on coxa IV long and narrow. Dorsal trochanter spur prominent, tapered with some pattern colour present. The 'knees' of legs II, III and IV marked with white. Tarsi (figs. 78*a* and *b*) I and IV thick and blunt, tarsus IV with weak ventral spurs; tarsi I and IV taper rather abruptly distally. Length of tarsus I, 0.63 mm., tarsus IV, 0.60 mm. Hairs longer and stronger on tarsus IV.

Spiracular plate. Small, comma-shaped with distinct, moderately broad dorsal prolongation. Goblets moderate in size and number, coarsely granular round the aperture.

FEMALE. Brown, usually inornate except at the distal ends of the individual segments of the legs; the pattern colour, if any, is otherwise restricted (see under *Scutum*).

Capitulum. Basis rectangular, about 2–2.3 times as broad as long (fig. 1): lateral margins straight, postero-lateral margins broadly rounded to form the cornua, width at base of latter greater than their length, apex rounded. Dorsal ridge straight, salient. Surface flat except behind porose areas where it is undulate, punctations absent or if present very few. Lateral and posterior margins more heavily sclerotised than the rest. Porose areas large, suboval or pear-shaped, depressed and obliquely set to the long axis of the body. Interval between the porose areas less than half the width of one of them in most specimens. In ventral view basis broad, with a prominent curved postero-ventral ridge, in front of which the surface is nearly flat to hypostomal base, the slope behind the ridge quite steep to posterior margin; ventro-laterally basis supplied with three or four short, sharp, pointed hairs. Postero-dorsal ridge of palp



Figs. 75-84, *Dermacentor parunapertus*. 75, male scutum; 76, female scutum; 77, coxae I-IV of the male; 78a, tarsus IV of the male; 78b, tarsus I of the male; 79a, tarsus IV of the female; 79b, tarsus I of the female; 80, coxae I-IV of the female; 81, scutum of the nymph; 82, spiracle of the nymph; 83, coxae I-IV of the nymph; 84, scutum of the larva.

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moderate, with rounded edges; inner margin of articles 2 and 3 more or less straight; apex of article III subangular near mid-line becoming gently convex laterally. Article 2 widest where it passes back obliquely to postero-dorsal ridge at about one-third distance from its proximal end.

Scutum. Length 1.75 mm., breadth 1.54 mm., but frequently the breadth may equal the length; margin behind the eye undulate as shown in fig. 76, posterior margin subangular. Scapular angles sharp, emargination deep, and the scapulae widely separated one from the other. Base colour brown, pattern colour, if any, seen at posterior end of scutum: Cooley (1938) observed that specimens which have more pattern show it in the broad portions of the cervical grooves; in forms where ornamentation reaches its maximum, grey occurs on much of the surface but not in the median and lateral fields. Around the eyes the base colour is darker than elsewhere. Cervical grooves form a short, deep trench anteriorly, and extend back as broad, shallow depressions which are punctate, or indicated by large confluent punctations or rugopunctate; grooves do not reach postero-lateral margins. Median field convex and elevated between the grooves, boundary of lateral field elevated but ill-defined. Punctations numerous, unequal in size, vary from large deep forms to small ones which are more readily detected in the grey zone (if present). Scattered fine hairs.

Post-scutal area. Pronounced lateral grooves which delimit a part or all of the festoons.

Legs. Like those of the male, except as regards coxa IV.

Spiracular plate. Short, comma-shaped, with distinct narrow dorsal prolongation, coarsely granular around the aperture. Goblets moderate in number and size.

NYMPH. In the unfed stage about one and a third times as long as broad (1.0 × 0.75 mm.). Oval in shape, widest about mid-length, narrowing anteriorly.

Capitulum. Basis capituli about twice as long as broad (mean ratio for fifty specimens 3.25:1.5) (figs. 11 and 12). Posterior margin straight, postero-lateral margin slightly convex, and drawn out laterally to form prominent, pointed projections; from the apices of the latter the straight anterior margins converge to the base of the cheliceral shafts. Surface generally flattened. In ventral view, basis broad; postero-ventral ridge broadly rounded and bearing small but distinct basal spurs and a single hair on each side. Palpal article 2 narrowed basally, greatest width just behind distal end: outer margin undulate, inner margin slightly sinuous, length 0.14 mm.: article 3 cone-shaped when seen from above, length 0.09 mm.

Scutum (fig. 81). Length 0.55 mm., greatest breadth of 0.59 mm. at the level of the eyes, i.e. towards the posterior extremity. Scapulae large, broad and rounded. Posterior margin broadly rounded, anterior margins rectilinear and convergent from the eyes to the scapulae. Cervical grooves parallel anteriorly where they are of moderate depth and width for about half their length, then strongly divergent to the posterior border. Median field pale brown and generally flattened. Surface towards the margins elevated, beyond which it is steeply downcurved. Base colour dark

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brown lateral to cervical grooves. Punctations large, moderate numbers. Festoons distinct.

Legs. Coxa I with strong pointed external spur, internal spur broad, flat and rounded. External spurs on coxae II-IV short, broad, pointed, becoming progressively smaller from coxae II-IV. Internal spurs lacking on coxae II-IV.

Spiracular plate. Oval, egg-shaped, being drawn out dorsally (fig. 82). Macula antero-ventral. Goblets relatively large, few in number. Maximum length of plate, 0.13 mm., maximum breadth, 0.12 mm.

LARVA. Length 0.6 mm., breadth 0.5 mm.

Capitulum. Similar in shape to that of the nymph, i.e. subtriangulate with moderate points at the side. No suture line between articles 2 and 3, combined length of articles 2 and 3, 0.11 mm. Palpal hairs relatively longer than in nymphs and adults.

Scutum. Length 0.24 mm., width 0.39 mm. Differs from the nymphal scutum in the more rounded lateral margins, and a less broadly rounded posterior margin; cervical grooves shallow, broad. Surface flat between cervical grooves, elevated lateral to these grooves. Finely punctate, with very few hairs present (fig. 84). Coxa II little larger than coxa III: small distinct internal spur on coxa I; small external spurs on coxae II and III.

EGG. Mean dimensions 0.50 × 0.40 mm., with larger sized eggs (0.66 × 0.5 mm.) laid in a ratio of 1 in every 225 (Allred & Roscoe, 1956).

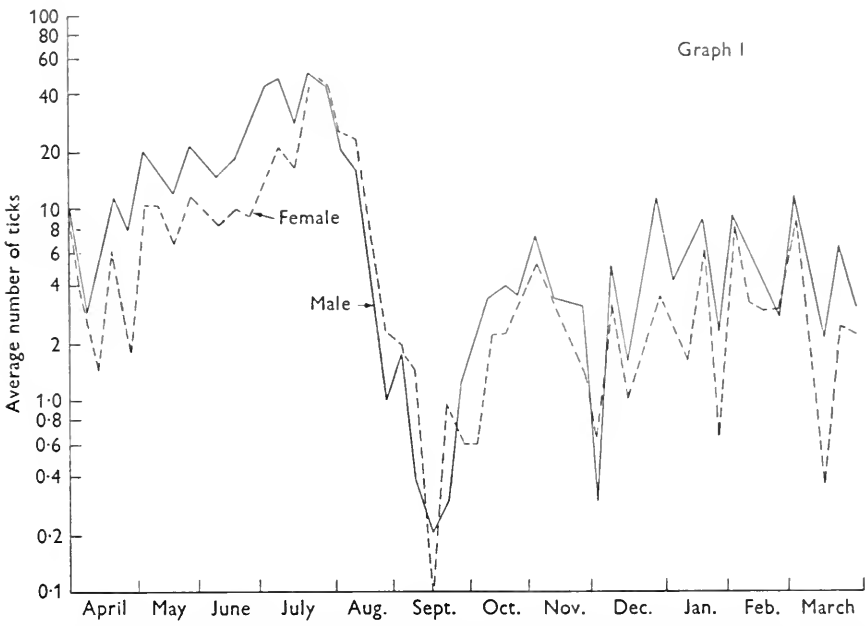
RELATED SPECIES

D. parumapertus is an extraordinarily Rhipicephalid-like species: indeed, the shape of the basis capituli and the enlarged coxa IV of the male are almost the only characters inconsistent with that genus. The females of *D. parumapertus* are easily recognisable from other American species in the rugo-punctate cervical grooves and the apical pattern colour (if any) of the scutum. The males if unpigmented have large deep punctations with small inconspicuous punctations, but if pigment is present there are one or two grey spots in the postero-lateral regions.

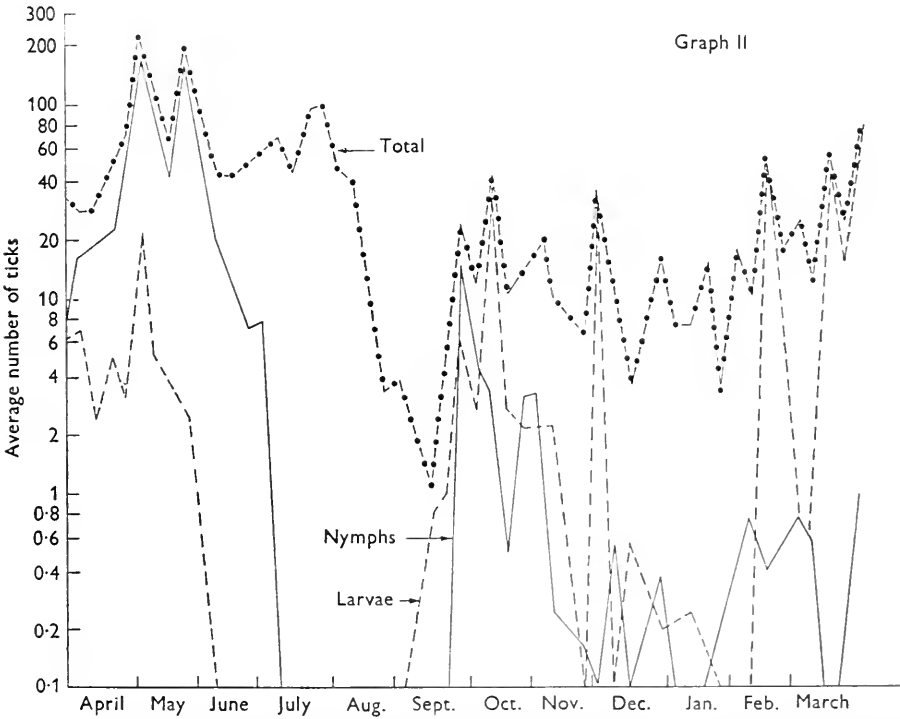
Neumann's type specimens were taken from a man and in a chicken house at Lakeside, California, and are deposited in the United States National Museum.

BIOLOGY

The adult population of *D. parumapertus* reaches its peak of activity on the black-tailed jack rabbit (*Lepus californicus*) in the latter part of July (Fremling & Gastfriend, 1955) and is the produce of overwintering adults and newly emerged females from spring feeding nymphs. According to these writers, between 29 July and 23 September 1954 female ticks were more numerous than males, otherwise males predominated. In April, May and June nymphs were the most abundant. The data supplied by Fremling and Gastfriend show irregularities in the curves of seasonal activity, but larger samples would undoubtedly smooth out these discrepancies. On



Graph I. Average number of adult ticks of *Dermacentor parumapertus* per rabbit for each week through one annual cycle. (After Fremling & Gastfriend, 1955.)



Graph II. Average number of nymphs and larvae and the total numbers of all stages of *Dermacentor parumapertus* ticks per rabbit for each week through one annual cycle. (After Fremling & Gastfriend.)

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analogy with other *Dermacentors* it seems probable that spring nymphal ticks overwintered in the unfed stage. Like the nymphs, the larvae occurred most frequently during the spring months, beginning in late February, attaining peaks during March to be followed by a secondary peak in September–November. The larval populations are smaller when compared with those of nymphs; it has been suggested that animal species other than those trapped may act as hosts for the larvae. This is confirmed by the observations of Gastfriend (1955) who showed that rodents are more heavily infested with larvae than with nymphs, and the converse is true for the black-tailed jack rabbit. The known hosts of the immature stages of this species are the antelope ground squirrel (*Citellus leucurus*), chisel-toothed kangaroo rat (*Dipodomys microps*)—the most heavily infested—Ord kangaroo rat (*D. ordii*), kangaroo mouse (*Microdipodops megacephalus*), desert bushy-tailed wood rat (*Neotoma cinerea*), desert wood rat (*Neotoma lepida*), long-tailed pocket mouse (*Perognathus formosus*), little pocket mouse (*P. longimembris*), great basin pocket mouse (*P. parvus*), deer mouse (*Peromyscus maniculatus*), Pinyon mouse (*P. truei*) and the western harvest mouse (*Reithrodontomys megalotis*). *Dermacentor parumapertus* is confined to the arid and semi-arid regions of western United States.

Allred & Roscoe (1956) in their laboratory experiments showed that at room temperature and at 81% relative humidity females started to lay eggs from 7 to 20 days after removal from the host, but at higher humidities (95%) the time varied from 5–12 days. Post-oviposition longevity of the female lasted about 14 days. The number of eggs laid by each female varied from 30 to over 6000 eggs, egg production being directly related to the quantity of blood imbibed. Incubation period of eggs varied from 28 to 37 days and from 26 to 36 days at 81% R.H. and 95% R.H. respectively. Larvae emerging from these eggs fed for 4–13 days under experimental conditions and having detached themselves from the host moulted in 7–16 days. Engorgement of nymphs lasted from 6 to 14 days, and the intervening period between detachment and moulting ranged from 17 to 28 days.

DISEASE RELATIONSHIPS

No published records of infestations of man by *D. parumapertus* are known, but it has been demonstrated that *Pasteurella tularensis* can survive in this tick and be transmitted by it (Parker, 1933), and that it also serves as a reservoir for Colorado tick fever virus (Fremling & Gastfriend, quoting Kohls). Natural infections of these ticks with *P. tularensis* are reported from the south-west of the United States (Phillip & Hughes, 1953) and from the Great Salt Lake Desert of Utah (Woodbury & Parker, 1954). The importance of this tick as a potential vector of epizootics in Utah is emphasised by the fact that it is widely distributed geographically and is abundant on many kinds of mammals.

D. OCCIDENTALIS

Dermacentor occidentalis Marx, 1892

Pl. 1, figs. 5-6; Figs. 85-99

SYN., LIT. AND ICON.

- 1892 *Dermacentor occidentalis* Marx (in Curtice, 1892*b*, p. 226, original description).
1897 *Dermacentor occidentalis* Marx: Neumann, p. 365 as a synonym of *D. reticulatus*.
1899 *Dermacentor occidentalis* Marx: Morgan, p. 134.
1901 *Dermacentor reticulatus* Salmon & Stiles, p. 448, figs. 61, 169-77 (pls. 32-5), in error.
1905 *Dermacentor reticulatus occidentalis* Marx: Neumann, p. 235; Neumann examined Marx's types and reported *occidentalis* as a variety of *reticulatus*.
1907 *Dermacentor occidentalis* Marx: Banks, p. 608.
1908*a* *Dermacentor occidentalis* Marx: Banks, p. 47.
1910 *Dermacentor occidentalis* Marx: Stiles, p. 32.
1911 *Dermacentor reticulatus occidentalis* Marx: Neumann, p. 100.
1911 '*Dermacentor occidentalis* Neumann', Hunter & Bishopp, p. 27, who state that it has been confused with *D. venustus* and thus wrongly accused of transmitting Rocky Mountain spotted fever.
1912 *Dermacentor occidentalis* Marx: Hooker, Bishopp & Wood, p. 181, biology and distribution.
1938 *Dermacentor occidentalis* Marx: Cooley, p. 39.

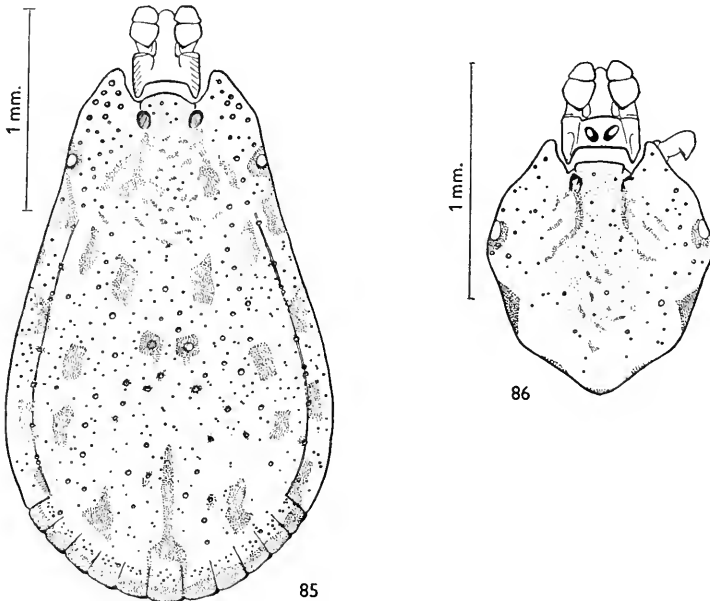
MALE. Highly ornate, pattern colour of silver grey superimposed on a base colour of dark brown; living specimens often show a waxy bloom over the scutum (pl. 1, fig. 5). The silver grey markings abound on the scutum and the festoons, the basis excluding the cornua, the dorsal surface of the palps, the legs including the antero-ventral margins of the coxae. Length 2.6-3.4-3.9 mm., width 1.7-2.3-2.6 mm.

Capitulum. Basis rectangular, not much longer than broad, length 0.46 mm., breadth 0.44 mm. (fig. 87). Lateral margins straight, almost parallel; cornua very strong, long, broad and tapered apically; posterior margin between the cornua weakly concave. Surface generally flattened except for median longitudinal depressed area posteriorly; few large punctations present. Some pattern colour present, a frequent arrangement is indicated in pl. 1, fig. 5. Palpi generally short and squat; articles 2 and 3 of nearly equal length, lateral salience slight, postero-dorsal ridges moderate. Punctations few; short hairs present on lateral and dorso-lateral surfaces and distally; length of palpal article 2, 0.21 mm., breadth of palpal article 2, 0.175 mm.; length of article 3, 0.23 mm. Colour pattern present but variable in extent. In ventral view (fig. 88) postero-ventral ridge a salience limiting the posterior side, broadly rounded posteriorly. In front of salience, surface flat, shiny and reticulate, slopes gently anteriorly to a sudden slope near the hypostomal base; behind the salience the basis slopes steeply. Palpi with irregular surface particularly along article 2, devoid of punctations and with strong, moderately long curved white setae. Base colour only present.

Scutum. Length about 2.6 mm., breadth about 1.6 mm. Elongate, broader posteriorly than anteriorly, lateral margins arcuate. Scapulae large, blunt apically

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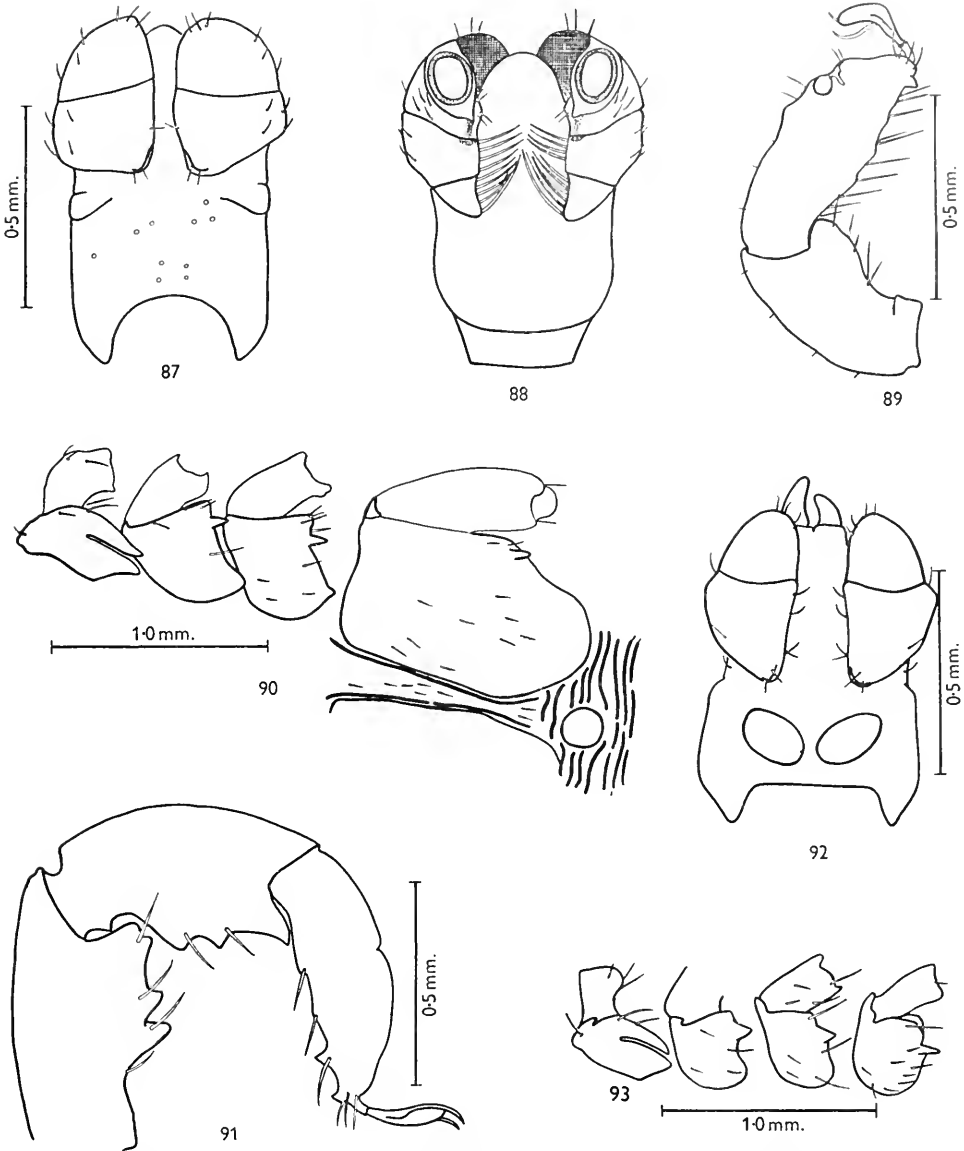
(pl. I, fig. 5; fig. 85). Extensive patterning of silver grey with small brown islands, the pseudoscutum most easily differentiated by its more uniform silver-grey colour. Punctations very numerous, with some disparity in size; all are, however, smaller than the foveae. Latter difficult to distinguish readily, being situated on median brown patches. Cervical grooves short and little more than deep pits. Lateral grooves indicated by a row of moderate to large punctations. Festoons long, well defined, ventral festoons ornate. Few, scattered, very short white hairs. Specimens from south-western Oregon have the pattern colour uniformly less brilliant than in specimens from middle and southern California, and the antero-lateral margin in front of the eyes is reddish yellow (Cooley, 1938).



Figs. 85 and 86, *Dermacentor occidentalis*. 85, male dorsum; 86, female, capitulum and scutum.

Legs. Of moderate length, broad. Very ornate both dorsally and ventrally and bearing distinct punctations. Hairs on dorsal surface of leg short and few in number, those on ventral surface very long and strong, and arranged in pairs. Similar long hairs at the base of the pulvillus. Dorsal spur on trochanter I long and tapered. Coxa I convex, coxae II-IV flat: some development of pigmentation on the coxae in some specimens: coxa I with subequal internal and external spurs (fig. 90); internal spur broader but both taper strongly to their extremities, proximal edges of spurs subparallel; apices of spurs of paler hue than the rest. External spurs on coxae II-IV longer than their basal breadths, tapering to tips. Internal spurs on coxa II as marginal saliences, those on coxa III distinct but shorter than external spurs. Coxa IV generally very broad (antero-posteriorly), internal spurs lacking. Hairs generally short. Three

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Figs. 87-93, *Dermacentor occidentalis*. 87-91, MALE: 87, capitulum, dorsal; 88, capitulum, ventral; 89, tarsus I; 90, coxae I-IV; 91, tarsus IV; 92-3, FEMALE: 92, capitulum, dorsal; 93, coxae I-IV.

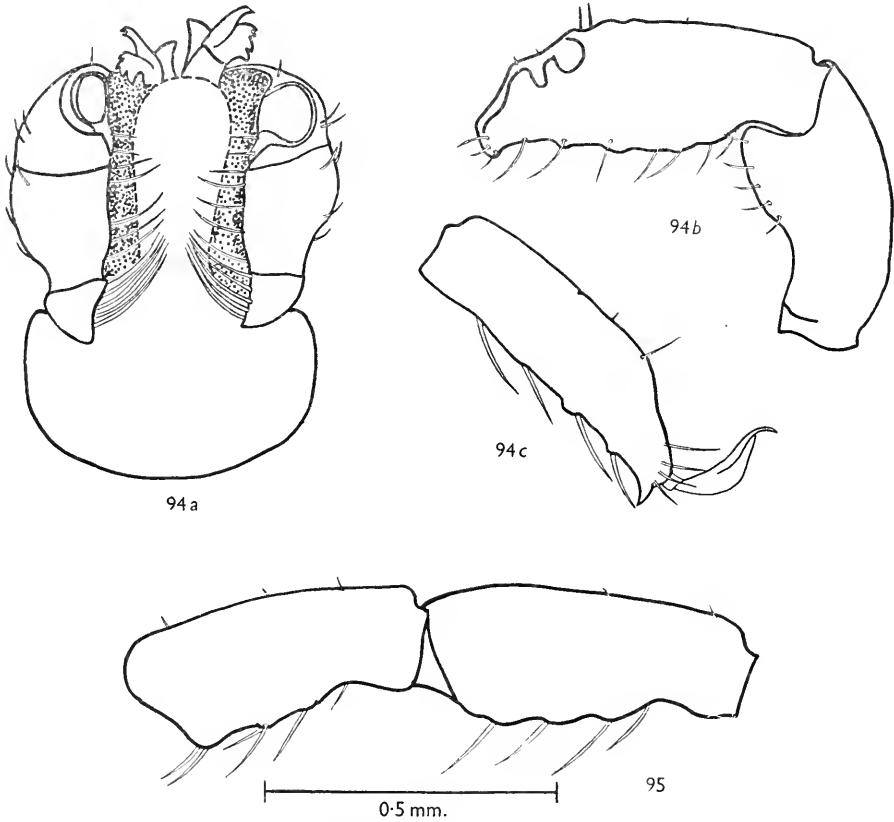
pairs of ventral tibial spurs very strong, two pairs of similar spurs on metatarsus IV and tarsus IV. Length of tarsus I (fig. 89), 0.62 mm., tarsus IV (fig. 91), 0.65 mm.

Spiracular plate. Long, with definite blunt dorsal process, coarsely granulated all over except in the prolongation. Goblets numerous and of moderate size.

FEMALE. Length 2.9-3.5-3.7 mm., breadth 1.8-2.3-2.6 mm. Very ornate, pattern colour more extensive than base colour on scutum (pl. 1, fig. 6).

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Capitulum. Length about 0.43 mm., breadth about 0.64 mm. Lateral margins slightly convergent anteriorly, curved postero-laterally; posterior margin between cornua straight (fig. 92). Cornua about as long as their basal breadth, narrowing quite appreciably posteriorly in many specimens and rounded apically. Porose areas oval, divergent anteriorly, very close to each other. Surface flat in front of porose areas but depressed behind the latter. Beyond porose areas surface elevated, and thence



Figs. 94-5, *Dermacentor occidentalis*. FEMALE: 94a, capitulum, ventral; 94b, tarsus I; 94c, tarsus IV; 95, metatarsus and tibia of leg IV.

downcurved to the margins. Palpi similar to the male, few punctations, and irregular depressions present; few hairs on inner and outer margins and distally. Palpal article 2 about one and a half times as long as palpal article 3. In ventral view basis with a salient postero-ventral ridge, surface generally flattened, with a gradual slope to the base of the hypostome.

Scutum. About as long as broad, posterior margin behind the level of the eyes subangulate (pl. I, fig. 6; fig. 86), greatest width at or in front of the mid-length. Whole surface in well-marked specimens silver grey except for narrow markings of

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brown base colour along cervical grooves and two small patches on either side, one internal to the eye, the other marginal and a little distance posterior to the eye (these well-marked post-orbital patches appear to be characteristic). Two parallel diagonal markings on either side on the middle area behind the eyes, which are observed in related species, are faint or absent in *D. occidentalis*. Occasionally the scutum between the grooves may be without pattern colour. Scapular angles moderately sharp, eyes fairly large and distinctly yellow. Cervical grooves short and deep; punctations few, more or less uniform in size. Hairs few, short, white.

Postscutal area. Bears short, stout white hairs, with rounded tips. Marginal groove distinct, delimiting either the anterior festoons or all festoons. Hairs associated with festoons longer than those on the rest of the postscutal area.

Legs. Very ornate. Coxa I, trochanters I and tarsi IV like those of the male, but tibial spurs much reduced (fig. 95). Coxal hairs relatively longer in female than male, internal spurs on coxa III reduced to marginal saliences.

Spiracular plate. As in male.

The following descriptions of the nymph and larva are taken from Cooley (1938).
NYMPH. Length 1.05 mm., width 0.81 mm. Oval.

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

Scutum. Length 0.39 mm., width 0.57 mm. Cervical grooves small and short. Posterior margins broadly convex and with no tendency to be pointed at the extremity. Festoons moderately distinct (fig. 96).

Legs. Coxa I with two spurs; external spurs on coxa II moderate, on coxa III faint and on coxa IV absent (fig. 97).

Spiracular plate. Broad, oval, with 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 dimensions as in *parumapertus*. Greatest length, 0.092 mm., width 0.077 mm. The plates in *occidentalis* and *parumapertus* are similar, but that of the former is smaller.

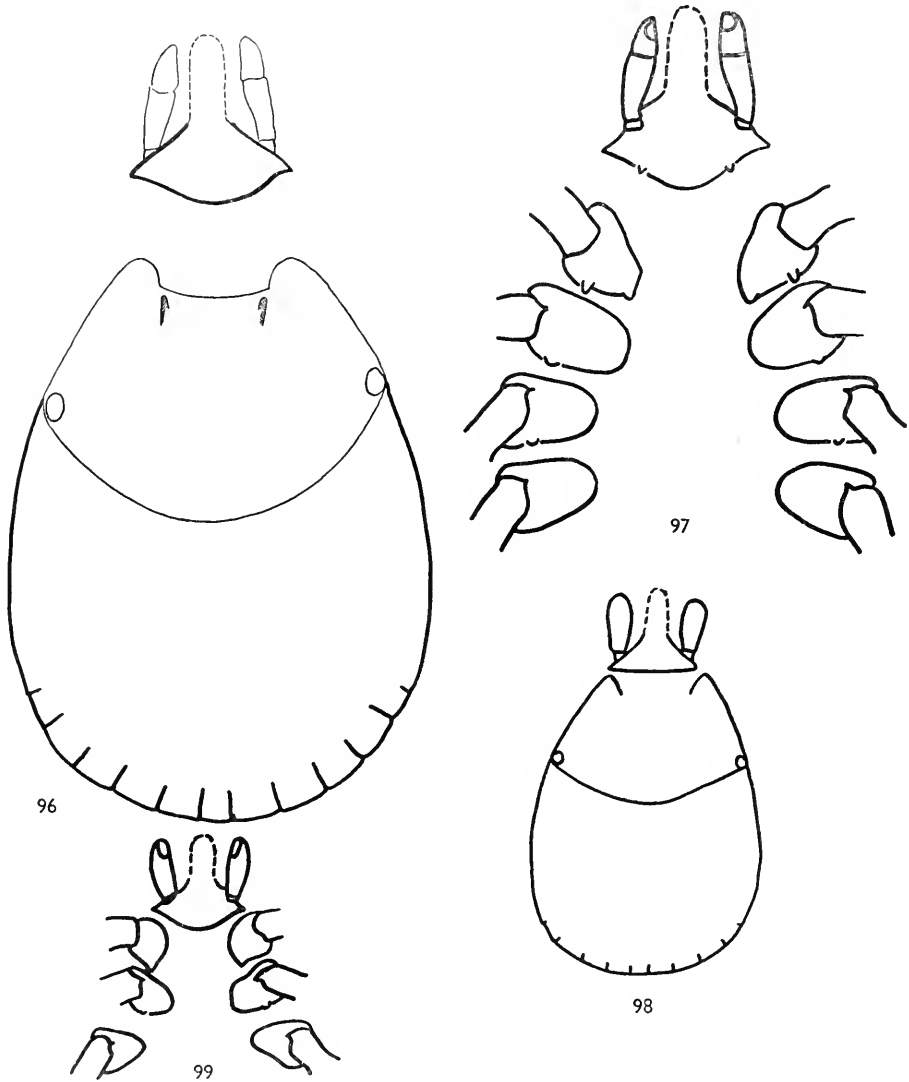
LARVA. Length 0.57 mm., width 0.48 mm. Length of scutum 0.23 mm., width 0.33 mm. Basis capituli laterally extended into moderate points (fig. 98). Coxa II somewhat larger than coxa III; coxa I with a definite pointed internal spur; coxa II with a faint rounded external spur; coxa III lacking spurs (fig. 99).

RELATED SPECIES

The adults of *D. occidentalis* are readily separated from *D. parumapertus* and *D. halli* in having the spurs on coxa I with the proximal margins either parallel or slightly divergent, and from *D. albipictus* by the oval spiracular plates with dorsal prolongations which have either a moderate or large number of goblets. The long cornua are a ready means of separation from *D. variabilis*, *D. andersoni* and *D. hunteri* of the

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North American species. The nymphs of *D. variabilis*, *D. halli*, *D. hunteri* and *D. occidentalis* agree in having no spurs on coxa IV, and of these species *D. hunteri* and *D. occidentalis* have an oval spiracular plate which is broader on the lower end, where



Figs. 96-9, *Dermacentor occidentalis*. 96, capitulum and dorsum of nymph; 97, ventral view of capitulum and coxae I-IV; 98, capitulum and dorsum of larva; 99, ventral view of capitulum and coxae I-III. (After Cooley, 1938.)

the aperture is also found. *D. occidentalis* nymphs differ from those of *D. hunteri* in having narrow pointed excrescences at the postero-lateral edges of the ventral surface of the basis capituli.

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Remarks. The accepted author of *occidentalis* is given as Marx (1892) by Banks (1908), Stiles (1910) and Cooley (1938). Curtice (1892) did, however, point out differences between this and other species, but such differences are inadequate criteria for separation.

BIOLOGY

D. occidentalis, the western dog tick, or Pacific tick, is the most frequent Ixodine tick in California, and is common from central Oregon to lower California. The type host is the deer and the type locality Occidental, Stanislaus County, California. Other hosts, according to the frequency with which they occur on them, are cattle, horses, man, mule, dog, ass, sheep and rabbits. At times deer are very heavily infested by these ticks.

Herms & Howell (1936) report that the average preoviposition period for ticks under laboratory conditions ranges from 18 to 41 days with a mean period of 21 days. Egg laying commenced 4-39 days after the fully fed female dropped from the host, according to Hooker *et al.* (1912), and under laboratory conditions twenty-five days was the minimum incubation period, the average being 32 days (Herms & Howell). Non-feeding larvae succumbed within 3 days after hatching, the majority dying in less than two months. Hooker *et al.* reported that the larvae lived for a maximum period of 124 days in tubes of moist sand plugged with cotton wool, but the bulk of the specimens died within 60 days. The larvae usually feed for about 4 days (3-5 days) but certain of them had not engorged at the end of 14 days. Transformation of the larvae to the nymphs takes 7-11 days after detaching themselves from the host, and the nymphs start feeding almost immediately. The feeding period of the nymph ranges from 4-11 days, the bulk of a feeding population taking about 6 days to complete engorgement. Unfed nymphs lived for a maximum period of 108 days in September and 69 days in July (Hooker *et al.*). The nymphs moult to adults in about 13-22 days (15-25 days according to Herms & Howell) and the sex ratio of emerging females to males is about equal. The females feed for about 6-17 days but under experimental conditions they have become replete in 3 days, particularly during warm weather. Females which had not fed to repletion were unable to lay as many eggs as fully fed females. The males remain upon the host for about 30 days, and copulation with the female occurs on the host. This species occurs on the hosts during all seasons of the year, the adults being most numerous in the rainy season. The adults are frequently taken on cattle but all stages have been reported on this host. Rees (1932) has shown that, as in other ticks, the small size of the larvae and the nymphs prevent them from being seen on large hosts, even though these immature stages are present in large numbers.

Dermacentor hunteri Bishopp, 1912

Figs. 100-12

LIT. AND ICON.

- 1912 *Dermacentor hunteri* Bishopp: original description, p. 33.
 1913 *Dermacentor hunteri* Bishopp: Bishopp & Wood, p. 155.
 1938 *Dermacentor hunteri* Bishopp: Cooley, pp. 45-8.

MALE. Length between 3.8-4.5 mm.; breadth between 2.7 and 3.1 mm. Body tapering quite strongly in front of the spiracle where it is widest, posterior margin broadly rounded. Base colour brown, pattern colour grey. Legs thick and strong, striped with enamel markings dorsally and distally on each article.

Capitulum. Basis rectangular, broader than long, breadth of basis about 0.5 mm., length about 0.33 mm. Overall length of capitulum 0.77 mm. (fig. 100). Posterior region between the cornua depressed; latter broad basally tapering to subacute extremities. Large and small punctations present. Base colour overlain by some pattern colour, notably as a median dorsal patch on the basis. Palpi short and broad; palpal article 2 widest at about the distal third where there is a small but distinct protuberance; postero-dorsal ridge moderately rounded; palpal article 3 broad, apex broadly rounded with inner distal edge sharply curved. Patterned at base of postero-dorsal ridge and along suture line between articles 2 and 3. Length of article 2, 0.25 mm., article 3, 0.21 mm. Short hairs present at the apex and more particularly along the outer margin. In ventral view basis broad (fig. 100a); almost straight postero-ventral ridge with postero-lateral angles rounded. Surface flat with gentle slope to hypostomal base. Few small punctations. Surface behind the ridge almost declivitous, short and more strongly punctate; laterally surface of basis gently curved, almost vertical, well supplied with very short, spinose white hairs. Palps with short lateral hairs and few small punctations.

Scutum. Narrower anteriorly than posteriorly (fig. 102). Cervical grooves indicated by a moderately deep depression (for a short distance) behind the scapulae, thence shallowing and diverging. Lateral grooves indicated by moderate depressions, accentuated by longitudinally disposed large punctations from which arise short white hairs (about 10-15). Few large punctations bearing hairs, most clearly seen lateral to the cervical grooves and behind the scapulae; moderate number of small punctations which occur in both median and marginal areas beyond the lateral grooves; size disparity of punctations moderate. Scapulae large, emargination well defined. Base colour brown, pattern colour grey. Colour pattern reticulate, leaving islands of base colour of variable size; peripheral to the lateral grooves and running across the festoons the pattern colour is an almost continuous narrow band; the anterior festoons more extensively patterned; pseudoscutal area may be extensively patterned or indicated by striping. The pattern colour in specimens from Libertad, Mexico, is less extensive, causing the base colour spots to be confluent in the lateral areas (Cooley, 1938).

Legs. Stout, of moderate length, with few small punctations; colour pattern present

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dorsally either as longitudinal stripes or as terminal patches on the segments of the leg. Dorsal spur on trochanter I well developed and pointed with some pattern colour present. Coxa I broad (fig. 103); internal spur broad and rounded; tip of external spur not reaching to apex of internal spur, narrower than internal spur, apex rounded, separated by a rather long parallel fissure; coxae II, III and IV with prominent external spurs, a little longer than the width of the bases. Internal spur on coxa II as a trenchant marginal salience; that on coxa III is much broader and more clearly defined as a spur. No internal spur on IV. Hairs increasingly numerous from coxae II-IV, on latter spinose and for the most part of moderate length.

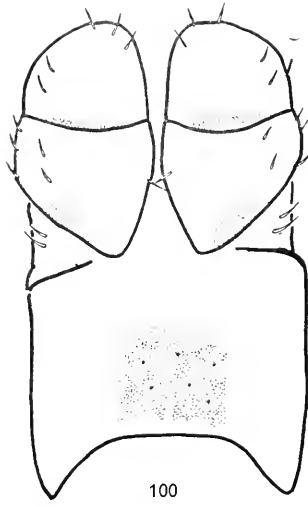
Spiracular plate. Dorsal prolongation very pronounced and attenuated; goblets moderate in number and in size (fig. 101).

FEMALE. Smaller than male, length 3.9 ± 0.33 mm., width 2.6 ± 0.23 mm. Body of unfed female elongate, legs of moderate length and thickness. Scutum, legs and parts of the palps extensively enamelled. Distinct marginal fold.

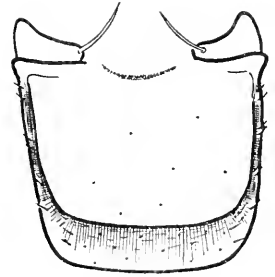
Capitulum. Basis much wider than long, generally about twice as long as broad (0.58×0.3 mm.) (fig. 104). Surface flattened mesially but slightly elevated lateral to the porose areas and including most of the cornua. Porose areas depressed, of moderate size separated by a narrow interval. Posterior margin of basis straight, cornua short, broad, rounded; some pattern colour present. Lateral margins almost straight and slightly convergent to palpal insertion. Palpi relatively longer than in the male; article 2 has the form of an inverted cone, postero-dorsal ridge moderate; inner margin of article 3 almost straight, apex almost flattened and continuous in a broad sweep with the outer margin. Hairs most numerous on the outer margin, generally of moderate length; two stronger hairs arise from meso-dorsal ridge. Palpal surface smooth with very few small punctations present, pattern colour around postero-dorsal ridge and at the suture lines between articles 2 and 3. Ventrally basis (fig. 104a) broad with curved ventral ridge, in front of which the surface is flat and dips gradually to hypostomal base; behind this ridge surface short, vertical; similar face laterally, well supplied with short thorn-like hairs.

Scutum. Length about 1.50-1.52-1.56 mm., maximum breadth just behind level of the eyes 1.34-1.37-1.39 mm., posterior margin faintly subangulate or undulate (fig. 106). Cervical grooves short, forming deep ravine-like depressions where the slope towards the mid-line is steep, with a more gradual slope laterally. Punctations both small and large, former moderate in number, latter few. The pattern colour is more extensive than the base colour, the latter being limited to the periphery extending back, in front of and around the eyes, reaching forward to the scapulae and along the anterior edge, otherwise found in cervical grooves and as two oblique stripes in the median field, originating just behind these grooves. Scapulae very broad, with rounded apices. Hairs quite numerous, short.

Postscutal area. Marginal grooves pronounced, demarcating three festoons on each side.



100



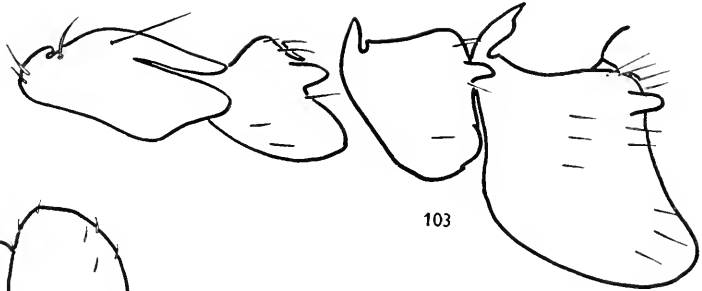
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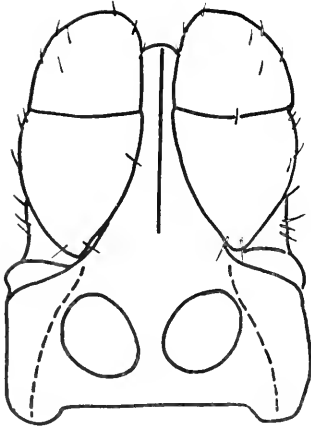
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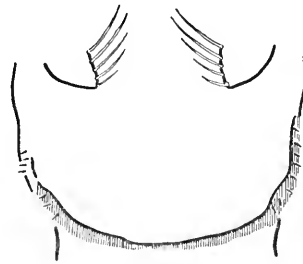
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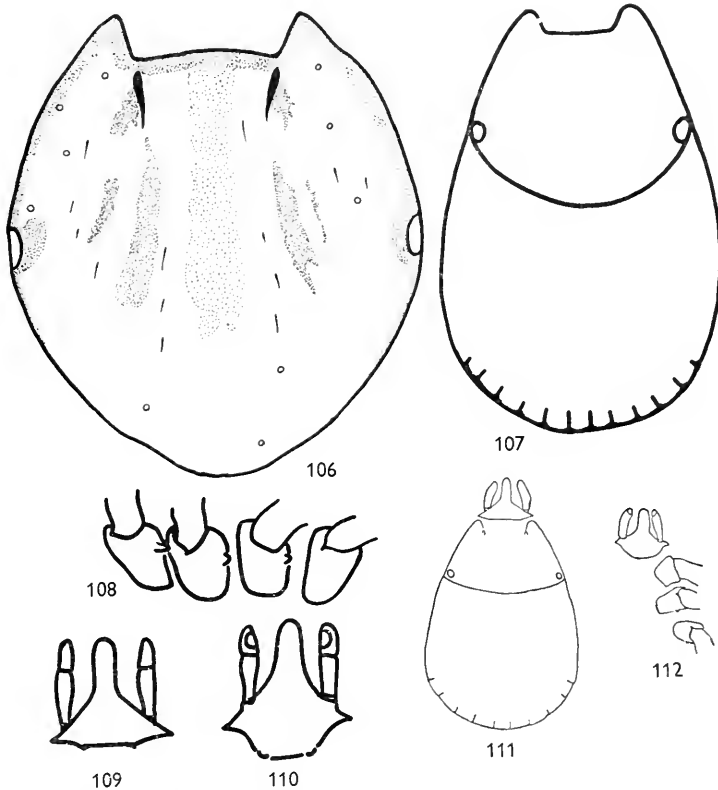
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Figs. 100-5, *Dermacentor hunteri*. 101-3, MALE: 100, capitulum, dorsal; 100a, ventral view of basis capituli; 101, spiracle of male; 102, scutum; 103, coxae I-IV; 104-5, FEMALE: 104, capitulum of female, dorsal; 104a, basis capituli of female, ventral; 105, spiracle of female.

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Legs. Less robust than in male but equally as extensively enamelled. Coxae essentially similar to the male, except that coxae II are broader, IV are smaller and lack the postero-internal bulge.

Spiracular plate. Small, with distinct narrow dorsal process. Goblets moderate in number and size (fig. 105).



Figs. 106-12, *Dermacentor hunteri*. 106, scutum of female; 107, nymph, dorsum; 108, coxae I-IV of the nymph; 109, capitulum of nymph, dorsal; 110, capitulum of nymph, ventral; 111, dorsum of larva; 112, ventral view of capitulum and of coxae I-III of the larva. (Partly after Cooley, 1938.)

Fully fed females are notably of a dark blue-grey hue which contrasts with the lighter green-grey colour in *andersoni* and the still lighter tan-grey in *halli*.

The descriptions of the larvae and nymphs are mainly after Cooley (1938).
NYMPH. Length 1.26 mm., width 0.87 mm. Oval, narrowed in front (fig. 107).

Capitulum. Basis subtriangular, extended laterally into sharp points, posterior margin straight before being gently angled to these points (fig. 109). Ventrally (fig. 110) there are broad, flat salient basal spurs.

Scutum. Broader than long (length 0.62 mm., breadth 0.66 mm.) (fig. 107). Cervical grooves distinct, short. Posterior margin evenly curved without tendency to be angular. Fестоons distinct.

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Legs. External spurs of coxa I distinct, of moderate length; internal spur broad, flat rounded apically. Smaller external spurs on coxae II and III; internal spurs lacking. No spurs on coxa IV.

Spiracular plate. Small, broad oval, with the eccentric spiracular opening in the broader end. Goblets moderate in size and number. (According to Cooley (1938) the spiracular plate of *hunteri* resembles that of both *parumapertus* and *occidentalis* but can be separated by the more eccentric position of the opening in *hunteri*.) Greatest length, 0.103 mm., width 0.09 mm.

LARVA. Length 0.69 mm., breadth 0.54 mm. Basis moderately extended laterally into points, otherwise similar to the nymph.

Scutum. Broadly rounded behind, eyes postero-laterally placed. Postero-lateral angles sharp, lateral edges more or less straight. Length 0.24 mm., breadth 0.42 mm. Coxa II longer than coxa III, coxa I with internal marginal salience, coxae II and III with slight indications of external spurs.

RELATED SPECIES

D. hunteri, like *D. albipictus*, *D. occidentalis*, *D. variabilis* and *D. andersoni* of the North American species, has the proximal edges of the spurs on coxa I either parallel or subparallel. The cornua are either short or of moderate length, a feature shared by *D. variabilis* and *D. andersoni*, and in common with the latter the goblets of the spiracular plate of *D. hunteri* are moderate in both size and number. The males of *D. hunteri* are easily separated from the males of other American *Dermacentors* by the long dorsal spiracular prolongation and a more definite confluent pattern colour. Fully fed females of this species are notably of a dark blue-grey hue when compared with the lighter green-grey pigmentation of *D. andersoni*. In the unfed stages *D. hunteri* can be separated from *D. andersoni* by the degree of demarcation of the festoons by the marginal groove; in the former only the three anterior festoons on either side are delimited, in the latter this groove is continuous in front of all the festoons.

The types of *D. hunteri* are deposited in the U.S. National Museum, Cat. no. 14575.

BIOLOGY

D. hunteri has been collected only near Quartzsite and Supai, Arizona, with the type from the former locality. The hosts are mountain sheep (*Ovis canadensis gaillardi* Mearns), and the ticks were collected on these hosts at 1500–2500 ft. altitude. Further and more detailed examination of mountain sheep for this tick in other localities may show a wider geographical range. As far as is known, in nature the host range is limited to these sheep but all stages have been raised experimentally on guinea-pigs. The only information on this species is that supplied by Bishopp & Wood (1913). The adults were collected on the hosts in July to September and again in December. A well-engorged female may lay about 2500 eggs. At a mean temperature of 90° F.

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development from the egg to the larva took 12-14 days. Only one larva was successfully bred through to the nymphal stage, and at 75° F. this breeding period was 23 days. During emergence from the larva to the nymph the cuticle fractured from just behind the hind coxae on each side up to the level of the eyes, thence dorsally, and the splits extended back to the hindermost region of the scutum where they met. The larval skin was left firmly attached by the tarsal claws. The nymph transformed to the adult in 23 days at above 86° F., and moulting took place as a result of a splitting of the cuticle above the stigmal plates which extended posteriorly along the ventral margins of the festoon grooves with their ultimate fusion. Anteriorly the line of fragmentation is continued as far forward as the scutal eyes and the nymph then escapes through the posterior gap. Such a moulting process is comparable to that which occurs in other *Dermacentor* ticks. Survival of adults collected from hosts ranged from 111-17 days. A partially fed tick (1/25 gorged—Bishopp & Wood, 1913) was induced to feed successfully on a guinea-pig and was fully gorged after 7 days. So that under natural conditions it seems reasonable to believe that 8-9 days would be the normal feeding period. Likewise under experimental conditions the feeding time of larvae and nymphs was 10 days and 7½ days respectively.

Dermacentor halli McIntosh, 1931

Figs. 113-24

LIT. AND ICON.

1931 *Dermacentor halli* McIntosh, original description, p. 124.

1932 *Dermacentor halli* McIntosh: McIntosh, pp. 1-6.

1938 *Dermacentor halli* McIntosh: Cooley, pp. 55-7.

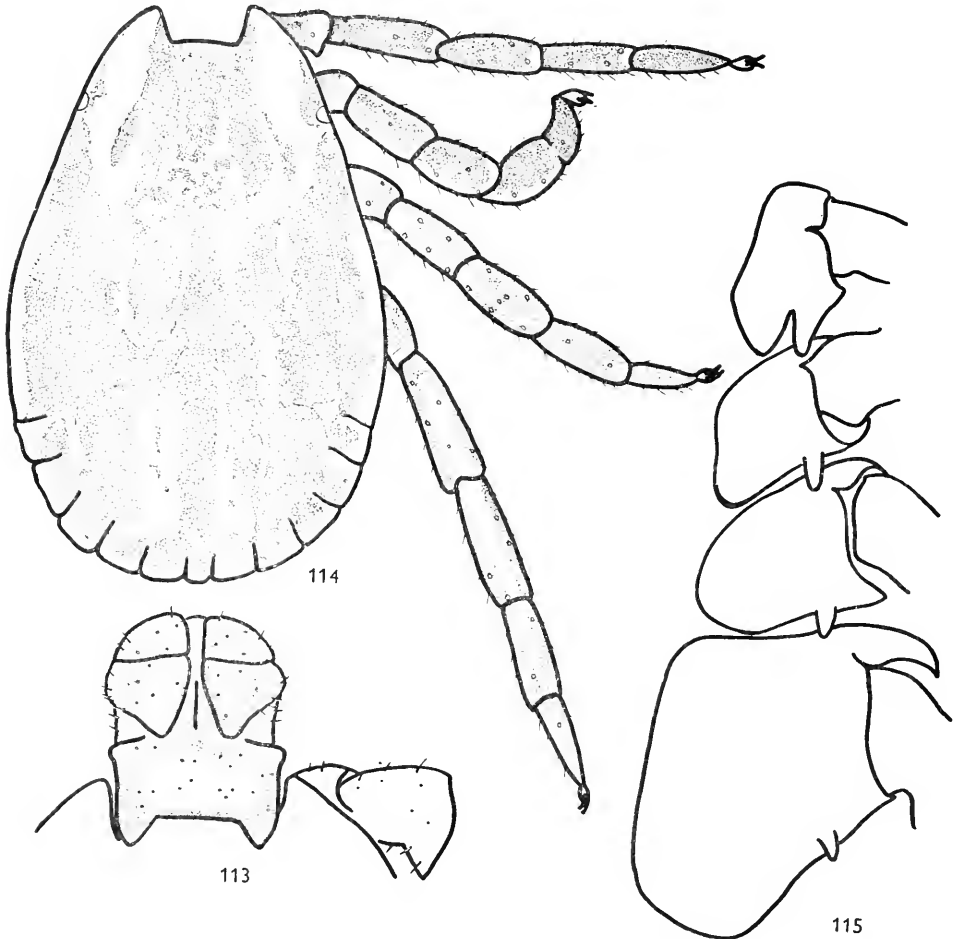
MALE. Length ranging from 3.4 to 4.4 mm., with a mean of 3.9 mm., breadth from 2.2 to 2.9 mm., with a mean of 2.6 mm.

Capitulum. Basis nearly twice as broad as long, surface flat or slightly convex (fig. 113). Punctations few with colour pattern faint on basis and also along inner margins of palpi. Cornua about as long as broad and rounded apically. Posterior margin between the cornua almost straight. Ventral ridge distinct as an overhang, straight, rounded laterally; punctations lacking; few short hairs at the sides and anteriorly. Palpi short, broad, greatest width across distal third of palpal article 2; postero-dorsal ridge moderately developed with elevated edges forming a wide angle; few short hairs on outer and distal margins; few punctations dorsally on palp but generally absent ventrally. Surface irregular or undulate, tinge of pattern colour present or absent.

Scutum. Lateral margins elevated above general level of scutum, which when viewed laterally is seen to be nearly straight (fig. 115). Cervical grooves short, deep, virtually appearing as pits; shallow lateral grooves emphasised by few punctations terminating at the anterior limit of the festoons. The grooves between the festoons deeper than lateral grooves. Clear large punctations in the marginal areas lateral of the grooves

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and in the humeral regions where there are also deep, small punctations of moderate number and more readily visible in regions of base colour. Pattern colour less extensive than base colour, occurring as a narrow band peripherally from just behind the level of the eye and reaching back to posterior limits (including festoons where the pattern is either spotted or barred). Anteriorly the pattern colour runs into scapulae and



Figs. 113-15, *Dermacentor halli*. MALE: 113, capitulum, dorsal; 114, scutum and legs; 115, coxae I-IV.

extends back as two irregular longitudinal stripes to beyond half scutal length; two fainter longitudinal bands extend from mesial edges of scapulae back to level of pseudoscutum where patterning becomes reticulate; beyond this two curved stripes which reach back to the hind limits of the two long bars. Posteriorly main pattern consists of two U-shaped bands with a basal thickening.

Legs. Of moderate length, segments generally shorter and stouter than in female. Pattern colour as longitudinal, dorsal bands on legs II-IV, but less emphasised on

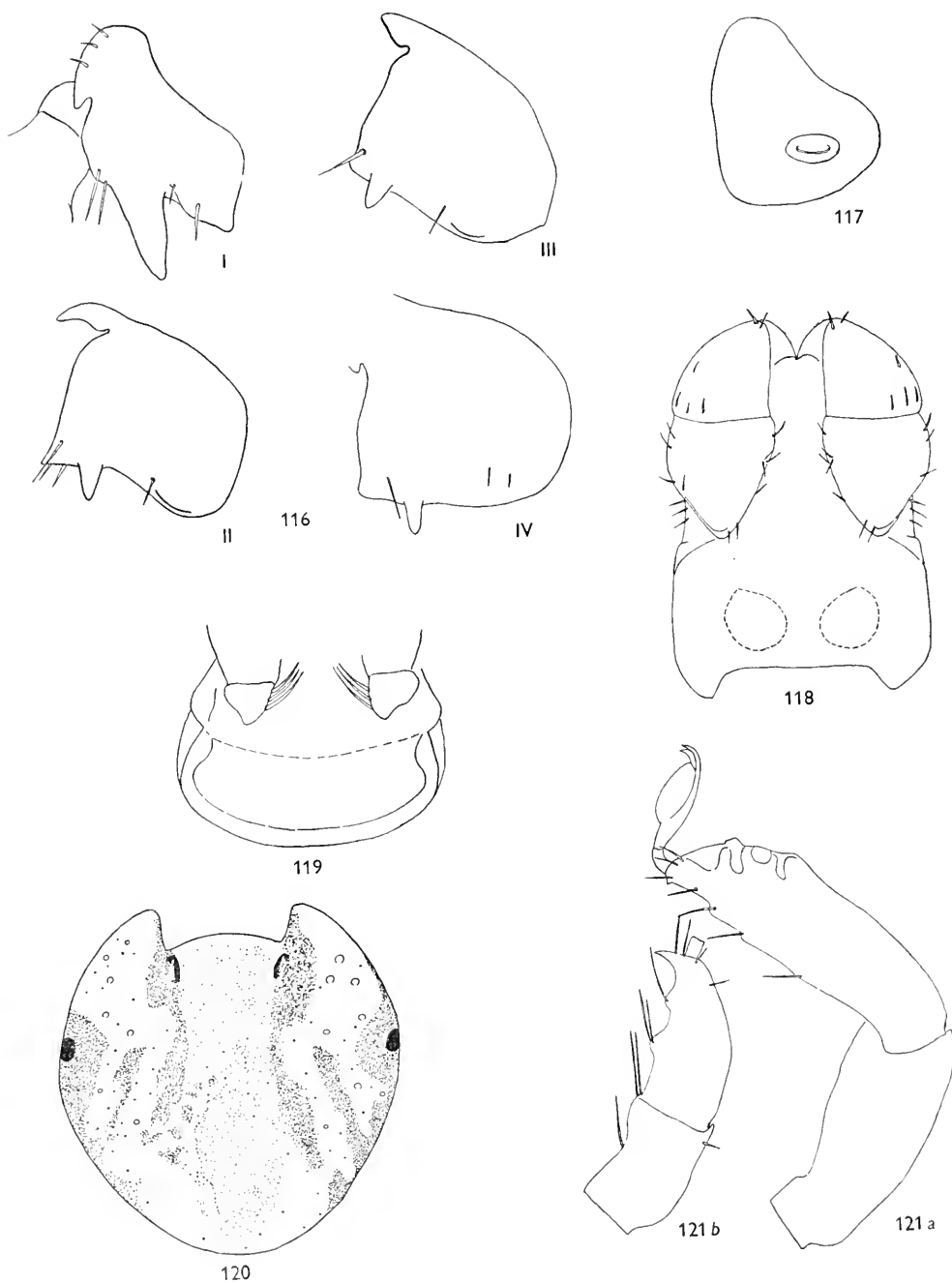
leg I; frequently the pattern colour is limited to the distal extremities of segments as on leg I. Hairs short, punctations moderate to large. Triangular, subacute dorsal spur on trochanter 1. Coxae (both sexes) (fig. 116): spurs on coxa I unequal in size, divergent, and apically rounded, external spur longer and narrower than internal spur, separated by a moderately deep concavity. Hairs few. External spurs on coxae II and III tapering, those on coxa IV with sides nearly parallel; all a little longer than the width at the base. Internal spurs on coxae II and III are virtually marginal saliences, with broadly rounded apical ends. No internal spur on coxa IV.

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

FEMALE. Length of body 3·7-4·5-5·6 mm., breadth across the level of the spiracle, 2·2-2·6-3·4 mm.

Capitulum. Basis much wider than long; length from dorsal ridge to apex of palps 0·86 mm., breadth just in front of cornua, 0·63 mm. Posterior margin straight, cornua subtriangular, curving round to form the lateral edges, postero-lateral margins slightly curved and slightly convergent to palpal base (fig. 118). Surface in median field flat, except for the depression of the porose areas; surface elevated lateral of the porose areas before curving downwards to the sides. Colour pattern (if present) extends as a faint transverse bar behind the porose areas and as a thicker band lateral to them. Porose areas suboval or piriform, depressed below general surface. Punctations and hairs few or absent. Palpi with colour pattern faint but quite extensive (if present), dorsally covering the inner margins and extending outwards basally. Postero-dorsal ridge moderate, subacute, leading to sharp, steep slope on the outer margin. Length of article 2, 0·3 mm., breadth of article 2, 0·27 mm.; length of article 3, 0·24 mm. General surface undulate. Ventrally basis broader than long, postero-ventral ridge curved in a broad arc of a circle (fig. 119), postero-lateral angles and sides also curved; distinctly constricted about midway along, and traversed by a faint, transverse groove. Pale brown colour, except for continuous darker brown pigmentation peripherally. Few short white hairs postero-laterally. Sides of basis almost vertical.

Scutum. The length and width about equal (Cooley, 1938); in specimens from the United States National Museum the breadth to length is as 1·6:1·57. Posterior border behind level of eyes almost semicircular (fig. 120); in front of eyes margins either slightly undulate or convex to the large rounded scapulae; emargination well defined. Cervical grooves short, deep, almost pit-like, with a steep inner face. Surface between grooves elevated, and almost flat, otherwise undulate. Punctations of two kinds, the smaller ones being the most numerous and evenly dispersed; the larger ones confined to the lateral field, where frequently they bear short white hairs. Colour pattern more extensive than base colour, latter present peripherally (except posteriorly) becoming broader in the vicinity of the eyes; between the cervical grooves and continuous posteriorly with these grooves, with a diagonal 'branch' from the latter about midway along its length which almost joins up with postero-lateral peripheral band



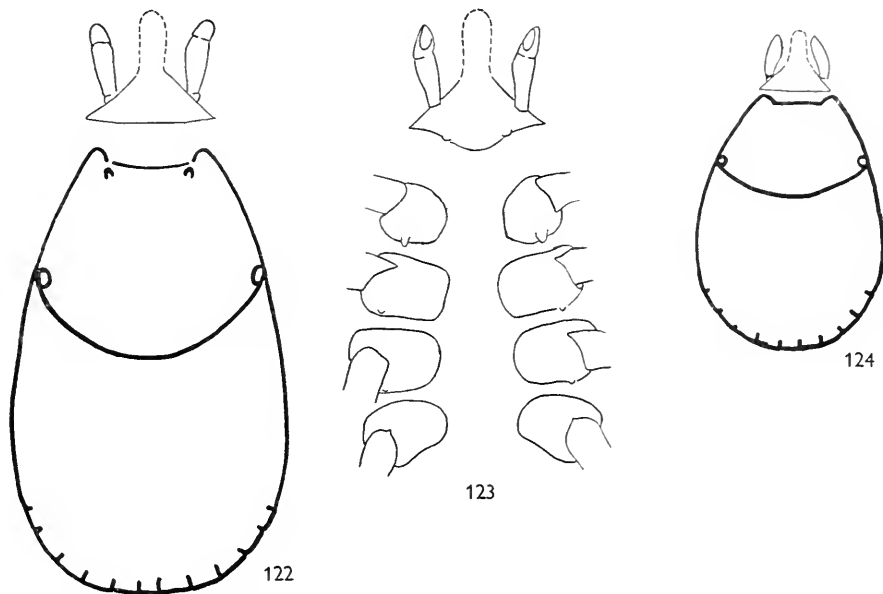
Figs. 116–21, *Dermacentor halli*. FEMALE: 116, coxae I–IV; 117, spiracle; 118, capitulum, dorsal; 119, ventral view of basis capituli; 120, scutum; 121a, tarsus I; 121b, tarsus IV.

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of base colour. Colour pattern of two degrees of shade, namely (i) a paler stripe arising internal to the cervical grooves which extends back about half the scutal length before reaching a broad reticulately patterned region, and (ii) the rest of the patterning which is more heavily pigmented.

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

Legs (fig. 121). Tarsus I is 0.8 mm. long, narrower proximally becoming progressively wider to just behind Haller's organ, then narrowing quite appreciably and strongly to the claw. On the ventral surface there is a small pointed subapical hump, succeeded more posteriorly by two rounded median tubercles. Tarsus IV is 0.71 mm.



Figs. 122-4, *Dermacentor halli*. 122, dorsum and capitulum of nymph; 123, ventral view of capitulum and coxae I-IV of the nymph; 124, dorsum of larva. (Partly after Cooley, 1938.)

long. Apical spur very long, strong, with two smaller tubercles posteriorly. Hairs on both tarsi and metatarsi long, but becoming more spinose on tarsus IV. Pulvillus about two-thirds length of claw, latter relatively narrow and fine. Coxae as in the male.

Spiracular plate. Dorsal prolongation broad, with numerous small goblets; shape as in fig. 117.

NYMPH (after Cooley). Body oval, narrowed anteriorly (fig. 122), length 1.05 mm., breadth 0.60 mm.

Capitulum. Basis capituli dorsally subtriangulate, extended laterally into sharp points, dorsal ridge straight, curving slightly at the sides, ventrally basal spurs very small, short, curved (figs. 122 and 123).

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Scutum. Length 0.45 mm., breadth 0.48 mm. Cervical grooves very faint or absent; posterior margin evenly rounded with no tendency to becoming pointed at the extremity (fig. 122).

Legs. Coxae I, II and III with small faint internal spurs, rounded apically (fig. 123); external spur on coxa I of moderate length, those on II and III reduced, but distinct and rounded apically. Spurs absent on coxa IV.

Spiracular plate. Length 0.108 mm., width 0.09 mm.; oval in outline; spiracular opening eccentric. Goblets moderate in size and number.

LARVA. Length 0.54 mm., breadth 0.42 mm. (fig. 124).

Capitulum. Basis capituli extended laterally and pointed as in the nymph.

Scutum. 0.24 mm. long, 0.36 mm. wide. Internal spur on coxa I faint, pointed. Spurs otherwise absent.

RELATED SPECIES

D. halli has the spurs on coxa I widely divergent, a feature shared with *D. parumapertus*. These two species can be separated on the punctation pattern of the scutum: in *D. parumapertus* the punctations are deep and large but in *D. halli* the punctations are of moderate size and shallow.

REMARKS

The holotype, allotype and paratypes (nos. 31500, 31501, 31502) are in the U.S. National Museum. This species is hitherto known only from Chichen—Itza, Yucatan, and southern Texas and the recorded hosts are the peccary (*Pecari angulatus angulatus*) and a skunk.

Dermacentor andersoni Stiles, 1908

Pl. 1, figs. 3, 4; Figs. 125-39

SYN., LIT. AND ICON.

- 1892 *Dermacentor venustus* Marx. Separated specimens of a tick from Texas from *D. occidentalis*, naming them as *D. venustus* new species. This name, however, is a *nomen nudum*.
- 1897 *Dermacentor reticulatus* Fab, Neumann. Considered *D. venustus* and *D. occidentalis* as synonyms of *Dermacentor reticulatus*.
- 1908a *Dermacentor venustus* Banks: original description. This description was applied to ticks collected from Pecos, Las Cruces, Mexico; Bozeman, Montana; Olympia, Yakima, Klikitat Valley, Grand Coulec, Washington; Fort Collins and Boulder, Colorado; Bridger Basin, Utah; Soldier, Idaho; and Texas. Marx's specimens originated from Texas, and Banks named these ticks for Marx's manuscript name in June 1908, p. 47.
- 1908 *Dermacentor andersoni* Stiles (3 July) believed the species from Montana to differ from Marx's *venustus* specimens and described the Montana species as *D. andersoni*, a name he had previously used in manuscript in 1905. The Texas ticks were designated as *D. venustus*, p. 36.
- 1908a *Dermacentor modestus* Banks: tubes labelled *modestus* (698) (Prescott, gift of U.S.A.), no details. They look like a rather small and badly marked *andersoni* and there seems

to be no valid difference between *modestus* and *andersoni* (author). Kohls has also examined specimens of *D. modestus* Banks and has identified them as *D. andersoni*.

- 1911 *Dermacentor venustus* Banks: Cooley, information on hosts and seasonal activity.
- 1912 *Dermacentor venustus* Banks: Hooker, Bishopp & Wood. A mine of information on host relationships and seasonal history.
- 1924 *Dermacentor venustus* Banks: Cockerell questioned the validity of *venustus* as from 1897, pointing out that the name was applied to the undescribed specimens of Marx. Accordingly the valid name of *D. venustus* should date from Banks 1908. The major issue was whether the Texas and Montana specimens were specifically different, for if they were identical the name *venustus* would necessarily be correct, p. 277.
- 1932 *Dermacentor andersoni* Stiles: Cooley, a review including much additional information.
- 1938 *Dermacentor andersoni* Stiles: Cooley examined the available types of *venustus* Marx, *venustus* Banks and *andersoni* Stiles and ascertained that they are 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.'
- 1938 *Dermacentor andersoni* Stiles: Hearle, p. 353.
- 1944 *Dermacentor andersoni* Stiles: Brown, p. 37.
- 1950 *Dermacentor andersoni* Stiles: Brown & Kohls, p. 198.
- 1956 *Dermacentor andersoni* Stiles: Gregson reviews the synonymy of this species and states that 'it is understood from correspondence with Dr C. B. Philip of the Rocky Mountain Laboratory, Hamilton, Montana that the International Commission on Zoological Nomenclature has been petitioned to suppress the name *venustus* and officially accept that of *andersoni*. In anticipation of an affirmative decision, the present writer has continued to refer to this species as *andersoni*', p. 29.

FEMALE. Length of unengorged specimens 2·8–3·75–5·4 mm., greatest breadth of 1·9–2·5–3·7 mm. across posterior third of body; when replete 13·8 × 10 mm. to 16·5 × 11·4 mm. Base colour brown, pattern colour grey.

Capitulum. Basis capituli rectangular, about twice as long as broad (fig. 125); posterior margin straight. Cornua broad, rounded apically, broader basally than long; lateral margins slightly convergent to palpal base. Dorsal surface slightly depressed in the posterior portion between the bases of the cornua. Punctations few and small, frequently present along the periphery. Porose areas relatively small, close together, elongate oval, obliquely placed relative to long axis of body. Palpi short, broad, article 2 about one and a half times as long as article 3, article 2 about as broad as long, surface irregular; few scattered punctations; few short hairs peripherally and on antero-dorsal margins; postero-dorsal elevation moderately developed. Some pattern colour present.

Scutum. About as broad as long (pl. 1, fig. 3; fig. 126). Shape in front of eyes convex, behind these eyes margin angular. Grey pattern colour more extensive than the base colour, but the amount of grey varies from specimen to specimen; usually the base colour is present in the cervical grooves, in diagonal bars lateral to these grooves and peripherally except for the posterior edge. Punctations of two sizes: the small ones are most numerous, the large punctations more abundant at the margins

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and the humeral areas sometimes with a few arranged in diagonal rows. Cervical grooves about three times as long as broad, diverging anteriorly and posteriorly. Behind the cervical grooves surface raised mesially and with two lateral diverging shallow depressions reaching almost to the postero-lateral scutal margins.

Postscutal areas. Marginal grooves very marked in unengorged females, delimiting all the festoons, large punctations frequent.

Legs. Spurs of coxa I well developed, proximal edges either parallel or only slightly divergent, rounded terminally (fig. 129*a*); external spurs on coxae II, III and IV a little longer than the basal width, internal spurs on coxae II and III short, broad and terminally rounded, internal spur on coxa IV lacking.

Spiracular plate. Moderate in size, but somewhat variable in shape, pronounced dorsal prolongation but variable in length and width, goblets moderate in size and number.

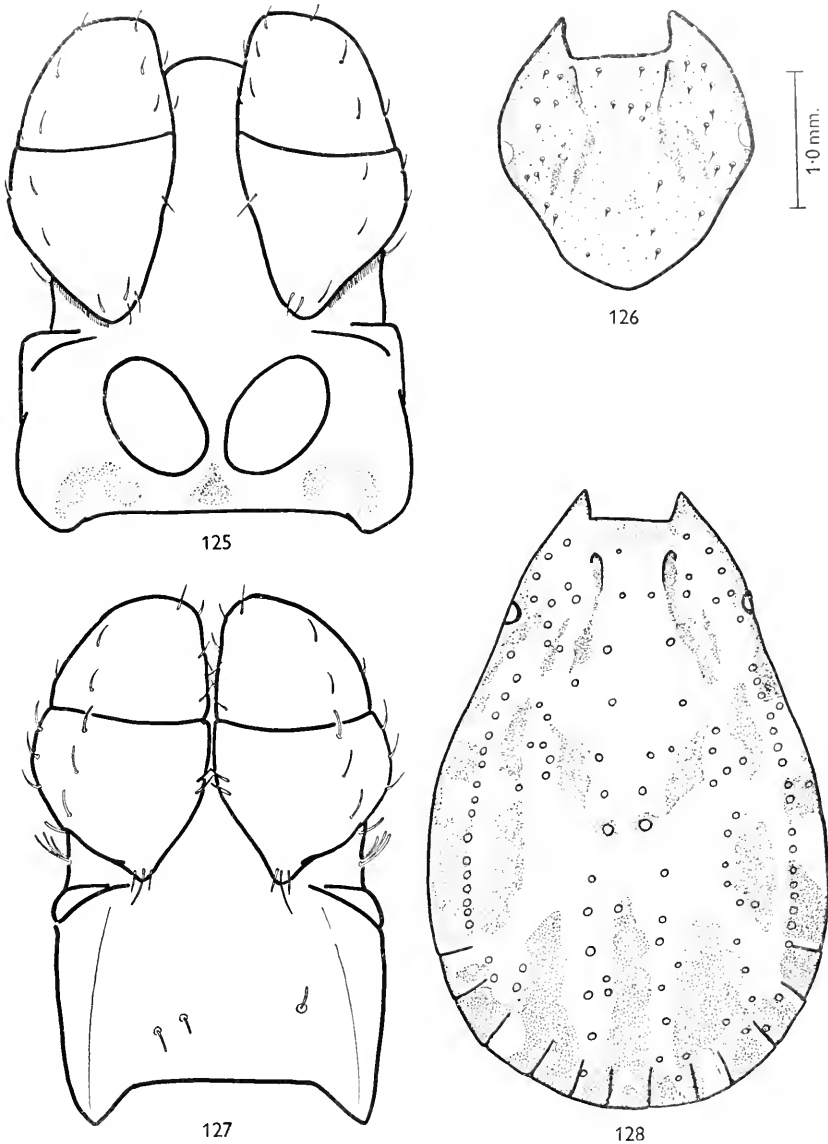
MALE. Length 2.1–3.7–6.1 mm., greatest width of 1.5–2.52–3.7 mm. just in front of anterior festoons. Base colour brown, pattern colour grey (pl. 1, fig. 4).

Capitulum. Basis capituli about 1.5–1.75 times as broad as long (fig. 127); median surface slightly depressed, punctate with short stout hairs arising therefrom; cornua of moderate length, about as long as basal breadth, apices rounded but in some specimens pointed. Posterior margin between cornua straight, as also are the lateral margins. Palpi, article 2 slightly broader than long, as 3.0:2.6, and slightly longer than article 3. Combined length of articles 2 and 3, 0.51 mm.; postero-dorsal elevation of article 2 moderate, but somewhat more acute than in the female. General surface slightly irregular, some pattern colour usually present, notably on the basis capituli and basal portion of article 2. Small punctations present with short hairs on the outer margin and meso-dorsally.

Scutum. Length 4.4 mm., breadth 2.9 mm.; narrowing more strongly anteriorly, broadly rounded behind, about one and a third times as long as the greatest breadth. Cervical grooves deep, three times as long as wide (fig. 128). Lateral grooves prominent and emphasised by large punctations, grooves cease at level of anterior festoons. Punctations variable in size, small ones most abundant; larger punctations uniformly distributed. If the base colour becomes more extensive or confluent, in the region posterior to the pseudoscutum, the punctations may occur within the areas of base colour. Grey of colour pattern generally more extensive than base colour; in pseudoscutal region base pattern spotted, between two longitudinal tracts of colour continuous with cervical grooves; foveae about mid-length, surrounded by brown spots of pigmentation; diamond-shaped marking in front of and lateral to the foveae, two large islands of base colour postero-lateral to the foveae, between them a postero-median band; a single island of base colour lateral of the diamond; pattern colour and base colour present peripherally, lateral margins of festoons bearing pattern colour. Eyes distinct, bounded by large punctations.

Legs. Pattern colour and hairs present; dorsal spur on trochanter 1 well defined,

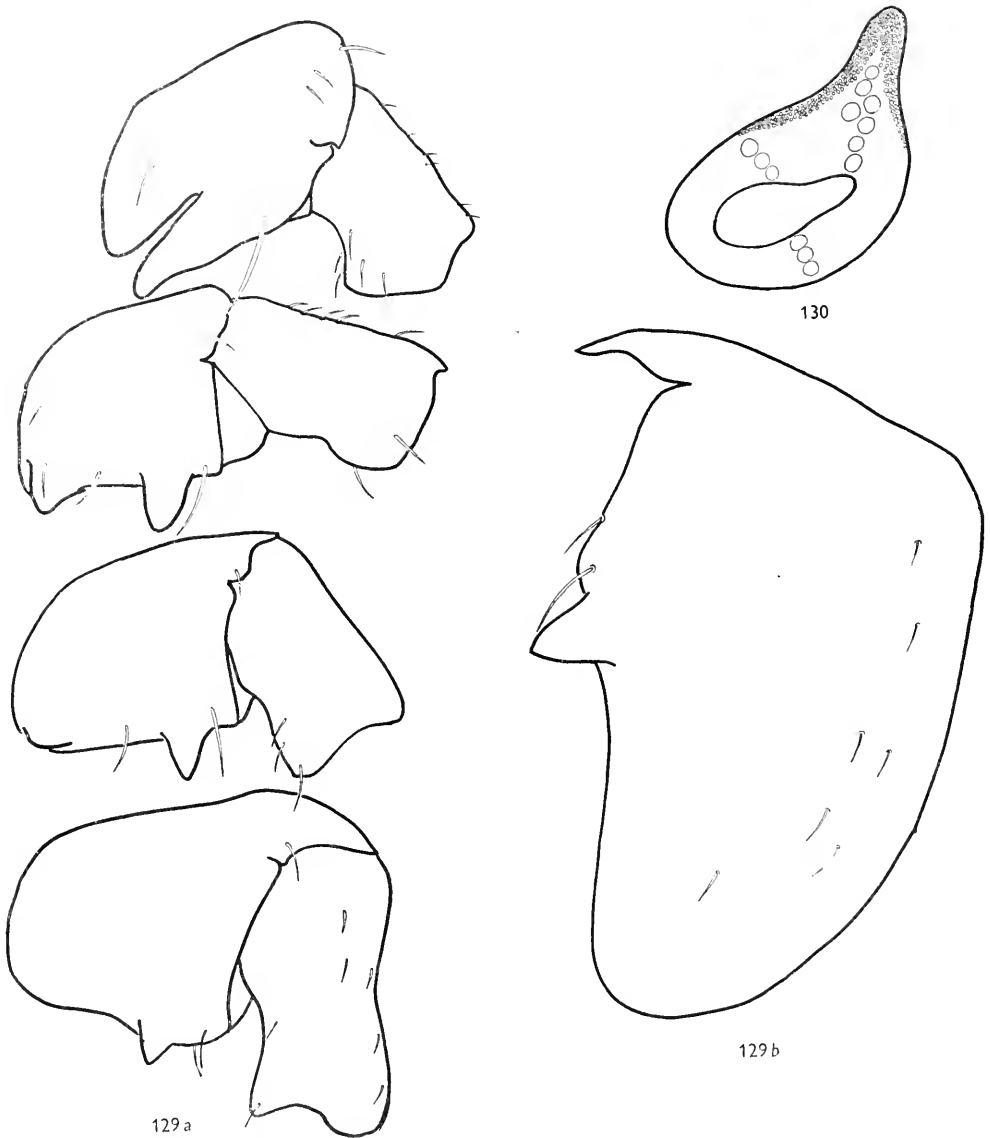
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Figs. 125-8, *Dermacentor andersoni*. 125, female capitulum; 126, female scutum; 127, male capitulum; 128, male scutum.

triangular, with some colour pattern frequently present. Coxa I with well-developed spurs, internal spur very broad and of about equal length to external spur; proximal edges of these spurs parallel or slightly divergent, rounded apically; external spurs on legs of II and IV prominent, tapering, as long or longer than their basal widths; internal spurs on coxae II and III short, broad, rounded terminally; internal spur lacking on coxa IV (see fig. 129*b*).

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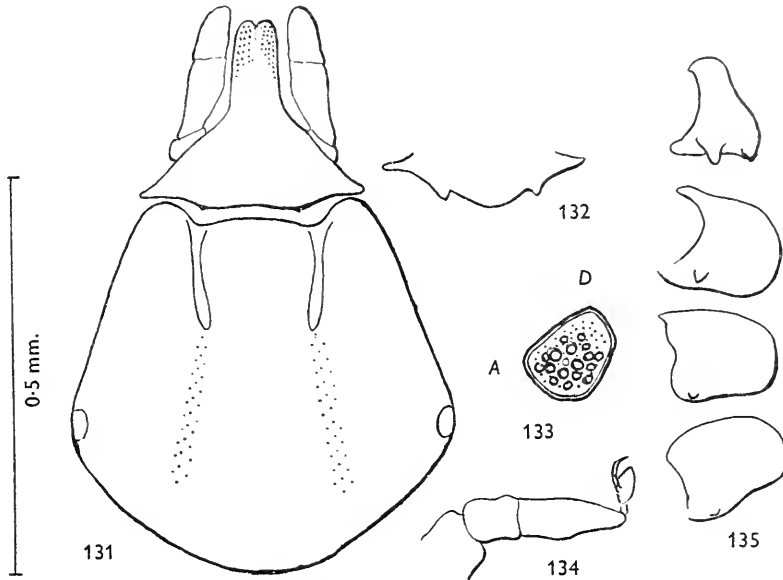
Figs. 129-30, *Dermacentor andersoni*. 129a, coxae I-IV of the female; 129b, coxa IV, male; 130, spiracle, male.

Spiracular plate. Of moderate size, length 0.54 mm., breadth 0.36 mm. but variable; dorsal prolongation variable in length but almost always present. Goblets moderate in size and number (fig. 130).

NYMPH. Length 1.36 × 0.72 mm. to 1.54 × 0.8 mm., but when replete reaches 3 × 2.1 mm. to 4.8 × 3.3 mm. Oval but narrowed more strongly in front of mid-length.

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Capitulum. Basis capituli subtriangular dorsally, posterior margin triarculate, quadridentate and well extended laterally to end in sharp points (fig. 131); antero-lateral margins straight and converging to the cheliceral foramen. Palpi relatively longer and narrower than in adults, article 2 more than one and a half times as long as article 3. Ventrally posterior and postero-lateral margins of basis capituli broadly curved, basal spurs on posterior border short, small and narrow (fig. 132).



Figs. 131-5, *Dermacentor andersoni*. NYMPH: 131, capitulum and scutum; 132, ventral view of basis to show basal spurs; 133, spiracle; 134, tarsus IV; 135, coxae I-IV.

Scutum. About as long (0.50 × 0.50 mm. to 0.63 × 0.60 mm.) as its greatest width across the level of the eyes. Cervical grooves prominent, moderately deep in front thence posteriorly by broad shallow valleys, at first convergent and then divergent, in direction of postero-lateral borders, but do not reach latter. Posterior and postero-lateral margins arcuate, as far as the eyes, then straight and convergent to the scapular angles (fig. 131). Festoons distinct.

Legs. Coxa I with pointed internal spur, external spur longer and rounded apically: coxae II, III and IV having external spurs only, that on coxa IV faint.

Spiracular plate. Almost circular, spiracular aperture almost centrally placed. Cooley (1937) stated that in some specimens the plate shows the tendency to become pointed dorsally (fig. 133). Goblets numerous and small. Length 0.15 mm., width 0.138 mm.

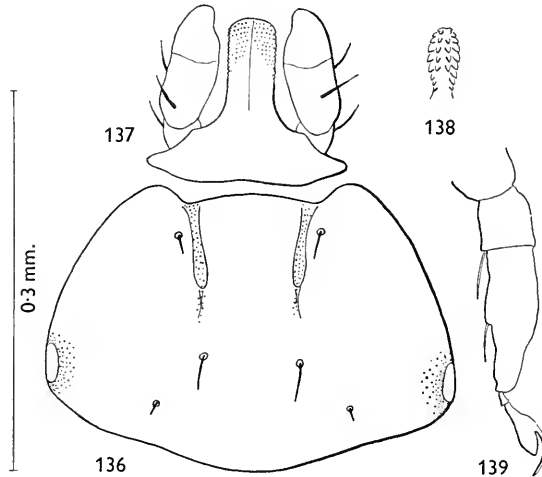
LARVA. Length of unengorged larvae from 0.57 × 0.38 mm. to 0.70 × 0.44 mm., when replete 1.28 × 0.76 mm. to 1.43 × 0.85 mm.

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Capitulum. Much as in the nymph but lacking the quadridentate, dorsal posterior margin (fig. 137). In ventral view basis capituli is produced laterally into sharp points. -

Scutum (fig. 136) considerably broader than long, 0.24×0.35 mm., broadest across the arcuate posterior margin, eyes placed far back. Coxa I with definite small internal spur, coxa II slightly larger than that of III. Small external spurs on coxae II and III, those on III very weak.

EGG. 0.64×0.46 mm.



Figs. 136-9, *Dermacentor andersoni*. LARVA: 136, scutum; 137, capitulum, dorsal; 138, hypostome; 139, tarsus I.

RELATED SPECIES

The short or moderate cornua serve to differentiate *andersoni*, *variabilis* and *hunteri* from the other North American species. Both *andersoni* and *hunteri* have spiracular goblets which are moderate in size and number, but the very large, deep punctations of the scuta of the former serve to distinguish it from the latter.

BIOLOGY

Ricketts (1906*a, b, c*; 1907*a, b, c, d*; 1908*a, b*) studied *D. andersoni* but his records are somewhat confused as he dealt with species other than *D. andersoni*. Cooley (1911) also studied its biology. The following data have been based on the observations of Hunter & Bishopp (1911), Dr M. B. Maver (1912 in correspondence with G. H. F. Nuttall), Hooker, Bishopp & Wood (1913), Nuttall (1915) and Hadwen (1913*b*).

D. andersoni is a three-host tick which is readily reared experimentally. All stages have been fed on sheep at Cambridge, and larvae and nymphs have fed successfully on guinea pigs. The tick remains on the host and feeds for 2-6 days, with the normal period being 3 days (Nuttall, 1915); 2-8 days is the time given by Hunter & Bishopp (1911) and by Maver (in private correspondence to Nuttall). Metamorphoses from

PLATE I



Fig. 1. *Dermacentor reticulatus* male.

Fig. 2. *Dermacentor reticulatus* female.

✓ Fig. 3. *Dermacentor andersoni* female.

Fig. 4. *Dermacentor andersoni* male.

Fig. 5. *Dermacentor occidentalis* male.

Fig. 6. *Dermacentor occidentalis* female.

the larva to the nymph lasted 6–7 days at 32° C. and 10–11 days at 24° C. under laboratory conditions. The usual feeding period of the nymph is 6–7 days, the shortest and longest periods being 5 and 11 days respectively. The observations of other workers (Hunter & Bishopp; Maver & Hadwen) give this period as 3–9 days. Having engorged, the nymph requires 14–15 days before metamorphosing to the adult (at 24–30° C.): the minimum and maximum periods according to Hunter & Bishopp range from 12–170 days, while Hadwen gives it as 32 days in summer and 84–94 days in winter. The female, having acquired a host, feeds for 5–15 days (Nuttall, Hunter & Bishopp and Maver); Hadwen gives the shortest period as 4 days and Hooker, Bishopp & Wood the longest as 17 days. The degree of nutrition of the nymph exercises a marked effect on the size and coloration of the adult. Under-feeding may result in the reduction of the size of the adult to less than half, the coloration may vanish and the structure be modified. The males imbibe the blood of the host for 3–4 days before seeking the female and during this period may alter their positions several times. Copulation takes place on the host and usually males show a preference in this respect for partially fed females. The process is similar to that observed in *Ixodes* ticks. The males remain on the host for some time after the females have dropped off and these males may copulate several times with different females. The female, having engorged for the requisite period, abandons the host and egg laying commences 3–5 days later at 30–32° C. and after 11 days at 24° C. (6–41 days is the time range given by Hunter & Bishopp, the egg-laying process being accelerated at higher temperatures). Oviposition lasts from 10–33 days at 24–32° C. and during this period 2500–4000 eggs are laid by a single fertilised female. In an experiment at Cambridge one female deposited 7140 eggs. Hooker, Bishopp & Wood gave the average of the number of eggs laid by one female as 5422 and the maximum as 7396. Under laboratory conditions unfertilised females either lay no eggs at all or if they do the eggs are usually infertile. The female survives for a varying period (generally 1–14 days) after completion of egg laying.

Emergence of the larvae from the eggs is much influenced by temperature: at 32° C. it takes place in 7–10 days, at 30° C. in 16 days and at 22° C. in 38 days.

The larvae appear to have a shorter survival period than either nymphs or adults in the unfed condition. Larvae usually die after 30 days if they do not succeed in attaching themselves to a host, but some larvae have been known to survive up to 117 days. Unfed nymphs may live for over 300 days and unfed females of one year readily attach themselves to hosts. Under the most favourable conditions in the laboratory the life-cycle is completed in 68 days.

In the field the adults appear in late February or early March and disappear about the middle of May in the dry belt of British Columbia (Gregson, 1951), irrespective of the atmospheric conditions. Bishopp & King (1913) stated that the accumulated effective temperature necessary to produce emergence from hibernation is in the neighbourhood of 37° F. In Alberta and in the damper regions of British Columbia the adults may, however, be active until June. Gregson throws some interesting light

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on the behaviour of the adults of *D. andersoni*. During sunny days these ticks are active on the ground, running about, climbing up vegetation and descending again. This suggests that as far as *D. andersoni* is concerned the dragging of a flannelette blanket or flag does not pick up all the ticks active at any one particular period of time. Moreover, as Gregson points out, there is a tendency for the ticks to roam; for example, marked specimens were recovered some 20 ft. away from the point of their release. By marking ticks with paint and flagging or dragging the same area in successive years it has been demonstrated that the marked ticks reappeared in some collections to the extent of some 8%. That the remainder of the catch were new stock moulted from the previous year's nymphs was suggested by the appearance of the males before the females. The curve of tick activity is of the unimodal type and analogous to the spring curve for *Ixodes ricinus* in Britain. Temperature and humidity appear to play no part in the dying down of the activity of ticks, nor can it be attributed to ageing or to lack of energy, for a measurable percentage return to carry on their activity in the ensuing year. During the inactive period the ticks have been found among the decaying roots of bunch grass (*Agropyron* sp.), suggesting that the adults aestivate and hibernate at shallow levels. *Dermacentor andersoni* can hibernate in all stages, and King observed that nymphs gorged in the summer of 1910 did not transform to adults until the summer of 1911. Under natural conditions, however, it would seem that nymphs gorged in the summer would moult and pass the winter as unfed adults.

The adult ticks show a predilection for large animals, horses, cattle, sheep, dogs, big game, other wild animals and man, and 'lie in wait' along trails and tracks frequented by these hosts. It seems highly probable that the stimulus of smell and its detection by Haller's organ is of some importance in this connection. When stimulated by a passing host these ticks climb on to the host and migrate rapidly to the head and shoulders (Gregson, 1956), attaching there within a few hours. Out of 108 ticks collected on about twenty-five sheep on the range in British Columbia, Hadwen (1913*b*) found all but four attached along the backbone; three were anchored round the base of the ears and one on the brisket. This is doubtless due to (*a*) there being a parting of the wool along the back, especially in Merinos, (*b*) ticks being brushed off the sheep's sides when passing through bush, (*c*) all parts devoid of wool being greasy, and (*d*) the wool being thick elsewhere except on the brisket. On horses and cattle they occur chiefly on the neck, withers and perineum and on man mainly on the nape of the neck (a common experience). When raised experimentally on rabbit, the larvae and nymphs attached themselves anywhere, by choice around the muzzle, eyes and neck.

The females insert the mouth parts and usually remain in the same situation for the whole feeding period of about 7 days; the males, on the other hand, take short blood meals and do not become unduly distended. Copulation takes place on the host, and according to Gregson (1944) this act accelerates the rate of feeding by the female. When fully engorged the latter drops from the host and lays her many eggs,

from which the larvae emerge. The larvae attach themselves chiefly around the hosts' ears and head, but frequently occur on the back between the shoulders on large animals. In nature, they occur 'mainly between the legs, along the escutcheon, belly and dewlap and sometimes on the shoulders'; on horses they often occur under the jaw and sometimes on the mane. The larvae, like the nymphs of this species, are far from being host specific, feeding on rodents in the main. The following hosts have been given by Parker & Wells (1916) and by Cooley (1938): jack rabbit (*Lepus townsendii campianus*), cotton tail rabbit (*Sylvilagus nuttalli grangeri*), striped spermophile (*Citellus tridecemlineatus pallidus*), kangaroo rat (*Peripodus montanus richardsoni*), grasshopper mouse (*Onychomys leucogaster missouriensis*), upland meadow mouse (*Microtus ochrogaster haydeni*), deer mouse (*Peromyscus maniculatus osgoodi*) and pale chipmunk (*Eutamias pallidus*), Richardson ground squirrel (*Citellus richardsonii*), flying squirrel (*Glaucomys sabrinus*), Say's ground squirrel (*Callospermophilus lateralis lateralis*), Montana hoary marmot (*Marmota caligata nivaria*), pigmy rabbit (*Brachylagus idahoensis*), weasel (*Mustela cicognani cicognani*), Abert squirrel (*Sciurus aberti aberti*), porcupine (*E. epixanthum*), prairie dog (*Cynomys ludovicianus*), etc. In fact, this wide range of hosts suggests very strongly that almost any mammal may be selected for parasitisation. The peak of larval activity occurs about July, and the nymphal activity persists through the summer.

RELATION TO DISEASE

Apart from the annoyance it must cause to animals, *Dermacentor andersoni* serves as a vector for Rocky Mountain spotted fever, Q fever, tick paralysis, tularaemia and Colorado tick fever. Rocky Mountain spotted fever is an acute specific infectious disease whose causal agent is *Rickettsia rickettsii*, a minute gram-negative organism which is to be found in ticks, the tissues of infected eggs and the lesions of patients who have contracted the disease. *Dermacentor andersoni* is the main vector in the western states of the U.S.A., except for the coastal areas and the southern area of these states. Despite the occurrence of *D. andersoni* in Canada the spotted fever associated with it is largely absent. Transmission of the rickettsiae to man is from the bite of the tick and the seasonal distribution of disease cases coincides with the activity of this arthropod vector. Usually the most susceptible subjects are ranchers, sheepherders, foresters and miners whose occupations take them into contact with animals and ticks. The mortality rate is particularly high, and in western Montana among unvaccinated and untreated cases is 65-70%.

Studies on Q fever were begun in America in 1935 when the pathogenic organism *Coxiella burnetii* was isolated from *Dermacentor andersoni*. Transmission to laboratory animals from *D. andersoni* was effectively demonstrated in the Rocky Mountain Laboratory. Despite the fact that the pathogen has been isolated from five species of ticks, as yet no human cases definitely associated with ticks are known (Kohls, 1947). Noguchi succeeded in conveying the infection of the obligatory aerobe and gram-negative Bartonella to monkeys by the bites of these ticks.

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In North America tick paralysis is due mainly to *D. andersoni* and its incidence is accordingly confined to the north-western United States and the adjoining south-western part of Canada. Paralytic symptoms in the host do not usually appear until the female ticks have fed for six days, becoming evident in the unsteadiness of the hind limbs, and the reflex actions are usually lost. The paralysis gradually ascends until the patient is completely immobilised. The pulse rate is usually accelerated and if the tick remains attached paralysis may proceed further and eventually result in death due to respiratory breakdown. Removal or cessation of feeding of the tick usually results in the disappearance of the symptoms with rarely any ill effects. Recovery generally takes place within a few hours of the removal of the tick. Man is susceptible to the disease following tick bite and about 250 cases have been recorded from British Columbia and 100 from the United States (Gregson, 1952). In these the respective fatalities were twenty-seven and twelve. Sheep, dogs and man can be paralysed by the bite of one infected tick, but cattle appear to be tolerant of large numbers of these ticks but become paralysed if heavily infested. In an interesting review of tick paralysis Gregson (1952) has shown that the concentration of infection is restricted to the north-west area of the distribution of *D. andersoni* and includes British Columbia, south-east Saskatchewan, eastern Alberta and the Rocky Mountain States. The reason for this limitation is not clear. Moreover, Jellison & Gregson (1950) have shown that the geographical areas affected with paralysis do not produce the Rocky Mountain spotted fever. The excellent work of Gregson has not, as yet, elucidated the cause of tick paralysis but from his present results he suggests that the occurrence of tick paralysis in an animal depends on a combination of host susceptibility and tick virulence.

Tularaemia, a specific infectious disease of rodents caused by *Bacterium (Pasteurella) tularensis* (from group agglutination tests it appears that this is closely related to the *Brucella* group) was found by Parker, Spencer & Francis (1924) in *Dermacentor andersoni*. This tick could then act as a host and a vector of the disease in rats and man. Moreover, they demonstrated that hereditary transmission takes place in this species.

Dermacentor albipictus Packard, 1869

Figs. 140-56

SYN., LIT. AND ICON.

- 1868 'Moose tick' Hays & Packard (Dec.): no scientific name.
1869 *Ixodes albipictus* Packard (between January and July), p. 65, refers back to the record of the 'moose tick' (1868); 1869 figure (fig. 61) of engorged female and larva in *American Naturalist*; 1869 figure of female repeated (fig. 638) in *A Guide to the study of Insects*, pt. 10, p. 662.
1869 *Ixodes nigrolineatus* Packard: original description p. 66. *Original description*: 'Female. Body oblong oval, sides very straight, not arcuated, being much more oblong, with much straighter, less curved sides than in *I. variabilis*, while the body increases in width to the end; it is much thicker. Head not as wide as in *I. variabilis*, depressed

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centrally, with the sides much thickened and ending in an unusually stout thick obtuse spine, tipped with black; palpi and beak of the same length, both being short and small; palpi ovate, broad at end, second joint shorter than first. Thoracic shield not distinct; the convexity and impressed lines observed in the two species are obsolete, there being a slight convexity just behind the head. Body behind irregularly spotted and lineated with irregular faint linear black lines, being transverse in the middle of the body, while posteriorly there are three longitudinal parallel faint black lines, the surface is smooth, polished with scattered punctures, becoming rather dense behind. Hinder edge with slight ridge, incised by about ten abbreviated rather indistinct lines. Beneath the body is paler, legs concolourous with the body, short and thick, much more so than in *I. variabilis*. The colour of the single specimen, which is dry, is a deep blood red. Length 0.16 of an inch, breadth 0.10 inch.' This description is that of a female specimen, but Packard's type is a male (Bequaert, 1946).

- 1897 *Dermacentor variegatus* Marx & Neumann: Neumann, pp. 367-70, figs. 22-4, male, female.
- 1901 *Dermacentor variegatus* Marx & Neumann: Salmon & Stiles (for 1900), pp. 452-4, figs. 178-85, male and female.
- 1901 *Dermacentor reticulatus* Fabricius: Salmon & Stiles (for 1900), p. 448.
- 1907 *Dermacentor nigrolineatus* Packard: Banks, p. 608.
- 1907 *Dermacentor albipictus* Packard: Banks, p. 608.
- 1907 *Dermacentor albipictus* Packard: Hunter & Hooker, p. 51.
- 1908a *Dermacentor albipictus* Packard: Banks, pp. 44-5, pl. VII, figs. 5, 9, 11; pl. X, fig. 11 (male, female).
- 1908a *Dermacentor nigrolineatus* Packard: Banks, pp. 48-9, pl. VIII, figs. 3, 9, 11.
- 1910 *Dermacentor nigrolineatus* Packard: Stiles, pp. 51-5.
- 1910 *Dermacentor albipictus* Packard: Jarvis, p. 97.
- 1910 *Dermacentor albipictus* Packard: Stiles, p. 60, figs. 37-9, 67, 68, 80, 97, 98, 116, 117, 133 (male, female, nymph).
- 1910 *Dermacentor salmoni* Stiles: original description, pp. 55-6, figs. 26-36, 65, 66, 79, 95, 96, 114, 115, 131, 132 (males, females, nymphs); hosts: cattle, horse.
- 1910a *Ixodes oregonensis* Stiles, p. 60 (quoted as a manuscript label of specimens of *D. salmoni*, no locality data).
- 1911 *Dermacentor variegatus* 'Marx': Neumann, p. 101, male, female.
- 1913 *Dermacentor nigrolineatus* Packard: Bishopp & Wood, pp. 180-6.
- 1913 *Dermacentor albipictus* Packard: Bishopp & Wood, p. 161, 1 map.
- 1915 *Dermacentor albipictus* Packard: Hewitt, p. 231, pl. II, figs. 5-6.
- 1927 *Dermacentor albipictus* Packard: Cameron & Fulton, p. 248, figs. 1-8 (male, female, nymph, larva).
- 1933 *Dermacentor varius* Schulze, p. 424 (proposed new name for *Dermacentor variegatus* of Neumann, 1897).
- 1938 *Dermacentor albipictus* Packard: Cooley, pp. 59-64, pl. XV, XVII, figs. 1-7, fig. 7, pl. II, fig. 12.
- 1938 *Dermacentor albipictus* form *nigrolineatus*; Cooley, pp. 59-64, pl. XVI.
- 1945 *Dermacentor albipictus* Packard: Bishopp & Trembley, p. 13, fig. 5.
- 1945 *Dermacentor nigrolineatus* Packard: Bishopp & Trembley, p. 31.
- 1946 *Dermacentor erraticus* typical (Say): Bequaert, pp. 173-5.
- 1946 *Dermacentor erraticus* var. *albipictus* (Packard): Bequaert, pp. 175-80.
- 1950 *Dermacentor albipictus* (Packard): Brown & Kohls, p. 198.
- 1956 *Dermacentor albipictus* (Packard): Gregson, pp. 31-2.

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This species presents a problem to the systematist as it appears to exist in two 'forms'. In one 'form' the scutum has extensive and somewhat iridescent white enamel markings, or is mostly white streaked or spotted with brown. Blotches of white are also apparent on the basis capituli, the palps and the legs. In the other 'form' the markings are much reduced, faint or lacking and in the male the dorsal integument is transparent, and the apparent black pattern is due to the gut diverticulae showing through. The basis capituli, palpi and legs are not blotched with white. Until Cooley's work in 1938 these two forms were considered as distinct species, the former being known as *Dermacentor albipictus* Packard, 1869 and the latter as *D. nigrolineatus* Packard, 1869. As *D. albipictus* has page priority over *D. nigrolineatus*, the latter has been sunk in synonymy with the former. No consistent or reliable differences, either biological or morphological, appear to separate these two forms which evidently belong to one species. Cooley considers the variant *nigrolineatus* with its black or dark lines to be a weakened strain of the species. However, according to Bequaert (1946) the two 'forms' are geographically distinct, as the white marked 'form' has a more northerly distribution than that of the 'form' with black lines. Whilst both 'forms' have been collected within the same geographical regions, Cooley (1938) recorded intergrades in both colour and morphology from California and western New Mexico, the form *nigrolineatus* having been found more frequently in the south.

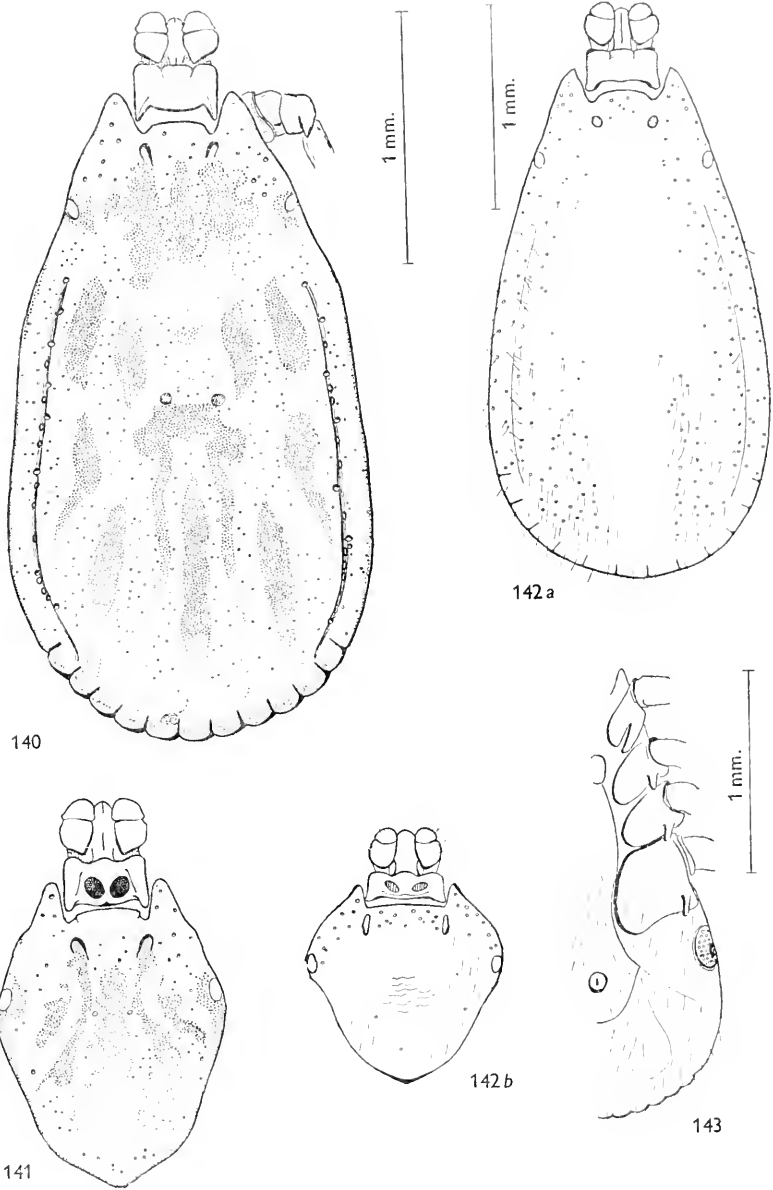
Bequaert (1946) did not accept Cooley's interpretation completely, but accepted Banks's (1908*a*) suggestion and reduced *nigrolineatus* Packard to synonymy with *D. erraticus* (Say) 1821. Bequaert felt 'certain that Say's description could be no other' and made Packard's *albipictus* a variety of *erraticus*. The original description of *erraticus* is given as an *Ixodes* tick, but no sex is indicated although it is evidently a male from the south-eastern United States. The following is the original description:

'Body oblong-ovate, gradually narrowed before, sides hardly arquated, with distant punctures, those behind more deeply impressed, posterior margin with ten or twelve impressed lines which are abbreviated by a submarginal impressed line, two abbreviated lines before; head, posterior edge transversely rectilinear, angles extended backward abruptly, and sub-acute; rostrum rather short; palpi oval-orbicular; the colour is reddish or ferruginous with acute black lines.'

No mention of *erraticus* is made by Cooley (1938) in his monograph on the species of *Dermacentor* of the United States. In retaining the name of this tick as *D. albipictus* I am influenced by Cooley's information on the considerable variation in colour and sclerotisation. Moreover, names dead for a hundred years, particularly those such as *erraticus* whose identity will remain in doubt, should stay that way.

MALE. Body broadly rounded behind, quite strongly narrowed anteriorly. Length of *albipictus* 'form' 3·1-4·5-5·9 mm., width 1·8-2·8-4·0 mm.; *nigrolineatus* 'form', length 2·6-3·2-4·3 mm., width 1·7-2·0-2·8 mm. Base colour brown, pattern colour grey with more highly ornamental species 'iridescent'.

Capitulum. Broader than long, posterior and lateral margins almost straight.



Figs. 140-3, *Dermacentor albipictus*. 140, dorsum of typical male; 141, capitulum and scutum of typical female; 142a, dorsum of 'nigrolineatus' form; 142b, capitulum and scutum of female of 'nigrolineatus' form; 143, venter of 'nigrolineatus' form.

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Cornua elevated, well developed, variable in length in the forms of '*albipictus*' and '*nigrolineatus*', apically rounded or subacute (fig. 144). Lateral edge of basis steep and well supplied with a number of short broad hairs. Surface smooth, depressed between bases of cornua; punctations distinct, faint or absent, number of fine short hairs present. Palpi short, length of article 2 about 0.26 mm., broad distally, length of article 3 about 0.18 mm., breadth at the junction of articles 2 and 3, 0.31 mm. Postero-dorsal ridge abbreviated and rounded posteriorly. Hairs on inner margin of article 2 sparse, becoming more abundant along corresponding margin of article 3; outer margins of articles 2 and 3 well supplied with hairs. Pattern colour extensive on the basis and palpi in well-ornamented forms but lacking colour in '*nigrolineatus*' forms. In ventral view basis (fig. 145) with straight posterior margin, lateral margins rectilinear, postero-lateral margins broadly rounded: surface with few punctations and with pronounced depression to the base of the hypostome (stippled in fig. 145).

Scutum. Length about 2.45 mm., breadth about 1.35 mm. Elongate oval, broadest slightly in front of anterior festoons, tapers appreciably to scapulae; posterior margin rounded. Cervical grooves shallow, short; lateral groove indistinct or only faintly visible, limited to short distance in front of anterior festoons, otherwise indicated by scattered punctations. Punctations of different sizes, some small, others large, well separated; smaller punctations more visible in areas of grey pattern colour; large punctations with short white hairs. Pattern colour continuous, base colour visible for the most part in stripes or spots but variable in definition and extent; pseudoscutum in ornate specimens clearly shown by the pattern; pattern colour continues marginally, but rimmed by a narrow line of base colour; festoons with liberal spots of brown more particularly the median and submedian ones (fig. 140).

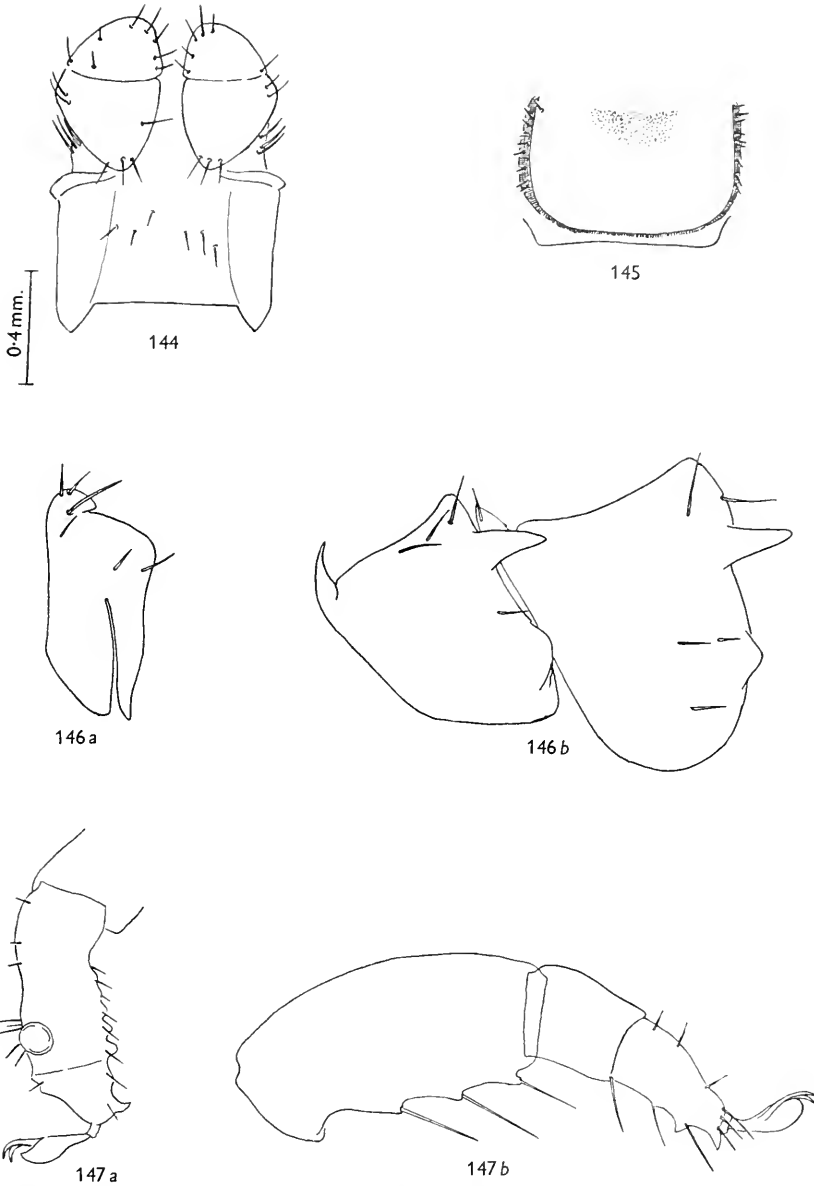
Legs. Pattern colour well marked in more ornate forms; upper surface of legs well supplied with moderately long hairs. Dorsal spur on trochanter I long, broad basally and pointed. All coxae convex, density of hair cover increasing from coxae I to IV; coxa I triangular, with internal spur broad and rounded distally, external spur narrower and tapering to a rounded tip, basally contiguous and separated only by a narrow subparallel gap, both spurs about equal in length. Posterior face of coxa I, near base of external spur, supplied with six long hairs. External spurs on coxa II long and tapering, internal spur short, broad and rounded; external spurs on coxa III about as long as those on II, internal spur with a tendency to be pointed, less broad than corresponding spurs on coxa II; external spurs of coxa IV long but thinner than on preceding coxae; internal spurs lacking on coxa IV.

Spiracular plate. Goblets always large and few in number; somewhat variable in shape; dorsal prolongation may be faintly indicated or absent. The variability of this structure in *D. albipictus* prohibits its use as a diagnostic character.

FEMALE. Elongate oval when unengorged, widest across the level of the spiracle and narrowing gradually to the scapulae. Base colour brown, pattern colour grey.

Capitulum. Basis capituli about twice as long as broad (average dimensions of fifty

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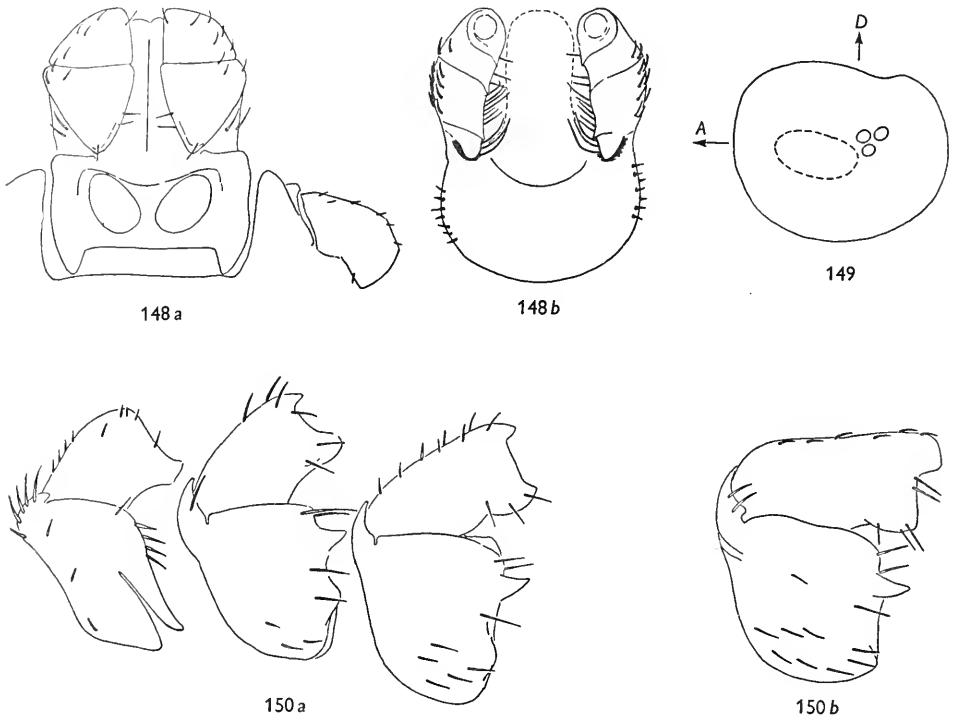


Figs. 144-7, *Dermacentor albipictus*. MALE: 144, capitulum, dorsal; 145, basis capituli, ventral; 146a, coxa I; 146b, coxae II and III; 147a, tarsus I; 147b, tarsus and metatarsus IV.

specimens, 0.43×0.23 mm.). Posterior margin straight, cornua variable in length and either subacute or rounded apically (fig. 148a), relatively shorter than in the male. Lateral margins almost straight. Porose areas large, obliquely placed relative to the long axis, depressed. In front of the porose areas a short, steep ridge leading by a gentle slope to the cheliceral foramen. Lateral margins and cornua elevated relative

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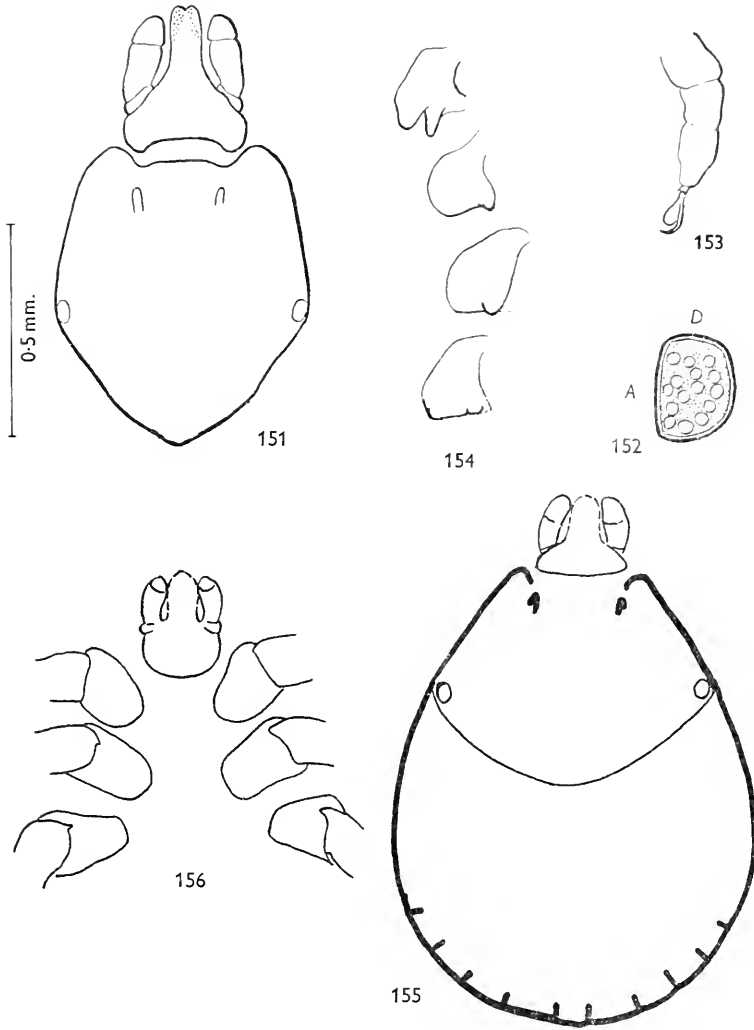
to the region around the porose areas. Palpi short, broad and apically rounded; length of article 2 about 0.35 mm., article 3 about 0.21 mm.; outer margins gently convex, inner margins of each palpal article almost straight; postero-dorsal ridge moderate with rounded margins. Few short hairs on basis, those on palpi longer with few scattered punctations. In ventral view postero-ventral ridge as a curved salience bearing strong, short spinose hairs laterally. Surface convex. Pattern colour on 'albipictus' forms.



Figs. 148-50, *Dermacentor albipictus*. FEMALE: 148a, capitulum, dorsal; 148b, capitulum, ventral; 149, spiracle; 150a, coxae I-III; 150b, coxa IV.

Scutum. Longer than wide (average length of forty-three specimens 1.25 mm., maximum breadth 0.9 mm.), greatest breadth at about the level of the eyes. Scapulae very long, bluntly rounded, emargination well defined. Antero-lateral margins convex or undulate, postero-lateral margins subangulate, posterior margin rounded, portion behind the eyes narrower than in other American species. Cervical grooves shallow, short, but according to Cooley (1938) in some specimens 'they extend caudad in narrow, shallow grooves that first converge and then diverge and terminate before reaching the postero-lateral margins'. Base colour consists of a median, irregular longitudinal strip; from the short semicircular cervical grooves two irregular and

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Figs. 151-6, *Dermacentor albipictus*. 151-4, NYMPH: 151, capitulum and scutum; 152, spiracle; 153, tarsus I; 154, coxae I-IV. 155-6, LARVA: 155, dorsum; 156, ventral view of capitulum and coxae I-III.

frequently broken strips of base colour extend back for about two-thirds scutal length, two divergent bars parallel and lateral to these markings. Frequently the base colour extends around the eye spots and peripherally. Pattern colour usually more extensive than base colour. Punctations of two sizes, larger ones more abundant in the lateral areas, smaller ones uniformly distributed and more clearly visible in regions of pattern colour.

Legs. Relatively narrower than in the male. Coxae broad. Spurs on coxa I variable in length, the external spur generally slightly shorter than internal spur, their inner margins parallel or only slightly divergent; their apices rounded. External spurs on

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coxae II, III, IV well developed, about twice as long as broad, narrowing apically; internal spurs on coxae II and III broad basally with tendency to being pointed, internal spur on coxae IV represented in some specimens by a marginal salience.

Spiracular plate. Much as in male. Dimensions about 0.45×0.37 mm.

Postscutal area. Marginal grooves distinct and emphasised by lines of punctations; two anterior festoons on each side delimited by the marginal grooves.

NYMPH. Unfed nymphs very long and narrow measuring about $1.3-1.7$ mm. \times $0.79-0.85$ mm. Fed nymphs also long-bodied.

Capitulum. Basis capituli more than twice as broad as long, subquadrate and lacking the lateral points of other North American species. Posterior margin concave. Cornua may or may not be present. Ventral surface arcuate, basalspurs faint and narrow.

Scutum. Slightly longer than broad, 0.60×0.57 mm. (in thirty-five specimens as $1.17:1.0$); sides curved with posterior margin pointed. Scapulae broadly rounded. Cervical grooves lacking or very faint. Eyes situated behind mid-length. Festoons ill-defined.

Legs. All coxae broad. Internal spurs on coxa I small, weak, pointed; those on II or III faint or lacking; absent on coxa IV. External spurs on coxa I rounded apically and prominent; external spurs on coxae II and III faint but distinct, those on IV variable in development.

Spiracular plate. Placed far back. Subcircular, length 0.2 mm., breadth 0.18 mm. Goblets large and few in number.

LARVA. Body shape of unfed larva subcircular, length about 0.60 mm., breadth 0.55 mm. Basis capituli lacking cornua and lateral points of other North American species. *Scutum* broader (0.39 mm.) than long (0.24 mm.), widest behind mid-length, eyes placed at the greatest width. Coxa II larger than III; lacking coxal spurs.

BIOLOGY

Packard's (1869) original specimens of *albipictus* were collected from moose and later, as *D. nigrolineatus*, from a deer (*Cervus virginianus*). As *albipictus* it has been recorded from moose and beaver 'as *nigrolineatus* from deer and horse and as *salmoni* on horses and cattle'. Additional hosts quoted are the elk (*Cervus canadensis*), *Odocoileus virginianus texanus*, *Odocoileus hemionus*, antelope (*Antilocapra americana americana*) and the Rocky Mountain sheep (*Ovis canadensis*).

The red-brown tick, *Dermacentor albipictus*, has been recorded from the following states in America: New York, Pennsylvania, Wisconsin, Tennessee, Oklahoma and Texas, particularly in hilly country where there is much wood and shrub. The type host is a moose, but this tick also occurs on horses and cattle, the former being heavily infested. The larvae of this tick occur on the hosts in late autumn and persist on the same hosts either as larvae or nymphs through the winter. During this period metamorphosis takes place on the host. Adults emerge from these nymphs in early spring. *D. albipictus* is a one-host tick, i.e. the life-history is completed on one host

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and when detached in an engorged condition either as a larva or nymph development is slow and imperfect. The female, on completion of engorgement, drops to the ground and a long preoviposition period follows, lasting 5–6 months. The number of eggs laid by females ranges from 2500 to 3000 eggs, and the egg-laying period is about 20 days. The oval eggs are yellow-brown in colour and for some days prior to hatching the developing appendages can be seen through the translucent shell. Their development, like that of other ticks, is considerably influenced by temperature and humidity—the higher the temperature and the greater the relative humidity, the shorter the period of incubation. Thus within the temperature range of 74–78° F. the incubation period varies from 55 to 37 days. Initially the emergent larvae are sluggish before becoming active and gregarious. During this period of activity there are, however, long periods of quiescence. Spring-hatched larvae apparently aestivate during the summer, becoming ready for feeding in the autumn. The larval feeding period, including the initiation of moulting, lasts for about 10 days. Nymphs emerge from the larval exuviae and move a short distance, where they remain until the integument is tanned when they attach and start feeding. Frequently the occurrence of this species is not detected on the host until the nymphs have engorged. In this stage they are blue-grey or dirty white in colour and about the size of a rice grain. From the nymph the adult emerges and at first both extremities are yellowish brown, with the rest of the body of a deeper pigmentation. Copulation occurs on the host after 3–4 days.

DISEASE RELATIONSHIPS

Wallace, Cahn & Thomas (1933) believe that *D. albipictus* is the vector of various pathogens of big game and that it is responsible for severe losses among deer and moose.

Dermacentor dissimilis Cooley, 1947

Figs. 157–71

SYN., LIT. AND ICON.

- 1938 *Dermacentor nigrolineatus* Packard; Bequaert, pp. 233–8. Incorrect identification (see below).
- 1947 *Dermacentor dissimilis* Cooley. Original description based on six females and two nymphs, southern Mexico. Pp. 1–3.
- 1952 *Dermacentor dissimilis* Kohls & Dalmat. Males described from six specimens (and thirteen females) from horses, Zongolica, Veracruz, Mexico. Pp. 140–2. Reports that *D. nigrolineatus* of Bequaert (1938) refers to *D. dissimilis* as evidenced by a female in the Rocky Mountain Laboratory collection bearing the same collection data.

FEMALE (based on Cooley's 1947 description). Body ovate. In slightly fed females length about 2.9–3.0 mm., greatest width at the middle 1.65 mm. Fully fed specimens 10 × 7 mm.

Capitulum. Basis nearly twice as broad as long, lateral margin straight, becoming broadly rounded postero-laterally before passing into the cornua. Cornua rounded, about as long as basal width (fig. 157). Porose areas oval, depressed and with their

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longer axes divergent anteriorly. Palpi short, broad, palpal article 2 slightly longer than article 3; postero-dorsal ridge prominent; apex of article 3 broadly rounded. Ventral view (fig. 158), basis convex, posterior margin bluntly rounded. Inner palpal faces mildly grooved; article 3 with a mild retrograde spur. Hypostome broad (fig. 159), about 0.3 mm. long; dentition in majority of specimens 4/4, less frequently it was 3/4 or 4/3 or $3\frac{1}{2}/3\frac{1}{2}$. Length of capitulum from tip of hypostome to tip of cornua, 0.55–0.61 mm., width of basis, 0.54–0.57 mm. Some pattern colour may be present on palpi and basis.

Scutum. Length 1.20–1.32 mm., width 1.10–1.14 mm. Widest anteriorly with mild antero-lateral extensions, the eyes (when present) at its maximum width. Postero-lateral profile lines distinctly concave, subangular along the posterior border. Scapulae long, bluntly pointed (fig. 157). Cervical grooves widely separated, moderately deep; punctations moderate in size and number. Eyes distinct, absent or obsolescent and not easily found. Pattern colour dirty white and variable in extent. Few short hairs.

Legs. Pattern colour on dorsal surface of legs. Dorsal spur on trochanter I conical and distinct (fig. 157); tarsus I with ventral apical spur, II and III with apical and subapical spur, IV with an apical and two subapical spurs (figs. 161, 162). Length of tarsus I, 0.48 mm., metatarsus I, 0.36 mm., tarsus IV, 0.48 mm., metatarsus IV, 0.39 mm. Coxa I bifid, wide internal spur, external spur not reaching apex of internal spur, divergent; coxae II, III and IV, with external spurs; internal spurs absent on coxae II–IV (fig. 158).

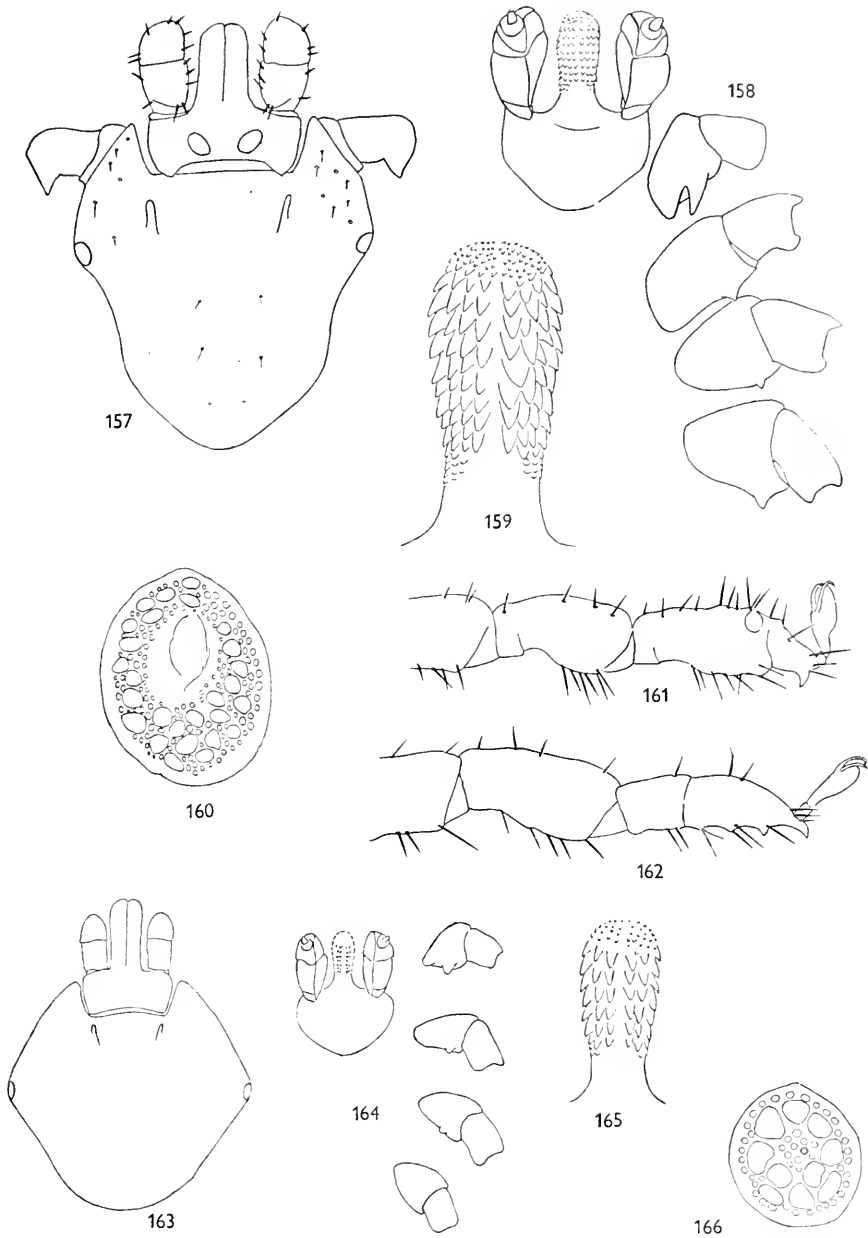
Spiracular plate (fig. 160). Subcircular; greatest width 0.33 mm.; goblets few and relatively large.

Genital aperture. At the level of the intercoxal space between coxae II and III.

MALE (mainly after Kohls & Dalmat, 1952). Shape suboval, widest just in front of the spiracular plates. Base colour brown, with grey pattern colour varying in distinctness and extent in individual specimens; pattern colour usually confined to the scutum, but may be faintly present on dorsum of basis capituli and on legs. Length from humeral angles to posterior border, 2.15–2.50 mm., breadth 1.56–1.85 mm.

Capitulum. Basis wider than long, lateral margins straight and parallel; postero-lateral angles merging with cornua and broadly rounded (fig. 167). Posterior margin concave; punctations and hairs present. Cornua subacute and about as long as their basal widths. Palpi short, broad and rounded apically, postero-dorsal angle only moderately developed. Ventrally basis broad and convex (fig. 168*a*), posterior margin more or less straight. Palpal article 3 with a mild retrograde spur. Hypostome, lateral profile lines nearly parallel, apex undulate as figured (fig. 169). Variable dentition, most specimens 3/3, fewer specimens 4/4; in about 25% of the specimens $3\frac{1}{2}/3\frac{1}{2}$ or 3/4 to 4/3. Length 0.27 mm.

Scutum. Narrows more strongly in front; cervical grooves represented by indistinct pits or shallow depressions in the anterior region. No lateral grooves. Punctations variable in size, number and distribution, more numerous and larger in lateral and

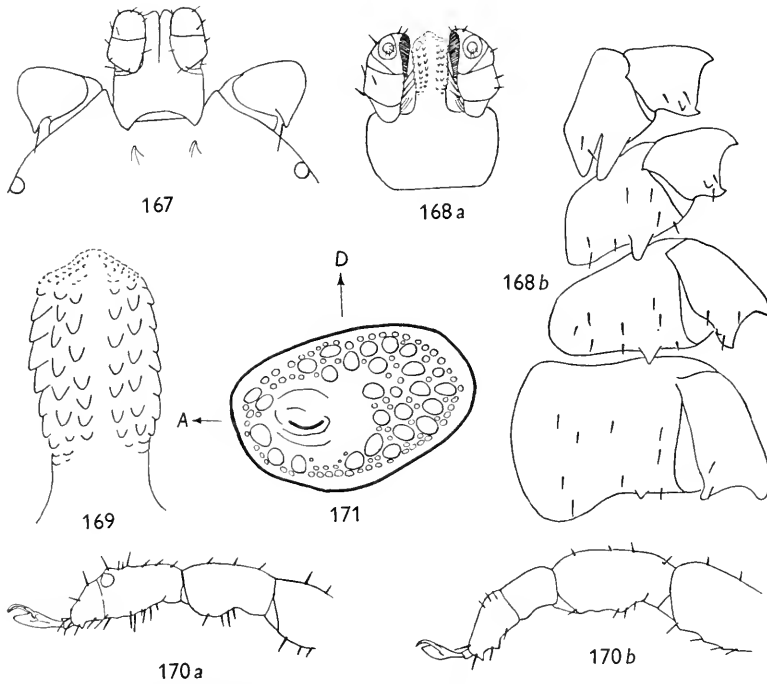


Figs. 157-66, *Dermacentor dissimilis*. 157-62, FEMALE: 157, capitulum and scutum; 158, ventral view of basis and coxae I-IV; 159, hypostome; 160, spiracle; 161, tarsus and metatarsus I; 162, tarsus and metatarsus IV. 163-6, NYMPH: 163, capitulum and scutum; 164, capitulum in ventral view and coxae I-IV; 165, hypostome; 166, spiracular plate. (After Cooley, 1947.)

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humeral areas. Small hairs, sparsely distributed but more abundant posteriorly and laterally. Festoons 11 in number; eyes distinct, absent or obsolescent.

Legs. Coxa I bifid, with external spur shorter, broadest at the base. External spurs on coxae II-IV, few faint hairs on coxae (fig. 168*b*). Mild spurs on trochanters I-III ventrally; moderate retrograde pointed trochanter spur on leg I. Length of tarsus I, 0.44 mm., metatarsus IV, 0.44 mm. Apical and subapical spurs on tarsus IV (figs. 170*a, b*).



Figs. 167-71, *Dermacentor dissimilis*. MALE: 167, capitulum; 168*a*, capitulum, ventral; 168*b*, coxae I-IV; 169, hypostome; 170*a*, tarsus and metatarsus I; 170*b*, tarsus and metatarsus IV; 171, spiracle. (After Kohls & Dalmat, 1952.)

Spiracular plate. Elongate oval, axis more or less longitudinal, macula anterior, goblets few and large, greatest length, 0.37 mm. (fig. 171).

Genital aperture. At level of intercoxal space between coxae I and II.

NYMPH. Well-fed specimens 2.5 mm. long, 1.75 mm. wide, oval in outline.

Capitulum. Length from the tip of the hypostome to posterior border of basis 0.28 mm., width of basis 0.21 mm. Basis wider than long, no lateral points, no cornua. Surface convex with no punctations or hairs. In ventral view lateral borders broadly rounded and tapering to the posterior margin. Ventral cornua absent (present in *D. albipictus*). Palpal article I visible as a very small convex plate. Hypostome short, broad, length 0.16 mm.; dentition 3/3 (fig. 165).

Scutum. Length 0.51 mm., breadth 0.60 mm. (fig. 163). Broadly rounded behind

D. DISSIMILIS

the eyes, antero-lateral margins straight. Eyes distinct, cervical grooves short, of moderate depth. Surface crazed, punctations few, faint; no hairs.

Legs. Coxa I with two short spurs, internal spur broader than external spur (fig. 164). External spurs on coxae II and III; no spur on coxa IV.

Spiracular plate. Subcircular, small; goblets few, large, greatest breadth 0.15 mm. (fig. 166).

REMARKS

This species is of some interest as it necessitates the modification of the definition of the genus *Dermacentor*, as already indicated. The shape of the basis capituli when seen in dorsal view and the similarity of the spiracular plates suggest a close affinity with *D. albipictus*. Kohls & Dalmat (1952) have separated the male of *D. dissimilis* from that of *D. albipictus* by the absence of internal spurs on coxae II and III. The latter is more elongate, is a larger species, internal spurs are present on coxae II and III, and the hypostomal dentition is 3/3.

The neallotype of *D. dissimilis* is one of thirteen males from horse, Finca Concepcion, Acatenango, Chimaltenango, Guatemala, 30 October 1950, H. T. Dalmat coll. (RML no. 28460); deposited in the collection of the Rocky Mountain Laboratory. *D. dissimilis* is a one-host tick infesting horses and cattle (Kohls & Dalmat, 1952).

Dermacentor imitans Warburton, 1933

Figs. 172-7

LIT. AND ICON.

1933 *Dermacentor imitans* Warburton. Original description based on twelve males and one female from peccary (*Pecari angulatus*), Turrialba, Costa Rica, 1 August 1927. W. J. Hamilton leg. Pp. 59-60.

MALE. Length 4-5 mm. (including capitulum); breadth 3-3.5 mm. Specimens show pattern colour (white) in varying degree on brown base colour of scutum: markings mostly obsolescent. Most persistent markings as white patches on external festoons and also as linear markings on the scapulae. White round blotches in front of submedian festoons dimly visible in most specimens, but only few show traces of white near lateral grooves of scutum.

Capitulum. Basis rectangular, broader than long; laterally indented, posterior margin straight and salient, cornua stout and strong, about as long as basal breadth, blunt apically (fig. 172). Palpal articles 2 and 3 massive, postero-dorsal ridge weak, articles 2 and 3 of about equal length, generally broad. Hypostome spatulate, dentition 3/3.

Scutum. Narrows appreciably anteriorly, greatest width at posterior third. Cervical grooves limited to small subcircular depressions; lateral grooves well defined, beginning just behind level of rather inconspicuous eyes and ending at the anterior festoon. Punctations few, shallow, inconspicuous. Festoons well marked, short, their ventral scutes (except the median) produced into chitinous tubercles (fig. 172).

AMERICAN SPECIES OF *DERMACENTOR*

Legs. Strong, thick. Coxa I small, internal spur broad and blunt, external spur narrow and tapering, shorter than internal spur: coxae II and III with very slight outer spur; coxa IV longer than broad, with only slight bulge posteriorly, external spur very much reduced. Tarsi I and IV rather short, sloping abruptly and with two ventral spurs (fig. 175).

Spiracular plate. Very short, comma-shaped with blunt, broad dorsal prolongation, dark anterior macula but granulations very fine (fig. 176).

Anal groove. Shallow curve with very poorly defined caudal prolongation.

FEMALE

Capitulum. Basis with blunt diverging large cornua (fig. 173). Porose areas large, circular with narrow interporose areas. Palpi longer and narrower than in the male, article 2 longer than article 3.

Scutum. Broader in front of the middle, nearly circular (length 1.5 mm.) (fig. 173), nearly angular at level of inconspicuous eyes, postero-laterally subangulate. Cervical grooves indicated by small oval pits, set well apart. Marginal grooves very shallow, broad, depressions chiefly indicated by the somewhat raised lateral fold. White pattern colour limited to few linear streaks. Punctations very few and large, located particularly in marginal groove region.

Legs. As in male, except as regards coxa IV.

Spiracular plate. Small, smaller than coxa IV, outline subcircular, granulations fine (fig. 177).

RELATED SPECIES

See under *Dermacentor dispar* Cooley, 1937.

REMARKS

Type specimens deposited in the British Museum (Natural History).

Dermacentor dispar Cooley, 1937

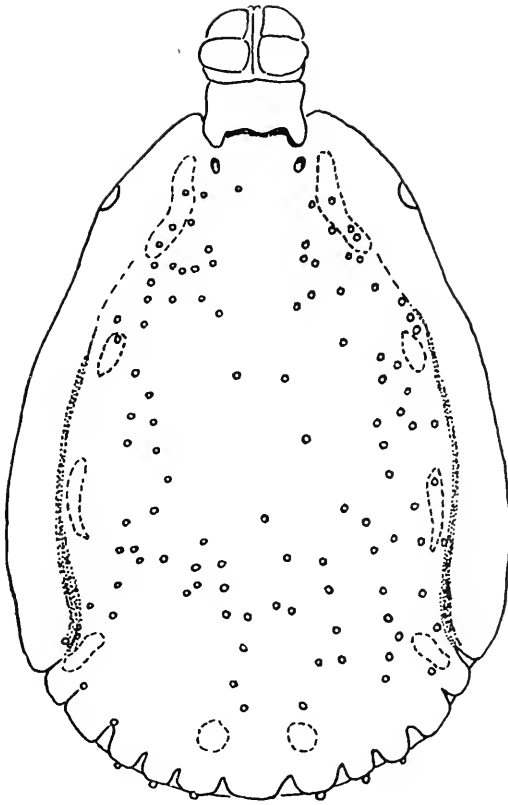
Figs. 178-81

LIT. AND ICON.

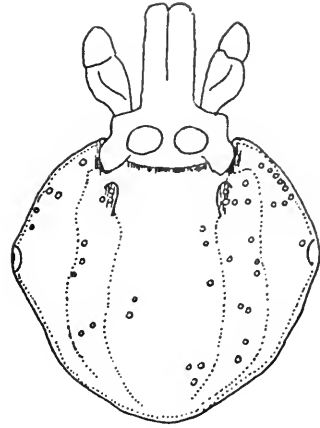
1937 *Dermacentor dispar* Cooley. Original description, p. 259.

This description is based on that of Cooley, from one male and one female from a peccary *Tayason pecari ringeus* (Merriam), at El Paso, Peten, Guatemala, S. Clark *leg.* (Deposited in the collection of the Rocky Mountain Laboratory, Hamilton, Montana, A.P. no. 12000.)

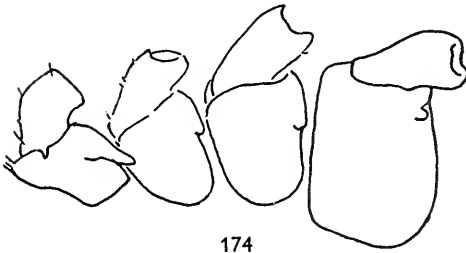
MALE. Body oval, concave on the dorsal surface, base colour amber-brown with a tan-grey pattern colour. Length from humeral angle to posterior extremity, 5.58 mm., breadth 3.78 mm.



172



173



174



175



176



177

Figs. 172-7, *Dermacentor imitans*. 172, male dorsum; 173, capitulum and scutum of female; 174, coxae I-IV of the male; 175, tarsi I and IV; 176, spiracle of male; 177, spiracle of female. (After Warburton, 1933.)

AMERICAN SPECIES OF *DERMACENTOR*

Capitulum. Basis capituli twice as broad as long, convex; posterior margin straight; cornua prominent about as long as basal breadth, rounded apically. Tan-grey colour over the dorsal surface and with numerous punctations present. Palpi short, broad; postero-dorsal ridge on article 2 moderately developed; hairs few, scattered. Punctate. Ventrally basis convex, posterior edge elevated into a salience which extends to and around the postero-lateral margins which are well rounded. Palpal article 1 with three palpal setae, article 2 with four setae, article 3 with two or three smaller setae.

Scutum. Elongate oval. Cervical grooves as deep circular pits. Lateral grooves lacking but an indication of their position by a linear arrangement of a few large punctations; bounded at the sides by definite ridges just peripherally to the linear series of large punctations, rounded over the top and reaching from the vicinity of the eyes to the spiracular plates where they cease abruptly in overhanging ends. Large punctations, few in number and more or less concentrated in the cephalic region; small punctations more numerous and clearly discernible against the tan-grey background.

Legs. Strong, smooth, glabrous, few hairs present; patches of tan-grey at the articulations on the dorsal surface. Coxae convex, glabrous with few spines. Coxa I considerably smaller than II-IV, IV of about similar size to III. External spurs present on all coxae, being long and narrow ('finger shape' of Cooley), that on I being largest and divergent, II-IV progressively smaller. Internal spur on coxa I broad, short, with the posterior edge elevated and convex; such spurs lacking on coxae II-IV (fig. 181).

Spiracular plate. Comma-shaped with very broad dorsal horn; goblets very numerous and very small (also in female).

Ventral surface. Without hairs or spines, numerous inconspicuous punctations; ventral festoons with short retrograde projections, four in number on each side of the median line.

Dorsal festoons, eleven in number, elevated and together with the lateral ridges delimiting the concave dorsum, arranged in groups of three, two and one, the latter being median; festoons in the groups are coalesced, each separated from the other by a broad deep groove.

FEMALE. The allotype female is partly engorged, and measurements as such are of little value.

Capitulum. Basis capituli flatter than in the male but still about twice as long as broad. Cornua generally similar to those of the male. The pattern colour predominant on the dorsum, few punctations present (fig. 178). Porose areas drawn out to a slight point anteriorly, long axis corresponds with that of the body. Ventral characters of the basis capituli much as in the male, but slightly longer. Palpi longer than in the male, broad, rounded at the ends, postero-dorsal elevation of article 2 prominent, tan-grey pattern colour prevails on palpi. Punctations few, scattered; short hairs.

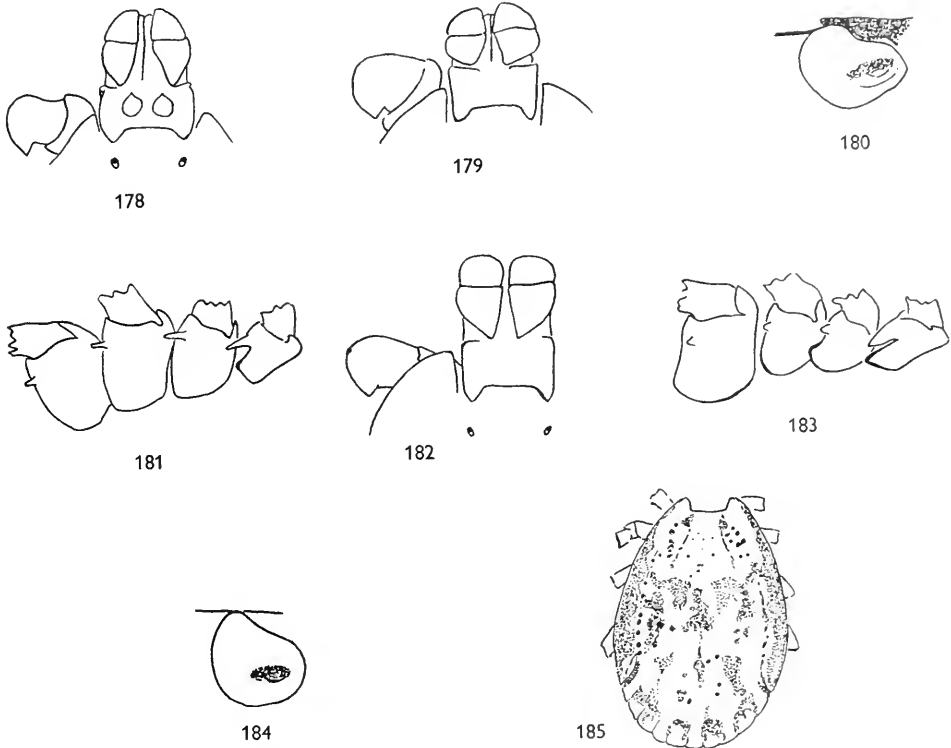
Scutum. Broader than wide, length 1.56 mm., breadth 1.8 mm. Cervical grooves

D. DISPAR

present as deep, oval pits; postero-lateral and posterior margins as a semicircle; colour predominantly tan-grey; few large punctations with more numerous small punctations; hairs lacking.

Postscutal area. Marginal grooves clearly discernible in partly engorged specimens; ten festoons (the possibility of it being a teratological specimen cannot be overlooked).

Legs. Much as in male, external spur on coxa I is longer and the external spurs on coxae II–IV are shorter.



Figs. 178–85, *Dermacentor dispar* and *D. latus*. 178, capitulum of *D. dispar* female; 179, capitulum of *D. dispar* male; 180, spiracle of male of *D. dispar*; 181, coxae I–IV of male of *D. dispar*; 182, capitulum of *D. latus* male; 183, coxae I–IV of *D. latus* male; 184, spiracle of *D. latus* male; 185, scutum of *D. latus*. (Redrawn after Cooley, 1937.)

BIOLOGY. Nothing known.

RELATED SPECIES

According to Cooley (1937) *Dermacentor imitans* Warburton is the most closely related species known, and he made the following comparisons: ‘The specimen of *imitans* has the lateral ridges much less elevated, the festoons are in units and not grouped; coxa IV is distinctly larger and external spurs on coxae II, III and IV are much shorter. The new species is larger than *imitans*; the male specimen here described being 5.58 mm., against 3.0 mm. long in *imitans*.’

Dermacentor latus Cooley, 1937

Figs. 182-5

LIT. AND ICON.

1937 *Dermacentor latus* Cooley, p. 261.

This species is described from male sent to Cooley by Professor Manuel Valerio, Director del Museo Nacional, San José, Costa Rica. Collected from a young tapir in the Province of Guanacaste, Costa Rica. (Holotype A.P. no. 10712, deposited in the Rocky Mountain Laboratory, Hamilton, Montana.)

MALE (adapted from Cooley). Oval, base colour dark amber-brown, pattern colour grey; length 4.75 mm., width 3.12 mm.

Capitulum. Basis₂capituli about twice as broad as long, posterior margin straight, cornua well developed, triangular and with subacute ends. Surface slightly concave in the median area, both large and small punctations present; grey colour on basis capituli (fig. 182). Ventrally basis convex with posterior margin salient and uplifted into a distinct edge; punctations with few short hairs ventro-laterally. Palpi with pattern colour, of moderate length, broad; postero-dorsal angle pronounced, elevated diagonal margin well defined to the lateral margin of the palp. Ventrally palpal setae on articles 1, 2 and 3 with few other hairs and punctations on the ventral and lateral surfaces.

Scutum (fig. 185). Elongate oval but tapering more strongly anteriorly; colour consists of continuous lines and stripes which border amber-brown spots; the limits of the pseudoscutum are indicated by the grey pattern colour present also on the lateral borders of all festoons. Cervical grooves as deep, oval pits in the cervical region; no lateral grooves, their positions occupied by a linear series of moderately large punctations, not in perfect alignment. Punctations of two kinds, large deep ones widely scattered including some on festoons, and numerous small ones, more clearly discernible on the grey background.

Legs. Of moderate length and breadth, with a few short hairs and small punctations on the dorsal surface; grey only evident in the alcoholic holotype specimen on the distal extremities of the femora and tibiae of legs II, III and IV. Coxae with few spines, coxa I with both internal and external spurs very prominent, proximal edges nearly parallel with rounded extremities; internal spur much longer than external spur, latter slightly curved. External spurs on coxae II-IV successively smaller but each one approximately about as long as the basal breadth; internal spurs on coxae II and III broad, short, rounded; internal spur on IV absent.

Spiracular plate. Comma-shaped, with broad dorsal horn directed at about 90° from the long axis of the macula, very numerous and very small goblets (fig. 184). Eleven festoons, well developed.

FEMALE. Not known.

BIOLOGY. Nothing known.

D. LATUS

RELATED SPECIES

Cooley (1937) stated that males of *D. marginatus* resemble this species in certain respects but differ from it on some points. *D. latus* is, in dorsal view, considerably broader in the anterior region than *D. marginatus*. The former also lacks lateral grooves, has shorter palps and a basis capituli which is markedly broader than long. The spiracular plate in *D. latus* is wider than in the male of *D. marginatus* and has a less attenuated dorsal horn.

CHAPTER IV

THE GENUS *DERMACENTOR*: 3.
EURASIATIC SPECIES

Key to the males

(The male of *Dermacentor pomerantzevi* is not known.)

- | | | |
|----|--|--|
| 1 | Coxa IV not elongated antero-posteriorly. | 2 |
| | Coxa IV elongated antero-posteriorly. | 4 |
| 2 | Coxae not increasing in size from legs I to IV. | <i>D. antrorum</i> |
| | Coxa IV increasing in length meso-laterally. | 3 |
| 3 | Palpi longer than basis; spiracular plate ovate with short narrow tail; external and internal spurs of coxa I well separated. | <i>D. auratus</i> |
| | Palpi not markedly longer than basis; spiracular plate with broader tail; external and internal spurs of coxa I separated by narrow parallel-sided fissure. | <i>D. taiwanensis</i> |
| 4 | Tibia and metatarsus each supplied with one large apical ventral spur in addition to smaller spurs. | <i>D. pavlovskyi</i> |
| | Tibia and metatarsus lacking large apical ventral spur, but usually with the smaller projections arranged in pairs. | 5 |
| 5 | Palpal article 2 with a distinct caudally directed spur on its outer dorsal margin and whose length considerably exceeds its basal breadth. External spur on coxa I very large and making coxa I larger than coxa II. | 6 |
| | Palpal article 2 either with or without a spur on the outer dorsal margin, but if a spur is present its basal breadth exceeds its length. External spur on coxa I not sufficiently large to make coxa I larger than coxa II. | 7 |
| 6 | Surface smooth and glossy. Spiracular plate with fine granulations. | <i>D. reticulatus</i> |
| | Surface covered with confluent punctations of various sizes, giving the surface a rough appearance. Spiracular plate with larger central granulations. | <i>D. asper</i> |
| 7 | Spiracular plate round and lacking the dorsal prolongation. Scutum completely covered with white pigment. | <i>Dermacentor albipictus kamshadalu</i> |
| | Spiracular plate with well-defined dorsal outgrowth. | 8 |
| 8 | Spurs on coxa I widely divergent. | 9 |
| | Spurs on coxa I either parallel or slightly divergent. | 10 |
| 9 | External spurs on coxae II-IV relatively long and narrow; external spur on coxa I as long as internal spur; postero-dorsal ridge broadly rounded (Tibet). | <i>D. everestianus</i> |
| | External spurs on coxae II-IV relatively short and broad; external spur on coxa I shorter than internal spur; postero-dorsal ridge sharply angled (China). | <i>D. sinicus</i> |
| 10 | Strongly thickened margin at the base of the dorsal prolongation of the spiracular plate (fig. 253 <i>b</i>). | 11 |
| | No thickening of margin of the spiracular plate at the base of the dorsal prolongation. | 13 |
| 11 | Cornua strong; scutal ornamentation well defined; prevailing punctations superficial; second palpal segment has relatively well-defined spur on its postero-dorsal aspect; external spur of coxa IV long and narrow. | 12 |

KEYS TO SPECIES

- Cornua moderate; scutal ornamentation ill defined; punctations mixed, being both large and small; second palpal segment with weakly defined spur on its postero-dorsal aspect; external spur of coxa IV shorter and broader. *D. marginatus*
- 12 Cornua narrow to the tips. Spiracular plate elongate oval, postero-ventral edge gently curved and continuous with short, wide dorsal prolongation. Scutal pigmentation as large blotches of mixed base and pattern colour. *D. niveus*
 Cornua long, parallel sided and bluntly rounded at the tip. Spiracular plate elongate oval, postero-ventral edge quite sharply angled and leading to long, narrow dorsal outgrowth. Scutal pigmentation almost entirely pattern colour except for narrow bands of base colour. *D. raskemensis*
- 13 Dorsal prolongation of spiracular plate wide and reaches to the edge of the scutum: trochanter I with prominent dorsal spur. *D. silvarum*
 Dorsal prolongation of spiracular plate narrow and not reaching edge of the scutum: trochanter I with poorly developed dorsal spur. **14**
- 14 External spurs of coxa IV short and not protruding beyond the edge of the coxae. Festoons of approximately similar size. *D. nuttalli*
 External spurs of coxa IV long and protruding beyond the edge of the coxa. Festoons unequal, being widest in the anterior festoons, and narrowing progressively to the median one. *D. coreus*

Key to the females

(Females of *D. asper*, *D. raskemensis* and *D. albipictus kamshadalus* are not known.)

- 1 Tibia and metatarsus each supplied with strong, ventral apical spur. *D. pavlovskyi*
 Tibia and metatarsus not supplied with such spurs. **2**
- 2 Second palpal article has a clearly defined spur marginally on the postero-dorsal surface, whose length is equal to or greater than its basal width. Palpi angular laterally. Genital aperture without wing-like extensions. *D. reticulatus*
 Second palpal article lacking such a spur or if present not as strongly developed. Palpi not as strongly angular and usually arcuate laterally. Genital aperture with or without wing-like extensions. **3**
- 3 Coxa IV with both external and internal spurs. **4**
 Coxa IV without internal spurs. **5**
- 4 Coxae with external and internal spurs well separated (fig. 326). *D. auratus*
 Coxa I with external and internal spurs not well separated although the spurs diverge (fig. 363). *D. taiwanensis**
- 5 Porose areas normal, palpal article 2 not drawn out to a point meso-dorsally. **6**
 Porose areas fused to form crescent-shaped depression which is concave anteriorly: palpal article 2 drawn out to a point posteriorly. *D. antrorum*
- 6 Basis capituli three times as broad as long: ventral spurs present on the basis (fig. 309). *D. pomerantzevi*
 Basis capituli not three times as broad as long: ventral spurs lacking on the basis. **7**
- 7 Basis capituli lacking cornua completely. **8**
 Basis capituli with cornua variably developed. **9**
- 8 Tarsi strongly dilated: strong spurs lacking on ventral surface of leg segments; palpi not strongly protuberant laterally. *D. sinicus*
 Tarsi not strongly dilated: strong spurs present on ventral surface of leg segments; palpi moderately protuberant laterally. *D. nuttalli*

* I have not examined specimens of *D. taiwanensis*, and it may well prove to be a synonym of *D. auratus*. The separation given above is based on Sugimoto's description and figures.

EURASIATIC SPECIES OF *DERMACENTOR*

- 9 Genital opening supplied with wing-like lateral extensions. 10
 Genital opening lacking wing-like lateral extensions. *D. coreus*
- 10 Chitinous edge of peritreme forms a strong thickening at the base of the dorsal prolongation of the spiracular plate. 11
 Chitinous edge of peritreme does not form a strong thickening at the base of the dorsal prolongation of the spiracular plate. 12
- 11 Scutum entirely covered with pattern colour except for narrow bands of base colour along the cervical grooves and around the eye. Trochanters lacking ventral spurs. *D. niveus*
 Base colour more extensive in the region of the eyes, cervical grooves and median field. Trochanters II and III with small ventral spurs. *D. marginatus*
- 12 Pattern colour almost completely covering the scutum except for cervical grooves and immediately around the eye; posterior and postero-lateral margins of scutum subangulate (fig. 268). Absence of postero-dorsal spur on palpal article 2. External spur of coxa IV does not project beyond posterior margin of coxa. *D. everestianus*
 Pattern and base colour about equally extensive and typical as in fig. 209; posterior and postero-lateral margins of scutum rounded; rudimentary spurs on postero-dorsal surface of palpal article 2; external spur of coxa IV reaches beyond posterior margin of coxa IV. *D. silvarum*

Dermacentor reticulatus Fabricius, 1794

Pl. I, figs. 1, 2; Figs. 186–200

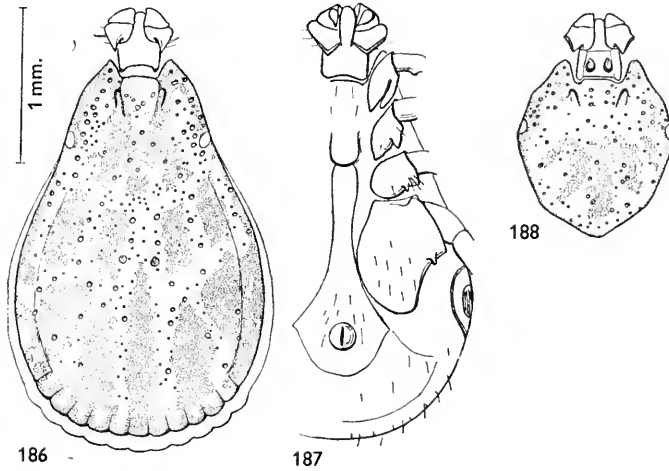
SYN., LIT. AND ICON.

- 1776 *Acarus marginata* Sulzer, pl. XXIX, fig. 7.
 1794 *Acarus reticulatus* Fabricius, p. 428, no. 17.
 1804 *Cynorhaestes pictus* Hermann, p. 67.
 1804 *Ixodes reticulatus* Latreille, p. 335.
 1826 *Ixodes marmoratus* Risso, p. 183.
 1829 *Crotonus variegatus* Duméril, p. 402, pl. 53, fig. 6.
 1844 *Dermacentor reticulatus* Koch, p. 235; 1847, pl. XXIII, figs. 85–6, pl. XXIV, fig. 88 (*D. albicollis*), p. 114, pl. XXIV, fig. 89 (*D. pardalinus*), p. 118, pl. XXV, fig. 92 (*D. ferrugineus*).
Dermacentor albicollis Koch }
Dermacentor pardalinus Koch } See preceding note—doubtful species.
Dermacentor ferrugineus Koch }
- 1844 *Ixodes pictus* Gervais, p. 239.
 1856 *Ixodes holsatus* Kolenati, p. 24, pl. II.
 1882 *Pseudoixodes holsatus* Haller, p. 311, pl. v, fig. 5.
 1888 *Haemaphysalis marmorata* Berlese, fasc. 47, no. 4 (M).
 1890 *Haemaphysalis marmorata* Canestrini, p. 519, pl. XLI, fig. 4; pl. XLII, fig. 3.
 1893 *Ixodes hungaricus* Karpelles, p. 43 (synonymised by Neumann, 1911, p. 99).
 1897 *Dermacentor reticulatus* Fabricius: Neumann, p. 363, fig. 20, male and female digits; fig. 21, male capit; 1901, p. 265.
 1901 Not *Dermacentor reticulatus* Salmon & Stiles.
 1907 *Dermacentor reticulatus* Fabricius: Pocock, p. 196, fig. 112*a* male dorsum, *b* female dorsum (sketchy).
 1907 *Dermacentor reticulatus* Fabricius: Donitz, p. 63, confuses true *reticulatus* with *variegatus* (= *albipictus*) as shown by reference to his figs. 24, 25, pl. IV. (Nuttall, personal notes.)

D. RETICULATUS

- 1911 *Dermacentor reticulatus reticulatus* Fabricius: Neumann, p. 99, figs. 45-7.
1927 *Dermacentor reticulatus* Olenev, pp. 451-5.
1929 *Dermacentor reticulatus* Fabricius: Schulze rejected generic and specific name of *D. reticulatus* on the grounds that Fabricius's species is an *Ixodes* (but see introduction).
1931 Not *Dermacentor silvarum* Olenev, pp. 84-5.
1931 *Dermacentorites marginatus* Sulz: Olenev, pp. 88-90.
1933 *Dermacentor reticulatus* Fabricius: Schulze, p. 3.
1933 *Dermacentor pictus* Hermann: Schulze, pp. 427, 429.
1935 *Dermacentor pictus* Hermann: Schulze, pp. 178-86.
1950 *Dermacentor pictus* Hermann: Pomerantzev, pp. 134-41.
1950 *Dermacentor marginatus* Pomerantzev, p. 149.

MALE. Scutum, capitulum and legs very ornate in well-marked specimens, but subject to great variation in this respect. Body elongate oval, strongly narrowed anteriorly.



Figs. 186-8, *Dermacentor reticulatus*. 186, dorsum of male; 187, venter of male; 188, capitulum and scutum of female.

Capitulum (figs. 189*a*, 189*b*). Very characteristic. Basis length about 0.7 mm., breadth about 0.8 mm., of dark brown colour. Posterior margin almost straight, cornua large, rounded apically; lateral margins straight. Dorsal surface generally convex. Palpi strongly protuberant, almost angular mid-laterally; article 2 slightly broader than long, as 0.575 mm. is to 0.55 mm. (when measured from the tip of the spur); article 3, 0.48 mm. broad across the base, length 0.3 mm., rather pointed anteriorly and towards its inner border. Article 2 with strong dorso-lateral retrograde spur. In ventral view basis broad, distended and globular. Article 3 with small ventral spur (fig. 189*b*).

Scutum (pl. I, fig. 1; fig. 186). Much narrowed in front with numerous light markings outlining the pseudoscutum and forming a reticulate pattern behind it on a dark brown background. In very ornate specimens the brown islands in the reticula-

EURASIATIC SPECIES OF *DERMACENTOR*

tion are themselves invaded by splashes of light enamel. Very numerous punctations of various sizes but all, or nearly all, smaller than the foveae, which generally show up clearly in the light central area. Cervical grooves deep circular or oval impressions. Lateral grooves distinct, forming a brown line within the light-coloured lateral fold extending up to, but not including any of the festoons. Festoons rather long and narrow, all bearing light markings which are most persistent in the submedians and the two extreme festoons on either side. Emargination deep; scapular angles blunt.

Legs (fig. 190). Long and strong. Coxa I with steep slope anteriorly, spurs long and not very dissimilar; external spur shorter than internal spur, separated by a narrow parallel fissure. External spurs on coxae II and III strong, tapering; coxa IV generally much broader (antero-posteriorly) than long, with narrow tapering external spur; all coxae supplied with hairs of moderate to long size. Tarsi (figs. 190*a, b*) short and broad, narrowing rather rapidly, tarsi II-IV lacking clearly defined spurs; pulvillus shorter than claw. Strong spur on trochanter I, broad at its origin and pointed apically; trochanters II and III have rudimentary ventral spurs.

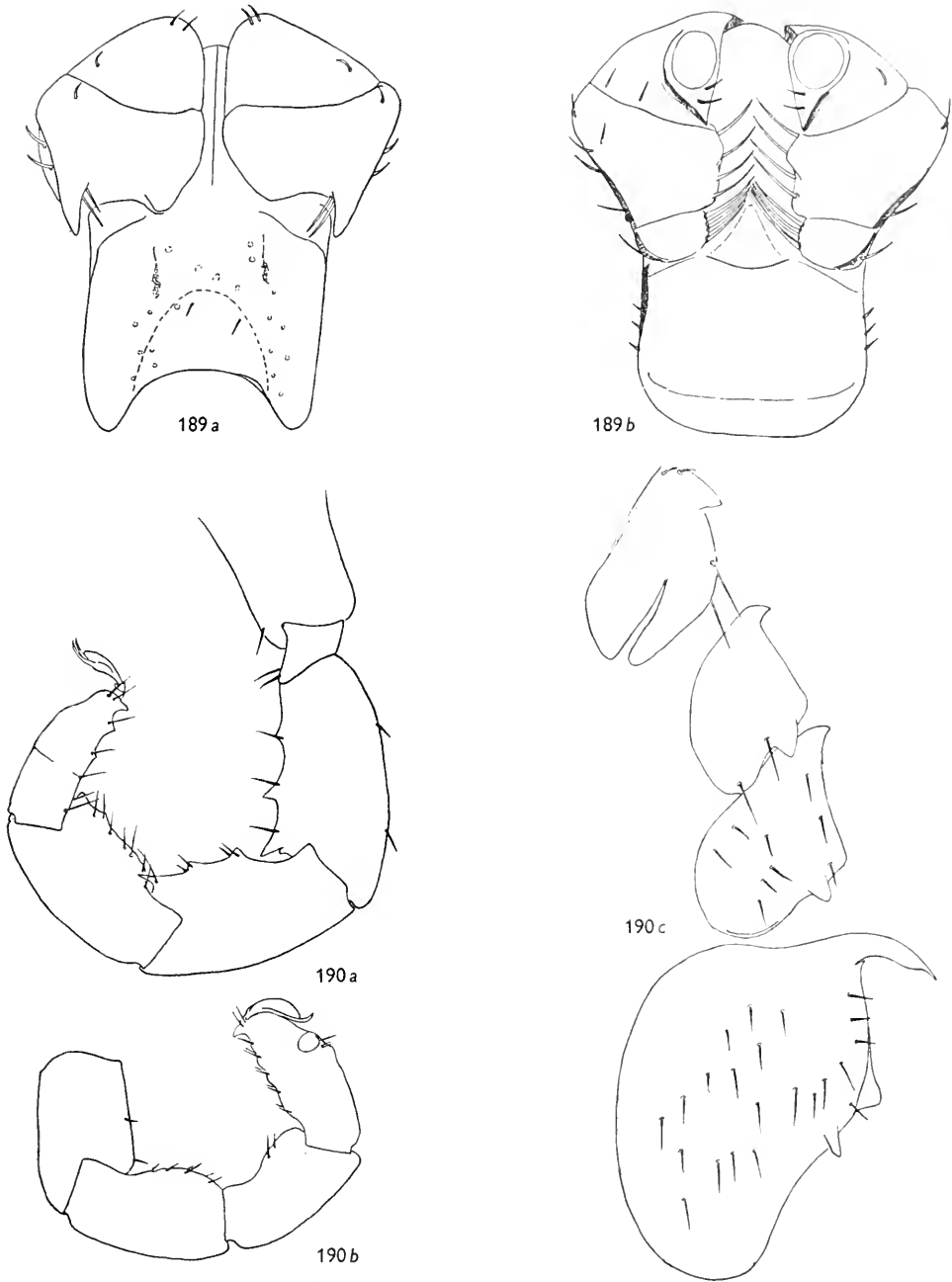
Spiracle (fig. 200*a*). Large, long oval with small but nevertheless distinct blunt dorsal process. All granulations very fine.

FEMALE

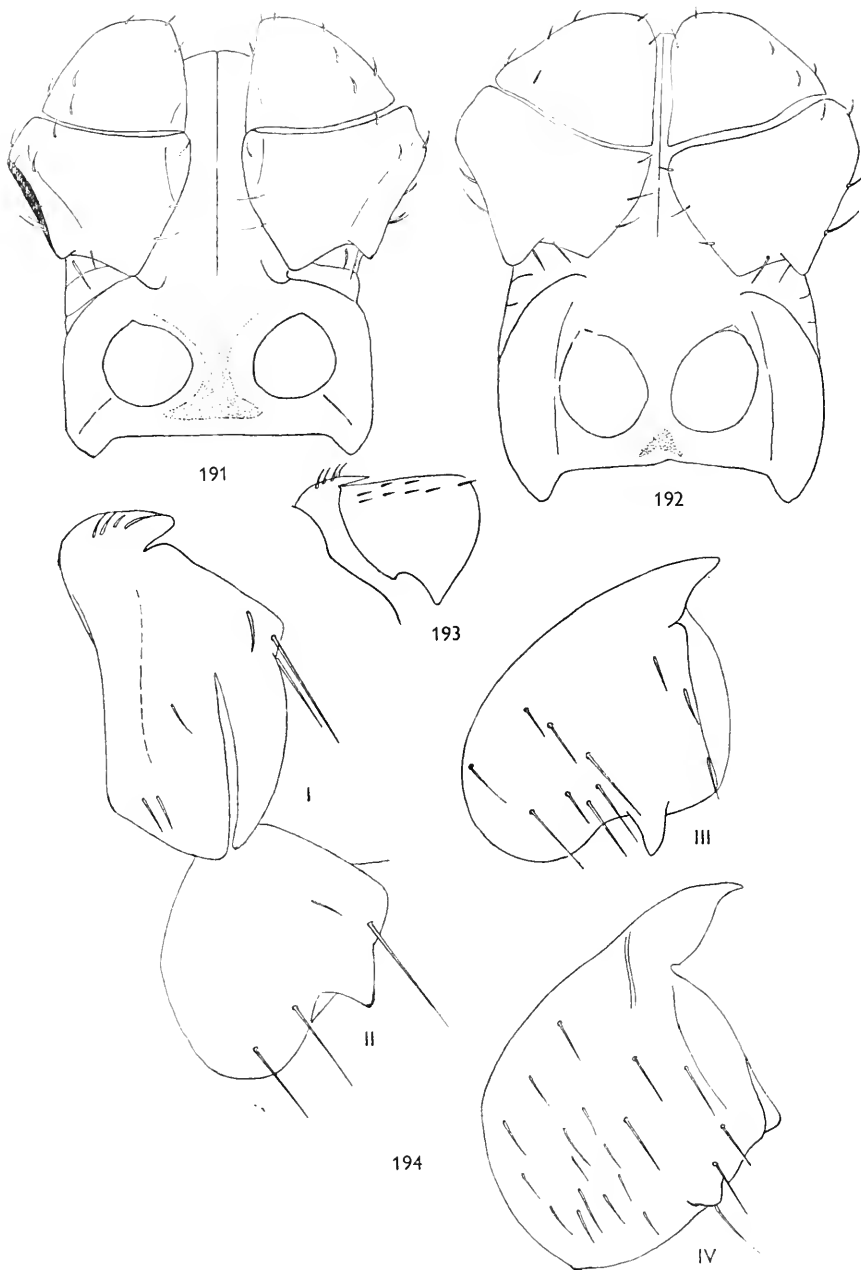
Capitulum (fig. 191). Length about 0.8 mm., breadth across widest points of basis about 0.58 mm. Basis rectangular or trapezoidal (being often somewhat narrower in front). Surface generally flattened except lateral to porose areas where it is elevated. Posterior margin straight, less frequently concave, lateral margins straight or gently curved. Porose areas large, vary from longitudinal oval to circular, depressed; interporose interval less than the maximum width of one of the areas. Cornua distinct, blunt. Retrograde spur on article 2 smaller than in the male, subtended by two short hairs. Inner margin of article 2 convex; outer margin sharply angled about two-thirds of the distance from distal extremity. Lateral face continuous with that of the retrograde spur, steep. Article 3 straight inner margin; outer margin arcuate. Hairs few and of moderate length. Punctations few and scattered.

Scutum. Length about 1.65 mm., greatest breadth, at the level of the eyes, of about 1.62 mm., i.e. not much longer than broad, sides rather rounded and not presenting much angularity (fig. 188). Scapulae large, emargination well defined. White enamel variegated with brown base splashes, consisting predominantly of a large postero-medial patch with pair of smaller patches laterally. The base colour also extends around the eyes and forwards peripherally to the scapulae. Scutal hairs variable in length but all ringed basally with brown. (Alloscutal hairs equal in length to the longer ones on the scutum, but stouter and more curved.) Cervical grooves fairly well defined behind the deep oval pits in which they originate and indicated by base colour. No lateral ridges. Punctations of two kinds, being small and superficial or large and deep.

Legs. Coxa I (fig. 194) strongly convex, with external spur a little shorter than



Figs. 189-90, *Dermacentor reticulatus*. MALE: 189a, capitulum, dorsal; 189b, capitulum, ventral; 190a, leg IV; 190b, leg I; 190c, coxae I-IV.



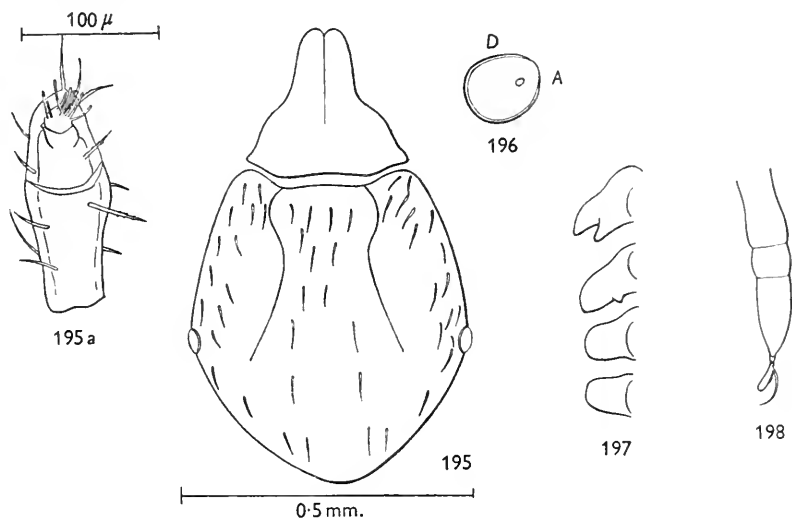
Figs. 191-4. *Dermacentor reticulatus*. FEMALE: 191, capitulum, dorsal; 192, variation of capitular pattern; 193, trochanter I with dorsal spur; 194, coxae I-IV.

D. RETICULATUS

broader internal spur, both rounded apically; coxa I supplied with hairs of varying lengths. Broad external spurs of moderate length and rounded at the tip on coxae II and III, that on coxa IV short and blunt. All coxae supplied with long hairs, more particularly coxae III and IV. Tarsi similar to male but rather longer. Trochanter I has a long, dorsal conical spur.

Spiracle. Large, shorter and broader than in male with distinct broad dorsal process; granulations all very small (fig. 200*b*).

Genital opening lacks wing-like outgrowths.



Figs. 195-8, *Dermacentor reticulatus*. NYMPH: 195, scutum and basis capituli; 195*a*, palp seen ventrally (after Černý, 1957); 196, spiracle; 197, coxae I-IV; 198, tarsus IV.

NYMPH

Capitulum. Basis with median straight posterior margin, thence diverging to lateral points at about one-third of basis length. Palpi of moderate length and breadth, article 2 not half as long again as article 3 (fig. 195*a*).

Scutum (fig. 195). Longer than broad, rather angular at the level of the eyes, which are situated behind the mid-length of the scutum, sharply rounded behind; number of bristles exceed 40. Cervical grooves well marked, emargination moderate.

Legs. Coxa I with blunt internal and external spurs near together; small external spur on coxa II; tarsus IV tapering (fig. 198).

Spiracle. Small with very fine granulations (fig. 196).

LARVA

Capitulum. Basis like that of nymph, but shorter antero-posteriorly; palps shorter and thicker than in the nymph, suture line between articles 2 and 3 indistinct (fig. 199*a*). Dermal sensilla lacking on dorsal surface of palp.

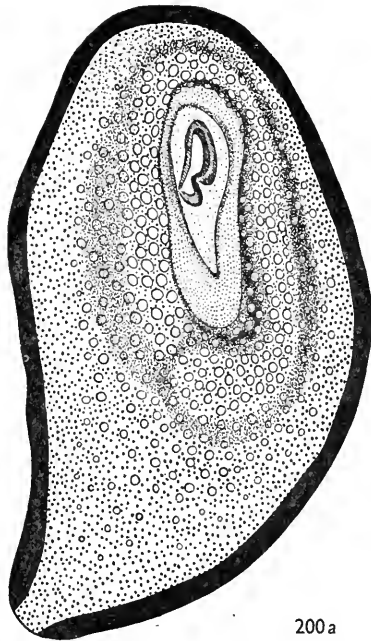
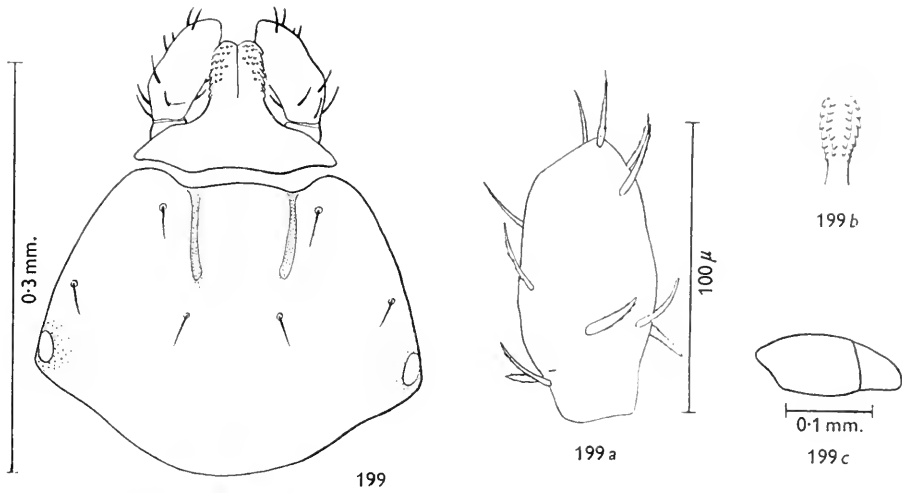
EURASIATIC SPECIES OF *DERMACENTOR*

Scutum. Broader than long, broadest nearer the posterior margin where the eyes are situated, broadly rounded and undulate behind (fig. 199). Postero-median pair of bristles exceed 40μ long. Emargination slight. Cervical grooves as parallel elongate-oval depressions.

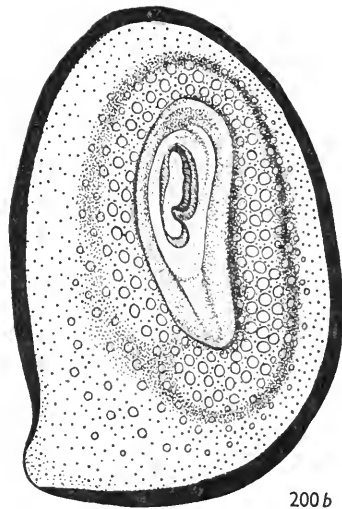
BIOLOGY

In nature *D. reticulatus* feeds on a variety of hosts: the immature stages feeding almost exclusively on small insectivores, rodents and small carnivores and occasionally on birds (Thompson & Arthur, 1955). Hedgehogs and hares are known to harbour both adults and young stages. Large domestic and wild animals (horse, cattle, buffalo, sheep, goat, pig, dog, donkey) are reported as the hosts of the adults. All stages have, however, been reared experimentally on sheep by Nuttall (personal notes). In Britain *D. reticulatus* has been reported from cattle in the south-west of England and in Cardiganshire (Evans, 1951), where the adults are found along the backs of cattle. They appear in large numbers in this position in early spring. A similar spring incidence is reported from Russia when the adults are to be found from the end of March to the beginning of June. Russian workers also report a secondary peak of activity in the autumn. The length of the engorgement period of the females is about 9–15 days. Copulation takes place on the host, and experimental evidence suggests that as females outnumber the males, the latter may copulate with several females. Egg laying occurs 3–4 days after the fecundated and fully fed female has dropped off the host, and the oviposition period lasts from 6–25 days when 3000–4500 eggs per female may be laid.

Under laboratory conditions (30° C.) the larvae emerged from the eggs after 12–19 days. In the field their first appearance on the hosts was in about the middle of June and they remained active for about a month or six weeks. Marzinowski & Bielitzer reported that unfed larvae can survive for six months. Like most other representatives of this genus, *D. reticulatus* is a three-host tick and when the larva has dropped from the host the shortest time recorded experimentally for transformation to the nymph is 5–7 days. Nuttall observed that the mortality rate in this species is less than in other species of this genus under experimental conditions: 'from 754 gorged larvae (many larvae and nymphs being preserved in our collection) we raised 247 nymphs, which after engorgement gave rise to 191 adults.' Unfed nymphs at room temperature survived for 37 days. A resting period of 2–4 weeks appears to be necessary before larvae and nymphs will commence feeding after emergence from the egg and after moulting respectively. Nymphs commence parasitisation under natural conditions at about the beginning of July and in general the activity curve is parallel with that of the larvae. Cessation of the activity of these immature stages occurs in Russia at about the end of August. The nymphs imbibe the blood of the host for 6–10 days (usually 8 days) and the transformation of the nymph to the adult under laboratory conditions is accomplished in 10–14 days. Nuttall recorded that unfed females can live for 400–450 days, but Pomerantzev (1950) gives the potential starvation



200a



200b

Figs. 199–200, *Dermacentor reticulatus*. LARVA: 199, capitulum and scutum; 199a, palp from dorsal aspect (after Černý, 1957); 199b, hypostome; 199c, tarsus I (after Reznik, 1956); 200a, spiracular plate of male; 200b, spiracular plate of female.

period as 2 years. They do, however, start feeding a few days after moulting when given the opportunity.

DISEASE RELATIONSHIPS

This species is involved in the transmission of *Babesia bovis* of cattle in Britain, of *Piroplasma caballi* and *Nuttallia equi* of horses, *Piroplasma canis* of dogs, the virus of infectious encephalomyelitis of horses, and has a virulent role both as a reservoir and vector of tularaemia among rodents, as an infective agent to sheep and, to a lesser extent, to cattle.

D. reticulatus has a wide distribution, being found in Russia, Germany, Poland, Czechoslovakia, the Iberian Peninsula, Switzerland, France and Britain.

Dermacentor asper n.sp. (Chinese form)

MALE. Yellow-brown, with light markings.

Capitulum. Like that of *niveus*, except that the basis is distinctly broader than long, and punctate.

Scutum. So covered with confluent punctations of various sizes as to appear rough. (In all other forms of *Dermacentor* the ground is smooth and glossy.) The light markings characteristic of *D. reticulatus* are obsolete except those delimiting the pseudoscutum, a central patch, and two bands proceeding to the extreme festoons. Cervical grooves as two short parallel linear pits succeeded by slight divergent depressions; lateral grooves fairly distinctly indicated by a row of punctations from the pseudoscutum to the extreme festoons. The area outside the lateral grooves and the festoons are equally punctate with the rest of the scutum.

Legs. Coxa I with rather short spurs; dorsal retrograde process on trochanter I small; coxa IV much broader (antero-posteriorly) than long; tarsus IV narrowing rather rapidly.

Spiracle. With long, rather narrow dorsal prolongation, and with distinctly coarse granulations round the aperture.

Described from two males (GHFN 2978).

The light yellow-brown colour and the rough integument give this tick a distinct facies and the shape of its spiracle with its larger central granulations serves to distinguish it from *reticulatus*.

A female (GHFN 2920) also received from China may belong to this variety, but it is not excessively punctate and cannot be certainly distinguished from a small example of *reticulatus*.

Type deposited in the British Museum (Natural History).

Dermacentor silvarum Olenev, 1927

Figs. 201-12

SYN., LIT. AND ICON.

- 1927 *Dermacentor silvarum* Olenev, pp. 451-4 (in part).
1931 *Dermacentor silvarum* Olenev, pp. 84-5 (in part).
1933 *Dermacentor silvarum* plus *D. silvarum ablutus* Schulze, pp. 416, 425-6.
1946 *Dermacentor silvarum* Pomerantzev, pp. 17, 18.
1950 *Dermacentor silvarum* Pomerantzev, pp. 159-63.

MALE. Ornate with reticulate silver marks on back, which surround the mid-dorsal foveae. Wider towards posterior end (maximum width in front of marginal festoons). Base colour brown, enamel colour dull; and occurs as encroachments on festoons.

Capitulum. Lateral margins of basis either straight or only slightly divergent to the base of the palps (fig. 202). Surface concave between two raised ridges extending in a line from the postero-dorsal ridge (of article 2) to, and involving, the cornua. Cornua quite strongly developed, about as long as basal breadth, rounded apically. Anteriorly the surface concavity is accentuated by a semi-ovate depression with short, steep margins before becoming flat to the rostral base. Two obliquely placed depressions antero-laterally. Posterior margin slightly concave between the cornua, where it is rimmed by darker pigmentation. Length of basis about 0.97 mm., breadth of basis about 0.53 mm. In ventral view postero-ventral ridge only weakly developed. Surface gently convex, becoming stronger anteriorly where it dips down sharply to the hypostomal base (see fig. 201). Lateral margins slightly divergent. Palpi short and broad, articles 2 and 3 of about equal length, 0.23-0.24 mm., breadth of article 2 near its tip 0.29 mm., basal width of article 3, 0.27 mm. Article 3 almost a right-angled triangle in shape. Inner margin of article 2 slightly undulate, that of article 3 almost straight. Outer margins of both articles arcuate, with a rudimentary dorsal spur on article 2; article 2 separated from article 3 by a broad depression. Punctations few, scattered and of moderate size. Hairs strong. Hypostome (fig. 210) spatulate, dentition 4/4 to 3/3 for greater part of its length.

Scutum. Length about 4.8 mm., greatest width about 3.2 mm., narrowing appreciably anteriorly. Cervical grooves indicated by short, deep depressions which broaden out posteriorly to very short, broad, shallow furrows. Superficial lateral grooves commence behind the level of the eyes and reach back to the anterior edge of the marginal festoon; groove has occasional large punctations, but the largest of these are smaller than the foveae. Punctations of moderate size antero-laterally, together with smaller punctations: punctations of median field more or less uniform in size and shallower than those beyond the grooves. Shallow depressions on each side beyond the foveae (fig. 203).

Legs. Uniformly pale brown in colour, hairs weak to moderate. Coxa I relatively short, external spurs of coxa I tapering apically and shorter than internal spurs;

EURASIATIC SPECIES OF *DERMACENTOR*

separated by a parallel fissure. Internal spurs on coxa II reduced to marginal salience, external spurs strong, rounded apically; internal spurs on coxa III larger than those of coxa II and more distinctly spur-like, external spurs similar to those of coxa II; surfaces mildly convex. External spurs on coxa IV long and tapering; postero-mesal extension of coxa IV almost in line with anus (fig. 204). Three pairs of ventral spurs on tibia and tarsus IV. Trochanter I with well-developed dorsal spur.

Spiracular plate (fig. 205). Comma-shaped, elongate, with dorsal outgrowth reaching the scutal margin. Length about 0.75 mm., greatest breadth about 0.45 mm.; lateral margins have steep, sharp slope to the alloscutal integument except in the tail region: margin lacks the dorsal thickening. Macula anteriorly placed, surface of plate convex, centering on macula; brown colour, granular appearance consisting of a large number of small goblets.

FEMALE

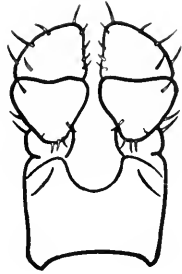
Capitulum. Overall length about 0.76 mm., breadth of basis 0.56 mm. Basis about twice as broad as long, sides broadly rounded and convergent to the palpal insertion. Cornua broad, short and rounded. Margin between the cornua straight, elevated, salient. Porose areas are relatively small, elongate oval, obliquely placed to the long axis. Flat semi-lunar region behind the origin of the chelicerae, passing to a steep slope which leads to the margins of porose areas; the surface lateral to these is strongly down-curved. Article 2 broader than long, as 1.25:1.1, postero-dorsal ridge moderate; distal end of article 2 broader than base of article 3, latter triangular-shaped with sharp apex near mid-line. Hairs longer on article 2 than article 3, but fewer in number on the former. In ventral view, basis broad, postero-ventral ridge weakly defined, in front of this the surface is gently convex, and supplied with two to three strong hairs laterally. Article 1 has a moderately developed lobe, not salient, article 2 flattened, hairs of about equal length to those on the dorsal surface. Length of article 2, 0.55 mm., breadth 0.63 mm.; article 3, length 0.50 mm., breadth 0.55 mm.

Hypostome. Length 0.33–0.35 mm., broadest near the apex, which is surmounted by a corona where the teeth are small and arranged in transverse rows. Dentition, four rows 4/4 teeth, eight distinct rows of 3/3, thereafter appearing as crenulations which thin out obliquely to the proximal margins.

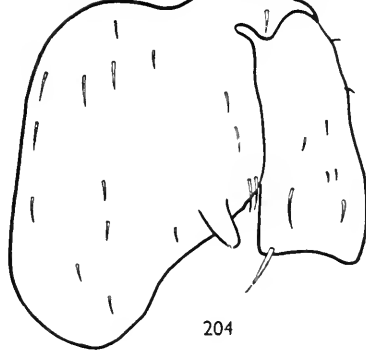
Scutum (fig. 209). About as long as broad, widest in front of the middle, eyes prominent or obsolescent. Admixture of small and moderate punctations uniformly distributed; punctations larger and deeper on periphery and more abundant here than elsewhere. Few short to moderately long hairs, scattered. Base colour brown which is usually extensive in the front half between the cervical grooves, otherwise enamel predominates and occupies most of the lateral field, except along the margins and a postero-lateral 'isthmus'; irregular island of base colour in posterior half of scutum, where the continuity of pattern colour is also interrupted by a projection of base colour; in front the pattern colour fades to merge with the base colour. Cervical grooves very short, consisting of very deep, sharp-sided pits which thin out behind



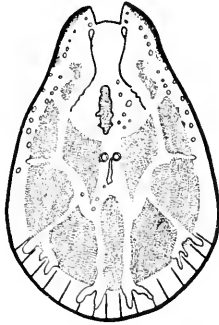
201



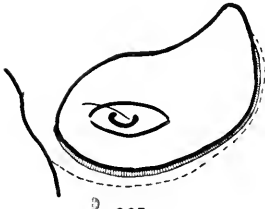
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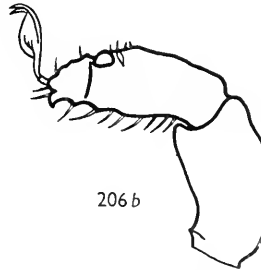
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205



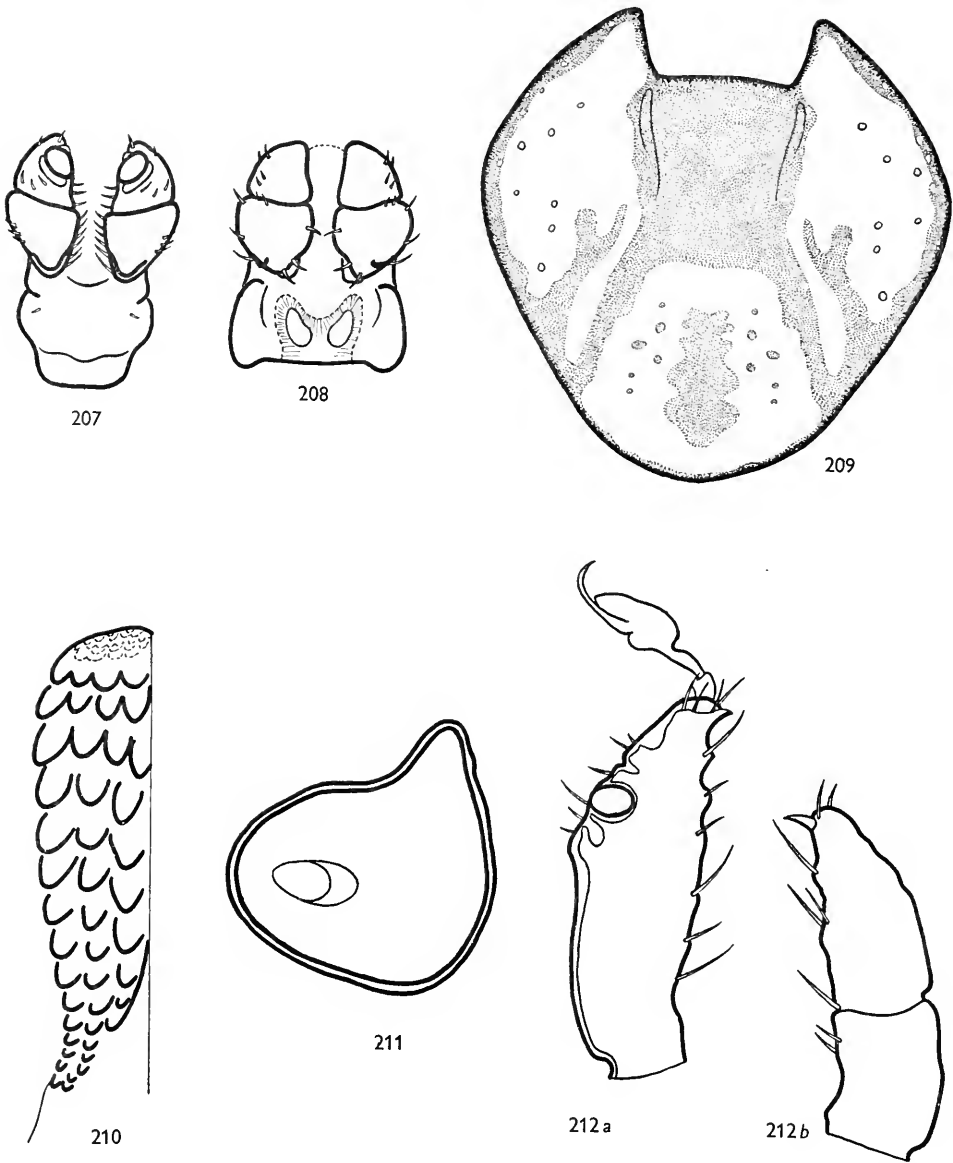
206 a



206 b

Figs. 201-6, *Dermacentor silvarum*. MALE: 201, capitulum ventral; 202, capitulum dorsal; 203, scutum; 204, coxae I-IV; 205, spiracle; 206 a, tarsus IV; 206 b, tarsus I.

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Figs. 207-12, *Dermacentor silvarum*. FEMALE: 207, capitulum, ventral; 208, capitulum, dorsal; 209, scutum; 210, left half of hypostome; 211, spiracle; 212a, tarsus I; 212b, tarsus IV.

and disappear rapidly. Area between cervical grooves flat and generally elevated above surface of rest of scutum. Lateral surface undulate, becoming sharply down-curved at the edges.

Legs. Broad. Base colour usually present. Internal spur of coxa I very broad and chisel-like, external spur tapering to a rounded apex. Coxae II and III with distinct

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external spurs, internal spurs evident as marginal saliences, which are stronger on coxa III than on II. Coxa IV with external spurs only. Tarsus I widest just behind Haller's organ (fig. 212a), supplied with moderately long hairs; on ventral surface and near tip these hairs long, curved and strong, particularly those near apex; ventral surface thrown into irregular ridges behind an apical spur. Tarsus IV shorter, about equally broad with more abundant strong hairs on ventral surface, apical spur present.

Spiracular plate. Length 0.9 mm., breadth 0.59 mm., longer and broader than that of male: more ovate in form with the 'tail' more acute (fig. 211); goblets small and numerous, becoming even smaller around the periphery and in the dorsal prolongation. Surface convex, macula anterior.

BIOLOGY

D. silvarum is an eastern Asiatic form and known from the Primor territory, Amur, eastern Transbaikal, the vicinity of Irkutsk, the Kemerov Province and eastern Altai in Russia, as well as from northern Mongolia. It is known to occur both in forests and in regions reverting to secondary bush vegetation.

Pomerantzev & Serdyukova (1947) have shown that there is a bimodal seasonal activity of adults on horses, cattle, sheep and dogs and that the length of the developmental cycle is about one year. The earlier peak attains its maximum intensity from the end of May to the beginning of June and a secondary peak from the end of August to the beginning of September. It has, however, been reported that *D. silvarum* can overwinter on large animals. The greatest number of larvae on the hosts occurs in June and July; the nymphs having a longer period of activity from June to the middle of August.

In addition to domestic animals, Pomerantzev (1950) cites the following as hosts: man, *Cervus canadensis xanthopygus*, *Capreolus pygargus bedfordi*, *Cervus nippon hortulorum*, *Canis lupus*, *Vulpes vulpes*, *Nyctereutes procyonoides*, *Tigris tigris amurensis*, *Lepus mantschuricus*. Larvae and nymphs are reported from small mammals; larvae and nymphs from *Apodemus agrarius mantschuricus*, *Evotomys rufocanus*, *Eutamias asiaticus orientalis*, *Lepus mantschuricus* and *Citellus evermanni*, and nymphs from *Colonocus sibiricus coreanus*, *Rattus norvegicus caraco*, *Cricetulus nestor triton* and *Microtus michnoi pellicus*.

DISEASE RELATIONSHIPS

In addition to transmitting endemic encephalitis of man this species is the vector of piroplasmiasis *Nuttallia equi* of horses, of tularaemia (*Pasteurella tularensis*), tick-borne typhus, plague (*P. pestis*) and of *Anaplasma ovis* and *Theileria ovis*.

Dermacentor raskemensis Pomerantzev, 1946

Figs. 213-19

LIT. AND ICON.

1946 *Dermacentor raskemensis* Pomerantzev. Original description of male. This description is based on that given by Pomerantzev.

MALE. Body elongate oval, narrowing anteriorly.

Capitulum. Basis capituli almost square. Cornua powerful and rounded apically (fig. 213). Palpi with outer margins rounded; palpal segment 2 with small posteriorly directed spur.

Scutum. Covered by white enamel leaving only very narrow spots of base colour in the cervical, central and supplementary grooves (fig. 215). Punctations mixed, being large and sparse, and fine and dense; the central portion is less heavily punctate. Eyes marginal and slightly convex. Lateral grooves most prominent behind mid-length, where large punctations are confluent.

Legs. Coxa I relatively short and the external spur does not extend to the rounded tip of the inner spur (fig. 216*b*); external spur of coxa IV long and curved on the outside (fig. 216*a*). Trochanter I has a narrow, triangular dorsal spur (fig. 218); small ventral spurs on trochanters II and III. Tarsi I with three pairs of ventral spurs.

Spiracular plate. Elongate, oval with narrow dorsal projection orientated almost at a right angle (fig. 217).

FEMALE. Unknown.

RELATED SPECIES

D. raskemensis is superficially like *D. niveus*, but differs from it by many structural characteristics and by its pigmentation.

BIOLOGY AND DISEASE RELATIONSHIPS. Nothing known.

Dermacentor antrorum Reznik, 1950

Figs. 220-31

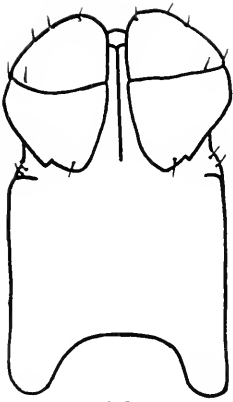
LIT. AND ICON.

1950 *Dermacentor antrorum* Reznik, original description, pp. 112-14, figs. 1-12.

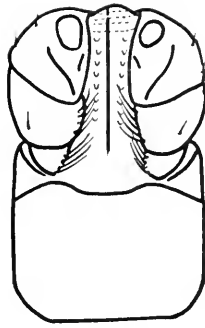
1951 *Dermacentor antrorum* Reznik: Serdyukova, p. 912.

MALE. Almost inornate, small, about 2.5 × 1.7 mm.

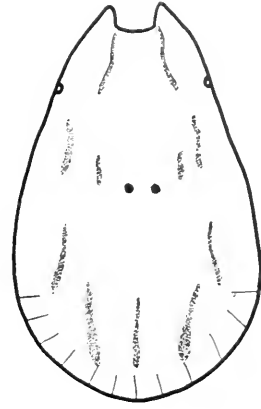
Capitulum. Rectangular and about twice as broad as long (0.3 × 0.13 mm.), posterior margin slightly concave with triangular cornua whose length is almost equal to their basal breadth; lateral margins straight and parallel, being produced into rounded protuberances immediately behind palpi. Surface elevated along the line of cornua and palpi and connected by transverse ridge (indicated by broken line in fig. 220).



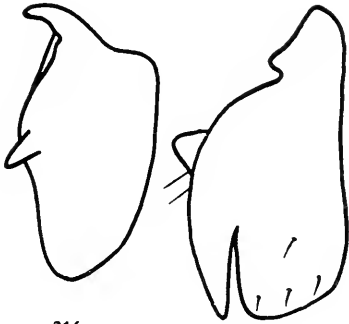
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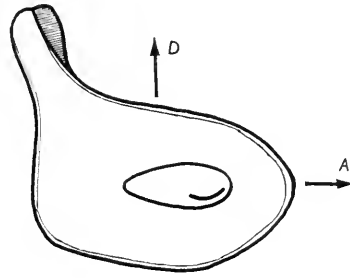
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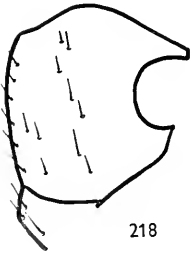
216a



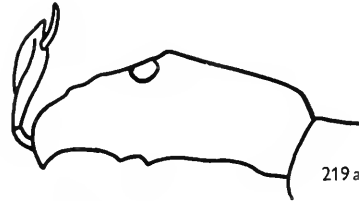
216b



217



218



219a



219b

Figs. 213-19, *Dermacentor raskemensis*, MALE: 213, capitulum, dorsal; 214, capitulum, ventral; 215, scutum; 216a, coxa IV; 216b, coxa I; 217, spiracle; 218, dorsal trochanter spur on trochanter I; 219a, tarsus I; 219b, leg IV. (After Pomerantzev, 1950.)

EURASIATIC SPECIES OF *DERMACENTOR*

Outer margins of palpi convex, inner margins more or less straight; article 2 sharply angled at about one-third of the length proximally, dorsal process moderate. Hairs spinose. Ventrally basis convex behind, postero-lateral angles sharp, sides straight and parallel. Palpal article 2 quadrate, bearing four palpal bristles; article 3 sub-triangular, bearing mesially directed pointed spur basally. Hypostomal dentition, 3/3 files for about six rows, becoming reduced in the basal lateral rows.

Scutum (fig. 222). Oval, length 2.2 mm., breadth 1.6 mm. Base colour brownish yellow with occasional diffuse traces of white pigment. Surface uneven, bearing fine sparse punctations, of more or less uniform distribution, with larger punctations anteriorly. Cervical grooves short, deep. Lateral grooves narrow, originating at about one-third the scutal length and reaching anterior margin of outermost festoons. Paramedial grooves do not reach to mid-length, in front of each a circular depression, and between the latter and the lateral grooves a shallow depression. Eyes almost flat.

Legs. Lighter in colour than the scutum, almost yellow. Coxae not increasing in size from legs I to IV as in other *Dermacentors* (fig. 229); external spur on coxa I broad and blade-like, internal spur smaller and narrower, deeply cleft and divergent. Coxae II–IV lacking internal spurs, external spurs broad, triangular and pointed. Tarsi lacking spurs; pulvillus and claws long.

Spiracular plate. Elongate oval, with broad dorsal process extending to the edge of the scutum, level with the commencement of first festoons; frame thickened on dorsal side of process. Macula anterior of centre.

Anal groove. Surrounds anus posteriorly; anal valves bear five pairs of hairs in position indicated in fig. 223.

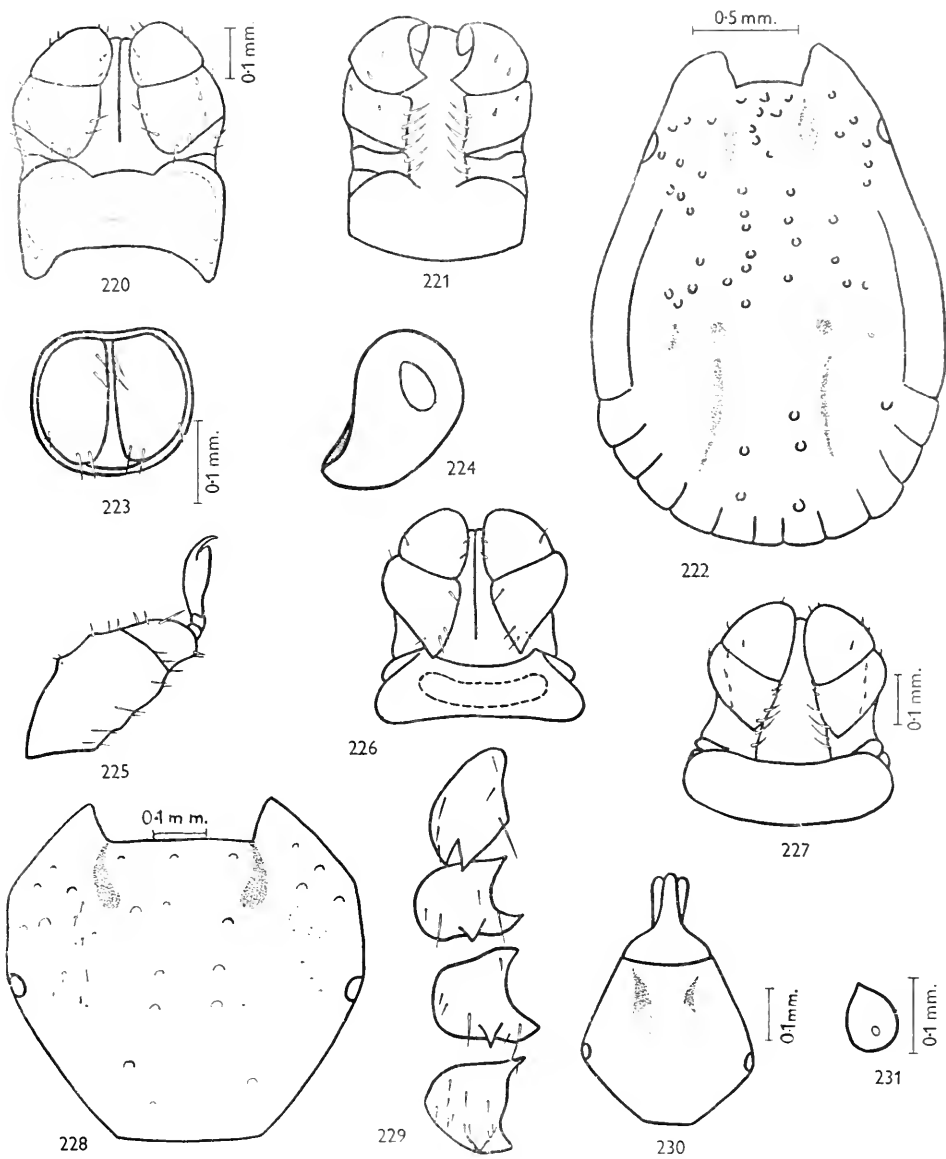
Genital grooves. Diverge gently from the genital aperture, reach the anus and thence curve round to the border of the second and third festoons.

FEMALE

Capitulum. Basis about three times as broad as long; length 0.12 mm., breadth 0.35 mm. Posterior margin very slightly concave, lacking cornua; sides strongly convergent to palpal insertion. Porose areas fused to form crescent-shaped depression which is concave anteriorly (fig. 226). Palpal article 2 drawn out to a point meso-dorsally, distal margin broadly convex, almost angular, inner margin straight; palpal article 3 with both inner and outer margins curved, apex broadly rounded. Ventrally basis has convex posterior edge and concave anterior margin, sides gently rounded. Hypostome as in the male.

Scutum. Length and breadth almost equal, length 1.0 mm., greatest breadth of 0.9 mm. at about mid-length. Ovate in outline but margins generally sharply angled (fig. 228). Cervical grooves, short, deep. Eyes located at about mid-length. Punctations coarse and concentrated mainly in the anterior and central parts. Base colour brown, and lacking ornamentation.

Spiracular plate and coxae much as in the male.



Figs. 220-31, *Dermacentor antrorum*. 220-5, MALE: 220, capitulum, dorsal; 221, capitulum, ventral; 222, scutum; 223, anal plates; 224, spiracle; 225, tarsus I. 226-9, FEMALE: 226, capitulum, dorsal; 227, capitulum, ventral; 228, scutum; 229, coxae I-IV. 230-1, NYMPH: 230, capitulum, and scutum; 231, spiracle. (After Reznik, 1950.)

EURASIATIC SPECIES OF *DERMACENTOR*

NYMPH (figs. 230-1). Posterior margin of basis broadly rounded, postero-lateral angles sharp, no cornua; sides sinuous to anterior cheliceral foramen. Scutum measures 0.4 mm. long by 0.41 mm. broad. Greatest breadth near posterior margin at the level of the eyes, antero-lateral margins straight and convergent to the basis, posterior and postero-lateral margins angular. Cervical grooves narrow and convergent at first, thence divergent and broadening, not reaching margins. Spiracular plate with short, pointed dorsal process directed upwards and rather backwards.

REMARKS

Reznik drew attention to the lack of pigmentation, the uniformity of coxal size in both sexes and the fusion of the porose areas in the female. On these grounds he suggested that it may be expedient to separate this species into a subgenus of *Dermacentor*. Serdyukova (1951) did not consider the differences mentioned by Reznik to be of sufficient significance in giving *D. antrorum* subgeneric status.

HOSTS

Microtus arvalis and *Chinomys nivalis*, all of which were collected in Armenia.

Type specimens deposited in the Parasitological division of the Stavropol laboratories, U.S.S.R.

Dermacentor pavlovskyi Olenev, 1927

Figs. 232-46

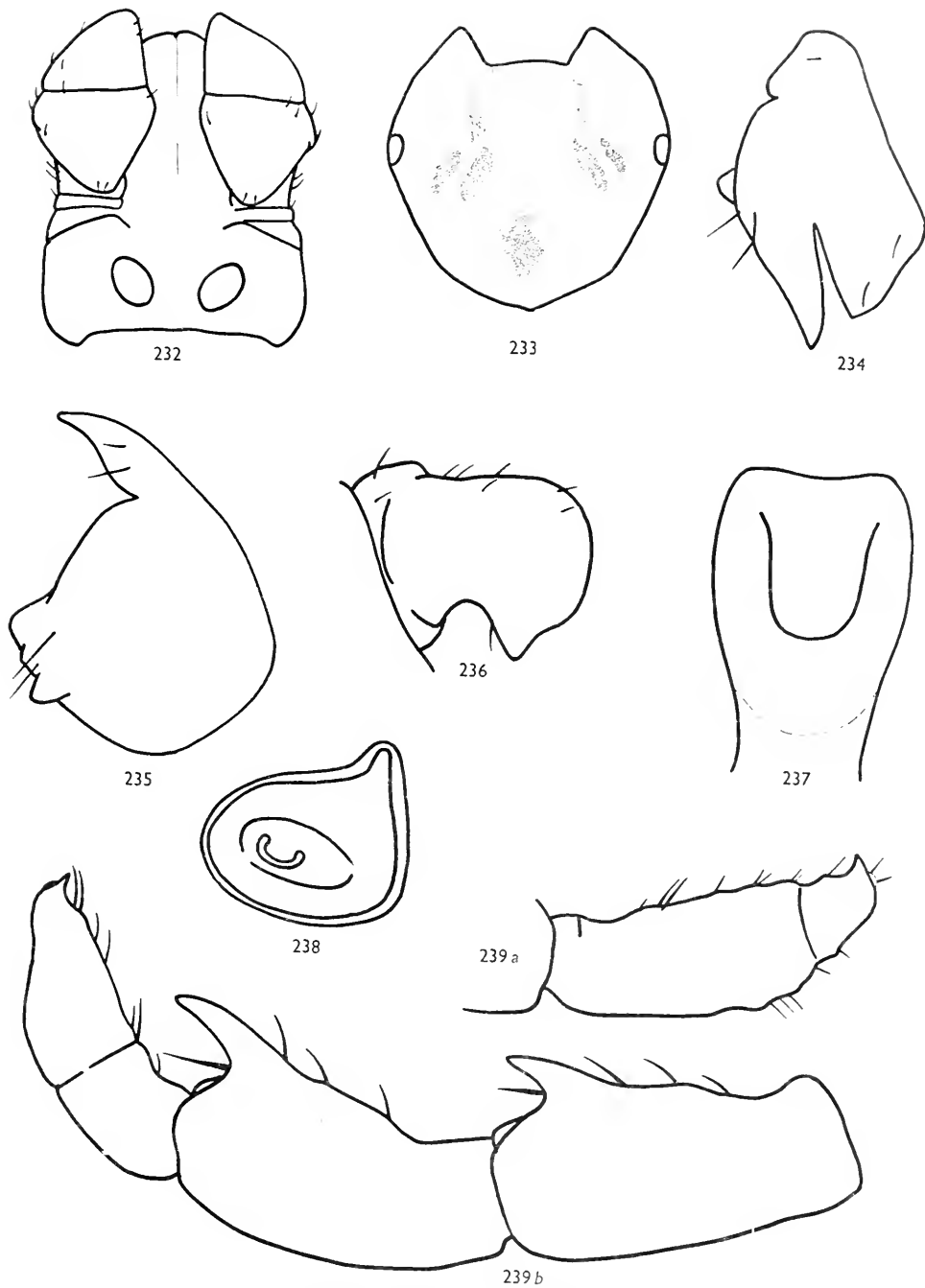
LIT. AND ICON.

- 1927b *Dermacentor pavlovskyi* Olenev, original description, pp. 84-5.
1927a *Dermacentor pavlovskyi* Olenev, p. 222.
1931 *Dermacentor pavlovskyi* Olenev, p. 87.
1946 *Dermacentor pavlovskyi* Olenev: Pomerantzev, pp. 15, 17.
1950 *Dermacentor pavlovskyi* Olenev: Pomerantzev, pp. 141-3.

FEMALE. Body shape, elongate oval, 3.5-3.7 × 1.4-2.1 mm., brownish red colour with the capitulum and legs paler.

Capitulum. Overall length 0.75 mm., basis about twice as broad as long, posterior margin straight, cornua forming short, broad protuberances, postero-lateral angles rounded, lateral margins straight and almost parallel, porose areas subcircular, small, separated from one another by about their greatest length; weakly developed whitish markings dorsally (fig. 232). Palpi short, broad, about 1.6 times as long as broad; article 2 slightly longer than article 3, latter subtriangular and broader basally than it is long; article 2 with moderately well developed, rounded postero-dorsal ridge; palpi well covered with hairs. Hypostome, dentition 3/3.

Scutum. Oval, widest in front of mid-length and across the eyes, antero-lateral borders convex, postero-lateral margin rectilinear, posterior margin subangular (fig. 233). Colour, rich whitish colour except for the punctations, along the cervical grooves, paired diagonal bands postero-lateral to the hinder portion of these grooves,



Figs. 232-9, *Dermacentor pavlovskyi*. FEMALE: 232, capitulum, dorsal; 233, scutum; 234, coxa I; 235, coxa IV; 236, trochanter I and dorsal spur; 237, genital aperture; 238, spiracle; 239a, tarsus I; 239b, tibia, metatarsus and tarsus of leg IV.

EURASIATIC SPECIES OF *DERMACENTOR*

and a large median area posteriorly. Cervical grooves forming deep lunules anteriorly. Punctations of two kinds, numerous fine punctations distributed over the whole surface, few coarse scattered punctations, all punctations with short hairs. *Venter* punctate, covered with short hairs; genital grooves nearly parallel as far back as coxa IV, thereafter diverging and terminating in front of the first festoons; genital aperture on a level with the second intercoxal space.

Spiracular plate. Broad, with a narrow well-developed tail, more finely punctate near the tail (fig. 238).

Legs. Thick, strong, ornate dorsally: coxa I with moderately long, close set, parallel spurs, the outer the more slender and tapering to its tip; coxae II and III with slight internal and external spurs; a single spur on coxa IV (fig. 235). Legs II–IV having their penultimate and antipenultimate articles furnished with strong ventral spurs (figs. 239*a* and *b*). Trochanter with broad, tapered dorsal spur (fig. 236).

MALE. Body oval; the body length, excluding the capitulum, is 3.5 mm., breadth from 1.2–2.5 mm. Brownish red.

Capitulum. Length 0.75–0.77 mm., basis capituli (fig. 241) slightly broader than long (including the cornua); slight ornate markings partly cover basis capituli, posterior margin concave, lateral margins almost straight and parallel, cornua very strong, long, narrow, with rounded tips. Palpi broad, slightly longer than broad as 1.4:1.0, with strong postero-dorsal ridge on article 2, together with weakly developed spur; articles 2 and 3 of nearly equal length; spinose hairs on their inner ventral side; article 3 triangular dorsally; with a small recurved ventral tooth; article 4 small, cylindrical. Some ornate markings visible dorsally on palpi.

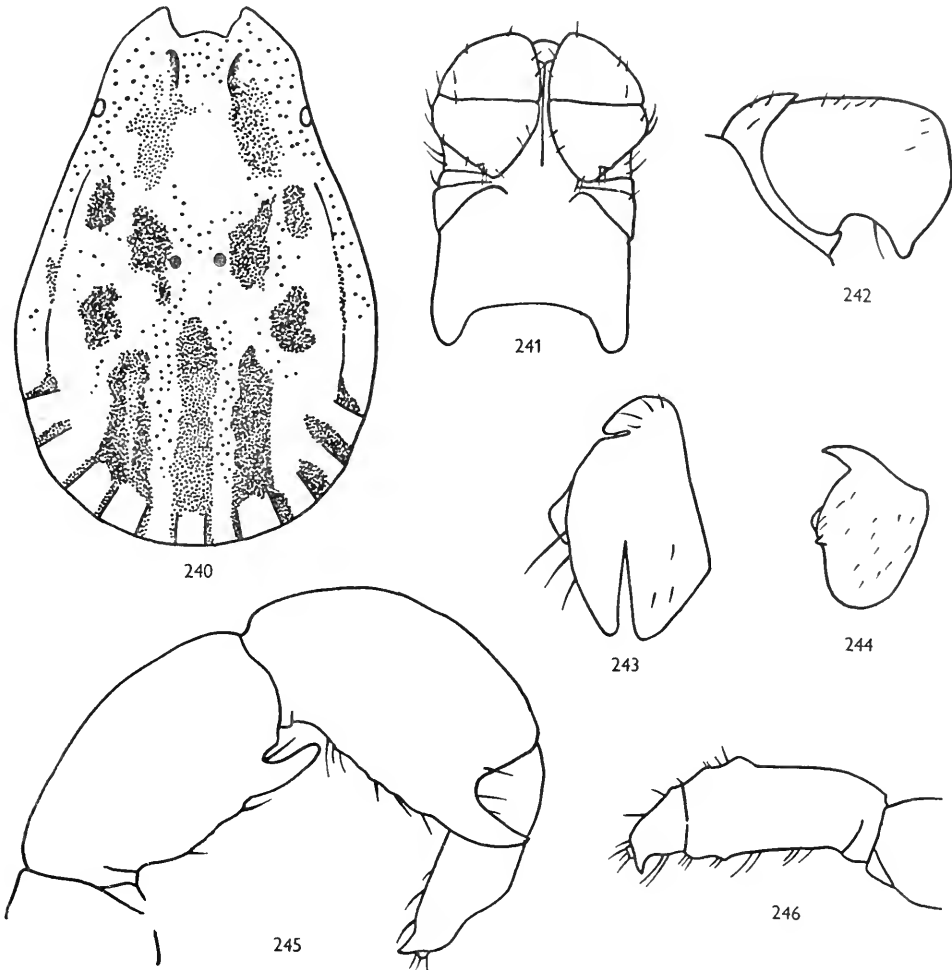
Scutum. Shape as figured (fig. 240). Surface slightly convex. Posterior margin of pseudo-scutum as a conspicuous white band; surface enamelled except for the grooves, punctations and the punctate spots, the latter arranged as one pair on the frontal, three small pairs on the median, and three elongate unpaired regions on the posterior part of the scutum. Cervical grooves divergent posteriorly, beginning as deep half-moon-shaped depressions; deep lateral grooves beginning on a level with the third pair of legs and extending back to the marginal festoons; outer festoons broader than the inner, all with central whitish markings. Posteriorly on scutum, midway between the elongate lateral spots, there is a depression. Punctations of two kinds, both with short hairs; a few coarse, scattered punctations with numerous fine punctations evenly distributed. Eyes on a level with coxa II. *Venter* hairy with scattered fine punctations. *Genital orifice* level with coxa II, genital groove parallel to level of coxa IV, thence sharply divergent posteriorly; long median groove runs backward from the anal groove to the median festoon.

Spiracular plate. With narrow well-developed tail, more finely punctate near the tail.

Legs. Ornate dorsally, well supplied with spinose hairs. Coxa I with moderately long, close set, parallel or slightly divergent spurs, the outer quite broad and not

D. PAVLOVSKYI

reaching the tip of the internal spur. Coxae II and III slightly pointed at the internal angle and with a sharp external spur. External spur of the enlarged and rounded coxa IV very small and sharp. Tibia and metatarsi of legs II-IV furnished with distinctive long ventral spurs (fig. 245).



Figs. 240-6, *Dermacentor pavlovskyi*. MALE: 240, scutum; 241, capitulum, dorsal; 242, trochanter and dorsal spur; 243, coxa I; 244, coxa IV; 245, tibia, metatarsus and tarsus IV; 246, tarsus I.

NYMPH. Not known.

REMARKS

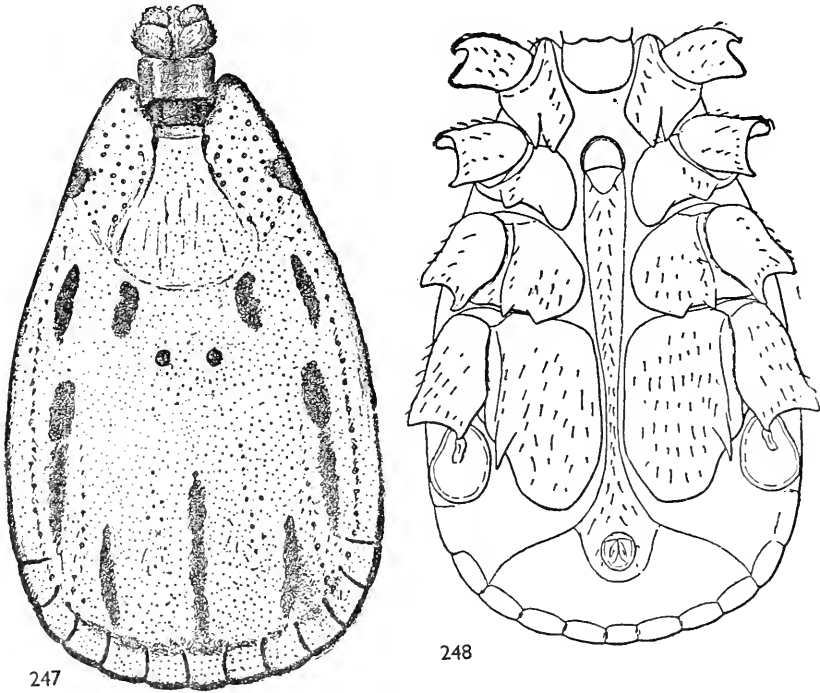
Type material collected from the head of *Ovis nigrimontana* at Akkinil, Syr-Darja Province, Turkestan, 31 January 1910. Deposited in the Zoological Museum of the Russian Academy of Science (Museum no. 43-1910).

EURASIATIC SPECIES OF *DERMACENTOR*

BIOLOGY

Very little is known concerning the biology of this species beyond the facts that heavy infestation of sheep and goats occurs in March and April, and that oviposition varied from 11 to 70 days under experimental conditions. Geographically it is confined to the mountains of central Asia and has hitherto not been recorded elsewhere.

DISEASE RELATIONSHIPS. Nothing known.



Figs. 247-8, *Dermacentor albipictus kamshadalus*. MALE: 247, dorsal view; 248, ventral view. (Neumann, 1908.)

Dermacentor albipictus kamshadalus Neumann, 1908

Figs. 247, 248

SYN., LIT. AND ICON.

1908 *Dermacentor variegatus kamshadalus* Neumann, original description, pp. 86-8.

1950 *Dermacentor variegatus kantschadalus* Neumann: Pomerantzev, p. 164.

MALE. Neumann described a male tick taken from a sheep as *D. variegatus* var. *kamshadalus*. We have not been able to see this specimen, but from his description and figure (which we reproduce) it agrees essentially with *D. albipictus* except as regards scutal pattern. Pomerantzev (1950) described the variety thus: 'Scutum oval narrowing in the anterior region. Pattern colour almost completely covering the

PLATE II



1



2



3



4



5



6

Fig. 1. *Dermacentor parumapertus* female.
Fig. 2. *Dermacentor parumapertus* male.
Fig. 3. *Dermacentor niveus* female.

Fig. 4. *Dermacentor niveus* male.
Fig. 5. *Dermacentor auratus* male.
Fig. 6. *Dermacentor auratus* female.

D. ALBIPICTUS KAMSHADALUS

dorsum. Coxa I short, with relatively short external spur and not reaching the tip of the internal spur. Spiracular plate almost circular with dorsal process rudimentary.'

REMARKS

Since *D. variegatus* has been synonymised with *D. albipictus*, the name of this doubtful variety has been correspondingly amended. Pomerantzev spells the specific name as *kamtschadalus*.

Dermacentor niveus Neumann, 1897

Pl. II, figs. 3, 4; Figs. 249-62

SYN., LIT. AND ICON.

1897 *Dermacentor niveus* Neumann. Original description, p. 365.

1911 *Dermacentor reticulatus niveus*, Neumann, p. 100.

1929 *Dermacentor niveus* var. *daghestanicus* Olenev, pp. 306-8.

1933 *Dermacentor niveus* Neumann: Schulze, p. 416.

1931 *Dermacentor niveus* Neumann: Olenev, p. 4.

1947 *Dermacentor daghestanicus* Olenev: Pomerantzev, pp. 16, 18.

1950 *Dermacentor daghestanicus* Olenev: Pomerantzev, pp. 155-9.

MALE. A highly ornate species with extensive covering of enamel, measuring about 5.07 mm. long and 3.4 mm. broad across a marked lateral extension in front of the spiracle (fig. 249).

Capitulum. Basis capituli about one and a half times as broad as long (including cornua); surface with a few large hair-bearing punctations, with moderate to large patches of enamel dorsally; peripherally elevated along a line from just behind the spur of article 2 to the postero-lateral corner, mesially depressed into a broad shallow valley which widens posteriorly to the mesial edge of the cornua; latter broad and narrowing apically (fig. 250). Palpi short, broad, about 1.4 times as long as broad, articles 2 and 3 of about equal length, lateral profile as a broad arc of a circle, well covered by curved spinose hairs of moderate length, small spur on the postero-dorsal edge of article 2; a blotch of enamel basally on article 2 and another distally, which is continuous with a similar blotch on the base of article 3. Ventrally, basis capituli broader than long, postero-lateral edges rounded, with posterior margin slightly concave; palpal article 1 triangular with a marked depression distally, surface of article 2 irregular, palpal bristles arising from article 1 longer than those from article 2, latter short, broad and almost straight; peripherally hairs long and spinose before becoming fine on the apex (fig. 251).

Scutum. Length 4.2 mm., greatest breadth 2.9 mm., narrows anteriorly (fig. 249), broadly rounded behind and demarcated by eleven festoons, eyes placed well forward; foveae large, distinct brown; scapulae large, rounded apically, emargination strong; lateral groove emphasised for third of its length by large punctations, festoons not delimited by the groove. Cervical grooves short, deep anteriorly. Punctations of two kinds, the fine ones being uniformly distributed over the surface, the larger ones concentrated along the lateral groove, lateral to this and antero-laterally, particularly

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in front of the eyes. Base colour brown, enamel yellow-white in preserved specimens; superimposed colour more extensive than base colour, latter confined to posterior extensions of cervical grooves and postero-lateral to them as small isolated patches;

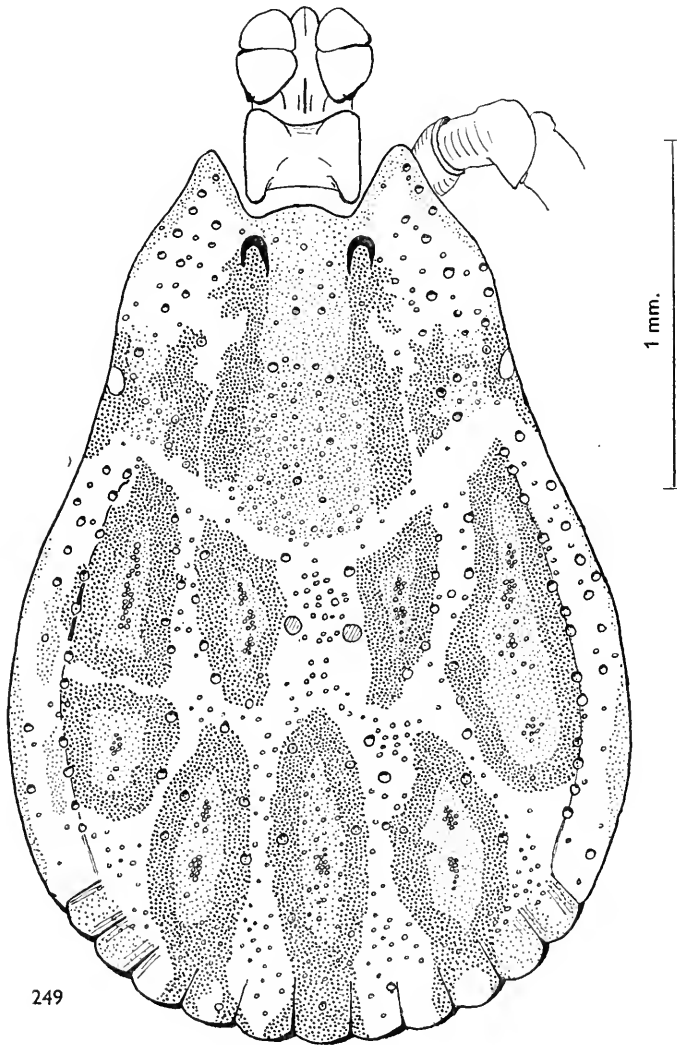
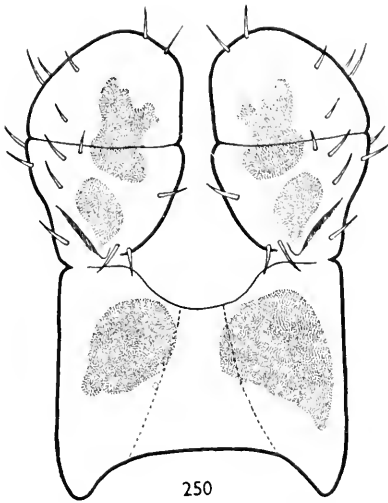
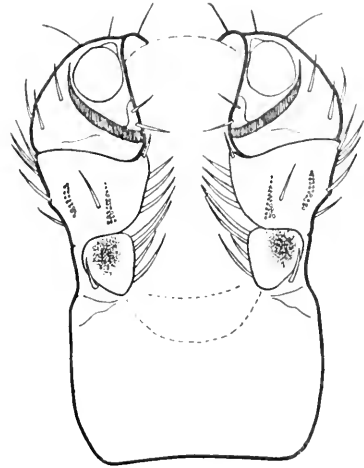


Fig. 249, *Dermacentor niveus*. Male dorsum.

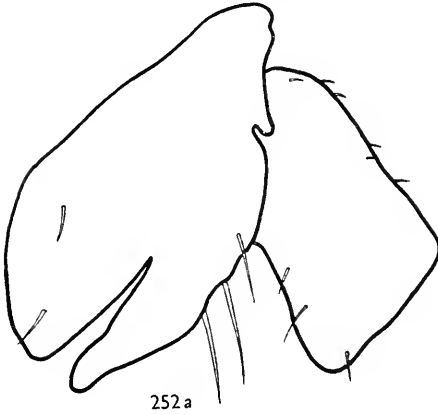
patches of base colour on either side of the foveae ('foveal' patches), encircling enamel areas which in turn have isolated spots of base colour; lateral to the foveal patches are larger patches of similar base and superimposed enamel pattern, which reach back nearly to the anterior edge of the first festoons. Beyond these and on a level with the foveae are small areas of base colour alone which overlie the lateral



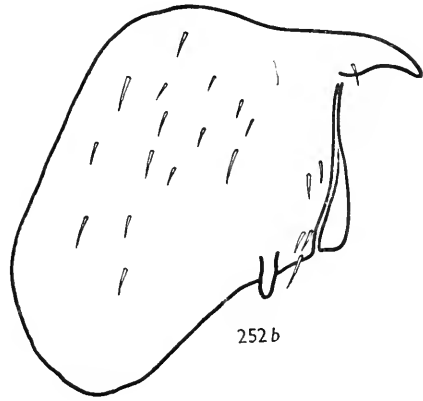
250



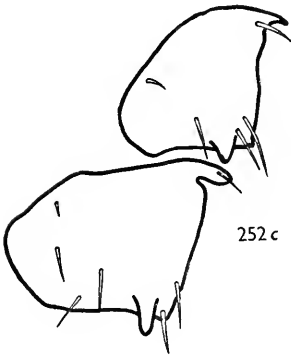
251



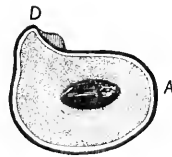
252 a



252 b



252 c



253 a



253 b

Figs. 250-3, *Dermacentor niveus*. 250, capitulum of male, dorsal; 251, capitulum of male, ventral; 252a, coxa I; 252b, coxa IV; 252c, coxae II-III (at half scale of 252a and b); 253a, spiracle of female; 253b, spiracle of male.

EURASIATIC SPECIES OF *DERMACENTOR*

grooves. The posterior quarter of the scutum bears three areas of ornamentation, the median one is long and narrow and passes back into the median festoon and to the festoons on either side of the latter. The lateral areas of ornamentation are shorter and usually broader than the median element and these reach back to the fourth, and sometimes the fifth festoons. These three posterior patches are like the foveal patches in that they surround enamel patches with dots of base colour. Enamel occurs on all the festoons, and the typical arrangement is shown in fig. 249. Festoons continued round ventrally, the dorsal portion 'separated' from the ventral portion by slight depression extending across all festoons, a transverse enamel band immediately behind this is followed by a broad band of base colour.

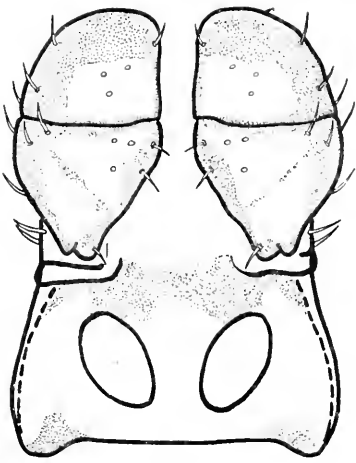
Legs. Strong and thick, with small teeth on the tibia and on tarsi II–IV. Coxa I with external spur shorter than its interior counterpart, only slightly divergent; coxae II and III with moderate to long, narrow pointed external spurs, internal spur on coxa II indicated by a short broad salience, very slight comparable salience on article III; external spur on article IV long and narrow; few spinose hairs of moderate length on coxae I–III, shorter and more numerous on coxa IV. Dorsal surface of leg segments ornate.

Spiracular plate (fig. 253*b*). Longitudinally oval and gradually turns into a relatively short and wide dorsal prolongation that forms with its posterior contour a clear convex line. Goblets very small. Posterior edge of dorsal prolongation contiguous with the front edge of the most anterior festoon.

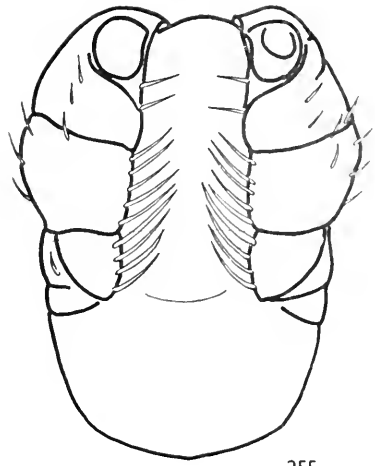
Re-description FEMALE

Capitulum. Basis capituli broader than long, as about 0.49 mm. is to 0.30 mm. (fig. 254), posterior margin straight with a short sharp posterior edge, cornua broader basally than long and frequently angular at their apices; lateral margins straight and narrowing quite distinctly to the palpal insertion; surface flat except peripherally (indicated by a broken line in fig. 254), where there is a distinct ventral slope. Porose areas elongate oval, very strongly depressed and obliquely placed relative to long axis of body. Palpi broadest just behind distal extremity of article 2 (0.26 mm.), where there is a slight mesial flange, length of article 2, 0.24 mm., article 3, 0.21 mm.; article 2 with small but distinct postero-dorsal spur, lateral profile broadly rounded. Punctations few, large on both articles; hairs of moderate length, spinose and slightly curved. Basis capituli with extensive area of enamel, base colour limited to the area in front of the porose areas and on the cornua, similar extensive patches of pigmentation on dorsum of articles 2 and 3. Ventrally basis capituli broadly rounded behind, lateral margins divergent to palpal insertions, separated into two portions by shallow transverse groove; few hairs ventro-laterally.

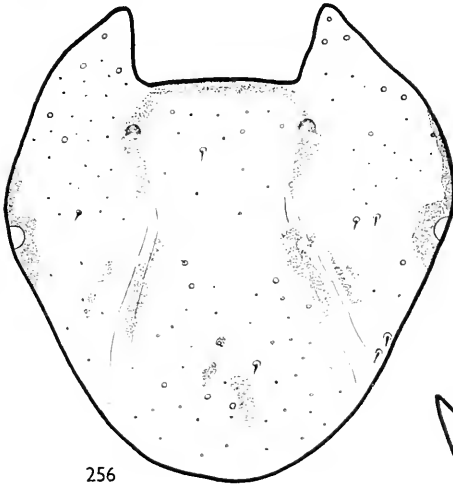
Scutum (fig. 256). Broadest (1.5 mm.) in front of mid-length, slightly longer (1.58 mm.) than broad in typical specimens, antero-lateral margins in front of the eyes either curved or slightly sinuous, almost rectilinear and convergent posteriorly to rounded posterior extremity; scapulae very large, tapered, with pronounced



254



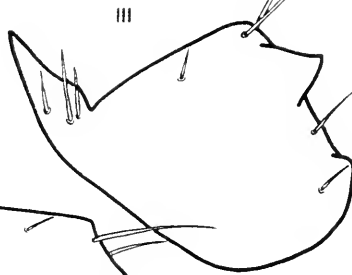
255



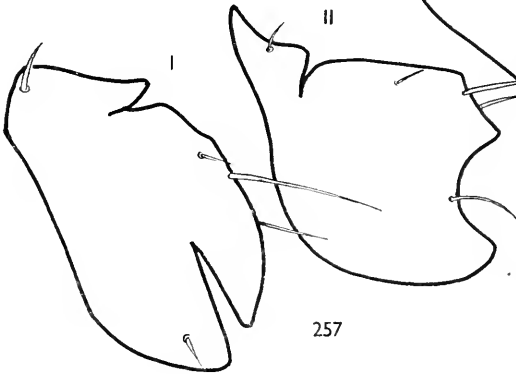
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IV



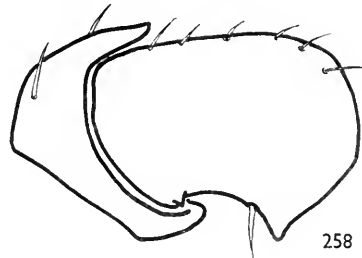
III



257



I



258

Figs. 254-8, *Dermacentor niveus*. FEMALE: 254, capitulum, dorsal; 255, capitulum, ventral; 256, scutum; 257, coxae I-IV; 258, trochanter I and dorsal spur.

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emargination. Cervical grooves very short, deep but leading back and diverging postero-laterally as a broad shallow depression. Surface generally flat except antero-laterally where it curves downwards moderately strongly. Almost all covered with white pigment; base colour distributed across the anterior edge between the scapulae, thence continued backwards around the cervical grooves to slightly in front of the level of the eyes; two short diagonal bars mesial of the shallow cervical depression and short irregular patches laterad and opposite them; small patches around the eyes and extending forwards as a narrow bar. Punctations brown, of two sizes; a few larger

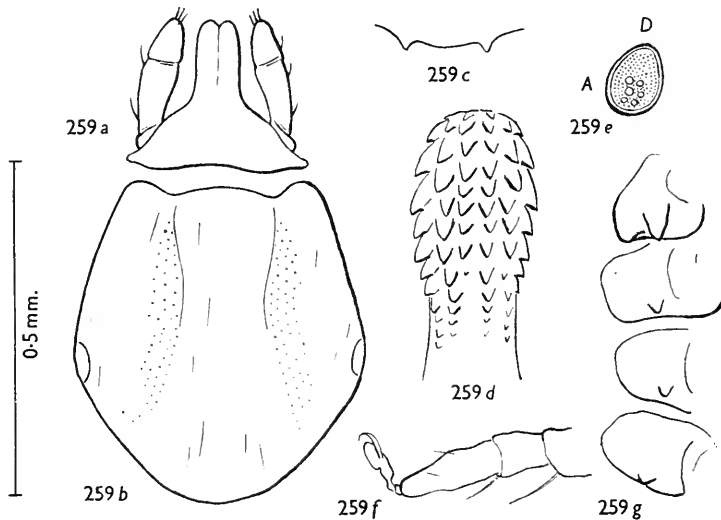


Fig. 259, *Dermacentor niveus*. NYMPH: 259a, dorsal view of capitulum; 259b, scutum; 259c, ventral view of basis to show basal spurs; 259d, hypostome; 259e, spiracular plate; 259f, tarsus I; 259g, coxae I-IV.

ones being most prevalent laterally and bearing short white, caducous hairs, smaller ones most abundant and uniformly distributed. Scutal hairs much shorter than those on alloscutum.

Legs. Broad and strong, dorsal surface pigmented, coxa I with broad external spur which is shorter than the internal projection (fig. 257), coxa II with broad pointed triangular external spur, internal spur represented by rounded marginal spur, larger than the external spur; coxa III with a larger external spur of similar shape to that of II, internal spur represented by a marginal salience less well defined than on coxa II, coxa IV broadly rounded mesially, external spur narrower than on preceding coxae and slightly uptilted. All trochanters without ventral spurs. Tarsus I short, broad, almost parallel to the tarsal suture, beyond tapers rapidly to the pulvillus. Apical ventral spur present, otherwise tibia and tarsi are without spurs.

Spiracular plate (fig. 253a). Chitinous edge of peritreme forms a strong thickening at the base of dorsal prolongation, plate generally elongate oval with short but distinct

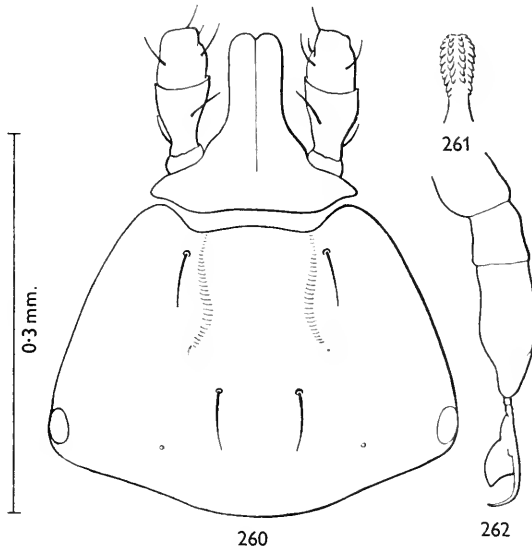
D. NIVEUS

dorsal prolongation; one or two rows of large goblets around the macula, with 3-4 rows of very much smaller goblets beyond these and extending up to the dorsal horn.

Genital aperture. Bounded by wing-like extensions.

NYMPH

Capitulum. Posterior margin of basis (fig. 259*a*) undulate, drawn out laterally into points, breadth across the points 0.27 mm., length from dorsal ridge to tips of palpi 0.23 mm. Ventrally basal spurs distinct and pointed (fig. 259*c*). Palpi long and narrow, article 2 almost twice as long as article 3. Hypostome (fig. 259*d*), dentition 3/3.



Figs. 260-2, *Dermacentor niveus*. LARVA: 260, capitulum and scutum; 261, hypostome; 262, tarsus I.

Scutum. Longer than broad, about 0.49 mm. long by 0.44 mm. broad; greatest breadth behind the mid-line. Cervical grooves narrow, short (fig. 259*b*).

Legs. Coxa I with external spurs stronger and longer than internal spurs, external spurs on coxae II-IV decreasing progressively in size; internal spurs lacking (fig. 259*g*).

Spiracular plate. Transversely ovate with few large punctations (fig. 259*e*).

LARVA

Capitulum. Basis capituli with much the same characters as the nymph, except for the more strongly indented proximal end of article 2 (fig. 260). Hypostomal dentition 2/2 (fig. 261).

Scutum. Greatest breadth of 0.33 mm. across the eyes just in front of posterior margin, latter sinuous; length 0.25 mm. Cervical grooves reaching back to about mid-length, shallow. Shape as figured (fig. 260).

REMARKS

The specific status of *D. niveus* has been questionable for very many years. Olenev (1927) stated that the presence in some places of both *D. reticulatus* and *D. niveus* and the absence of transitional forms indicated their specific independence. This specific distinction of *D. niveus* was first confirmed by Nuttall (see Olenev, 1927). Neumann (1897) gave the name of *D. reticulatus niveus* to a variety of *D. reticulatus* on the basis of a fairly large number of specimens in the Paris Museum collected in Persia off sheep and cattle. The only difference noted between *D. niveus* and *D. daghestanicus* is in the posterior margin of the ventral side of the basis capituli, which is concave according to Pomerantzev (1950), while in *D. niveus* it is broadly rounded. This is, however, a moot point. Olenev (1927, 1927a) had described the occurrence of *D. niveus* in European Russia, Western Siberia, Eastern Siberia and Turkestan, and originally (Olenev, 1929) designated *daghestanicus* as a variety of *niveus*. A comparison of *niveus* and Pomerantzev's description of *daghestanicus* leaves me in considerable doubt as to the validity of *daghestanicus*, and until further information is available I prefer to consider these as synonyms.

BIOLOGY

Nuttall (1915) described the individual biology of *D. niveus* under the name of *D. reticulatus* and the following summary is based mainly on these data (from personal notes of Dr G. F. H. Nuttall).

D. niveus has been reported as occurring in the adult stages on wild boars (in Tunisia, Algeria and Spanish Morocco according to Senevet, Colas Belcour and Gil Collado, 1933), horses, cattle, camels, pigs. In Russia Pomerantzev recorded that it had been found on *Cervus bactrianus*, *Hemiechinus albulus* and that it attacks man. The immature stages are found on small mammals such as hedgehogs. It is a three host tick, all stages attaching themselves readily to sheep under experimental conditions. The larva remains feeding on the host for 3-6 days (mostly 4 days), the nymph 6-10 days (mostly 8 days) and the adult female for 9-15 days. The heaviest infestation of adults on the host under natural conditions occurs at the end of April and the beginning of May and a secondary peak of activity in the autumn. When adults are placed upon a host they usually scatter and the male after feeding seeks the female and copulation takes place upon the host. Males tend to wander about and may copulate with several females. Under experimental conditions (at 30° C.) it took 12-19 days for the larvae to emerge from the egg and parasitisation of hosts by the larvae occurs in midsummer (June, July, August). On dropping off from the host the larvae metamorphosed (at 30° C.) to nymphs within 7 days (usually 5) and these are evident on the host at about the same time as the larvae. Twelve days was the normal period required for the nymphs to develop into adults.

Egg laying began, according to temperature, 3-24 days after the gorged and fecundated female had abandoned the host; the process lasting 6-23 days, during which about 4000 eggs were laid per female. Sex-ratio of 191 adults raised: 81 male

and 110 female. Longevity: unfed nymphs survived for 37 days, a male lived 474 days and a female for over 750 days unfed, the ticks being kept in semi-darkness at room temperature. The shortest time required for the completion of the life-cycle would be 80 days, but this period is doubtless considerably prolonged under natural conditions. Serdyukova (1948) suggests that the developmental cycle takes up to one year. A complete summary of the results obtained by Russian workers on *Dermacentor niveus* is given by Anastos (1957).

DISEASE RELATIONSHIPS

D. niveus has been implicated as an important vector of piroplasmiasis of horses (*Piroplasma caballi*) and of nutalliosis (*N. equi*). Zasukhin considered that this tick species was a possible vector of plague (Zasukhin, 1931) and that the larvae and nymphs were implicated in the transmission of *Babesia ninense* to *Erinaceus rumanicus* (Zasukhin, 1936a, b).

Dermacentor everestianus Hirst, 1926

Figs. 263-72

SYN., LIT. AND ICON.

- 1926 *Dermacentor everestianus* Hirst, original description without figures, male only described.
- 1927a *Dermacentor birulai* Olenev, original description, p. 223. Original description reads: 'Couleur brune rougeâtre. Dessin blanchâtre, formant une large bordure et délimitant les sillons latéraux, couvre le reste de la surface à l'exception des sillons, des ponctations et de cinq taches. Hypostome du mâle et de la femelle portant 3/3 files de dents (la file antérieure en a 4/4). Le deuxième article des palpes du côté dorsal postérieure, et munie de deux petites saillies latérales à la surface ventrale postérieure. Ecusson de la femelle plus long que large. Les saillies des trochanters de la première paire des pattes courtes, arrondies. Les hanches IV du mâle allongées, les II et III à deux épines, dont l'interne est large et plate. Les pérित्रèmes du mâle allongées se terminant par une queue rétrécie et très longue. Les pattes du mâle portent à leurs bouts deux épines qui se suivent.' No figures.
- 1929 *Dermacentor birulai* Olenev: Olenev, pp. 310-11. Descriptions of male and female: fig. C 1-4, of coxa I male, leg IV male, spiracle of male, coxa I female.
- 1929 *Dermacentor birulai kukunoriensis* subsp.n. Olenev, original description pp. 311-13. Diagnosis given as 'Scutum longer than broad, abundantly covered with whitish enamel. Hypostome with dentition as 4/4 files (in the first four files) and 3/3 files. The second palpal article devoid of spines and protuberances. Porose areas oval and longer than those of *D. birulai*. The dorsal trochanter spur of the first pair of legs short, rounded. External spurs of coxa I longer than internal spurs. Coxae II and III each with internal and external spurs, the former being broad and flat.'
- 1943 *Conocentor everestianus* Schulze. We consider generic status to be unwarranted.
- 1950 *Dermacentor nuttalli* Olenev: Pomerantzev, p. 144, gives *D. birulai kukunoriensis* as a synonym of *D. birulai*.

MALE. Length of body 4.2 mm., greatest breadth of 2.3 mm. just in front of the spiracle; narrowing anteriorly, broadly rounded posteriorly; eleven festoons, wider and more deeply separated anteriorly. Very heavily ornate (fig. 263).

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Capitulum. Basis capituli about 1.4 times as broad as long (fig. 264). Surface gently convex. Posterior margin straight between the cornua, the latter rounded, broader basally than long; lateral margins straight but markedly undulate. Pattern colour extensive, base colour limited to narrow bands along the dorsal ridge and antero-laterally. Punctations few, of moderate size and depth. Palpi short, palpal article 2 slightly longer than palpal article 3 (ratio of 1.9:1.8), postero-dorsal ridge of article 2 weakly developed, extensive pattern colour and a few punctations present; a few moderately long hairs present at the sides. Hypostomal dentition 3/3.

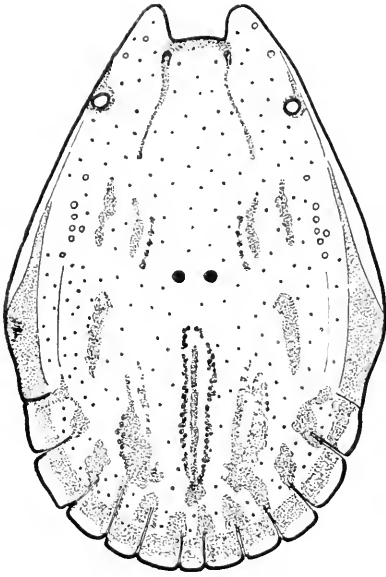
Scutum. Cervical grooves deep, short, smooth; lateral grooves weak, not extending to the posterior margin and not including the festoons, a line of large punctations at the anterior end of the lateral grooves. Large punctations very few, small punctations fine, numerous and present in both the median areas and in the marginal areas outside the lateral grooves. Pattern colour extensive; base colour present around the eyes as narrow longitudinal strips passing posteriorly from the cervical grooves, three short bands on either side mesially of the large punctations; behind the foveae two short lateral bands, extending back but not reaching the front edge of the foremost festoon, behind these bands larger insular lateral patches; between the latter narrow median band, much broken by pigmentation, extending about a third of the scutal length (see fig. 263).

Legs. Increasing in breadth from legs I–IV (cf. figs. 271 *a, b*) and extensively ornate on all surfaces; with few small punctations; femur, trochanter and metatarsus of leg IV broad and undulate ventrally. Dorsal spur on trochanter I broad and pointed. Coxa I with large external spur pointed apically, and not reaching tip of internal spurs; spurs divergent; external spurs on coxae II–IV pointed and longer than their basal widths, internal spurs on coxae II and III reduced to marginal saliences, coxa IV long, narrow with inner margin straight. Pattern colour extensive on coxae I and II, present but more restricted on coxae III and IV. Length of tarsus I 0.6 mm., with distinct subapical pointed spur, succeeded by a smaller ventral spur. Hairs shorter and finer on leg I, longer and more spinose on leg IV.

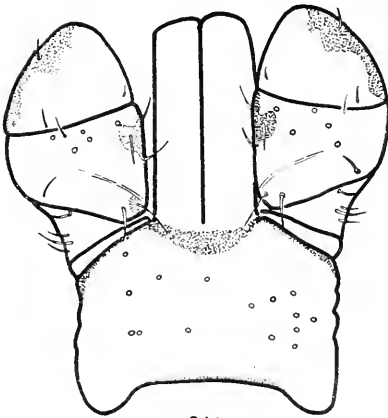
Spiracular plate. Long, with long narrow dorsal prolongation. Goblets small and numerous (fig. 266).

FEMALE. Body: two well-engorged females measured 12 × 8 mm. and 12.1 × 8.1 mm. Alloscutum dark brown, pattern colour more prominent than base colour on scutum, capitulum and legs.

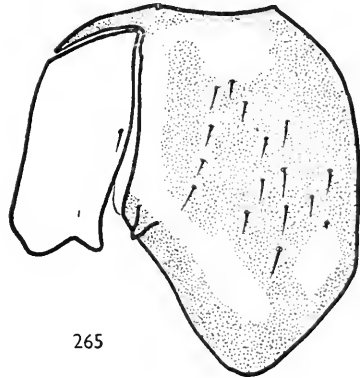
Capitulum. Basis capituli about 1.9 times as broad as long, surface elevated and convex beyond the porose areas, depressed in the median field. Porose areas piriform, slightly oblique to the long axis, strongly depressed. Posterior margin between cornua straight; cornua short, broadly rounded. Lateral margins slightly convergent anteriorly, and continued transversely behind the palpal insertion as a rounded ridge. Pattern colour almost completely covering the basis; base colour limited to narrow bands peripherally on the cornua, and behind the palpal insertion (fig. 267). Palpi



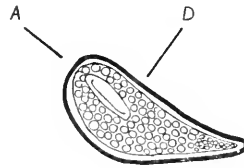
263



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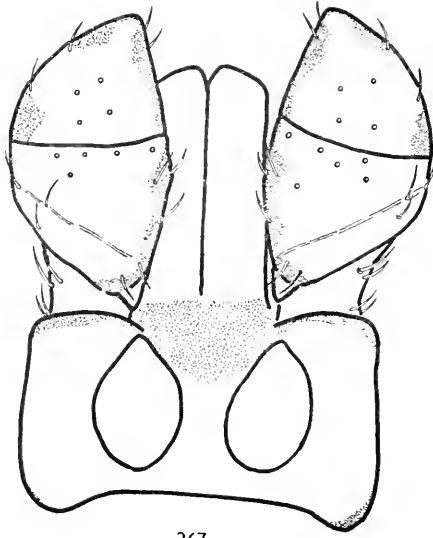


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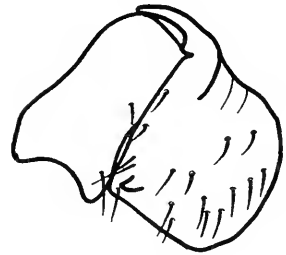


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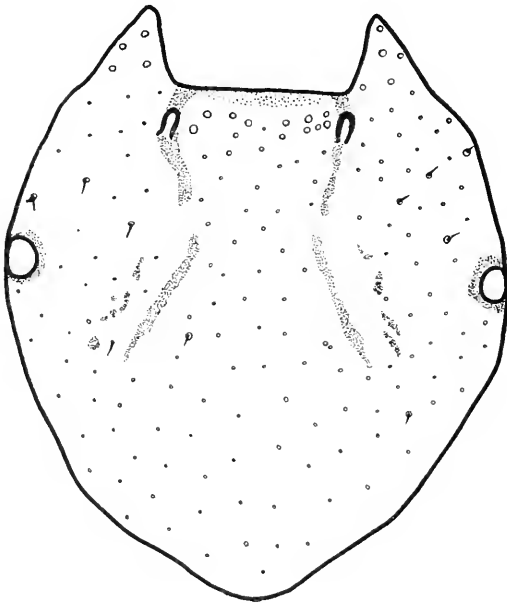
Figs. 263-6, *Dermacentor everestianus*. MALE: 263, scutum; 264, capitulum, dorsal; 265, coxae I-IV; 266, spiracle.



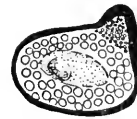
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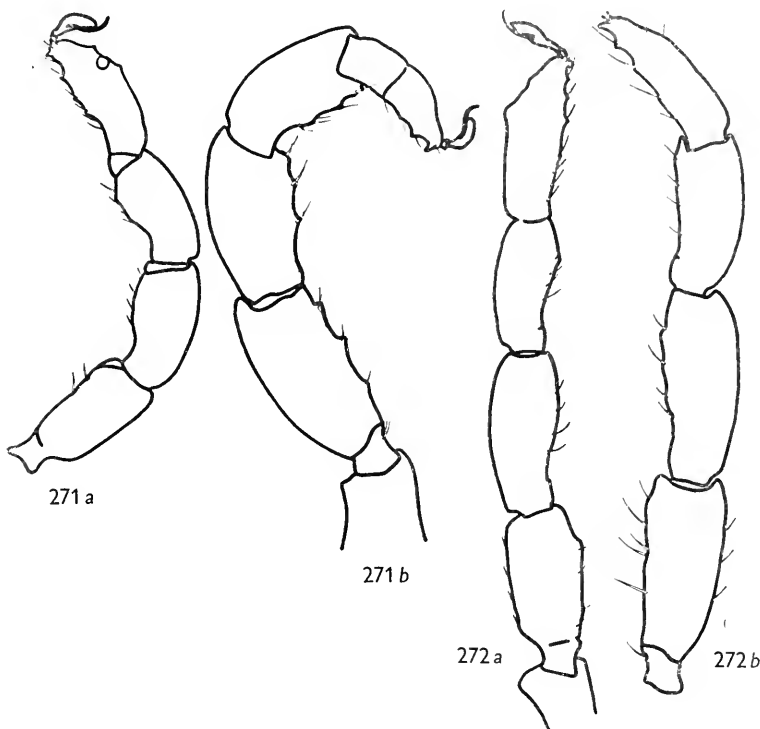


270

Figs. 267-70, *Dermacentor everestianus*. FEMALE: 267, capitulum, dorsal; 268, scutum; 269, coxae I-IV; 270, spiracular plate.

D. EVERESTIANUS

longer than in male, combined lengths of articles 2 and 3, 0.5 mm.; article 2, 0.27 mm., article 3, 0.23 mm.; breadth across article 2, 0.29 mm. Postero-dorsal ridge of article 2 weak; a narrow transverse groove extends diagonally across article 2; article 3 subtriangular with sharp meso-apical angle. Heavily patterned except along the inner dorsal margins of articles 2 and 3 and around the apex of article 3. Palpal hairs of moderate length.



Figs. 271-2, *Dermacentor everestianus*. 271a, leg I of male; 271b, leg IV of male; 272a, leg I of female; 272b, leg IV of female.

Scutum (fig. 268). Length about 1.95 mm., greatest width of about 1.6 mm. across the eyes, with postero-lateral margins faintly sinuous and posterior margin angulate. Cervical grooves deep and short. Large punctations, few and limited to the front edge between the scapulae, and antero-laterally; smaller punctations very numerous and uniformly distributed over the surface, disparity of sizes moderate. The pattern colour more extensive than the base colour, the latter being present posterior to the emargination, in the cervical grooves, around the ocular spots, in two diagonal marks median of the eye spots; lateral to these diagonal marks are two diffuse patches as in fig. 268.

Postscutal area. Marginal grooves pronounced and not delimiting the festoons.

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Legs. Increasing only slightly in width from leg I to IV; coxae much as in male except that the external spurs are short and broad, the external spurs on coxa IV slightly upturned. Length of tarsus I 0.7 mm.; tarsi I and IV provided with sub-apical spur and with three ventral spurs on I, and one ventral spur on IV. Hairs longer and more spinose on tarsus IV than on tarsus I (fig. 272a, b).

Spiracular plate. Broadly rounded and produced dorsally into a short rounded spur, length 0.43 mm., greatest breadth 0.37 mm. Goblets small to moderate in size, becoming granular in the dorsal projection.

REMARKS

This species was originally described from a single male by Hirst and collected at Tinki Dzong, Tibet (alt. 15,000 ft.). This type has one palp and half the capitulum poorly developed. Hirst stated that a longer description and figures would be presented in a later publication, but as far as I am aware this was not done. Our description is based on the type: one female from Rongbuk, Tibet, 25 May 1924, 16,500 ft., Mt Everest Expedition 1924. Major R. W. G. Hingston *leg.*; and one male, Tinki Dzong, Tibet, 2 May 1924, 15,000 ft., Mt Everest Expedition 1924, Major R. W. G. Hingston *leg.* Also one male and two females collected from sheep at Dochin (alt. 14,700 ft.), Tibet, 19 August 1931, C. Strickland *leg.* All these specimens are now deposited in the British Museum (Natural History).

Having carefully checked Olenev's description of *D. birulai*, which lacks adequate figures, I am of the opinion that it is synonymous with *D. everestianus* of Hirst. Added support to this contention is also supplied by the fact that both Olenev and Hirst reported the species in question from Tibet. Olenev's records are from Eastern Tibet, 'basin of the river Goluboi: upper part of the R. Re-Chu, 12,700 ft, II. 1901, male, female; R. Yulin-Chu, Bana Azshun, river Er Chu, 11,500 ft, male (P. K. Kozlov *leg.* 1902).'

BIOLOGY AND DISEASE RELATIONSHIPS. Nothing known.

Dermacentor nuttalli Olenev, 1928

Figs. 273-88

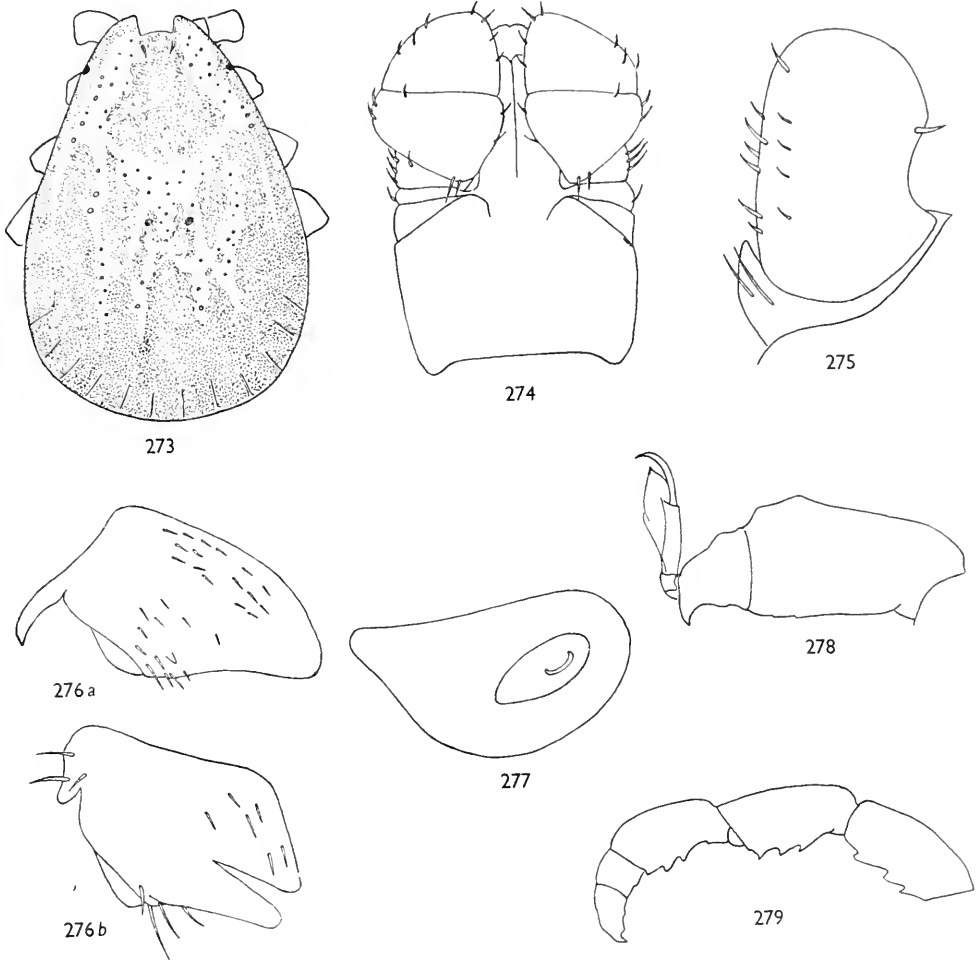
SYN., LIT. AND ICON.

- 1928 *Dermacentor nuttalli* Olenev, *nomen nudum*.
1929 *Dermacentor nuttalli* Olenev, original description, which validates *nomen nudum*, pp. 311-13.
1929 *Dermacentor birulai* subsp. *kukunoriensis* Olenev. Considered as a synonym of *Dermacentor nuttalli* (see Pomerantzev, 1950, p. 144).
1931 *Dermacentor nuttalli* Olenev, pp. 86-7.
1934 *Dermacentor chacassicus* Degtarev. A synonym of *D. nuttalli*.
1946 *Dermacentor nuttalli* Olenev: Pomerantzev, pp. 5-19.
1950 *Dermacentor nuttalli* Olenev: Pomerantzev, pp. 144-9.

MALE. Body elongate oval, narrowing anteriorly. Pattern colour relatively poorly developed.

D. NUTTALLI

Capitulum. Basis capituli of the typical form, broader than long in the ratio of about 1.0:0.75 (fig. 274). Posterior margin slightly concave; cornua slight; lateral margins straight and slightly divergent to palpal insertion. Palpi with outer margins broadly curved, postero-dorsal ridge moderately developed, ventral spur on palpal segment 3 lacking.

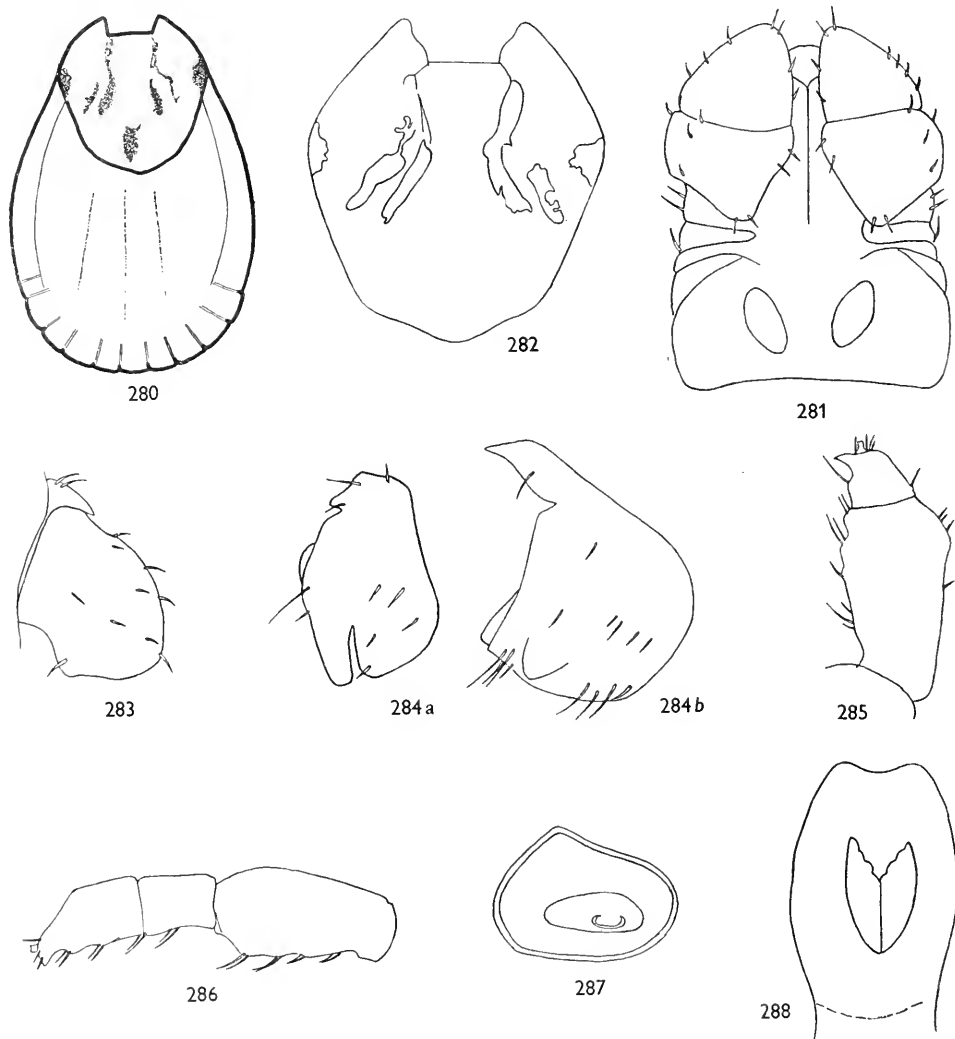


Figs. 273-9, *Dermacentor nuttalli*. MALE: 273, scutum; 274, capitulum, dorsal; 275, trochanter and trochanter spur; 276 a, coxa IV; 276 b, coxa I; 277, spiracular plate; 278, tarsus I; 279, leg IV.

Scutum. Elongate oval (fig. 273). Base colour predominating, pattern colour arranged as a blotch between the cervical grooves which at about one-third the scutal length give off antero-lateral arms of enamel to the periphery; beyond this division the pigment is continued posteriorly and encloses the foveae before splitting up into four branches which do not usually reach the festoons. Lateral to each fovea is an

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island of base colour, bordered laterally by a linear extension of pigment colour. Punctations mixed, the larger punctations being confined to the anterior half. Lateral grooves, demarcated by large confluent punctations; they do not cut off the festoons.



Figs. 280-8, *Dermacentor nuttalli*. FEMALE: 280, dorsum; 281, capitulum, dorsal; 282, scutum; 283, trochanter and trochanter spur; 284a, coxa I; 284b, coxa IV; 285, tarsus I; 286, tarsus and metatarsus of leg IV; 287, spiracular plate; 288, genital aperture and wing-like extensions.

Legs. Broad, strong and of moderate length (fig. 279). Coxa I relatively short, external spur broad, rounded or flattened distally and almost reaching the tip of the internal spur (fig. 276b). Dorsal spur on trochanter I almost absent (fig. 275). Trochanters I-III have small rudimentary spurs ventrally. Tibia and tarsi IV with three pairs of ventral spurs (fig. 279).

Spiracular plate. Drawn out posteriorly into a small, subtriangular dorsal process (fig. 277); margin of plate lacks dorsal thickening.

FEMALE

Capitulum. Basis capituli almost twice as broad as long. Posterior margin undulate, cornua lacking or only as very weak protuberances. Lateral margins slightly curved. Porose areas elongate oval, obliquely set to the long axis of the body; interporose interval greater than the maximum breadth. Palpi with outer margins broadly rounded; inner margin of article 2 sinuous, that of article 3 almost straight (fig. 281).

Scutum. Ovate in outline as figured (fig. 280). Margins in front of the level of the eyes convex, behind this level margins angular. Punctations mainly small, with few scattered larger punctations. Pattern colour predominates and is extensive, the base colour localised into two parallel blotches in the region of the cervical grooves, around the eyes and in some specimens a spot in the posterior third of the median field.

Legs. Thick and of moderate length. First pair of coxae small, external spur relatively broad and bluntly rounded apically; extends as far as the apex of the internal spur (fig. 284a). External spurs on coxae II–IV all of approximately equal length; those of coxa IV do not extend beyond the posterior margin of the coxa (fig. 284b). Dorsal trochanteral spur short and broadly rounded, rather weak (fig. 283). Ventral trochanter spurs lacking or only weakly defined.

Genital aperture. Bounded by wing-like projections (fig. 288).

RELATED SPECIES

Pomerantzev (1950) stated that *Dermacentor nuttalli* is phylogenetically very close to *D. everestianus* (= *D. birulai* of Olenev) found in Central Asia.

BIOLOGY

Under laboratory conditions the adult female feeds for 5–17 days on rabbits and 5–13 days on guinea pigs (Petrova-Piontkovskaya, 1941), and about 4 days after engorgement and dropping to the ground, egg laying commences. The actual period of egg laying extends on average over three weeks. The eggs hatch about 24 days after being laid and the emerging larvae are ready to feed after 3 or 4 days. Feeding lasts for 5–8 days and moulting to the nymphs occurs some 5–8 days after dropping from the host. The feeding time of the nymphs was similar to that of the larvae. Moulting of the nymphs to the adults is correlated with temperature; thus at 24° C. the time was 11–12 days, at 18° C. 20–5 days and at 10–13° C. 51–73 days.

Larvae and nymphs generally parasitise small mammals such as field mice, rats, marmots, hamsters, hares, cats and dogs, and their occurrence on these hosts extends from the middle of June to the middle of August. The adults of *D. nuttalli* are found on larger hosts such as horses, cattle, camels, sheep, dogs and man, occurring on these hosts in high numbers in the spring and in lesser numbers in the autumn. The maximum of the spring peak occurs from the end of April to the first fortnight of May.

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Males and females, although occurring on the hosts in autumn, are reported not to feed and they overwinter in this state. Dubinin (1948) further stated that nymphs probably spend the winter on cattle. The vast majority of the adults do, however, spend the winter off the host in the nooks and crannies of the steppe vegetation.

DISEASE RELATIONSHIPS

D. nuttalli has been implicated in the transmission of human and swine tick typhus and is probably a vector of nuttalliosis of horses. In experimental studies the virus of spring-summer encephalitis persisted in the adult ticks, and transovarian transmission to the larvae of the second generation is reported by Chumakov, Petrova and Sondak (1945).

Dermacentor marginatus Sulzer, 1776

Figs. 289-307

SYN., LIT. AND ICON.

- 1776 *Acarus marginata* Sulzer, original description in *Abgekürzte Geschichte der Insekten*.
1897 *Dermacentor reticulatus* pro parte Neumann, p. 363.
1911 *Dermacentor reticulatus* pro parte Neumann, p. 26.
1931 *Dermacentor silvarum* pro parte Olenov, p. 4.
1933 *Dermacentor marginatus lacteolus* Schulze, pp. 423-4.
1946 *Dermacentor marginatus* Sulzer: Pomerantzev, p. 17.
1950 *Dermacentor marginatus* Sulzer: Pomerantzev, pp. 150-5.

Description mainly after Pomerantzev (1950).

MALE. Body elongate oval, narrowing in the anterior half. Generally very ornate but varying in the intensity of the pattern colour (fig. 290).

Capitulum. Basis capituli rectangular in shape, broader than long in about the ratio of 1.05:0.8. Posterior margin concave, with moderately well developed broad cornua, whose basal breadths exceed their lengths (fig. 289). Lateral margins almost straight and parallel. Outer margin of palpal article 3 curved, inner margin straight; outer margin of palpal article 2 angled to the mid-line at about half its length, inner margin almost straight; very short broad dorsal spur on article 2. Article 3 lacks the ventral spur.

Scutum. Silver enamel punctation vague and variable, but generally distributed as shown in fig. 290. Punctations of two sizes, large and small, which are unevenly distributed. Lateral grooves well defined and carrying large punctations, not delimiting any of the festoons.

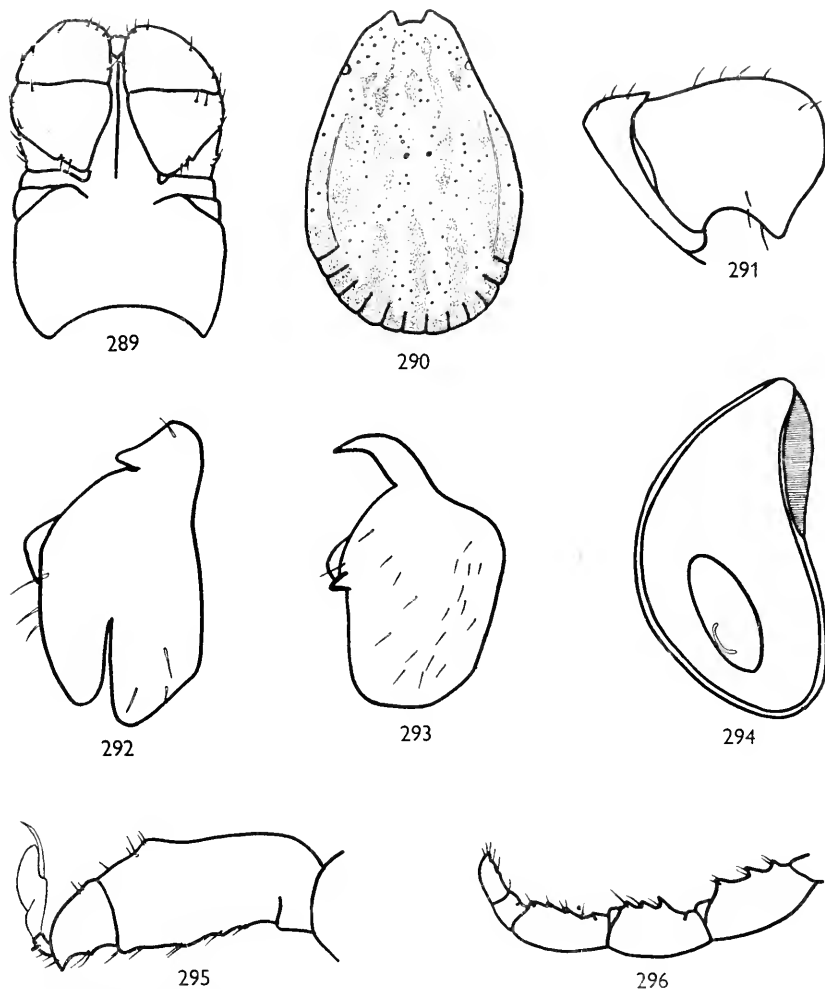
Legs. Short, broad. Coxa I relatively short; external spurs on coxa I broad, rounded apically and not reaching postero-internal edge of the internal spur (fig. 293). External spurs on coxae II-IV of similar size, those on IV extending beyond the posterior limits of the coxae (fig. 293). Trochanter I with prominent, tapering dorsal spur (fig. 291). Small ventral spurs on trochanters II and III. Tibia and tarsi IV with three pairs of ventral spurs (fig. 296).

Spiracular plate. Ovate in outline with the dorsal process well defined and curved up to the scutal margin, chitinous margin with strong dorsal thickening (fig. 294).

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FEMALE

Capitulum. Basis capituli about twice as broad as long (fig. 297). Posterior margin almost straight, cornua very short and broad. Lateral margins curved to palpal insertion. Porose areas oval and diverging anteriorly, interporose interval about equal



Figs. 289-96, *Dermacentor marginatus*. MALE: 289, capitulum, dorsal; 290, scutum; 291, trochanter and trochanter spur; 292, coxa I; 293, coxa IV; 294, spiracle; 295, tarsus I; 296, leg IV.

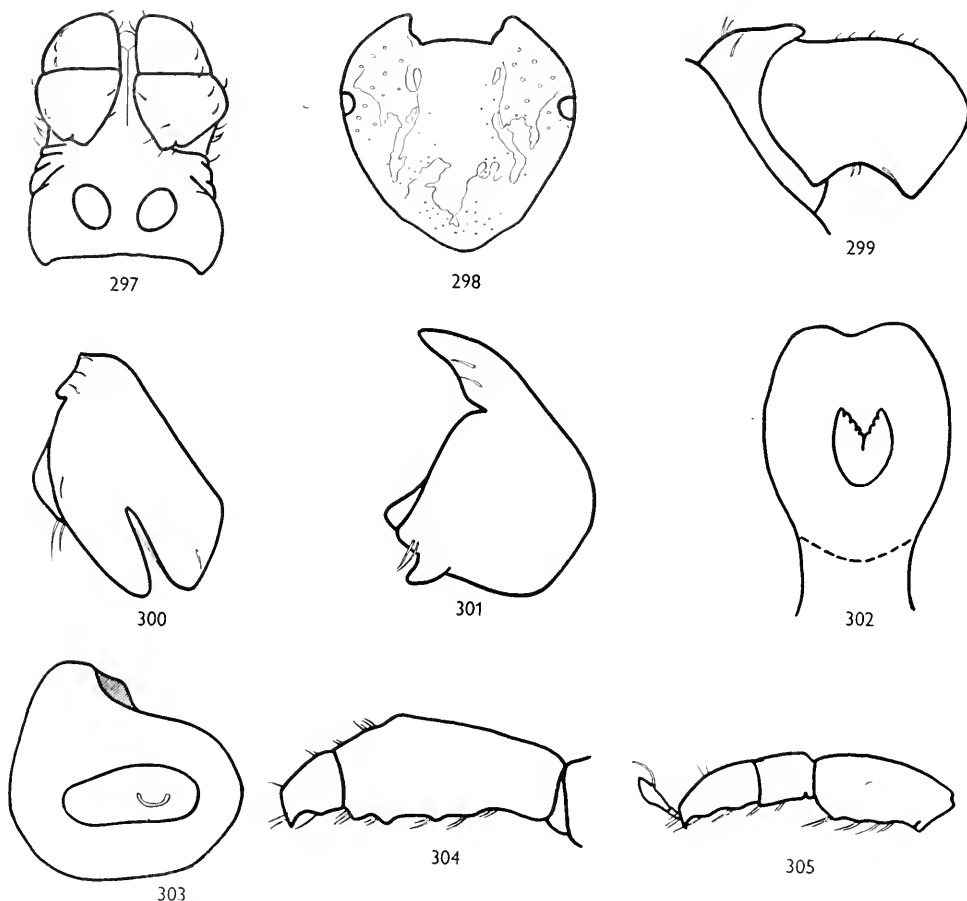
to less than the maximum breadth of one area. Outer margins of palpal articles 2 and 3 broadly rounded, with short broad spur postero-dorsally on article 2; inner margins of both articles almost straight.

Scutum. Attaining its greatest width at the level of the eyes, antero-lateral margins broadly convex, behind the eyes the curvature is stronger with an appreciable

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narrowing in the posterior third (fig. 298). Enamel pigment rather irregular; many blotches of pattern colour more particularly in the region of the eyes.

Legs. Coxa I small, external spur broad and in most specimens not reaching postero-internal angle of internal spur, divergent (fig. 300). External spurs on coxae



Figs 297-305, *Dermacentor marginatus*. FEMALE: 297, capitulum, dorsal; 298, scutum; 299, trochanter and spur; 300, coxa I; 301, coxa IV; 302, genital aperture; 303, spiracle; 304, tarsus I; 305, metatarsus and tarsus IV.

II-IV of similar size to those of IV, curving outwards and reaching beyond the posterior limit of the coxae (fig. 301). Trochanter I with well-developed dorsal spur (fig. 299). Ventral spurs of trochanters II-IV poorly developed. Tarsi as figured (figs. 304, 305).

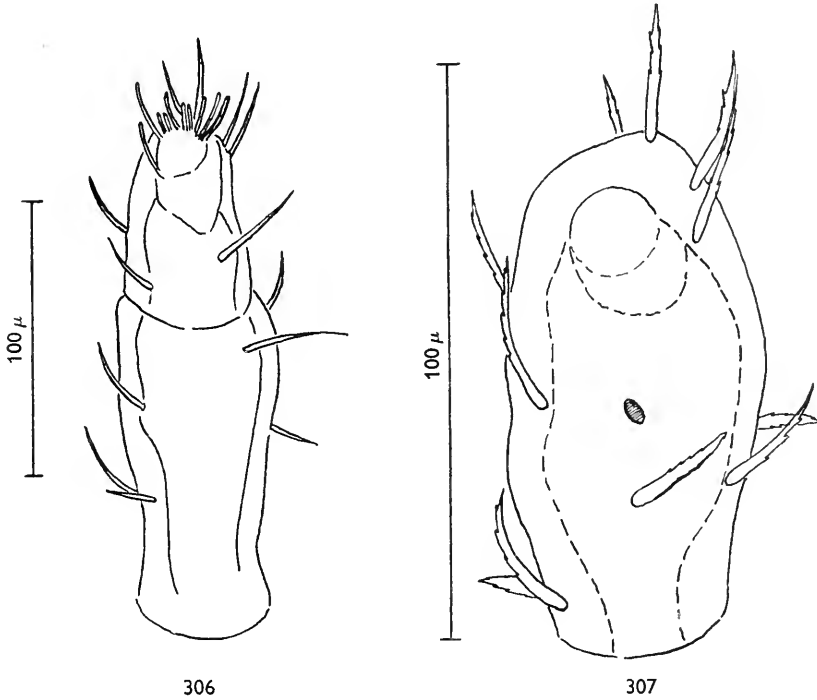
Spiracular plate. Longitudinally oval, sharply curved dorsal process with a pronounced dorsal thickening (fig. 303).

Genital aperture. Bounded by well-defined alar extensions.

D. MARGINATUS

IMMATURE STAGES

Nymphs of *D. marginatus* are readily separated from those of *D. reticulatus* by having palpal article 2 half as long again as that of 3 when viewed ventrally; fewer than forty bristles on the scutum. In the larva there is a single dermal sensilla on the palp dorsally; the postero-median pair of scutal bristles are not longer than 40μ (Černý, 1957).



Figs. 306-7, *Dermacentor marginatus*. 306, ventral view of palp of the nymph; 307, dorsal view of the larval palp to show the position of the dermal sensilla.

BIOLOGY

The Russian literature on the hosts and seasonal activity of this species is extensive and is summarised by Anastos (1957) but the most up-to-date work in Europe is limited and surveyed by Mačička, Rosický & Černý (1955). The species occurs in both lowland and mountain steppe in Russia and Central Europe, particularly where agricultural treatment of pastureland is deficient, and where there is a reversion to scrub conditions. Mačička *et al.* report that this tick can be collected from the vegetation and also on low-growing shrubs about 20-50 cm. above ground. In Russia the reported hosts of the adult ticks are horses, cattle, sheep, dog, man, deer, hare, buffalo, donkey, swine, hedgehog, camel and wolf. In Central Europe the major hosts are horned cattle, sheep and goats, and the immature stages occur most frequently on

EURASIATIC SPECIES OF *DERMACENTOR*

Microtus arvalis, although other rodent species are quite heavily infested, notably *Eliomys quercinus*, *Muscardinus avellanarius*, *Apodemus microps* and *A. flavicollis*. The hosts of the immature stages in Russia are *Cricetus cricetus*, *Arvicola terrestris sylvaticus*, *Apodemus flavicollis*, *Dyromys nitedula*, *Microtus arvalis*, *Clethrionomys glareolus*, *Lepus europaeus*, *Vulpes vulpes*, *Lagurus lagurus*, *Mustela nivalis*, *Putorius eversmanni*, *Alactaga jaculus*, *Erinaceus rumanicus*, *Citellus suslica*, *Sorex areneus*, *Apodemus agrarius*, *Neomys fodiens*, *Rattus norvegicus*, *Sicista nordmanni* and *Spalax mirophthalmus*.

Adults of *Dermacentor marginatus* were active in the spring and again in the autumn in Central Europe and in Russia, with the exception of Transcaucasia, where the ticks were active through the year but predominantly so from February to March and again from August to November (Pomerantzev & Matikashvili, 1940). Egg laying commenced 7–12 days after the adult females dropped off the hosts, with an optimum of 12 days. Larval development within the egg lasts for about three weeks. The feeding period of the larvae is related to their ages; thus young larvae tend to feed faster than older larvae: in the age group of 2–25 days the feeding time varies from 2–5 days; in the group of 36 days feeding extends over 3–7 days, and in larvae of 57–65 days engorgement is complete in 4–10 days. Larvae and nymphs were active in June to August both in Russia and Central Europe, with the maximum occurring later in the latter. In general the larvae are numerically predominant in June and July and the nymphs in July and August. Pomerantzev suggested that in view of the sequence of attack by these tick stages that the developmental cycle is completed in one year, a view which is supported by Serdyukova's observations (1948).

REMARKS

The subspecies *D. marginatus lacteolus* which was established by Schulze in 1933 differs from the typical species only in the base colour of the body which is yellow-brown and the greater thickness of the white ornamentation of the scutum. To date this subspecies has been collected in Sardinia, Spain (Pantazi, 1947), Rhodes (Paoli, 1917), Sicily (Starkoff, 1957). Starkoff (*loc. cit.*) agrees with the author in believing that the subspecies *lacteolus* is a case of colour variation and that it is synonymous with *marginatus*.

DISEASE RELATIONSHIPS

Dermacentor marginatus is a recognised vector of nuttalliosis and piroplasmosis of horses, and according to Pomerantzev transmits horse encephalomyelitis, sheep brucellosis, tularaemia, theilleriosis, babesicellosis and anaplasmosis of sheep. It has also been suggested that this tick is the probable reservoir and vector of the plague virus and of tularaemia of man and domestic animals.

Dermacentor pomerantzevi Serdyukova, 1951

Figs. 308-17

LIT. AND ICON.

1951 *Dermacentor pomerantzevi* Serdyukova, original description based on one female, pp. 909-12, 10 figs.

FEMALE. Overall length 2.6 mm., reddish brown with indistinct spots of enamel on the scutum.

Capitulum (figs. 308, 309). Basis capituli about 2.5 times as broad as long, almost rectangular when viewed dorsally. Posterior margin straight, cornua broader basally than long and tapered; lateral margins almost straight but indented at about mid-length. Porose areas elongate oval, sharply tapered posteriorly, strongly divergent anteriorly; interval between the porose areas about equal to the greatest breadth of one of them; deeply depressed. Palpi broad and when at rest folded over the chelicerae; article 2 almost triangular in outline, lateral margin rounded and lacking the meso-dorsal spur, about 1.6 times as long as article 3; article 3 also triangular and sharply tapered to the apex, outer and inner margins gently convex. In ventral view basis capituli almost semicircular and bearing posteriorly two ventral spurs, subtended by a pair of hairs in front of and lateral to the spurs. A single pair of hairs antero-laterally. Palpal article 1 bears four bristles on its inner margin, article 2 subrectangular and bearing two pairs of setal bristles as in fig. 309, article 3 subtriangular. Hypostome broad, with one partial and three complete longitudinal rows of relatively small denticles.

Scutum (fig. 310). Very broad, about 1.2 times as broad as long, with the greatest breadth well in front of mid-length. Antero-lateral margins concave immediately behind and lateral to the scapulae, before becoming convex in front of the eyes; behind the eyes the margins are rectilinear and converge to an almost pointed posterior margin. Surface with a slight depression in the mid-line, antero-lateral margins downcurved and overlapping the surface of the body. Cervical grooves discontinuous, anteriorly they are elongate and deep, posteriorly the grooves diverge and almost reach the postero-lateral margins. Punctations of two kinds, large ones which are concentrated in the lateral margins, smaller ones sparse and uniformly distributed. Hairs few, short and set in deep depressions.

Postscutal area. Bears longitudinal rows of short pale bristles.

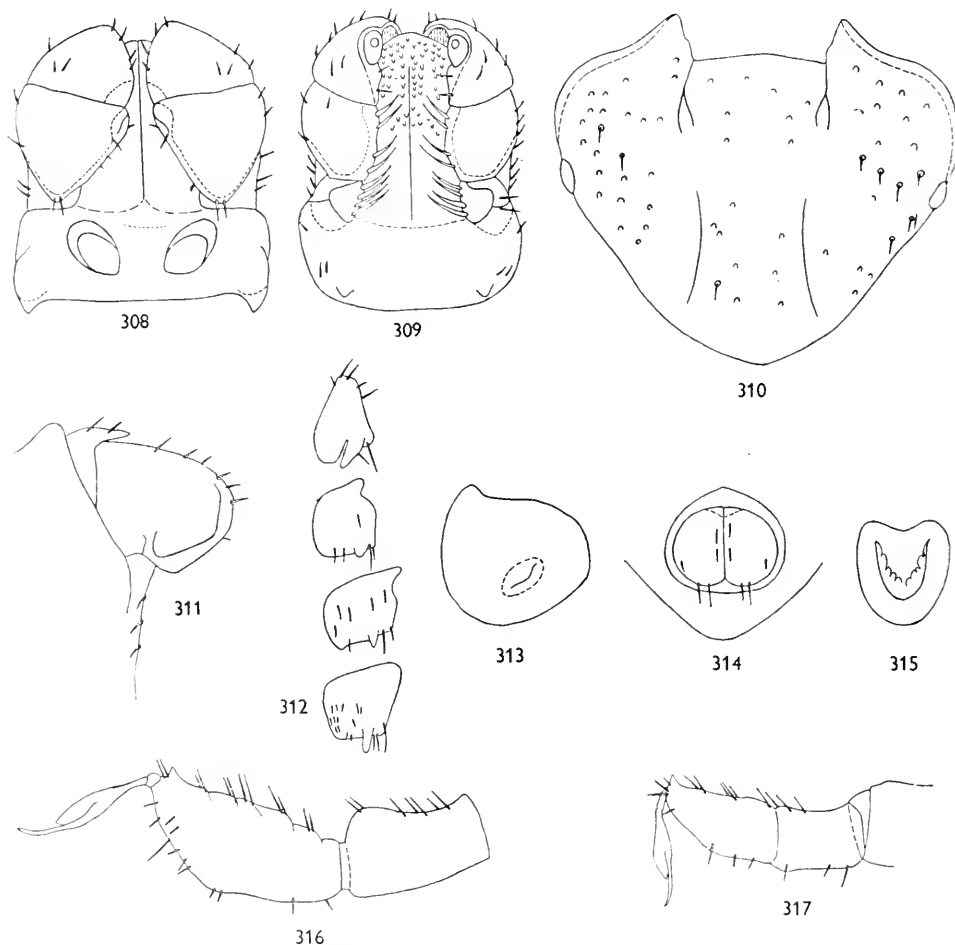
Legs. Rather long, thin and yellow in colour. Coxa I bifid with external spur reaching almost to tip of inner spur (fig. 312). Coxae II-IV of approximately same size, external spurs projecting beyond posterior margins of coxae, that of coxa IV being very much longer and narrower. Trochanter spurs blunt and slightly developed (fig. 311). Tarsi bear subapical spurs, with ventral surface undulate and bearing spines. Claws very much longer than the pulvilli (fig. 316).

Spiracular plate (fig. 313). Small, wide almost oval with a small dorsal process, margin without thickening; the macula antero-ventrally placed; goblets numerous, being small around the macula and large near the periphery.

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Genital aperture (fig. 315). Wide, oval, with lateral alae; grooves subparallel to the level of anus, thence divergent to the edge of the extreme festoons.

Anal groove. Deep and angular (fig. 314).



Figs. 308-17, *Dermacentor pomerantzevi*. FEMALE: 308, capitulum, dorsal; 309, capitulum, ventral; 310, scutum; 311, trochanter; 312, coxae I-IV; 313, spiracular plate; 314, anal plates; 315, genital aperture showing the wing-like outgrowths; 316, tarsus I; 317, tarsus IV.

HOSTS

This species was described from a single female and collected from the hedgehog in the Dulovsha region of Stalingrad. G. R. T. Shatas *leg.* 14 August 1949.

REMARKS

Serdyukova (1951) has suggested that *D. pomerantzevi* has pronounced affinities with Schulze's subgenus *Indocentor* (see under *Dermacentor auratus*) but its systematic position, on the basis of one female only, is not clearly defined. This species is readily

D. POMERANTZEVI

separated from *D. nuttalli* by dimensions, the degree of development of the white pigment, by the scutal form, the shape of the basis capituli and presence of the ventral spurs. This latter feature is characteristic of the larvae and nymphs of this genus. The form of the coxae, the structure of the palpi and the well-developed cornua are adequate criteria for separating *D. pomerantzevi* from *D. sinicus*. Biologically *D. pomerantzevi*, *D. sinicus* and *D. antrorum* have a common feature in that they parasitise small mammals, hedgehogs and voles.

Dermacentor auratus Supino, 1897

Pl. II, figs. 5, 6; Figs. 318-36

SYN., LIT. AND ICON.

- 1897 *Dermacentor auratus* Supino, original description, p. 235, pl. XIII, fig. 14.
1897 *Dermacentor auratus* Supino: Neumann, p. 382, female.
1901 *Dermacentor compactus* Neumann, p. 268 (*pro parte*).
1905 *Dermacentor auratus* var. *compactus* (Neumann): Neumann, p. 236 degrades *compactus* to a variety.
1906 *Dermacentor atrosignatus* Neumann, p. 210, fig. 12, male dorsum (see figs. 331-6 of the present work).
1911 *Dermacentor auratus auratus* Neumann, p. 103.
1911 *Dermacentor auratus compactus* (Neumann): Neumann, p. 103 as subspecies.
1933 *Indocentor* Schulze. A new genus erected (with *Dermacentor auratus* Supino 1897 as the type species) for species limited to India, China and the East Indies.
This new genus of Schulze included *Dermacentor compactus* Neumann 1901, *Indocentor compactus tricuspis* new subsp., *I. confractus* n.sp., *Dermacentor atrosignatus* Neumann 1916, *Indocentor steini* n.sp. and *I. steini leviculus* n.subsp. Schulze in 1935 described *I. bellulus* n.sp. and altered the spelling of *confractus* to *confragus*. Sugimoto (1937) reduced *bellulus* of Schulze to a synonym of *atrosignatus* Neumann, and in 1939 Schulze proposed the name of *ater* for the New Guinea tick previously identified as *atrosignatus*. *I. compactus sumatranus* Schulze 1939, new subsp. from Sumatra.
1950 *Indocentor* as a synonym of *Dermacentor*, Anastos, p. 51.
1950 *Dermacentor atrosignatus* Neumann: Kohls reported that Schulze, in personal communication to him, stated that '*atrosignatus* of Neumann is either *auratus* or *compactus* and that without the type it would be impossible to come to a decision'.
1950 *Indocentor* Schulze: Pomerantzev, p. 131, does not consider *Indocentor* to merit generic status but recognises it as a subgenus.

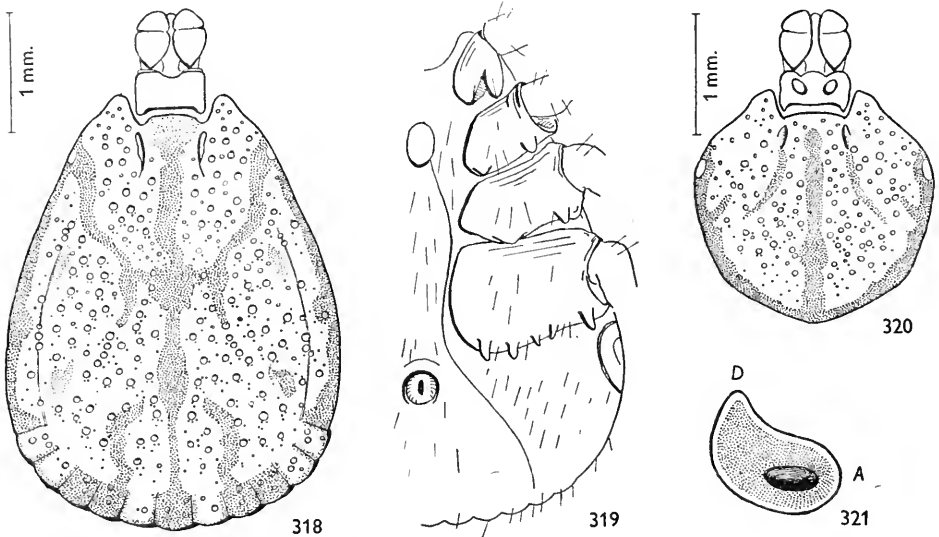
MALE. Highly ornate on scutum, capitulum and legs (pl. II, fig. 5; fig. 318).

Capitulum. Basis rectangular, twice as broad as long; ornate dorsally, with mixture of fine and moderate punctations; posterior margin straight, cornua short, broad and blunt, lateral margins weakly curved and either parallel or slightly divergent to the palpal insertion. Palpi massive and longer than basis; length of article 2 to article 3 as 2.0:1.5; postero-dorsal ridge of article 2 pointed and outer margin of this article sharply angled at about its mid-length, inner margin of article 2 curved, both margins of article 3 convex, apex broadly rounded, article 1 almost completely concealed by the posterior prominence of article 2. Ventrally basis more or less rectangular, postero-

EURASIATIC SPECIES OF *DERMACENTOR*

lateral angles rounded, ventral ridge distinct: article 1 triangular with normal palpal setae. Hypostome short, spatulate, dentition 3/3 (figs. 324, 325).

Scutum (pl. II, fig. 5; fig. 318). Variable in shape, from almost a circular pattern to an elongate oval, when the greatest width may be at mid-length or in the posterior third. Length and breadth variable from 4.2×3.6 mm. to 3.6×2.8 mm. in specimens we have seen. Variable brown base colour markings all more or less raised, the brown lines typically define the pseudoscutum and posteriorly form a long streak, of variable width, down the mid-line; two incomplete posterior markings, on either side of the mid-line, stand second from the middle festoon; lateral margins partially offset by



Figs. 318-21, *Dermacentor auratus*. MALE: 318, dorsal view; 319, male, ventral view; 320, scutum and capitulum of female; 321, spiracle of male.

peripheral brown pigmentation extending back to anterior festoon; antero-lateral lines from the mid-line stripe fuse with peripheral stripes in the ocular region; variable smaller patches of brown in lateral field; some of these lines are often obsolete. Pattern colour white.* Punctations variable on pseudoscutum, and usually missing from dark brown raised surfaces. Elsewhere very numerous and of two very different sizes, many very large ones interspersed by others which are extremely minute. The large punctations may occur all over the pseudoscutum or they may be rather few in number in the median posterior field (as in Neumann's variety '*compactus*'). Cervical grooves deep, short, wider in front than behind, may be continued back as brown stripes (this is, however, variable). Lateral grooves indicated by a single line of large punctations which commence just behind the eye. Festoons generally all more or less ornate,

* Neumann, 1905, p. 236, found no justification for the name '*auratus*' as the ornamentation is white, not golden yellow; the metallic spots figured on the abdomen and legs of the female by Supino 'do not exist'.

D. AURATUS

but the submedians and the two extremes on either side the most persistently so; longer than broad and separated by deep white grooves. *Venter* lighter in colour, hairs short and inconspicuous: genital opening between coxae II; anal opening on level with spiracles; genital groove undulate, becoming widely divergent at level of anus (fig. 319).

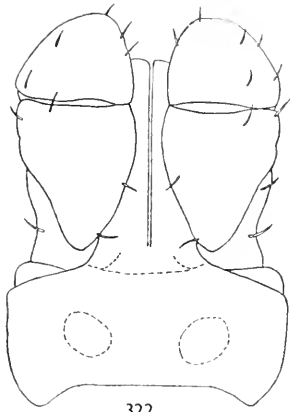
Legs. Large, thick, ornate, punctate (pl. II, fig. 5). Coxa I with two short, rounded, not very dissimilar spurs, well separated (fig. 319); coxae II and III with conical, rounded external and blade-like internal spurs; coxa IV much enlarged transversely (i.e. in length) and not antero-posteriorly, posterior border slightly undulate, broader basally than distally, bearing a small tapering external spur extending beyond the posterior edge of the coxae and a varying number of denticles (usually 3 or 4) postero-internally. Dorsal spur on trochanter I moderate, pointed, ornate. Tarsus I with long proximal part and short distal part, tarsus IV rather cylindrical, only tapering slightly distally and bearing three ventral spurs (fig. 330).

FEMALE

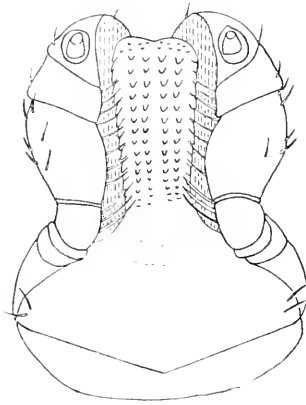
Capitulum. Basis rectangular, lateral margins straight or weakly curved, postero-lateral angles rounded before passing into distinct cornua. Latter very much broader basally than long. Porose areas variable, usually oval, deep and relatively small, interporose interval about equal to or exceeding their greatest diameter. Palpi long when compared with the male (fig. 322), ratio of length of article 2 to article 3 as 1.1:0.6; article 2 narrows and tapers appreciably along the proximal half, postero-dorsal ridge well developed, article 3 much as in the male. Ventrally basis broad, postero-lateral and posterior borders gently convex, ventral ridge prominent, with a tendency to be pointed in the mid-line. Palpal article 1 bears three long curved palpal setae. Hypostome short, lateral margins converging slightly to base, indented apically, dentition 3/3 for about 14-15 rows (fig. 323).

Scutum. Of variable shape and ornamentation, usually at least as broad as long and with little angularity of outline, widest slightly in front of mid-length (pl. II, fig. 5; fig. 320). All brown markings devoid of punctations: brown markings arranged as a longitudinal median strip, extending nearly to the front margin of the scutum; distinct sinuous cervical stripes on each side of the mid-line, not attaining lateral margins; peripheral brown marking extending from slightly in front of the eye posteriorly as a continuous border to the scutum. Punctations of two different sizes, the numerous larger punctations deep, extensively developed in patterned regions, may sometimes be absent in median posterior region. Smaller punctations very fine, uniformly distributed in scapular and posterior regions. Cervical grooves deep at their origin and far apart, may be either convergent or divergent; eyes large, flat, nearer anterior end of scutum.

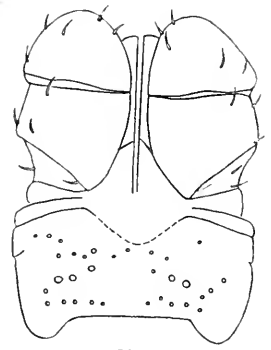
Postscutal area. Thick white hairs arise from many large punctations; distinct long marginal groove, cuts off three anterior festoons completely and also part of fourth. Festoons distinct, slightly longer than broad, white hairs in or near grooves separating



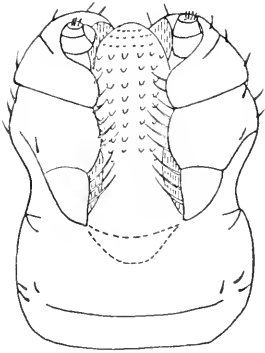
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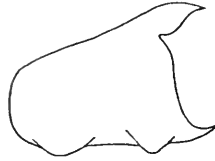
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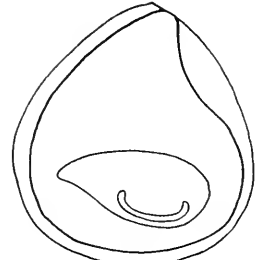
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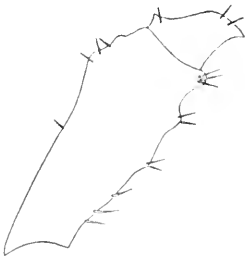
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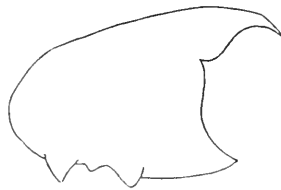
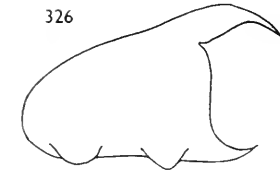
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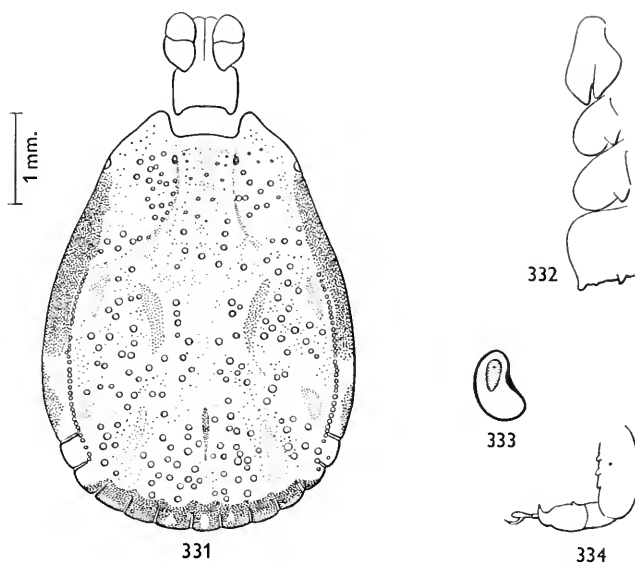
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Figs. 322-30, *Dermacentor auratus*. 322, dorsal surface of capitulum of female; 323, ventral surface of same; 324, dorsal surface of capitulum of male; 325, ventral surface of same; 326, coxae I-IV of female; 327, spiracle of female; 328, tarsus I; 329, tarsus IV, male; 330, tarsus IV, female. (Partly after Anastos, 1950.)

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festoons (pl. II, fig. 6). Venter generally lighter in colour, with few short white hairs in region of genital opening, latter between coxae II; anal aperture level with spiracles, genital grooves as in male.

Legs. Base colour brown, strong, thick, ornate more particularly on upper surface of third and fourth pairs. Coxae I-IV armed with two small, well-separated spurs; internal spurs on coxa I about twice as long as external spurs, largest on coxa I and smallest and sharpest on coxa IV. Sometimes an additional small spur between the external and internal spurs of coxa IV (fig. 326). Tarsi II-IV (fig. 330) tapering gradually with three distinct ventral spurs; pulvillus long.



Figs. 331-4, Neumann's '*atrosignatus*'. MALE: 331, dorsum, 332, coxae I-IV; 333, spiracle; 334, tarsus IV.

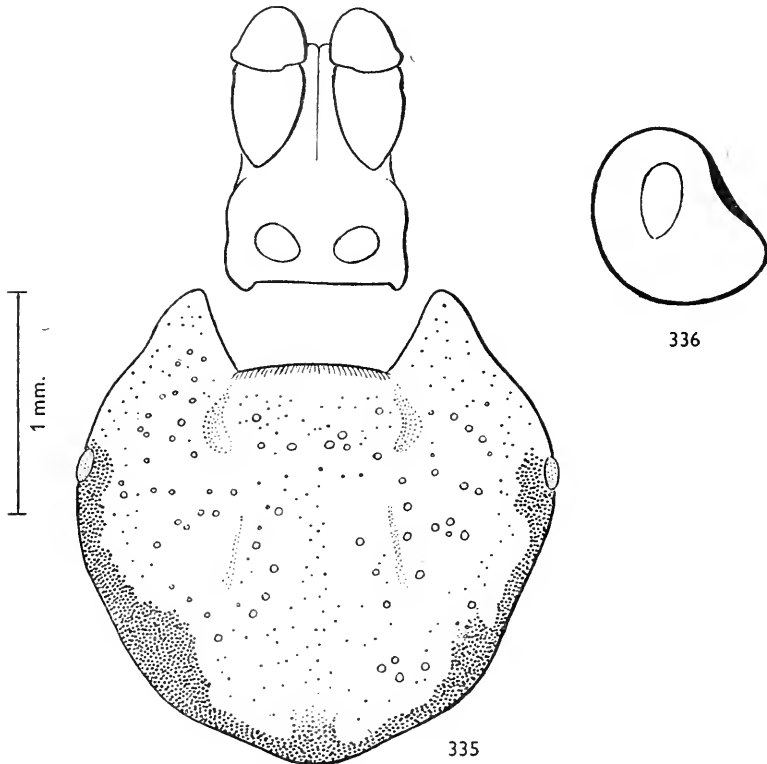
REMARKS

The types and co-types of Supino's *D. auratus* (N. 2961 coll.) were collected by Fea at Tenasserim, Burma, and the type is now lodged in the Genoa Museum. The host is given as '*Ursus torquatus*' (= *Euaretos thibetanus thibetanus*) *Susa cristatus*.

A comparison of Neumann's *D. atrosignatus* (figs. 331-5) taken from a dog in Formosa differs from *D. auratus* only in trifling matters of colour pattern, the darker markings in *atrosignatus* being almost obsolete. Neumann's drawing of the male of *D. atrosignatus* (Neumann, 1906, p. 211) is an excellent representation of Supino's co-type of *D. auratus*. In Neumann's description of the male of *atrosignatus* it is stated that coxa IV has only two small teeth, but the specimen sent me is precisely like *D. auratus* in having several small denticles at its inner angle. I therefore see no reason why *D. atrosignatus* should not be sunk in synonymy with *D. auratus*. *D. auratus compactus* Neumann was originally described (1901, p. 268) from a female

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which differed from the type in unimportant matters, well within the range of this obviously variable species, and accordingly I am of the opinion that it cannot be sustained. Neumann maintained the variety (1905, pp. 236-7) after seeing many males and females as having 'scutum slightly broader than long, contour almost circular, slightly sinuous, large punctations, deep, unequal, lacking in places'. In 1939 Schulze proposed the name of *ater* for the tick he had previously identified as *atrosignatus*, on the grounds that Neumann's *atrosignatus* is either *auratus* or *compactus*,



Figs. 335-6, Neumann's '*atrosignatus*'. FEMALE: 335, capitulum and scutum; 336, spiracle.

and in addition he described in the same year a new species *I. compactus sumatranus*. Kohls (1950), after an examination of Philippine specimens from the Parlarran Province, expressed doubt as to the number of species in addition to *auratus* which should be recognised, and all the described forms closely resemble *D. auratus*. Kohls did observe that coxa I of the latter has two short, widely spaced spurs, but in the other 'species' these structures are noticeably longer and more closely set. Differences in colour and colour patterns have been stressed by Schulze but in view of the known wide range of colours and patterns exhibited by individual species of *Dermacentor* (Cooley, 1938)

the validity of these criteria is questionable. Schulze also emphasised the shape of the male scutum in splitting this genus, but Anastos (1950) has shown from an examination of twenty-three males collected from one host (in the Museum of Comparative Zoology, Harvard) that the shape of the scutum varies from that characteristic of *Indocentor* to that characteristic of *Dermacentor*. Moreover, there are intermediate stages which preclude their definite inclusion in either group. Nor do we find significant differences in the host relationships between *auratus* and the related forms; adults have been collected from pigs but several larger wild and domestic animals harbour these ticks, whilst larvae and nymphs commonly occur on smaller animals. Until such time as it is possible to ascertain the degree of variability in *D. auratus* and related 'species' I propose to follow Anastos (1950) in considering *Indocentor* as a synonym of *Dermacentor*. Pomerantzev (1950) likewise does not consider Schulze's inclusion of *Indocentor* as a distinct genus to be sufficiently substantiated but recognised the necessity of the separation of *Indocentor* from *Dermacentor* as a subgenus.

Anastos (1950) has described *D. auratus* with which the present work is in very close agreement. He described males collected near the type locality in Burma which are undoubtedly typical *auratus*. His description of a single male from Medan, Sumatra, probably represents a variation from typical *auratus*. Only one female from the same locality was found to agree with the type. The three females from Sumatra and the one female described by Anastos from Java are also probably variants.

Dermacentor sinicus Schulze, 1931

Figs. 337-47

LIT. AND ICON.

1931 *Dermacentor sinicus* Schulze, original description, pp. 62-4. Figures of male (3) and female (4).

(Description partly after Schulze.)

MALE. Overall length 4.6 mm., maximum breadth 2.8 mm. Base colour dark wine red, with rather indistinct silvery white pigmentation.

Capitulum (fig. 338). Basis almost rectangular, nearly twice as broad as long. Posterior margins straight; lateral margins straight and slightly divergent to palpal insertion; cornua blunt, broader basally than long. Palpi not protruding laterally, article 2 almost triangular when seen from above, postero-dorsal ridge narrow and well defined, article 3 subtriangular with rounded apex. Hypostome spatulate, dentition 3/3.

Scutum (fig. 337). Ovate, broadest behind the middle and narrowing appreciably to well-defined scapulae. Pattern colour arranged as in fig. 337. Punctations with moderate disparity in size.

Legs. Broad and strong, slightly pigmented. Coxa I with external spurs not reaching tip of internal spurs, spurs divergent with rounded apices (fig. 339). Coxae II and III with shorter, sharp spurs which become increasingly broader to coxa IV, the latter

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relatively short and slightly broader antero-posteriorly than long. Strong spurs lacking on leg segments; distal segments dilated as shown in figs. 340*a-d*.

Spiracular plate. Elongate oval with blunt appendix which overlaps on to the dorsal side (fig. 341).

FEMALE. When fully fed reaches 10 × 6 mm.

Capitulum. Basis capituli almost a rectangle, being nearly twice as long as broad; sides and posterior margin straight; cornua lacking. Surface flat and impunctate. Porose areas slightly elongate oval, along the long axis of the body, divergent, strongly depressed below the general surface. Palpi similar to those of the male but relatively longer (cf. figs. 347*a, b*). Hypostomal dentition 3/3.

Scutum (fig. 342). Length: breadth ratio as about 1.4:1.0. Antero-lateral margins broadly convex, postero-lateral and posterior margins sub-angular. Base colour most prominent in the median field between the cervical grooves and along the antero-lateral margins.

Legs. Much as in the male; external spurs on coxae II-IV prominent, those on coxa II being the strongest. Tarsus IV as shown in fig. 345.

Spiracular plate. Broadly rounded, with short, sharp dorsal prolongation (fig. 346).

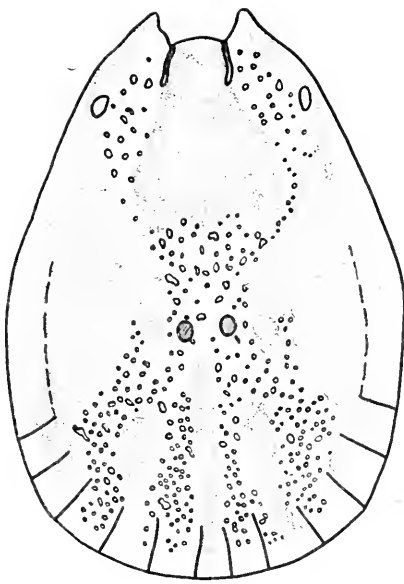
HOSTS

D. sinicus occurs frequently on hedgehogs, and the material examined by Schulze was collected by Hoeppli in Peiping, Northern China. The type of the material is deposited in the Berlin Zoological Museum.

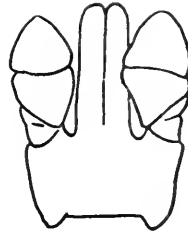
REMARKS

This species appears to be closely related to *D. nuttalli* from which it may be recognised by the absence of strong spurs on the leg segments and the more strongly dilated tarsi. The palpi in both males and females of *D. nuttalli* are more strongly protuberant laterally than those of *D. sinicus*.

D. sinicus pallidor was a subspecies erected by Schulze for males and females collected from hedgehogs at Tsingtau, Mai, by Professor Hoffman and deposited in the Entom. Instit. Berlin-Dahlem. This subspecies is identical in all morphological respects with *D. sinicus*, as well as in the pattern of the design. The base colour of the subspecies is yellowish to reddish brown and the pattern colour is more conspicuous. Whether subspecific status is warranted is problematical for here we may have a species which is subject to much colour variation as in *D. albipictus* in America and probably in *D. marginatus* in Europe. Accordingly, I think that this must be a moot point until such time as more extensive collections of this species are available and breeding experiments are carried out.



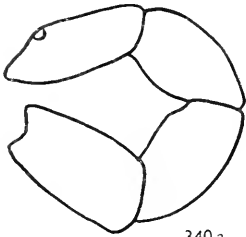
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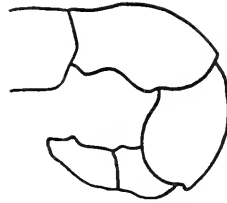
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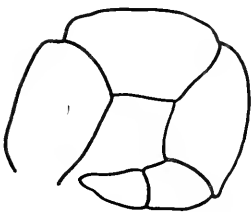
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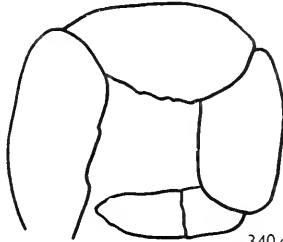
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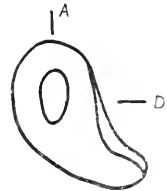
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340 c

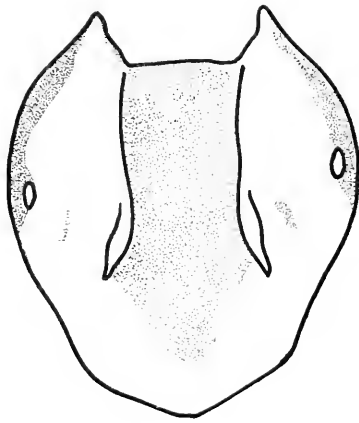


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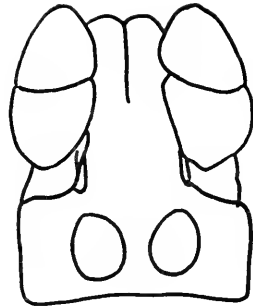


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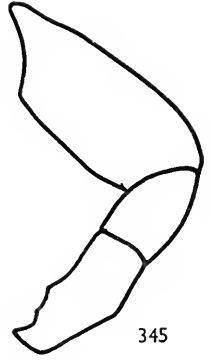
Figs. 337-41, *Dermacentor sinicus*. MALE: 337, scutum; 338, capitulum, dorsal; 339, coxae I-IV; 340a-d, legs I-IV; 341, spiracle. (After Schulze, 1931.)



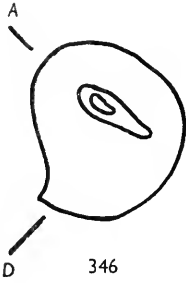
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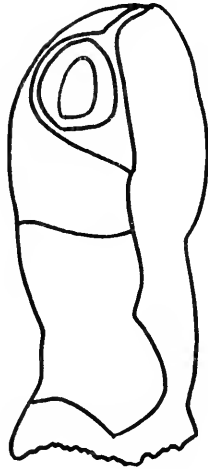
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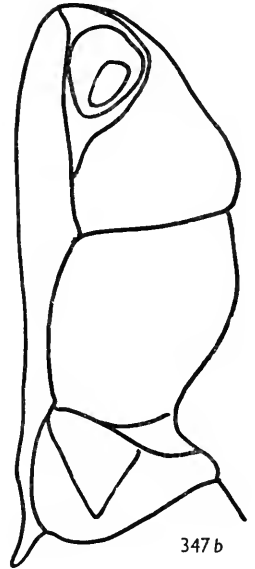
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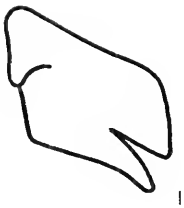
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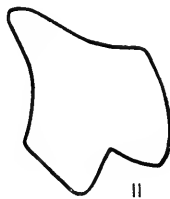
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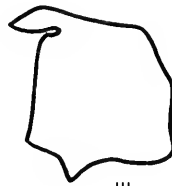
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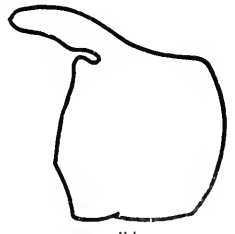
I



II



III



IV

344

Figs. 342-7, *Dermacentor sinicus*. FEMALE (except 347a): 342, scutum; 343, capitulum, dorsal; 344, coxae I-IV; 345, tarsus and metatarsus IV; 346, spiracle; 347b, ventral view of palp; 347a, ventral view of the male palp. (After Schulze, 1931.)

Dermacentor coreus Itaki, Noda & Yamaguchi, 1944

Figs. 348-59

LIT. AND ICON.

1944 *Dermacentor coreus*, Itaki, Noda & Yamaguchi, original description, pp. 87-8. Pls. 11/1 (figs. 1-4 male), 11/2 (figs. 5-8).

MALE. Body length 6.2 mm., width 3.8 mm. Body wide from mid-length to posterior margin, narrowing appreciably in front. Base colour dirty brown, pattern colour silvery grey.

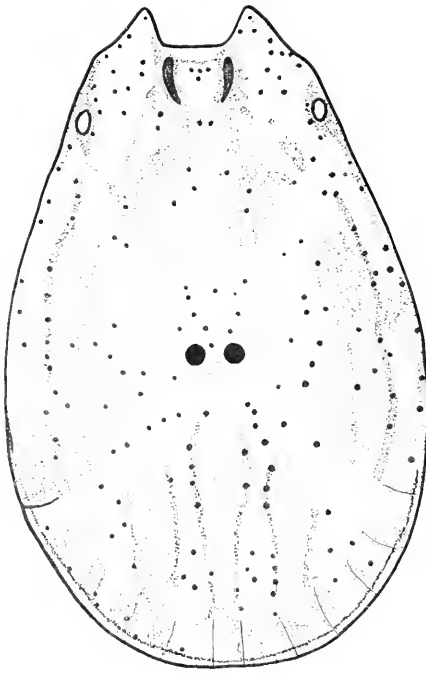
Capitulum (figs. 350, 351). Overall length of capitulum 0.98 mm., greatest breadth behind palpal insertion of 0.63 mm., basis about 1.3 times as broad as long. Posterior margin almost straight; cornua short, broad, rounded, basal width exceeds length; lateral margins straight and slightly divergent anteriorly. Surface ornamented with silvery white spotted pattern interspersed with which are medium to large punctations. Palpi broad, slightly longer than broad; palpal article 2, 0.25 mm. long, palpal article 3, 0.23 mm. long; postero-dorsal spur on article 2 short and broad. In ventral view basis slightly broader than long, posterior margin broadly rounded, sides divergent to palpal insertion. Hypostome narrow, dentition in 10 rows of 3/3 files, teeth broad.

Scutum (fig. 348). Broadly rounded behind mid-length, narrowing anteriorly. Base colour more extensive than pigment colour, the former present as three longitudinal bands posteriorly behind the foveae, as two pairs of islands lateral to the foveae of which the outermost pair, delimited by the lateral groove, is the most extensive, as peripheral bands of varying thickness which partially invade each festoon and which surround the eyes, and as a band of paler colour between the cervical grooves. Cervical grooves distinct, commencing as deep depressions and reaching back to the limits of the pseudoscutum. Lateral grooves indicated by band of darker base colour and a linear arrangement of large punctations.

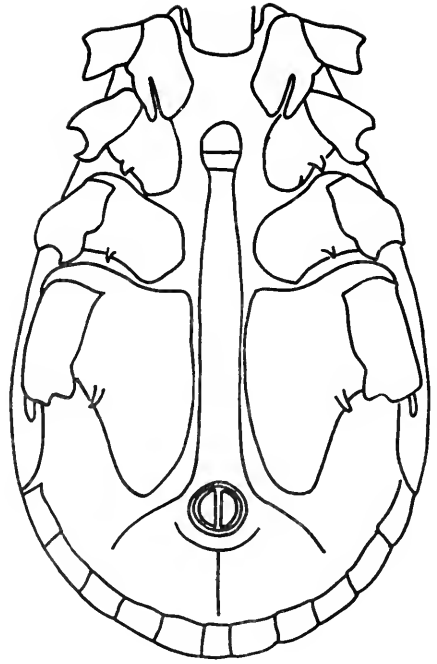
Legs. Of moderate length and thickness. Coxa I small, increasing in size from coxae II-IV; coxa IV large, posterior edge extending beyond the hind margin of the spiracle; internal edge curved and about twice the length of the anterior margin. External spurs of coxa I relatively narrow and slender, tapering to their blunt apices and with the posterior face curved before bending inwards near distal margin of coxae, slightly shorter than internal spurs and separated from them by parallel-sided fissure. External spurs on coxae II and III short, tapered and hook-like, internal spurs short, broad, rounded. External spurs on coxa IV long and slender with blunt extremities (fig. 349). Tarsus IV slender with apical spur, metatarsus with three pairs of ventral spurs (fig. 353).

Spiracular plate. Elongate oval and produced dorsally into a short almost pointed dorsal prolongation (fig. 352).

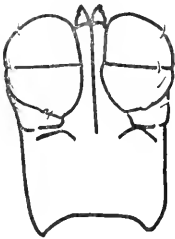
Genital opening. Between second pair of legs; genital grooves roughly parallel to behind the level of coxa IV, where they diverge suddenly but do not reach the edge of the body (fig. 349).



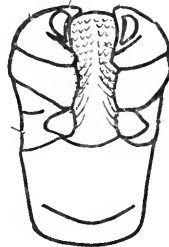
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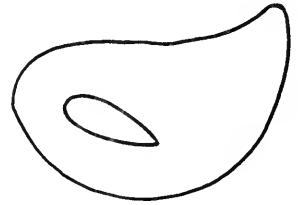
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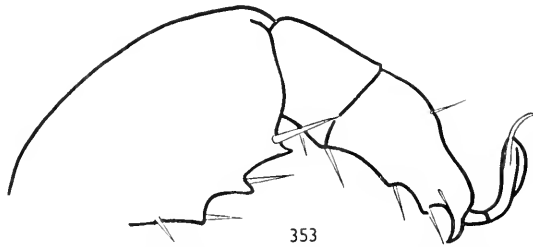
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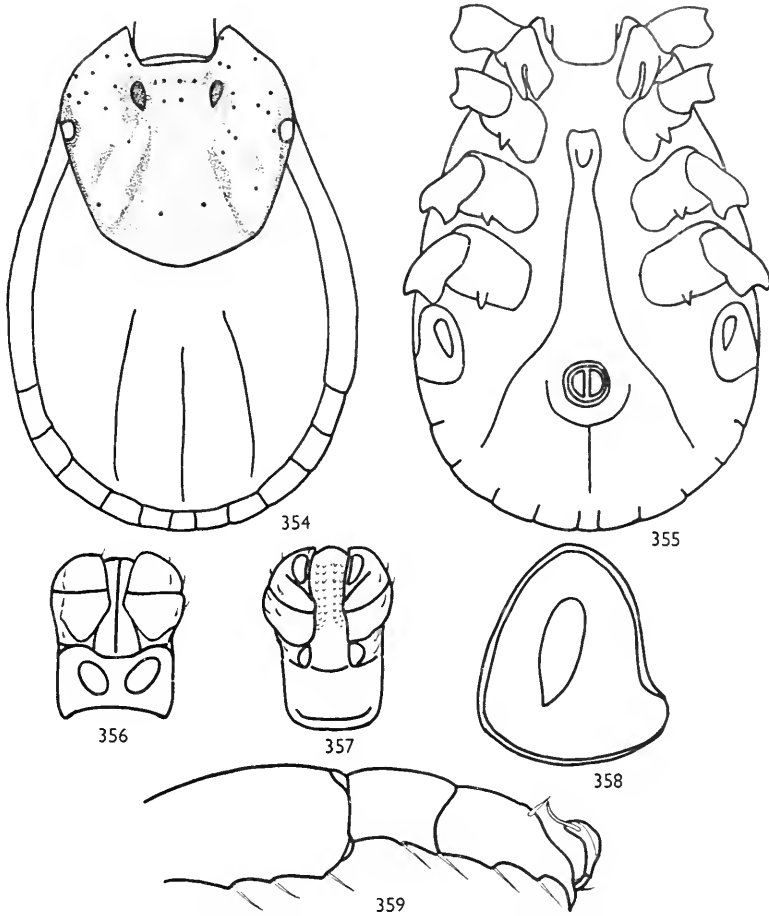
353

Figs. 348-53, *Dermacentor coreus*. MALE: 348, scutum; 349, venter; 350, dorsal view of capitulum; 351, ventral view of capitulum; 352, spiracular plate; 353, tarsus and metatarsus IV. (Redrawn from Itaki, Noda & Yamaguchi, 1944.)

D. COREUS

Anal groove. Arcuate behind the anus and continued posteriorly as a single median groove.

Festoons. Anterior festoons broad, narrowing progressively to the median one, not delimited by the lateral grooves. Ventral festoons broader than long with the exception of the median one which is almost square, and delimited in front by a groove.



Figs. 354-9, *Dermacentor coreus*. FEMALE: 354, scutum and opisthosoma; 355, venter; 356, capitulum, dorsal view; 357, capitulum, ventral view; 358, spiracular plate; 359, tarsus and part of metatarsus IV. (Redrawn from Itaki, Noda & Yamaguchi, 1944.)

FEMALE. Body oval, length 4.2-10.8 mm., width 3.3-8.5 mm., varying in colour from red to dark dirty brown, pattern colour silver-grey.

Capitulum (figs. 356, 357). Basis capituli about twice as broad as long. Posterior margin straight, cornua much reduced; lateral margins straight and almost parallel. Porose areas elongate oval, quite strongly divergent anteriorly. Palpi much as in male. Hypostome dentition as ten rows of $4/4-3/3$ files of teeth, all of equal size.

EURASIATIC SPECIES OF *DERMACENTOR*

Scutum. Length 2.0 mm., breadth across the level of the eyes 2.0 mm., greatest breadth in front of the middle, antero-lateral margins convex, outline behind the eyes angular and tapering appreciably to the broad posterior edge. Cervical grooves long, deep anteriorly, convergent at first and then divergent to the postero-lateral margins. Base colour limited to the cervical grooves, between them and as a peripheral band which encloses the eyes.

Post-scutal area. Marginal groove well defined and delimiting rectangular dorsal festoons which progressively decrease in size to the middle one. Ventral festoons not demarcated by transverse fissures.

Legs. More slender than in males. Coxal spurs of coxae I-III as in male, external spurs slender with blunt apices (fig. 355). Tarsus IV slender with pointed apical spur; ventral spurs lacking on metatarsus (fig. 359).

Spiracular plate. Situated behind coxa IV, ovate with short rounded dorsal prolongation (fig. 358).

NYMPH and LARVAE. Not known.

HOSTS. Known only from the horse and no details of its biology are available.

Dermacentor taiwanensis Sugimoto

Figs. 360-9

LIT. AND ICON.

1936a *Dermacentor taiwanensis* Sugimoto, original description.

1936b *Dermacentor taiwanensis* Sugimoto: Sugimoto.

1936? *Dermacentor taiwanensis* Sugimoto: Sugimoto, pp. 583-4.

The above literature refers to the description of a male tick of this species collected from a wild boar in the Northern Province of Taiwan (Formosa) in 1934.

1937 *Dermacentor taiwanensis* Sugimoto: Sugimoto, pp. 325-7. Pl. iv, p. 329. The male is re-described from further specimens and the female described for the first time. One male and five females were collected in the Eastern Province of Taiwan, 18 December 1936 and four males and two females in the Central Province of Taiwan, 22 December 1936.

MALE. Body large, measuring 5.5-6.0 mm. long by 4.0 mm. broad. Sclerotised parts dirty brown with the legs of the same colour.

Capitulum. Overall length 1.054-1.105 mm. Basis roughly rectangular in shape, slightly less than twice as broad as long, length 0.425 mm., breadth 0.816 mm. Cornua represented by small 'ear-like' projections; posterior margin straight; lateral margins almost straight. Surface depressed laterally, and antero-mesially. Palpi large, overlapping the cheliceral shafts; longer than broad and well supplied with hairs; lateral margins not unduly swollen. Hypostome as long as the palpi, with dentition of ten files of 3/3 teeth. Ventrally article 2 of the palp shows a lateral protuberance.

Scutum. Pattern colour greyish white with a metallic sheen, with longitudinal chocolate stripings as in fig. 362; oval in shape, with a slight tendency to narrowing

D. TAIWANENSIS

anteriorly; scapulae broad and indented in front, emargination pronounced. Punctations large (diameter 0.0765–0.102 mm.) and between them are numerous smaller punctations (average size 0.017 mm.). Hairs are absent from these small punctations. Cervical grooves as small 'pear-shaped' depressions anteriorly, thence divergent and ill-defined to the edge of the pseudoscutum. Lateral grooves originate behind the level of the eyes and extend to the front margins of the most anterior festoons, but not delimiting any of them; position of the groove emphasised by a row of punctations. Eleven almost square festoons separated by deep grooves. Eyes placed well forward, flat and frequently difficult to see.

Legs. Coxal lengths greater than their widths (compare the Japanese text), the length–breadth ratio increasing from legs I to IV. Internal spurs of coxa I broad, external spurs shorter and more pointed, separated from one another by a parallel-sided fissure. Internal spurs of coxa II broad, flat and rounded, external spurs sharp; internal spurs of coxa III tapered, sharp and larger than the external spurs; external and internal spurs on coxa IV sharp with additional spurs (1–3) between them. Tarsus I with upper surface quite strongly curved distally, ventrally there are four blunt projections (Japanese text); on tarsus IV there are three similar spurs in corresponding positions. Pulvillus shorter than the claws.

Spiracular plate. Comma-shaped, short, of a dirty brown colour.

Genital aperture. Between the second pair of coxae. Genital grooves constricted at the level of the fourth pair of coxae, thence diverging strongly posteriorly, ceasing in front of the third and fourth festoons. Crescent-shaped anal groove located behind the anus and continued as a median posterior extension. Venter generally with small non-hair-bearing pits.

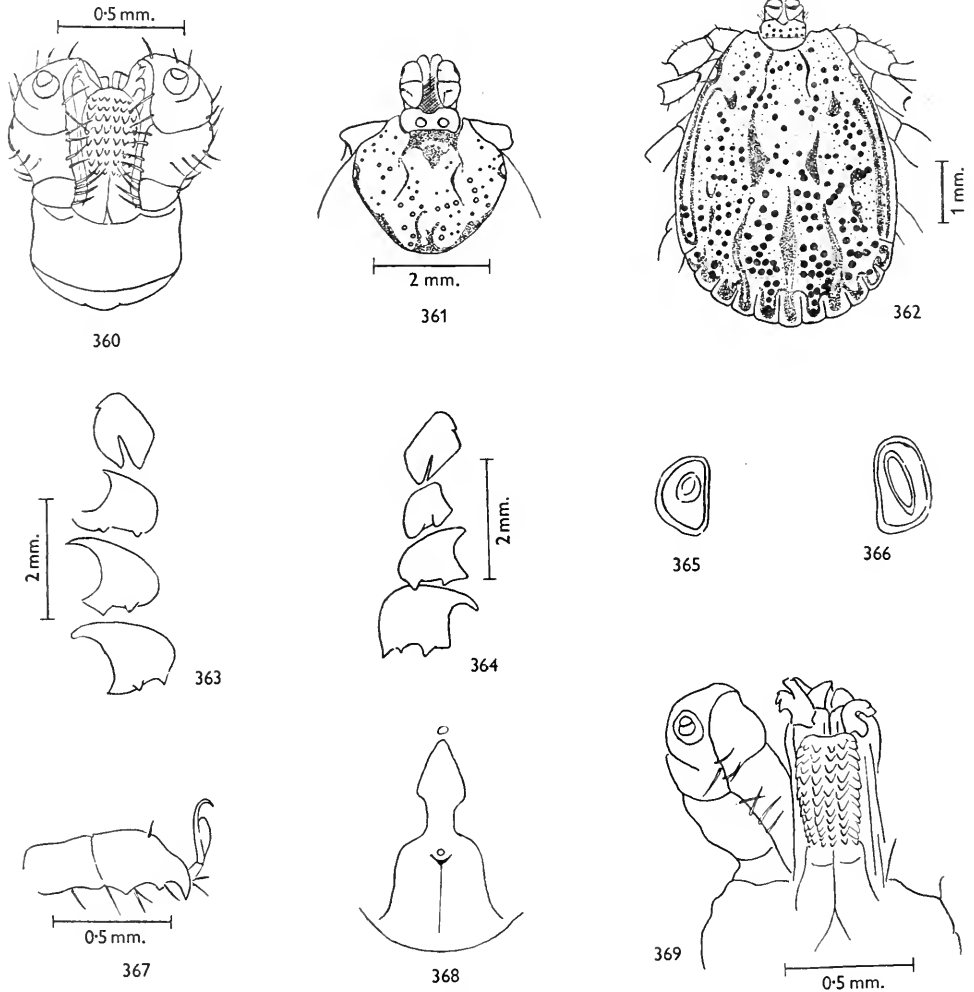
FEMALE. Body length 7–14 mm., breadth 5–10 mm. Base colour yellow-brown with 'tiger' stripes of dark brown ('it resembles the colour of the wild boar of the moors'—literal translation). In the fed condition the colour varies from brick red to chocolate. Legs blackish brown.

Capitulum. As in the male of a metallic brilliance with small shallow punctations. Overall length 1.42–1.53 mm. Basis rectangular in shape and more than twice as broad as long—breadth 1.105 mm., length 0.51 mm. Cornua slight, basal widths greater than their lengths; between cornua posterior border straight; lateral borders convex. Surface flat except for an anterior semicircular depression. Porose areas about 0.22 mm. in diameter, interporose interval about equal to the diameter of one of them. At rest the chelicerae are almost overlapped by the palpi; length of combined palpal articles 2 and 3, 0.85–1.02 mm., width 0.46 mm.; palpal article 2 the longer, with slight swelling laterally, the postero-dorsal ridge sharply rounded and reaching back to the anterior edge of the basis. Length of hypostome, 0.85–1.07 mm., dentition in twelve rows of $\frac{3}{3}$ files of teeth.

Scutum. Broader than long, length 2.04–2.47 mm., breadth 2.72–2.89 mm. Pattern colour greyish white; base colour chocolate and limited to the 'ocular spot', postero-

EURASIATIC SPECIES OF *DERMACENTOR*

median stripe and the postero-lateral borders. Eyes located in front of mid-length and at the maximum width. Cervical grooves deep anteriorly, convergent at first and then divergent and almost attaining the periphery.



Figs. 360-9, *Dermacentor taiwanensis*. 360, ventral view of basis capituli of female; 361, capitulum and scutum of female; 362, dorsal view of male; 363, coxae I-IV of female; 364, coxae I-IV of male; 365, spiracular plate of male; 366, spiracular plate of female; 367, tarsus I of the male; 368, genital and anal grooves of the female; 369, ventral view of the female capitulum to show palpal structure and hypostome. (From Sugimoto, 1937.)

Legs. Coxa I longer than broad, internal spurs very large, external spurs shorter and separated from one another by a slightly divergent fissure. Coxae II-IV supplied with both internal and external spurs (fig. 363). Tarsus I measures 1.53 mm. long and provided with one spur on the ventral surface; tarsus IV is 1.309 mm. long with two ventral spurs.

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Spiracular plate. Comma-shaped.

Genital aperture. On a level with coxa II. Genital groove much as in the male, does not reach to the posterior margin.

Anal aperture. Just behind the level of the spiracle.

REMARKS

This species has hitherto been only recorded from the Northern, Central and Eastern provinces of Taiwan at altitudes of 909–1500 m. The principal host is the wild boar of Taiwan, 'taiwan inoshishi'. The immature stages have not hitherto been described.

The immature stages of known Eurasiatic species

For many of the Eurasiatic species of this genus the immature stages are unknown or else are vaguely described so that re-examination of the material is essential for correct diagnosis. The immature stages of the European species *D. reticulatus* (= *D. pictus* of the Russian authors), *D. marginatus* and *D. niveus* (= *D. daghestanicus* of the Russian authors) have been investigated in much detail by Černý (1957) and Reznik (1956), and it is possible to produce a workable key for their separation.

Key to nymphs

- | | | |
|---|--|-----------------------|
| 1 | Basal spurs distinct and pointed. | <i>D. niveus</i> |
| | Basal spurs otherwise. | 2 |
| 2 | Palpi long, when seen ventrally palpal article 2 about half as long again as palpal article 3. | |
| | Less than forty scutal bristles. Basal spurs short, rounded. | <i>D. marginatus</i> |
| | Palpi shorter, when seen ventrally article 2 only slightly longer than article 3. | |
| | More than forty scutal bristles. Basal spurs broader and larger. | <i>D. reticulatus</i> |

Key to larvae

- | | | |
|---|--|-----------------------|
| 1 | Rostrum long, palpal segment 1 conspicuous. | <i>D. niveus</i> |
| | Rostrum short; first palpal segment inconspicuous. | 2 |
| 2 | Dermal sensillum present on dorsal surface of palp; postero-median pair of scutal bristles not exceeding 40 μ in length. | <i>D. marginatus</i> |
| | No dermal sensillum on dorsal surface of palp; postero-median pair of scutal bristles exceeds 40 μ in length. | <i>D. reticulatus</i> |

Reznik suggested that the length/breadth index of tarsus I was a ready means of separating *D. reticulatus* from *D. marginatus*, a view that is not confirmed by the very detailed study of Černý on these two species.

Despite repeated attempts to examine specimens of the immature stages of the exclusively Russian *Dermacentor* ticks I have thus far been unsuccessful. Accordingly they are not dealt with in the present volume, but for completeness I do include a translation of Reznik's key to the larvae and his descriptions of the diagnostic features of the Russian forms. I must, however, make the reservation that I do not accept his characters for separating *D. reticulatus* and *D. marginatus*. In view of the great resemblances between the larvae of different species some knowledge of the hosts, locality data and seasonal occurrence are of considerable assistance in identification.

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Reznik's key to the larvae

- 1 (2) Anterior leg short, thickened, its size no more than 0.18–0.183 mm., its index (i.e. ratio of length to breadth) no more than 2.2. Larva small, the length of the rostrum, its base included, usually less than 0.16 mm. *D. pictus*
- 2 (1) Anterior leg longer than 0.2 mm., rostrum usually longer than 0.16 mm.
- 3 (4) Rostrum long, the ratio of the rostrum length, including the basis, to the width of the basis more than 0.93. First palpal article conspicuous. *D. niveus*
- 4 (3) Rostrum shorter, its index less than 0.93.
- 5 (6) Rostrum base broad, its width more than 0.21 mm. *D. silvarum*
- 6 (5) Rostrum base narrower than 0.2 mm.
- 7 (8) Tarsus narrow, its index more than 2.75, usually 3. *D. pavlovskyi*
- 8 (7) Tarsus broader, its index less than 2.75.
- 9 (10) Surface of the anterior tarsi from the side of Haller's organ slightly knobbly, tarsus index more than 2.5; palpi longer, their index exceeds 2.3. *D. marginatus*
- 10 (9) Tarsus with conspicuous tubercles and cavities, its index less than 2.5; palpi shorter and broader, their index less than 2.3. Tooth on the anterior coxae has an angle approximating to a right angle. *D. nuttalli*

The distinctions between the larvae of known Russian species are not well defined (Reznik, 1956), and in addition to the characters given in the above key Reznik notes that (1) in *D. nuttalli* the coxal spurs are moderately well developed, the external one being almost a right angle; tarsus I is clearly very large and characterised by well-developed tubercles and cavities, and is relatively broad; (2) *D. silvarum* possesses better developed knife-like spurs on the coxae, particularly on the third pair where they extend beyond the posterior margin of the coxae. The postero-lateral corners of the basis capituli are well drawn out and narrow—whereby the collar attains the width of 0.12 mm.; (3) *D. pavlovskyi* is similar in many respects to *D. nuttalli* from which it may be distinguished by having the first palpal segment clearly defined, and tarsus I is narrow.

It is also suggested by this author (Reznik, *loc. cit.*) that in the territory of the Soviet Union there is no locality where all species occur together. In almost all the European parts of the Soviet Union, and the greater part of the Caucasus, *D. marginatus* and *D. reticulatus* alone occur; on the western shores of the Caspian sea and in some regions of central Asia, *D. niveus* is also represented. *D. pavlovskyi* breeds in regions of central Asia. In western Siberia, *D. marginatus*, *D. reticulatus* and *D. nuttalli* are found together, and around Lake Baikal *D. nuttalli* and *D. silvarum* are the two species involved, whilst in the Far East the latter alone occurs.

Our knowledge of the nymphae of the Russian species is practically negligible, and further investigation is required.

CHAPTER V

THE GENUS *DERMACENTOR*:

4. AFRICAN SPECIES, DOUBTFUL SPECIES, ETC.

Key to the males

Ornamentation consisting of eight pale spots near the periphery of the scutum; festoons and central areas inornate. *D. circumguttatus*

Ornamentation more variable in its arrangement but reducible to seven large spots, which are more extensive than the base colour, and which extend to some at least of the festoons. *D. rhinocerinus*

Key to the females

Postscutal area wrinkled, bearing a patch of thick short yellow to reddish brown hairs about midway between the scutum and the posterior extremity of the body. Base colour limited to the cervical grooves, around the eyes and the scapulae. *D. rhinocerinus*

Postscutal area smooth, lacking hair tufts. Colour pattern limited to three patches, one posteriorly and one antero-laterally on each side. *D. circumguttatus*

Dermacentor (Amblyocentor) rhinocerinus (Denny), 1843

Pl. IV, fig. 3, pl. III, fig. 4; Figs. 370-80

SYN., LIT. AND ICON.

- 1778 *Acarus rhinocerotis* de Geer, p. 160, pl. xxxviii, figs. 5, 6. The specific name of *rhinocerotis* de Geer 1778, frequently used for this species, actually refers to a distinct species in the genus *Amblyomma* (see Donitz, 1910).
- 1843 *Ixodes rhinocerinus* Denny, p. 313, pl. xvii, fig. 3, original description. Denny noted that his specimens did not sufficiently accord with de Geer's description of *rhinocerotis*, whence his new species.
- 1844 *Ixodes rhinocerotis*, Gervais (in Walckenaer, 1884, p. 246).
- 1844 *Amblyomma rhinocerotis*, Koch, p. 231.
- 1844 *Amblyomma rhinocerinus*, Koch, p. 231.
- 1873 *Dermacentor rhinocerotis*, Gerstaecker, p. 466.
- 1897 *Dermacentor rhinocerotis* (de Geer) in Neumann, p. 370, figs. 25, 26 (female scutum, male and female digits, male dorsum).
- 1901 *Dermacentor rhinocerotis*, variety noted but not named by Neumann, p. 266.
- 1907b *Dermacentor rhinocerotis* (var.) *permaculatus* Neumann, p. 23.
- 1911 *Dermacentor rhinocerotis rhinocerotis* (de Geer) in Neumann, p. 102, fig. 48 (female scutum).
- 1911 *Dermacentor rhinocerotis permaculatus* Neumann, p. 102 (only distinguished from type by brighter red coloration of scutum and the male having the mid-spot of scutum divided to form five spots, festoons marked yellow or red. This previously mentioned by Neumann, 1901, p. 266. See *supra*).

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- 1932 *Amblyocentor rhinocerinus* Schulze, a new genus, = *Dermacentor rhinocerinus*.
 1950 *Amblyocentor* Schulze: Pomerantzev, 1950, p. 132, as a subgenus of *Dermacentor*.
 1956 *Amblyocentor* Schulze: Hoogstraal, p. 336, as a subgenus of *Dermacentor*.

MALE

Capitulum. Basis rectangular (fig. 370*b*). Length 0.38 mm., breadth 0.24 mm., surface smooth, generally flat and sloping away to the slightly sinuous lateral margins. Posterior border concave; cornua small, sometimes merely the sharp angles of a concave posterior border. Palpi longer than basis; article 2, 0.11 mm., article 3, 0.095 mm.; article 2 nearly cylindrical and rounded dorsally; article 3 broader basally than article 2. Postero-dorsal spur of article 2 forming median postero-directed ridge. Hairs arranged in two rows dorsally, being stronger and more curved basally; series of strong, short, spine-like hairs arise from mesial border of palpal article 2, overlap chelicerae but do not extend to mid-dorsal line. Strong curved lateral hairs on article 1. Ventral view, basis broad (fig. 370*a*), sides straight, either parallel or slightly convergent, postero-lateral angles rounded. Surface convex with the 'ridge' of the convexity nearer posterior border, strongly down-curved behind, less strongly so in front. Antero-laterally three short, sharp, thick spines on each side. Palpal article 1 drawn out to oblique, salient, ventrally directed projection; similar projection on proximal margin of article 2, which is also sharply salient laterally as a strong projecting ridge, lateral surface of article 2 forms a declivitous flat slope. Hairs longer and stronger on article 3 than on article 2.

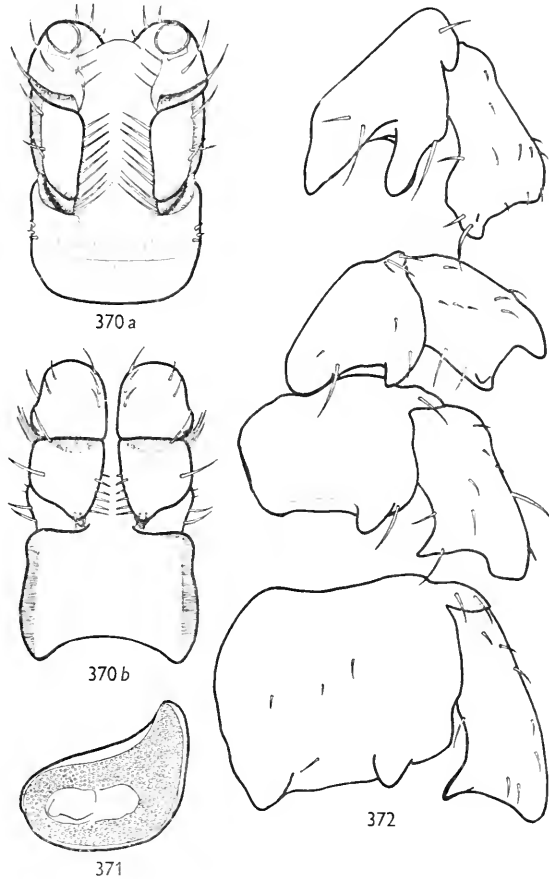
Hypostome (fig. 375). Length 0.8 mm., spatulate shaped, apex trifold and surmounted by short spine-like teeth, corona distinct with number of small teeth arranged transversely, seventeen lateral rows of teeth, arranged 3/3, thinning out obliquely to basal crenulations.

Scutum (pl. iv, fig. 3; fig. 380*a-c*). Variable in shape, generally broader posteriorly and narrowing substantially anteriorly. Ornate, bearing yellow-ochreous blotches on a chocolate brown base colour. The typical colour pattern (fig. 380*a*) consists of a median unpaired subtriangular blotch occupying the posterior part of the pseudo-scutum in front of the foveae; antero-lateral to this and, either connected with or free from it, is a smaller irregular blotch on each side; two small spots on the inner margin of the scapulae; three pairs posterior to the subtriangular blotch, in the median field; two yellow spots on each lateral field; median festoon, extreme festoons and the two festoons midway between them ornate. There may be yellow spots on the festoons bordering the median one. Cervical grooves as small pits; lateral grooves obsolete but all festoons marked off from rest of scutum by distinct furrows (fig. 380*a*). Eyes small; punctations of two sizes, but all much smaller than foveae, the larger few scattered and most obvious on the pattern colour, smaller minute and numerous, general effect a smooth surface. Scapular angles blunt, emargination deep.

Legs. Moderate length, thick becoming more so from legs I to IV; brown; segments ornate distally (pl. iv, fig. 3). Coxa I of moderate size, with large triangular internal spur, external spur parallel-sided and rounded at the tip; divergent fissure; internal

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spurs of coxae II and III broadly rounded and blade-like; external spurs smaller and rounded apically; coxa IV trapezoidal, broadest internally, posterior border more or less straight, two prominent spurs of about equal size. Trochanter spurs increasing in size from I-IV, very small on I, about as large as external coxal spur on IV. Tarsus I, length 1.2 mm., narrow proximally becoming very broad behind Haller's organ,



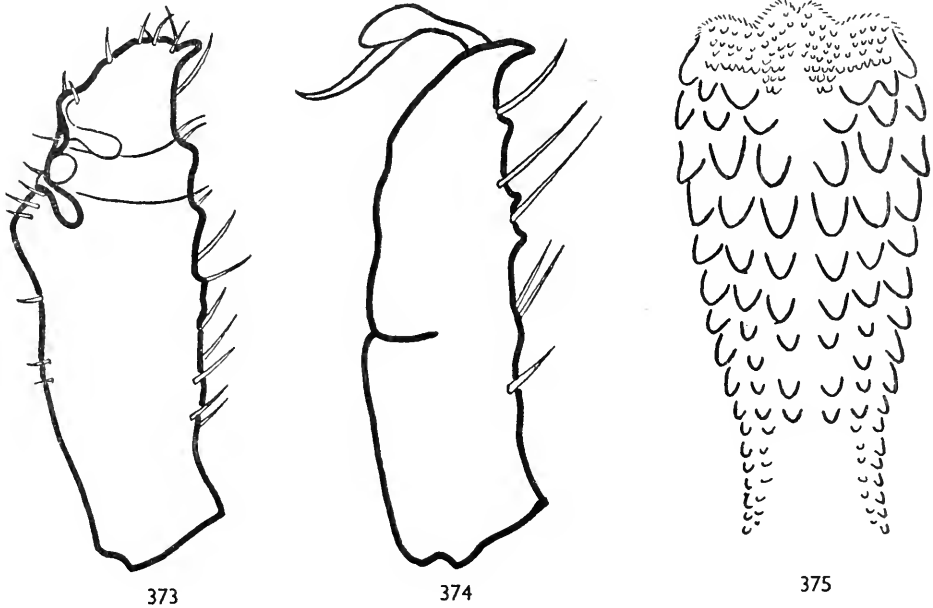
Figs. 370-2, *Dermacentor rhinocerinus*. MALE: 370a, ventral view of capitulum; 370b, dorsal view of capitulum; 371, spiracular plate of male; 372, coxae I-IV.

narrowing quite strongly in front of the latter, two ventral spurs behind the pseudo-articulation; tarsus IV, length 1.2 mm., three ventral spurs in front of the pseudo-articulation. Claws very much longer than pulvillus (figs. 373, 374).

Spiracular plate (fig. 371). Subtriangular; length 0.9 mm., breadth 0.45 mm. Frame thickened and gently concave on dorsal surface before passing to narrow dorsal prolongation. Goblets small, numerous. Macula parallel with long axis of body; orifice wide.

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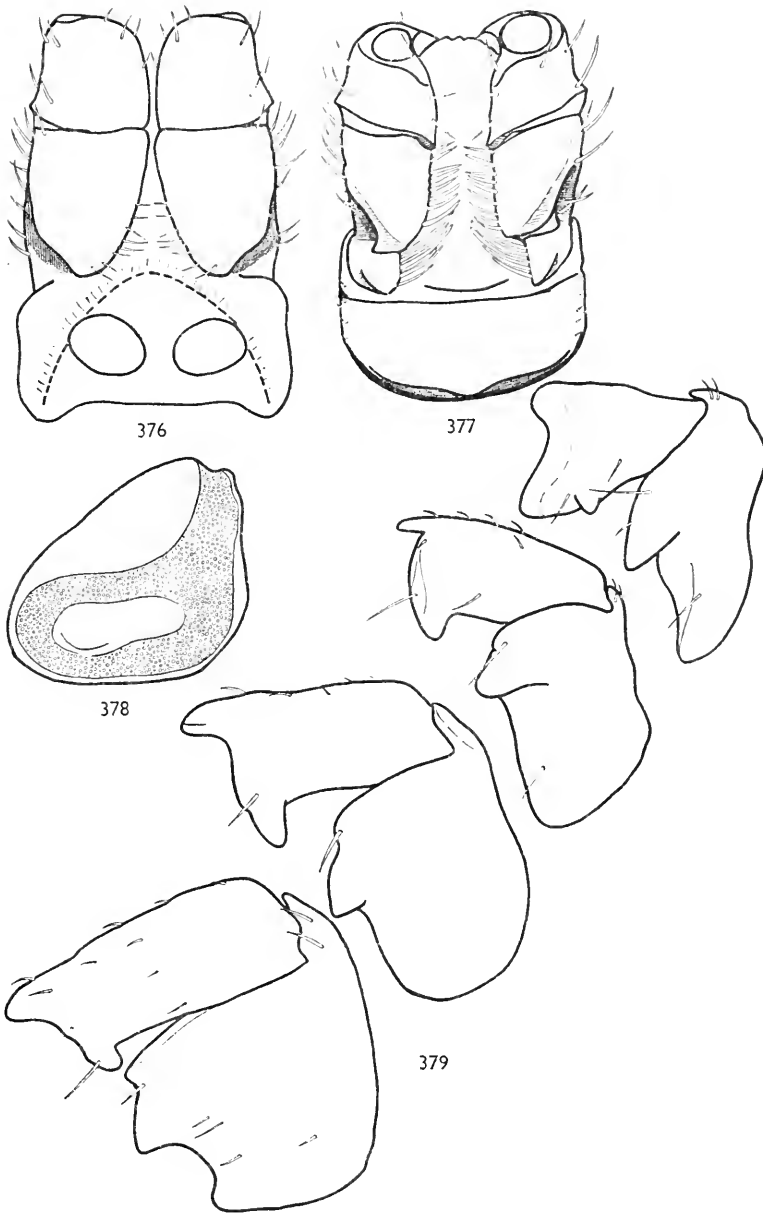
FEMALE (pl. III, fig. 4). Body large; base colour chocolate brown to black, but sclerotised parts extensively covered by yellow ochre pattern colour in dry specimens. Postscutal area almost black in colour and thrown into deep irregular folds; short thick brown hairs in well-defined marginal grooves; dorsally and on a level with the spiracles two patches of dense, short thick reddish brown hairs, which with the naked eye appear as two brown patches. Behind and between them similar white hairs, which are less dense than in the patches and extend back to festoons becoming less abundant laterally.



Figs. 373-5, *Dermacentor rhinocerimus*. MALE: 373, tarsus I; 374, tarsus IV; 375, hypostome.

Legs thick, brown with pattern colour covering much of the distal portion of each segment other than tarsi.

Capitulum. Larger than that of the male. Basis nearly twice as broad as long. Surface flattened in a semicircle surrounding porose areas (broken line in fig. 376). Antero-lateral margins downcurved. Porose areas small, deeply sunk into strong depressions, giving impression of large circular porose areas separated by about half their diameter. Lateral margins and posterior margin almost straight, cornua broad basally, short and rounded, frequently negligible. Palpi, articles 2 and 3 strong, convex dorsally, postero-dorsal ridge rounded. Length of capitulum 1.8 mm., breadth of basis 1.21 mm.; palpal article 2, 0.62 mm. long, 0.5 mm. broad; palpal article 3, 0.58 mm. long, 0.54 mm. broad. Strong curved hairs on articles 2 and 3, particularly on the former. Ventrally, lateral margins of basis straight, postero-lateral margins rounded, posterior border undulate; surface convex, steeply downcurved posteriorly (lined in fig. 377), gentler slope to hypostomal base. Article 1 triangular, with strong



Figs. 376-9, *Dermacentor rhinocerus*. FEMALE: 376, capitulum in dorsal view; 377, capitulum in ventral view; 378, spiracular plate; 379, coxae I-IV.

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oblique ridge, bearing 5 or 6 long, strong palpal setae directed antero-mesially; article 2 flat, apart from an outer oblique and basal elevation, beyond which lateral surface declivitous (fig. 377), about 9-11 palpal setae on its inner face; surface of article 3 irregular, proximal edge salient, sharp and produced mesially to a broad spur. Hairs spinose, curved.

Scutum (pl. III, fig. 4). Large, length 4.3 mm., breadth 4.1 mm., i.e. just about as long as broad; greatest width at or slightly behind the level of the eyes. Eyes yellow-brown. Cervical grooves as two short depressions indicated by base colour; two oblique, short bands of brown base colour behind; periphery chocolate brown, widening around the eyes and on the scapulae. Punctations of two types, one large and deep, the other excessively fine; larger deeper punctations more particularly in lateral fields and in the anterior region between cervical pits (about fifty present). Surface otherwise smooth, with only a very few scattered short, fine hairs. Emargination deep; posterior border undulate.

Legs. Coxae I-III as in male; coxa IV smaller than in male, external spur larger than internal spur (fig. 379). Trochanter spurs present on legs I-IV (fig. 379).

Spiracular plate. Subtriangular in outline (fig. 378). Antero-dorsal frame much thickened and gently curved; dorsal prolongation broad and concave at its tip. Goblets small and numerous; macula large, and the goblet surface is concave and centred on the macula.

An anomaly has been observed in a male (Bureau of Animal Industry, Washington, D.C.), the fourth right leg showing arrested development. The right coxa is half as large as the left. The whole leg is scarcely equal in size to one and two, whereas it should be stouter than leg III.

LARVA AND NYMPH. Unknown.

BIOLOGY

The recorded hosts for this species are *Diceros bicornis*, the black rhinoceros, *Ceratotherium simum*, the square-lipped rhinoceros, a buffalo (at Elmenteita), a donkey (in Masai, Kenya), domestic cattle (Tanganyika, Nyasaland), sheep and elephants (Tanganyika), jackal (Uganda) and from an eland (Neumann, 1907*b*, 1911). This species has also been collected from grass or vegetation in East Africa. It is by no means rare and specimens have been collected from West Suk, the Matthews range of mountains, and Garba Tulla in the Northern Province, from north of Malindi, the mouth of the Tana river, Taveta, Tsavo, Embu, Makuyu, Makuendi, north Yatta, Tiva river, Kibwezi, Makindu, Kiboko, Loitokitok, Namanga, Kajiado and Mara river (Wiley, unpublished data). It is also reported from the Belgian Congo, Ethiopia, Italian Somaliland, Angola, the Rhodesias, Nyasaland, South-west Africa and the Union of South Africa.

Little is known of its biology apart from its occurrence around the genital organs of its host.

PLATE III

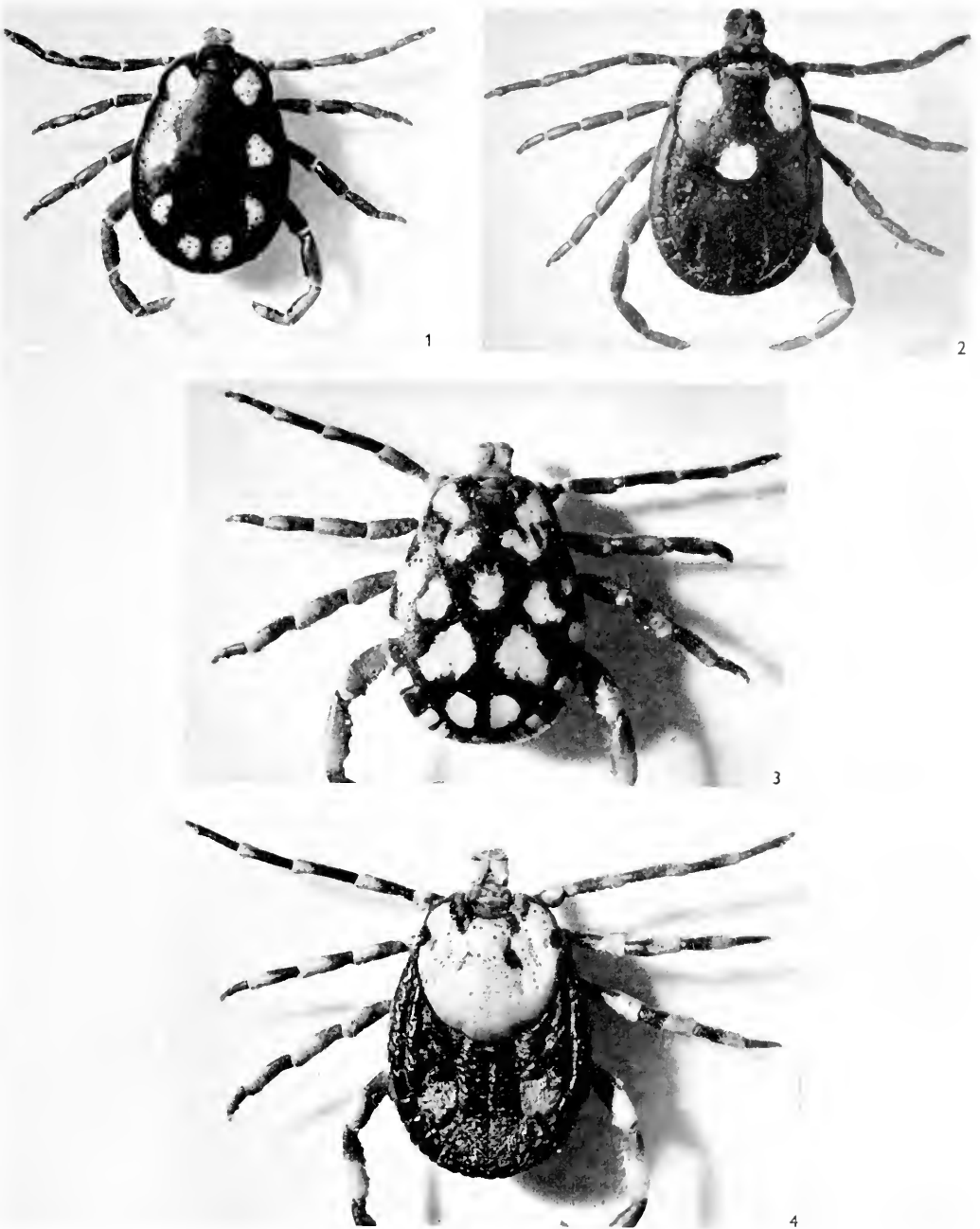
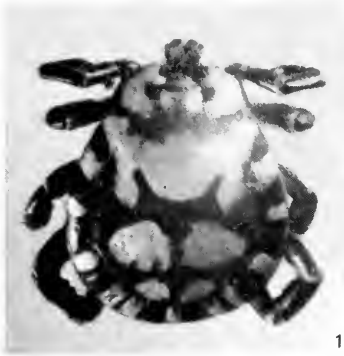


Fig. 1. *Dermacentor circumguttatus* male.
Fig. 2. *Dermacentor circumguttatus* female.
Fig. 3. *Dermacentor rhinocerinus* male, atypical maculation.
Fig. 4. *Dermacentor rhinocerinus* female.

PLATE IV



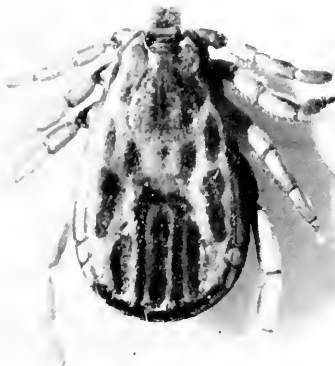
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Fig. 1. *Derma-centor rhinocerinus* male, atypical maculation.

(Photograph by kind permission of Mr Alex Wiley.)

Fig. 2. *Derma-centor rhinocerinus* female, atypical form.

(Photograph by kind permission of Mr Alex Wiley.)

Fig. 3. *Derma-centor rhinocerinus* male, typical form.

Fig. 4. *Derma-centor albipictus* male.

Fig. 5. *Derma-centor pavlovskyi* female.

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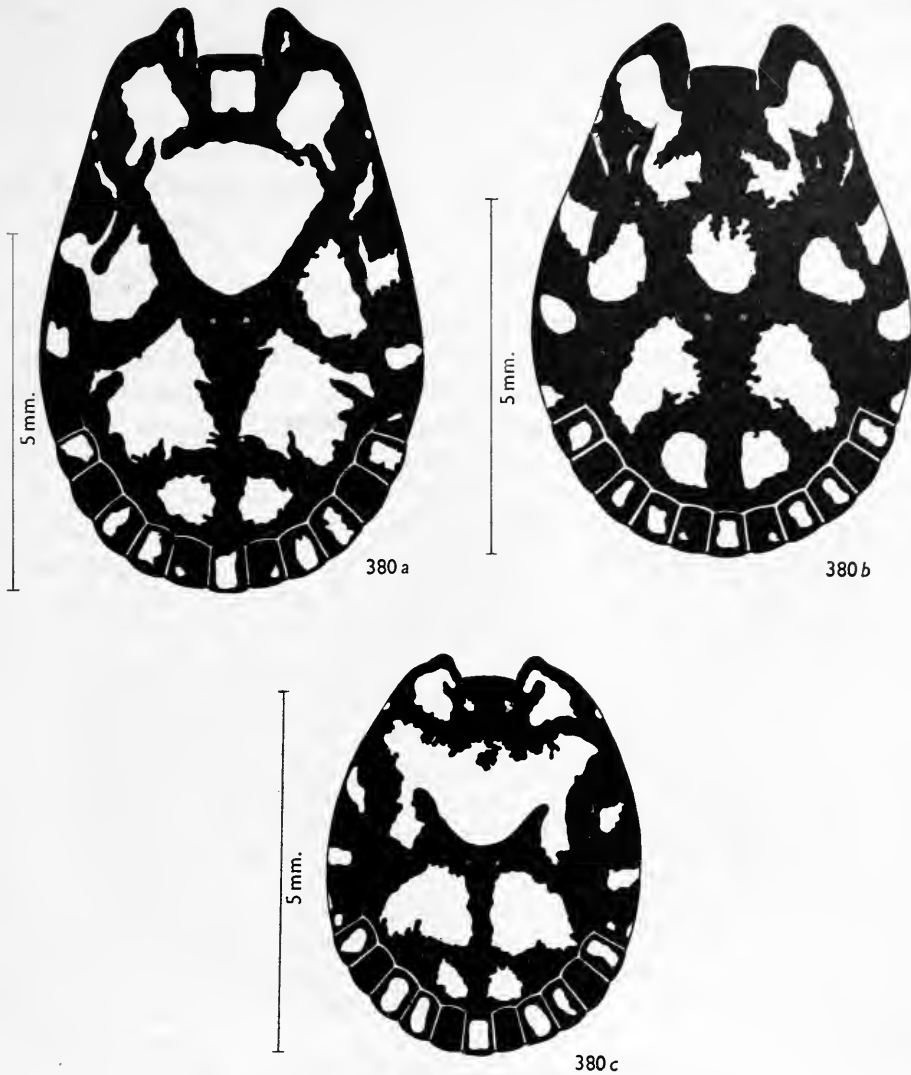


Fig. 380a-c, *Dermacentor rhinocerinus*. Colour patterns of the male scutum (see text).

REMARKS

Neumann (1907*b*) established a variety of *rhinocerinus* based on the maculation of the male scutum. In his varietal form he noted that the male shows more spots on the scutum (pl. III, fig. 3; fig. 380*b*) as the subtriangular blotch is divided by the dark background into five spots; of which one is single representing the posterior angle of the usual large spot, two other spots in the scapular angles and two others represent the borders, which are broadened transversely. The single 'rectangular' blotch and the smaller ones in the scapular angles of the typical form are lacking. In the female the

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spot contouring the eye is prolonged backwards over half of the lateral border. To this variety Neumann gave the name *permaculatus*. From our observations on specimens from Tanganyika, the Zambezi and the Belgian Congo, we concur with Neumann's description and note that the female of Neumann's variety, whilst having the same facies as the typical form, is consistently smaller, with postscutal hair tufts of a golden yellow, with very large punctations antero-ventrally but lacking such punctations in the mid-line behind the cervical grooves (cf. *D. rhinocerinus* typical form), and that the pigment is of an iridescent, greenish hue.

Another group of atypical forms shows a reduction in the number of spots on the male scutum (pl. iv, fig. 1; fig. 380c) by fusion of the antero-lateral, and the first of the three paired posterior spots of the typical form with the large median subtriangular blotch. Coincident with this the festoons on either side of the median one are devoid of colour pattern. Such specimens are on record in the Berlin Museum, in free-living material collected by A. Wiley from Kenya, and in the collections of the British Museum (Natural History). In these various collections with the exception of one lot in the British Museum, all the specimens coming from one host show exactly the same kind of atypical maculation. Similarly, typical forms illustrate a uniformity of pattern. The only lot, of which I am aware, which contains admixture of typical and our atypical forms (but no intermediates) consists of ten males collected from Hippo, Quaso Nyria, British East Africa, by R. Kemp, 22 January 1911 (British Museum, Natural History collection). Lack of intermediates between these typical and atypical forms does suggest most strongly that here again we may have varietal differences. The geographical distribution of the typical and atypical forms overlaps considerably in East Africa, and the occurrence of typical and atypical forms (without intermediates) on one host may well be accounted for by the host being infested with the two varieties.

More extensive collecting in all parts of Africa does, however, seem necessary before committing ourselves categorically to the establishment of varieties on the strength of such uniform colour patterns in *rhinocerinus*. All investigators subsequent to Neumann, with the exception of Tonelli-Rondelli (1930) have disregarded the varietal concept of Neumann and have considered these characters to be cases of intraspecific variation.

Dermacentor circumguttatus Neumann, 1897

Pl. III, figs. 1, 2; Figs. 381-96

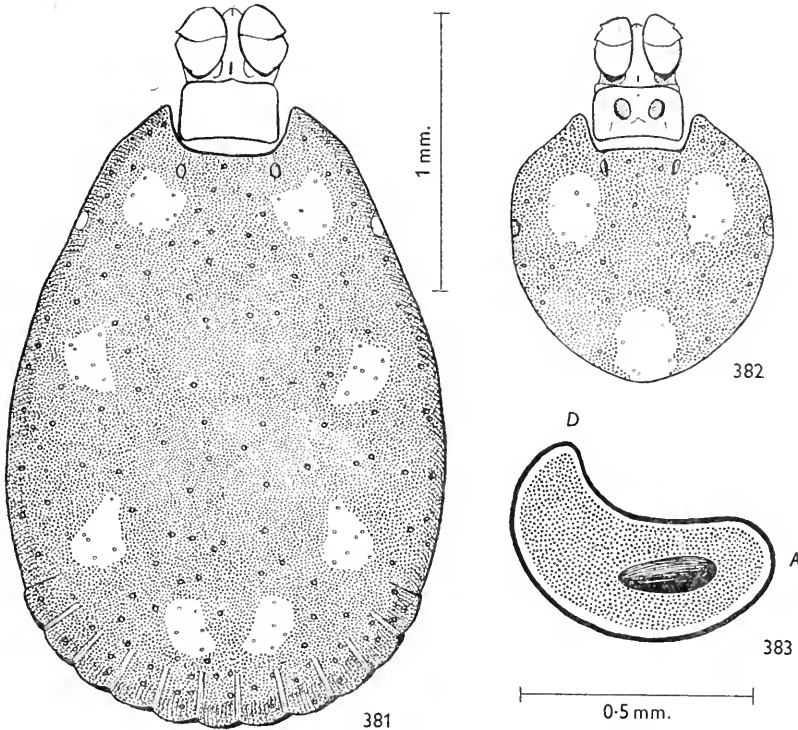
SYN., LIT. AND ICON.

- 1897 *Dermacentor circumguttatus* Neumann, original description, p. 374, fig. 27 (male and female scutum, 1911, p. 102).
- 1932 *Amblyocentor (Puncticentor)* Schulze: *Puncticentor* as a subgenus of *Amblyocentor* (s.str.), p. 463.
- 1950 *Amblyocentor* Schulze: Pomerantzev, as a subgenus of *Dermacentor*, p. 131.
- 1951 *Amblyocentor* Zumpt. Synonymised *Puncticentor* along with *Amblyocentor*.
- 1952 *Dermacentor (Puncticentor) circumguttatus cunha-silvai*: Santos Dias separated Mozambique populations into a subspecies.
- 1956 *Dermacentor circumguttatus* Neumann, Hoogstraal, p. 326.

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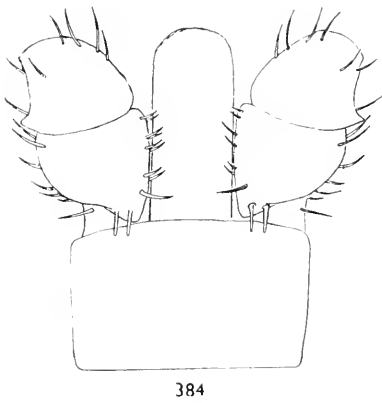
FEMALE. A large species; base colour chocolate brown, tips of leg segments ornate, marginal grooves distinct, glabrous. Readily distinguished from the other African species, *D. rhinocerotis*, by the absence of short thick brown hairs on the dorsum. Claws very much longer than pulvillus.

Capitulum. Basis rectangular (fig. 386), length 0.7 mm., breadth 1.3 mm., i.e. nearly twice as broad as long, impunctate, with lateral margins straight, postero-lateral angles straight. Cornua lacking. Surface generally flattened. Porose areas elongate oval and

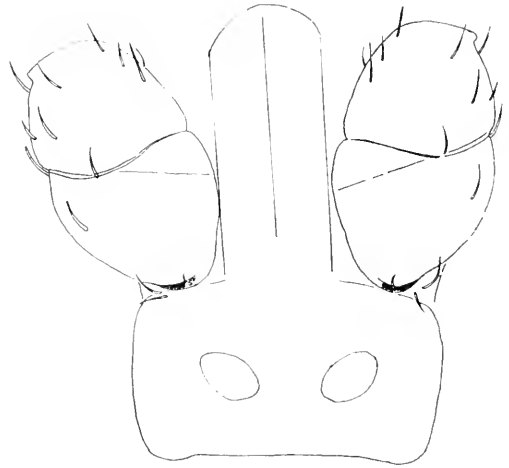


Figs. 381-3, *Dermacentor circumguttatus*. 381, male in dorsal view; 382, capitulum and scutum of the female; 383, spiracular plate of the male.

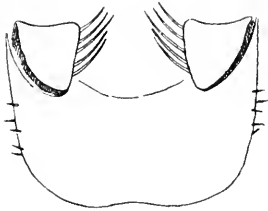
set obliquely to the long axis of body, strongly depressed; interporose areas about equal to the maximum length of one of the areas, and situated well in front of the posterior border. Palpi rather longer than in males, postero-dorsal ridge not markedly salient, oblique furrow near distal margin of article 2: base of article 3 sharply edged for outer four-fifths; outer margin of article 3 slightly salient basally and distally; apex of article 3 rounded; outer edge of article 2 sharp, oblique, more arc-like than inner border. In ventral view, sides straight, postero-lateral and posterior margins broadly rounded (fig. 387); postero-ventral ridge salient, behind which it is declivitous; in front surface generally flattened, except for transverse groove. Article 1 drawn out



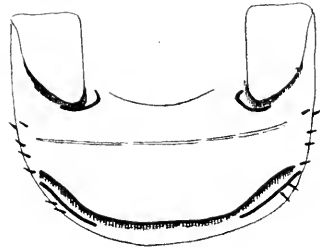
384



386



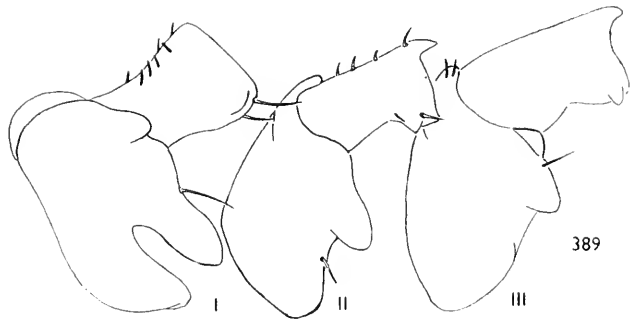
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388

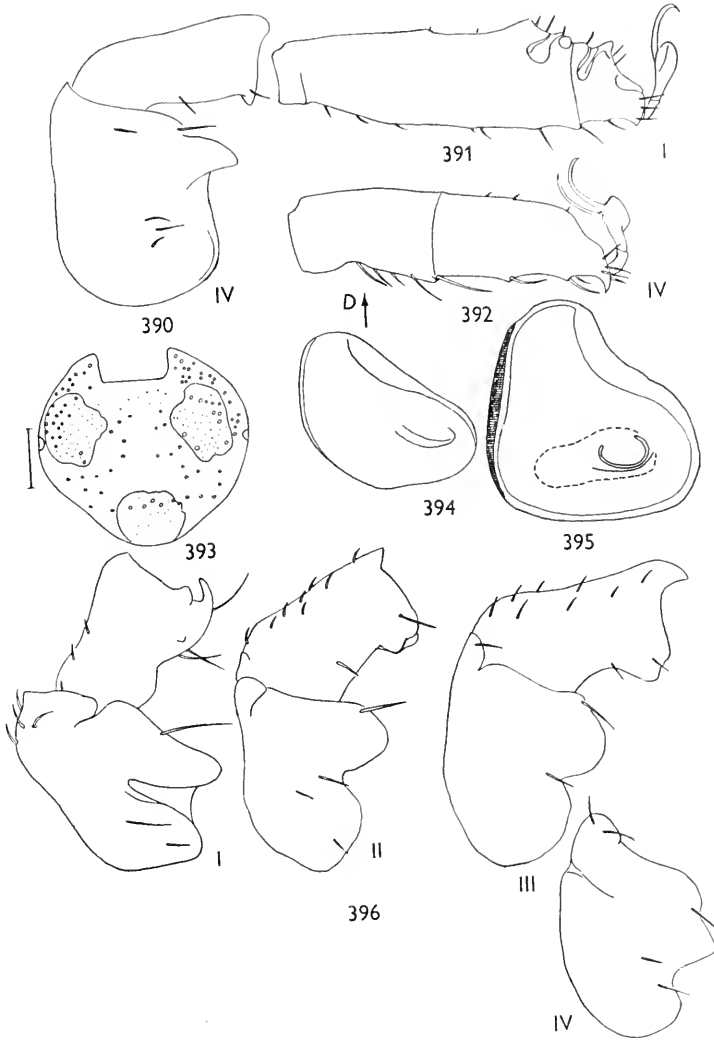


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Figs. 384-9, *Dermacentor circumguttatus*. 384, dorsal view of capitulum of male; 385, ventral view of basis of male; 386, dorsal view of the capitulum of female; 387, ventral view of the basis of female; 388, side view of palp of female; 389, coxae I-III of male.

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postero-ventrally to form a short broad spur (fig. 388). Length of article 2, 0.49-0.52-0.56 mm., article 3, 0.41-0.46-0.48 mm.; breadth of article 2, 0.54-0.56-0.60 mm., article 3, 0.54-0.56 mm. Hypostome, apex rounded, distinct corona, succeeded by one row 4/4 files, remaining rows 3/3 files of teeth.



Figs. 390-6, *Dermacentor circumguttatus*. 390, coxa IV of the male; 391, tarsus I of the female; 392, tarsus IV of the female; 393, scutum of the female; 394, spiracular plate of the male; 395, the same of the female; 396, coxae and trochanters I-IV of the female.

Scutum. Nearly circular, with posterior and postero-lateral margins tending to be undulate (fig. 393); length about 3.1 mm., breadth about 3.5 mm. Surface convex dorsally, dark brown, with three large peripheral ochreous-yellow patches; the two anterior patches extending from about the level of the cervical groove to behind the

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level of the eyes, and a single patch meso-posteriorly (pl. III, fig. 2). Cervical grooves as small deeply sunk, elongate oval pits; no lateral grooves. Punctations of moderate size and predominating antero-laterally, finer punctations of uniform distribution. Postscutal area very smooth, without patches of broad hairs, glabrous marginal grooves well defined.

Legs. Dark brown with pale articulations (pl. III, fig. 2). Coxa I with moderate spurs not very dissimilar and fairly well separated; coxae II and III with broad rounded external spurs, internal spurs distinguishable as marginal saliences; coxa IV with broad internal and external spurs (fig. 396). Trochanter spurs much reduced. Tarsus IV strong, cylindrical, narrowing abruptly near the tip and with a strong apical spur when compared with tarsus I (cf. figs. 391 and 392).

Spiracular plate. Subtriangular, rather broad, antero-dorsal margin broad and rounded, posterior edge of frame sharply ridged and wide when compared with the rest (fig. 395).

MALE

Capitulum. Basis subrectangular (fig. 384) with rounded angles, length 0.36 mm., breadth 0.92 mm. Surface smooth, impunctate, generally flattened dorsally, margins slightly downcurved; cornua lacking. Palpi short and broad; article 2 slightly longer than article 3, as 1.95:1.7; both articles broader than long, length/breadth ratio of article 2, 2.2:1.95; length/breadth ratio of article 3, 2.1:1.7. Article 3 salient laterally and distally. Hypostome with dentition of 3/3 files. Ventrally basis broadly rounded behind (fig. 385); lateral margins only slightly divergent; and bearing a few short spinose hairs.

Scutum. Long oval, length about 2.2 mm., breadth about 1.6 mm.; strongly curved dorsally, slightly narrowed anteriorly, scapulae pointed, emargination deep. Ornamented with four pairs of lateral yellowish ochre markings (pl. III, fig. 1). Cervical grooves represented by two minute pits; no lateral grooves and no furrows delimiting the festoons. The latter fairly long, inornate. Punctations of small and moderate size; the latter most numerous laterally. Eyes of moderate size, placed more laterally than dorsally, flat, inconspicuous. *Venter* with very few white hairs lateral and posterior to the anus. *Spiracle* comma-shaped, with moderate rather blunt dorsal process; granulations very fine.

Legs. Dark brown with light articulations (pl. III, fig. 1). Coxa I with external and internal spurs of about equal length and well separated, internal spur broader than external spur, both rounded at the tip; surface gently convex (fig. 389); coxae II-IV with strong blunt external spurs, internal margins of coxae II-IV approximating to marginal saliences: coxa IV only slightly enlarged. Tarsus IV strong, cylindrical, narrowing abruptly near the tip and with strong terminal spur.

Dermacentor circumguttatus var. *cunha-silvai* Santos Dias, 1952

Travassos Santos Dias (1952) has described a subspecies of *D. circumguttatus* as *cunha-silvai* from elephants *Loxodonta africana africana* from the Gogói region (Mossurize, Beira district, Manica et Sofala Province). As far as I am able to determine the crucial difference lies in the ornamentation of the scuta of both males and females.

BIOLOGY. Not studied. Hosts *Loxodonta africana*, common 'duicker'.

DISEASE RELATIONSHIPS. Not studied.

SPECIES CONDEMNED, DOUBTFUL, INSUFFICIENTLY DESCRIBED
OR MATERIAL INSUFFICIENT

D. albicollis

Koch, 1844, p. 236; 1847, p. 113, Pl. XXIV, fig. 88 (female dorsum, venter), female, origin unknown: probably *D. reticulatus*.

D. americanus

Railliet, 1893. Impossible to identify, but see below.

D. americanus (Linneas)

Neumann, 1897, p. 365. Was referred by Neumann, 1901, p. 265, to *D. electus* Koch, 1844, but the latter = *D. variabilis* (Say, 1821). Neumann's synonymy of 1897 should be discarded as partly guesswork; several species and even different genera being probably confused.

D. atrosignatus

Neumann, 1906, p. 210 (type in British Museum); 1911, p. 103 = *D. auratus* Supino, 1897 q.v. = *ater* Schulze, 1939.

D. bellulus Schulze, 1935

= *atrosignatus* Sugimoto, 1937 (see also pp. 157-9).

Ixodes bifurcatus Neumann 1899

ICON. AND LIT.

I. bifurcatus Neumann, 1899, p. 122; Neumann, 1899, p. 155 quotes the description by Koch in five lines. Neumann, 1901, p. 289 degrades *I. bifurcatus* to a synonym of *I. brunneus* = *Ixodes brunneus* Koch, 1844, p. 232; 1847, p. 101, pl. xx, fig. 74. Neumann (1904), p. 453, renamed *Ixodes bifurcatus* as *Dermacentor bifurcatus*: omits mention of eyes and anal grooves. Noted under synonymic list of *Ixodes* by Nuttall *et al.* (1911), where they stated it is not *I. brunneus* Koch as given in Neumann, 1901.

MALE. Unknown.

FEMALE. Body oval, yellowish brown, 4 × 2.4 mm., with lateral borders almost straight. *Scutum* oval, glossy, longer (1.5 mm.) than broad, with sides rounded;

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cervical grooves shallow, short, rarely attaining one third of the length; no lateral grooves; punctations equal, medium, few. Dorsum glabrous; traces of a marginal groove and posterior festoons; longitudinal grooves normal. Venter bearing a few short hairs; punctations superficial; vulva facing coxa II; anus toward the posterior third of the body; anal grooves but slightly apparent; traces of posterior festoons. Spiracles whitish, large, almost circular, with a very short postero-external prolongation. *Capitulum* short (0.6 mm.), with base broad and short, punctate; porose areas small, shallow. Hypostome 3/3. Palps short and broad. *Legs* medium, slender. Coxae small, slightly hairy; coxa I with two equal spurs; two very short spurs on coxae II-III; a chitinous prominence at the postero-internal angle of coxa IV. The other articles bear long hairs on their ventral border. Tarsi of medium length, tapering at their tips, pads almost as long as the claws.

Description based on one young female found on the wild cat, from Texas, Marx coll., Bureau of Animal Industry, Washington, see Neumann, but Banks says not. Banks, 1908a, p. 43, pl. x, fig. 1 includes: dorsal and ventral aspects, coxae, capitulum, palp, scutum and spiracle from Marx's drawings (MS.). Although the capitulum as figured shows porose areas, Banks regards *bifurcatus* as a synonym of either *D. variabilis* or *parumapertus*.

D. clathratus Koch, 1844

ICON. AND LIT.

Koch, 1844, p. 236; Koch, 1847, p. 117, pl. xxv, fig. 91; Neumann, 1897, p. 380.

MALE. Body oval, broader behind, flat, glossy, 3.8 mm. long. *Scutum* without punctations, posterior marginal festoons present; colour ferruginous yellow, with black radiating lines extending from an oval anterior spot, open in front and radiating to the sides. Rostral base almost quadrangular, the posterior angles salient; palps short, almost triangular. *Legs* fairly long. *Habitat* unknown.

FEMALE Unknown.

REMARKS. Species poorly determined; according to Koch's figure it would appear to represent *Haemaphysalis concinna*. Origin unknown, type in British Museum.

D. compactus Neumann, and associated subspecies of Schulze, probably variants of *auratus*.

D. cruentus, Koch, 1844.

ICON. AND LIT.

Koch, 1844, p. 236; 1847, p. 120, pl. xxv, fig. 93. Neumann, 1897, p. 381.

FEMALE. Body oval, broader behind, 3.3 mm. long. Rostrum and legs as in *D. parabolicus*. Scutum dark red-brown, with a light wine-red median field, limited by the cervical grooves which extend almost to the posterior border. Lateral border and scutum light red. The rest of the body dark red-brown.

DOUBTFUL SPECIES

MALE. Unknown.

REMARKS. Koch considered *D. cruentus* to be related to *D. parabolicus*. They may represent the same species but are insufficiently described for determination. Female from Orowitza, Banat, Hungary.

D. dentipes Koch, 1844.

ICON. AND LIT.

Koch, 1844, p. 236. Koch, 1847, p. 115, pl. xxiv, fig. 90. Neumann, 1897, pp. 379-80.

MALE. Body oval, broadened behind, flat, glossy, 4.35 mm. long. *Pseudoscutum* present; a marginal groove and eleven posterior festoons. Rostrum with almost quadrangular flat base, and salient posterior angles; palps very short. *Legs* fairly short and thick, ferruginous red; three pointed teeth on coxa IV. Three smaller teeth on the femur (article 2?), three small tuberosities on the legs. General colour dark wine red; rostrum and marginal folds lighter coloured. From Banat.

FEMALE. Unknown.

REMARKS. A poorly determined species. Koch's figure represents more probably an unfed female than a male. From Banat, Hungary.

D. electus Koch, 1844, p. 235; 1847, p. 109, pl. xxii, figs. 83 (male), 84 (female). = *D. variabilis* (Say, 1821), Banks, 1907. Types of *electus*, one male, two males in Berlin Museum, see Neumann, 1901, p. 265; from Pennsylvania and Texas.

D. feai Supino, 1897.

ICON. AND LIT.

Supino, F., 1897*a*, fasc. 1; 1897*b*, fasc. 2, pl. xiii, fig. 12. Neumann, 1897, pp. 381-2.

MALE. Body, not including the rostrum, 2 × 1.2 mm. Hypostome with eight rows of teeth of uniform size in each transverse series.

FEMALE. Body, not including the rostrum, 8 × 6 mm. Chelicera with internal apophysis bidentate, the external apophysis tridentate. Hypostome with six rows of teeth decreasing in size from the external to the internal rows. Tarsi long and thick; those of pair I bear four stout protuberances dorsally, all joined together on the distal half of the article; on the ventral side there are three angular prominences, equidistant, the proximal smallest. Pad one-third as long as the claws. *Habitat*: found by Fea on *Testudo elongata* and *Nicoria trijuga* at Bhamo, Burma; probably *Amblyomma supinae* Neumann, 1905.

D. ferrugineus Koch, 1844, p. 236; 1847, p. 118, pl. xxv, fig. 92, male, origin unknown; probably *D. reticulatus*.

D. indicus Supino, 1897

ICON. AND LIT.

Supino, 1897*b*, pl. xiii, figs. 15-16. Neumann, 1897, pp. 382-3.

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MALE. Body 4.8 × 4 mm. (rostrum not included). Chelicera with internal apophysis bidentate, likewise the external apophysis. Tarsi large and thick, similar to those of the female.

FEMALE. Body 10 × 7 mm. (rostrum not included). Chelicera with internal apophysis unidentate, the external quadridentate. Hypostome with six rows of teeth decreasing in size from the tip to the base. Tarsi large and long; pair I bear on the distal half of the dorsal border three prominences of which the proximal is small, the others stout; on the ventral border there are two angular prominences, the distal stouter, both opposite the two proximal protuberances of the dorsal border; a small terminal spur. Pad one-third as long as the claws.

REMARKS

Neumann (1902, p. 127) has examined the types, four males and one gorged female, and identifies them as *Amblyomma badium* Neumann. The specific name *A. indicum* (Supino) cannot be retained for the reason that Koch gave the name of *A. indum* to the form indicated as *Acarus indus* by Linnæus. Nuttall (personal notes) believed it to be *Amblyomma sublaeve*.

D. longipes Supino, 1897*b*

ICON. AND LIT.

Supino, 1897*b*, pl. XIII, fig. 13. Neumann, 1897, p. 383.

MALE. Tarsi small and thick; tarsi I bear at their dorsal border at the distal half two protuberances, the first more marked than the second; on the ventral border three protuberances occur toward the middle of the length of the article.

This specimen is probably lost and the figures for identification purposes are useless.

D. parabolicus Koch, 1844

ICON. AND LIT.

Koch, 1844, p. 236. Koch, 1847, p. 119, pl. xxv, fig. 93. Neumann, 1897, pp. 380-1.

MALE. Unknown.

FEMALE. Body oblong, lateral borders almost parallel, posterior border almost straight, slightly narrowed in front and on a level with the stigmata, flat, dull coloured; posterior festoons clearly marked, darker than the rest of the abdomen which is yellowish brown; length 6.5 mm. *Scutum* oval, with posterior angle rounded and bordered on each side by a broad, poorly marked sinus; few punctations; cervical grooves short, broad, reniform; colour very dark red-brown, excepting over a longitudinal median area which is constricted in the middle and of yellowish colour with a ferruginous red median band, ending in a point behind. The base of the rostrum and palps as in the type (?). *Legs* relatively short, with hairs along the ventral border of the articles, which are dark red, with distal extremities light yellow. Collected at Orowitza, Banat, Hungary.

DOUBTFUL SPECIES

REMARKS

The species is scarcely better defined than *D. clathratus*.

D. pardalinus Koch, 1844, p. 235; 1847, p. 114, pl. xxiv, fig. 89, probably female, from Hungary, described as a male; probably *D. reticulatus*.

D. parvus Neumann, 1897, pp. 378-9.

MALE. Body oval, broader behind, 2.6 × 1.6 mm. *Scutum* convex, blackish brown, glossy, as though varnished, glabrous, the internal organs partially visible through it: cervical grooves very short; lateral groove shallow, ending at the extreme marginal festoons; festoons with well-marked intervals; very many fine punctations; eyes pale, situated on a level with legs II. Ventral surface reddish brown, glabrous; sexual pore facing coxa II; sexual grooves separated, divergent; peritremes whitish. Rostrum with posterior basal angles prolonged into salient blunt points. Hypostome barely spatulate, with many anterior denticles, and eight rows of teeth. Palps short, swollen outwardly, extending much beyond the external border of the rostral base, bearing hairs on the external border, the third article with a pointed retrograde process ventrally; seven or eight closely ranged hairs along the internal border of the second article. *Legs* fairly stout, reddish brown. Coxae glabrous, increasing but slightly in size from pair I-IV; coxae I and II elongated to form a but slightly salient spine; coxae III and IV bear a tuberosity at the posterior border. The other articles thick, bearing two rows of hairs on the ventral border. Tarsi with a small terminal spur; pad almost attaining the recurved part of the claws.

FEMALE. Unknown.

REMARKS

Description based on one specimen, probably unfed, from Syria (Paris Mus.).

D. planus Rudow, 1870, p. 18. Neumann, 1897, p. 381.

FEMALE. Body flat, orbicular, red-brown, 4 mm. long. *Scutum* elongate, dark brown, broader behind. Dorsum uniformly granular, bordered with yellow; a yellow line surrounds the scutum; festoons large, bordered with yellow. Rostrum brown; palps broad, oval in front, with a ventral appendix directed inwardly. Legs very long, light brown; tarsi haired, claws unequal.

MALE. Unknown.

REMARKS. A doubtful species, badly studied, it may represent a but slightly coloured specimen of *D. reticulatus*. Origin unknown.

D. puncticollis Koch, 1844

ICON. AND LIT.

Koch, 1844, p. 236. Koch, 1847, p. 112, pl. xxiii, fig. 87. Neumann, 1897, p. 379.

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FEMALE. Gorged. Body oval, swollen, red-brown, 14 mm. long. *Scutum* oval, flat, swollen, cervical grooves sinuous, extending slightly beyond half the body length, with many large punctations, colour dark brown-red. Base of rostrum as broad as long; porose areas, palps very short, without apparent divisions. Collected in Greece.

REMARKS

An almost nominal species based on a legless specimen which may not even be a *Dermacentor*.

D. rosmari Ass, 1935, pp. 601-7, figs. 1-5, nymphs from walrus in the Kara (White) sea. Pomerantzev (1950) considers it to be a synonym of *Hyalomma aegyptium* (p. 193), but Hoogstraal (1956) stated that its systematic position is uncertain and that this synonymy is hardly convincing on the basis of the original description and figures.

D. steini and *steini leviculus* Schulze, 1933; probably *D. auratus*.

D. triangulatus Neumann, 1901, p. 266.

MALE. Unknown.

FEMALE. Body elongate oval, 10 mm. long, 6 mm. broad. *Scutum* triangular, latero-posterior borders straight, posterior angle narrow; eyes yellow, flat, toward the anterior third; cervical grooves equal to half the length; punctations numerous, very fine, equal; general colour yellowish white, with dark brown parts contouring the eyes, punctations and cervical grooves; a narrow longitudinal spot in front of the posterior angle, another on each posterior border facing the cervical groove, a small one external to each cervical groove, another lighter-coloured on the cervical border. Body yellowish brown; three longitudinal dorsal grooves in the posterior half; fine punctations; anus small, reddish; peritremes small, triangular. Rostrum relatively long; porose areas deep, oval; a light yellow spot occurs between them. Chelicera and hypostome? Palps with article 3 broader than long; article 2 yellowish white, almost twice as long as 3. *Legs* short. Coxa I divided into two pointed spines; a small protuberance on the posterior border of the others. Tarsi very short, not humped.

The above description is based on one specimen from Corrientes, Argentine Republic (Carlos Berg Collect.).

D. variegatus Marx in Neumann, 1897, p. 367, figs. 22-4; Neumann, 1911, p. 101: from *Cervus caudensis* Briss (?=moose) United States. Neumann, 1901, p. 266 may be the *Ixodes s. striatus* Fitch, 1872, p. 366. Salmon & Stiles, 1902, pp. 452-4, merely translate Neumann, 1897, p. 367. Banks, 1908, p. 45 says 'Neumann, using Marx's manuscript name, described it as *D. variegatus*'. This name falls, *D. albipictus* (Packard, 1869) having priority.

D. venustus Banks = *andersoni* Stiles, 1908, p. 22. Neumann, 1911, p. 100 gives its origin as Montana. Hosts: horse, man, *Bos taurus* L.

DOUBTFUL SPECIES

GEOGRAPHICAL DISTRIBUTION OF THE GENUS

AMERICA: *D. albipictus*, *occidentalis*, *variabilis*, *andersoni*, *hunteri*, *halli*, *dissimilis*, *imitans*, *dispar*, *latus*.

ASIA: *D. reticulatus*, *niveus*, *silvarum*, *pavlovskyi*, *albipictus*, *kamshadalus*, *everestianus*, *nuttalli*, *marginatus*, *auratus*, *asper*, *sinicus*, *taiwanensis*, *coreus*, *antrorum*, *pomerantzevi*.

EUROPE: *D. reticulatus*, *niveus*, *marginatus*.

AFRICA: *D. (Amblyocentor) rhinocerinus*, *D. (Puncticentor) circumguttatus*, *D. (Puncticentor) circumguttatus* var. *cunha-silvai*.

CHAPTER VI

THE GENUS *ANOCENTOR* P. SCHULZE, 1937

SYN., LIT. AND ICON.

- 1897 *Dermacentor nitens* Neumann, pp. 376-8, original description.
1908a *Dermacentor nitens* Neumann: Banks, pp. 50-1.
1910 *Dermacentor nitens* Neumann: Stiles, p. 63.
1911 *Dermacentor nitens* Neumann, p. 103.
1912 *Dermacentor nitens* Neumann: Hooker, Bishopp & Wood, pp. 197-204.
1937 *Anocentor colombianus* Schulze.
1938 *Otocentor nitens* (Neumann): Cooley, pp. 65-8.
1953 *Anocentor nitens* (Neumann): Vogelsang & Travassos Dias, pp. 63-89.

GENERIC CHARACTERS

Ixodidae, which are inornate, without ventral plates or shields in the male; postanal grooves faint. Basis capituli rectangular dorsally. Palpi short, moderately broad and when apposed not concealing the chelicerae and hypostome dorsally. Palpal article 1 not articulating with article 2. Hypostomal dentition 4/4 on each side of mid-line. Coxa I bifid in both sexes. Eyes present (obsolescent). Lateral grooves absent in the male, marginal grooves absent in the female. Fестоons seven in number.

Anocentor nitens (Neumann, 1897)

Figs. 397-412

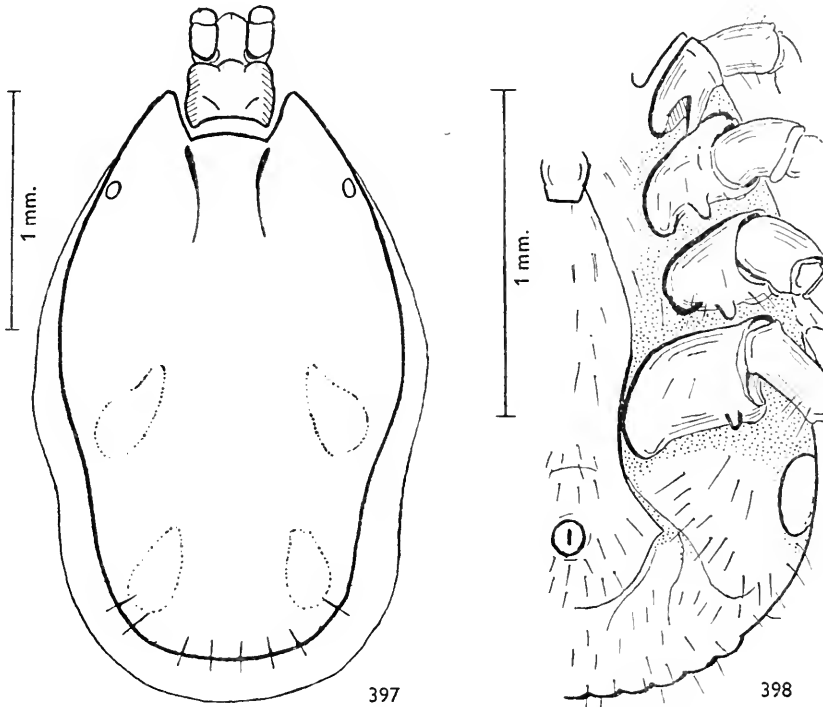
FEMALE. Length 2-3.1 mm., breadth 1.7-2.0 mm.

Capitulum. Dorsally basis capituli a little more than twice as long as broad (fig. 402); posterior margin straight, postero-lateral margin rounded; cornua frequently absent but when present faintly indicated, being very short and blunt. Antero-lateral margins either straight or slightly convex, in some specimens the margins converge from mid-length to palpal base. Punctations lacking and devoid of hairs. Distal ventro-lateral margins steep. Porose areas oval, longer axes divergent anteriorly. Palpi shorter than hypostome, but longer than the basis; article 2 longer than article 3, and both longer than they are broad; outer margins of article 2 arcuate, inner margins straight, moderate postero-dorsal lobe posterior to tumescent surface, hairs most abundant mesially; apex of article 3 broad, rounded with few hairs on the inner edge. Ventrally basis broadly rounded with a group of 3 or 4 spinose hairs ventro-laterally; surface of palpi flat, except distally where it is slightly concave. Dentition of hypostome 4/4.

Scutum (fig. 403). Brownish yellow, slightly longer than broad; length about 1.7 mm., breadth about 1.6 mm., inornate, very glossy. Posterior margin rounded,

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divergent to the level of the obsolescent eyes, thence converging by almost rectilinear margins to large tapering scapulae; emargination very pronounced. Cervical grooves linear, narrow, shallow but sometimes faint or absent. Numerous short fine hairs (shorter than those on other parts of the body). Punctations numerous and deeper in cervical and humeral areas, where short hairs usually arise from them. Postscutal area with dorsal surface strongly narrowed at the level of the spiracle, which may in some specimens be visible from above; seven very small indistinct festoons; strong sharp spinose bristles.

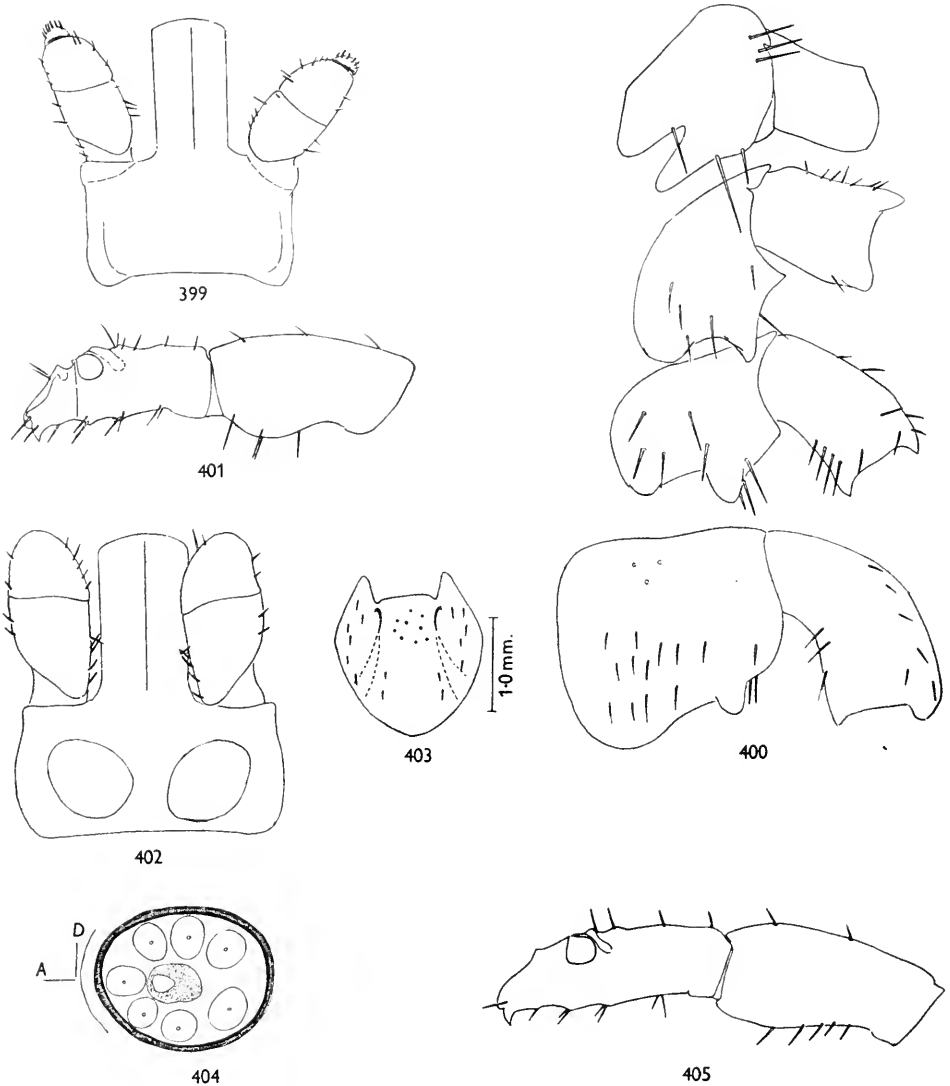


Figs. 397-8, *Anocentor nitens*. MALE: 397, dorsal view of body; 398, ventral view of body.

Legs. Well supplied with hairs, similar to those on the postscutal area. Dorsal trochanter spur short and terminally rounded. Coxae smaller than in *Dermacentor*. Coxa I with divergent spurs, external spur elevated, smaller and more tapered than the broader internal spur; external spurs on coxae II-IV subtriangular about as long as the basal breadth, flattened and elevated; internal spurs on coxae II and III broadly rounded and extending beyond the coxal edge, that on coxa IV weak.

Spiracular plate. Elongate oval, long axis corresponding to that of the body, whole surface strongly elevated above the surface, convex macula anterior of centre; 6-8 large goblets, each being convex; rest of the spiracular surface granulated.

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Figs. 399-405, *Anocentor nitens*. 399, capitulum of male in dorsal view; 400, coxae I-IV of the male; 401, tarsus I and metatarsus I of the male; 402, capitulum of the female, dorsal view; 403, scutum of female; 404, spiracular plate of the male; 405, tarsus and metatarsus I of the female.

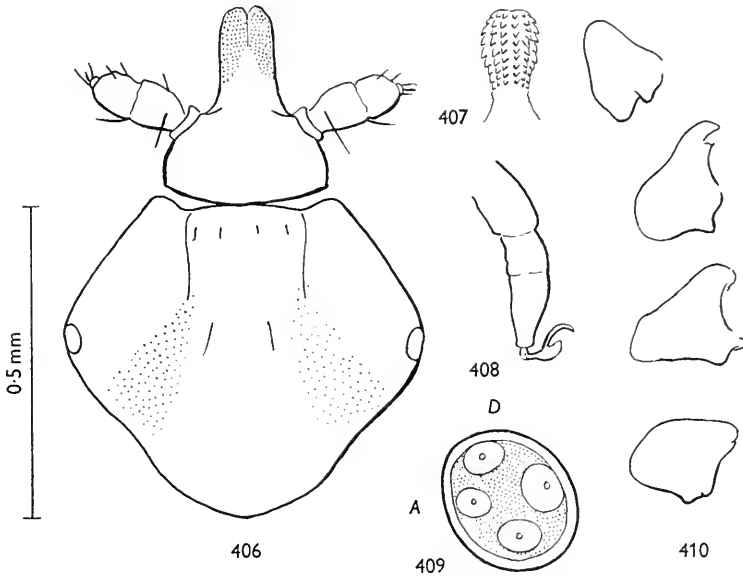
MALE. Inornate and of a yellow-brown colour.

Capitulum. Basis capituli rectangular, nearly twice as broad as long, posterior margin slightly convex, cornua broad, rounded, much shorter than the basal breadth (fig. 399); lateral margins slightly sinuous; surface smooth, flat with a slight postero-mesial triangular depression; more heavily pigmented postero-laterally. Palpi shorter than hypostome, but about as long as the basis capituli; lateral profile almost straight,

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not salient laterally, apex blunt; article 2 slightly longer than article 3 which is broader than long; dorsal surface tumescent proximally with broad postero-dorsal ridge; hairs present at the sides and apically. Ventrally surface of basis convex, postero-ventral ridge and punctations lacking: few short hairs ventro-laterally. Surface of palpi irregular, hairs present marginally; no punctations. Hypostomal dentition 4/4.

Scutum. Length about 2.37 mm., greatest breadth of about 1.44 mm. just in front of the spiracle. Surface convex, inornate, very glossy, smooth with numerous punctations which are more abundant in the anterior region (in some specimens these punctations may be few with numerous rugosities). Scutum does not cover the whole



Figs. 406-10, *Anocentor nitens*. NYMPH: 406, capitulum and scutum; 407, hypostome; 408, tarsus I; 409, spiracular plate; 410, coxae I-IV.

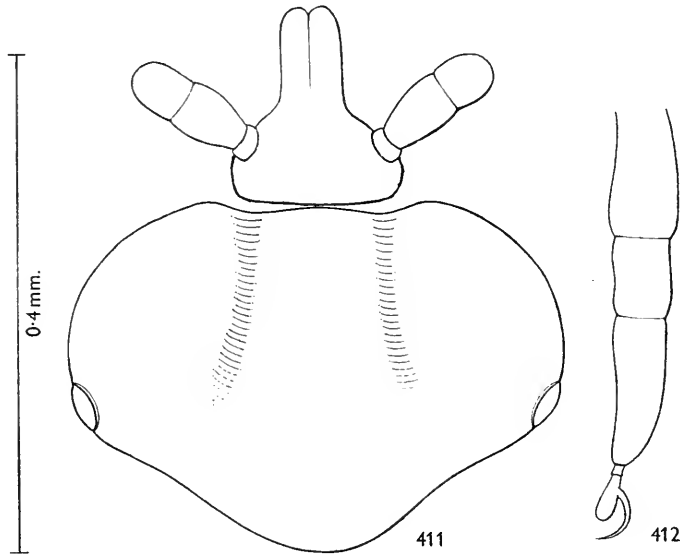
of the dorsum in gorged specimens, lateral margins narrowing strongly in the region of the spiracular plate; numerous short hairs (frequently caducent) present and more apparent in the lateral and posterior area, and also visible on the antero-lateral edges of the body. Cervical grooves linear, shallow, narrow, varying in length, a few times longer than broad. Lateral grooves indistinguishable; scapular angles very sharp. Eyes small, obsolescent. Festoons seven in number, small and indistinct (fig. 397). *Venter* bearing numerous short white hairs. *Spiracle* unique, being oval and lacking dorsal process, with very few (4-10) very large, more or less isolated goblets (figs. 398 and 404).

Legs. Much as in the female except for coxa IV; latter with large external lobate spur which is longer than its basal breadth; internal spur of coxa IV broadly rounded. Coxa I with rather short parallel spurs not very unequal in width; coxae II and III with two blunt equal spurs. Tarsi I and IV tapering with fairly strong terminal spur; claws longer than pulvilli.

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NYMPH. Length 1.12 mm., width 0.80 mm. According to Cooley (1938) the larvae and nymphs when compared with the adults are relatively larger than in *Dermacentor*. Generally of characteristic shape, the body narrowing quite strongly behind the spiracles.

Capitulum. Basis capituli strongly resembling that of the female but lacking porose areas (cf. with *Dermacentors*), posterior border broadly rounded both dorsally and ventrally, basal spurs lacking. Hypostome broad, apically rounded, dentition arranged in nine rows of $3/3$ teeth.



Figs. 411-12, *Anocentor nitens*. LARVA: 411, capitulum and scutum; 412, tarsus I.

Scutum. Rather broader than long (length 0.5-0.51 mm., breadth 0.59-0.61 mm.), rounded behind with a slight tendency to be pointed (fig. 406); postero-laterally the margins are convex, widest at the level of the eyes, where it is rather sharply angular at about half scutal length. Scapular angles blunt. Cervical grooves very far apart and short. Hairs numerous in the vicinity of the spiracles.

Spiracular plate. Inordinately large; oval with macula near centre. Goblets very large, few in number (3-8 goblets), length 0.25 mm., breadth 0.23 mm.

Legs. Internal spur on coxa I indistinct; absent on coxae II-IV; external spurs small but distinct.

LARVA. Length 0.5 mm., width 0.4 mm.

Capitulum. Closely reminiscent of that of the nymph. Palpi like those of nymph. Hypostome broad, dentition $2/2$.

Scutum. Length 0.27 mm., greatest breadth of 0.4 mm. slightly in front of the

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eyes; broadly convex in front, sinuous behind the eyes. Cervical grooves shallow broad, reaching just beyond half length.

Legs. Coxal spurs lacking; coxa II longer than coxa III.

BIOLOGY

A. nitens was originally described from Jamaica and Santo Domingo. In the United States its probable distribution is limited to the southern parts of Texas. Hooker, Bishopp & Wood (1912) report the species from Mexico, Guatemala, Panama, Costa Rica, Cuba, Haiti and Trinidad. More recently it has been noted from Colombia, for which Schulze (1937) established the new genus *Anocentor*, and in the Argentine in South America by Vogelsang & Travassos Dias (1953).

Of the species described in this volume, *A. nitens* is probably the most aberrant because of its habit of infesting the ears of its host, wherein it undergoes its development from the larva to the adult. Hooker in 1907 and Bishopp in 1909 found very heavy infestations of the ears of horses in Texas and Mexico respectively. In Texas the horses' ears were 'literally filled with ticks of this species in all stages of development. The moulted skins and excrement which had collected in the ears in large quantities were the source of a nauseating stench.' In Mexico this tick is a 'troublesome pest, the horse becoming touchy about the head and sometimes refusing to be bridled'. It has been stated that in Cuba 'these ticks sometimes collect in horses' ears in such numbers as to cause the ears to lop and the screw-flies attack the ear and permanently disfigure the animal'. If Mazo's identification of *A. nitens* is correct then we have an analogous effect to that produced by the Argasid tick *Otobius megnini*. Hooker *et al.* (1912) named it the 'tropical horse tick' and although it is principally a parasite of the horse, mule and ass, it has been recorded from cattle, deer and goats.

Having dropped off the host the fully-fed female proceeds to lay eggs within 3-15 days at 85° F. and the process extends over a period of 15-37 days, the shorter period being associated with higher temperatures and vice versa. Twelve females laid an average of 2784 eggs with the maximum number produced by one female being 3392 eggs.

Eggs hatched within 74 days at a temperature of 85° F., 39 days at about 73° F. and 32 days at 76° F. *A. nitens* is a one-host tick, and exact feeding and transformation times are accordingly difficult to establish. That the larva changes to the nymph in 8-16 days and the nymph to the adult in 7-14 days has been suggested. It is, however, known that females drop from the host between 26-41 days after the larvae have become attached, and of this period 9-23 days are spent feeding by the female. Males spend a much longer time on the host than do the females, and their period of sojourn here may range for about 90 days. Copulation occurs on the host as early as 2 days after moulting and the males remain with the females until the latter are fully engorged and drop off.

It is of interest to note, however, that the female voids much excrement during the ingestion of blood, and so copious is this that the male frequently dies, being unable

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to free himself from the female. It is also likely that this excrement may make a serious contribution to the 'nauseating stench'.

The maximum longevity of unfed larvae was 71 days, but usually they died in about 10 days. This is in contrast to the condition found in *Dermacentor albipictus* where the survival of unfed larvae extends for 60-346 days. The larva remains attached and feeding for 3-6 days (mostly 4 days), the nymph 6-10 days (usually 8 days), and the adult from 9-23 days. When the adults are placed upon a sheep they usually scatter, but when the male has completed his blood meal he seeks a female, and copulation takes place upon the host. At 30° C. it took 12-19 days for the larvae to hatch, 5 days for the larvae to transform into nymphs and 12 days for a similar change from the nymphs to adults. When maintained in semi-darkness at room temperature unfed nymphs survived for 37 days, an unfed male lived for 474 days and an unfed female for over 450 days. Assuming hosts were available at the appropriate time the shortest time required for the completion of the life-cycle would be 80 days, but this period is doubtless considerably prolonged under natural conditions.

CHAPTER VII

THE GENUS *COSMIOMMA* SCHULZE, 1919

SYN., LIT. AND ICON.

- 1843 *Dermacentor hippopotamensis* Denny, original description, pp. 312-14.
1843 *Ixodes bimaculatum* Denny, pp. 312-14.
1844 *Amblyomma hippopotami* Koch, pp. 217-39.
1910 *Dermacentor hippopotamensis* Denny: Dönitz, pp. 397-494.
1919 *Cosmiomma hippopotamensis* Schulze, pp. 189-96.
1951 *Dermacentor hippopotamensis* Denny: Zumpt, synonymised *Cosmiomma* with *Dermacentor*, pp. 87-101.
1956 *Dermacentor hippopotamensis* Denny: Hoogstraal, pp. 325-6.

GENERIC CHARACTERS

Basis capituli subtriangular dorsally; palpal article 2 appreciably narrower than article 3, and about twice as long. Enamel pigmentation on the palps, basis capituli, scutum and legs. Eyes well developed. Eleven festoons in the female more or less clearly defined, with large spiracles abutting against the margins of the anterior festoons. Female with anal groove encircling the anus and produced behind in a median groove; the male with one pair of adanal shields only and lacking the accessory and subanal shields and the posterior abdominal protrusions capped by chitinised points (cf. *Hyalomma*). Coxa I with long external spur and prominent internal spur, divergent.

Cosmiomma (Dermacentor) hippopotamensis (Denny, 1843)

Figs. 413-27

Re-description MALE. Large, measuring 8.5 mm. long, maximum breadth 6.0 mm. Reddish brown base colour, golden yellow superimposed colour.

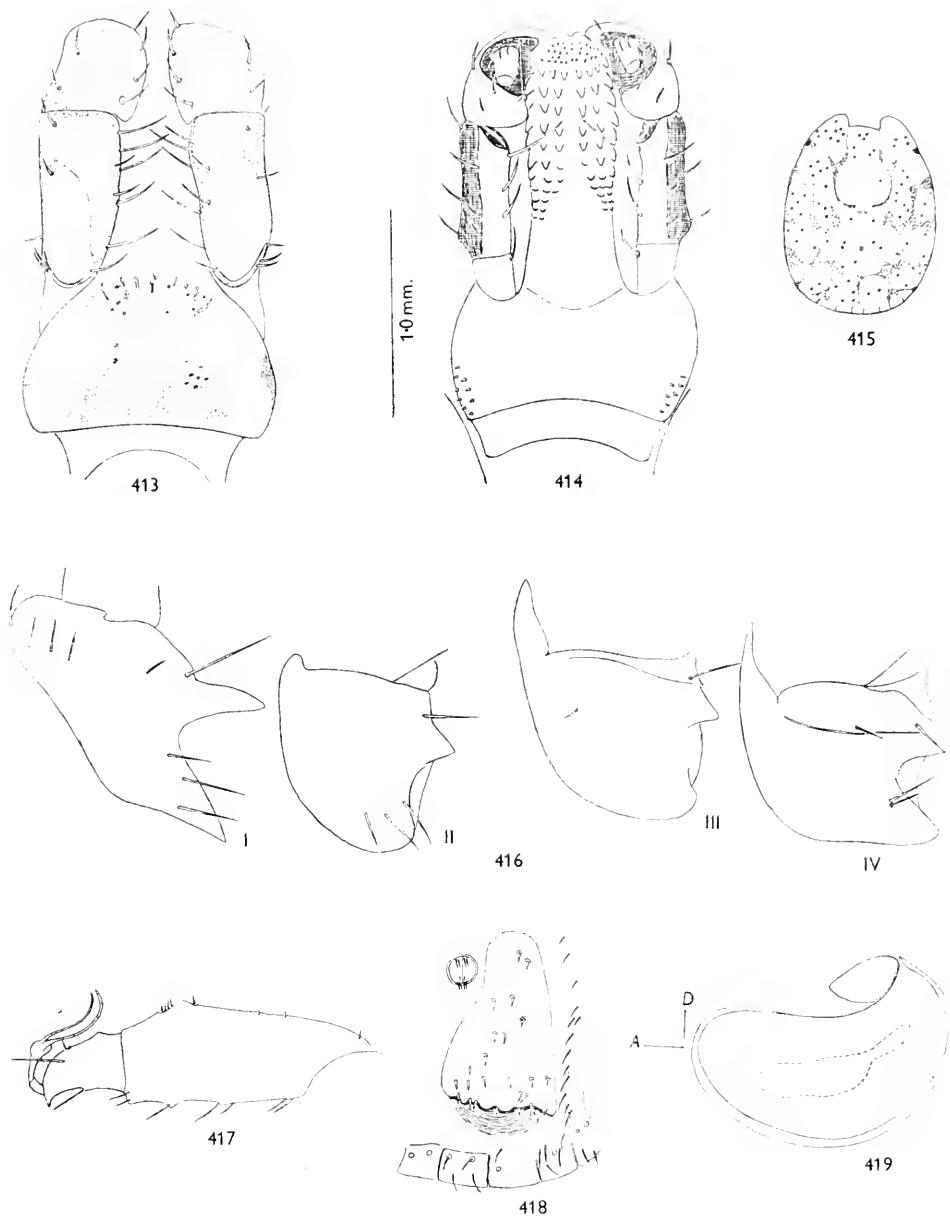
Capitulum. Basis capituli broader than long as 1.15 mm. is to 0.78 mm. Dorsal ridge concave, postero-lateral angles rounded and lacking cornua, postero-lateral margins subparallel, slightly convex for less than half their length, then narrowing appreciably to anterior cheliceral foramen. Behind the dorsal ridge a short steep slope leading to a stout 'neck', which bears an arcuate elevated region; laterally the basis capituli slopes steeply in the posterior half. Surface gently convex, smooth for the most part except distally where the surface is thrown into slight shallow rugosities. Base colour predominates but marginally pattern colour extends from the palpal base to the postero-lateral extremities. Punctations small and most easily visible on the patterned areas. Palpi long; article 2, 0.6-0.8-1.0 mm., article 3, 0.3-0.4-0.6 mm.; article 2 with subparallel sides for most of its length but tapering proximally and

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strongly elevated postero-dorsally; article 3 distinctly broader and about half as long as article 2, general form of article 3 lobate (fig. 413); hairs few laterally, more numerous mesially where they are spinose and slightly curved. Punctations small and more clearly seen on the patterned areas, latter extensive on article 2 covering almost the whole of the mid-dorsal surface; on article 3 pattern colour limited to a meso-proximal area. Hairs on article 3 shorter and finer than on article 2. Ventrally lateral margins of basis capituli subparallel, posterior border slightly concave, surface strongly tumescent; ventro-laterally a large number of small thorn-like hairs. Article 1 (not visible from above) longer than broad, bearing a strong spinose hair on the inner margin, article 2 with an undulate inner edge, ventro-mesial half of surface convex, lateral margins flat beyond a ridge which bears short hairs; distal end separated from palpal article 3 by a flat surface (shaded in fig. 414). Article 4 orientated dorso-ventrally. Hypostome: length 1.0 mm., broad, spatulate, slight median indentation apically and small protuberances on each side; corona prominent, dentition as one row of 4/4 files of teeth, six rows of 3/3 files of teeth and proximally four rows of crenulations.

Scutum (fig. 415). Broadly ovate in outline with nine indistinct festoons indicated posteriorly. Pattern colour of golden yellow very much more extensive than the base colour, and forms a large patch on pseudoscutum, separated from lateral patches by short, deep, base-coloured cervical grooves; pigmented antero-laterally except for small region of base colour around the brown eyes; mesially the antero-lateral patches connect with a broad posteriorly indented patch; laterally as far back as posterior edge of anterior festoon are three large spots, which are sometimes confluent; the second and third festoons with small patches of pattern colour, the patch on the fourth being large and reaching forward to the posterior edge of the large indented area, the middle festoon covered with a small patch. Punctations of moderate size, deep and fairly uniformly distributed and bearing very short caducent hairs (fig. 415).

Legs. Of moderate length but very stout with short spurs on the tibia and tarsi (fig. 417). Coxa I subtriangular; internal spur broad and pointed, external spur long, narrow, tapering; former directed postero-mesially, latter posteriorly; moderate to long hairs on posterior edge, shorter and more spinose antero-distally; coxa II with anterior and antero-mesial edges arcuate, external spur short, broad basally and tapering apically, internal spur as a rounded marginal salience; coxa III of similar form but broader; coxa IV with a transverse groove subapically, external spur broad, subtriangular, internal spur of similar form but slightly longer and less broad. Tarsus I (fig. 417) widening distally to a 'hump', thereafter dipping appreciably to the pseudo-articulation, slightly humped in front of latter, thence curving quite strongly to the well-defined apical spur; ventrally the apical region has in addition one pair of short spurs, in front of which arise a pair of long stout pointed hairs; three similar protuberances are present on the proximal part, each supporting a similar pair of hairs; dorsally hairs short, unpaired. Length of tarsus I, 1.6 mm. Claws about twice as long as the pads (fig. 417).



Figs. 413-19, *Cosmiomma hippopotamensis*. MALE: 413, capitulum, dorsal; 414, capitulum, ventral; 415, scutum, dorsal; 416, coxae I-IV; 417, tarsus I; 418, posterior view of half the opisthosoma to show the anus, the adanal plates and the ventral festoons; 419, spiracular plate.

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Spiracular plate. Placed far back, posterior edge contiguous with anterior margin of first festoon, with small punctate, patterned coloured patch anterior to dorsal prolongation; large, length 1.24 mm., dorsal prolongation small, dorsal margin quite strongly concave, peritreme thick, serrated, ridged and sloping sharply to the post-scutal area; large dark brown region around the macula, paler marginally and studded with small pores which extend up into dorsal prolongation.

Venter. Genital orifice between coxae II, covered by a lobate genital apron. Genital grooves diverging distinctly to anterior edge of adanal plates; hairs between these grooves as long as those on adanal plates, but finer. Adanal plates originate in front of the anus, long, rounded in front and relatively narrow to just behind level of anus, thence broadening appreciably; posterior margin free with scalloped edge, moderate number of large deep punctations, each bearing short, thick, spinose hairs, more abundant posteriorly and peripherally. Festoons continued ventrally, broad but lacking anterior sutures, few punctations bearing finer hairs than on adanal plates (fig. 418).

Re-description FEMALE. Of similar size to the male, legs thick and strong; pigmented dorsally. Base colour chocolate brown, pattern colour golden yellow. Alloscutum much wrinkled and reminiscent of that of soft ticks; eleven festoons of which only the anterior ones are demarcated by the lateral grooves. Alloscutal hairs very strong, thick and curved apically.

Capitulum. Basis capituli about one and a half times as broad as long, breadth 1.38 mm., length 0.8 mm.; dorsal ridge almost straight with very slight, broad protuberances postero-laterally in the position of the cornua; lateral margins broadly arcuate and convergent to the anterior cheliceral foramen. Surface flat in front of porose areas, elevated laterally and between the porose areas, with a shallow median depression and smaller depressions antero-mesial of the postero-lateral protuberances. Porose areas almost circular, strongly depressed and separated by an interval about equal to half the diameter of one of them. Median area behind front margin of porose areas with base colour; but in front of, and lateral to, porose areas pattern colour extensive. Palpi large, length of article 2, 0.81–0.85–0.89 mm., article 3, 0.5–0.6–0.8 mm. Latter broader than former as about 0.55 mm. is to 0.53 mm.; article 3 lobate; outer margin slightly undulate to its greatest breadth subapically, whence it turns sharply inwards to the apex, inner margin gently curved; hairs more numerous mesially; base colour predominates and pattern colour restricted to narrow mesial band distally and a larger patch proximally and nearer to the mid-line, this latter traversed by short, shallow, oblique fissure; article 2 with subparallel sides for most of its length, tapering basally to narrowly rounded postero-dorsal lobe; hairs most abundant on the inner edge; surface strongly convex, pattern colour extensive with the base colour limited to a narrow mesial fringe and to a larger antero-lateral patch. Ventrally basis capituli broad, posterior margin straight, lateral margins either rounded or slightly sinuous, generally tumescent except for deep transverse trough-like depression at about mid-length. Palpi, article 1 longer than broad, bearing stout

C. HIPPOPOTAMENSIS

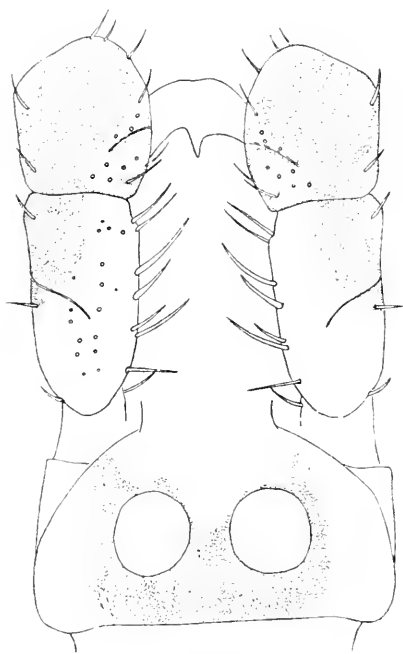
meso-distal spinose hair; article 2 with steep sharp face laterally with few hairs of varying lengths, meso-ventrally surface almost straight with 4 or 5 marginal spinose hairs; article 3, surface convex, mesial edge broadly lobate with three spinose hairs directed to the mid-line, inner ventral edge produced into a flange, terminating in a spur-like projection; hairs shorter than on article 2; article 4 originates on the dorsal surface of article 3 and its apex directed ventrally. Hypostome, length 1.39 mm., widest distally and narrowing only slightly proximally; teeth and crenulations confined to the distal millimetre behind a small corona, dentition from apex to base as one row of 4/4 files, six rows of 3/3 files of large pointed teeth, thereafter as twelve rows of crenulations, the median ones of which pass back obliquely (fig. 421).

Scutum. Large, with greatest width in front of the level of the eyes, lateral margins almost rectilinear, broadly rounded posteriorly, slightly broader than long (fig. 424). Surface smooth, shiny, few large deep punctations carrying short spinose hairs, being most numerous antero-laterally in front of the eyes, other numerous small punctations uniformly distributed. Cervical grooves deep, narrow and sinuous for anterior third, then widening, becoming shallower and divergent but barely reaching postero-lateral margin. Surface flat between cervical grooves, undulate lateral to the latter. Lateral carinae lacking. Extensively ornate.

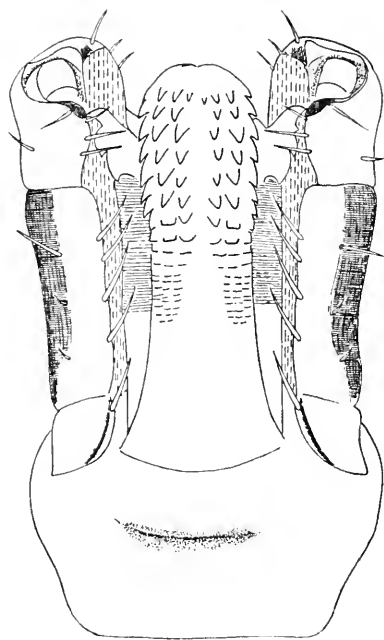
Venter. Broadly rounded behind with eleven festoons indicated, of which the median one is the narrowest; the furrows separating these festoons of about equal length except for those separating the festoons adjacent to the median one, which extend further forward. Anal groove surrounds anus closely then passes back as single median groove. Genital grooves faintly divergent to just anterior of the anus, then becoming more strongly so to terminate a short distance in front of the third festoons (fig. 422).

Legs. Strong, thick, ornate dorsally. Coxa I subtriangular in outline, external spurs broad, subparallel sides and apically tapered, slightly longer than broad tapered internal spurs, hairs variable in length; coxae II and III with short, broad, tapered external spurs, internal spurs as rounded marginal saliences, larger on coxa II than on coxa III, coxa IV much broader than long, with a subapical transverse depression, external spurs with slightly convergent sides and broadly rounded apices, internal spurs more nearly subtriangular in outline ending in a rounded tip: the internal 'spurs' on coxae II-IV are postero-ventrally placed and directed towards the mid-line, the external spurs directed backwards. Tarsi long, thick and strong, tarsus I being essentially as in the male; tarsus IV is shorter and narrower than the latter and tapers more or less uniformly to the pointed apical spur, ventrally there are two pairs of protuberances in front of the telotarsus and two pairs of long hairs associated with them; metatarsus IV is stouter and longer than metatarsus I and the three ventral protuberances more strongly defined; the hairs, also, are longer. Length of tarsus I, 1.0 mm., metatarsus I, 1.75 mm.; tarsus IV, 1.72 mm., metatarsus IV, 2.05 mm.

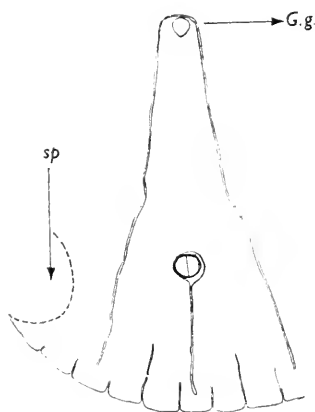
Spiracular plate. Very large, 1.65 mm. long, with the greatest breadth of 1.1 mm. posteriorly across the dorsal prolongation, latter short, broad and tapering to a point,



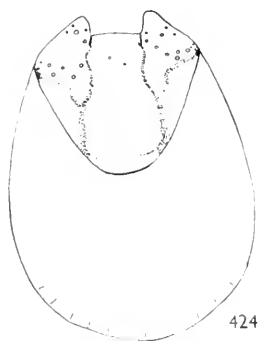
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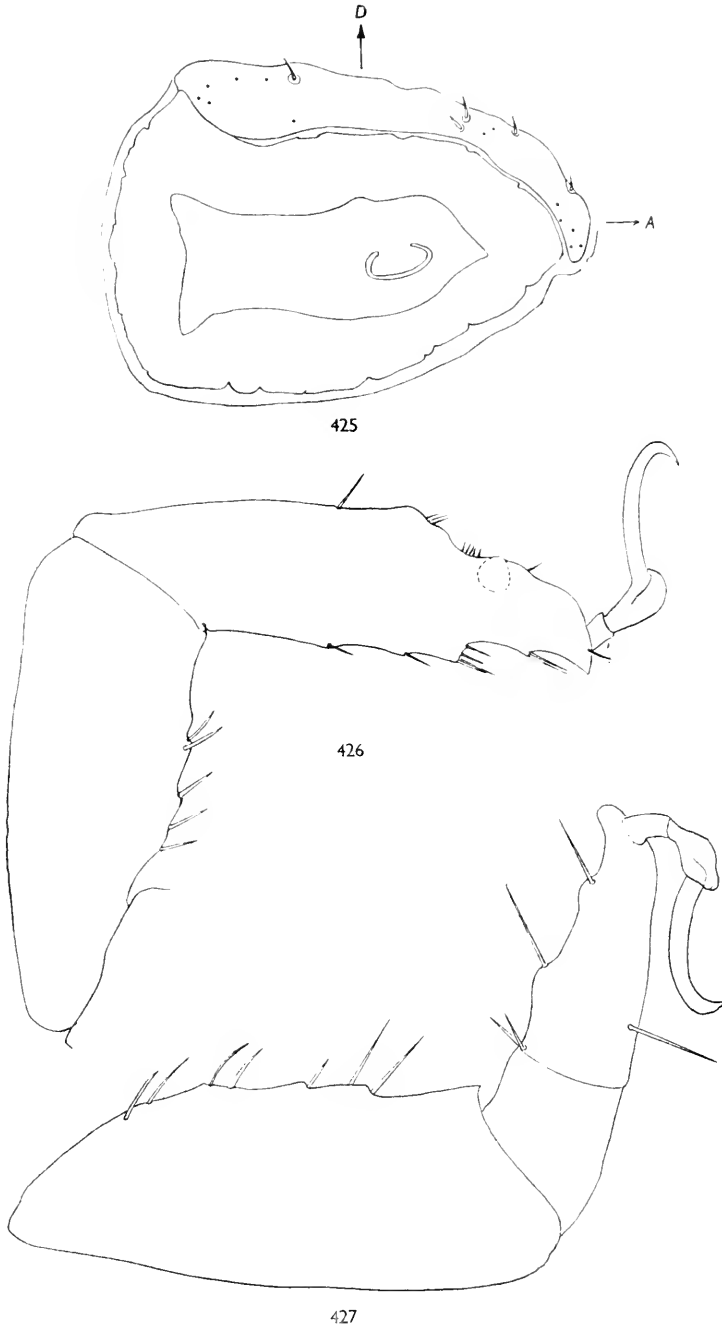


III

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IV

Figs. 420-4, *Cosmiomma hippopotamensis*. FEMALE: 420, dorsal view of capitulum; 421, ventral view of capitulum; 422, genital and anal grooves; *sp.* spiracle; *G.g.* genital groove; 423, coxae I-IV; 424, dorsum of female to show shape and scutal pigmentation.



Figs. 425-7, *Cosmiomma hippopotamensis*. FEMALE: 425, spiracular plate; 426, tarsus and metatarsus I; 427, tarsus and metatarsus IV.

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otherwise in general outline egg shape, with an appreciable narrowing anteriorly. Dorsal to, and in front of, the prolongation is a large area of pattern colour bearing large punctations with hairs and a larger number of smaller punctations; macula anteriorly placed in a 'fish-shaped' region of dark brown pigmentation, beyond this the colour is red-brown and studded with small pores; peritreme thick, serrately ridged and continuous in part at least around the front margin of the pattern colour. In position similar to that of the male.

REMARKS

Cosmiomma hippopotamensis was originally described from *Hippopotamus amphibius* of South Africa and for which Schulze (1919) subsequently erected the genus *Cosmiomma*. This latter species was sunk under *Dermacentor* by Zumpt (1951) but Hoogstraal (1956), quoting Theiler, stated that Schulze's definition justifies its retention as a genus. Other authors have placed this species in the genus *Hyalomma*, but the species under discussion does not fit in here as it lacks the posterior abdominal protrusions capped by chitinised points, and coxa I is not bifid. The male of *Cosmiomma* agrees only with the male of *Hyalomma* in having paired adanal shields. On the whole the weight of evidence suggests that Schulze was justified in erecting this genus, and I am in agreement with him on this point.

Until recently the only positively known specimens of this tick have been the types as described by Denny and Koch. A single male collected from vegetation at Manyani, Teita District, Kenya (W. L. W. Sheldrick *leg.*) is very similar to the type as illustrated by Dönitz (1910). Females have likewise been collected from vegetation on three occasions in Tsavo-Teita District, South-east Kenya (A. Wiley personal communication). Unconfirmed specimens have been reported from South Africa and Tanganyika. Nothing is known about the biology of the species other than that its normal host is the hippopotamus.

CHAPTER VIII

THE GENUS *BOOPHILUS* CURTICE, 1891

SYN., LIT. AND ICON.

- 1891 *Boophilus* Curtice, *nomen nudum*, pp. 313-17.
1901 *Boophilus* Curtice: Salmon & Stiles, p. 319.
1904 *Margaropus* (s.g. *Boophilus*) Neumann.
1907b *Margaropus* Neumann (*nec* Karsch, 1879).
1908a *Margaropus* Karsch: Banks, p. 35.
1911 *Margaropus* (pro parte) Neumann.
1934 *Boophilus* s.g. *Palpoboophilus* Minning.
1934 *Boophilus* s.g. *Uroboophilus* Minning.
1941 *Boophilus* Curtice: Osorno-Mesa, p. 428.
1946 *Boophilus* Curtice: Cooley, p. 9.
1950 *Boophilus* Curtice: Anastos, p. 71.
1950 *Boophilus* Curtice: Pomerantzev, pp. 129-31, considers *calcaratus* to be a genuine species but indicates that there is insufficient evidence to subdivide it into sub-species.
1951 *Boophilus* Curtice: Zumpt follows Minning's interpretation.
1956 *Boophilus* Curtice: Hoogstraal (p. 302) agrees with Cooley and Anastos and considers Minning's new species as cases of intraspecific variation.

Minning subdivided the genus *Boophilus* into three subgenera, *Boophilus* (*sensu strictu*), *Uroboophilus* and *Palpoboophilus* at the same time establishing a number of new 'species'. Anastos (1950), Cooley (1946) and others have questioned the validity of Minning's findings on the grounds of inadequate appreciation of the degree of intraspecific variation occurring within each of the individual species. Minning's diagnostic characters in the separation of species depends partly on the position of the eyes, alleging that in some species the eyes lie near the border of the scutum, in others on the border and yet in others overlap this border. It has now been recognised (Theiler, 1943) that the position of the eye will vary according to the tension on the alloscutum consequent on engorgement. The shape of the coxal spurs is yet another character used by Minning but Anastos (1950) invalidates this by showing that there is a considerable gradation in this character. Similarly the anal plates are subject to fluctuation as evidenced by the work of Bequaert (1926) on specimens collected from Panama. Hoogstraal's (1956) remarks on Minning's studies indicate agreement with the comments of Anastos and others, and he wrote that 'There is little or no correlation between the present and other extensive collections of boophilids collected from several geographical areas throughout the world, and Minning's illustrations about species collected in the same localities'. Accordingly until the genus can be surveyed on a world-wide and intensive scale it is necessary to accept the fact that the genus is represented by three species and that Minning's subgenera must be dispensed with.

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It must also be realised that so-called variations arise from the angle at which the specimen is examined (as is true for all ticks, but frequently not appreciated), the techniques employed in preservation and the degree of distension due to feeding, which modifies certain characters so that they are difficult to evaluate. It is of interest to note that Zumpt (1951) follows Minning's interpretation.

GENERIC CHARACTERS

Unfed adults of small size, inornate with eyes but lacking festoons; very short compressed palps ridged dorsally and laterally; palpal article 1 small or reduced to a sclerotised spot or plate which, if present, is on mesial edge; hairs present or absent on the small plates, or with a tongue-shaped retrograde projection on the ventral surface of article 1; all palpal articulations movable, that between 2 and 3 slight; basis capituli hexagonal dorsally, or sometimes the lateral points may be absent in males, weakly sclerotised; hypostomal dentition 3/3 or 4/4. Scutum in female small, in male extending the length of the body; the male with adanal and accessory adanal shields. Coxa I bearing two spurs, and a long antero-dorsal projection in the male; degree of spurring on coxae II, III and IV variable; tarsi with terminal ventral spurs. Spiracular plate round or oval in both sexes. Male with caudal process present or absent.

Type species: *Boophilus annulatus*.

At present three species of *Boophilus* are recognised in the world, *B. annulatus* (Say, 1821), *B. microplus* (Canestrini, 1887) and *B. decoloratus* (Koch, 1844), all of which have small yellow males and pod-shaped but somewhat larger females. *B. annulatus* is a North American tick which presumably originally parasitised deer and buffalo, subsequently infesting cattle and transmitting *Babesia bigemina*, the causative agent of American Texas fever. *Boophilus microplus* occurs in Central and South America, Australia, the Orient, the southern part of Florida, South and East Africa where it appears to be extending its range. *B. decoloratus* is essentially an African species and is extensively distributed south of the Sahara in regions where the rainfall is heavy and there is adequate shrub cover.

Key to the males

- 1 With caudal process. 2
Caudal process absent. Palpal basal article lacking ventral bristle-bearing projection on inner face. Posterior spurs lacking from adanal shields. Hypostomal dentition 4/4.
B. annulatus
- 2 Palpal basal article with ventral bristle-bearing projection. Adanal shields with long narrow spur protruding beyond posterior margin of body. Hypostomal dentition generally 3/3. *B. decoloratus*
Palpal basal article without a ventral bristle-bearing projection. Adanal shields not drawn out to narrow spurs, and not reaching posterior margin of body. Hypostomal dentition 4/4. *B. microplus*

Key to the females

- 1 Palpal basal article and hypostome as in male. Posterior face of coxa I slightly emarginate, external and internal spurs not strong. *B. annulatus*
 Posterior face of coxa I strongly cleft into an inverted V, external and internal spurs well defined. 2
- 2 Hypostome 3/3. Palpal article 1 with ventral inner bristle-bearing projection. *B. decoloratus*
 Hypostome 4/4. Palpal article 1 without such a projection. *B. microplus*

Boophilus microplus (Canestrini, 1887)

Figs. 428-45

SYN., LIT. AND ICON.

- 1887 *Haemaphysalis micropla* Canestrini (original description), pp. 104-5, 110, pl. 9, figs. 3, 3a-d, 5, 5a-b (type specimen from Chaco australe, Paraguay and deposited in the Genoa Museum).
- 1890 *Rhipicephalus micropla* Canestrini, p. 493.
- 1897 *Rhipicephalus annulatus* Neumann (not Say, 1821), p. 412.
- 1899 *Rhipicephalus australis* Fuller, pp. 389-92.
- 1900 *Rhipicephalus australis* Koningsberger (figures male, female, nymph, larva from Indonesia, figs. 1-6).
- 1901 *Boophilus australis* Stiles & Hassall, pp. 2-3: 1901, Salmon & Stiles, pp. 417, 420, 422, 426-33, figs. 140-51, 153d, 154c, pl. 80, figs. 114-39; 1924, Nieschulz, p. 195; 1928, Sharif, pp. 284-9, figs. 27-30.
- 1901 *Rhipicephalus annulatus* var. *australis* Neumann, p. 280.
- 1912 *Margaropus annulatus australis* (Fuller): Hooker, Bishopp & Wood, p. 117.
- 1913 *Margaropus annulatus australis* (Fuller): Bishopp, p. 366.
- 1923 *Boophilus annulatus* (not Say, 1821): Doeve, 1931; Krijgsman & Ponto, 1932; Krijgsman & Ponto, pp. 6-7, 32.
- 1934 *Boophilus (Uroboophilus) krijgsmani* Minning, pp. 11, 29-30, 40, figs. 23-4 (male and female). Holotype female in Berlin Museum.
- 1934 *Boophilus (Uroboophilus) rotundiscutatus* Minning, pp. 9, 10, 30-1, 40, figs. 25-6 (male and female). Holotype female in Berlin Museum.
- 1934 *Boophilus (Uroboophilus) longiscutatus* Minning, pp. 11, 31-2, 40, fig. 27 (female). Holotype female in Berlin Museum.
- 1934 *Uroboophilus cyclops*, Minning, p. 35, original description.
- 1941 *Boophilus (Uroboophilus) microplus* (Canestrini): Osorno-Mesa, p. 398.
- 1941 *Boophilus annulatus microplus* (Canestrini): Travis, pp. 465-7.
- 1943 *Boophilus microplus* (Canestrini): Franchild, p. 586.
- 1950 *Boophilus microplus* (Canestrini): Anastos, pp. 71-2, fig. 16A-M.
- 1956 *Boophilus microplus* (Canestrini): Hoogstraal, pp. 295-6, 319-20, fig. 117.

MALE. Small, yellowish to reddish brown coloured tick, varies from about 1.5 mm. to 2.5 mm. overall length and from 1.0 to 1.4 mm. broad at about mid-length. Body form elongate oval, with short tapering caudal appendage.

Capitulum. Basis capituli subhexagonal with greatest width of 0.4-0.5 mm. in front of mid-length, length 0.3-0.37 mm.; cornua short, triangular and usually blunt—in some specimens they are, however, sharply tipped. Posterior border straight, posterolateral margins asymmetrically concave, antero-lateral margins convex (fig. 428).

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Palpi hirsute, short; article 2 mildly indented mesially at about mid-length. Ventrally articles 1-3 each provided with short retrograde processes, and ventrally the inner margin of the basal palpal segment is concave. Hypostome short, broad and spoon-like, with 4/4 dentition and approximately eight teeth per file.

Scutum. Yellow to reddish brown in colour; covering the body antero-posteriorly but leaving a narrow band of the extra-scutal region exposed on each side, the latter finely striated longitudinally. Surface uniformly granulated with few medium punctations between the cervical grooves; latter as wide shallow depressions reaching to the hindermost limit of the pseudoscutum (fig. 428); behind, in line with the cervical grooves and beyond mid-length, are a pair of shallow oval depressions, and another pair of depressions nearer the posterior extremity (postero-lateral grooves) which are wide, deep and may converge to a similar postero-median groove; lateral grooves and festoons lacking; eyes small, flat, inconspicuous and placed well forward; hairs long and fine and absent only from the grooves and depressions; scapulae strong, sub-triangular with well-defined emargination.

Venter. Bears long fine white hairs; genital opening on a level with coxa II covered by a genital operculum, anal opening about one-third the distance between apex of the posterior prolongation and coxa IV; anal groove obsolete; adanal plates long, punctate, hairy, ending posteriorly in a short internal spur; very often there may be a shorter external spur (fig. 429). Accessory plates short, arcuate externally, hairy, punctate, terminating posteriorly in a single sharp spine.

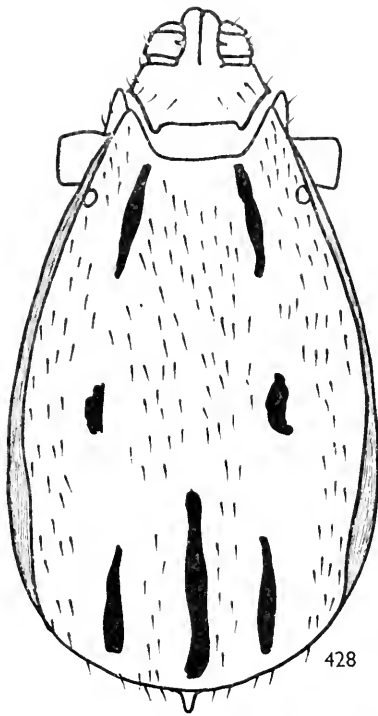
Legs. Of moderate length, but stouter than in female, becoming progressively stouter from leg I to leg IV, well supplied with numerous hairs ventrally and dorsally. Tarsus I, thick with a sharp drop subapically and a single terminal spur; succeeding tarsi, narrower, shorter and gradually tapered to the tip, each bearing a terminal spur and a ventral subterminal spur; pulvilli shorter than claws (figs. 435 and 436). Coxa I with antero-distal margin prolonged into a long narrow projection; external and internal spurs triangular, the latter usually being broader and longer than the former (fig. 429); coxae II and III much as in female, coxa IV lacking spurs (fig. 429).

Spiracular plate. Nearly circular, nearer to coxa IV than the posterior extremity.

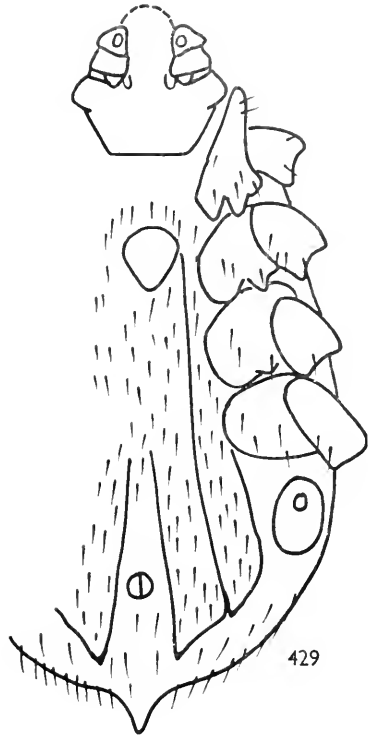
FEMALE. Length 1.9-2.1-2.5 mm., breadth 1.1-1.3-1.6 mm., attaining 13 × 8 mm. when fully fed.

Capitulum. Basis capituli as a broad hexagon, width 0.56-0.70 mm., length 0.4-0.56 mm., porose areas of moderate size, ovate or piriform, widely separated and divergent; posterior margin almost straight, lacking cornua (fig. 437). Palpal article 2 mildly indented mesially about mid-length, the indentation continued laterally as a groove; palpal basal segment ventrally with inner margin concave and lacking bristle-bearing protuberance. Hypostome short, broad, dentition 4/4 with 7-8 teeth per file.

Scutum. Variable in size; Anastos gives the range of specimens from the East Indies as 0.42-0.56 mm. long and 0.35-0.49 mm. wide, i.e. longer than wide, colour yellow to brown (fig. 439). Antero-lateral margins as far back as the level of the eyes slightly



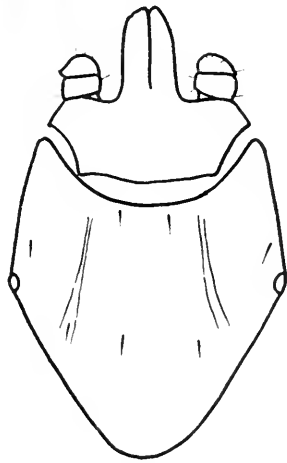
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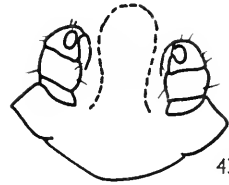
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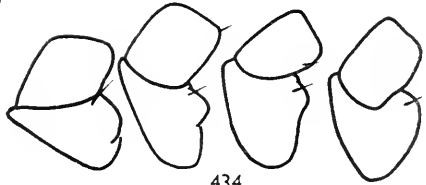
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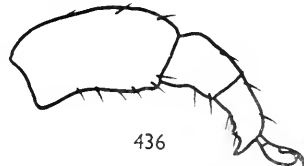
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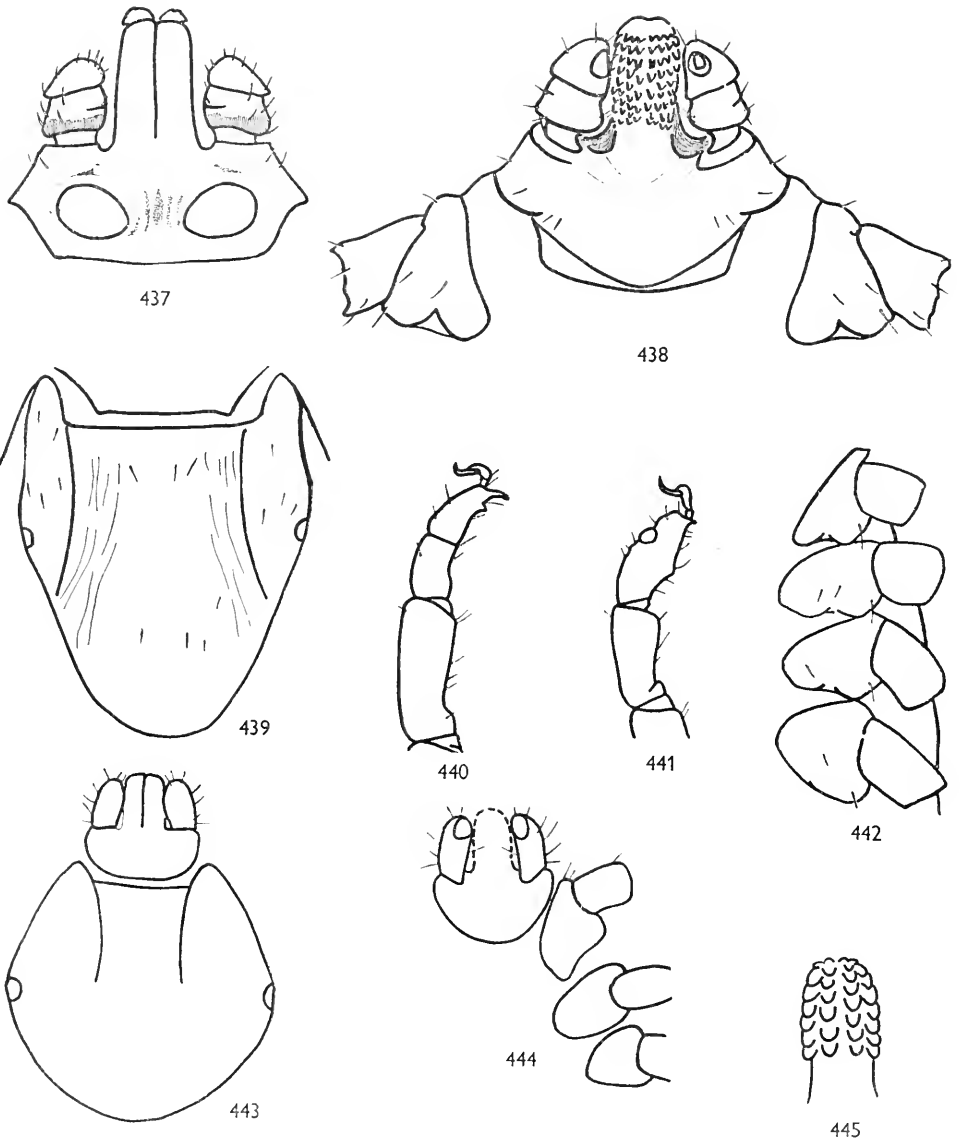


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Figs. 428-36, *Boophilus microplus*. 428-30, MALE: 428, dorsum; 429, venter; 430, hypostome; 431-4, NYMPH: 431, scutum and capitulum, dorsal; 432, capitulum, ventral; 433, hypostome; 434, coxae I-IV; 435, tarsus and metatarsus I of male; 436, tarsus and metatarsus IV of male.



Figs. 437-45, *Boophilus microplus*. 437-42, FEMALE: 437, capitulum, dorsal; 438, capitulum, and coxa I, ventral view; 439, scutum; 440, tarsus and metatarsus I; 441, tarsus and metatarsus IV; 442, coxae I-IV; 443-5, LARVA: 443, capitulum and scutum; 444, capitulum and coxae I-III, ventral; 445, hypostome.

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concave; the eyes mark the greatest width which lies at about one-third the scutal length (including scapulae), behind this level postero-lateral margins sinuous and tapering to narrowly rounded extremity. Cervical grooves long, broad, shallow and reaching back to the postero-lateral margins. Few long white hairs sparsely distributed. Punctations lacking, surface finely granular. Scapulae very large, straight laterally, broadly convex mesially; emargination strong. Alloscutal grooves variable in length, postero-median groove extends about two-thirds the distance towards the scutum, postero-lateral grooves nearly as long as median groove (Anastos) but in some African specimens longer than median groove. Hairs numerous, long, thin, white and present on all areas except in the grooves. Marginal grooves and festoons lacking.

Legs. Of moderate length, rather stout; coxa I triangular, longer than wide with two nearly equal rounded spurs, which are divided by a deep inverted V-shaped cleft, coxa II with two broadly rounded spurs which are broader basally than long and separated less definitely than in coxa I, coxa III much as in II, coxa IV with external spurs as a marginal salience (fig. 442). Tarsus I long, slightly swollen about mid-length, terminating in a long ventral spine; tarsi II-IV slender with subterminal and terminal spurs, former broad, latter strongly tapered (figs. 440 and 441).

Spiracular plate. Almost circular and nearer to coxa IV than to the posterior extremity.

Genital opening. On a level with coxa II, genital grooves subparallel to just beyond level of coxa IV, thence diverging but not reaching posterior border. Broad shallow posterior median grooves pass from the anus posteriorly. Venter with large number of long white hairs, being absent only from the aforementioned grooves.

NYMPH. Well-engorged specimens measure 2.5-2.9 mm., with maximum widths of 1.5-1.8 mm., being widest in front and narrowing posteriorly, constricted slightly at the spiracular level.

Capitulum. Rather variable in size, mean values of length from dorsal ridge to palpal apices range from 0.22 to 0.26 mm., width of basis capituli 0.28-0.31 mm.; posterior margin salient and convex; cornua weak or absent. Palpi very short, with few short inconspicuous hairs, lightly sclerotised, transverse ridge weak. Cheliceral sheaths very long. Hypostome short (length 0.13-0.16 mm.), broad, teeth arranged as 5-7 files of 3/3 teeth (fig. 433).

Scutum. Pentagonal, eyes slightly in front of mid-length, antero-lateral margins convergent; straight, postero-lateral borders almost rectilinear and narrowly rounded behind, deeply emarginate in front; length and breadth about equal, 0.43-0.48 mm. Cervical grooves shallow, divergent posteriorly. Surface smooth, shining, punctations lacking, hairs few. Eyes oval, small, faint (fig. 431).

Legs. Short, rather heavy. Coxae I, II and III with broadly rounded external spurs (fig. 434).

LARVA. Broad oval in shape, length from palpal tips to posterior extremity about 0.60 mm., greatest breadth about 0.42 mm.

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Capitulum. Overall length 0.15 mm., breadth 0.18 mm. Lateral and postero-lateral profiles convex, posterior margin straight and short. Cornua lacking. Palpal article 1 lacking. Basis capituli broadly rounded ventrally (figs. 443, 444). Hypostome short (0.06 mm.), broad, teeth as 6-7 files of 2/2 broad teeth.

Scutum. Occupies about three-fifths of body length, length 0.29-0.33 mm., greatest breadth of 0.40-0.43 mm. at about mid-length. Cervical grooves short, shallow. Surface smooth, shining, impunctate but lacking hairs.

Legs. Short and heavy; much as in nymph; coxa I with short, broad internal spur, spurs lacking on legs II and III.

REMARKS

Minning (1934) established the species *B. fallax* from Africa, but Anastos (1950), after examining specimens of this alleged species, is convinced that it is synonymous with *B. microplus*. Hoogstraal (1956) likewise has been unable to differentiate between *B. fallax* from Africa and *B. microplus* from populations in the Near and Middle East, various parts of Asia and South America. Hoogstraal quotes Theiler as stating that she can readily distinguish between *B. fallax* and *B. microplus*. The former is localised in its distribution, but where it does occur it is frequently numerous.

BIOLOGY

Under natural conditions the fully-fed female drops from the host and, in response to negative phototaxis, seeks a sheltered place to oviposit. According to Hitchcock (1955*a*) the preoviposition is influenced by temperature but not by relative humidity; at 59-60° F. the range of the preoviposition period extended from 19-39 days but with increased temperatures the length of this period decreased, thus above 80° F. this was between 2-4 days. The greatest numbers of eggs were produced at 75-80° F., and in Hitchcock's experiments the lowest egg production occurred at 59° F. No oviposition took place at 40° F. There is considerable variation in the length of time for ovipositing, and this varies from 5-30 days according to the season (Legg, 1930), 18 days at 71° F. (Sapre, 1940) and as long as 44 days at 59° F. (Hitchcock). Egg laying even under constant conditions reaches a sudden peak within 2-4 days after commencement (Hitchcock, 1955*a*; Gelormini, 1940), thereafter decreasing to a low figure, and the mean daily egg output was seriously affected by temperature. No hatching of eggs occurred at constant relative humidities of less than 70% but some were able to survive lowered relative humidities if placed occasionally in a saturated atmosphere. The developmental period varied from 146 days (at 62° F.) to 14 days (at 97° F.) with the greatest hatch at R.H. exceeding 95% and between 85-95° F. The free-living larva was strongly influenced by both temperature and humidity; thus Hitchcock recorded a maximum longevity of 240 days (72° F. and 90% R.H.) and Legg 154 days *in vitro*. The former worker also indicated that larvae were more vulnerable than eggs to lowered temperatures, and that the length of the larval period was influenced by the atmospheric conditions to which it was subjected in the egg

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stage. If larvae are maintained at low relative humidities for some time they are able to replenish their body moisture by absorption of water from the atmosphere during subsequent periods of high relative humidity. Wilkinson (1953) has shown that larvae can imbibe free water from dew and other fluid droplets.

Hitchcock (1955*a*) has shown that under experimental conditions a very high proportion of larvae embedded their mouth parts in the skin of cattle within an hour of being placed on the host, and that only a small percentage wandered about the body hairs for 2–3 days. Larvae feed for about 4–13 days, at the end of which time the integument is creamy and shining in appearance, and the legs are rigid. These larvae lose their ability to move soon after the body begins to distend. Moulting takes place on the host and the succeeding nymphal instar immediately on hatching is pale brown. In the unfed phase it is able to crawl if removed from the host, but to what extent it is capable of doing so under natural conditions is not clearly established. The spatial distribution of the various stages on cattle, however, suggests that movement does in fact occur. Wilson (1946) found that the nymphs and adults are restricted to the flanks, belly and udders; the larvae being confined to the inner faces of the ears. The fully-fed nymph is incapable of movement and one of the striking features is the appearance of the Malpighian tubules through the translucent dorsal integument. From the moulting of the larvae to engorgement of the nymphs varies from about 5–11 days. The latter on moulting yielded the adult males and females, both of which can move throughout the whole of their life. The male wanders freely over the host, apparently imbibing blood for short periods but never becoming fully engorged. The female on the other hand becomes firmly affixed at one point and feeds continuously to repletion. The time taken by the females to complete feeding varies quite considerably. Hitchcock (1955*b*) records that the first females to drop off did so at about 19 days after the attachment of the larvae, and the last at about 36 days; Lounsbury (1905) gives the minimum and maximum periods in South Africa as 35–149 days. From the available experimental evidence it appears that there is a considerable natural mortality of all stages of the tick on the hosts.

No seasonal periodicity of the adults on cattle has been observed (Wilson, 1946) and in South Africa there may be two or three generations during the year (Lounsbury, 1905). Roberts (1952) stated that appreciable numbers of ticks appear on cattle in southern Queensland after spring storms, and that infestations are heaviest in January to May. In northern Queensland, however, the maximum incidence is about April–May. Larval ticks, according to Wilkinson (1955), are most numerous on cattle in central Queensland from mid-November to mid-December.

Boophilus microplus occurs in both the old and new world, being reported from Australia, the Oriental region, Africa (Uganda, Tanganyika, South Africa, Madagascar), Central America, South America and the southern part of Florida. Even so, in these various areas it occurs locally and where present may be very abundant. In Africa, for example, it is most prevalent under natural forest conditions, and is probably localised because of climatic influences (Theiler, 1943).

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The primary host of this species is domestic cattle, although records from horses (Minning, 1934; Bück & Ramambazafy, 1950), sheep (Bück, 1935, 1948*a, b*; Theiler, 1943), goats and a lion (Theiler, 1943), and domestic animals from Indonesia (Anastos, 1950) are noted. From an economic point of view this species is important as a vector of *Babesia bigemina*, *B. berbera* and *Anaplasma marginale* in relation to cattle, of *Babesia ovis* causing babesiosis of sheep, and of Biliary fever (*Nuttalia equi*) to horses.

Boophilus decoloratus (Koch, 1844)

Figs. 446-59

SYN., LIT. AND ICON.

- 1844 *Boophilus decoloratus* (Koch), original description, pp. 217-39.
1936 *Boophilus* (*Palpoboophilus*) *decoloratus* Koch: Minning, pp. 365-70.
1956 *Boophilus decoloratus* (Koch): Hoogstraal, pp. 305-16.

MALE. Very small, 2.5-2.9 mm. long; 1.4-1.8 mm. broad, straw yellow, translucent, through which the gut caecae are visible, readily distinguishable from *B. annulatus* by a median, posterior caudal protuberance (fig. 448). Body covered with long white hairs.

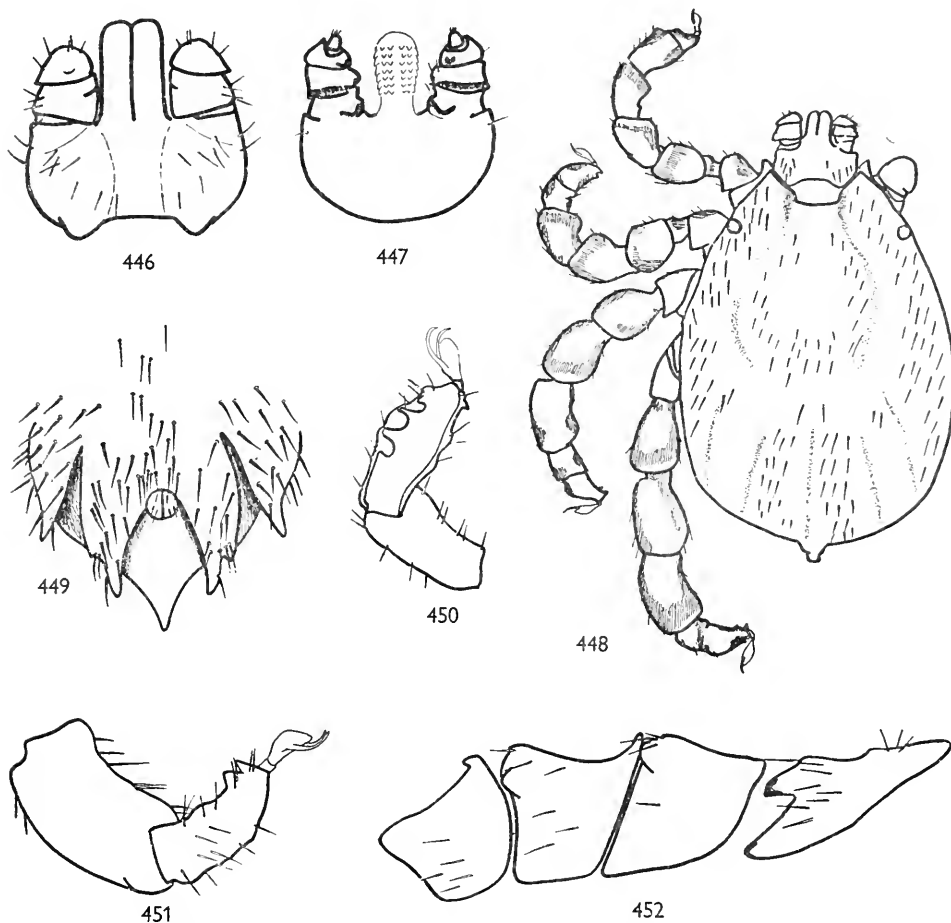
Capitulum. Basis capituli about 1.8 times as broad as long (length 0.43-0.47-0.49 mm., breadth 0.23-0.26-0.28 mm.), posterior margin short, straight, cornua subtriangular with basal breadth greater than the length, apex rounded; lateral margins broadly rounded (fig. 446). Surface depressed and flat mesially, slightly elevated laterally, impunctate but well supplied with long hairs particularly laterally; peripherally strongly downcurved. Palpi short and broad, article 2 broader than long with proximal and mesial edge salient and elevated, article 3 broader than long, with postero-dorsal edge salient and protruding laterally, apex broadly rounded; hairs similar to those on basis capituli (fig. 446). Ventrally, basis capituli broader than long, with peripheral hairs similar to those on the dorsum. Palpal articles 1, 2 and 3 with distal ventral surfaces drawn out into spurs of progressively decreasing size, ventral surface of palpal article 1 bearing small bristle-bearing protuberance on the internal ventral surface (may be difficult to see in small specimens and the bristles may be frequently broken, nevertheless the knob is usually visible). Hypostome spatulate, small (length 0.08 mm.); dentition in seven files of 3/3 (rarely 3.5/3.5), posterior to moderately well-developed corona.

Scutum. Completely covering the body, colour varies from yellow to pale brown (fig. 448), frequently translucent. Broadly rounded behind, narrowing from about mid-level to the prominent scapulae. Cervical grooves shallow, extending back to posterior limits of pseudoscutum. Punctations moderate to large in diameter, shallow with fairly uniform distribution. A median shallow linear depression on the posterior third, with two shorter diverging depressions lateral of it. Eyes small, flat, yellow.

Legs. Of moderate length, with the individual segments very thick (very much more so than in *B. microplus*). Coxa I with very strong, long anterior process visible dorsally and ventrally, broad tapering internal spurs, longer than external spurs and

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separated from it by cleft-like depression (fig. 452). Coxae II and III with broadly rounded external spurs, internal spurs on the former as strong broad saliences, much reduced on the latter; external spurs on coxa IV much reduced and more frequently absent; small, ventral trochanter spurs on legs I-III, lacking on leg IV; strong,



Figs. 446-52, *Boophilus decoloratus*. MALE: 446, capitulum, dorsal; 447, capitulum, ventral; 448, dorsal view of entire animal; 449, posterior part of body to show anal plates; 450, tarsus and metatarsus I; 451, tarsus and metatarsus IV; 452, coxae I-IV.

narrow, tapering dorsal trochanter spur on leg I. Tarsus I dilated on both upper and lower surfaces as far as the level of Haller's organ, thereafter narrowing quite appreciably to the rounded apex; ventral surface with small but distinct subapical spur and at about mid-length two broad hair-bearing protuberances, metatarsus I wider distally than proximally, but not unduly thickened; length of tarsus I 0.35 mm., metatarsus I, 0.30 mm. Claws longer than pulvilli. Tarsus IV slightly shorter (0.33 mm.) than tarsus I, metatarsus IV longer (0.45 mm.) than I, upper surface of

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tarsus IV arcuate, apex rounded, on ventral surface two strong broad retrograde subapical spurs, set close together, slight distension at about mid-length; metatarsus IV dilated, with proximal end wider than distal end. Claws longer than pulvilli.

Ventral plates. Well supplied with long white hairs. Adanal plates originate on anterior level of anus, and produced mesially and backwards as a long narrow internal spur usually extending beyond the body margin, frequently there is a small projection laterad of the aforementioned spur; accessory adanal plate drawn out into a sharp long spur; few moderate punctations (fig. 449).

Spiracular plate. Elongate oval, with in some specimens the posterior margin more strongly narrowed; macula anterior of centre, surface granular.

Genital opening. On a level with coxa II.

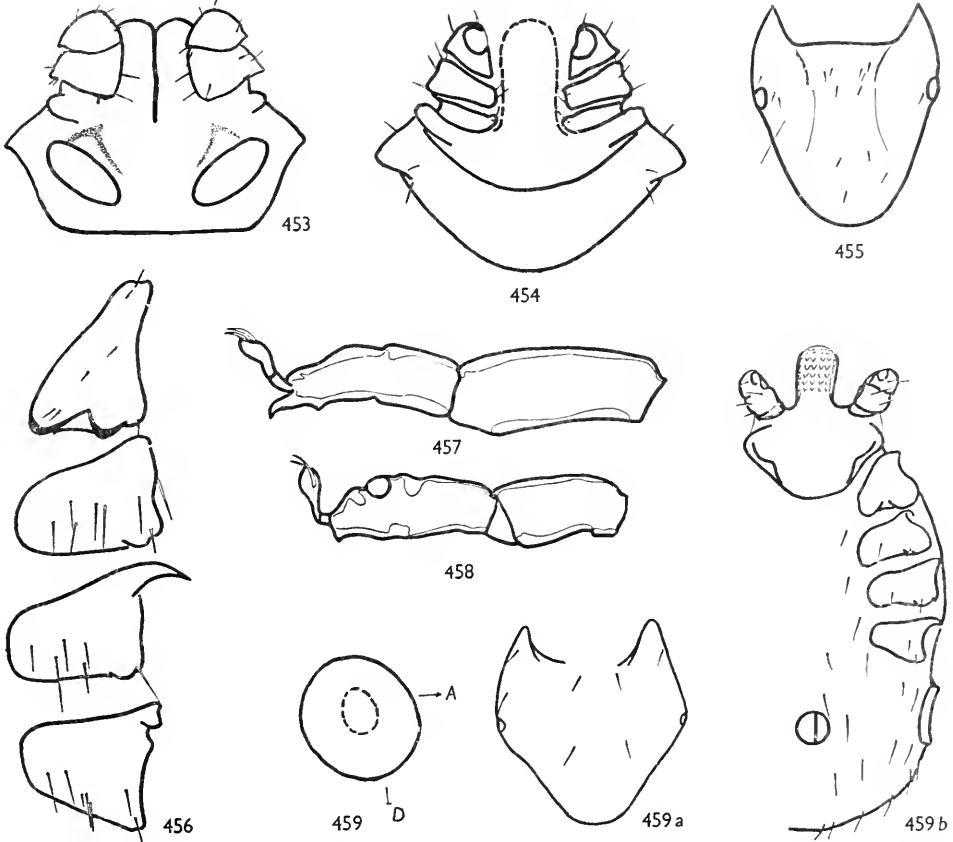
FEMALE. Unfed specimens small, elongate oval in outline, but when fully fed may reach 12.0 mm. long and about 8.0 mm. in width. Body hairs of opisthosoma as long as those on the scutum. Lightly sclerotised and unfed females are frequently translucent. Short median groove and two longer lateral grooves on opisthosoma.

Capitulum. Basis capituli about two and a half times as broad as long, length 0.69–0.76 mm., breadth 0.25–0.29 mm. Posterior margin straight or weakly sinuous, postero-lateral angles rounded, cornua lacking; lateral margins divergent for about three-quarters of the length, terminate in point on each side, thence antero-lateral margin is convergent to palpal insertion (fig. 453). Surface generally flattened except for distinct gradual down-curvature postero-laterally; lateral margin just behind maximum width declivitous. Porose areas elongate oval, sometimes elliptical, superficial and separated from each other by about the greatest length of one of them; depressions immediately in front of these areas (stippled in fig. 453); few hairs antero-laterally. Palpi short, broad, article 2 broader than long, lateral margin salient; article 3 broader than long, postero-lateral angle salient, broadly rounded apically; moderate number of medium-sized hairs. Ventrally basis capituli broadly rounded, with broader spur-like extensions antero-laterally; surface divided into proximal and distal parts by a shallow transverse groove extending across from the front of the spurs. Surface in front of this groove, steep to base of hypostome, behind surface horizontal and flat (fig. 454). Palpi with postero-lateral edges of articles 2 and 3 salient, article 1 with internal bristle-bearing protuberance. Hypostome longer than in female, spatulate with 10–11 files of $\frac{3}{3}$ teeth behind an apical corona.

Scutum. Generally longer than greatest width (length 0.96–0.98–1.1 mm., breadth just in front of eyes, 0.85–0.90–1.03 mm.). Scutal margin, more commonly in front of eyes, curves slightly outwards, behind eyes margins almost rectilinear, terminating in a narrowly rounded posterior margin (fig. 455). Cervical grooves deepest anteriorly then shallowing posteriorly, ceasing before attaining scutal periphery. Surface gently convex between cervical grooves, depressed postero-lateral of the latter. Hairs of moderate length, most abundant anteriorly between the cervical grooves and in region of eyes. Latter yellow and of moderate size.

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Legs. Longer but not as stout as in male. Coxa I triangular, with two well-defined spurs, the internal one being longer than its external counterpart, both broadly rounded apically, separated by a narrow, deep inverted V-shaped cleft (fig. 459); coxa II with broadly rounded external spurs, coxae III and IV with slight marginal saliences externally, coxae II and III distinctly longer than broad; all bearing long fine white hairs. Tarsus I similar to that of male; length 0.4 mm., tarsus IV with a sinuous upper surface, rounded apex, supplied with one forwardly directed retrograde



Figs. 453-9, *Boophilus decoloratus*. 453-9, FEMALE: 453, capitulum, dorsal; 454, capitulum, ventral; 455, scutum; 456, coxae I-IV; 457, tarsus and metatarsus IV; 458, tarsus and metatarsus I; 459, spiracular plate. 459a-b, NYMPH: 459a, scutum; 459b, ventral view.

spur and a very short broad pointed spur slightly behind; length 0.43 mm.

Spiracular plate. Almost circular, macula central, finely granular.

Genital opening. On level with coxa II; genital grooves subparallel to just beyond coxa IV then more strongly divergent, do not reach postero-lateral border.

NYMPH. Well-fed specimens measure 3.0 mm., with greatest widths of 1.7 mm. being widest in front, constricted at about the level of coxa IV and tapering to a broadly rounded posterior edge.

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Capitulum. Rather variable in size, mean lengths from dorsal ridge to palpal apices of specimens examined 0.32–0.35 mm., width of basis capituli 0.32–0.37 mm., posterior margin only slightly convex; cornua lacking. Palpi short, broad with few long, conspicuous hairs. Cheliceral sheaths about as long as the hypostome. Hypostome short, broad, teeth generally arranged in more than five rows of 3/3 files.

Scutum. Shape as figured (fig. 459*a*), widest at about mid-length, postero-lateral margins slightly concave, broadly rounded behind. Length 0.44–0.47 mm., breadth 0.44–0.46 mm. Cervical grooves shallow, divergent posteriorly. Surface finely punctate and hairs distributed as in fig. 459*a*. Eyes oval, small, faint.

Postscutal area and venter. With long, spinose hairs.

Legs. Moderate in length. Coxa I with internal and external spurs as in female; external spurs of coxae II and III broadly rounded.

Spiracular plate. Relatively large with goblets of moderate size and number.

LARVA. Broad oval in shape, length from palpal tips to posterior edge about 0.5–0.6 mm., greatest breadth 0.42–0.46 mm.

Capitulum. Overall length 0.10–0.13 mm., greatest breadth of 0.14–0.155 mm., just behind mid-length. Dorsal ridge straight or slightly undulate, lateral margins sharply convex and protuberant. No cornua. Ventrally basis capituli broadly rounded. Hypostome short, 0.05–0.07 mm., with five or six files of 2/2 teeth.

Scutum. Broader than long, greatest breadth at about mid-length. Cervical grooves short, shallow. Surface finely punctate and bearing hairs.

Legs. Of moderate length. Coxa I with short broad internal spurs; spurs absent on coxae II and III.

BIOLOGY

Like *B. microplus* this species is a one-host tick. The larvae, which may survive for eight months without food (Theiler, 1949), on finding a suitable host show predilection for the dewlap and neck, or else at the tip and outer edge of the pinnae of the ears. Having fed to repletion the larvae remain for a week before moulting to nymphs who then feed at the same sites. On transformation of the nymph to the adult, the latter move to the flanks and the belly for feeding, and Lounsbury (1905) noted that females detach themselves 23 days after having attached as larvae. Males generally remain on the host for a further 4 weeks. After a preoviposition period of about 6 weeks, some 2000 eggs are laid, and under laboratory conditions they hatch in about 5 weeks. Matthyse (1954) stated that all stages of *B. decoloratus* occurred throughout the year on cattle, reaching peak infestations in May, June and July. Apart from a slight reduction in numbers in late July and August, there was no evidence of reduced infestation in the dry season, nor was there an appreciable build up of populations in the wet season. Theiler's (1949) observations on this species in the Union of South Africa indicated that the limiting factor affecting its geographical distribution was the

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degree of aridity which was represented by an annual precipitation of 15 in. This is confirmed by Lewis's (1939) observations in Kenya. Temperature does not appear to be a restrictive factor, and the species is tolerant of a wide range of such conditions as indicated by its wide horizontal distribution and its vertical distribution from sea level to about 8000 ft. in Kenya. In the Congo, on the other hand 'the blue tick is certainly numerous in many Congo areas' and 'is uncommon at high elevations and in dense forest areas' (Hoogstraal, 1956).

B. decoloratus has a wide distribution in Africa, being known from West Africa, Central Africa, Belgian Congo, Sudan, Kenya, Uganda, Tanganyika, Angola, Moçambique, the Rhodesias, Nyasaland, South-west Africa, Swaziland, the Union of South Africa, Ethiopia, Eritrea, French Somaliland, British Somaliland, Italian Somaliland and Zanzibar. The details of the literature on this distribution have been excellently summarised for the whole of Africa by Hoogstraal (1956) and a very detailed survey of its occurrence in the Union has been made by Theiler (1949). Undoubtedly the predominant hosts are cattle, although horses and less frequently man, sheep and goats are infested. Of the wild fauna antelopes are most frequently attacked, but records from hares, zebra, bushpig and buffalo are noted. Carnivores appear to be rarely attacked by this species.

Cases of acute anaemia in hosts have been reported as a result of the feeding activities of this tick species and it has been implicated as a vector of *Babesia bigemina* (Texas or redwater fever) and *Anaplasma marginale* (gall sickness) in cattle and of *B. theileri* (Spirochaetosis) in horses, sheep and dogs. It may possibly too be associated with the transference of *Babesia trautmanni* causing porcine babesiosis.

Boophilus annulatus (Say, 1821)

Figs. 460-80

SYN., LIT. AND ICON.

- 1821 *Ixodes annulatus* Say, original description, pp. 59-83.
- 1844 *Haemaphysalis rosae* Koch, p. 237.
- 1869 *Ixodes bovis* Riley, p. 168.
- 1869 *Ixodes indentatus* Gamgee, p. 121.
- 1880 *Ixodes dugesi* Megnin (*nec* Gervais), p. 344.
- 1891 *Boophilus bovis* (Riley): Curtice, pp. 313-19.
- 1894 *Ixodes calcaratus* Birula, p. 137.
- 1895 *Rhipicephalus calcaratus* Birula, pp. 353-64.
- 1897 *Rhipicephalus annulatus* (Say): Neumann, pp. 324-420.
- 1901 *Boophilus annulatus* (Say): Salmon & Stiles, pp. 421-2.
- 1901 *Ixodes annulatus* (Say): Stiles & Hassall, p. 3.
- 1901 *Rhipicephalus annulatus* var. *dugesi* Neumann, pp. 249-372.
- 1904 *Boophilus annulatus* (Say): Banks, 120-47.
- 1904 *Rhipicephalus annulatus* var. *calcaratus* Neumann, pp. 444-64.
- 1907a *Margaropus annulatus* (Say): Neumann, p. 224.
- 1908a *Margaropus annulatus* (Say): Banks, pp. 36-7. Agrees with Neumann in synonymising *Boophilus* with *Margaropus*.

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- 1911 *Margaropus annulatus annulatus* (p. 47) and *M. annulatus calcaratus* (p. 48) Neumann.
 1912 *Margaropus annulatus* (Say): Hooker, Bishopp & Wood, pp. 1-239.
 1922 *Margaropus calcaratus* Senevet, p. 519.
 1924 *Margaropus calcaratus* Senevet & Rossi, p. 223.
 1929 *Boophilus calcaratus* Olenev, p. 48.
 1934 *Boophilus calcaratus calcaratus* Minning, pp. 14-16.
 1934 *Boophilus calcaratus balanicus* Minning, pp. 1-43.
 1934 *Boophilus calcaratus palestinensis* Minning, pp. 1-43.
 1934 *Boophilus calcaratus hispanicus* Minning, pp. 1-43.
 1934 *Boophilus congolensis* Minning, pp. 1-43.
 1934 *Boophilus schulzei* Minning, pp. 1-43.
 1937 *Boophilus annulatus* var. *calcaratus* Senevet, p. 51.
 1937 *Boophilus annulatus annulatus* Senevet, p. 53.
 1941 *Boophilus annulatus* (Say): Travis, pp. 465-7.
 1946 *Boophilus annulatus* (Say): Cooley, pp. 1-22.
 1950 *Boophilus calcaratus* (Birula): Pomerantzev, pp. 129-31. Does not agree that there is sufficient evidence to subdivide *calcaratus* into subspecies.
 1956 *Boophilus annulatus* (Say): Hoogstraal, pp. 302-33, is of the opinion that the following criteria used by Minning are reducible to cases of intraspecific variation: (i) the pointed and blunt external spurs of coxa I, the former being, according to Minning, a diagnostic character of *B. congolensis*; (ii) the proposed diagnostic features for separating the females is based on the arching of the eyes and the shape of the distal margin of third palpal segment. These characters intergrade in both American and African species. The 'hairiness' or 'non-hairiness' of the scuta from both continents are, in our opinion, inadequate to justify specific rank.

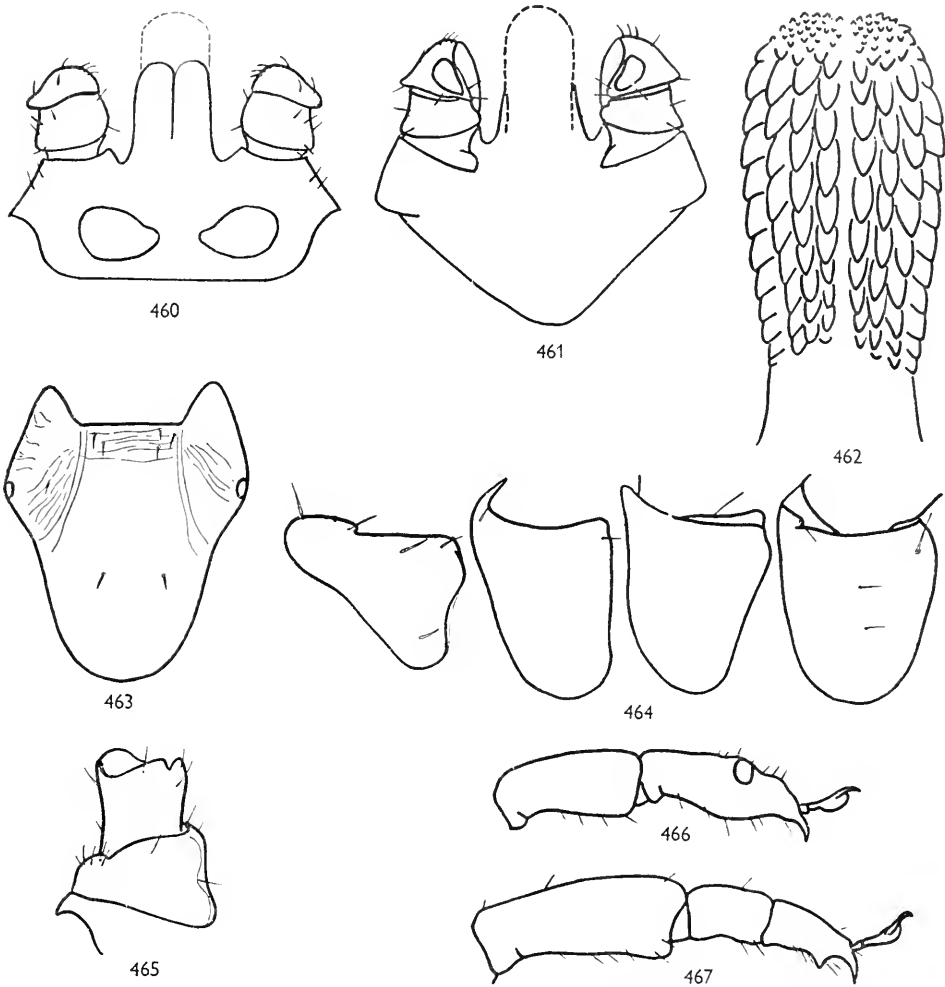
FEMALE

Capitulum. Basis capituli very broad compared to its length, maximum breadth across the points, 0.79 mm., length 0.3 mm.; posterior margin straight or weakly convex; postero-lateral angles form slight protuberances; postero-lateral margin slightly concave, divergent and ending pointedly at about mid-length; antero-lateral margin straight, convergent to palpal insertion (fig. 460). Surface slightly undulate between porose areas, elevated antero-laterally to the latter, peripherally down-curved. Palpi short, broad; article 2 broader than long, postero-lateral angle salient; article 2 with comparable angle also salient, and with an asymmetrically convex apex; hairs of moderate length, strong, curved. Ventrally basis capituli very broad, strong antero-lateral spurs which are dorsally curved. Behind hypostome transverse furrows. Posterior extremity more sharply angled than in either *B. microplus* or *decoloratus*. Palpal article 2 much broader than long, article 3 about as long as broad, ventral projecting spur visible only on article 3; inner margin of basal article elongate, mildly concave (fig. 461); no bristle-bearing protuberance on inner ventral margin of article 1. Hypostome broad, length 0.3 mm., dentition after an apical corona as 10-11 definite files of 4/4 teeth which decrease in size proximally (fig. 462).

Scutum. Length 1.1-1.3-1.6 mm., breadth 0.98-1.08-1.2 mm., and the scutum is definitely longer than broad, the greatest width at about eye level; the scutal margins anterior of the eyes may be straight and parallel, or else converge and merge with the

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scapulae, postero-laterally scutal margins almost rectilinear and terminate in a broadly rounded extremity. Cervical grooves shallow anteriorly becoming broader and shallower, divergent to the periphery at about mid-scutal length. Anteriorly between



Figs. 460-7, *Boophilus annulatus*. FEMALE: 460, capitulum, dorsal; 461, capitulum, ventral; 462, hypostome; 463, scutum; 464, coxae I-IV; 465, coxa and trochanter I; 466, tarsus and metatarsus I; 467, tarsus and metatarsus IV.

cervical grooves and in lateral fields surface rugose. Punctations small and large, shallow and widely dispersed over the scutum. Moderate length hairs anteriorly between the scapulae and peripherally on the lateral fields. Postscutal hairs short, caducous (fig. 463).

Legs. Of normal length, relatively thin when compared with the male. Coxa I

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triangular, with external and internal spurs broadly rounded, of about equal size, separated by a shallow rounded emargination (fig. 465); coxae II–IV longer than broad and lacking both internal and external spurs. Tarsus I with dorsal surface flat almost to a slight hump proximal to Haller's organ, thereafter with a gradual slope to the apex; ventral surface swollen at about mid-length beyond telotarsus, thence narrowing to small subapical pointed spur; length 0.5 mm. Tarsus IV undulate dorsally, convex and tapering distally from the telotarsus suture line; ventrally large subapical retrograde spur, succeeded by short triangular spur a little distance behind it; length 0.51 mm.

Spiracular plate. Obliquely placed to long axis of body, elongate oval, macula almost central, widely scattered small goblets, surrounded by granulations, peritreme thick, steep sided.

Genital opening. On a level with coxa II, genital grooves long, subparallel reaching back beyond level of coxa IV, whence they diverge strongly.

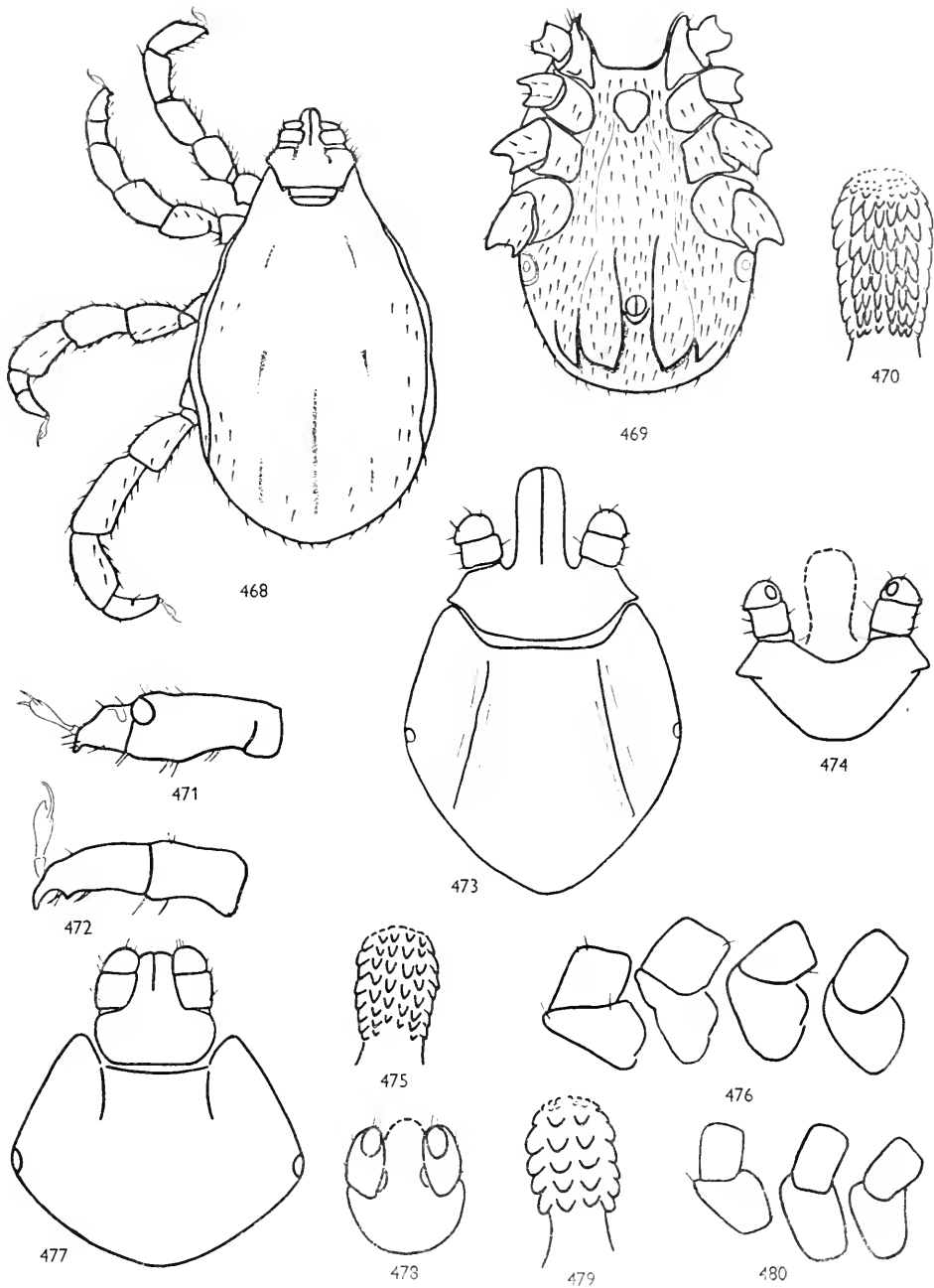
MALE (mainly after Cooley). Length from palpal tips to posterior margin, 2.16–2.28 mm., greatest width of 1.26–1.32 mm. slightly in front of mid-length. Scutum not completely covering dorsal surface, being sinuous in the posterior third of its length. Body-folds striate and lacking hairs.

Capitulum. Length from dorsal ridge to palpal apices about 0.36 mm., maximum breadth of basis capituli about 0.48 mm. Basis capituli nearly twice as broad as long; posterior margin straight, cornua usually triangular, always definite (but variable in length), salient and elevated over the dorsal ridge. Ventrally basis capituli short, broad, lateral margins divergent to antero-lateral elevations, posterior margin non-salient. Venter of palpal article 1 either forming an indefinite sclerotised edge or a mildly sclerotised plate mesially whose inner margin is elongate and mildly concave. Few palpal setae mesially on articles 2 and 3. Hypostome measures 0.19–0.21 mm., dentition of about ten rows of 4/4 teeth behind a distinct corona (fig. 470).

Scutum. Slightly sinuous at the sides near the spiracular plate; lateral and rounded posterior extremity mildly crenate; scapulae very prominent, deeply emarginate (fig. 468). Cervical grooves as shallow depressions reaching back almost to the level of third pair of legs, and behind them two subcircular depressions at about the widest part of the scutum. Median and postero-lateral grooves generally straight but somewhat variable in length. Surface smooth, shining; eyes small and generally flat, frequently indistinct. Hairs absent from grooves and depressions but present on the elevated regions.

Ventral shields. Both anal and adanal plates taper bluntly posteriorly, and the inner margin of the adanal shields does not project posteriorly as a spine; surface covered with fine white hairs (fig. 469).

Legs. Short and broader than in the female: coxa I with external, and slightly wider and more rounded internal, spurs of about equal length, interval between them as shallow, rounded emargination (fig. 469). Length of tarsus I, 0.30 mm., metatarsus I,



Figs. 468-80, *Boophilus annulatus*. 468-72, MALE: 468, dorsum; 469, venter; 470, hypostome; 471, tarsus I; 472, tarsus IV; 473-6, NYMPH: 473, capitulum and scutum; 474, capitulum, ventral; 475, hypostome; 476, coxae I-IV; 477-80, LARVA: 477, capitulum and scutum; 478, capitulum, ventra view; 479, hypostome; 480, coxae I-III.

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0.27 mm.; length of tarsus IV, 0.33 mm., metatarsus IV, 0.45 mm. Coxal hairs few and small.

Genital aperture. Between coxae II.

NYMPH. Widest anteriorly in engorged specimens, waisted slightly at level of spiracular plate, latter frequently visible from above.

Capitulum. Broader than long, overall length 0.22–0.26 mm., greatest breadth of basis capituli 0.41–0.47 mm. at about mid-length where it is sharply pointed. Dorsal ridge weakly convex, cornua lacking. Palps as in adult but very weakly sclerotised, article 1 not seen ventrally; hairs few. Hypostome about 0.15 mm. long, quite broad, dentition in seven rows of 3/3 files of teeth.

Scutum. About as long as broad (0.48–0.57 mm.), almost pentagonal, antero-lateral margins rectilinear, postero-lateral periphery weakly convex before becoming narrowly rounded behind. Surface smooth, shining; impunctate; glabrous. Cervical grooves as divergent broad shallow valleys reaching to postero-lateral border.

Legs. Short, heavy. Coxae small, convex; coxae I–III with broad, short, rounded external tuberosities, lacking on coxa IV.

LARVA. Broad oval, scutum occupying about half the opisthosomatic length; overall length 0.63 mm., greatest breadth of about 0.45 mm.

Capitulum. From dorsal ridge to apices of palps about 0.13–0.16 mm., of similar maximum breadth; convex lateral profile with the posterior extremity either straight or gently convex. No cornua. Ventrally basis capituli arcuate. Palpi short (shorter than in *B. microplus*), lacking article 1. Hypostome short, with five rows of denticles arranged in 2/2 files.

Scutum. Broadest behind the middle (at about two-thirds scutal length), and broader than long, eyes small, flat, frequently indistinct. Cervical grooves short and limited to anterior quarter. Surface smooth, shining, impunctate and glabrous.

BIOLOGY

Boophilus annulatus was originally described from a deer (*Cervus virginianus*) in Florida, and the species as a whole was widely distributed in the southern states of North America at the beginning of the present century. Eradication schemes have, however, 'reduced its numbers to or near extinction in the United States' (Cooley, 1946) but it still occurs in Mexico. It is known from West Africa, Central Africa and certain parts of the southern Sudan (Hoogstraal, 1956), and occurs in Russia under the name of *Boophilus calcaratus* (Pomerantzev, 1950).

The biology of this species was fully described by Hunter & Hooker (1907) in the United States, and the present account is based on this data. *B. annulatus* is a single host tick and it appears to be limited to hot climatic zones. The female on dropping from the host has a preoviposition period of about 3–4 days when temperatures are suitable, but under winter conditions in the southern United States it may be prolonged for 20–40 days. Similarly the egg-laying period appears to be determined by

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the air temperature, as in summer this lasts from 8–9 days and in winter to about 42 days. Each female is capable of laying about 2000 eggs which under conditions of high relative humidity hatch in 17–21 days, but winter incubation may require between 5 or 6 months—in fact, a similar picture to that noted for *B. microplus* by Hitchcock (*loc. cit.*). The emerging larvae climb to the tips of vegetation and attach themselves to passing hosts generally exhibiting a preference for the legs, belly or dewlap. Heavy infestations may, however, result in a more widespread distribution on the host. The larval-nymphal moult occurs some 7–12 days later, the nymph metamorphosing to the adults in a further 5–10 days. The female engorges for 4–14 days, being fertilised while still on the host. Cattle are the most frequent hosts, but in America they are reported on deer, horse, mule, sheep, goats and buffaloes. They have been reported from the giant eland and the domestic donkey in the Sudan by Hoogstraal (1956). These ticks appear to have been acclimatised to humid West Africa but their occurrence in the Sudan (rainfall 800–1500 mm. annually) rather suggests that the limiting factor is to be looked for elsewhere. In north and central America *B. annulatus* is a tropical or subtropical tick which dies out when introduced elsewhere. Its biology and ecology are as yet unstudied in Africa.

DISEASE RELATIONSHIPS

Unstudied as yet in Africa, but is known as the vector of *Babesia bigemina*, the causal agent of Texas fever of cattle in the United States, hence the great eradication schemes and the wellnigh complete elimination of this species.

CHAPTER IX

THE GENUS *MARGAROPUS*

SYN., LIT. AND ICON.

- 1879 *Margaropus winthemi* Karsch, original description, p. 96. Source of material questionable, stated to be 'Valparaiso' but see Hoogstraal (1956).
1901 *Margaropus* (?) *microplus*; Neumann stated that *Margaropus winthemi* was malformed '*M. microplus*'.
1907 *Margaropus*; Donitz rejects Neumann's statements of 1901, pp. 187-92.
1910 *Margaropus* Donitz, pp. 397-494.
1956 *Margaropus* Hoogstraal, pp. 901-2.

GENERIC CHARACTERS

Inornate, with eyes which may be indistinct in males of *M. winthemi*, but without festoons, palpi short and intermediate between those of *Rhipicephalus* and *Boophilus*, but lacking the ridges of the latter. Coxae conical, unarmed but for a small spur posteriorly on coxa I, tarsi elongate, narrow, tapering with a large apical hook-like projection. Adanal shields of the male arising at the level of coxa IV and extending posterior of the anus, and either free (*M. reidi* Hoogstraal) or joined (*M. winthemi*) in the mid-line in front of the anus. Legs of the male increase in size from pair I to IV, the segments of the fourth leg especially greatly enlarged and more or less deeply separated from each other. In the females leg segments not greatly widened. Integument bears conspicuous hairs posteriorly. Anal groove obsolete. Spiracles rounded or short oval in both sexes.

Type species: *Margaropus winthemi* Karsch, 1879.

Key to the species (from Hoogstraal, 1956)

Key to the males

Adanal shields sharply pointed distally, lacking accessory shields. Six pairs of hair tufts and a ventral hook on posterior body margin; when fully replete a caudal protrusion present. Lateral margin of scutum convex, posterior margin bluntly rounded. Free segments of leg IV as wide as long. *M. winthemi*

Adanal shields bluntly rounded distally, accessory shields present. Abundant scattered hairs on posterior body margin but without ventral hook; caudal protrusion absent. Lateral margins of scutum subparallel and gently rounded posteriorly. Intermediate segments of leg IV slightly longer than wide. *M. reidi*

Key to the females

Basis capituli about three times as broad as long dorsally; porose areas transversely oval; palpal articles 2 and 3 not separated by a slight constriction. Scutum widest across the eyes, posterior margin rounded. *M. winthemi*

Basis capituli about twice as broad as long dorsally, porose areas vertically subtriangular; palpal articles 2 and 3 separated by a slight constriction. Scutum widest at mid-length between the scapulae and the eyes, posterior margin bluntly pointed. *M. reidi*

Margaropus winthemi Karsch, 1879

Figs. 481-92

SYN., LIT. AND ICON.

In addition to the literature cited under generic synonymy, etc., Hoogstraal (1956) gives the following:

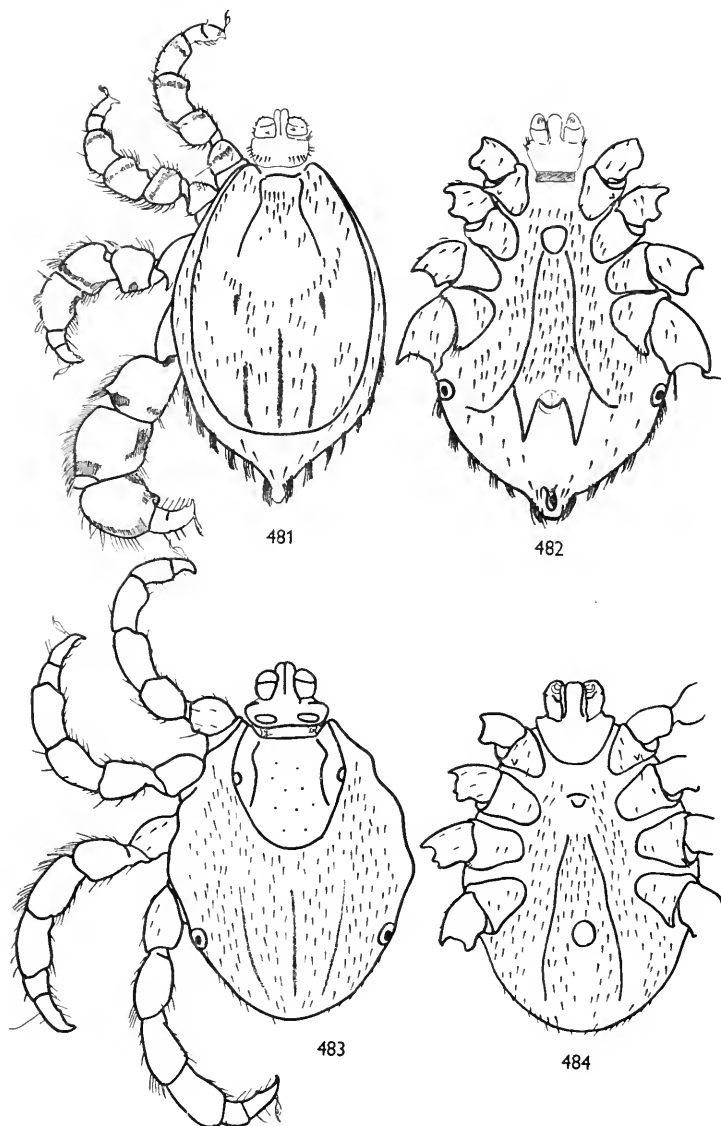
- 1904 *Margaropus* Orpen, without species name, p. 92.
 1904 As *Rhipicephalus* sp. Lounsbury, p. 92.
 1907a *Margaropus lounsburyi* Neumann, pp. 215-32.
 1907 *Rhipicephalus phthirioides* new spp., Cooper & Robinson, pp. 35-8.
 1907 *Margaropus winthemi* Karsch; Donitz, pp. 187-92.
 1908 *Margaropus lounsburyi* Neumann; Howard, pp. 73-172.
 1910 *Margaropus winthemi* Karsch; Donitz, pp. 397-494.
 1911 *Margaropus lounsburyi* Neumann, p. 169.
 1920 *Margaropus winthemi* Karsch; Bedford, pp. 317-40.
 1921 *Margaropus winthemi* Karsch; Jack, pp. 480-93.
 1926 *Margaropus winthemi* Karsch; Bedford, pp. 705-817.
 1926 *Margaropus winthemi* Karsch; Cowdry, pp. 147-58.
 1927 *Margaropus winthemi* Karsch; Bedford (reprint of 1926 paper).
 1927 *Margaropus winthemi* Karsch; Cowdry (reprint of 1926 paper).
 1928 *Margaropus winthemi* Karsch; Jack, pp. 537-56.
 1932 *Margaropus winthemi* Karsch; Bedford, pp. 223-523.
 1934 *Margaropus winthemi* Karsch; Bedford, pp. 49-99.
 1937 *Margaropus winthemi* Karsch; Jack, pp. 907-29.
 1942 *Margaropus winthemi* Karsch; du Toit, pp. 251-9.
 1947 *Margaropus winthemi* Karsch; du Toit, pp. 408-23.
 1953 *Margaropus winthemi* Karsch; Hoogstraal, pp. 37-113.
 1956 *Margaropus winthemi* Karsch; Theiler & Salisbury (in press).
 1956 *Margaropus winthemi* Karsch; Hoogstraal, pp. 899-905 (gives the source of these records).

This information is based on Hoogstraal's description.

MALE. Unfed adults large, length up to 3.7 mm., width 2.5 mm. Outline elongate oval with integument distended beyond the scutum laterally and posteriorly. When replete the male shows a caudal protrusion.

Capitulum. Basis about twice as broad as long, posterior margin slightly concave, lateral margins convex; surface bears a transverse row of 18-20 hairs at about mid-length. In ventral view posterior edge of basis straight or gently curved, lateral margins straight and divergent to palpal insertion. Palpi short, broad. Article 2 quadrate with slight but distinct angular projection mesobasally, length about one-third greater than article 3; article 3 very short and broad, with broadly pointed outline apically; article 1 barely visible dorsally. In ventral view article 1 broader than long,

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Figs. 481-4, *Margaropus winthemi*. 481, dorsal view of male; 482, ventral view of male; 483, dorsal view of female; 484, ventral view of female. (Redrawn from Hoogstraal, 1956.)

article 2 slightly longer on the almost straight inner edge, article 3 with prominent tapering triangular retrograde spur. Hypostome about twice as long as broad, slightly notched in the mid-line distally, and behind a well-defined corona the dentition is 4/4 with 5 or 7 teeth in the inner files and 9-11 teeth in the outer files.

Scutum. Lateral margins convex, more strongly convergent anteriorly, bluntly rounded behind, about a third as long again as it is wide. Cervical grooves short, not

reaching to the limits of the pseudoscutum, convergent anteriorly and thence divergent for three-quarters of their length. Postero-median groove distinct, shallow, narrow and elongate; paramedian grooves not as long but otherwise similar. Scutal hairs pale and shorter than lateral hairs, 'about twelve in each scapular area and about twenty anteriorly between the cervical grooves', a row in the position of the pseudoscutum, more irregularly scattered on the posterior half of the scutum. Eyes indistinct, small, flat.

Postscutal hairs, few rows of long hairs on the integument beside the scutum, those posterior of the spiracular plates forming six pairs of longer hair groups, each tuft consisting of five to ten hairs.

Legs. 'Bead-like',* increasing progressively in size from legs I to legs IV. Coxae equidistant from each other, almost contiguous; inner margins of each broadly rounded, I and IV subtriangular, II and III subquadrate. Slight indistinct blunt external spurs on coxae I and IV. Free segments of legs I and II subequal, becoming progressively wider in legs III and IV, constriction between first and second proximal segments of each leg very narrow. Tarsi tapering strongly from proximal to distal end, where they terminate in claw-like apices; a small subapical hump ventrally on each tarsus. Claws and pulvilli dorsally placed, claws longer than pads. Hairs long and pale and disposed as irregular rows on the dorsal surface of each segment, a few laterally and ventrally, a distal encircling row on most segments, and dorsal tufts apically on the apex of segments III and IV.

Spiracular plate. Subcircular with two rows of large goblets around the ostium.

Ventral plates. Preanal shield bearing spinose hairs originates at about mid-length between the genital aperture and coxa IV, where the anterior margin is rounded though frequently irregularly sclerotised, projects on either side of the anus as narrow, tapering robust spurs; accessory shields lacking. Hairs between genital grooves and coxae in three irregular rows reaching from coxa I to the level of the spiracular plates, between the genital grooves as five rows and two irregular rows between the anus and the posterior margin. Ventral hook located on posterior margin of unfed males, being visible on the venter of the caudal protrusion in fed males; hook itself twice as long as broad and articulated with the body basally.

Genital aperture. Situated on a level with the anterior half of coxa II, grooves mildly undulating from genital opening to level of anus and then strongly divergent but not reaching the periphery.

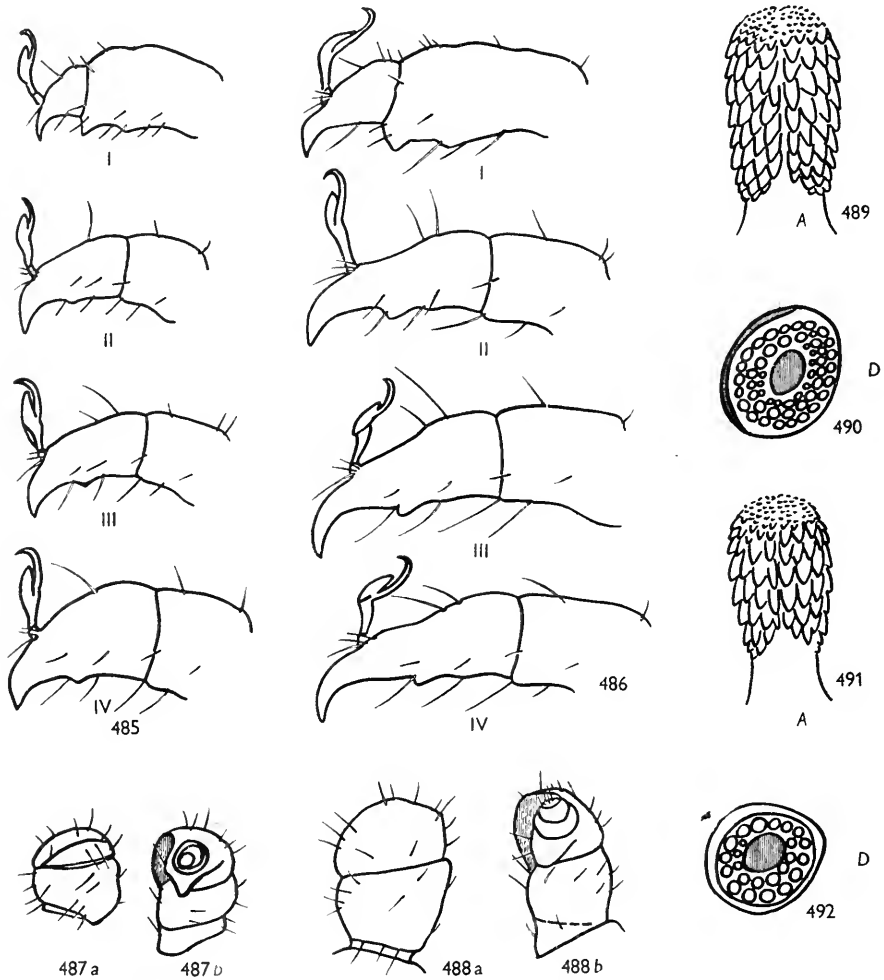
Anal groove. Obsolete.

FEMALE. The free segments of the legs are much reduced in size and do not have the beaded appearance of the males. The posterior ventral hook, the conspicuous lateral hairs and hair tufts are missing. The unfed female of large size reaches up to 6.9 mm. and about 4.0 mm. across. Unengorged specimens are yellowish.

* The name *Margaropus* has become established. It should read *Margaritopus*, signifying beady-legged.

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Capitulum. Basis capituli about three times as broad as long, widest at or in front of mid-length, lateral margins markedly convex, with posterior margin either straight or slightly concave. Porose areas large, transversely ovate and located immediately



Figs. 485-92, *Margaropus winthemi*. 485, tarsi I-IV, male; 486, tarsi I-IV, female; 487a, dorsal view of palp of male; 487b, ventral view of palp of male; 488a, dorsal view of palp of female; 488b, ventral view of palp of female; 489, hypostome of female; 490, spiracular plate of female; 491, hypostome of male; 492, spiracular plate of male. (Redrawn from Hoogstraal, 1956.)

behind each palp. Palpi slightly longer than wide; larger than the corresponding structures in the male, the ratio of article 2 to article 3 being 1.0:0.75; apex of article 3 broadly ovate. In ventral view basis capituli with arcuate lateral and posterior margins, article 3 with a blunt protuberance on the ventral face. Hypostome larger than in the male but with the same general appearance. Dentition consists of 4/4 rows

M. WINTHEMI

of denticles with seven or eight denticles in the inner files and 10-11 denticles laterally.

Scutum. About as long as broad, with distinct eyes located at the widest points of the scutum, the eyes oval and slightly convex. Antero-lateral margins, in front of the eyes, almost rectilinear and convergent to the prominent scapulae; postero-lateral margins behind the eyes, convex or less frequently slightly concave, which terminate in the bluntly rounded posterior margin. Cervical grooves divergent at first from the anterior margin then curving inwards and attaining postero-lateral margins at about half-way between the eyes and the posterior extremity. Surface between grooves shagreened with widely scattered short hairs.

Legs. Strong. Coxae much as in male except that they are longer; spurs and ridges much reduced. Tarsi of similar pattern to those of males except that they are relatively longer and narrower in the females. Claws and pulvilli as in male.

Spiracular plate. Subcircular, three rows of large goblets around the ostium.

Genital aperture. Between coxae II, shield-shaped. Genital grooves similar to those of the male as far as the anus, being then only slightly divergent and nearly reaching posterior margin. Arrangement of hairs generally similar to those of the male.

NYMPH and LARVA undescribed.

BIOLOGY

The biology of *M. winthemi* has not been studied with any degree of certainty and the available information indicates that it is a single host tick whose life-history extends for 186-201 days from adults to the emergence of larvae (Hoogstraal, 1956, quoting Lounsbury and Howard). These ticks occur on the hosts in winter (May-August) and are recorded in localities having more than 90 days of frost and an annual rainfall of less than 30 in. (Theiler & Salisbury, in press). Horses and domestic animals appear to be well-established hosts.

Margaropus reidi Hoogstraal, 1956

Figs. 493-510

LIT. AND ICON.

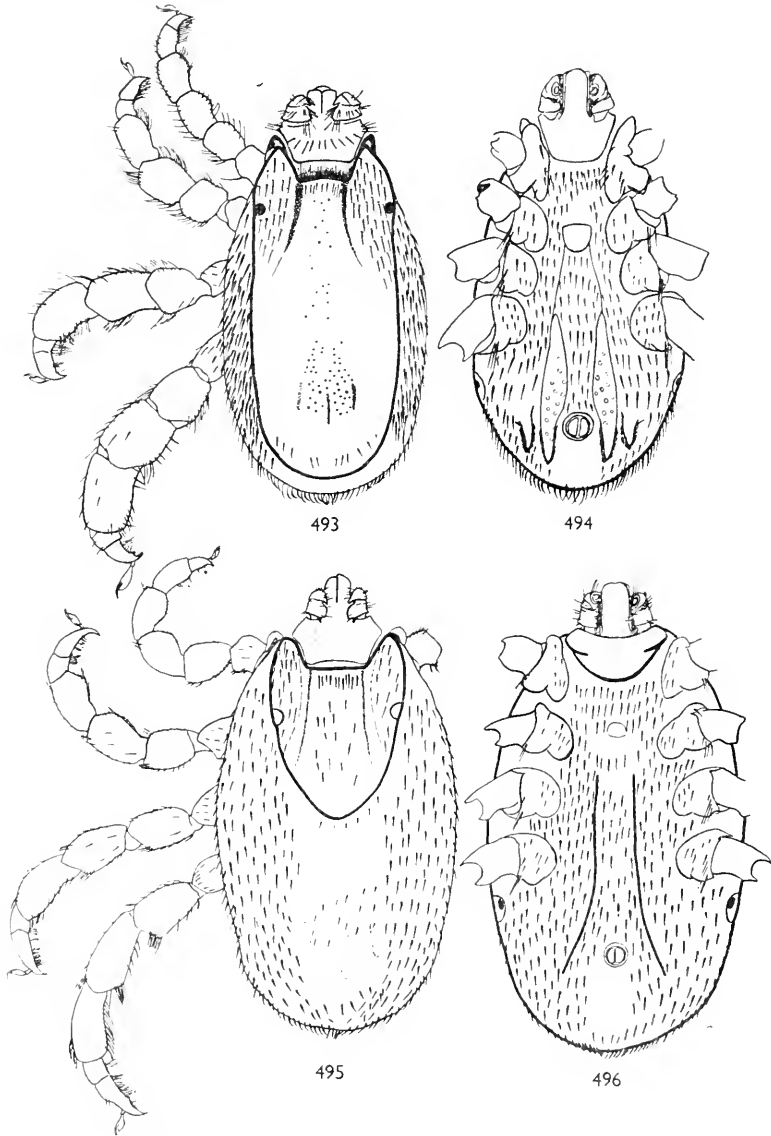
1956 *Margaropus reidi* sp.nov. Hoogstraal, pp. 576-82, original description.

This species is known only from the western Sudanese form of giraffe, *Giraffa camelopardalis* subsp. and was collected from Liednhom in the Sudan.

The following description is taken from Hoogstraal's excellent monograph on African ticks.

'MALE (figs. 493, 494). Length overall approximately 3.0 mm., width approximately 1.4 mm. Colour (dry) dark reddish brown, legs yellowish; integument white, yellowish, or dark brown. Outline oval with integument bulging beyond scutum laterally and posteriorly, but lacking caudal protrusion (available specimens are moderately engorged).

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Figs. 493-6, *Margaropus reidi*. 493, dorsal view of male; 494, ventral view of male; 495, dorsal view of female; 496, ventral view of female. (Redrawn from Hoogstraal, 1956.)

Capitulum. Basis capituli twice as wide as long; lateral margins markedly diverging anteriorly, basal margin slightly concave; dorsal surface bearing a horizontal row of twenty hairs at level of mid-length; ventrally more elongate, length and width equal, lateral margins slightly concave, basal margin convex. Palpi comparatively short; overall length and width of each palpus approximately equal; segment 1 forming a short, wide pedicle for segment 2. Segment 2 subquadrate, approximately twice as

wide as long; outer margin slightly expanded basally, inner margin straight or slightly convex; anterior and posterior margins straight, parallel. Segment 3 triangular, outer margin approximately twice as long as inner margin, the latter drawn out into a distinct spur basally. Palpi ventrally with segments 2 and 3 of almost equal length, segment 3 bearing a small triangular retrograde spur extending just beyond the apex of segment 2; segment 4 small, inserted in pit of segment 3; segment 1 forming a slight pedicle for palpi and bearing at its inner basal margin a slight knob with at least one bristle. Hypostome twice as long as wide, apical margin broadly rounded and notched medially; a dense corona present; dentition 5/5, with nine to eleven denticles in each file, files of equal length.

Scutum. Outline narrowly elongate with lateral margins parallel, posterior margin bluntly rounded; lateral margins widening slightly to scapulae; emargination deep. Postero-median and para-median grooves shallow, narrow, short and indistinct, situated at level of spiracular plates. Cervical grooves shallow, broad, but distinctly divergent to lateral margin posterior of eyes. Eyes on lateral margin at level of coxa II; distinct, rounded and slightly raised. Surface of scutum smooth and shiny, with a narrow median field of few scattered moderate-sized punctations extending the full length of the scutum and in scapular region; a single row of twelve hairs along posterior margin and a few hairs among posterior grooves; area between cervical grooves and lateral margins punctate and bearing scattered fine, long, white hairs; a row of hairs also situated on anterior margin between cervical grooves. Marginal groove wide, from level of coxa I. Integument bulging around scutum from level of eyes posteriorly; furnished with regularly scattered, dense, long, yellow, conspicuous spinose hairs bordering scutum to level of spiracular plates; thence these hairs more confined to narrow lateral surface of integument around posterior margin of scutum, where they are more strongly curved than elsewhere; few or no hairs on dorsal surface in this area.

Spiracular plate. Subcircular, with one and a half rows of large goblets surrounding aperture. *Genital aperture* situated at mid-level of coxa II, anterior and posterior margins parallel, lateral margins slightly converging posteriorly. *Genital grooves* extending from genital aperture to level of anus, slightly divergent. *Adanal shields* commencing at anterior level of coxa IV and extending beyond level of anus almost to posterior margin of body (depending on degree of integumental stretching due to feeding), narrowly elongate, slightly expanded just anterior of anus, tapering and bluntly rounded distally; divided from each other by narrow area of integument; unattached to integument posterior of anus; surface bearing a few scattered hairs distally. *Accessory shields* extending from level of anus to approximately same level as apex of adanal shields, tapering, bluntly rounded apically; narrower than adanal shields. Hairs on ventral surface fairly dense and evenly distributed but shorter than those on lateral surfaces.

Legs. With free segments appearing beaded due to width and constriction between several segments; length/width ratio of segments variable but width of none equalling length of same segment; free segments with numerous long, fine hairs dorsally and

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ventrally. Tarsi apically extended into a downward projecting, spur-like point; IV also with a short ventral subapical spur; outline narrowly elongate; claws and pads arising from dorsal surface at apex; claws long, narrow, recurved at some distance beyond pads. Coxa I narrowly, elongately subtriangular and extending anteriorly almost to anterior margin of basis capituli, visible from dorsal view; posteriorly deeply cleft to form a widely triangular outer spur and a narrower, tapered inner spur; other coxae subrectangular with rounded margins; posterior margins slightly cleft; all coxae with numerous hairs.

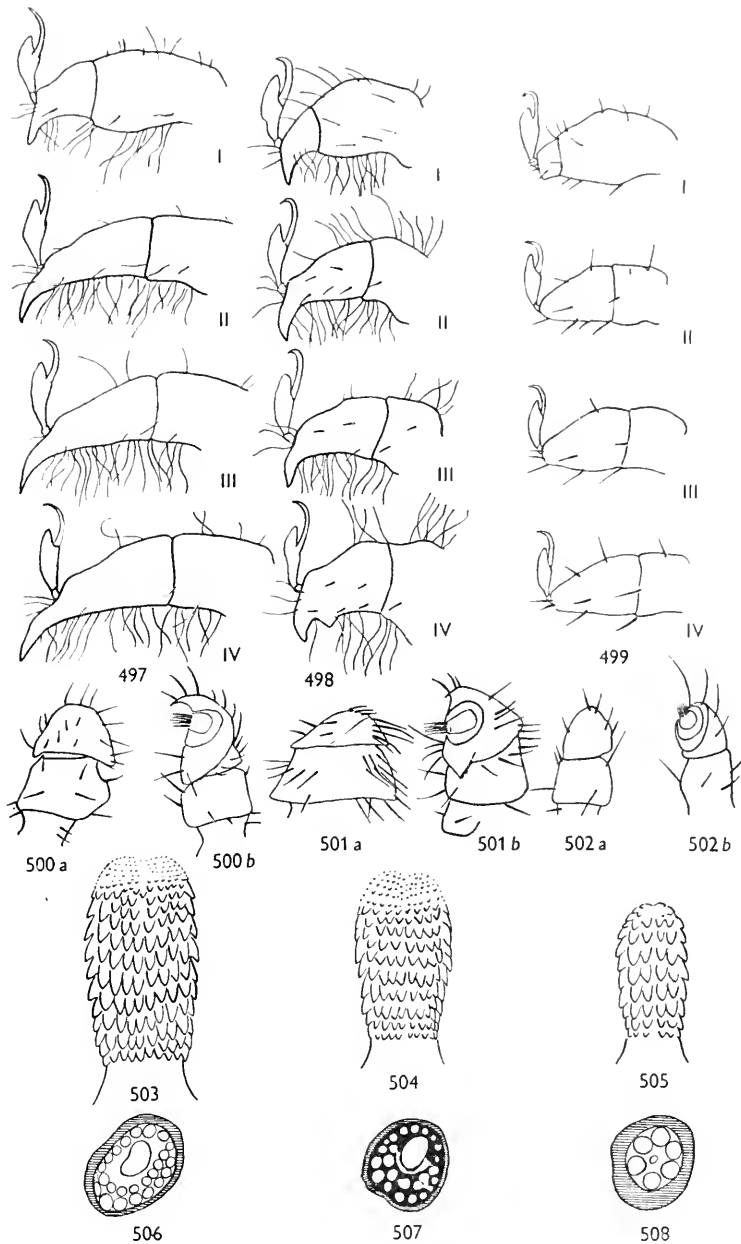
FEMALE (figs. 495, 496). Unengorged specimens are very slightly larger than males; engorged specimens measure up to 6.2 mm. long but retain the linear, pod-shape appearance of boophilid females due to the severely parallel lateral margins of the body. Female characters recall those of the male but the leg segments are less expanded and the palpi are more elongate with a slight constriction between the second and third segments.

Capitulum. Basis capituli from one and a half to twice as wide as long; basal margin moderately concave and joined to lateral margins by slight expansions suggestive of cornua; lateral margins concave to widest point at anterior third, thence recurved to anterior margin; porose areas small, shallow, and indistinct, subtriangular or pear-shaped; bearing four or five hairs laterally on dorsal surface. Palpi more elongate than those of male, segments 2 and 3 separated by a pedicle-like constriction and of approximately equal length; segment 2 arising from pedicle, with straight outer margin, convex inner margin, and subparallel anterior and posterior margins; segment 3 with lateral margins slightly converging to bluntly rounded anterior margin, posterior margin straight though forming a slight, more or less downcurved projection at junction with inner margin; segment 3 ventrally with short, broad spur reaching basal margin; segment 1 narrow, pedicle-like, not observed to bear a ventral knob as in male; palpi with hairs as illustrated. Hypostome larger but otherwise similar to that of male.

Scutum. Three-fourths as wide as long; outline slightly convex anterior of eyes, slightly convergent from eyes to junction of cervical grooves, abruptly converging posteriorly; anterior emargination deep. Cervical grooves reaching lateral margins as in male and delimiting an antero-lateral area that is hirsute and somewhat punctate as in male. Surface otherwise smooth except for a transverse row of hairs bordering anterior margin between cervical grooves and a few scattered hairs arising from punctations in central field. Eyes on lateral margins at scutal mid-length, slightly convex.

Spiracular plate. Of similar construction to that of male but differing slightly in outline. Genital apron a wide oval at level of coxa II. Genital grooves subparallel to level of spiracular plates, thence divergent to level of posterior margin of anus.

Integument. With numerous fairly regular rows of short hairs on both dorsal and ventral surfaces; hairs more dense on posterior margin between spiracular plates.



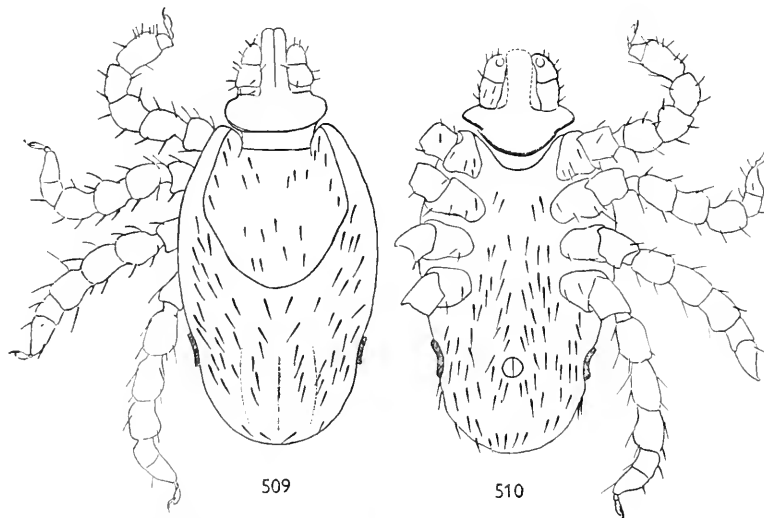
Figs. 497-508, *Margaropus reidi*. 497, tarsi I-IV, female; 498, tarsi I-IV, male; 499, tarsi I-IV, nymph; 500a, dorsal view of female palp; 500b, ventral view of same; 501a, dorsal view of male palp; 501b, ventral view of same; 502a, dorsal view of nymphal palp; 502b, ventral view of same; 503, female hypostome; 504, male hypostome; 505, nymphal hypostome; 506, spiracle of female; 507, spiracle of male; 508, spiracle of nymph. (Redrawn from Hoogstraal, 1956.)

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Legs. Similar to those of male except that the free segments are narrower and tarsi more elongate; tarsus IV lacking ventral subapical spur; anterior projection of coxa I variable, as distinctly produced as that of male or more truncate.

NYMPH (figs. 509, 510)

Capitulum. Basis capituli three times as wide as long, with straight basal margin, rounded junctures, and divergent lateral margins. Palpi four times as long as wide; segment 1 forming a slight pedicle; segments 2 and 3 of approximately equal length and subrectangular; apex more or less bluntly rounded; segment 3 ventrally with a short, wide spur not reaching basal margin of segment. Hypostome similar to that of adults but with smaller corona and 3/3 dentition in files of eight denticles.



Figs. 509-10, *Margaropus reidi*. NYMPH: 509, dorsal view; 510, ventral view.
(Redrawn from Hoogstraal, 1956.)

Scutum. With length/width ratio approximately equal; outline gradually diverging from scapulae to mid-length, thence abruptly converging to narrow, bluntly rounded posterior margin. Surface lightly shagreened and with a few scattered hairs; cervical grooves as in adults (not visible in all specimens); eyes small, indistinct or invisible.

Spiracular plate. Subcircular, with six large goblets in a circle.

Integument. With long hairs.

Legs. With length/width ratio of free segments intermediate between those of male and female sexes; coxa I not so deeply cleft and truncate anteriorly; tarsi short, robust, not tapered downwards as in adults; dorsal margin gradually tapering; claws and pads as in adults.'

LARVA. Unknown.

BIOLOGY. Nothing known.

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