Part I, Argasidae] **[October, 1908**

TICKS

A MONOGRAPH OF THE IXODOIDEA

By

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PREFATORY NOTE

THE discovery of the economic importance of ticks as carriers of disease to man and domesticated animals has led to a vast increase of our knowledge of this group. No existing work in any language attempts to deal with the subject in a comprehensive manner, and the student is confronted with a very extensive and widely scattered literature from which he derives an impression of hopeless confusion. There is therefore urgent need for a work of the nature here attempted.

The book will deal with the Classification, Structure and Biology of Ticks, the study of the group having occupied the authors for several years. Practically all that has been published on the subject has received adequate consideration. The parts on Classification have entailed much labour since it was found necessary to revise a large amount of the work which has been done by others. The book will be very fully illustrated by numerous text figures and plates, the majority of which are original, the remainder reproduced from the best sources.

It was at first intended to publish a full account of the Ixodoidea or Ticks as a complete volume, but the increasing demand for a work dealing with this group of parasites has caused us to decide to issue without delay the part relating to the *Argasidae*. Other parts will follow, and the whole, we hope, will be ready in about a year.

The parts will be complete in themselves but are designed to form a volume of about 500 pages when all the parts have been published. Each part will be issued in a stiff paper cover and will include a bibliography printed on one side of thin paper so that the references can be conveniently cut out and gummed on index cards. A complete bibliography, including all the publications cited in each part, will conclude the volume.

In the text the Harvard system of references is adopted, the year and page of the authors' papers being added after their names. Unless otherwise stated all the authors cited have been consulted in the original. The completed volume will also contain an adequate introduction, which we think it better to omit for the present.

CAMBRIDGE
August 1908

PART I

THE ARGASIDAE

by

G. H. F. NUTTALL

and

C. WARBURTON

aided by

W. F. COOPER and L. E. ROBINSON

NOTE.

G. H. F. Nuttall and C. Warburton are responsible for the systematic portion of this Part, while the biological section has been almost entirely in the hands of the former. W. F. Cooper and L. E. Robinson have assisted in collating the literature on the subject.

CONTENTS

OF

PART I

THE ARGASIDAE

SECTION I

DEALING WITH THE CLASSIFICATION OF THE *ARGASIDAE*

(Illustrated by 3 plates and 116 figures in the text.)

Description, Synonymy, Iconography and Literature relating to the following species :

SECTION II

DEALING WITH THE GENERAL BIOLOGY OF THE *ARGASIDAE*—THE EFFECTS OF THEIR BITES,—THEIR RELATION TO THE SPREAD OF DISEASE, ETC.

For what is known regarding other species of *Argasidae* in this respect see Section I. The internal anatomy will be considered in the general introduction to the completed volume.

LIST OF ILLUSTRATIONS

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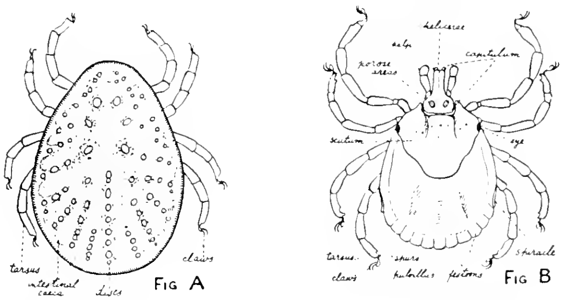
SECTION I

DEALING WITH THE CLASSIFICATION OF THE ARGASIDAE

Superfamily: **IXODOIDEA** Banks.

Family I: **ARGASIDAE** Canestrini, 1890.
Family II: **IXODIDAE** Murray, 1877.

The most striking difference between the *Argasidae* and the *Ixodidae* is the possession by the latter of a shield or *scutum*, which covers the whole body of the male, and prevents any large degree of distention, while it forms a small patch on the anterior part of the dorsum of the female, the rest of the body being greatly distensible. The *Argasidae* possess no such scutum, but are covered by a more or less uniform leathery integument. Many other differences, however, exist, and the principal may be tabulated as follows:



Figures illustrating the main points wherein the *Argasidae* (A, an Argas) differ from the *Ixodidae* (B, an Amblyomma ♀).

	Argasidae	*Ixodidae*
Sexual dimorphism	Slight	Marked.
Capitulum:		
Base	Ventral, in camerostome, no porose areas in ♀	Anterior, porose areas in ♀.
Palps	Leg-like, with sub-equal articles	Relatively rigid, of very varied form, 4th article rudimentary.
Body:		
Scutum	Absent	Present.
Festoons	Absent	Generally present.
Eyes (when present)	Lateral, on supra-coxal folds	Dorsal, on the sides of the scutum.
Spiracles	Very small, more anterior	Generally large, well behind coxa IV.
Legs: Coxae	Unarmed	Generally armed with spurs.
Tarsi	Without ventral spurs	Generally armed with 1 or 2 ventral spurs.
Pad (pulvillus)	Absent, or rudimentary	Always present.

The differences extend to their habits as well as to their structure. The Argasidae feed moderately, and the change of shape in both sexes is chiefly a dorso-ventral thickening, while the females of the Ixodidae, when gorged, are greatly increased in size, and their coxae widely separated. The Argasidae live for several years, and as a rule lay comparatively few eggs in small batches, have two or more nymphal stages, and may moult after attaining maturity. The Ixodidae probably do not live more than two years, lay a single huge batch of eggs, and moult twice only, on leaving the larval and nymphal stages.

Family I. ARGASIDAE Canestrini, 1890.

FAMILY CHARACTERS. *Non-scutate ticks with leathery integument and slight sexual dimorphism, with capitulum inferior in the nymphs and adults, the palps being free and leg-like, with their articles sub-equal in length. The spiracles are small and usually anterior to coxae* IV. *Pulvilla absent or rudimentary, porose areas absent on the female capitulum. The capitulum lies partly (larvae) or wholly (adults and nymphs) in a hollow of the overhanging anteriorly protruding body. When gorged the hollow is shallower.*

The Argasidae, even when gorged, never increase much in size, and in their flattened appearance when fasting they bear some general resemblance to bed-bugs. Their principal hosts are man, birds and bats. They are mostly inhabitants of warm climates or choose a habitat in colder climates which assures them protection: thus *Argas reflexus* lives in pigeon coops and fowl houses, *Argas vespertilionis* in the retreats of bats. *Ornithodoros moubata* and *savignyi* inhabit native dwellings, retreating into chinks in the walls or dusty floors. The Argasidae appear to be chiefly nocturnal in their habits, like *Cimex lectularius*, and to prefer dryness.

The family Argasidae includes two genera, *Argas* and *Ornithodoros*.

N.B. There is some difference of opinion as to the number of genera to be admitted under the family Argasidae. Pocock (1907, p. 189) has advocated the revival of Latreille's genus *Caris* (or *Carios*) for the aberrant form *vespertilionis*, which he considers clearly marked off from other members of the family by the possession of a "conspicuous transverse, slightly curved groove just behind the anus," and he would also remove *O. talaje* to another genus, for which he proposes the name *Alectorobius*, on account of the movable lateral wings of the camerostome. Now the post-anal structure so conspicuous in *vespertilionis*, and which on examination appears to be a curious paired organ rather than a simple groove, occurs also in other forms, notably in *O. talaje*, and is not peculiar to *vespertilionis*. With regard to *O. talaje*, we hesitate to remove it from *Ornithodoros*, as in most respects it more closely resembles *O. erraticus* than that species resembles, for example, *O. savignyi*.

In fact we are by no means sure that the family Argasidae contains more than one genus, *Argas*[1]. At the time *Ornithodoros* was separated off from it by Audouin (1827), the peculiar characteristics of *O. savignyi* seemed to warrant that proceeding, but the gap has largely been bridged over by subsequently discovered species. For the present, however, we prefer to retain the genus *Ornithodoros*, though some of the distinctions which were supposed to exist between it and *Argas* have to be discarded.

Synonymy and Literature:

Family **ARGASIDAE** Canestrini, 1890[2].

Argasiden Koch, **1844,** p. 219 ; 1847, p. 11.—Fam. **Argantidae** Agassiz, **1846,** p. 32. —Fam. **Argasides** Fürstenberg, **1861,** p. 208.—Subfam. **Argasidae** Murray, **1877,** p. 180.—Berlese, 1885, p. 131 (incl. one genus : *Argas*).—Riley, 1887, p. 744.—Tribe **Argasides** Mégnin, **1880,** p. 132 (comprising but one genus : *Argas*).—Laboulbène and Mégnin, 1882, p. 320 (both papers contain the same).—Mégnin, 1892, p. 64 (brief mention only).—Tribe **Argasinés** Railliet, **1886,** p. 499.—Neumann, 1888, p. 89 ; 1892a, p. 93.—Subfam. **Argasinae** Trouessart, **1892,** p. 38.—Railliet, 1893, p. 704.—Neumann, 1896, p. 2.—Dubreuilh and Beille, 1896, p. 68.—Ward, 1900 a, p. 196 ; 1900 b, p. 436, and numerous recent authors.—Trouessart, 1891, p. 308 ; misquotation for Argasidae.—Fam. **Argasini** Canestrini and Fanzago, **1877,** p. 192.—Canestrini, 1890, p. 530.—Fam. **Argasidae** Canestrini, **1890,** p. 530 ; 1892, p. 582.—Marx, 1892, p. 232.—Trouessart, 1892, p. 22.—Salmon and Stiles, 1901, p. 400.—Pavesi, P., 1884,

[1] In support of this view we may cite the case of *Argas aequalis* (Nn.) Neumann. This species was first named *Ornithodoros aequalis* by Neumann (1901, p. 259), being referred to the genus *Ornithodoros* because of its general form, parallel sides, and especially the anterior portion of the body which narrows to a short rounded point. In *Argas* the anterior portion of the body is usually broadly rounded and this had appeared to Neumann to constitute a generic distinction until he came to describe *A. brumpti* which possesses the physiognomy of *Ornithodoros*, together with essential characters of *Argas*. Neumann (1908, p. 26) now refers *aequalis* to the genus *Argas*, because, on closer examination, it has been found to possess the typical margin radially striated or with quadrangular areas, visible ventrally and dorsally, which he now regards as a generic distinction. Neumann appears to be almost in favour of degrading *Ornithodoros* to a subgenus, differing from *Argas* by the ventral folds and the absence of the margin above mentioned.

[2] The above Synonymy of the Family is taken from Salmon and Stiles, 1901. Additions have been made to date.

p. 485, used as a heading only to brief mention of *A. erraticus* = Ornithodoros q.v.—Banks, 1904, p. 45, brief mention only.—Dönitz, 1907, pp. 17, 24.—Pocock, 1907, p. 189.—Nuttall, 1908, p. 389.—Banks, 1908, p. 14.—Tribe **Argasinae** Neumann, **1892 b**, p. 96.—Group **Catastomata** Marx, 1892, p. 233.—Morgan, 1899, p. 136.—Subfam. **Argasinés** Railliet, **1893**, p. 715.

Genus 1. ARGAS[1] Latreille, 1796.

Generic Characters. *Body flattened, oval or rounded, with a distinct flattened margin differing in structure from the general integument; this margin gives the body a sharp edge which is not entirely obliterated even when the tick is fully fed. Capitulum (in adults and nymphs) entirely invisible dorsally, distant in adults by about its own length from the anterior border. On both dorsum and venter there are numerous symmetrically arranged discs[2], generally round or oval, more or less disposed in radial lines. Elsewhere the integument is minutely wrinkled into irregular zig-zag folds. Eyes absent.*

Type species: *Argas persicus*[3].

Synonymy and Literature: Genus ARGAS Latreille, 1796[4].

Argas Latreille, **1796**, p. 178, obs. specimen 8 mm. long, had seen specimens from Tuscany (*A. reflexus*, doubtless); 1804, p. 53: type, *Acarus reflexus*; 1806, p. 155; 1829, p. 288; 1835, p. 512.—Leach, 1815, p. 397.—Risso, 1826, p. 182.—Heyden, 1826, p. 612.—Audouin, 1832, p. 413.—Sundvall, 1833.—Dugès, 1834 a, p. 15 (included in the family *Gamasei* by this author); 1834 c, p. 31.—Gervais, 1844, p. 229; 1847, p. 351.—Koch, 1844, p. 219; 1847, p. 12.—Gervais and van Beneden, 1859, p. 455.—Gerstaecker, 1860, p. 464; 1863, p. 344.—Fürstenberg, 1861, p. 208.—Moquin-Tandon, 1861, p. 304.—Verrill, 1870, p. 116.—Spicer, W. W., 1874 a, p. 185.—Taschenberg, E. L., 1874.—Mégnin, 1876, p. 288; 1880, pp. 133, 320.—Conil, 1877, p. 27; 1878, p. 101.—Murray, 1877, p. 180.—Canestrini and Fanzago, 1877, p. 193.—Küchenmeister and Zürn, 1879, p. 538 *et seq.*—Berlese, 1885, p. 131.—Ludwig, 1886, p. 612.—Railliet, 1886, p. 499;

[1] Often misspelt *Argus*, see Ant. Dugès and Milne Edwards, pl. 27; Fullager, 1874 a; Francis, 1894, p. 452; Fuller, 1897, p. 590, etc. The derivation of "*Argas*" attributed to the Greek ἀργής (=white, glistening) by Spicer (1874a, p. 185), who adds that being eyeless, it can have nothing to do with him "of the hundred eyes." The numerous discs on *A. reflexus* may well have been considered to represent "many eyes" by earlier observers. We have never seen any specimens which could be described as white or glistening. The white incrustations dotting the backs of *A. reflexus* found at Canterbury in 1874 (noted by Gulliver) appears to have been derived from the plaster in the walls, or it may have been excrement.

[2] Scutella, foveolae, patellae, pits of other authors.

[3] *A. reflexus* (Fabr.) has been the hitherto accepted type of the genus (*vide* Nn., 1896, p. 2). We prefer to take *persicus* for our type because it is world-wide in its distribution and commonly found, besides having been the better studied.

[4] Literature given by Salmon and Stiles, 1901, p. 401, revised and with additions.

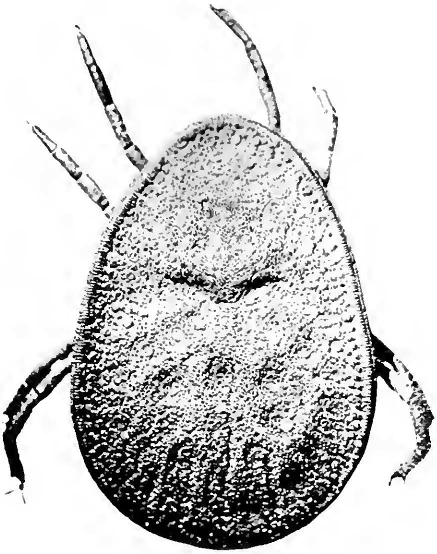


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 1. *A. reflexus* ♂, × 10. Fig. 2. *A. reflexus* ♀, × 10. Fig. 3. *A. persicus* ♂, × 9. (Wheler, 1906, figs. 6, 7. 39.)

Fig. 4. *A. vespertilionis*. Last nymphal stage, dorsal aspect, × 16. (Specimen from Cape Colony, Lounsbury Coll.)

Fig. 5. The same, ventral aspect. (Original, C. and R. phot.)

1893, p. 715.—Neumann, 1888, p. 89; 1892 a, p. 92; 1892 b, p. 96; 1896. p. 3, etc., and 1908, p. 26.—Blanchard, 1890, p. 329.—Canestrini, 1890, p. 530; 1892, p. 582.—Trouessart, 1891, p. 290; 1892, p. 35.—Efisio, 1892, p. 257.—Marx, 1892, p. 233.—Du Buysson, 1896.—Moniez, 1896, pp. 499-509.—Osborn, 1896, p. 255.—Morgan, 1899, p. 137.—Ward, 1900 a, p. 196; 1900 b, p. 437.—Salmon and Stiles, 1901, p. 401.—Banks, 1904, p. 45.—Aclogue, 1905, p. 536 (inaccessible).—Dönitz, 1907, p. 24.—Pocock, 1907, p. 189.—Nuttall, 1908, p. 390.—Banks, 1908, p. 14, and many recent authors making casual mention.

(Not to be confused with *Argas* Scoul., 1835, crustacean; *Arges* Hann., 1835, crustacean; *Arges* Goldf., 1839, crustacean; *Arges* Val., 1840, fish; *Argus* Boh., 1761, mollusk; *Argus* Scop., 1777, lepidopteron; *Argus* Poli, 1795, mollusk; *Argus* Temm., 1815, bird; *Argus* Walk., 1837, arachnoid.)

Carios Latreille, **1796**, p. 176; 1806, p. 161.—Kolenati, 1857, p. 16.—Canestrini, 1890, p. 480.—Neumann, 1896, p. 19.

Rhynchoprion Hermann, **1804**, p. 69.—Heyden, 1826, p. 612.—Treviranus, 1831, p. 188.—Latreille, 1829, p. 288.—Canestrini, 1890, p. 531.—Trouessart, 1891, p. 290.—Railliet, 1893, p. 715.—Neumann, 1896, p. 3.

(Not to be confused with *Rhynchoprion* or *Rhyncoprion* Oken, 1815, dipteron; *Rhynchoprium* Marx, 1895, arachnoid.)

Caris Latreille, **1806**, p. 161; type, *vespertilionis* (= *Carios* renamed for no obvious reason); 1829, p. 290.—Risso, 1826, p. 182.—Heyden, 1826, p. 613.—Latreille, 1835, p. 511.—Gerstaecker, 1863, p. 343. (See also Audouin, 1832, p. 413.)—Dugès, 1834 c, p. 14 (regards it as *Argas* larva).—Kolenati, 1857, p. 15; 1858, p. 4.—Murray, 1877, p. 181.—Canestrini and Fanzago, 1877, p. 184.—Haller, 1882, p. 312.—Canestrini, 1890, p. 480.—Trouessart, 1891, p. 290.—Neumann, 1896, p. 19.—Pocock, 1907, p. 189.

(Not to be confused with *Caris* Fisch., 1821, col.)

"**Rhyachoprion** (*sic*) Hermann," of Dugès, 1834 c, p. 14.

In our opinion the genus *Argas* comprises six well established species:

		PAGE
1.	**persicus**	8
2.	**reflexus**	22
3.	**transgariepinus**	29
4.	**brumpti**	30
5.	**aequalis**	33
6.	**vespertilionis**	34

There are four doubtful species:

7.	**cucumerinus** (possibly = *reflexus* var. *magnus*)	28
8.	**hermanni** (near to *reflexus* var. *magnus*)	27

9. **transversa** Banks, 1902, p. 70, Pl. II, Fig. 9. (Species founded on one specimen; description insufficient.)
10. **brevipes** Banks, 1908, p. 15, Pl. I, Figs. 3, 4. (Description insufficient. Legs shorter than in *A. persicus*: may be but a variety.)

The following species have been suppressed:

americanus, chinche, mauritianus, miniatus, radiatus, sanchezi = **A. persicus**; *columbae, magnus, marginatus* = **A. reflexus** (including var. *magnus*); *kochi* = **A. transgariepinus**; *decussata, elliptica, fischeri, inermis, longimana, pipistrellae, pulchella* = **A. vespertilionis**; *stroguloides* Gervais, 1844, p. 231, is a purely nominal species (Nn., 1896, p. 25). *A. forskăli* Audouin, 1827, p. 430, figured as a hexapod larva in Savigny, 1826, Pl. IX, Fig. 13 (1 and 2 g.); mentioned in Dugès, 1834, p. 32; called *Hyalomma Forskaelii* (Aud.) by C. L. Koch, 1844, p. 222; possibly *H. aegyptium* according to Nn., 1896, p. 24, and 1901, p. 255.

Explanation of terms and signs used in the following diagnoses.

L. = the extreme length of the tick.

W. = its width at the widest part.

(*l.* and *w.* refer to length and width of various structures.)

DORSUM = the whole dorsal surface of the body.

Mammillae = minute hemispherical or conical protuberances into which the integument is generally raised.

Discs = the foveolae, patellae, scutella, pits of other authors, see Figs. 6, 7, 23.

VENTER = the whole ventral surface of the body.

spiracle = the "peritreme" or "stigmal plate" of some authors.

vulva = the genital orifice of the female.

grooves = linear depressions. In Fig. 1 note pre-anal groove, post-anal groove and post-anal median groove.

folds = prominent integumental ridges. In Fig. 1 note supra-coxal and coxal folds.

camerostome = the cavity in which the capitulum lies.

hood = the projection of the integument forming the walls of the camerostome.

CAPITULUM = the "rostrum," "head" or "false head" of various authors (Fig. 2).

basis capituli or shortly *base* = the basal ring, etc., of most authors.

hypostome = the "maxilla," "radula," "labium," or "Unterkiefer" of various authors. The dentition is indicated by figures on either side of a vertical line. Thus 3|3 means three longitudinal files of teeth on each half of the hypostome.

chelicerae = the "mandibles" or "pseudo-chelicerae" of some authors. The terminology usually applied to the portions of the *digit* of the chelicerae appears to us wrong and confusing, and we prefer to recognise (1) an "internal article," the latter bearing a "dorsal process" which is a portion of it (not articulated), and (2) an "external article" which articulates with the internal article upon its outer side.

1. *internal article* = "median apophysis" or "immovable finger" of some authors.

dorsal process = "internal apophysis" of some authors.

2. *external article* = "external apophysis" or "free" or "movable finger" of some authors.

Palps, the pedipalpi, 4-jointed, leg-like appendages on either side of the hypostome.

(For details of the capitulum consult Fig. 2.)

LEGS, six articles, *coxa*, *trochanter*, *femur*, *tibia*, *protarsus* and *tarsus* are always recognisable, and there may be additional "false articulations." Articles 1 and 6 are generally referred to as the *coxa* and the *tarsus* respectively, the others being indicated by their numbers. Certain dorsal prominences often present on articles 5 and 6 are referred to as *humps* or *dorsal protuberances*.

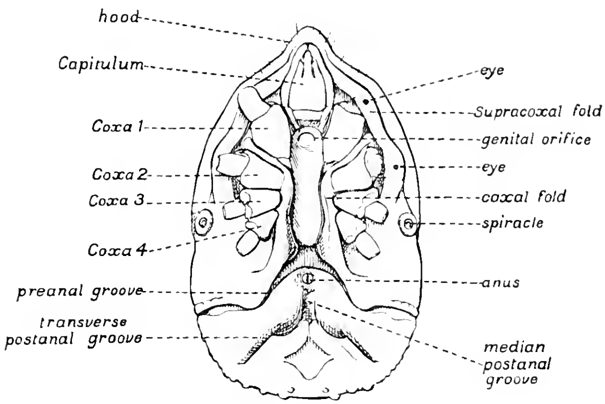


Fig. 1. Ventral aspect of *Ornithodoros coriaceus* ♂ with names of parts referred to in the descriptions (Nuttall, 1908, Fig. 2).

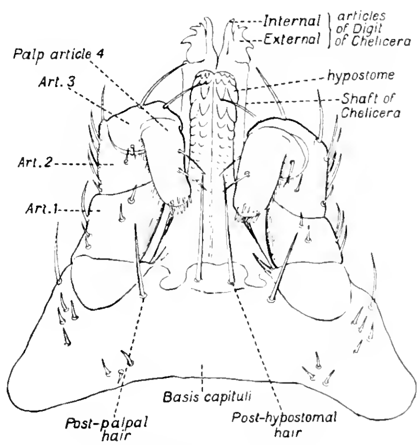


Fig. 2. Capitulum of *Argas persicus* ♂ with names of parts referred to in the descriptions (Nuttall, 1908, Fig. 4).

Key for the determination of species of Argas.

(Exclusive of doubtful species *q.v.* p. 5)

			PAGE
(*a*)	Body circular	*vespertilionis*	34
	„ oblong	*b*	
(*b*)	Margin striate	*c*	
	„ with quadrangular "cells" .	*persicus*	8
(*c*)	Body sub-conical in front	*d*	
	„ rounded in front	*e*	
(*d*)	Dorsum with polygonal depressed areas .	*brumpti*	30
	„ without „ „ „ .	*aequalis*	33
(*e*)	Body scarcely narrower in front, capitulum very small and posterior .	*transgariepinus*	29
	Body narrower anteriorly, capitulum large and more anterior . .	*reflexus*	22

ARGAS PERSICUS (Oken) 1818[1].

Synonymy. Owing to its wide geographical distribution (*q.v.*) due, it appears to us, to the distribution of its chief host, the domesticated fowl, this species has been given a great many specific names:

Rhynchoprion persicum Oken, 1818, p. 1567.

Argas persicus Fischer de Waldheim, 1823, p. 269.

Argas mauritianus Guérin-Méneville, 1829–43.—Mégnin, 1880, p. 134 (only mentioned). Neumann, 1901, p. 256, examined a dried specimen collected by Desjardins in Mauritius (Paris Mus.) and identified it as *A. persicus.*

Argas miniatus C. L. Koch, 1844, p. 219 ; 1847, p. 32 (Pl. I, Fig. 4, legend states it is a ♂ but text states ♂ is unknown. Description insufficient, specimen from Demerara, Brit. Guiana. Original description translated in Neumann, 1896, p. 24). Neumann, 1901, p. 255, examined the type. Name commonly used by American writers and others, see var. *miniatus.*

Argas americanus Packard, 1872, p. 740, identified with *A. miniatus* by Neumann, 1901, p. 255. Synonymy explained by Salmon and Stiles (1901, p. 406) :—Ercolani (1859) gave the name *A. americanus* Latreille to a form which is parasitic in the ears of horses in San Domingo, and Gamgee (1871) did likewise, consequently the specific name *americanus* has to lapse. Again, *Amblyomma americanum* was placed under *Rhynchoprion* by Hermann (1804), but *Rhynchoprion*=*Argas.* For this reason Railliet (1893, p. 718) gave the tick the name of *Argas radiatus* (see below). *Acarus americanus* L. (*Acarus nigua* de Geer)

[1] The priority for this species has hitherto been given to Fischer de Waldheim.

placed under *Rhynchoprion* by Hermann was probably *Amblyomma americanum* according to Neumann, 1901, p. 255.—Ward, 1900 b, p. 196.

Argas sanchezi Alf. Dugès, 1891, p. 20 and Neumann, 1896, p. 16. Referred to *A. miniatus* by Neumann, 1901, p. 255, after seeing the type. This name recurs occasionally in the literature, *vide* Ward, 1900 b, p. 198.—Banks, 1901, p. 590; 1902, p. 568, etc.

Argas chinche Goudet, referred to *A. miniatus* by Neumann, 1901, p. 344 (no reference).

Argas radiatus Railliet, 1893, p. 718. Neumann examined Koch's type of *A. miniatus* and degraded *radiatus*.

Argas miniatus firmatus Neumann, 1896, p. 12, a variety based on 1 ♀ from Algiers.

Argas persicus var. *miniatus* Neumann, 1905, p. 240. (Neumann finds no constant difference between *A. miniatus* and the type, and largely because of its distribution retains it as a variety. We see no reason for recognising the variety.)

Popular names: "Fowl tick" (America, Australia and Africa), "Adobe tick"[1] in Arizona and New Mexico. In S. Africa "Wandluis" or "Tampan" (Lounsbury, 1900). In Persia "Miana bug," "Miané bug," "Mialleh de Mianeh," "Garibguez" or "Guerib-guez," the last name meaning "stranger bug" according to Churchill, 1880, p. xxi (see also Tholozan, 1881, Mégnin, 1880, p. 134); "Mèllèh" (Dupré, 1819, p. 324), "mallèh" (Fischer de Waldheim, 1823, p. 272)=native name; "punaise de Miana" (Kotzebue, 1819, p. 180), Schlimmer (1874) states it is called "bhebguez" ("Shebgaz," according to Churchill, 1880, p. xxi, meaning "biting at night") at Chahroudé and Bestham.

Iconography: OKEN, 1818, Pl. XIX, Figs. 1–4, notes resemblance to *A. reflexus*. He gives sketchy figures of *A. persicus*; dorsal and ventral aspects.—FISCHER DE WALDHEIM, 1823, Pl. I, Figs. 8-10, shows dorsal aspect with correct distribution of the discs; ventral aspect and capitulum not so good.—SAVIGNY, 1826, Pl. IX, Fig. 8, dorsal aspect, very good considering the date when it was drawn. —GUÉRIN-MÉNEVILLE, 1829–43, Pl. VI, Fig. 3, of *A. mauritianus* dorsal aspect, Fig. 3a part of capitulum. Both figures inaccurate.—KOCH, 1847, Pl. I, Fig. 4. —KOLLAR[2] (date?) is stated by Heller, 1858, to have figured the capitulum.—HELLER, 1858, Pls. I–IV, deals chiefly with the internal anatomy.—PACKARD[3], 1872, Fig. 68, referred to by Neumann, 1901, p. 255 (*A. americanus*).—MÉGNIN, 1880, Pl. VI, Fig. 3 (poor, *A. mauritianus*).—LABOULBÈNE and MÉGNIN, 1882, Pl. XXI, Figs. 1–10; none of them accurate, except that of the capitulum, which is fair. Pl. XXIII, Figs. 1, 2, represent the larva and egg.—DUGÈS[3], 1891, Plate referred to by Neumann, 1901, p. 255 (*A. sanchezi*).—MARX in OSBORNE, 1896, Pl. III, Figs. 3–3k. Drawings by Marx of *A. americanus* ♀ and larva.—NEUMANN, 1896, p. 8, Figs. 4, 5, of digit (2 views) and tarsus I; Figs. 6, 7 (*A. americanus*), details of integument, 8* anus, 9* digit, 10* hypostome, 11 tarsus IV; Figs. 16–21 (*A. sanchezi*), details of integument, digit, hypostome, tarsus I, larval hypostome and ambulacrum. (Here reproduced,

[1] "Adobes" are sun-dried bricks used in building houses.

[2] Inaccessible. Pohl and Kollar (1823) mention Argasidae.

[3] These figures could not be studied, the originals being inaccessible.

* Figures marked by a star are reproduced in this work.

except Figs. 5, 6, 9, 11, 16, 18 and 20, which duplicate the others since the species *americanus* and *sanchezi* no longer hold.)—WOODS[1], 1898, Figs. 20a, b, referred to by Salmon and Stiles under bibliography (1901, p. 402) *A. americanus*.—HASSALL, 1899, Coloured Plate XVI (*Argas americanus*) of ♀, dorsal and ventral aspects: reproduced in Salmon and Stiles (1901). Text Fig. 16, larva (dorsum); Fig. 17, ventral view of the larva (otherwise good), omits the coxae; Figs. 18, 19, larval capitulum; Figs. 20–22, larval ambulacrum (leg I), drawn like Figs. 16 and 17 from living specimens.—WARD, 1900a, Fig. 2; 1900b, Fig. 260, referred to in Salmon and Stiles, 1901, p. 402.—SALMON and STILES, 1901, *A. miniatus*, Coloured Pl. LXXVIII, ♀, reproduction of Hassall, 1899, Pl. XVI. They give a number of excellent text figures, of which these marked by a star are reproduced by us. Figs. 56, 57, views of chelicera complete. Figs. 71, 72* ♀; 73 portion of the marginal skin; 74*, tarsus I of adult; 75, anus; 77, 78*, larva (dorsum and venter); 79, larval capitulum (quite as well shown in Fig. 78, but both omit the two hairs on the basis capituli figured by Hassall); 80, larval mandibles; 81, larval Haller's organ.—LOUNSBURY, 1903, gives a photograph illustrating *A. persicus* upon a sliver of wood torn from a fowl house (× 2), and a plate showing the ♀ (ventral aspect), the larva (dorsal aspect) and a part of the larval capitulum. He gives Wheler's photograph of the male (dorsum).—BLANCHARD, reproduced in Neveu-Lemaire, 1904, p. 154, Figs. C and D, are very inaccurate, and appear to be only poor copies from Savigny (1827). The same figure appears in Perroncito (1882 and 1901) and is copied from Perroncito by v. Linstow (1894).—BANKS, 1904, Fig. 71, ♀ venter, poor.—FROGGATT, 1906, Figs. 1 and 2, showing *Argas* in crevices of splintered wood, and mouth-parts of tick.—WHELER, 1906, Fig. 39*, the ♂, dorsum.—DÖNITZ, 1907, Pl. II, Figs. 9, 10 ♀, 13, 14 larval leg.—REANEY, 1907, p. 401, two very bad figures of larva and female.—MANSON, 1908, Pl. IV, coloured figure of adult (?) dorsum.—NUTTALL, 1908, Fig. 4 ♂ capitulum*.—Banks, 1908, Pl. I, Figs. 1, 2, legs 1 and 4.

Literature. Papers marked "O" contain no original matter or only make casual mention of *A. persicus*.

1818. OKEN, pp. 1567–1570.—**1819.** DUPRÉ, p. 323, refers to effects of bite. Passage quoted in Fischer de Waldheim, 1823, p. 272.—KOTZEBUE, pp. 180, 194, rough description, fully quoted in Fischer de Waldheim, 1823, pp. 272–274. Dwells on effect of bites on man.—**1821.** PORTER[2].—**1823.** FISCHER DE WALDHEIM, pp. 269–273, gives brief description, dwells especially on effect of bite.—**1828.** SZOVITS[2].—**1829.** LATREILLE, b, p. 289. O.—**1829–43.** GUÉRIN-MÉNEVILLE, p. 17, only refers to plate and habitat (*A. mauritianus*).—**1833.** CUVIER, cited by George, 1876, p. 224, as referring to *A. persicus*.—**1844.** DUGÈS, cited by Laboulbène and Mégnin, 1882.—KOCH, C. L., p. 219. *A. miniatus*, described in 18 words.—WALKENAER, p. 232. Also cited by Heller, 1858, p. 297. Passage translated in Churchill, 1880a.—**1847.** KOCH, C. L., p. 12. *A. miniatus*. O.—**1849.** LUCAS, H., p. 317. O.—**1855.** KÜCHEN-

[1] These figures could not be studied, the original being inaccessible.
* Figures marked by a star are reproduced in this work.
[2] Cited in bibliography by Huber, 1899.

MEISTER, p. 423. O.—**1858.** HELLER, C., pp. 297–326. Distinguished the sexes and describes and figures the ♂ and ♀ genital orifice. Spiracle between legs 3, 4. Heller gives the first detailed study of the internal anatomy.—KOLLAR, cited by Heller, 1858, p. 297, as giving first description and figure of capitulum. —**1862.** HUSEMANN, p. 248.—**1863.** GERSTAECKER, C. E. A., p. 344. O.—**1867.** LABOULBÈNE, A., p. 54, obviously compiled from Fischer de Waldheim, 1823 (*q.v.*).—**1872.** PACKARD, pp. 740, 741 (*A. americana*), cited by Salmon and Stiles, 1901, p. 402.—**1873.** FUMOUZE, inaccessible[1].—**1874.** SCHLIMMER, cited in Nuttall, 1899, p. 46. Notes occurrence in different parts of Persia and records effects of bite.—SPICER, p. 209, quotes Walkenaer, 1844.—TASCHENBERG, p. 171.—**1875.** FRITSCH, p. 61[1].—**1877.** PACKARD in Murray, p. 182 (*A. americanus*).—**1880.** CHURCHILL, S., p. xx, cites older authors and adds a few observations of his own.—ERNOUF, p. 256[1].—MÉGNIN, P., p. 134. More fully dealt with in Laboulbène and Mégnin, 1882.—GOUDET, J., cited by Mégnin (1880) as having described and figured "*A. americanus* de Geer" and that it looked like an *Argas* (see synonymy) = "chinche" or "nigua" in Colombia. Mégnin (1892, p. 67) thinks it must be *O. talaje.*—**1881.** THOLOZAN. See Laboulbène, 1881.—LABOULBÈNE, A., (27, vii). Report from Tholozan. Cited in full in Laboulbène and Mégnin, 1882, p. 327.—**1882.** BORDIER, p. 131, cited by Nuttall, 1899, p. 47.—COBBOLD, p. 77.—LABOULBÈNE and MÉGNIN, p. 327, deal at length with *A. persicus*, very diffuse, omit many essentials but describe development and sexes.—PERRONCITO, p. 450. O.—THOLOZAN, p. 15[1].—**1885.** MÉGNIN, p. 460 (*A. americanus*)[2].—**1890.** BLANCHARD, II, p. 883 *et seq.*—**1892.** MARX, p. 234 (*A. americanus*)[2].—**1893.** HOEHR, p. 348 (*A. americanus*)[2].—RAILLIET, p. 718 (*A. radiatus*).—RILEY and HOWARD, p. 267 (*A. americana*, also *A. americanus*)[2].—WEBSTER, p. 149 (*A. americanus*)[2], inaccessible.—**1894.** FRANCIS, p. 452 (*Argus americanus*)[2].—v. LINSTOW, p. 120. O.—**1895.** BRAUN, p. 258. O.—HOWARD, p. 417 (*A. americanus*)[2].—LOUNSBURY, p. 657.—MARX, p. 199 (*A. americanus*)[2].—RILEY and HOWARD.—PACKARD, p. 417.—**1896.** DUBREUILH and BEILLE, p. 79. O.—FULLER, p. 593. General description of fowl tick.—NEUMANN, pp. 9–12, 24, 25 (*A. americanus*).—OSBORN, H., p. 256, quotes Packard's description verbatim (*A. americanus*).—**1898.** WOODS, p. 102 (*A. americanus*)[2]. —**1899.** HART, p. 180 (*A. americanus*) in Trinidad.—HASSALL, pp. 496–500 (*A. americanus*).—LOUNSBURY, repr. A fuller account in his publication of 1903.—MARLATT, C. L. (11, viii). O.—MORGAN, p. 137 (*A. americanus*)[2].—NUTTALL, pp. 46, 47, cites older literature regarding effects of bite.—TASCHENBERG, 1900, p. 738. O.—UTILITY, p. 185, inaccessible[2].—**1900.** WARD, H. B., p. 197, quotes Packard's description; mentions "*A. sanchezi*" as another species.—WARD, H. B., p. 437 (*A. americanus*).—**1901.** FROGGATT, p. 1349, inaccessible, cited in Hunter and Hooker's Bibliogr.—NEUMANN, pp. 255, 256.—PERRONCITO, p. 561. O.—SALMON and STILES, pp. 402–406, give a very full description (*A. miniatus*), which we have utilized in part.—**1902.** BROWN, p. 86, cited by Lounsbury, 1903, p. 6, *re* oviposition.—**1903.** LOUNSBURY, pp. 1–15, gives a very good description of the different stages and the biology. (Cited in text.)—MARCHOUX and SALIMBENI, p. 569. Regarding spirillosis in fowls.—**1904.** BANKS,

[1] Cited in bibliography by Huber, 1899.

[2] Cited in bibliography by Salmon and Stiles, 1901, p. 402.

p. 331. O. Described as "*A. miniata*."—LOUNSBURY (November. Repr., brief mention), see Lounsbury, 1903.—MOSLER and PEIPER, p. 346. O.—NEVEU-LEMAIRE, p. 154. O.—**1905**. BORREL and MARCHOUX, p. 362. Regarding spirillosis in fowl.—NEUMANN, p. 240.—NUTTALL, p. 22. O.—ROBERTSON, p. 561, quoted by Hunter and Hooker, 1907.—**1906**. BRAUN, p. 371. O.—FROGGATT, pp. 14–18 ; gives general account of life history and habits ; measures for tick destruction in infested fowl houses (*A. americanus*).—**1907**. DÖNITZ, W., p. 27.—HUNTER and HOOKER, p. 71. REANEY, p. 401.—**1908**. HOOKER, a, p. 39.—MANSON, p. 204. O.—NUTTALL, p. 394 *et seq.*—BANKS, p. 15.

(Not "*Argas americanus* Latreille" of Ercolani, 1859, p. 248; Gamgee, 1871, p. 219. Not "*Argas americanus* De Geer" of Mégnin, 1880, p. 134. (Mégnin thought it an *Argas* from a figure published by J. Goudet; no reference.) *Acarus americanus* see *Amblyomma americanum*. Dolly, 1894, p. 980. From Salmon and Stiles, 1901, p. 402.)

With the exception of a few unimportant papers all of the above have been consulted in the original.

Specific Description.

(Refer to Figs. 2—26, Pl. I, Fig. 3.)

Adults :—*Body* ovate or quite oval, widest towards the posterior end. Margin (150–200 μ wide), composed of quadrangular units or " cells," each enclosing a circular pit. Discs numerous, oval or round, arranged as shown in figures 3, 4. *Venter:* anus nearly central, with smooth anal ring; spiracles small (125 μ) crescentic, equal to about half the width of the anal ring; genital opening between coxae I and II[1]. *Capitulum:* base ventrally with four long hairs directed forwards, two post-hypostomal, one near the articulation of each palp (post-palpal). Palps about twice as long as hypostome, second article longest, the others equal in length. Chelicerae (see Figs. 15 *a* and *b*). Hypostome indented, 6 or 7 fine denticles on each half distally, followed by stout teeth 2 | 2, the numbers of teeth increasing to 3 | 3, 4 | 4, 5 | 5 basally, the teeth decreasing in size, not attaining the external border nor extending beyond half the length of the hypostome. *Legs:* sub-equal and similar; coxa I distinctly separated from coxa II in ♀ ; coxae II, III and IV contiguous; article 3 the longest; articles 3 and 4 broader distally; tarsi with very slight dorsal protuberance.

The above description applies to both sexes, which differ chiefly in the slightly smaller size of the ♂—which is slightly narrower in front (ovate, Pl. I, Fig. 3)—and in the appearance of the genital orifice (Figs. 11, 12). The latter is slit-like and broader than the capitulum

[1] See Figs. 11, 12. In gravid ♀ it may be more anterior, as in Fig. 4.

immediately behind which it lies in the ♀ (it is situate between coxae II according to Laboulbène and Mégnin, 1882, p. 333). In the ♂ it is half-moon shaped and surrounded by an oval ring narrower than the capitulum and placed further back.

The ♂ measures from 4 × 2·5 to 5 × 3 mm. (Nn. 1896) but it may attain 8 × 5 mm. (Salmon and Stiles, 1901, p. 404). Fecundated ♀s measure 7 × 5 to 10 × 6 mm. (Nn. 1896, p. 8); we have seen specimens from Merced, California, measuring 10·4 × 6·3 mm. Gorged females may however attain 11 × 8·5 mm.; Lounsbury (1903, p. 5) and Dönitz (1907, p. 27) have seen specimens from Cape Colony 12·5 and 12·7 mm. long[1].

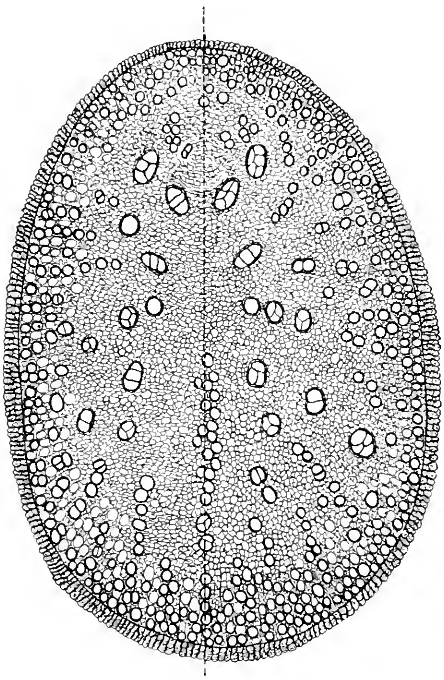


Fig. 3.

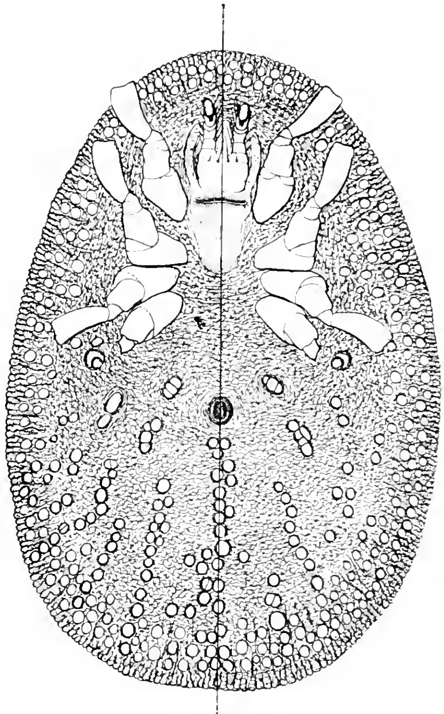


Fig. 4.

Figs. 3, 4. *A. persicus.* Female, dorsal and ventral aspect. Drawn from mounted specimen. Salmon and Stiles, 1901 (figs. 71 and 72, 17th Ann. Rep., B.A.I., U.S. Dep. Agr.)[2].

[1] There is a considerable discrepancy in the measurements given by different authors, due, no doubt, to the variation in size of *A. persicus* ♂ and ♀. Most authors do not distinguish the sexes.

[2] Lounsbury (1903, p. 5) notes that asymmetry is common, a fact we have also observed; these figures show such asymmetry.

The integument, in this and all other species of *Argas*, is of a uniform pale yellow colour, and the darker tints generally observable are entirely due to the ingested blood. Thus the partially fed living specimen appears of a leaden colour, with yellow margin, pale legs and capitulum. Further feeding increases the darkened area and deepens its hue to a blackish tint which may appear more or less red in preserved specimens. The radiating series of discs (seen in Figs. 3, 4, 22, 23) correspond to intervals between the digestive caeca, and serve for the attachment of muscles.

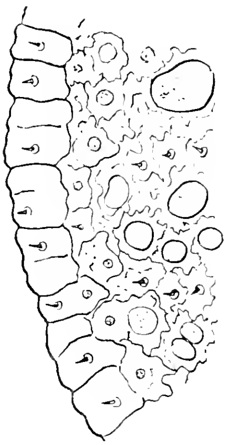


Fig. 5.

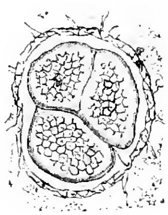


Fig. 6.

Fig. 7.

Fig. 5. *A. persicus*. Portion of integument from posterior dorsal border of female, × 44. Original N.

Fig. 6. *A. persicus*. A disc ("fossette") of medium size, × 110 (Nn. 1896, fig. 17: *A. sanchezi*).

Fig. 7. *A. persicus*. Detail of integument showing a disc and irregular smooth areas bearing hairs. From dorsum of adult, highly magnified. Original N. and W.

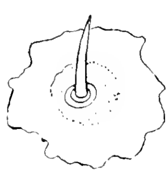


Fig. 8.

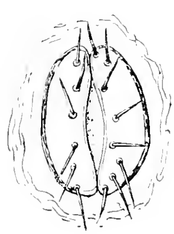


Fig. 9.

Fig. 8. *A. persicus*. Integumental hair, × 500. N.

Fig. 9. *A. persicus*. Anus, × 95 (Nn. 1896, fig. 8, of *A. americanus*).

Nymphs resemble ♂s, but have no sexual orifice. There are two nymphal stages (*a* and *b*) separated by a moulting. Nymphs (*a*, Figs. 21, 22) measure when full-fed, 4 to 4·5 mm. In second-stage nymphs (*b*, Fig. 23) the discs are more marked, though not as distinct as in adults; when full-fed they measure 5·5 to 6·7 mm.

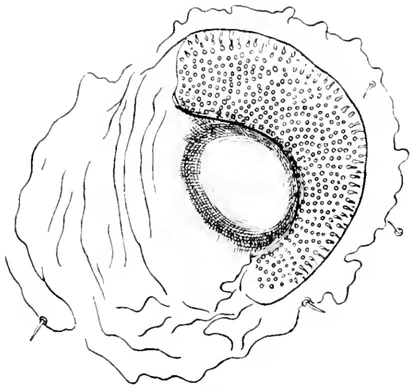


Fig. 10.

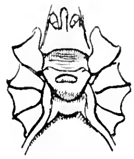


Fig. 11.

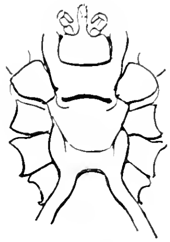


Fig. 12.

Fig. 10. *A. persicus* (Indian). Left spiracle of last stage nymph, oriented to the long axis of the tick's body (compare with Fig. 4 of ♀). The crescentic cribriform plate 170 μ long. Drawn from balsam specimen and opaque object with camera lucida. Original N.

Figs. 11, 12. *A. persicus* ♂ and ♀ genital orifices and coxae, etc. Specimens from India. Original N. and W.

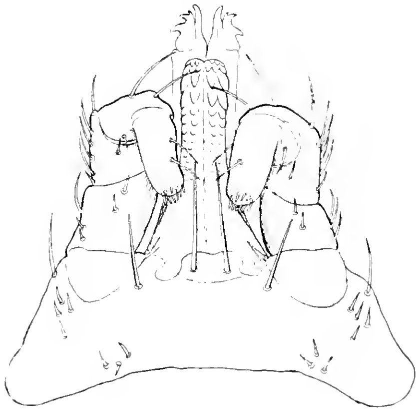
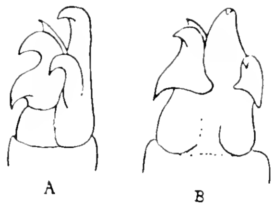


Fig. 13.

Fig. 14.

Fig. 13. *A. persicus* ♂ capitulum, ventral aspect, × 71. Indian specimen. Original N.

Fig. 14. *A. persicus* ♀ right palp in profile, external aspect, × 75. American specimen. Original N.



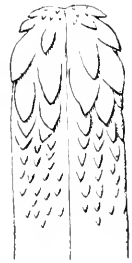


Fig. 15. Fig. 16. Fig. 17.

Fig. 15. *A. persicus*. Left digit *A*, dorsal and *B* external aspects, ×220 (Nn. 1896, fig. 4, modified).

Figs. 16, 17. *A. persicus*. Hypostomes, ×135 (Nn. 1896, fig. 17 of *A. sanchezi* and fig. 10 of *A. americanus* respectively).

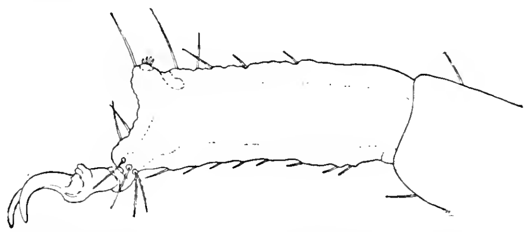
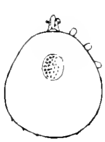
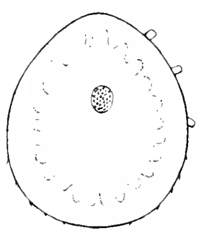
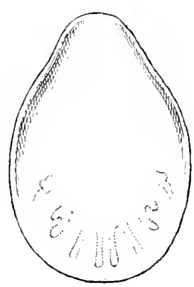


Fig. 18. *A. persicus*. Adult, tarsus I (*A. miniatus*). Salmon and Stiles, 1901 (fig. 74, 17th Ann. Rep., B.A.I., U.S. Dep. Agr.).







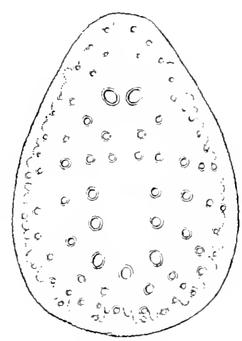


Fig. 19. Fig. 20. Fig. 21. Fig. 22.

Figs. 19—22. *A. persicus* showing successive stages of development. Drawn from living specimens, excepting Fig. 21. Specimens received from India and raised in Cambridge. Fig. 19. Unfed larva 3 weeks after hatching. 1 mm. *l*. Fig. 20. Gorged larva 11 weeks after feeding (in winter). 2 mm. *l*. Fig. 21. Unfed nymph (1st stage, dead). 2·5 mm. *l*. Showing upturned margin as seen in hungering specimens when alive, the intestinal caeca (dotted lines in Figs.) being practically empty. Fig. 22. Nymph (1st stage) one month after gorging (in winter), note appearance of discs omitted in previous figure. 3·3 mm. *l*. Original N.

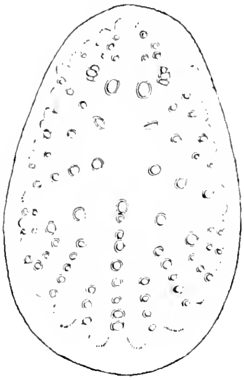


Fig. 23. *A. persicus.* Nymph (2nd stage) 8 months after feeding, the discs more numerous than in 1st stage nymph. Living specimen from India. 5 mm. *l.* Original, N.

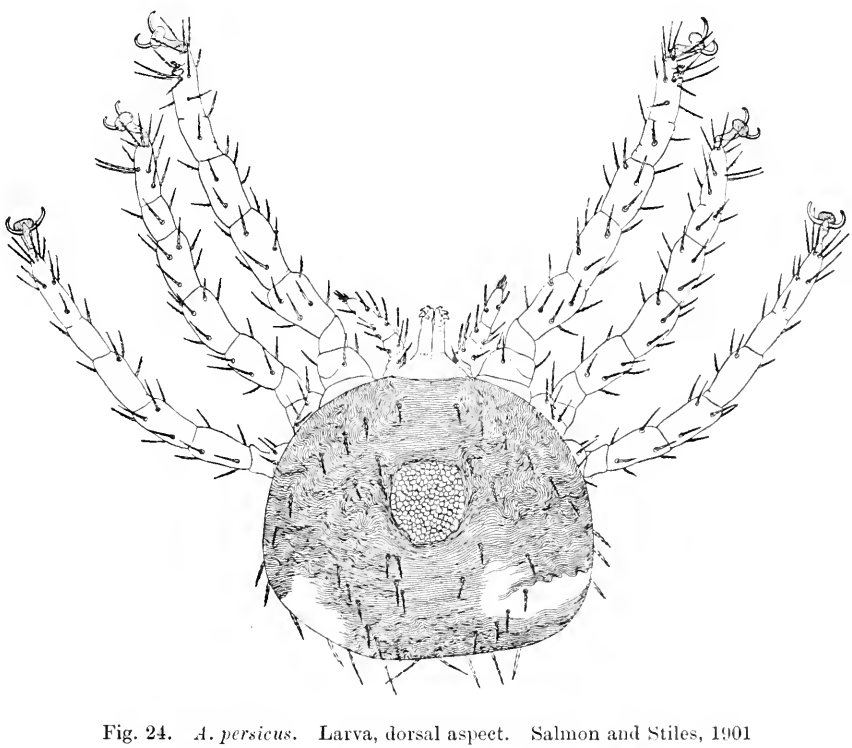


Fig. 24. *A. persicus.* Larva, dorsal aspect. Salmon and Stiles, 1901 (figs. 77, 78, 17th Ann. Rep., B.A.I., U.S. Dep. Agr.).

Larva: 680–770 μ in length (minus capitulum), hexapod and nearly spherical (Figs. 19, 20, 24, 25). The larva becomes flattened and longer as it matures, whilst unfed. The capitulum, though inserted ventrally, projects well in front of the body, which is much wrinkled dorsally and ventrally, but has no spiracles or discs. There is a circular or oval unwrinkled area or plate in the middle of the dorsum. There are numerous pennate hairs, the most prominent being a ventral row

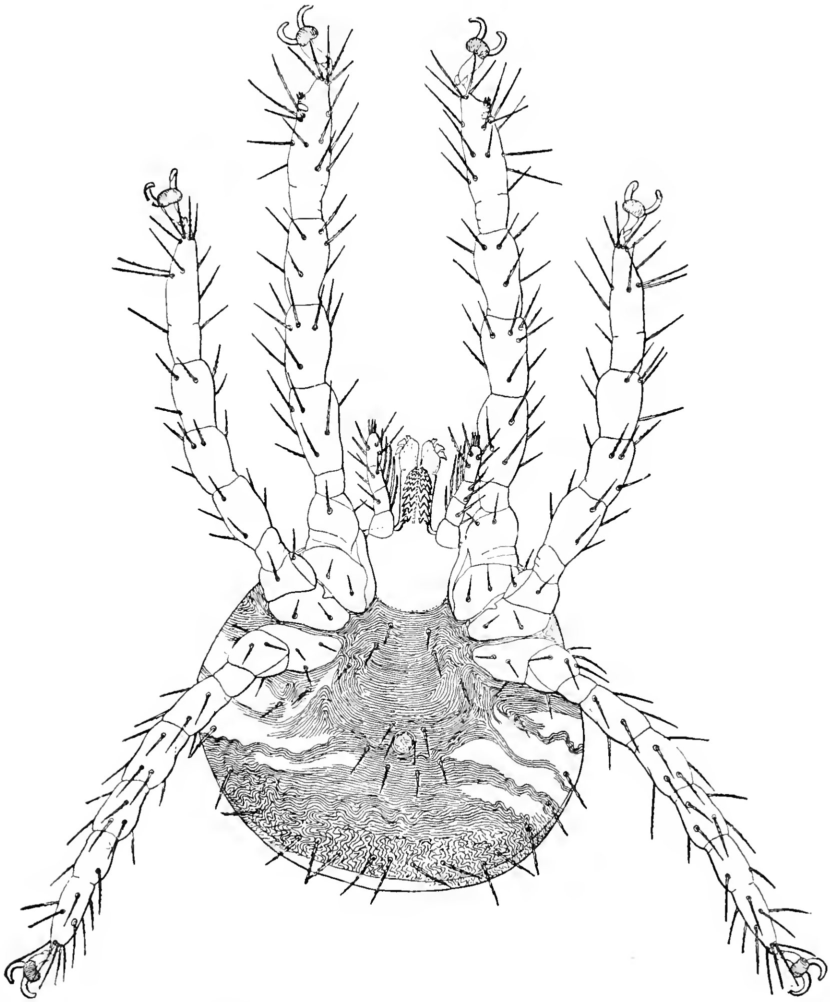


Fig. 25. *A. persicus.* Larva, ventral aspect. Salmon and Stiles, 1901 (figs. 77, 78, 17th Ann. Rep., B.A.I., U.S. Dep. Agr.).

near the posterior margin of the body (hypostome and palps see Figs. 24–26). *Legs* (Figs. 24–26) long; there is a distinct pad on the tarsi.

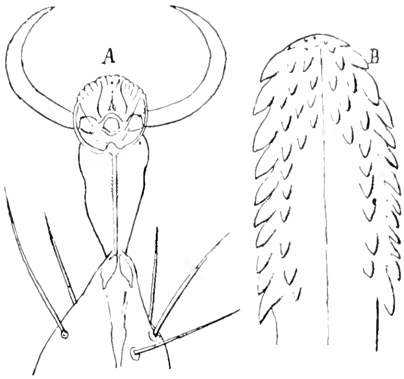


Fig. 26. *A. persicus*. *A*. Larval tarsus II (× 300); *B*. larval hypostome (× 270) (Nn. 1896, fig. 21, *A. sanchezi*).

Egg almost spherical, yellowish brown, ·6 to ·8 mm. in diameter, apparently without external structure.

Hosts: In all parts of the world *A. persicus* appears to be pre-eminently a *fowl* tick. It commonly attacks man in Persia, where, at an early date, it had acquired a most evil reputation. In South Africa, Lounsbury (1903, p. 11) states that it also seriously infests *ducks, geese* and *turkeys,* and that he has on several occasions found a few adults in pigeon-coops. But a few were attracted to feed on *pigeons* under experimental conditions. It has been reported from Graaff-Reinet as killing young *ostriches* and from Grahamstown as attacking *canary birds.* A gentleman at Graaff-Reinet suffered once from a severe bite. Neumann (1896) and Ward (1900 a) state that the tick has been found on *quail* and Packard (1895) on *turkeys* in California, and according to Salmon and Stiles (1901, p. 405), Packard found it once among *Boophilus annulatus* which had been collected from *cattle.* The larvae have been found on the *wild dove* (California) and on *Zenaidura macroura* L. (Mexico). Riley and Howard (1893, p. 267) state that the fowl tick attaches itself chiefly under the wing and shoulder of infested hens.

Geographical distribution.

A. persicus appears to be cosmopolitan, though its representatives in different countries have been allowed specific rank by different writers (see Synonymy, p. 8).

Europe: *Russia.* Neumann states that it was collected at Ssamjam by A. Spoof (Oudemans Coll.).

Asia: *Persia.* Oken (1818) and Dupré (1819) were the first to report the presence of this tick in Persia. Kotzebue (1819, p. 180) states that it has infested Miana from time immemorial, that it hibernates in the cracks in the walls to become aggressive in summer. He reports passing several villages which the natives told him had been abandoned owing to *A. persicus.* At Avanlung it was only necessary to break away a part of a house wall to discover hundreds of the ticks. The houses were built of clay mixed with straw. It was first described by Oken (1818) and by Fischer de Waldheim (1823, p. 269). Schlimmer (1874) reported it from Chahroudé and Bestham on the main road from Teheran to Khoragan. Churchill (1880, p. xx) states that the natives of Persia believe it lives on fowls in winter and that it occurs at Mazrah on the Resht-Teheran road, at Chesna Ali, near Asterabad, at Shahrud in Khorassan and at Kashan. According to Neumann it is distributed throughout N.E. and N.W. Persia. Tholozan collected specimens in chicken coops in different parts of Persia and sent them to Laboulbène (1881). The Paris Museum contains specimens from Miana, of which Neumann (1901, p. 253) gives particulars. The latter author also records and gives particulars of specimens from *Palestine*, *E. Turkestan*, and Pekin, *China* (all in Paris Mus.). Captain E. W. W. Greig, I.M.S., has sent us specimens from *India* (Kasauli, Punjab, 1906).

Africa: *Egypt.* Taschenberg (1874, p. 171) had specimens collected in houses in Egypt. Neumann (1901, p. 253) records *persicus* from Egypt (Klunzinger Coll.) and from Dongola, collected by Ehrenberg (Berlin Mus.). Nuttall has received numerous live specimens from Cairo collected in fowl houses by Prof. H. Bitter, and others from the *Soudan* collected similarly by Dr A. Balfour (Khartoum). A ♂ was collected at Fort National, *Algeria*, by P. Lesne (Nn., 1901, p. 253). Lounsbury (IX. 1903, p. 1) states it occurs in most if not all the towns of *Cape Colony*, also in the *Transvaal*, *Orange River Colony* and *Natal* (at Pietermaritzburg). In South Africa it appears to thrive as well on the coast as inland, being as abundant about Cape Town, Port Elizabeth and Uitenhage as at Grahamstown and Graaff-Reinet. Nuttall has received numerous live specimens from Mr Lounsbury and others have been examined (from the same source) by Neumann (1901, p. 253). Guérin-Méneville's (1829–43) specimens came from the Island of *Mauritius* (*A. mauritianus*) where they infested fowls.

America: It (*A. miniatus*) appears to be widely distributed, having been found in N. and S. America and in the West Indies. In the *United States* it has been frequently reported from *Texas*[1]: F. G. Schanph (according to Packard, 1895, p. 417) reported in November, 1884, that it caused a large mortality in chickens in Dunant County. It is also reported by Marx, 1892 a, Riley and Howard, 1893, p. 267, Hoehr, 1893, p. 348, Osborn, 1896, p. 256, as destroying fowls in Kinney Co. and San Diego. Hassall, 1900, p. 499, believed that it was extending northward in Texas. Banks (1901, p. 590 and 1902 a, p. 568) reports "*A. sanchezi*" from Catalina Springs, *Arizona* (April), and from *New Mexico* (July). Several authors report the ticks from *California* where they infested a fowl house at Lakeside (Marx, 1892 a, Banks, 1904, p. 331). Packard, 1895, received specimens from Merced[1] where they attacked chickens and turkeys, and they have been found on the quail at Mariposa according to Neumann (1896, p. 18). They injure fowls in *Florida* according to Salmon and Stiles, 1901, p. 405. The tick occurs in *Mexico* (*A. sanchezi*) at Guanajuato and in Southern California. Numerous specimens have reached us from *Brazil* from Dr A. Lutz (São Paulo) and through the courtesy of Drs Marchoux and Borrel, of the Pasteur Institute, the ticks being infected with Spirochaetes causing disease in fowls. "*A. chinche*" also occurs in temperate parts of *Colombia* where it attacks man, and Koch's type of "*miniatus*" came from Demerara (*Brit. Guiana*). In the *West Indies* the fowl tick has been found at Trinidad where Hart[2] (1899, p. 180) supposes they were imported from the United States, and Goodwin (Nn., 1901, p. 235) also reports it as infesting chickens at Antigua.

Australia: Lounsbury (IX. 1903, p. 1) says the fowl tick occurs in all five of the Australian Colonies, and no doubt he is correct for *W. Australia* and *Queensland*. We find it recorded for the other colonies as follows: *Victoria:* specimens found on fowls at Melbourne by Desmond (Nn., 1901, p. 253; see also Brown, 1902). *New South*

[1] We have examined specimens collected in fowl houses in Texas in 1907 (sent by W. D. Hunter), and others off fowls in Merced, collected by Ehrhorn in 1891. Banks (1908, p. 15) has seen specimens from Austin, Georgetown, El Paso, Patton, San Antonio, Brackettville, and Colorado City, Texas; also from Riverside, California.

[2] Nuttall has received specimens in all stages collected by Mr Hart from Mr H. A. Ballon (Barbados).

Wales: specimens in the collection of the Department of Mines and Agriculture were examined by Neumann (1901, p. 255; see also Fuller, 1896, 1897, p. 590). *S. Australia:* Michael (1892, p. 202) received live specimens from Adelaide, and Nuttall (1906) received live specimens from the same place, sent by Dr E. A. Johnson. In all places it infests fowls. According to Froggatt (1906, p. 14) it was introduced from America into N. S. Wales and has since spread over all the south-western towns.

Habitats: When *A. persicus* abandons its host, be it bird or man, it retreats into the crevices in the walls of the chicken house or dwelling to digest its food, undergo its metamorphosis or to oviposit, etc. Schanph (published by Packard, 1895, p. 418) in Texas found them retreating into the cracks and under the bark of trees upon which chickens roosted.

N.B. For *Seasonal Prevalence, General Biology, Effects of bite and part played in Pathology*, see Section II.

ARGAS REFLEXUS (Fabricius) Latreille, 1796.

Figs. 27—33, Pl. I, Figs. 1, 2.

Synonymy: *Acarus reflexus* FABRICIUS, 1794, p. 426; 1805, p. 353.
Acarus marginatus FABRICIUS, 1794, p. 427; 1805, p. 354.
Ixodes reflexus Fabricius in LATREILLE, 1829 b, p. 288.
Argas reflexus (Fabricius) LATREILLE, 1796, p. 178; 1829 b, p. 288.
Rhynchoprion columbae HERMANN, 1804, p. 69, No. 1; also FABRICIUS, 1805, p. 356.
Argas magnus NEUMANN, 1896, p. 14, degraded to *A. reflexus* var. *magnus* NEUMANN, 1905, p. 239.
Argus reflexus in FULLAGER, 1874 a, p. 86.
Common name: Pigeon tick, Taubenzecke (Ger.); Schellack (1908, p. 487) states that the *larva* is known as the "Lederwanze" by pigeon fanciers in Germany.

Iconography: LATREILLE, 1796, Pl. VI, Fig. 3.—HERMANN, 1804, Pl. IV (coloured), Figs. 10, 11, *N* and *O*, dorsal and ventral aspects, capitulum and tarsus (very crude figures).—DUGÈS, ANT., and MILNE EDWARDS, Pl. 27, Fig. 2 (poor).—GERSTAECKER, 1860, Pl. XV, Figs. 1–6.—PAGENSTECHER, 1861, Pl. I.—BIANCONI, 1867, figured the larva and its capitulum (part seen dorsally) and the capitulum of the "adult" in ventral aspect. Figures sketchy.—FULLAGER, J., 1874 a, p. 122, Fig. 86; inaccurate figure of tarsi corrected in author's paper of later date 1874 b, p. 234, Fig. 164. He also gives other figures.—MÉGNIN, 1880, Fig. 45, same as following: 1892, p. 64, Figs. 5–7, ♀ dorsal and ventral aspects, capitulum (very poor figures).—TASCHENBERG, 1880, p. 152, Fig. 39, small sketch, side view (poor figure, reproduced by v. Linstow (?)).—CLAUS, 1887, Fig. 444, sexual organs, after Pagenstecher, 1861.—BERLESE, 1888, fasc. XLVII, No. 5.

♂ dorsum (coloured), venter, detail of dorsal and marginal integument.—CANESTRINI, 1890, Pl. XLI, Fig. 2, digit and hypostome (very inaccurate).—RAILLIET, 1895, Figs. 487, 488, capitulum (inaccurate); gorged ♀ dorsum and venter (sketchy).—DUBREUILH and BEILLE, 1896, Fig. 6 (sketchy).—NEUMANN, 1896, Figs. 1–3, of digit, hair; tarsus 1 in two positions, tarsus 4, Haller's organ. Figs. 14, 15 (*A. magnus*), digit, hypostome; here reproduced.—TASCHENBERG, 1900, p. 739, dorsum and venter of adult (?) (inaccurate).—WHELER, E. G., 1906, Figs. 6, 7, ♂ dorsum, ♀ venter, both good photographs; here reproduced.

Literature: **1794**. FABRICIUS, pp. 426, 427. *Ac. reflexus*, *Ac. marginatus*, *Rhync. columbae* (few words).—**1804**. HERMANN, p. 69.—**1805**. FABRICIUS, pp. 353, 354, 356 (Latin). Same as 1784.—(No date) DUGÈS, ANT., and MILNE EDWARDS (no date).—**1837**. WALCKENAER, III, p. 231. O[1].—**1839**. RASPAIL, p. 9.—**1844**. KOCH, C. L., p. 219, only mentioned.—**1859**. GERVAIS and VAN BENEDEN, I, p. 459. O.—**1860**. GERSTAECKER, pp. 457–470; effects of bite.—MOQUIN-TANDON, p. 281.—BOSCHULTE, p. 554.—**1862**. PAGENSTECHER, p. 142.—**1863**. GERSTAECKER, p. 344; brief mention only.—COQUEBERT, Pl. 27, Fig. 10 (cited thus by Bianconi, 1867).—BOCQUILLONS (before 1867), p. 113 (cited thus by Bianconi, 1867). O.—**1867**. BIANCONI, C. A., pp. 107–112; the first to describe larva.—**1871**. GULLIVER & GULLIVER.—**1872**. GULLIVER, p. 205.—**1874**. FULLAGER, J., (*a*) p. 121; (*b*) p. 234.—"R. E.," p. 161; brief mention.—SPICER, (*a*) p. 185. O. (*b*) p. 209. O.—TASCHENBERG, p. 171 *et seq.* (mostly citations from other authors).—**1877**. CANESTRINI, G., and FANZAGO, p. 125.—**1879**. BOSCHULTE, p. 562.—**1880**. MÉGNIN, p. 135; repeated verbatim in Laboulbène and Mégnin, 1882, p. 322.—RIVOLTA and DELPRATO, p. 314.—**1882**. LABOULBÈNE and MÉGNIN, pp. 332, 340.—CHATELIN (see *re* effects of bite).—CONTARINI, pp. 16, 161 (cited by Berlese, 1888).—ZÜRN, p. 78.—**1885**. JOHANNESSEN, p. 347.—**1888**. BERLESE, fasc. XLVII, No. 5. Short Latin description.—**1890**. BLANCHARD, II. p. 883 *et seq.*—CANESTRINI, p. 532, cites Bianconi's description of larva. He describes ♂ and ♀.—**1892**. ALT, p. 531.—BRANDES, d. p. 10.—MÉGNIN, p. 64; brief mention.—**1893**. TERRENZI, pp. 73, 79; reports *reflexus* attacking persons at Narni.—**1894**. v. LINSTOW, p. 121, cites Brehm, p. 688 (see below). O.—**1895**. BRAUN, p. 258. O.—PLANCHON, p. 29 (inaccessible).—**1896**. DUBREUILH and BEILLE, p. 76. O.—NEUMANN, p. 4.—MONIEZ, pp. 499–509.—GIBERT (*thesis*).—**1897**. BRANDES, p. 747.—**1898**. AJUTOLO, p. 222; attacking persons in Bologna.—MINGAZZINI, pp. 245–249.—**1899**. WHELER, p. 12.—**1900**. BREHM (see Taschenberg).—TASCHENBERG, p. 739 (in Brehm's *Tierleben*).—WARD, H. B., (*a*). O.—**1901**. NEUMANN, p. 253.—PERRONCITO, p. 568.—**1904**. MOSLER and PEIPER, p. 345. O.—**1906**. TONNEL, p. 552.—BRAUN, p. 369. O.—**1907**. DÖNITZ, p. 26.—**1908**. SCHNEE, p. 32.—SCHELLACK, p. 486; transmission of spirochaetosis.—BANKS, p. 16.

Adult: (Figs. 27, 28, Pl. I, Figs. 1, 2). *Body* oval, widest toward the posterior end. Margin *irregular wrinkled into radial striae* forming a border 200 μ wide, which is slightly turned up especially in unfed specimens (whence *reflexus*) and is stated to always remain yellow

[1] Papers marked O contain no original matter.

(*marginatus*); discs arranged much as in *A. persicus* but the integument much more finely wrinkled. *Ventral surface:* anus nearly central, with smooth anal ring. Spiracles crescentic, elongated transversely, *equal in length to the width of the anal ring*; genital opening as in *A. persicus*. *Capitulum:* base with two long post-hypostomal hairs ventrally, directed forwards. Palps with articles sub-equal, the third the shortest, denticulated hairs (Fig. 29) dorsally. Chelicerae: digit, see Figs. 30, 31. Hypostome (Fig. 32) rounded terminally, some small denticles at the tip, followed by 2 | 2 stout teeth merging into 3 | 3 to 6 | 6 progressively

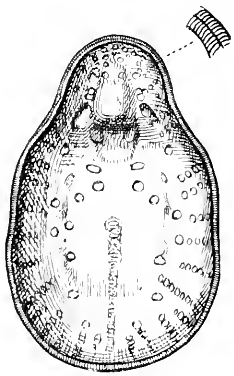


Fig. 27.

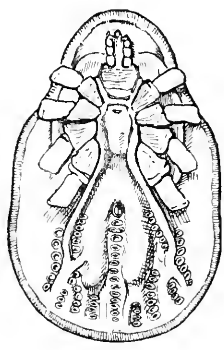


Fig. 28.

Figs. 27, 28. *Argas reflexus*, ♂ × 10 dorsum (with detail of margin) and venter. From specimen lent by Prof. Neumann. Original, N. and W.

Fig. 29.

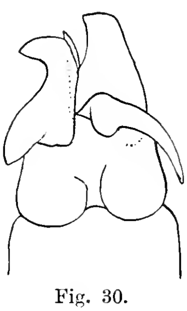


Fig. 30.

Fig. 31.

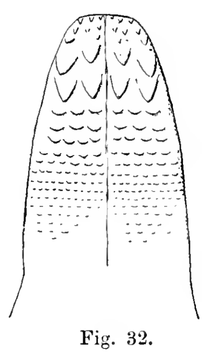


Fig. 32.

Fig. 29. *A. reflexus*. Palpal hair, × 250 (Nn. 1896, fig. 2).
Fig. 30. *A. reflexus* var. *magnus*. Left digit, × 225 (Nn. 1896, fig. 14, modified).
Fig. 31. *A. reflexus*. Left digit, dorsal aspect, × 220 (Nn. 1896, fig. 1, modified).
Fig. 32. *A. reflexus* var. *magnus*. Hypostome, × 100 (Nn. 1896, fig. 15).

smaller teeth. *Legs* as in *A. persicus*, except that the coxae are contiguous and the tarsi (Fig. 33) have a more distinct dorsal prominence.

The sexes are distinguished by the same characters as in *A. persicus*. The male (Figs. 27, 28) may attain 4 × 3 mm. ♂ pore between coxae II, ♀ as in *A. persicus* (Mégnin, 1880, p. 136; also Canestrini, 1890, p. 532). The newly emerged female is about 5 × 3 mm., but when gorged attains 8 × 4 mm. or even 9 × 5 mm.

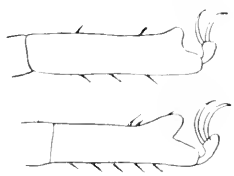


Fig. 33. *A. reflexus*. Tarsi I and IV of large nymph. Sketch. W.

Nymphs measure 4 × 2 mm. (1st stage) or 5·5 × 4·2 to 7·3 × 4·8 (2nd stage), they resemble the male, but the larger ones are without a true sexual aperture.

Larvae almost spherical, *L.* 0·5 mm., at most 2 mm. (Mégnin, 1880) with terminal or subterminal capitulum. Hypostome with dentition 2 | 2. Colour testaceous.

Eggs ovoid, reddish, ·5 mm. *l.*

The foregoing description is taken in part from Mégnin, 1880, Laboulbène and Mégnin, 1882, and Neumann, 1896, pp. 4, 5 (condensed); the measurements of the nymphs were made on specimens received by us from Germany in 1908.

ARGAS REFLEXUS var. MAGNUS Nn. 1905.

Figs. 30, 32 (see Synonymy above).

This variety only differs from the type in its large size, its relative narrowness, and the fact that the posterior border of the body is more lanceolate. The details of the digit appear also to differ (compare Figs. 30 and 31). Origin: Equador and E. Patagonia (Gulf of St George).

A. REFLEXUS.

Hosts: *Pigeons*, the larvae have been found once on the *horse* (Starcovici), and the nymphs and adults may attack *fowls* and *man* occasionally.

The Geographical Distribution of this species appears to be limited to Europe and N. Africa. Osborn (cited by Ward, 1900) has stated that it occurs in the United States as far north as St Louis but there is no certainty that the determination was correct.

England: *A. reflexus* was found at Canterbury Cathedral by Gulliver (1872, p. 205) who states that its presence had "long been known in the dark recesses of our time-honoured fane" and that it was regarded there as an "insect peculiar to Canterbury Cathedral." The ticks were found "rather plentifully crawling about the inside of the base of the Cathedral" (see also Fullager, 1874 a and b; "R. E.," 1874; Spicer, 1874, Taschenberg, 1874, Wheler, 1899, p. 12). Two specimens were secured alive in the Cathedral by W. F. Cooper in March, 1908. We find no other records of its presence in Great Britain although Dönitz (1907, p. 26) states that it used to prevail in Ireland (authority not stated).

France: the pigeon tick, according to Neumann, occurs especially in the Ardennes. Latreille (cited by Mégnin, 1880, p. 136) once found it in a house, but judging from the statements both of Latreille and Hermann it has grown much rarer in France. Laboulbène and Mégnin (1882, p. 323) sought in vain for years to procure specimens from pigeon fanciers, and Neumann could only lend us a single ♂ specimen for purposes of study.

Germany: Pagenstecher (1862) records its presence in large numbers in the loft of a house at Frankfort where it greatly disturbed the sleep of the servants at night. Gerstaecker (1863, p. 344) notes its having been recently found to attack man in Germany, and states it occurs more commonly in Southern Europe. Taschenberg (1880, p. 152) states it has long been known in Alsace and in the Province of Saxony at Eisleben (Taschenberg, 1873; 1900, p. 740) having been recorded there and in Westphalia and at Friedeberg a. d. Saale before 1871. Dönitz (1907, p. 26) writes that it is difficult to obtain. Schnee (1908, p. 32) records that about 1896 an old church was torn down at Magdeburg and that persons visiting the church at the time were much attacked. As is usual in such cases, pigeons had been kept there and the ticks wandered into the church. Mertens in 1907 sent specimens to Hamburg from Magdeburg and some of these were kindly placed at our disposal by Dr Fülleborn (Institute of Tropical Medicine, Hamburg). Schellack (1908, p. 487) found it in two pigeon coops in Magdeburg.

Italy: Bianconi (1867) reports it from Modena. Canestrini (1890) states it was found in 1876 in the interstices of the mosaic in the church of San Marco, Venice. Berlese (1888) states that it is found about Venice and Florence. Laboulbène and Mégnin (1882) obtained specimens from Pisa, and according to Perroncito (1873 and 1901) it prevailed to such a degree at Turin as to make it impossible to raise young pigeons. Birds 1 to 2 weeks old were attacked and died of exhaustion. Terrenzi (1893) reports it as attacking persons at Narni and as present at Tivoli, and Ajutolo (1898) as attacking persons at Bologna. At Narni, according to Terrenzi, they wandered out of a pigeon coop which had been disused for years and gained entrance to an adjoining house where they inflicted troublesome bites upon the inhabitants at night.

Russia and Roumania: R. Blanchard records it from Odessa and the larvae have been found on the horse in Roumania by Starcovici (cited by Neumann, 1896, p. 5).

Africa: according to Neumann (1901, p. 253) Simon found a large specimen at Tlemen, Algeria.

It is obvious from the foregoing that this species is not common. One of us (N.) tried in vain for years to obtain specimens from England, France, Italy, and Germany but it was only recently that some were received from Magdeburg. Owing to the growing interest in relation to ticks as disease-carriers it is however quite possible that a more careful search in the future will lead to *A. reflexus* being found to be more prevalent in Europe than has hitherto been supposed.

Habitat: *A. reflexus* lives chiefly in pigeon-coops where it hides in cracks in the walls and woodwork, the adults and nymphs attacking the birds at night.

N.B. For *General Biology, Effects of bite and part played in Pathology*, see Section II.

ARGAS HERMANNI Audouin, 1827.

Figs. 34, 35.

Literature, etc.: Savigny, 1826, Pl. IX, Fig. 7 (resembles *A. reflexus*).—Audouin, 1827.—Neumann, 1896, p. 13, Figs. 12, 13, here produced; 1901, p. 253.

Adults: *Body* oval, almost always markedly convex. Integument of uniform appearance, very finely wrinkled. Numerous small discs arranged as in *A. reflexus*. Margin finely striate, 75—80 μ wide. *Venter:* spiracles about two-thirds (150 μ) the width of the anal ring. Anal aperture bordered by a few short hairs. *Capitulum* relatively small (275–300 μ *l.*); digit (see Fig. 34); hypostome (Fig. 35) tapering and slightly rounded at the tip; two long post-hypostomal hairs on the basis capituli. Females attain 8 × 5 mm., and the males are only slightly smaller.

Fig. 34.

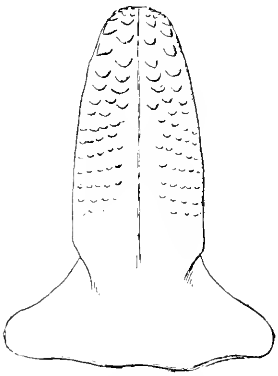


Fig. 35.

Argas hermanni.

Fig. 34. Left digit, ×225 (after Nn. 1896, fig. 12, modified).
Fig. 35. Hypostome, ×135 (Nn. 1896, fig. 13).

Nymphs show great variation in size, ranging from 1·5 × 1 mm. up to the size of the male.

Neumann identified a tick collected by Raffray (E. Simon's Coll.) in N. Abyssinia as belonging to this species on collating it with the numerous specimens, of unknown origin, in the Paris Museum. Subsequently, three specimens were brought from Egypt by Klunzinger (Neumann, 1901, p. 253). Neumann separates this species from *reflexus* chiefly on account of "the fineness of the texture of its integument, and the minute size and details of its capitulum." We regard it as a doubtful species.

ARGAS CUCUMERINUS Neumann, 1901.

Lit.: Neumann, 1901, p. 254.

Male: *Body* flat, long oval, 10 × 5 mm., almost as broad in front as behind. Integument rather finely wrinkled. Margin striate, rather narrow. *Venter:* anus almost circular, central, well behind the spiracles, which are less than the anal width. *Capitulum* small and anterior; hypostome 2 | 2. *Legs* long; coxa I slightly separated from coxa II;

the space between the coxae of the two sides equal to $\frac{1}{4}$ the body-width. Tarsi with a thick dorsal protuberance distally.

Description based on two specimens found beneath rocks in dry places at Lima, Peru, by Gaudichaud (Paris Museum).

This species is doubtfully distinct from *A. reflexus.* Neumann thought it might be the male of *A. magnus*, which he has since fused with *A. reflexus* (see p. 22).

ARGAS TRANSGARIEPINUS White, 1846.

Figs. 36 and 37.

Lit., Icon. and Syn.: *Argas transgariepinus* White, 1846, p. 363, Pl. II, Fig. 4, dorsal and ventral aspects (Figs. and description useless).
Argas kochi Neumann, 1901, p. 254.

Resembling *A. reflexus*, but differing from it as follows:

Adults: *Body* short oval, and almost as broad in front as behind. Margin striate like that of *reflexus*, but relatively broad (3 mm.). Spiracles scarcely as long as the width of the anus. Sexual orifice of the male very small, facing the posterior extremity of coxa I. Capitulum very small (·8 mm.) and very posterior, far from coxae I, lying in a clearly marked camerostome. Hypostome narrow, palps short. Coxa I far from coxa II, and the space between the coxae on the two sides very broad—equal to one-third the width of the venter. Tarsi I much humped distally, the protuberances on the other tarsi slight.

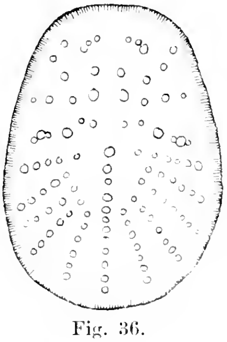


Fig. 36.

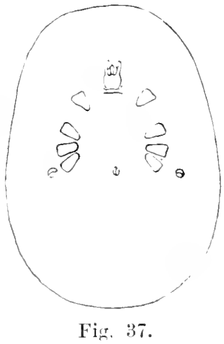


Fig. 37.

Figs. 36, 37. *Argas transgariepinus* ♀, × 4. Dorsum and venter. Sketch from type specimen in Brit. Mus. Original, N.

N.B. These points are taken from Neumann's description of *A. kochi*, based on a single ♂ from Basutoland, collected by Cristol (Paris Museum). White's description is insufficient, but Neumann found the types (2 females) in the British Museum and they agreed with *A. kochi*, except in the genital orifice (a sexual character) and the fact that the tarsal protuberance was almost as well marked on tarsi 2, 3 and 4 as on tarsus I. If the examination of other specimens of *A. transgariepinus* should show similar tarsi in both sexes, Neumann's species would become *A. transgariepinus* var. *kochi*. (There are 3 females (dry specimens) in the British Museum collection. The accompanying figure was drawn from one of these measuring 10 × 7 mm., a smaller specimen measured 8·5 × 6 mm.)

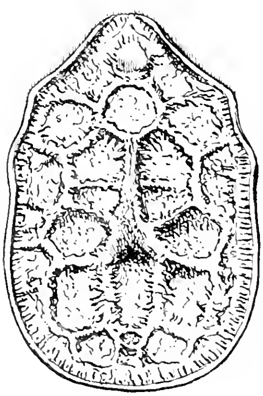


Fig. 38.

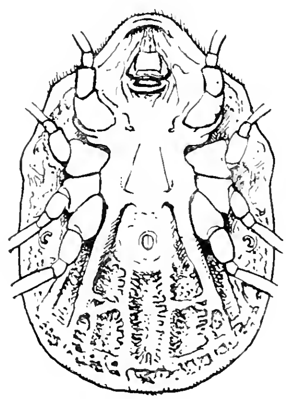


Fig. 39.

Figs. 38, 39. *Argas brumpti* ♀, ×3. Dorsum and venter. Original, N. and W.

ARGAS BRUMPTI Neumann, 1907.

Figs. 38 to 47.

Lit. and Icon.: NEUMANN, 1907, pp. 224–229, Figs. 9–14, here reproduced.

Adults and Nymphs: *Body* flat, only a few nymphs and males showing the dorsum convex through repletion. The adult ♀ (Figs. 38–41) attains 20 × 13 mm., average size 15 × 10 mm., nymph or young ♂ measure 7 × 5 mm. Sides of the body parallel, its anterior border conical, recalling *Ornithodoros*; posterior border broadly rounded; margin (Fig. 47) finely striate. *Dorsum* pitted by symmetrically arranged polygonal depressed areas, bounded by rugose ridges, and containing small discs, as shown in Figs. 40, 46. Numerous short hairs, especially along anterior border. *Venter:* the anterior conical portion is hollowed out into a deep triangular camerostome bounded by lips divergent behind, and connected behind the capitulum by a transverse fold, immediately behind which is the vulva in the ♀, the ♂ genital orifice

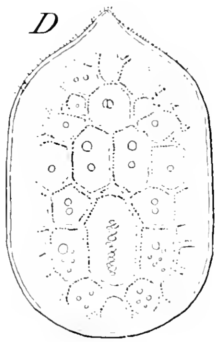


Fig. 40.

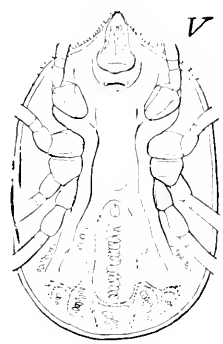


Fig. 41.

Argas brumpti ♀.

Figs. 40, 41. Dorsal and ventral aspects. Nn. 1907, fig. 9.

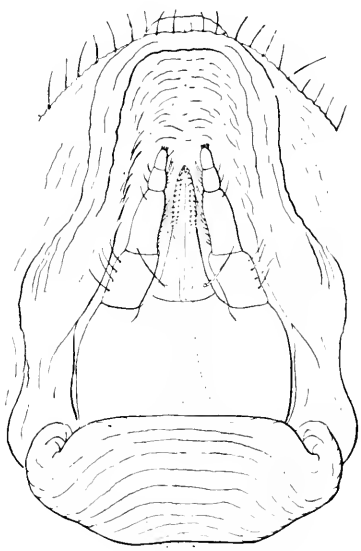


Fig. 42.

Fig. 43.

Argas brumpti ♀.

Fig. 42. Capitulum and anterior part of venter, ×28. Nn. 1907, fig. 12.
Fig. 43. Capitulum in profile, ×28. Nn. 1907, fig. 12.

being somewhat more posterior. Spiracles crescentic, less than the width of the anal ring, which is oval. Hairs rather more abundant than on the dorsum. *Capitulum* (Figs. 42, 43): with very thick base; palps tapering, the first two articles (especially art. 2) long, the 3rd and 4th short; four strong hairs on the outer surface of 1st article. Chelicerae: see digit, Fig. 44; hypostome (Fig. 42) long, narrow, lanceolate, bearing two long hairs at its base; dentition 2 | 2, 14—15 teeth per file, the inner teeth widely separated. *Legs* yellowish, relatively

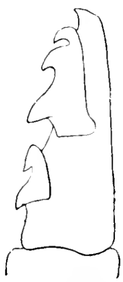


Fig. 44.

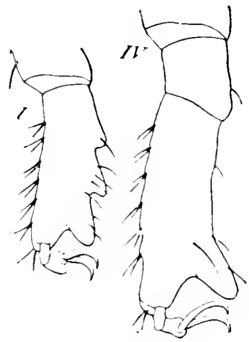


Fig. 45.

Fig. 44. Digit, ×210. Nn. 1907, fig. 13.
Fig. 45. Tarsi I and IV, ×14. Nn. 1907, fig. 14.

Fig. 46.

Fig. 47.

Argas brumpti.

Fig. 46. Detail of dorsal integument, ×11.
Fig. 47. Marginal integument, ×25.

(Neumann, 1907, figs. 11 and 10.)

short and strong; coxa I (Figs. 39, 41) separated from coxa II by an interval equal to their breadth; coxae II, III and IV contiguous; all coxae have their anterior and posterior borders covered by striated integument; tarsi (Fig. 45) with a spiniform protuberance which gives them a bifid appearance.

Origin: Description (condensed from Neumann) based on 35 specimens collected by Dr Brumpt at Ogaden, Somaliland.

Note: Dr Brumpt having kindly sent us a specimen of *A. brumpti* ♀ (Dakhatto Valley, Somaliland), we have been able to compare it with Neumann's description. We have figured our specimen (Figs. 38, 39).

Effects of Bite, etc. See Section II.

ARGAS AEQUALIS (Nn.) Neumann, 1908.

Syn. and Lit.: *Ornithodorus aequalis* Neumann, 1901, p. 259.
Argas aequalis (Nn.) Neumann, 1908, p. 26.

Nymph: *Body* flat, 5 × 2·5 mm., with lateral borders parallel, rounded posteriorly, tapering anteriorly to a short rounded point; colour reddish, capitulum and legs yellowish white. Integument folded, with very fine granulations, covered with whitish hairs, excepting on the venter between coxae. A distinct striated margin visible dorsally and ventrally; a dorsal protuberance corresponding to the capitulum; symmetrical depressions occupied by discs. *Venter* very prominent centrally. Sexual orifice punctiform, between coxae I. No eyes. *Capitulum* twice as long (1 mm., including base) as broad, the base twice as broad as long, resting on a broad transverse fold equal to twice its breadth; hypostome long, narrow, pointed, lanceolate, with numerous teeth anteriorly, followed by dentition 2 | 2, not extending to the middle of its length. *Legs* fairly long; coxa I stout, thick, somewhat separated from coxa II; tarsi without protuberance.

The description (modified from Neumann) is based on a specimen (late-stage nymph) collected at Utengala, German East Africa, by Fülleborn (Berlin Mus.). This species is unfortunately not figured. (See p. 3, footnote 1.)

ARGAS VESPERTILIONIS (Latreille), 1796.

Figs. 48–57, Pl. I, Figs. 4 and 5.

Synonymy and Literature: *Carios vespertilionis* LATREILLE, 1796, p. 176, larvae.
Caris vespertilionis LATREILLE, 1804, p. 161, larvae. Generic name changed for no apparent reason. Latreille, 1829 b, p. 290, notes the "peau écailleuse" as a generic character, see also Latreille, 1835, p. 511.
Acarus fischeri in Savigny, 1826 (see Iconography).
Argas fischeri AUDOUIN, 1827, p. 427, probably mature nymph.
Argas pipistrellae AUDOUIN, 1832, p. 412, larvae.
Argus pipistrellae in Ant. Dugès and Milne Edwards (no date).
Caris vespertilionis GERVAIS, 1844, p. 227, larvae.
Caris elliptica KOLENATI, 1857, p. 16, probably nymphs.
Caris longimana KOLENATI, 1857, p. 16, probably nymphs.
Caris decussata KOLENATI, 1857, p. 16, probably nymphs.
Caris inermis KOLENATI, 1857, p. 16, probably nymphs.
Argas fischeri GEORGE, 1876, pp. 223–225, in Westwood, 1877, p. lxii, referring to George's paper. Probably nymphs[1].
Argas pulchella GEORGE, 1876, p. 224. The author proposed this name tentatively as he thought the "Blyborough tick" might be *A. fischeri*. He described the mechanism of the foot and notes the spiracles between legs III and IV.
Argas pipistrellae WESTWOOD, 1877, p. lxii.
Argas vespertilionis (Latreille) NEUMANN, 1896, pp. 20–23; 1901, p. 254.
Caris vespertilionis LATREILLE, revived by Pocock, 1907, p. 189.

Iconography[2]: SAVIGNY, 1826, Pl. IX, Fig. 6 (1, 1′, 2, 2′) much better figures than most of those published since; large nymphs or possibly adults.—AUDOUIN, 1832, Pl. XIV, Fig. 1.—ANT. DUGÈS and MILNE EDWARDS, Pl. XXVII, Fig. 3 (larva, poor).—GERVAIS, 1844, Pl. XXXIV, Fig. 8, larva.—GEORGE, 1876, Pls. XXI, XXII, figures of nymph: venter, part of capitulum, tarsus, dorsum, intestinal caeca*.—NEUMANN, 1896, Figs. 22–26*: nymph, ventral surface and detail thereof; capitulum; hypostome, digit; larval hypostome, digit, dorsal plate, anus.—WHELER, 1899, p. 12, Fig. 4, described as nymph; reprinted 1906, Fig. 8*, described as adult after balsam specimen of the "Blyborough tick" (see George); also (1906) figures part of capitulum and marginal integument.

[1] Westwood (1877, p. lxii), who is quoted in Neumann's synonymy (1901, p. 254), refers incidentally to George's papers (1876, 1877) in his Presidential Address, stating with regard to the name given by George: "It is given as *Argas fischerii* of Walcken., but it seems to me identical with *A. pipistrellae*, Aud."

[2] Figures marked * are reproduced herein.

There is no extant description of the adult of this species. Wheler (1899, p. 12) described a specimen at the British Museum which he believed to be adult, but we have examined it and find it to be a nymph, probably in the second stage. Lounsbury has kindly lent us a mature ♀ of the form, recognised by Neumann as at least only a variety of *A. vespertilionis*, which infests penguins at Queenstown, Cape Colony. The following description refers to this specimen:

Female: *L.* (hood not included) 7·4, *W.* 8·8 mm., broad oval, much depressed, irregularly convex in the middle of the dorsum, red-brown with narrow reflexed margin of reddish-yellow colour, the integument entirely covered with very fine, conical, sharp granulations, except on the discs, which are arranged as shown in the figure (Fig. 48). The

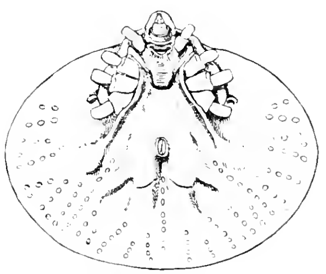


Fig. 48. *Argas vespertilionis* ♀, *L.* 7·4 mm. Venter (see text). Original, N. and W.

anterior margin projects in the form of a triangle on a level with the dorsum, and from beneath this projection a rounded, yellow convex hood proceeds forward and downward, visible dorsally, and concealing the capitulum. *Venter:* anus at about the middle of the body; supra-coxal fold well-marked, short, extending from the sides of the hood to the posterior ends of coxae IV. Coxal folds well-marked, narrow; very numerous, small, radially arranged discs. Vulva: a very broad slit between the posterior ends of coxae I, much wider than the basis capituli and reaching the coxae on either side. Behind the anus, at a distance of about three times its diameter, there is a remarkable paired organ (see Fig. 49) consisting of two narrow, deep, crescentic clefts, on each side of the middle line; each cleft lies in an area of modified integument, free from mammillae; behind the cleft the area is finely punctate, while in front, on its concave border, it is finely striate at right angles to the direction of the cleft. (This structure is also observable in the nymphs.) *Capitulum* very salient ventrally, with very long base and extremely small appendages; hypostome narrow, indented at the tip, with small inconspicuous teeth, apparently all marginal. Palps: article 1 comparatively large and massive, the other articles very small and narrow. *Legs:* coxae sub-conical, coxa I separated from coxa II; coxae II, III and IV contiguous; tarsi abruptly tapering, almost humped.

The descriptions of the nymph and larva given below are condensed from Neumann (1896, pp. 22–24).

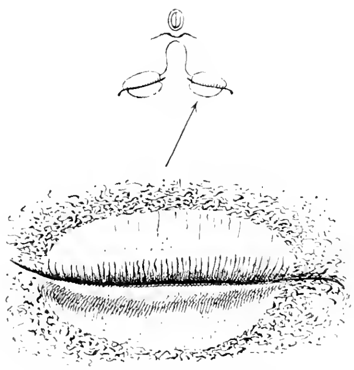


Fig. 49. *Argas vespertilionis.* One of two curious grooved organs lying posterior to anus as indicated in key-figure above and highly magnified below. Present in adults and nymphs. Drawn from large nymph (opaque object) and only indicated by a line in Fig. 48 of ♀. Original, N. and W.

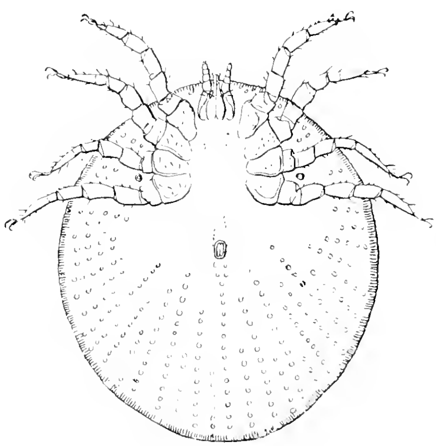


Fig. 50.

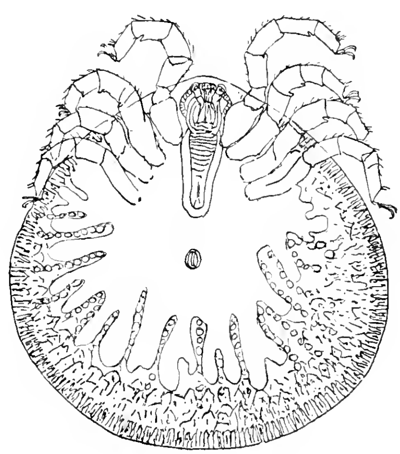


Fig. 51.

Argas vespertilionis.

Fig. 50. Nymph, ventral aspect, ×28 (Nn. 1896, fig. 22).

Fig. 51. Nymph, ventral aspect, ×13 (Wheler, 1906, fig. 8).

We regard these as 1st and 2nd stage nymphs.

Nymph (Figs. 50–52): *Body* nearly circular, 2·4 × 2·1 mm. (3·7 × 3·8 mm. to 4·95 × 4·37 mm. according to Wheler, 1899, p. 12, ? 2nd stage nymph. We have examined large nymphs from the Cape, measuring 5·5 mm. in length). Integument finely creased in zig-zags in young individuals, in polygonal design in the more aged; margin (Fig. 53) with irregular folds in young individuals, quadrangular areas

Fig. 52. *Argas vespertilionis.* Nymph's intestinal caeca. After George, 1875, pl. II, fig. 2.

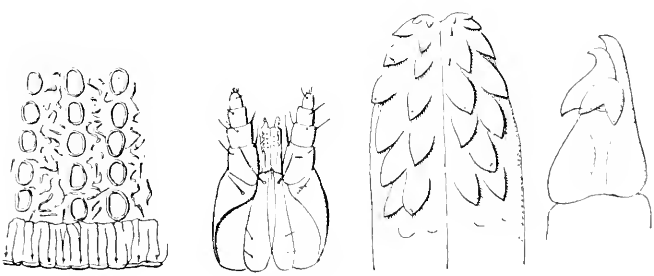


Fig. 53. Fig. 54. Fig. 55. Fig. 56.

Argas vespertilionis. Nymph.

Fig. 53. Slightly schematic figure of part of ventral surface and margin, × 300.
Fig. 54. Capitulum, ventral aspect, × 65.
Fig. 55. Hypostome, × 585.
Fig. 56. Digit, × 665.
(Neumann, 1896, figs. 23, 24, 25 *a* and *b*.)

in others, radiating, having very short hairs; numerous small slight depressions dorsally and ventrally, arranged similarly to the discs in *A. persicus*. *Venter:* spiracles reniform (34 μ *w.*), less than half the width of the anal ring (130 × 90 μ). *Capitulum* (Fig. 54) anterior, the three distal articles of the palp together with the tips of the chelicerae and hypostome visible dorsally (in younger nymphs); hypostome (Fig. 55) slightly indented, 2 | 2 rows of 5 or 6 teeth; digit, see Fig. 56:

palps short, thick, with articles scarcely longer than broad, excepting the first; each article bears 4 short denticulated hairs dorsally; two long post-hypostomal hairs, two shorter post-palpal hairs more posterior. *Legs* thick sub-equal; coxae contiguous; tarsi tapering, tarsus I alone showing a slight dorsal protuberance. In some of the large 2nd stage nymphs we have examined there existed an imperfect sexual orifice.

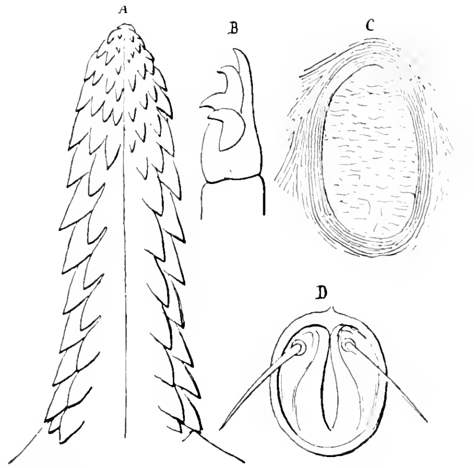


Fig. 57. *Argas vespertilionis.* Larva: *A.* hypostome, ×575; *B.* digit, ×865; *C.* dorsal plate, ×110; *D.* anus, ×370 (Nn. 1896, fig. 26).

Larva (Figs. 57 *A–D*): Body short oval, 1·3 × 1 mm. or 2 × 1·5 mm. Some ten radiating furrows on the posterior half of the dorsum. Integument with fine transverse parallel folds except on an oval squamous shield anterior to the middle of the dorsum. Three pairs of hairs on the anterior part of the dorsum. Twenty marginal hairs. Radiating series of discs between the intestinal caeca. *Capitulum* almost entirely visible dorsally. Hypostome narrow, long, pointed; dentition 4 | 4. Palps slender, article 1 nearly as wide as long, articles 2, 3, and 4 twice as long as wide; article 4 small. Hairs on the basis capituli as in the nymph, but short. *Legs* slender, sub-equal; coxae nearly contiguous, elongated, a broad interval between the coxae of the two sides.

Neumann's description of the nymph is based on three specimens, one in the possession of M. Julien (Paris), and two specimens of the "Blyborough tick" from R. Blanchard. The ticks were taken from *Vesperugo pipistrellus.*

It is probably *Argas fischeri* Audouin. (*Caris elliptica* Kol. was found on *Myotus murinus*; *Caris longimana* Kol. on *Miniopterus schreibersi* and *Rhinolophus clivosus*; *Caris decussata* Kol. on *Myotus murinus* and *Rhinolophus hippocrepis*; *Caris inermis* Kol. on *Brachyotus dasycnemus* and *Synotus barbastellus*.)

Neumann's description of the larva is based on the examination of four specimens; two collected in Paris by E. Simon, from *Vesperugo pipistrellus*, one taken by Dr Buysson from *Plecotus auritus* at Bronet-Vernet (Allier), and one from *Vesperugo kuhli* at Chegga (R. Blanchard's Coll.). Latreille's Caris was taken from *Vesperugo noctula*. *Argas pipistrellae* Audouin, and *Caris vespertilionis* Gervais, were taken from *V. pipistrellus*. *Argas fischeri* Audouin, collected in Egypt, is only known through Savigny's figure. There are larvae of *A. vespertilionis* in the British Museum; Mr E. G. Wheler's collection contains larvae and nymphs collected at Puttenham (1903), and we have also obtained larvae taken from *V. pipistrellus* from Histon, Cambridgeshire, 11 May, 1905 and 29–30 July, 1908.

Genus 2. ORNITHODOROS C. L. Koch, 1844.

Synon. and Lit.: *Ornithodoros* Koch, 1844, p. 219; 1847, p. 11.—Fürstenberg, 1861, p. 208.—Canestrini and Fanzago, 1877, p. 194.—Canestrini, 1890, p. 531; 1892, p. 582.—Trouessart, 1892, p. 47.—Neumann, 1896, p. 3 *et seq.*—Lounsbury, 1899, p. 240.—Ward, 1900 a, p. 196; 1900 b, p. 437.—Salmon and Stiles, 1901, p. 407.—Neumann, 1901, p. 256.—Banks, 1904, p. 45.—Dönitz, 1906, p. 145.—Pocock, 1907, p. 189.—Banks, 1908, p. 16.

Argas (*Ornithodoros*) Murray, 1877, p. 183.

Ornithodoros Karsch, 1878, p. 321.—Marx, 1892, p. 233; 1895, p. 199.—Osborn, 1896, p. 255.—Morgan, 1899, p. 137.—Neumann, 1908, pp. 17, 26.

Rhynchoprium Marx, 1895, p. 199.—Osborn, 1896, p. 255.—Neumann, 1896, p. 42 (*Rhynchoprium* a misprint).

Ornithodorous Koch: Morgan, 1899, p. 136 (*sic*).

Alectorobius Pocock, 1907, p. 189 (see *Ornithodoros talaje*).

Ornithodorus of numerous writers since Koch.

Generic Characters. *Body flat when unfed, but usually becoming very convex on distention. Anterior end more or less pointed and hood-like. Margin thick and not clearly defined, similar in structure to the rest of the integument, and generally disappearing on distention. Capitulum sub-terminal, its anterior portions often visible dorsally in the* *adult. Discs*[1] *present or absent; but when present, not arranged radially. Certain fairly constant grooves and folds on the venter, namely a coxal fold internal to the coxae, a supra-coxal fold external to the coxae, a*

TARSI I AND IV OF SPECIES OF ORNITHODOROS

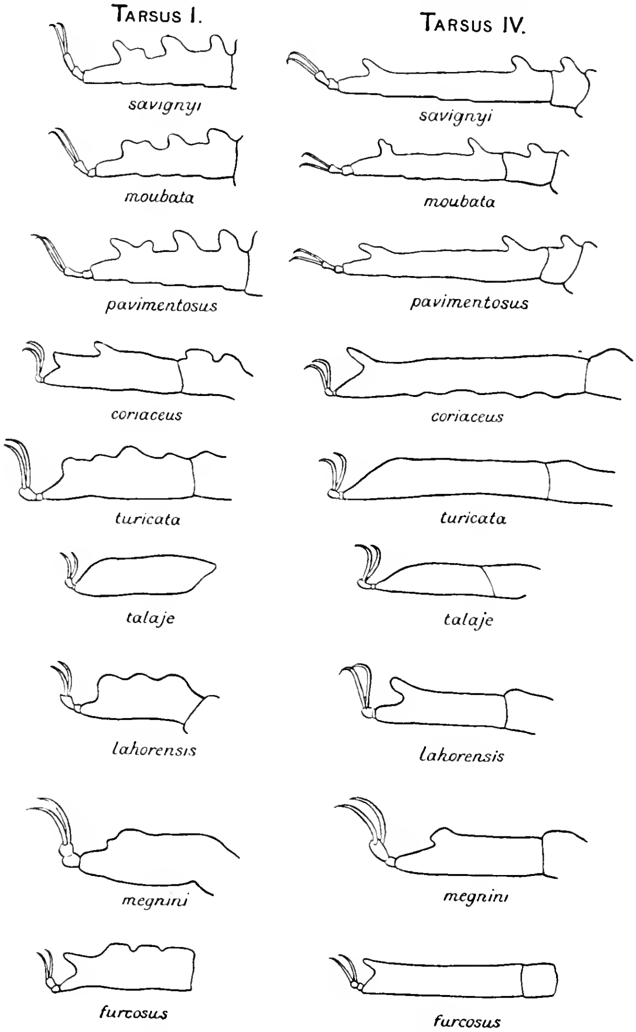


Fig. 58. Original, N. and W.

[1] Structures analogous to the "discs" of *Argas* are probably to be found in all species of *Ornithodoros* under sufficient magnification, but in some species they are not visible as such to the naked eye, or by the aid of a simple lens. In such cases the species is said in the subsequent diagnoses to be without obvious discs.

transverse pre-anal and a transverse post-anal groove or furrow, and a post-anal median groove[1]. *Eyes present or absent.*

Type species *Ornithodoros savignyi* (Audouin).

N.B. *O. savignyi* differed so markedly from the species of *Argas* known when Koch established the genus *Ornithodoros* that the diagnoses of the two genera presented no difficulties. More recently described forms have, however, tended to narrow the gulf between them. *Argas brumpti*, for example, has some features more characteristic of *Ornithodoros*, while *Ornithodoros tholozani* in some respects approaches *Argas*.

The genus Ornithodoros includes 11 *well established species:*

Suppressed are:

americana = turicata
miliaris = erraticus
coniceps = talaje var. coniceps
rudis = talaje
reticulatus Gervais, 1849–51, in de Gay, *Zoologie*, p. 44, Pl. V, Fig. 8. Latin description in two lines and figure. Species purely nominal (Nn., 1896, p. 41).

[1] Refer to Fig. 1, p. 7.

Key for the determination of species of Ornithodoros.

(Exclusive of doubtful species *q.v.* p. 41.)

(*a*)	Integument mammillated or granular	*b.*
	„ not mammillated	*c.*
(*b*)	with eyes	*d.*
	without eyes	*e.*
(*c*)	Integument pitted, no eyes	*megnini*, p. 71.
	„ finely wrinkled	*lahorensis*, p. 67.
(*d*)	with flat contiguous granulations	*pavimentosus*, p. 62.
	with hemispherical granulations	*f.*
(*e*)	with body broad and rounded in front	*moubata*, p. 46.
	with body sub-conical in front	*g.*
(*f*)	with eyes of equal size	*savignyi*, p. 42.
	with anterior pair of eyes larger	*coriaceus*, p. 55.
(*g*)	with obvious discs[1]	*h.*
	without obvious discs[1]	*i.*
(*h*)	with movable cheeks to camerostome	*talaje*, p. 59.
	without movable „ „	*j.*
(*i*)	coxae II larger than I; with tarsi forked distally	*furcosus*, p. 70.
	coxae II smaller than I; with 3 humps on tarsi I—III	*turicata*, p. 57.
(*j*)	tarsi slightly humped	*erraticus*, p. 63.
	tarsi II—IV with prominent dorsal humps	*tholozani*, p. 64.

ORNITHODOROS SAVIGNYI (Audouin), 1827.

Pl. II and Figs. 58, 59–65, 70, 71.

Synon.: *Argas savignyi* Audouin, 1827, p. 183.
Ornithodoros savignyi C. L. Koch, 1844.
? *Ornithodoros morbillosus* Gerstaecker, 1873 (see p. 80).
Argas schinzii Berlese, 1889.
Native names: see *O. moubata*, p. 46, with which it must be included by natives in the places where both species occur together, as will be seen by reference to their geographical distribution (see pp. 46, 52).

[1] See footnote, p. 40.

Fig. 1. *O. savignyi* ♀. Dorsal aspect, ×8. Specimen from S. Africa. Original, C. and R. phot.

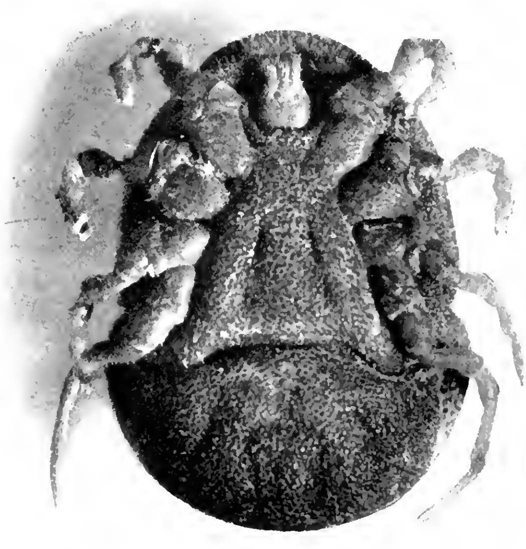


Fig. 2. *O. savignyi* ♀. Ventral aspect, ×8. (Same specimen as in preceding figure.)

Lit. and Icon.: Savigny (1826, Pl. IX, excellent figures of dorsum, venter, legs; less good of capitulum and mouthparts), reproduced by Walckenaer and Gervais (1837–47, Pl. XXXI, Fig. 2).—Guérin-Méneville, 1829–43, Pl. VI, Fig. 4, mouthparts taken from Savigny without acknowledgement.—C. L. Koch, 1844, p. 2.—L. Koch, 1875, p. 1, notes (only) three specimens from vicinity of Anseba river.—Murray, 1877, p. 182.—Mégnin, 1880, p. 134 (nothing original).—Laboulbène and Mégnin, 1882, p. 324 (nothing original).—Berlese, 1889, Pl. VII.—Neumann, 1896, pp. 27–29, Figs. 27–32; here reproduced.—Pocock, 1900, p. 49.—Neumann, 1901, p. 256.—Lounsbury, 1899.—Braun, 1906, p. 372. O.—Christophers, 1907, Pl. I–V, two text figures, deals especially with internal anatomy. Figure of larva here reproduced.—Dönitz, 1906, p. 145, Pl. Figs. 3 and 6 (here reproduced).

Adult: *Body* (Pl. II, Figs. 1 and 2) short oval, broadly rounded at both ends and often slightly narrowed on a level with coxae III and IV. Integument thick, and covered by distinct mammillae (100 to 200 μ in diameter, Pl. II and Fig. 59), except along certain tracts which appear as furrows in unfed individuals, and are still recognisable by the absence of mammillae in gorged specimens; their arrangement is best seen from the figure. They are transversely wrinkled and present no obvious discs. Numerous short hairs between the mammillae, more

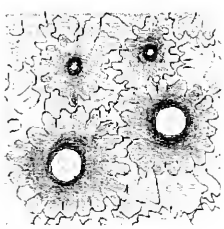


Fig. 59.

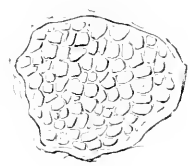


Fig. 60.

Fig. 59. *O. savignyi.* Granulations of integument, ×65 (Nn. 1896, fig. 27).
Fig. 60. *O. savignyi.* A "fossette" or disc, ×235 (Nn. 1896, fig. 28).

numerous on the venter. *Venter* (Pl. II, Fig. 2): supra-coxal folds well-marked, and bearing four *eyes* of equal size, one pair facing coxae I and the other the intervals between coxae III and IV[1]; coxal folds slight; pre-anal groove well-marked; behind it, three pairs of longitudinal furrows, especially noticeable in large specimens; a short median depression in the form of an inverted **Y**; anus wider than long (400 × 450 μ). Spiracles above the supra-coxal folds, 600 μ wide,

[1] See Figs. 1 and 83 of *O. coriaceus* where position of eyes is similar.

crescentic. *Capitulum* stout, free; palps (Fig. 61) tapering, articles 1 and 2 equal in length; article 3 the shortest; hypostome (Fig. 62) short with dentition 3 | 3 as regards the principal teeth, the external teeth the stoutest; more numerous smaller teeth posteriorly; Chelicerae: see digit (Fig. 63). *Legs* (Figs. 58, 64, 70 and 71) stout, the last pair one and a half times the length of the first; coxae contiguous and diminishing from I to IV; the protarsus (article 5) of leg I has three large dorsal humps, the middle the largest, and the tarsus three sub-equal humps equidistant; the tarsus of leg IV has three humps,

Fig. 61.

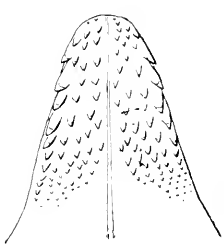


Fig. 62.

Fig. 63.

Fig. 61. *O. savignyi*. Palp, the articles measuring from base to tip 400—400—250—310 μ (Nn. 1896, fig. 31).
Fig. 62. *O. savignyi*. Hypostome, × 65 (Nn. 1896, fig. 30).
Fig. 63. *O. savignyi*. Digit, 200 μ *l*. (Nn. 1896, fig. 29).

the two proximal near together, an interval three times as great separating the second and third. The ♂ and ♀ resemble each other except in the generally smaller size of the ♂ and of the ♂ genital orifice[1]. Many long blunt hairs thickly beset the anterior margin of the body giving it a downy appearance.

[1] See Figs. 66, 67 of *O. moubata*.

Nymphs: There are at least two nymphal stages, if not more. In the nymphal stage preceding maturity, there is a great resemblance to the adult and there is a rudiment of the sexual aperture. Smaller nymphs, belonging to an earlier stage, are also encountered which show no trace of a sexual aperture.

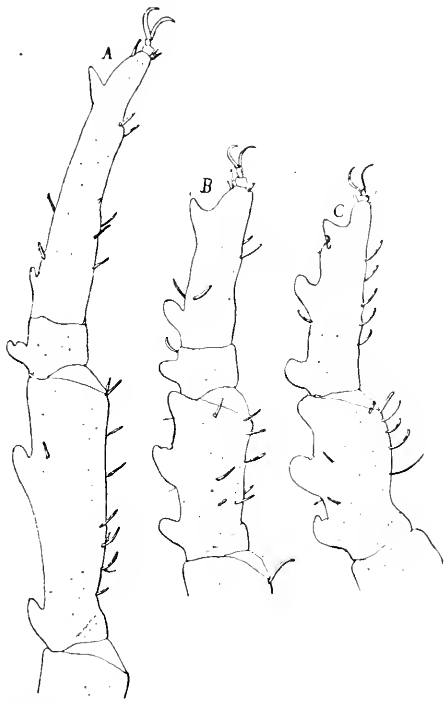


Fig. 64. *O. savignyi.* Legs IV (*A*), III (*B*), I (*C*), ×17 (Nn. 1896, fig. 32).

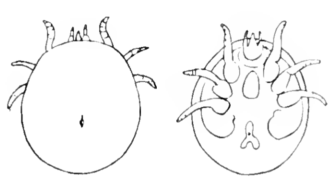


Fig. 65. *O. savignyi.* Larva recently emerged from the egg, dorsum and venter. After Christophers (1906, p. 51, about 1 mm. *l.*, same size as the egg).

Larvae (Fig. 65): These issue from the egg as in other Ixodoidea, *O. savignyi* differing from *O. moubata* (*q.v.*) in this respect, according to Christophers (1906, p. 51), in India. This author informs us (1908) that the larva does not feed and does not increase in size before it moults, but unlike that of *O. moubata* it appears able to throw off the eggshell before turning into a nymph.

Hosts: This species attacks man and Lounsbury (1899; he may have included *O. moubata* in the statement) reports that it feeds on various animals: fowl, dog, horse, goat, cattle, pig. We have fed it on fowls and rabbits in Cambridge. It may be noted that it feeds like *O. moubata* but for the fact, observed in one instance, that it inserts its palps into the wound it inflicts.

Geographical distribution: Recorded from Nubia (at Bularli, Pell Coll.), W. Somaliland, Abyssinia (Courbon Coll., Paris Mus.), German East Africa, S. W. Africa (Nn. 1901, p. 256), and the Congo (Pocock, 1900, p. 49, and 1907). Its distribution in Africa overlaps with that of *O. moubata*. Lounsbury has sent us specimens from Cape Colony, and he records it (1899) as occurring in Rhodesia, Bechuanaland, Portuguese E. Africa and Transvaal. Neumann records in detail (1896, p. 29) the specimens found in different parts of Africa, possibly some of them represent *O. moubata* which at that time was not recognised as another species. Neumann and Gerstaecker record it from Egypt (where it was first found by Audouin) and Upper Nubia. Neumann has examined specimens from Southern India, where its presence has been recorded by Christophers (1906, p. 2). We have received specimens from Aden and Egypt through the courtesy of Dr C. W. Daniels.

ORNITHODOROS MOUBATA (Murray), 1877.

Figs. 58, 66–80.

Synon.: *Argas moubata* Murray, 1877, p. 182.

Ixodes moubata, Cobbold, 1882, p. 78.

Ornithodoros savignyi var. *caeca* Neumann, 1901, p. 256 (referred to as var. *caecus* or *caecum* by various authors).

Native names[1]: *bibo*, Toro name in Uganda (Christy, 1903, p. 187).—Suaheli terms are *pasi* (plural *papasi*) and *Kupé* (Wellman MS.).—*gourat* in Nubia and Soudan; *mechger* in Abyssinia; *courdoud* in Galla; *oldirrho* in Kilima-ndjaro (Brumpt, 1901, p. 578).—*papazi* in Mombassa (Karsch, 1878, p. 311, who calls it *O. savignyi*).—*tampan* or *tampão* on Lower Zambesi (Livingstone, 1857, p. 628; Pocock, 1903 and 1907; Wellman, 1907, the last-named author informs us that this name is employed by the Portuguese E. African colonists).—*kufu* or *mbu*[2]

[1] Without doubt some of these names include *O. savignyi*.

[2] Also applied to mosquito and to malaria, according to R. Koch, in parts of E. Africa.

in Tete (misspelt "bu" in Manson, 1903, p. 714).—*carrapato*[1] in Portuguese East Africa (a loose term), Livingstone (1857, p. 382) spelt it carapato, often misspelt garrapato. Wellman (in MS.) states that *karapatti* and *garapata* are Arabic and Bantu corruptions of the Portuguese word.—*tapazi* at Nyañgwe, Lualaba river, Livingstone (1874, II, p. 115).—*bifundikala* about Leopoldville Congo (Dutton and Todd, 1905 b).—*bimpusi* is the Batéké name (Dutton and Todd, 1905 b).—*mouyata* at Popokabaka (Dutton and Todd, 1905 b).—*moubata* in Angola (Murray, 1877, p. 182). According to Wellman (in MS.) *Dibata* (singular) and *Mabata* (plural) is the Kimbundu name for the tick, so that the name *moubata* given by Welwitsch as the native name and adopted by Murray is incorrect, a rarer Kimbundu name is *Mbanze*.—*ochihopio* (pl. *ovihopio*), native Umbundu name in Angola, W. Africa (Wellman, 1906, p. 154).—*liwuno*[2] is the Lovale name in E. Angola and N. W. Rhodesia (Wellman, 1908, personal communication).—*kimputo*, common name in Eastern Congo Free State (Dutton and Todd, 1905 b).

Icon.: **1877**. Murray, Fig. on p. 182 (wretched).—**1903**. Christy, coloured Pl. XV and photograph, 4 figs.—**1905**. Newstead, Pls. I and II. some figs. here reproduced.—Dutton and Todd, Pl. III, Figs. 2–4; Pl. IV, Figs. 1–3, photographs of *O. moubata* feeding, in a dish, profile of tick showing line of cleavage of skin when moulting, details of internal anatomy.—**1906**. Dönitz, plate showing tarsi I and IV*.—Wellman, p. 155, Fig. 2; dorsal and ventral aspects (very poor); 1906–07, Fig. 1.—Guiart and Grimbert, Fig. 410, sketchy.—**1907**. Pocock, text Fig. 111, ♀; dorsal and ventral aspects.—**1908**. Manson, Pl. IV, Fig. 3; dorsum of adult (?). Nuttall, VII, 1908, Fig. 1*.

Lit.: **1857**. Livingstone, pp. 382, 628.—**1874**. Livingstone, Vol. II, pp. 33, 115.—**1877**. Murray, p. 182, gave a quite useless description. The species was established by Pocock, 1900, who examined the types (Brit. Mus. collected by Welwitsch in Angola).—**1882**. Cobbold, p. 78. O.—**1895**. Dowson, p. 1201, sent specimens from Tete to British Museum; describes effect of bite, fever, etc.—**1896**. Neumann, p. 30.—**1900**. Pocock, p. 222, first described some of the specific differences between *moubata* and *savignyi*.—**1901**. Neumann, p. 256.—Brumpt, p. 578.—**1903**. Christy, p. 187.—Manson, p. 713.—Pocock, p. 188, determined specimens collected by Christy in Uganda, and states that Dowson had also sent specimens of *O. moubata* from Tete, Zambesi.—**1905**. Calman, p. 124, determined specimens sent by Wellman from Angola.—Dutton and Todd (b), pp. 123–127.—Feldmann, p. 64, *Filaria perstans*, supposed host being *O. moubata*. Author states it is an Argas, and it might be from his figure. His description appears to apply partly to *moubata* and partly to one of the Ixodidae.—Kerr, p. 126, criticism of Feldmann's observations.—Newstead, pp. 1696, 1697.—Wellman, repr.—**1906**. Dönitz, pp. 145, 148.—Werner, p. 776.—Wellman, p. 155 (also 1906-7).—**1907**. Pocock, pp. 194–196.—Möllers, p. 278.—**1908**. Manson, p. 203.—Nuttall, p. 388.

[1] Used in Europe to denote the castor-oil plant (*Ricinus communis*) according to Wellman (MS.).

[2] Also applied to *Sarcopsylla penetrans* according to Wellman (MS.).

This species closely resembles O. savignyi, from which, however, it may easily be distinguished by the absence of eyes, and the details of its leg structure (*compare* Figs. 70–73). *The humps on the protarsus of leg I are sub-equal and toothlike, while the tarsus of leg IV is shorter and thicker than in O. savignyi, and its humps are nearly equidistant, the intervals (proximal and distal) between them being as* 4—5[1]. *Less hairy than O. savignyi*[1].

Adults usually measure 8 × 6 or 7 mm. (Christy, 1903, p. 187; Pocock, 1907, p. 195, and others), but the females, especially when gorged, may attain *l.* 11 mm. (Dönitz, 1906; Wellman, 1906), or even 12 × 10 mm. when fully grown and filled with eggs and blood (Dutton and Todd)[2]. The colour varies from dusty brown to greenish brown in living specimens with occasional dull ochreus patches; after gorging it appears darker and turns reddish or blackish brown in alcohol. Reference to the figures (Figs. 66–69) will give a better idea of the appearance of the tick than a lengthy description. From the observations of Newstead, Dutton and Todd, and of Dönitz (1906, p. 146; 1907, pp. 11, 20) and R. Koch, whom he cites, there appears to be no doubt but that *adults* (8—9 *mm. l.*) *may moult.* Dönitz states he has observed females moult after ovipositing. Newstead, Dutton and Todd (1907) raised a female from the egg and kept her under observation for 25 months during which time she moulted six times. Other specimens moulted 6—9 times during a year. Under favourable conditions they may moult 2—3 times in two months. Möllers (1907, p. 278) states that the nymphs moult after each feed of blood and that they feed 6—7 times before reaching the adult stage, after which only the males continue to moult. The females lay batches of eggs after each feed but do not continue to moult. (This is contrary to what Dönitz states.) It is obvious, therefore, that there are **several nymphal stages**, the number not having been clearly established. The largest nymphs may equal adults in size, and we have noted that they show a punctiform mark where the sexual orifice is situated in the adult,

[1] A point established by Dönitz, 1906. According to Newstead (1905, p. 1696) the species can be further distinguished by the dorsal process of the digit being bidentate in *O. moubata*, but this is not of practical importance.

[2] According to Möllers (1907, p. 278) ticks descended from the same parents may differ considerably in size. The males are usually smaller than the females but the size is very variable in both sexes. Nymphs of the same age which have fed 4 to 5 times may measure 3—4 or 8—9 mm. long. (This variability in size, also noticeable in other Ixodoidea, doubtless depends upon the amount of blood consumed.)

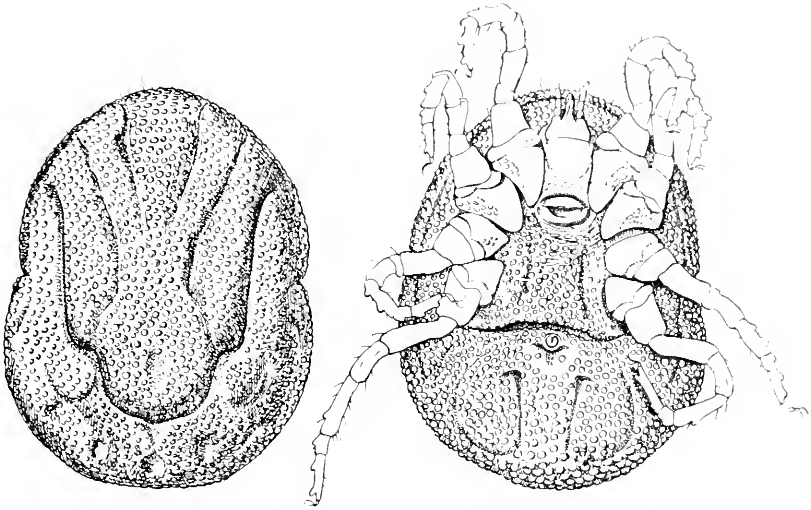


Fig. 66. *O. moubata* ♀, × 5. Dorsum and venter; specimen from British Central Africa. (Nuttall, 1908, fig. 1.)

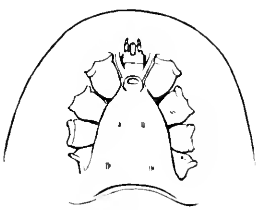


Fig. 67.

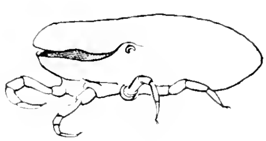


Fig. 68.

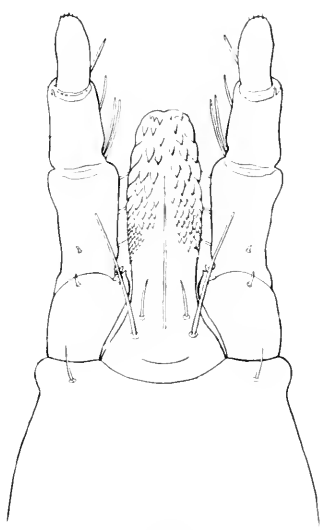


Fig. 69.

Fig. 67. *O. moubata* ♂. Anterior portion of venter. Original, N. and W.

Fig. 68. *O. moubata*. Sketch of second stage nymph's cast skin, seen in profile and showing line along which it splits running back above spiracle, ×6. Original, N. and W.

Fig. 69. *O. moubata* ♀. Ventral aspect of capitulum omitting chelicerae, ×66. Original, N.

otherwise they conform to the adult in all essential characters. Nymphs of intermediate sizes may be encountered down to the smallest or first stage nymph after its ecdysis from the larval skin and the egg-shell. In moulting (see Fig. 68) the skin of the adult or nymph splits along a definite line on each side running from the front margin backward above the spiracles, the tick emerging anteriorly, but the whole dorsal cuticle may come off like a cap or adhere for some days to the tick which has issued. Nymphs of the third stage attain 5 × 2·5 mm., whereas unfed nymphs of the second stage average 1·4 × 1·2 mm.

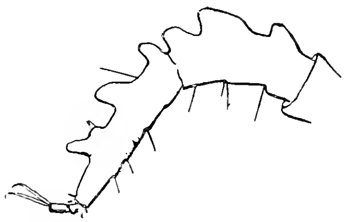


Fig. 70.

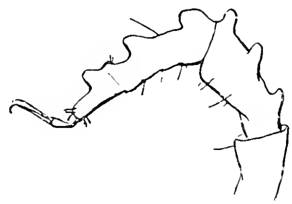


Fig. 72.

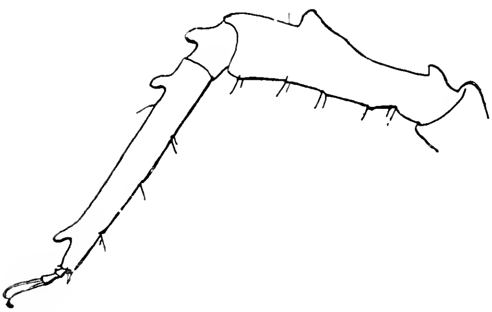


Fig. 71.

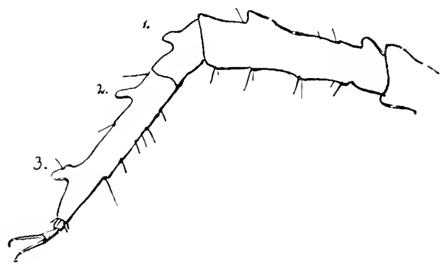


Fig. 73.

Figs. 70, 71. *O. savignyi*. Distal ends of legs of adult of large size, (70) leg I and (71) leg IV.

Figs. 72, 73. *O. moubata*. Distal ends of legs of adult of large size (11 mm. *l.*), (72) leg I and (73) leg IV with tarsus 1·3 mm. *l.*

(Dönitz, 1906, pl., figs. 1, 3, 4, 6.)

The Nymph (1st stage, Figs. 74 and 75), immediately after it has emerged from the larval skin and the egg-shell, measures on an average 1 × ·87 mm. After some time it becomes somewhat flattened and longer, its contour being sub-circular and the colour ochreus. The minute spiracle is situate as in adults, between legs III and IV. The mammillations covering the dorsum extend but partially over the postero-ventral border, the capitulum is well developed, the hypostome bears 2|2 rows of teeth, with two prominent hairs on its base as in the larva. They are usually ready to feed 3—4 days after ecdysis[1] and may double in size after feeding.

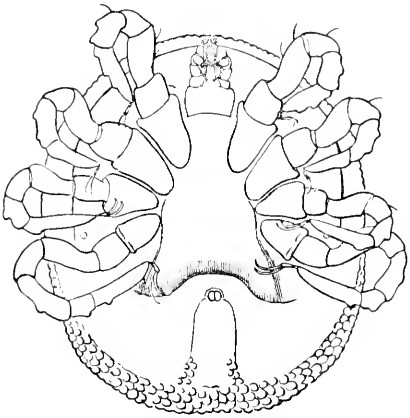


Fig. 74.

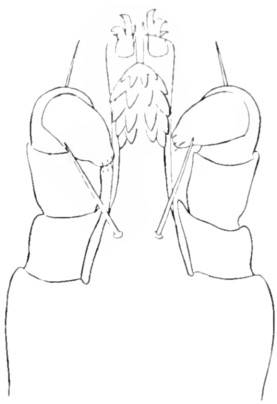


Fig. 75.

Fig. 74. Nymph, 1st stage, *l.* 1·3 mm., unfed, dead and shrivelled. Ventral aspect. From specimen given by Mr Newstead. Original, N.

Fig. 75. *O. moubata.* Nymph, capitulum, × 200. Original, N.

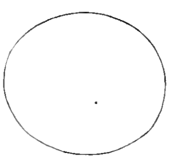


Fig. 76.

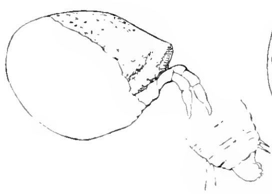


Fig. 77. Fig. 78.

Fig. 79.

Figs. 76–79. *O. moubata.* After Newstead, 1905, pl. I, figs. 1–4, showing respectively contour of egg on first day, × circa 40.—Egg on about 10th day with cuticle broken away showing larva protruding in profile, × circa 40.—Larva removed from the egg, ventral aspect, × circa 40 (anus, omitted in the original figure, has been added, G. H. F. N.).—Tarsus of larva, × 250, seen between the foregoing figures.

Larva (Figs. 77–80). The larva can be extracted from the egg-shell as was first observed by Dutton and Todd (1905 b, p. 126), "it moves its legs but cannot crawl." It has been fully described by Newstead (1905 b, p. 21), whose figures are here reproduced. It is very

[1] The nymphs were first recorded by Livingstone (1857, p. 382) and described as "the size of a pin's head."

imperfectly developed but shows all the essential structures seen in larval ticks. It is sub-circular, dull purplish brown, and, as it matures, a **Y**-shaped mass of excrement accumulates posterior to the anus and the cuticle grows opaque. The chitin is exceedingly thin, and in shed skins is colourless. *O. moubata* and *O. savignyi* are the only ticks at present known which have an inert larval stage[1], the larva of *moubata* appears however to be even more undeveloped than that of the closely allied species *O. savignyi*, for the latter casts its egg-shell before turning into a nymph.

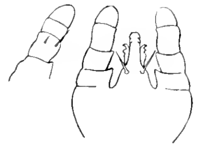


Fig. 80. *O. moubata.* Capitulum of larva, ventral aspect and dorsal aspect of left palp. Whole length of capitulum including palps, 180 μ. The figure differs from that given by Newstead (1905). Original, N.

Eggs (Fig. 76): slightly ovoid, glistening, golden yellow when newly laid, they measure about ·9 × ·8 mm. (Dutton and Todd); closely examined, they show "an irregular faint whitish polygonal reticulation and interrupted radiating streaks" seen through the cuticle (Newstead). (*Biology*, etc. see further under Section II.)

Hosts: Besides man, they may attack domesticated animals. Thus, Wellman (1906, p. 154) states that they bite pigs, sheep, goats and dogs, etc. in Angola. He has found them in pig-styes. In the Laboratory in Cambridge, they readily fed on fowls, rabbits, rats and mice. They also feed on monkeys. (Laboratory experiments in Liverpool and London.)

Geographical distribution: *O. moubata* is *widely distributed in Africa*, it is chiefly recorded from British East Africa to the Transvaal in the East, and across the Continent to the Congo and southward to German South West Africa and Cape Colony. It has been collected in *Egypt*[2] by Boué, *Abyssinia* by Courbon, to the south of *Lake Tchad* by Closel (Nn. 1901, p. 256). Brumpt states (1901, p. 578) that he encountered it in vast numbers at Biocobaba, *Somaliland*. In *German East Africa* it is found in all places along the caravan route from Dar-es-Salaam to beyond Kilossa in the direction of Mpapua and on the way from Kilossa

[1] This has been confirmed by Dönitz (1906, p. 146; 1907, p. 20), by R. Koch (cited by Dönitz) and by Nuttall. The large size of the eggs in these species may be noted in this connection.

[2] Brumpt says similar ticks are common in dirty prisons in Cairo, possibly the ticks he refers to are *O. savignyi*.

to Iringa. It is also found in villages in the Rubeho Mountains and in places off the caravan routes (R. Koch, XI. 1905, p. 1866). Specimens had been previously collected by Kramer (labelled *A. schinzii* in Hamburg Mus.) and Stuhlmann in German East Africa (identified by Nn. 1901, p. 256). A native from Kilima-ndjaro told Brumpt (p. 578) that the tick and fever were well known in his country, as was also the case with the natives of Galla. Dutton and Todd (1905, map) note its presence at Tabora, and Dönitz (1906, p. 145) at Pokomani, Wituland. There are specimens from Quango in the Berlin Museum (Nn. 1901, p. 256). *Zanzibar Island:* it is common in prisons there according to Brumpt, and this locality is mapped by Dutton and Todd.

In *British East* and *Central Africa*, Christy (1903, p. 187) notes it as fairly common in Usoga, Uganda and Buda, and at Wadelai on the Nile (North of Lake Albert). Neumann (1901, p. 256) and Pocock (1907) record it from *Namaqualand* and *Transvaal.* Dutton and Todd (1905) state it is reported to be present in Shescheke, *Rhodesia*, and Wellman (MS.) states it occurs in *Bechuanaland, Cape Colony* and *German South West Africa.* In *Portuguese East Africa* at Tete (Livingstone, 1857, p. 382) where it occurs to-day. Wellman (MS.) states it occurs at Mozambique. In *West Africa* its presence was noted in *Angola*, at Ambaca, and it was stated to be common in native huts of the country by Livingstone (1857, p. 382). It is from this country that Murray's types came. Specimens from Angola were identified by Neumann (1901, p. 256). It is still found at Ambaca and in Malange, Bihé, Bailundo, Andulo, Caconda, Chiyaka, Benguella, Lovaleland, Moxico and Landana, according to Wellman (in MS.). In the *Congo Free State* its presence was recorded at Nyangwé, on the Lualaba river, by Livingstone (1874, II. p. 115). Dutton and Todd (1905, p. 123 and map) state that it certainly occurs at Lokandu, Ukungwa, Mulamba, Mwana, Maketa, Nyangwé and Kasongo, whilst it is reported to occur in Kimpudi and from Popokabaka to Francis Joseph Falls, at Katola on the Kasai River, at points along the route from Kasongo to Baudovinville (west of Tanganyika) and along the western frontier to the shores of Lake Albert Edward. It certainly occurs northward at Beni. Neumann (1901, p. 256) recorded it from the Congo and from the upper Zambesi at Loango, Landana, where it was collected by Foà. Dutton and Todd consider that the tick came into the Free State from the East Coast with Arabs, and into the Oriental Province and Cataract Region with traders from Portuguese territory to the South where the tick existed in Livingstone's time. The rivers are the present highways. "A glance at the map will show that ticks are found particularly along much travelled roads. Although plentiful in many Arabised villages along the Congo between Kasongo and Ponthierville, they are quite unknown in native villages an hours' walk inland."

One of us has received specimens collected at Dowa, Lilongwe, and at Blantyre, British Central Africa; at Tete, Portuguese East Africa, and in the District of Benguella, Angola. These, and other specimens of uncertain origin, have reached us through the courtesy of Messrs Daniels, Leishman, Newstead and Wellman.

Habitat: Livingstone (1857, p. 628) noted their presence in native huts at Ambaca, at Tete and "wherever the Arabs go."

Karsch (1878, p. 311) writing of Mombassa, states that "*papazé*" are found especially in the "Fort" and the huts of the Wanika and Wataita.

Christy (1903, p. 187) states that the "bibo" is most easily collected in Uganda by "searching the dust and straw on the floors of the huts erected for the caravan porters, or the houses of the natives, though in the latter it is not so easily found when the floors are kept clean. Near Kampala the natives collected them around the bases of the vertical supporters of the roof." He further states that they are "frequently carried long distances in mats or bedding, or in porters' loads which have been piled for safety in the rest-huts at night." Some specimens he collected in Toro had been carried in bags of salt from Kative at the north end of Lake Albert Edward.

Dutton and Todd (1905 b) suggest that "Perhaps one of the reasons for which ticks are more often found in Arab than in native houses is that the Arabs make better, drier buildings, and live in permanent villages. Native huts are temporary affairs and a slight cause, one or two cases of sickness, is often enough to make a community leave their houses and build a village elsewhere." Along the Congo the rest houses for native travellers were always the most infested. "In infested houses the ticks are found in the dust and cracks of mud-floors, particularly in dry places near the hearth, in bed-platforms, or immediately inside the door-sill, just where the natives are accustomed to sit down. They hide themselves in the cracks and crevices of mud or grass walls, and even in the thatched roofs."

Specimens sent to us by Dr Wellman were collected in cracks in the floor in native kraals, District of Benguella, West Africa. Wellman states he has found "as many as 100 in one hour in an old native hut."

See further under Section II, regarding observations on the hatching of eggs, oviposition, longevity, natural enemies, feeding habits, effects of bite and the part played in the transmission of disease.

ORNITHODOROS CORIACEUS C. L. Koch, 1844.

Figs. 1, 58, 81–84.

Icon.: C. L. Koch, 1847, Pl. I, Fig. 2, ♀ (coloured); Fig. 3, ventral aspect in outline (very good figures).—Nuttall, VII, 1908, Fig. 2*.—Banks, 1908, Pl. I, Figs. 5, 6, legs.

Lit.: C. L. Koch, 1844, p. 219; 1847, p. 31.—Berlese, 1888, p. 193.—Neumann, 1896, p. 31; 1901, p. 258.—Banks, 1908, p. 18.

Body narrow and more pointed in front than in *O. savignyi*; integument with mammillae white in living specimens, reddish or dark in old preserved specimens; large reticulated areas where mammillae are absent (see Fig. 81) not showing up as definite discs. Four eyes (Figs. 1, 82, 83) placed as in *O. savignyi*, hemispherical, greenish, the anterior large, prominent, the posterior one half smaller. *Venter:* spiracles rather large, circular, prominent; pre- and post-anal grooves well marked. *Capitulum* closely enveloped in a camerostome; base long, four equal post-hypostomal hairs at the same level; two post-palpal hairs; palps long, tapering, 1, 2, 4, 3[1]; long white hairs on dorsal sur-

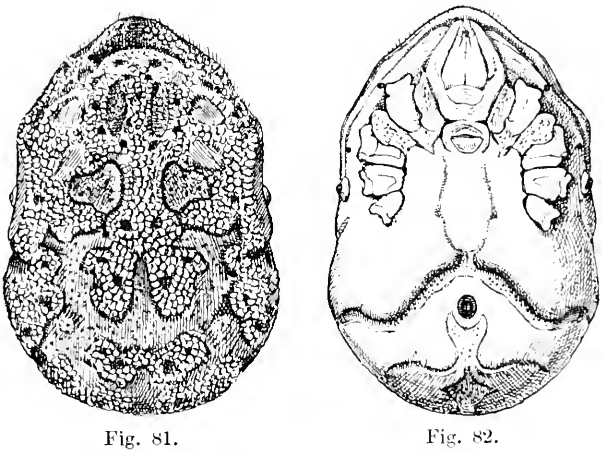


Fig. 81. Fig. 82.

Figs. 81, 82. *O. coriaceus* ♀, ×4. Dorsum and venter. Drawn from living specimen a few days after feeding to repletion. Original, N. and W.

[1] These numbers refer to the relative lengths of the articles.

faces of articles 1, 2, 3; hypostome spatulate, emarginate at the tip, extending as far as the middle of article 3 of the palp; a corona followed by a few large teeth, 2 | 2, about 3 teeth per file, then a few squamous teeth; only the distal third toothed. *Legs* (Figs. 58 (p. 40) and 83) longer and thinner than in *O. savignyi*; coxae I and II separated, II—IV contiguous, diminishing posteriorly. Tarsi as in Fig. 58. Closely allied to *O. savignyi*.

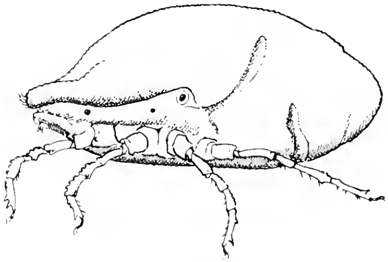


Fig. 83.

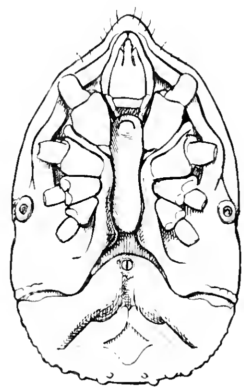


Fig. 84.

Fig. 83. *O. coriaceus* ♀. Living specimen, lateral aspect (same specimen as in fig. 81), shows size and position of eyes and spiracles. Original, N. and W.[1]

Fig. 84. *O. coriaceus* ♂, × 8. Venter. (The eyes are hidden by the legs, see fig. 1, p. 7.) Original, N. and W.

C. L. Koch (1844 and 1847) describes this species as follows: "Shaped like the sole of a shoe, thick margined, roughly shagreened, yellowish earthy colour, spotted rusty red, legs toothed dorsally. Length 9·3 mm. Body about twice as long as wide, width fairly uniform, indented on the sides, pointed above the mouthparts, rounded posteriorly, a thick turned up border all around[2]; the whole surface, above and below, thickly granulated like fish skin (shagreen), the granules flat above, consequently, the whole leathery; on the back unequal folds and grooves. Beneath in the front of the body a deep groove running to the stigmata and on the inner protrusion the rather large round quite clearly marked eyes. The coxae gradually thicken towards the distal extremity and are somewhat bent; the other articles somewhat compressed and clearly notched or

[1] This figure was drawn several days after feeding and the body has shrunk somewhat, especially in front. Immediately after feeding the body, viewed in profile, appears much more rounded behind, and the anterior margin is almost obliterated.

[2] This applies to an unfed specimen.

round-toothed. The whole surface, above and below, dirty yellowish earthy colour, rusty red spots irregularly distributed throughout. Capitulum and palps light yellow. Legs grey-brown. Female. Male: unknown. Habitat: Mexico." (Translation from the original.)

Berlese (1888) states that he saw a specimen found by A. Balzan at Rio Apa, *Paraguay*. We have recently determined specimens received both from *California* and *Mexico*. Those from California[1] were collected by Mr H. A. Moran at Los Olivos in August, 1904, and comprised 7 ♂♂ and 9 ♀♀ (Stanford University Coll.); the largest ♀ measured 13·8 × 8·2, the smallest 9·5 × 5·3 mm.; the largest ♂ measured 8·6×4·6, the smallest 6·4 × 3·4 mm. Those from Mexico were collected by Mrs Zelia Nuttall in January, 1908, the lot including 1 ♂, 2♀♀, and 3 nymphs (resembling the ♂). Both females were received alive and the better specimen was drawn, as also the ♂ (Figs. 81–84). In respect of colouration, the female agreed very closely with Koch's figure, the other specimens are all dull brown like the soil in which they were found. As noted above, the males are smaller than the females and are similar in structure but for the sexual aperture (see Figs. 82, 84). The nymphs were as small or smaller than the males and showed no trace of sexual "Anlage." The ticks are called "talajas" by the natives, and were found whilst exploring some rock inscriptions near San Geronimo, on a hill in a sandy plain (Isthmus of Tehuantepec). Our description is based on our Mexican specimens.

See further under Section II on feeding habits and effects of bite.

ORNITHODOROS TURICATA (A. Dugès), 1876.

Figs. 58, 85–87.

Synonymy: *Argas turicata* A. Dugès, 1876.
Ornithodoros americanus G. Marx, 1895.
Native name: "turicata" in Mexico (Dugès, 1876).

Lit. and Icon.: Dugès, 1876.—Mégnin, 1885, p. 463, Pl. XX, Figs. 1–4.—Marx, 1895, posthumously published plate, appeared in Osborn, 1896, Pl. III, Figs. 2, 2 *i*; good figures of ♂ dorsum, venter, etc.—Neumann, 1896, p. 31, Fig. 33, digit*.—Ward, x. 1900 a and b. O.—Braun, 1906, p. 373. O.—Banks, 1908, p. 18, Pl. I, Figs. 13–16, integument, palp, legs 1 and 4.

Adult (Figs. 85, 86): Body with sides almost straight and parallel, the anterior extremity narrowed to a round point, the distal portions of

[1] Banks, 1908, p. 19, has seen specimens from San Francisco and from Santa Clara County which had been taken from cattle and cattlemen.

the capitulum more or less visible dorsally in the replete adult. Integument thick, with hemispherical, brilliant contiguous granulations, larger posteriorly. No obvious discs, but tracts where mammillae are absent, arranged as in *O. savignyi.* Numerous clubbed hairs between the mammillae. No eyes. *Venter:* coxal and supra-coxal folds well marked in unfed specimens; a pre-anal groove reaching to the supra-coxal fold; a post-anal groove parallel to it, and midway between the anus and the posterior border; median post-anal groove reaching the posterior border. Anus almost as wide as long, with numerous hairs; anal frame nearly quadrangular, 225 μ broad. *Spiracles* circular (180 to 200 μ wide), with crescentic perforate plate. *Capitulum* with integument finely honey-combed; hypostome slightly lanceolate with a crown

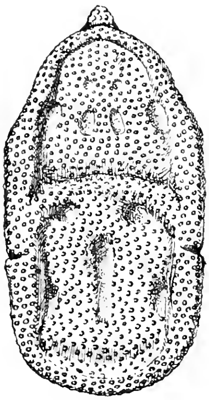


Fig. 85.

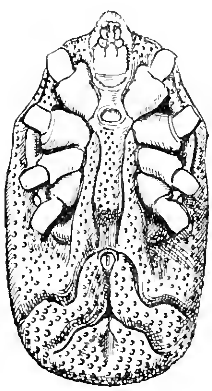


Fig. 86.

Figs. 85, 86. *O. turicata* ♂. *L.* 3·5 mm. Dorsum and venter. Specimen from Guanajuato, Mexico. Original, N. and W.

of numerous small teeth, followed by 2 | 2, 11 or 12 teeth per file; two hairs at the base of the hypostome; digit (see Fig. 87); palps long and only slightly tapering; articles 1 and 2 equal in length (♂ 230 μ, ♀ 300 μ) and articles 3 and 4 equal (♂ 150 μ, ♀ 170 μ); numerous pennate hairs on dorsal surface of palps and basis capituli. *Legs:* coxae contiguous, decreasing in size from I to IV; bristling with very fine spines, reinforced by granulations, especially on the posterior border; tarsi cylindrical, slightly tapering at their tips; three dorsal humps, more marked the more anterior the leg, scarcely visible on leg IV (invisible in our specimen. See Fig. 58, p. 40); similar tubercles, less salient, on the protarsi.

Males average 3·5 × 2·5 mm.; females 6 × 4 mm.; nymphs 2·2 × 1·5 mm.

Neumann's description, from which the above is partly taken, is based on numerous specimens collected in Guanajuato, Mexico, by A. Dugès[1].

Fig. 87. *O. turicata.* Digit, 90 μ *l.* (Nn. 1896, fig. 33, modified).

This species attacks pigs, cattle and man. Its bite is painful and is said to produce grave effects. The *O. americanus* of Marx was found in Texas on the nostrils of the horse, in South America on the llama and in Florida on the tortoise, *Xerobates polyphemus*, whose burrows it appears to infest (see Hubbard, 1894, p. 306). Banks, 1908, p. 18, has moreover seen specimens from Florida (in gopher holes), New Mexico, Arizona and California (on cattle).

ORNITHODOROS TALAJE (Guérin-Méneville), 1849.

Fig. 88.

Synonymy: *Argas talaje* Guérin-Méneville, 1849, pp. 342, 343.

Ornithodoros rudis Karsch, 1880, p. 141; identified by Neumann, 1901, p. 259, as *O. talaje* after examination of type.

(? *Argas coniceps* Canestrini, 1890, p. 535. Regarded as *A. reflexus* ♂ by Canestrini and Fanzago, 1897, p. 193. From Canestrini's description and figure (see *Icon.*) Neumann, 1896, p. 36, appears almost justified in referring it to *O. talaje*, of which he makes it a variety: *O. talaje coniceps* (Canestrini). The determination is, however, doubtful.)

Alectorobius talaje Pocock, 1907, p. 189.

Lit. and Iconography: Guérin-Méneville, 1849, Pl. II; figures inaccurate, reproduced by Mégnin, 1885, Pl. XX, and by Murray, 1877, p. 183.—Canestrini, 1890, Pl. XLI, Figs. 1–1 *d*; dorsal and ventral aspects, palp, tarsus (like *O. talaje*), digit; sketchy.—Blanchard, 1890, p. 883 *et seq.*—Neumann, 1896, Fig. 34*.—Braun, 1906, p. 373. O.—Banks, 1908, p. 19, Pl. I, Figs. 7, 8, 17, palp, legs 4 and 1.

[1] We are indebted to Professor Neumann for the gift of one of these specimens from which our figure was drawn.

Body: *L.* 5—6, *W.* 3—3·5 mm., with sides almost straight and parallel, conical anteriorly, bluntly rounded posteriorly, earthy yellow or dirty brownish red when replete, dorsum and venter covered by large glossy mammillae (150—200 μ in size); dorsum bearing large discs. When unfed the dorsal border is raised and thick and the dorsal surface undulating with a prominence over the capitulum, flanked by four symmetrical depressions; all of these, and other depressions posteriorly, disappear when the tick is gorged. Pre-anal and post-anal grooves, supra-coxal and coxal folds well marked, the coxal folds passing between coxae I and II. Post-anal groove with fine transverse striae. Anal frame almost as wide as long (225 × 200 μ), the valves bearing two to four hairs each. Spiracles conical, 100 μ broad, plate crescentic, situated dorsally on the supra-coxal folds. *Eyes absent*. *Capitulum* lying in a deep camerostome or *pit, with prominent lateral flap-like borders* which move as upon a hinge and protect the capitulum; ventral

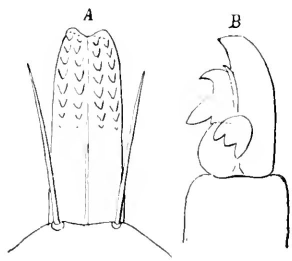


Fig. 88. *O. talaje*. *A*, hypostome (× 160). *B*, digit, 60 μ *l.* (Nn. 1896, fig. 34).

base of capitulum finely wrinkled transversely, permitting (according to Mégnin) the mouthparts to be protruded and retracted. Chelicera: digit 60 μ *l.* (Fig. 88 *B*) with tridentate dorsal process near base of internal article and external article bidentate. Hypostome (Fig. 88 *A*) emarginate, with many fine teeth distally, followed by dentition 2|2 covering half its length; two very long post-hypostomal hairs. Palps with articles 1—4 measuring respectively 134, 114, 80, 87 μ *l.* Numerous pennate hairs especially on dorsal surface of articles 1 and 2, a stout hair at the antero-internal angle of article 1. *Legs* long and slender; coxae contiguous, decreasing in size from pair I to IV, covered with granulations or mammillae posteriorly; tarsi tapering without marked distal protuberance, unless on pair I; all the articles bear semi-pennate hairs, which are longest on tarsi.

The foregoing description (condensed from Neumann, 1896, pp. 34–36) is based on the examination of three specimens from Cumana

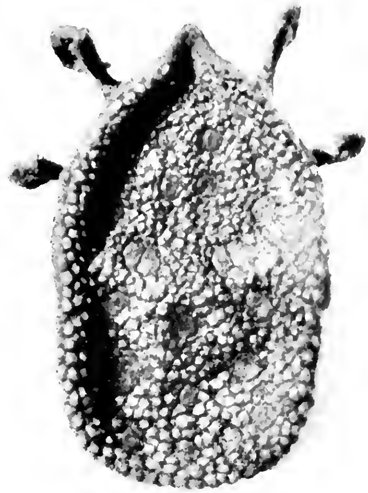


Fig. 1. *O. talaje*, var. *capensis*. Dorsal aspect, ×16. (Lounsbury Coll.)
Original, C. and R. phot.

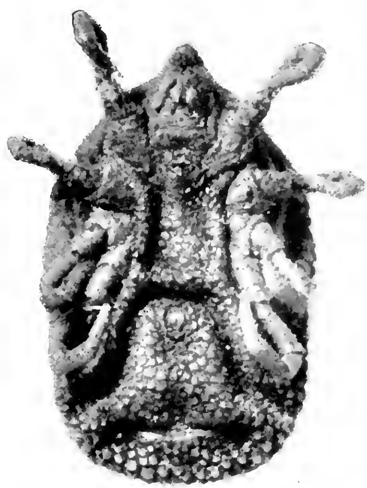


Fig. 2. *O. talaje*, var. *capensis*. Ventral aspect, ×16. (Lounsbury Coll.)
Original, C. and R. phot.

Venezuela (Paris Mus.), and two specimens collected by Sallé in *Guatemala*. Guérin-Méneville's specimens were collected on the route from Guatemala to Zacapa. Mégnin's specimens were sent from *Mexico* by Dugès. Karsch's specimens (in Berlin Mus., identified by Neumann) were collected in *New Granada* by Goudot. According to Neumann (1901, p. 258) the Paris Museum possesses specimens collected by Gay at *Santiago de Chili* and by Steinheil in *Colombia*, and Shauinsland found a nymph on the Island of Laysan, *Hawaii* (Poppe Coll.). We have examined specimens, determined by Neumann for the British Museum, from native houses at Santana-Totima, Colombia (nymphs 2·5 mm. *l.*; adults 5 × 2·5 mm.). Guérin-Méneville's specimens measured 5—7 mm. *l.*; those of Karsch 5·5 × 3 mm. Banks (1908, p. 19) records specimens from *Florida*, *Texas* and San Clemente Island, *California*.

Canestrini (1890, p. 536) found his *Argas coniceps*, together with *A. reflexus*, in the interstices of the mosaic of the Church of San Marco, *Venice*. Birula states that several specimens taken near the *Sea of Aral* are in the Zool. Mus. of the Acad. of Sc., St Petersburg. Canestrini's specimens measured 5—6 mm. *l.* The determination of this species or variety is doubtful.

This species approaches *O. turicata*, but is distinguished especially by the structure of the capitulum and legs.

Habitat: native houses, attacks man. (See further under Section II for effects of bite, etc.)

ORNITHODOROS TALAJE var. CAPENSIS Nn., 1901.

Figs. 58, 89 and Pl. III.

Lit.: Neumann, 1901, p. 258; 1907, p. 193.

According to Neumann this variety differs from the American type chiefly in (1) the cheeks or flaps being less developed in width, more separate at their attached borders, which do not appear capable of completely hiding the hypostome and palps and do not attain the level of the ventral surface of the base of capitulum; (2) by the longer and more abundant hairs on the movable articles of the legs. This variety is based upon numerous specimens collected in Penguin nests, on guano, on Islands off the coast of Cape Colony (Lounsbury Coll.). It readily attacks fowls when given the opportunity. It abounds in its native home. (Nn. 1901, p. 258.) Through the courtesy of Mr Lounsbury we have been able to examine his specimens. Moreover, the British

Museum possesses numerous specimens of nymphs and adults collected by the *Challenger* Expedition, 28, VIII. 1876, at St Paul's Rocks from birds' nests, where they were found together with small spiders, etc. The specimens, preserved in spirit, were mostly yellowish or reddish brown in colour. Neumann (XII. 1907, p. 193) records specimens found on the ground at Cargados Carajos (Siren Island) by Mr J. Stanley Gardiner.

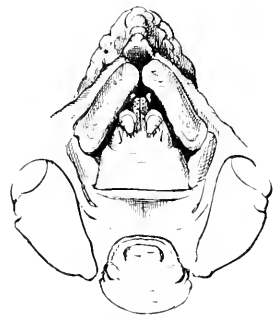


Fig. 89. *O. talaje* var. *capensis* ♂. Anterior portion of venter (same specimen as figured on Pl. III). Original, N. and W.

ORNITHODOROS PAVIMENTOSUS Neumann, 1901.

Figs. 90–92.

Lit. and Icon.: Neumann, 1901, p. 257, Fig. 1, of legs I and II*.—Dönitz, 1906, pp. 144–148, Pl., Figs. 2 and 3, of legs I and IV*.

Male: Unknown.

Female: Body short oval, rounded at both ends, 12 × 8 mm.; covered by *contiguous, flat granulations* (whence "pavimentosus"), smaller on the depressed areas; coarse hairs, especially anteriorly. In other respects like *O. savignyi*, except that the protarsi and tarsi of legs I, II and III are much shorter, with the dorsal protuberances arranged close together (see Fig. 58 and compare with Figs. 70, 71).

Neumann's description is based on a single dried[1] ♀ taken by Schenk at Bethany, Great Namaland, S. Africa (Berlin Mus.). In his original description, Neumann pointed out the differences in the leg structure between this species and *O. savignyi* (should be *O. moubata* as pointed out by Dönitz). According to Dönitz, who has examined many

[1] This may account for the "black" eyes.

specimens collected in Namaland by Schultze, *O. savignyi* generally has larger humps on the tarsi, but in two specimens of *savignyi* from Dongola, no differences in leg structure were observable. According to Schultze, *O. pavimentosus* has the same habits as *O. moubata* (*q.v.*), being common in places where travellers rest, and attacking men when they lie upon the ground (apparently its attack is not confined to the night time).

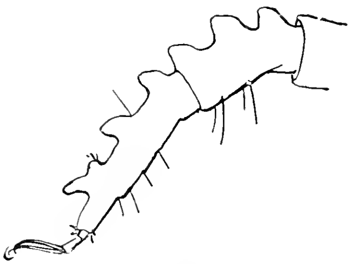


Fig. 90.

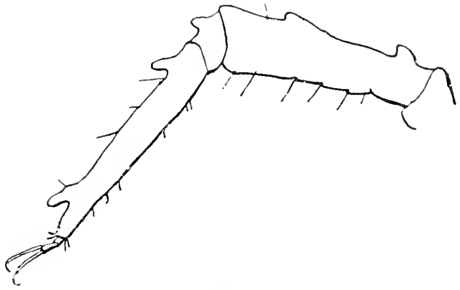


Fig. 91.

Fig. 90. *O. pavimentosus*. End of leg I of a specimen measuring 12 mm. *l*. (Dönitz, 1906, pl., fig. 2.)

Fig. 91. *O. pavimentosus*. End of leg IV of same specimen as preceding, tarsus 2·4 mm. *l*. (Dönitz, 1906, pl., fig. 2.)

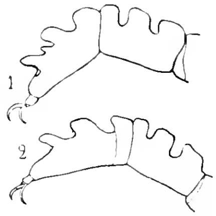


Fig. 92. *O. pavimentosus*. Ends of legs I and II. (Nn. 1901, fig. 1.)

ORNITHODOROS ERRATICUS (Lucas), 1849.

Syn. and Lit.: *Argas erraticus* Lucas, 1849, p. 316, gives a fairly good description, considering the date.

Ornithodoros miliaris Karsch, 1880, p. 141: brief Latin description of three lines. Neumann, 1901, p. 256, examined the type and referred it to *O. erraticus*.

Ornithodoros erraticus (Lucas) Neumann, 1896, p. 37.

Icon.: No figures published.

Body 5 × 3 mm., oval (lateral borders parallel in the young), tapering anteriorly to a rounded point. Integument thin, with closely crowded hemispherical granulations of unequal size (75 to 100 μ), with some short claviform hairs between them; large symmetrical discs, of which four in a transverse series across the middle of the dorsum; another transverse series in a groove which limits posteriorly a dorsal prominence corresponding to the capitulum; a broad undifferentiated margin. No eyes. *Venter:* well-marked pre-anal groove, concave behind; post-anal groove midway between the anus and the posterior border; post-anal median groove extending beyond the post-anal, but not reaching the posterior border; anal frame 230 × 200 μ; anus with hairs on the valves. *Spiracles* semicircular (?), 100 μ wide. *Capitulum* free, exposed ventrally; palps 1, 4, 2, 3[1]; numerous pennate hairs on the dorsal surface of the palps and basis capituli; hypostome resembling that of *O. talaje*, a crown of denticles being followed by 2 | 2 files of 5 or 6 stout teeth, then squamiform teeth 3 | 3, then 4 | 4; two pennate hairs at the base of the hypostome. *Legs* medium; coxae contiguous, the first pair only being slightly granulated; article 2 conical, the others cylindrical; tarsi only slightly humped.

Neumann's description, from which the above is taken, is based on three specimens from Algiers. Pavesi (1884, p. 485) records two specimens, 3·5 mm. *l.*, found by Doria in the vicinity of Tunis, one from Nemours and two from Marnia (?). Lucas received his three specimens (4 × 2·5 mm. in size) from the plain of Lake Houbeira, near La Calle. They were found beneath stones where *Bufo pantherinus* was also in hiding. Karsch's *O. miliaris* came from Bengal (type in Berlin Mus., Karsch gives the size at 2·5 × 1·7 mm.). Neumann states that it resembles *O. talaje*, but does not possess the lateral expansions of the camerostome. These specimens also differ in the details of the digits of the chelicerae, and in the tegumentary characters of the legs.

[1] The relative lengths of articles.

ORNITHODOROS THOLOZANI (Laboulbène and Mégnin), 1882.

Figs. 93, 94.

Syn., Lit. and Icon.: *Argas tholozani* Laboulbène and Mégnin, 1882, pp. 335–337, Pls. XXII and XXIII; the figures include: adult dorsum and venter, capitulum, hypostomes (♂ and ♀), digits, palp, integument, tarsus; larva (showing intestinal caeca apparently passing into the legs), the ovum.—Blanchard, 1890. —Neumann, 1896, p. 38, Fig. 35*.—Dubreuilh and Beille, 1896, p. 80, Fig. 8 (copied from Laboulbène and Mégnin).—Braun, 1906, p. 373. O.
(*Argas papillipes* Birula, 1895, pp. 38–44, Fig. 35; digits of ♂ and ♀; referred here by Neumann, 1901, p. 259. See *O. papillipes*, p. 79.)
Native name: "Kené" or "sheep bug" in Persia (Laboulbène and Mégnin, 1882, p. 329).

Adults: *Body* (the ♂ varies from 4 × 2 mm. to 6 × 4 mm.; the ♀ from 8 × 4 mm. to 10 × 5 mm.), with lateral borders nearly straight and parallel, tapering abruptly, but sinuously, to a rounded process in front, and broadly rounded behind; a broad margin is marked off from the rest of the dorsum by a well-defined marginal groove. Integument coarsely shagreened, then, with numerous short hairs, longer and more apparent anteriorly; hemispherical granulations 40—60 μ in diameter; giving the effect of a network of meshes limited by creased folds; one mesh out of every 5 or 10 bears a long hair. Discs similar to those of *O. erraticus*, but relatively smaller; seven on the anterior median prominence arranged in three rows (3, 2, 2), surrounded by an irregular circle of similar discs whence a median row starts posteriorly, double at its origin and reaching the posterior border. A short row on each side, and other scattered discs. On the ventral surface discs occupy the depressions and grooves. No eyes. *Venter:* pre-anal groove deep, concave behind; post-anal groove nearly straight; median post-anal groove nearly reaching the posterior border; sexual orifice in ♂ and ♀ between coxae II; anal frame wider than long (300 × 350 μ); anus with seven or eight long hairs on each side. Spiracles (350 μ), crescentic. *Capitulum:* palps tapering, and not much longer than the hypostome; chelicerae (digits, Figs. 93, 94). The hypostome differs in the sexes: in the ♂, it is somewhat spatulate and indented, a crown of small teeth being followed by two rows of three teeth on each side, the middle rows not far apart; then three or four rows of simple squamiform teeth; in the ♀, it is somewhat lanceolate, and the dentition is 2 | 2 throughout, the median rows being far apart. Four long hairs (post-hypostomal and post-palpal) on the base of the capitulum, as in *O. avignyi*. *Legs* fairly long and slender; coxae II—IV contiguous; tarsi 2—4 with terminal dorsal protuberance prominent, pointed and directed distally, the terminal portion tapering. Short hairs on all articles, longest on the tarsi.

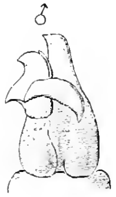


Fig. 93.

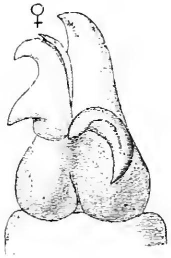


Fig. 94.

Figs. 93 and 94. *O. tholozani*. Left digits of ♂ and ♀. (Nn. 1896, fig. 35.)

Nymph: resembles the male but has no sexual orifice.

Larva: 1 × ·5 mm. when newly hatched; a circular dorsal area (disc ?); the intestinal caeca pass into the legs (Laboulbène and Mégnin).

Egg: yellowish brown, ·8 × ·6 mm.; about 100 laid by each ♀ (Laboulbène and Mégnin).

This species is allied to *O. erraticus*, from which it may be distinguished by its tarsi and the dimorphism of the hypostome.

Origin: *Persia*, where Neumann states they were collected by Tholozan, mostly in a chicken yard at Teheran, others were found on camels (specimens in Paris Mus.).

The above descriptions of the adult and nymph are condensed from Neumann, who has communicated certain particulars by letter (6 April, 1908), stating that Laboulbène and Mégnin figure the tarsus inaccurately, and that his description is based on the examination of specimens received at the Paris Museum from Dr Tholozan at the time when Laboulbène and Mégnin received theirs from the same source. We have, unfortunately, not succeeded in obtaining a specimen of this tick. Neumann's description does not agree in some respects with Laboulbène and Mégnin's figures, but he assures us that these are inaccurate.

Laboulbène and Mégnin (1882, p. 329) state that they were fed on man and rabbits in Paris and (p. 337) that unfed specimens survived four years.

ORNITHODOROS LAHORENSIS Neumann, 1908.

Figs. 95–100.

Lit. and Icon.: Neumann, 1908, p. 17, Figs. 12–15 (here reproduced, p. 68).

Adult (Figs. 95–97). *Body:* ♂ 8 × 4·5 mm., ♀ 10 × 5·6 mm.; lateral borders parallel with a faint constriction behind coxae IV; the anterior extremity narrowed to form a conical hood, more pointed in the ♂; posterior border broadly rounded. Colour earthy yellow, legs paler. *Dorsum* convex anteriorly, irregularly concave posteriorly, grooves and discs as in figure, the principal discs being 2 oval, parallel, near together in front, and 4 circular forming a trapezium, narrower anteriorly, in front of the middle of the dorsum, the integument between the discs not

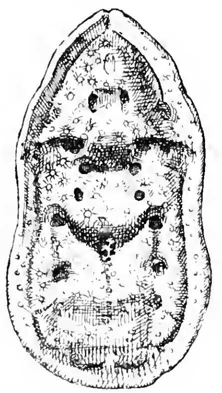


Fig. 95.

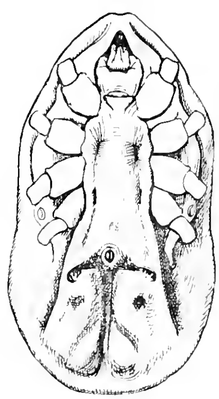


Fig. 96.

Figs. 95, 96. *O. lahorensis* ♀. After feeding and ovipositing, 10 mm. *l.* Original, N. and W.

granular but finely wrinkled, the wrinkles radiating from the discs. A few very short and scattered hairs. No eyes. *Venter:* anus about half way between the basis capituli and the posterior border; pre-anal groove shallow and incomplete; post-anal groove immediately behind the anus, a well-marked ano-marginal groove, occupied by a file of discs; on either side of it several depressions with discs; camerostome triangular, deep, narrow, longer than broad (♂) or about as long as broad and less pointed (♀), its sides converging and uniting in part in a transverse lip. Hairs longer and more abundant, especially in front, than on the dorsum. Spiracles semi-lunar, equal to (♀) or larger (♂) than the anal ring.

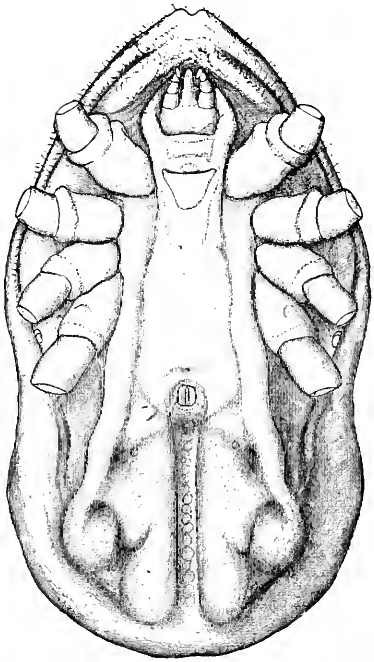


Fig. 97. *O. lahorensis* ♀. Nn. 1908, fig. 12 (circa 10 mm. *l.*).

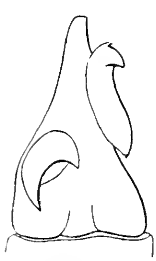


Fig. 98.

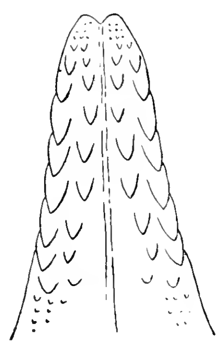


Fig. 99.

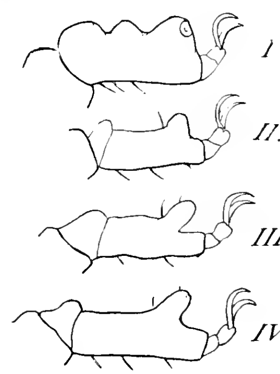


Fig. 100.

Fig. 98. *O. lahorensis*. Adult, digit, ×215. Nn. 1908, fig. 13.
Fig. 99. *O. lahorensis*. Adult, hypostome, ×120. Nn. 1908, fig. 14.
Fig. 100. *O. lahorensis*. Adult, tarsi I—IV, ×28. Nn. 1908, fig. 15.

Capitulum (♀ about 1·2 mm. long); chelicerae (see digit, Fig. 98); hypostome (Fig. 99) long, lanceolate, indented at the end, 2 | 2 files of eight or ten teeth, the internal files far apart; palps cylindro-conical, the articles 300 μ, 250 μ, 150 μ and 200 μ respectively; long hairs, curved forward, on dorsal surface of articles 2 and 3. *Legs* medium, coxae (Fig. 96) sub-conical, coxae I and II slightly separated, the others contiguous; tarsus I (Fig. 100) with three blunt dorsal prominences; tarsi II, III and IV with very short proximal false articulation, prominent dorsally, and with progressively longer blunt spurs near the distal end of the distal false-articulation.

Nymph: Neumann has recognised two nymphal forms:

First nymph: 5·5 × 2·7 mm. Integument with very fine folds, with a few spiniform hairs, discs hardly visible; the ventral grooves only faintly marked, except the ano-marginal. No trace of sexual aperture; camerostome shallow; legs short and thick.

Second nymph: attaining 11 × 6 mm. Integumental folds coarser and polyhedric; discs visible, hairs almost absent; a punctiform sexual orifice[1]; camerostome deeper, but less completely filled by the capitulum; legs like the adult, but with spurs less pronounced.

Taken from *Ovis aries* in Lahore by E. Montgomery (all were collected in the nymphal stage in January, 1906, but six weeks afterwards some gave rise to adults. Collection of the Liverpool School of Tropical Medicine). Our figure is drawn from a living ♀ kindly sent to one of us by Mr Newstead (Liverpool). We received a ♂ and ♀. The ♂ fed for 25′ on a fowl 7. v. 1907, for 45′ on 2. xii. 07 and was killed and preserved 27. iii. 08. The ♀ refused to feed 7. v. and 11. vi. 07, she began to oviposit 27. xi. 07, fed for 2 hours 20′ on 2. xii. and began again to oviposit 9. xii. She lived until iii. 08 when she was lost. All the eggs, about 80, proved sterile. The ticks refused to feed on other occasions (G. H. F. N.). Our specimens agreed so closely with the description of *O. tholozani* given by Laboulbène and Mégnin that we referred it to this species, from which, however, as Neumann informs us, it differs in the structure of the integument and tarsi, L. and M.'s figures of the tarsi being inaccurate.

[1] Doubtless but an "Anlage," in any case imperfect.

ORNITHODOROS FURCOSUS Neumann, 1908.

Fig. 101.

Lit. and Icon.: Neumann, 1908, p. 21, Fig. 16 (here reproduced).

Female: 10 × 5 mm.; lateral borders nearly parallel with anterior conical hood; posterior border broadly rounded; blackish-brown, capitulum and legs paler. Dorsum irregularly convex; integument granular, the granulations larger than the intervals between them; a few long hairs more abundant in front. No eyes. *Venter* convex, the folds not well-marked; anus nearer to the posterior border than to the vulva; camerostome shallow, without lateral folds; vulva between coxae I. Spiracles circular, prominent. *Capitulum* (about 1·4 mm. *l.*); base flat ventrally, very convex dorsally, nearly as deep (dorso-ventrally) as broad; hypostome somewhat lanceolate, 2 | 2, the inner files far apart; palps long, tapering, forwardly curved hairs on the dorsal surface of articles 1, 2 and 3. *Legs:* long, especially pair IV; coxae sub-conical, contiguous with wrinkled integument; coxa II larger than I; coxa III smaller than I; coxa IV still smaller; article 2 sub-cylindrical, rather longer than broad; articles 3, 4 and 5 very long and swollen at their distal extremities; tarsi forked, owing to a sharp terminal dorsal spur; tarsus I has three low, rectangular dorsal prominences in addition; tarsus IV very long.

Described from one ♀ in bad condition, taken at Riobamba (Equador), by Dr Rivet (Paris Mus.).

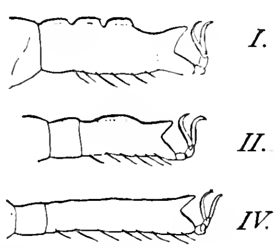


Fig. 101. *O. furcosus* ♀. Tarsi I, II, IV, ×20. Nn. 1908, fig. 16.

ORNITHODOROS MEGNINI (Dugès), 1883.

Figs. 102–112.

Synon.: *Argas megnini* Dugès, 1883, p. 196.
"*Argas americana* Packard": Townsend, 1893, p. 50.
Rhynchoprium spinosum Marx, 1895, p. 199.
Ornithodoros megnini (Dugès) Neumann, 1896, p. 42.
The "*Spinose Ear Tick*" of American authors.

Lit. and Icon.: Dugès, 1883, p. 195[1].—Mégnin, 1885, p. 460, Pl. XXI, Figs. 1–8.—Neumann, 1888, p. 96[2]; 1892a, p. 101[2]; 1892b, p. 105.—Blanchard, 1890, p. 883 *et seq.* O.—Railliet, 1895, p. 718.—Townsend, 1893, p. 49.—Dolly, 1894, p. 980[2].—Marx, 1895, p. 195, Figs. 1*a–i*, reprinted by Osborn, 1896 (p. 255), Pl. III; Figs. 1 and 1*a* reproduced by Salmon and Stiles, 1901, and in this book.—Neumann, 1896, p. 42, Fig. 36 (here reprinted).—Ward, 1900a, p. 199, Fig. 3 (good figures of nymph, dorsal and ventral aspects, but termed "full-grown" adult by author; agrees very well with Marx's figures).—Stiles and Hassall, 1901, repr. 2 pp.—Salmon and Stiles, 1901, p. 408, Pl. LXXIX (coloured, of nymphs and adults (?) natural size and × 2), two figures after Neumann's Fig. 36; Fig. 98, integument of nymph; Figs. 103, 105–107 represent the larval capitulum, the "pupa-like stage," the larval tarsus; the remaining (essential) figures here reprinted.—Simpson, 1901, repr. 7 pp., 3 Figs. (2 photographs of spinose nymph, dorsal and ventral aspects; rough sketch of spiracle, both by S. G. Wheler).—Wheler, 1901, p. 61; 1903, p. 49.—Banks, 1904, Fig. 72, after Marx.—Braun, 1906, p. 374. O.—Hooker, 1908a, pp. 40, 42, 45, 51.—Banks, 1908, p. 17; Pl. I, Figs. 9–12, palp, legs 4 and 1, integument.

Adult (Figs. 102, 103): Body panduriform, slightly attenuated anteriorly; broadest at legs 2 or 3, constricted behind legs 4, broadly rounded posteriorly; colour brown to violet or black. *Dorsum:* symmetrical depressions, one arciform, longitudinal, from each side of the projection corresponding to the capitulum; lateral and slightly anterior to this an infundibuliform depression; posteriorly along the lateral border, a longitudinal groove of variable length, sometimes interrupted; a median groove occupying the greater length of the posterior half. *Venter:* pre-anal groove absent; replaced by a first post-anal groove at a tangent to the anal frame, straight and joining the coxal groove; the true post-anal groove near posterior border; a broad median anal groove terminating at this posterior groove. Supra-coxal and coxal folds broad,

[1] Original inaccessible, passages quoted in Salmon and Stiles, 1901, and referred to by Neumann, 1896.

[2] Unimportant, cited in bibliography by Salmon and Stiles, 1901.

well marked. *Spiracles* circular, 250 μ in diameter, stigmal plate semilunar (resembling Fig. 10). Anus: anal frame broader than long (150 to 200 $\mu \times$ 200 to 250 μ), each valve provided with four short hairs. *Eyes absent.* *Integument* (see Fig. 102) with small circular, shallow pits (not mammillae) with short central hairs, the whole surface

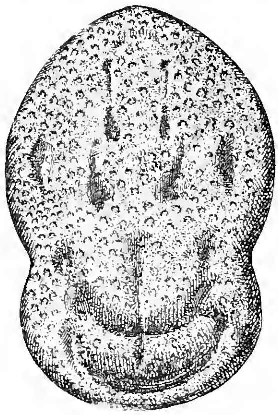


Fig. 102.

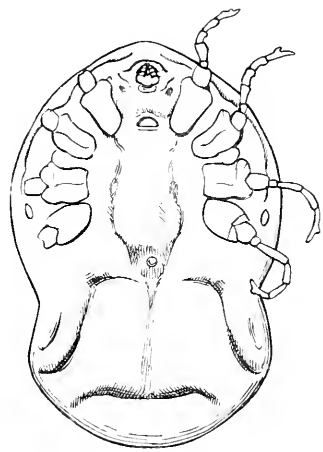


Fig. 103.

Figs. 102, 103. *O. megnini* ♂, $\times$ 8. Dorsum and venter. From specimen, loaned by Prof. Neumann, from New Mexico, U.S.A. Original, N. and W.

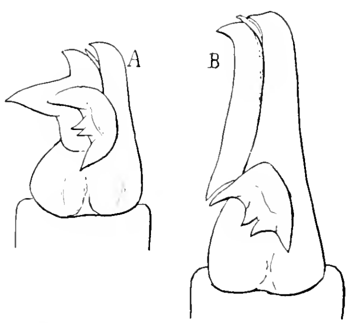


Fig. 104. *O. megnini.* *A*, digit of nymph, 85 μ *l*. *B*, digit of ♀, 75 μ *l*.

being finely granular like sandpaper. Reticulate fossettes occupy the ventral and dorsal depressions; others scattered here and there. On the ventral surface, between the two post-anal grooves, extremely small and crowded spines. *Capitulum* very small and very short; 150 μ (from base of palps to tip of hypostome). Chelicerae: see Fig. 104 *B*.

Hypostome short, broad basally, rounded distally, *unarmed*[1]. Palps thick, 300 μ long (90 μ, 85 μ, 65 μ, 60 μ, from first to fourth article), with articles relatively broad and short, the second 110 μ broad; on dorsal surface of the articles, especially on the first and dorsally on the basis capituli, posterior to the palps, numerous pennate hairs. Two post-hypostomal hairs. *Legs* comparatively thinner and a little shorter than in the nymph; coxae disposed as in the other members of the genus: a dorsal tuberosity on tarsi (see Fig. 58). *Size:* ♀ *L.* 5 to 6 mm., *W.* 3 to 4 mm.; ♂ somewhat smaller. We have received 2 ♂ and 1 ♀ from Texas (W. D. Hunter), the ♂♂ measured 6·7 and 7 mm. *L.*, the ♀ 7·5 mm. *L.*

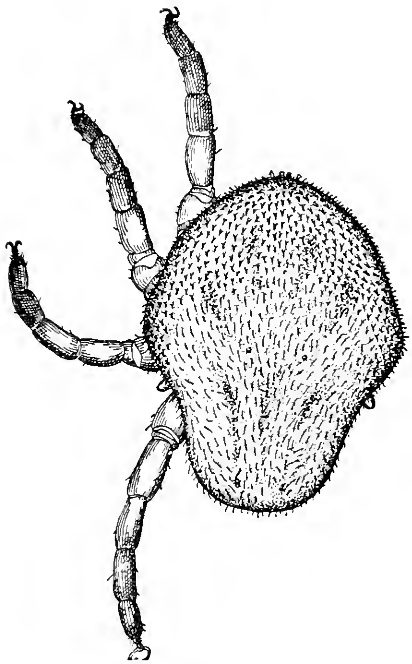


Fig. 105.

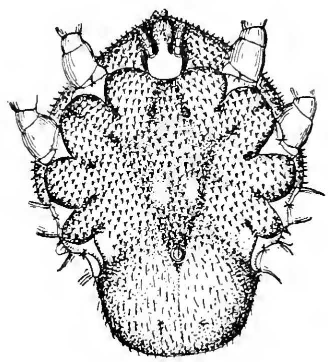


Fig. 106.

Figs. 105, 106. *O. megnini.* Unfed. Nymph, dorsal and ventral aspects. Salmon and Stiles, 1901, figs. 94, 95 after Marx, 1895, pl. II, figs. 1 and 1 *a*. 17th Ann. Rep. B.A.I., U.S. Dept. Agric.

Nymph (Unfed. Figs. 105–107). Body somewhat lozenge-shaped, slightly longer than broad, greatest breadth at about the third pair of legs, anterior to this the outline is rounded; posteriorly, suddenly con-

[1] Note observations on this point in Section II.

tracted at the fourth pair of legs; border thick, dorsal surface more or less undulating. *Integument,* both ventrally and dorsally, is beset with posteriorly directed spines or bristly hairs: the spines on the dorsum are much crowded and form a crescentic area anteriorly with concavity directed posteriorly, the horns thereof extending laterally to legs 2 and 3 (Neumann) or to legs 3 and 4 (Salmon and Stiles); the rest covered by bristly hairs; ventrally, the spines extend to or slightly beyond the

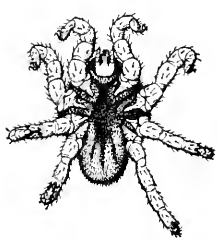


Fig. 107.

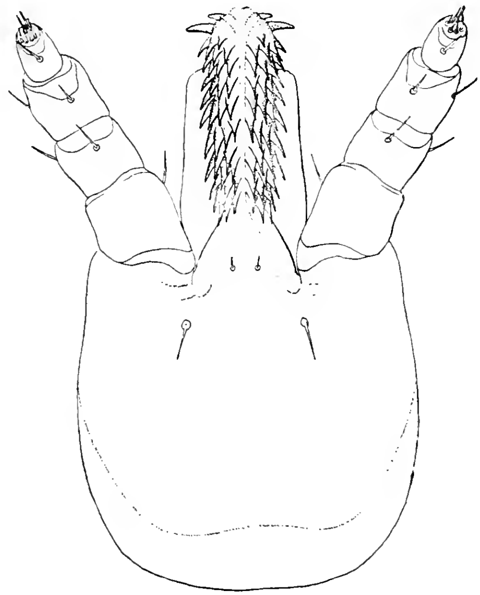


Fig. 108.

Fig. 107. *O. megnini.* Unfed. Nymph, ventral aspect. Salmon and Stiles, 1901, fig. 100. 17th Ann. Rep. B.A.I., U.S. Dept. Agric.

Fig. 108. *O. megnini.* Capitulum of nymph, ventral aspect. Salmon and Stiles, 1901, fig. 99. 17th Ann. Rep. B.A.I., U.S. Dept. Agric.

anus; integument finely striated, pits absent. Colour, unfed, earthy yellow; replete, violet brown; when replete, the contours more rounded, integument glossy, the spines more separated owing to stretching of integument between them. Anus very small, slightly broader (110 to 120 μ) than long; two long hairs on each external border. Spiracles 300 to 350 μ in diameter, on salient tubercles[1] (seen in Fig. 105) near

[1] Wheler (1901) states that in the living specimen he has seen a "pointed organ," protruded and retracted from the apex of the tubercle, and he gives a rough figure of it in Simpson's paper. The structure requires further study.

the dorsal border, between coxae III and IV; stigmal plates covered by numerous hairs. *Capitulum* (Fig. 108) subterminal in first-stage nymphs, inferior in later stage nymphs, elongate, base as long as palps; about 375 μ long (from base of palps to tip of hypostome); chelicerae (see Fig. 104 *A*); hypostome lanceolate, dentition 4 | 4, with 7 to 9 teeth per file; palps thick (articles 1 to 4 measure 140, 125, 110, 180 μ); second article 110 μ broad; simple hairs, not very numerous, on articles 2—4, six to eight short terminal bristles; some short thick hairs, symmetrically placed, on basis capituli. *Legs* long and strong; coxae very short, but broad, distant from median line, almost marginal; other articles cylindrical, relatively short compared with their diameter; terminal portion of tarsi elongate, claws strong, pulvillum absent, hairs sparsely distributed on all articles. *Size:* 3 to 4 mm. long, when unfed, to 8·5 mm., when maturer and gorged, the latter 5·5 mm. wide (Neumann).

The foregoing description of the adult is partly based on that of Neumann (1896, pp. 43, 44), that of the nymph on the descriptions of Neumann (*ibid.*, pp. 42–43), and Salmon and Stiles (1901, pp. 409–410). According to Hooker (1908, p. 40 *et seq.*) there is but one nymphal stage. The full-sized nymphs we have seen conform to the adults in general appearance but differ in having no sexual aperture and having the hypostome armed as in Fig. 108. We have verified the descriptions by the examination of specimens in our possession, and have added matter of our own.

Larva[1] (Figs. 109–110): hexapod, elongate oval, with long terminal capitulum, measuring 0·61 mm. from tip of hypostome to posterior extremity. *Integument* finely striated with symmetrically arranged pits, from which bristle-like hairs issue. *Capitulum:* hypostome 2 | 2, almost as long as palps; palps: articles 2 and 3 equal, 1 and 4 short; large pits in inter-coxal spaces 1 and 2. *Legs:* pulvillum small (see Fig. 111).

Gorged larvae attain 4 × 2 mm. (Salmon and Stiles' "pupa-like stage," see Fig. 112); they appear as "rounded white pyriform structures with one end elongate," the "distended smooth hexapod skin with terminal capitulum" contains the spinose nymph "with subterminal capitulum, and with well-developed claws on the tarsi, and four rows of denticles on each half of the hypostome." (Condensed and modified from Salmon and Stiles, 1901, pp. 410–411.) This is obviously the stage which Townsend (1893, p. 49) interpreted as an egg.

"This tick is remarkable for the difference in appearance between

[1] Also described by Stiles and Hassall, 1901.

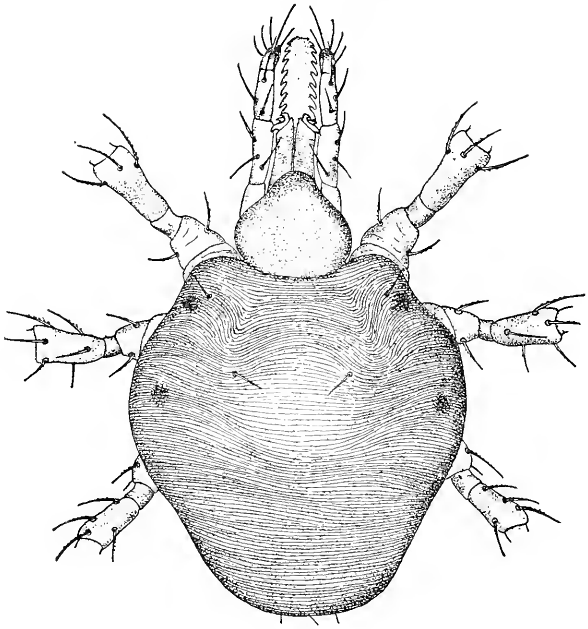


Fig. 109.

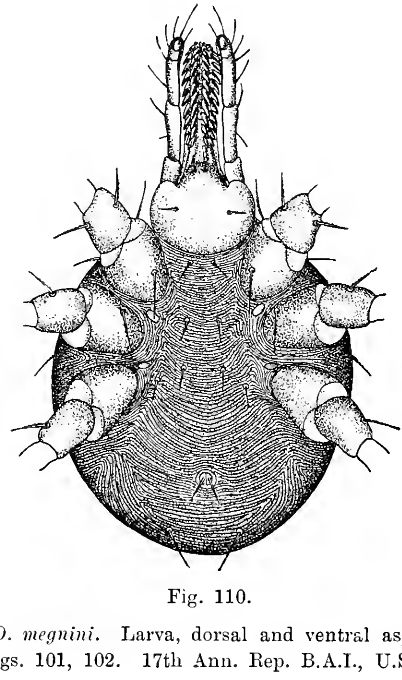


Fig. 110.

Figs. 109, 110. *O. megnini*. Larva, dorsal and ventral aspects. Salmon and Stiles, 1901 (figs. 101, 102. 17th Ann. Rep. B.A.I., U.S. Dept. Agric.).

the young spiny stage and the adult form, a difference that is so great that the two stages have been described as belonging to different species" (Salmon and Stiles). The identity of the different stages has, however, been fully established by Neumann and Salmon and Stiles.

Hosts: occurs chiefly in the ears of the horse, ass, ox, and not infrequently in the human ear in Mexico (Dugès). Simpson (1901) has reported a case in which two spinose nymphs occurred in the ear of a gentleman who came to England from Arizona where he had been camping in June. One tick came away and the other was removed in the end of August.

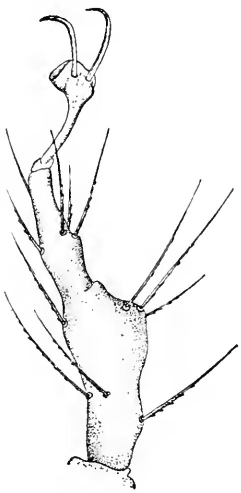


Fig. 111.

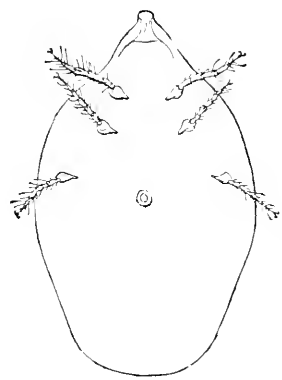


Fig. 112.

Fig. 111. *O. megnini.* Leg of larva, tarsus I in profile.
Fig. 112. *O. megnini.* Larva, gorged, so-called "resting- or pupa-stage."
Both figures from Salmon and Stiles, 1901 (figs. 108 and 104. 17th Ann. Rep. B.A.I., U.S. Dept. Agric.).

Geographical distribution: it was first described from *Mexico* by Dugès (1883), who states it is very abundant in the State of Guanajuato, and it has been reported from various parts of the *United States, i.e.* Louisiana, Texas, New Mexico, Arizona, California, Nevada, Idaho, Iowa, Kentucky, Kansas and Nebraska (Salmon and Stiles, 1901, p. 411; Banks, 1908, p. 17).

ORNITHODOROS CANESTRINII (Birula), 1895.

Fig. 113.

Synon.: *Argas canestrinii* Birula, 1895, p. 353.—Neumann, 1901, p. 260.

Icon.: Birula, 1895, Pl. I, Figs. 1–3. Anterior part of venter, tarsus I, anus (Figs. 1 and 2 here reproduced).

Body (♂ 10 × 5 mm., ♀ 14 × 8 mm.) elongate, with sides sub-parallel, rounded posteriorly, cone-shaped anteriorly. General colour fawn or blackish fawn-coloured, lighter on venter; palps and legs lighter. Eyes absent. No grooves on venter. Integument finely wrinkled dorsally, with rounded depressions, shallow, confluent in places; on the ventral surface, integument smooth on the median line and on coxae; sexual aperture between coxae I (in ♂ and ♀); on each side of the base of the capitulum,

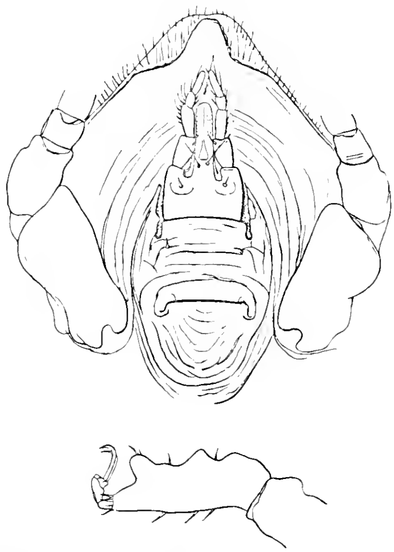


Fig. 113. *O. canestrinii* ♀; anterior part of venter, and tarsus I; slightly modified from Birula, 1895, pl. I, figs. 1, 2.

a fold half as long as capitulum. *Capitulum:* base rectangular, scarcely wider than long; hypostome elongate, rounded and not indented at its apex, one and a half times as long as the base; dentition 2 | 2, two rather long hairs ventrally on its base; palps longer than hypostome, bearing hairs on their dorsal border; article 1 very thick; article 2 of the same length, more slender; article 3 a half shorter. *Legs* stout; coxa I divided in two short, rounded teeth; tarsus 1 bearing three successive protuberances on dorsal border; a single one near distal extremity of the other tarsi.

Found at Teheran, Persia, by E. v. Keyserling (1839) and at Tasch-Burun, Caucasia (1885). (After Birula's description with the aid of his figures.)

We are not acquainted with this tick but admit it provisionally as a good species since in the detailed figure it resembles no species known to us.

ORNITHODOROS PAPILLIPES Birula, 1895.

Fig. 114.

Lit. and Icon.: A. Birula, 1895, p. 354, Pl. I, Figs. 4-6, anterior portion of venter, including capitulum, tarsus IV, Haller's organ (Figs. 4 and 5 here reproduced).

Body 7 × 4 mm. elongated, oval, rounded behind, prominent in front (uncleft); reticulate-rugose, grey or greyish-yellow. No eyes. Lateral folds of camerostome constricted in the middle. (Apparently free in figure.) *Venter*: genital orifice behind coxae I. *Capitulum* (1 mm. *l.*), base almost square, 3 small setae on each side; hypostome 2 | 2, about as long as the base; palps short and thick; two long hairs at base of

Fig. 114. *O. papillipes* ♀. Anterior part of venter, and tarsus IV; slightly modified from Birula, 1895, pl. I, figs. 4, 5.

hypostome; two hairs posterior to the palps. *Legs* (pair I, 4 mm., pair IV, 5 mm. *l.*); a single hump on all the tarsi.

Neumann is probably correct in considering *O. papillipes* a synonym of *O. tholozani*, since, as he informs us in a letter (6. iv. 08), in the copy of Birula's paper which he had received from the author the latter had crossed out the name *papillipes* and substituted "*tholozani* (Laboulbène and Mégnin)." He points out, also, that the integument is similar "corporis derma reticulato-rugosum." Birula's figures, however, are difficult to reconcile with the description of *O. tholozani* given above, especially as regards the sides of the camerostome and the tarsi, so that we have thought it best to insert them here, together with his description of *O. papillipes*.

Birula's specimens were collected in the Caucasus by Motschulsky.

ORNITHODOROS MORBILLOSUS Gerstaecker, 1873.

Lit. and Synon.: *Ornithodoros morbillosus* Gerstaecker, 1873, p. 464.

Ornithodoros savignyi (Audouin); referred to this species by Neumann, 1896, pp. 27–29, but Dönitz, 1907, p. 23, who has examined the type, states that it differs in the leg structure as noted below.

Species based on a single specimen, measuring 6·3 × 4·3 mm., which may be an abnormality. Dönitz (1907) states that it differs from *O. savignyi* in having 2 *humps on tarsus IV* instead of 3. Gerstaecker only had Savigny's figure (1826) to consult in determining the differences. *Origin:* Lake Jipe, German East Africa, October 1862.

SECTION II.

DEALING WITH THE GENERAL BIOLOGY OF THE ARGASIDAE—THE EFFECTS OF THEIR BITES,—THEIR RELATION TO THE SPREAD OF DISEASE, ETC.

Argas *persicus* (p. 81), *reflexus* (p. 91), *brumpti* (p. 95).

Ornithodoros *savignyi*[1], *coriaceus* (p. 102), *turicata* (p. 102), *talaje* (p. 103), *pavimentosus*[1], *tholozani* (p. 103), *lahorensis*[1], *megnini* (p. 103).

ARGAS PERSICUS.

The life-history has been carefully studied by Lounsbury (1903, pp. 6—11).

The eggs are laid in the hiding places of the adults, in cracks and crevices in the walls, etc. Fuller (1896, p. 593) and Brown (1902, p. 86) state that oviposition takes place occasionally on fowls. The eggs are laid in batches of about 20, 50, 100 more or less, usually about a week after feeding in warm weather, and hatching begins in about three weeks.

The larvae which issue from the eggs are almost colourless, and in Lounsbury's experience, die if unfed within 8 weeks. When the chitin has hardened they attach themselves to a host within a few minutes, as we have observed. After about 3 days they swell visibly, appearing as small dark spheres on the skin of the fowl. On the 5th day they drop off, but if the weather is cool they may remain attached for 10 days. The body has now flattened (Fig. 20, p. 16) and assumed somewhat the form of that of the adult. In summer, moulting follows after about 8 days (Lounsbury).

First nymphal form: the ticks feed quickly from now on to the adult stage, taking $1\frac{1}{2}$—2 hours to gorge[2]. After about two weeks, in warm weather, they moult and the *second nymphal form* appears. These in turn feed upon a host and after some weeks moult and

[1] The few facts known regarding the biology of these species are included under Section I: *savignyi* (p. 42), *pavimentosus* (p. 62), *lahorensis* (p. 67).

[2] See feeding experiments in Cambridge, noted below.

appear as *Adults*: the *female* feeds more plentifully than the male and increases in size, whereas the *male* may be mistaken for a second nymphal form. *Copulation* was observed four times by Lounsbury, the male inserting his mouthparts (not the palps) into the vulva—after the manner observed in Ixodidae.

Feeding: the adults feed about once a month in hot weather, at longer intervals when it is cool. No feeding may take place during the winter. Experimenting with adults, Lounsbury found that females were ready to feed after each batch of eggs had been laid, remaining practically stationary prior to oviposition. Batches of eggs were laid after each meal. He liberated the hungry ticks in the bird cages at night. Few eggs were laid after the fourth feeding and fewer still after the fifth and sixth. It took about 10 months to raise one lot of ticks from egg-stage to egg-stage, thus completing the life-history. Although under natural conditions they appear to feed only at night (the larvae excepted), nymphs and adults have fed readily upon fowls and pigeons etc. in the Laboratory at Cambridge when protected from strong light. Oken (1818) also notes that they occasionally attack man during the day-time in Persia, they are not, therefore, "strictly nocturnal" as stated by Riley and Howard (1895). Lounsbury (1903, p. 7) is correct in stating that *persicus* is "always uneasy in strong light, and tends to crawl away from it." When disturbed, they often sham death, lying still with their legs retracted.

The following observations were made by one of us (N.) in Cambridge upon specimens received alive from India, S. Africa, Egypt and N. and S. America:

Larvae were placed on fowls in cages and observed from day to day.

Experiment I.	20.	iii.	1907	larvae placed on fowl, some attached themselves at once.
	23.	"	"	larvae measure 1 mm. in length, appear as blueish black points, somewhat rounded, hanging by capitulum, like Ixodidae.
	24.	"	"	larvae measure over 1 mm., appear spherical, blackish.
	25–26.	"	"	an equal number dropped off each day (8 in all), they appeared blackish, but flattened[1], with hood projecting quite over the capitulum; measured 2 × 1·5 mm.
	27.	"	"	one gorged larva found in cage.
	13.	v.	1907	Nymphs of first stage appeared.

[1] Hooker (1908 a, p. 39) states that the larvae are globular in shape up to within a few hours of their abandoning the host. They then become flattened like the adult ticks which

Experiment II.	4. iv. 1907	larvae placed on fowl.
	9. iv. 1907	larvae (29) found gorged.
	10. iv. 1907	larvae (17) found gorged.
	2. vi. 1907	Nymphs of first stage appeared.

The larvae in both experiments remained attached 5—6 days and first-stage nymphs issued after a further interval of 48 to 53 days, the ticks being kept at about 20° C.

First Stage Nymphs feed rapidly; thus 14 specimens were observed to drop off gorged within 35 minutes. *Second Stage Nymphs* were on one occasion observed to cast their skins 15 days after feeding, having been kept at 24° C.

Second Stage Nymphs and Adults appear to feed still more rapidly, but at times the process of feeding may be much prolonged, especially if the ticks have grown feeble or been starved too long. Where they gorge rapidly (in 5—10 minutes), they often discharge clear fluid from the 1st inter-coxal space, as observed in *Ornithodoros moubata*, *O. savignyi*, etc. The following table contains a record of the time consumed in feeding by all the ticks experimented with:

103	16	fed in	5 minutes	22	4	fed in	50 minutes
	22	,,	10 ,,		3	,,	55 ,,
	9	,,	15 ,,		6	,,	60 ,,
	22	,,	20 ,,		1	,,	65 ,,
	20	,,	25 ,,		3	,,	75 ,,
	14	,,	30 ,,		2	,,	80 ,,
23	8	,,	35 ,,		1	,,	90 ,,
	7	,,	40 ,,		1	,,	110 ,,
	8	,,	45 ,,		1	,,	120 ,,

From the foregoing, it appears that $\frac{2}{3}$ of the ticks fed in half-an-hour or under.

It was noted that

2	fed for	95 minutes,	after starving		4	months
1	,,	90 ,,	,,	,, over	5	,,
1	,,	85 ,,	,,	,,	10	,,

permits them to "crawl rapidly and to secrete themselves in cracks and crevices protected from the wily fowl." The replete larvae usually drop at night when the fowls are roosting, consequently when they emerge as nymphs they have no difficulty in finding birds upon which to feed.

Nevertheless, they may feed more rapidly after fairly long starvation, if they are in good condition. On the other hand, they appear to have some difficulty, possibly a mechanical one, in feeding on mammals. Thus of 7 hungry specimens placed on a *rat*, 4 fed for 2 hours and 3 for 4½ hours, and 1, placed on a mouse (having starved 3 months), fed for 5½ hours. A meal of blood does not always appear to agree with them. We do not know upon what this depends. Thus Lounsbury (1903) saw an adult turn black and die soon after having sucked his blood, and Dönitz (1907, p. 28) saw larvae which had fed on white mice die rapidly after they had abandoned the host. Dönitz supposes that the death of his larvae may have been due to the blood of the mouse being toxic for the tick, but he brings no proof in support of the hypothesis.

Note relating to oviposition and hatching of larvae.

Female fed on	Oviposition began	Oviposition ceased	Eggs kept at 24° C. hatched out	Larvae alive
23. i. 07	6. iii. 07	—	19. iii. 07	—
19. ii. 07	26. ii. 07	6. iii. 07	11. iii. 07	—
31. v. 07	18. vi. 07	—	—	7. ix. 07
19. vi. 07	25. vii. 07	—	—	7. ix. 07
24. vi. 07	25. vii. 07	—	—	1. ix. 07
30. i. 08	6. ii. 08	15. ii. 08	—	—
31. i. 08	6. ii. 08	15. ii. 08	—	—
3. ii. 08	11. ii. 08	18. ii. 08	—	—

From the foregoing, oviposition appears to last 7 to 9 days, and larvae hatch out in 11—13 days, when the eggs are kept at 24° C. The period when oviposition takes place after feeding was 6—8 days in four cases, 18—42 days in four cases. Retarded oviposition may be due to fertilization not having taken place.

Longevity (*unfed*)*:* Lounsbury observed unfed adults to survive in captivity for a little over 2 years. He believes that under natural conditions both larvae and nymphs can survive unfed for long periods. Laboulbène (1881, and Laboulbène and Mégnin, 1882, p. 337) observed the survival of unfed specimens (from Persia) for over 3 years. Robertson (1905, p. 561) kept adults unfed in pill-boxes for 2 years and 3 months, nymphs survived 2 months without food. Borrel and Marchoux (1905, p. 362) kept adults and nymphs alive for a year unfed and in a dry place.

Resistance to immersion in fluids: they may, in our experience, survive for over an hour in spirit. In von Loder's letter to Oken (1818,

p. 1567), it is even stated that a specimen survived 24 hours' immersion in spirit!

Seasonal Prevalence: Riley and Howard (1895, p. 267) state that the plague of *persicus* continues through the winter in Texas, their numbers being greatest in dry, hot years. Lounsbury (1903, pp. 9, 11) found about Cape Town, that "a few specimens of all stages may be found on almost any night in the year prowling about roosts in search of hosts." Complaints of their ravages are, however, most frequent in November and December. "This is undoubtedly because in these months great numbers almost simultaneously take their first feed after their long winter fast, and because of the brood of young ticks which then appears."

Effects of the bite of Argas persicus on man and animals[1].

Argas persicus has a rather formidable reputation in Persia. Dupré (1819, pp. 323—324) seems to have been the first to write regarding it, stating that its bite is at times dangerous, causing prolonged sickness; he speaks of it as a "teigne." Oken (1818, p. 1567) cites a letter from v. Loder stating that the bite of *persicus* is fatal to man within 24 hours. He reports the case of an Englishman who kept a starved specimen one year in a glass, and died 24 hours after he allowed it to bite him. Kotzebue (1819, p. 180) says that it behaves like a bed-bug, and may so infest villages as to drive out the inhabitants. The natives, he relates, are comparatively immune, but foreigners suffer severe pain, delirium and convulsions, and even death, within 24 hours in consequence of its bite. Fischer de Waldheim (1823, pp. 269—273) also says that the bite of this species may prove fatal owing to some complication. Heller (1858), who examined their anatomy, denies that they have a poison gland, and ascribes the effects to the mechanical injury (!) inflicted by the parasite. Taschenberg (1873) thinks that the effects ascribed to *Argas persicus* are really due to a fever which prevails in Miana ("dem in Miana herrschenden Faulfieber"). Taschenberg (1874, p. 171) records *persicus* as attacking man in Egypt as it does in Persia. Schlimmer (1874), of Teheran, considers that the relative immunity of the natives is acquired by their having been bitten at some time or other by the *Argas*, and that such bites act like a preventive inoculation with vaccine against smallpox. He says the symptoms are like those of "remittent

[1] The portions dealing with the effects of the bite of *Argasidae* is reprinted from Nuttall (1899, pp. 42—49) with additions to date.

fever, extreme lassitude, disinclination to work, yawning, fever, perspiration, not accompanied by much thirst, increasing and decreasing at stated hours in the day," so that many think it is only malaria acquired during a short stay at Miana. Schlimmer does not share in this opinion, and denies that the natives are subject to malaria. He says that fatigued travellers, and those who have undergone privations, are especially susceptible. *A. persicus* is also found at Chahroudé and Bestham on the main road from Teheran to Khoragan. No malaria exists in these parts, but the effects of the *Argas* bite are the same as at Miana. Schlimmer relates that he once (1858) treated 400 soldiers who claimed to have been bitten by these parasites at Miana, but many were unable to state on what part of their body they had been bitten. The soldiers suffered from the symptoms above described, and were promptly cured by the aid of "la poudre minerale de Bondin," or, when the cases were refractory, by the administration of quinine. Bordier (1882), who reprints the part of Schlimmer's publication from which the above data are quoted, inclines towards the supposition that the effects of the *Argas* bite are due to a poison, and, referring to the reported immunity of the natives, says that this reminds him of the fact that in many countries it is the strangers who are especially attacked by mosquitoes, the natives having apparently acquired a resistance towards the poison of these insects. Mégnin (1882, p. 305) denies the statement generally made by medical zoologists that the bite of *A. persicus* is dangerous. He refers to a letter of Tholozan's to Laboulbène (1881) which says that it is the belief among the common people in Persia that the bite of *Argas* is dangerous and fatal to foreigners, intermittent and remittent fevers being attributed to it. Fumouze repeatedly placed a female *Argas* on a rabbit's ear from which it sucked blood, but no pathogenic effects followed. Laboulbène and Mégnin (1882, p. 338) made a similar observation. Brandes (1897), in view of his experience with *A. reflexus* cited later, considers that the effects of the bite are due to a poison. Lounsbury (1900) at Cape Colony, allowed himself and Davidson to be bitten by *A. persicus*, the experiment gave rise to no further symptoms than a slight itching at the seat of the bite; the latter healed within 10 days in Davidson's case and in 3 weeks in Lounsbury's. There may well be some exaggeration in earlier accounts regarding the effect of *Argas* bites, but there is sufficient evidence to prove that they produce evil effects. It has not been demonstrated that *persicus* conveys any infectious disease to man as has been proved in the case of fowls.

Economic Importance: the effect of the bites of *A. persicus* on fowls, when the birds are attacked by many ticks, may certainly be serious. Thus Riley and Howard (1893, p. 267) published a note by A. Turpe of Kinney Co., *Texas*, who states that these ticks kill pullets "by creeping in masses under their wings, under their shoulders, and actually suck their lives out until they die." Hoehr (1893, p. 348) wrote from the same locality, stating that he had been acquainted with the pest since 1888 and had seen 25—30 % of the chickens succumb in a short time on a ranch. "They spread very rapidly. Last year I built a new chicken house, but in 8 days it was literally full." Hoehr lays stress upon its being the young Argas (larvae) that inflict the chief injury. If numerous, they even cover the bird's skin, and kill off old as well as young birds. Railliet (1895, p. 718) states that it kills off fowls in Mauritius ("*A. mauritianus*"), and Osborn (1896, p. 256) confirms the statements of the American observers. Salmon and Stiles (1901, p. 405) report "We have seen one case from Florida in which a chicken was literally covered with the hexapod stage," and one of us has received a piece of a fowl's skin from Barbados, preserved in alcohol, the skin being crowded with larvae of *persicus* in all stages of repletion. Hart (1899, p. 180) of Trinidad, states that the infested birds sit down, drop their wings, and show fever. Dressing with petroleum kills the ticks and the birds recover. Fuller (1897, p. 590) of New South Wales, states that fowls may die from exhaustion due to intense tick-infestation. According to Lounsbury (ix. 1903, p. 11) the fowl tick "is regarded by many as the most pernicious poultry pest that we have in South Africa. It is directly responsible for the death of numerous fowls, far more, indeed, than is generally suspected. It also seems to be the worst of poultry parasites in many parts of Australia and in the Southern States of America." Lounsbury, moreover, writes: "Paralysis is commonly attributed to the attack of the ticks but I am not certain that any disease is caused or transmitted by them at the Cape, and I incline to the belief that the victims die entirely from the loss of blood and the inflammation produced by the excessive parasitism. Vast numbers of the creatures take their fill from the legs, and the after irritation and the soreness probably account for the inability to walk often noticed on the part of many fowls in a suffering flock; and birds thus lamed and thus made unable to mount the roosts at night become doubly troubled by the pest. Young chickens, being also easily accessible, suffer more than their share, and it is not uncommon to meet with a whole brood almost black from the presence of adhering larvae. Sad to relate even such destructive infestation often fails to attract the attention of the owner to the pest. The losses are most striking when a fowl house is first occupied after having stood empty for a few months, as frequently happens in and about towns. The hungry ticks swarm to the birds and may kill half or more of them before their presence is discovered."

Reaney (1907), in Central India, saw fowls die within 24—48 hours from intense infestation with *persicus*, after being placed in a fowl house which had been disused for a fortnight. He attributed the death of the birds to a poison emanating from the tick and noted that the bites produced extensive extravasations of blood beneath the wings.

From the foregoing it appears reasonable to conclude that *persicus* may kill animals by massive infestation comparable to the "tick worry" seen in cattle infested with Ixodidae. Apart from this there appears to be evidence pointing to the ticks giving off some poisonous substance into the wounds they inflict, and evidence in this respect will be also found in the notes relating to other Argasidae. Experiments conducted in the laboratory at Cambridge have recently proved that the salivary glands of *A. persicus* contain a substance which retards or prevents blood coagulation, *i.e.* anticoagulin (Nuttall and Strickland). Again it is a not infrequent occurrence that tick bites become secondarily infected, the wound serving as a point of entrance for pathogenic bacteria. Finally we know that some Argasidae and Ixodidae may transmit certain blood parasites to their hosts in the manner considered below for the Argasidae.

Argas persicus in Relation to Disease.

Spirochaetosis in Fowls is a disease whose cause, the *Spirochaeta marchouxi*[1], was first discovered in Brazil by Marchoux and Salimbeni (1903). The disease may be very fatal, since it is capable of destroying all the fowls in a yard in the course of a few days. The disease begins with diarrhoea, followed by loss of appetite, the birds appearing somnolent; the feathers being ruffled and the comb pale. The birds cease to perch, lie down with the head resting upon the ground, and death takes place during a convulsive attack. At times the disease runs a slower course, the legs become paralysed, then the wings, and the bird grows thin and dies in 8—15 days. Recovery may take place, but it is rare after paralytic symptoms have appeared. At autopsy, during the acute period of the disease, the spleen appears much enlarged and

[1] *Sp. marchouxi* Nuttall, 1904, p. 16 = *Sp. gallinarum* Blanchard, 1905.

the liver swollen with more or less fatty degeneration, at times the liver is dotted with focal necroses. In chronic cases both of these organs may appear atrophied. The blood is fluid and dark. Spirochaetes are plentiful in the blood until shortly before death, and they disappear as recovery sets in.

This disease is transmitted by *Argas persicus* (= *miniatus*), as was proved by Marchoux and Salimbeni. By means of infected *Argas persicus* sent to one of us (N.) in England by Drs Marchoux and Borrel, of Paris, the disease was reproduced in fowls at Cambridge. Balfour (1907) has observed the same disease in Anglo-Egyptian Soudan, and has also transmitted it by means of infected *A. persicus*. Blood films or infected ticks or both have been received from Dr Balfour (Khartoum), Dr Bitter (Cairo), Captain Greig, I.M.S. (Punjab, India), and Dr Johnson (Adelaide, S. Australia), from which it appears that the disease is very widely distributed. Reaney (1907) has observed spirochaetosis in fowls at Agar-Malwa, Central India, and also records the presence there of *persicus*. He demonstrated that the ticks conveyed the disease. Marchoux and Salimbeni (1903) and Borrel and Marchoux (1905) found that when *A. persicus* sucks blood containing *Sp. marchouxi* the latter multiplies within the body of the tick (maintained at 30—35° C.) and it is capable of transmitting the disease for 6 months or more afterwards if it bites a susceptible animal. When the ticks are maintained at 15—20° C. after feeding upon infected blood they are not capable of transmitting the spirochaetes to clean fowls. The spirochaetes seem to disappear in ticks kept at a low temperature, but they reappear if the ticks are placed at 30—35° C. although a period of 3 months may have elapsed since the ticks fed upon infected blood. The spirochaetes may be demonstrated in the coelomic fluid of the infected ticks by cutting off a leg and collecting the fluid on a slide. The spirochaetes do not appear to injure the ticks. The disease usually breaks out 4—5 days after the ticks bite the birds.

Spirochaetosis in Geese was observed in the Transcaucasus by Sakharoff (1891), of Tiflis. The disease is as fatal as Spirochaetosis in fowls, and it is probable that it is transmitted by *A. persicus*, since this tick occurs in Southern Russia.

Note: Proof is still lacking that *A. persicus* plays a part in human pathology as a carrier of infection, or that the fever attributed to its bite in Persia is relapsing fever. Manson (1908, p. 196) states that "miana fever" is "certainly communicated" by *A. persicus*, but there is no scientific evidence in support of the statement.

Destruction of Argas persicus.

We have referred to the fact that the Persians migrate from their villages or burn them when the tick grows too aggressive (Oken, 1818, p. 1569, etc.).

With regard to fowls, Riley and Howard (1893, p. 267) have recommended spraying the hen-coops and poultry yard and washing the poultry with kerosene-emulsion. Hoehr (1893), on the other hand, did not find the emulsion satisfactory and obtained better results with lime and sublimate. Ehrhorn (published by Packard, 1895, p. 418) reported that a spray of "creozozone" instantly killed the ticks and gave good results. Riley and Howard (1895, p. 348) state that oil of sassafras kills the ticks quickly but is dangerous when applied to young birds. Fuller (1897, p. 590) recommends white-wash, and scalding the fowl's nests, boiling water being effective. The ticks are killed by turpentine. Lounsbury (ix. 1903, p. 12) discusses the value of various remedies and describes an instance in which the following procedure was successfully adopted:

All the old roosts and nests were burnt, the wooden walls of the fowl-house were well brushed over with *hot* coal-tar. New roosts were suspended by wires from the roof so that they did not touch the walls (into the crevices of which ticks retreat; poles with bark on them should not be used for roosts for the same reason). Paraffin was freely applied to nests when ticks were encountered in them, the floor was regularly swept clean and sprinkled with wood ashes and lime. In other cases *frequent* spraying of fowl-houses with various sheep-dips proved effective. The ends of the roosts may be wrapped around with oiled waste or be insulated in a deterrent fluid. Corrugated, or better, sheet iron fowl-houses have the advantage of being readily cleaned if any ticks are about; they may be tarred inside. Loose bark on trees in fowl-runs and wooden fences are also hiding places for ticks. Instead of dipping or treating young birds, Lounsbury recommends isolating them for some days in crates when any young ticks on them drop off and may be destroyed by burning the crates.

ARGAS REFLEXUS.

Longevity (unfed): Hermann (1804, p. 70) fed a specimen and then kept it unfed in a glass in which it survived 8 months. Bianconi (1867) reports that it survived in a disused hen-coop for fully 8 months. Gulliver (1872) states that specimens survived 5 months unfed in a tin box, and Fullager (1874, p. 121) kept them alive 22 months in a glass-topped box; unfed larvae lived 6 months. He was informed by Austin that the latter saw them (later stages of the tick) survive 4—5 years unfed in a box in which they had been placed and forgotten. Berlese kept an unfed specimen alive for about 6 years in a corked bottle. Ghiliani informed Perroncito (1901, p. 568) that he had seen unfed specimens survive for 22 months. Brandes (1897) states that living specimens were found in an abandoned pigeon-coop after the lapse of 2 years.

Seasonal Prevalence: Schellack (1908, p. 487) in Magdeburg, Germany, found *reflexus* in fairly large numbers in autumn, but they were scarce in March.

Feeding Habits, Economic Importance, etc.: Taschenberg (1880, p. 153) states that it remains motionless during the day-time or when exposed to lamplight, this being in accord with the statements of other writers. A few observers record the time occupied by the tick in feeding (meaning nymphs and adults); thus Alt (1892) saw them feed 20 minutes on man, and Boschulte (1860), who allowed himself to be bitten by a specimen, states that it took 27 minutes to feed. Obviously, in this respect its habits are similar to those of *A. persicus.* The larvae are stated by Braun (1895) to remain "some time" on their hosts, from which we may gather that they stay attached for some days as do *A. persicus* larvae (*q.v.*). According to Perroncito (1901), the larvae (we assume) occurred in large numbers on the skin of the young pigeons he saw succumb to their attacks. Bianconi (1867) placed 4 pigeons in a *reflexus*-infested hen-coop, which had been disused for 8 months. Two of the pigeons (young birds) died the first day, and the other two (adults) died on the third and fourth days respectively. The pigeons were literally covered by the ticks, and Bianconi attributed their death to exhaustion and loss of blood. Fowls similarly placed did not appear to suffer. The injury they inflict on pigeons are also noted by Mégnin, 1880; Laboulbène and Mégnin, 1882; Railliet, 1895;

Osborn, 1896; Brandes, 1897. Young birds are the chief sufferers, and at times it is impossible to raise them owing to the pest. Schellack (1908, p. 487) writes that *reflexus* attacks pigeons especially on naked parts of the skin, beneath the wings and about the anus.

Effects of the bite of Argas reflexus on man and animals.

When numerous, they may, through their bites, cause the death of pigeons. They have been observed to wander into chicken-houses and dwellings. They do not seem to annoy chickens, but they occasionally attack man and cause much trouble. Raspail (1839) attributed a severe erythematous eruption on a child's neck to the bites of this species, consequent on his going into a pigeon-coop. Boschulte (1860) describes the case of a family, several members of which were bitten by *reflexus*, only pain and slight swelling following in all cases excepting that of an old man. The latter was bitten on the lower part of the thigh, with the result that a deep circular suppurating wound about the size of the head of a pin marked the spot where he had been bitten. There was extensive oedematous swelling and redness of the surrounding parts. Boschulte allowed himself to be bitten by *reflexus*. The pain was like that of a mosquito-bite. A small drop of coagulated blood subsequently covered the puncture. Nothing especial was noticed, and three days later the wound had healed. Ten days after he had been bitten the spot began to itch and showed a nodular swelling, which grew red and increased to the size of a pock. No exudation of serum occurred, but the itching was very annoying. This subsided after six days, a small scab was cast off at the point bitten, and the skin resumed its normal appearance. Boschulte (1879) reported, *nearly twenty years later*, that the place where he had been bitten still showed a sharply-defined circular flattened elevation with a central cicatrix, and that in the interim several similar, but smaller, elevations had appeared in its vicinity.

Taschenberg (1873) wrote that *reflexus* attacked some children in Friedeberg a. d. Saale. In a later paper, Taschenberg (1880, p. 153) states that in all cases where *reflexus* has attacked human beings, the latter slept in rooms adjoining pigeon-coops. The bites occur chiefly on the hands and feet and appear as small red points which cause much itching, extending up the limb. A bite on the hand produced itching up to the shoulder, a bite on the foot itching up to the hip and back, there being less irritation about the bite itself. Scratching aggravates the trouble especially in children, where there may be inflammation. In a girl 5 years old, blisters formed over the hand, wrist and forearm. The itching may last 8 days. Chatelin (1882) reports the case of a child that was bitten by *reflexus*, which had wandered from the pigeon-house into the dwelling. The pigeon-house had not been used for 6 years. The bites were followed by pain and oedematous swelling, which persisted for some time. Other persons who were bitten at the same time exhibited no such symptoms. Brandes (1892 d, p. 10) describes the case of a man who was bitten at Aschersleben in 1883, the bite being followed by much swelling. Alt (1892) saw a case which occurred under similar circumstances, where the bite was followed by urticaria factitia and general erythema, which subsided in a few hours. Brandes (1897) also describes this case—that of a man who had been bitten five times in four years. Hauch, who attended him, stated that he woke at night with pain about the wrist, on which he discovered the *Argas*. Within half an hour an erysipelatoid swelling spread from point of the puncture all over the body, increasing, particularly about the head, until the eyes were hidden by the swollen lids. During this time the patient suffered from shortness of breath, palpitation, dulness, etc. for an hour, when the symptoms began to subside with the appearance of profuse perspiration. The swelling gradually subsided during the following 10 to 15 hours. The patient, who seems to have been particularly susceptible to the bite of the *Argas*, had previously kept pigeons in his house, but the pigeon-house had been walled up two years before. As Brandes states, this latter proceeding seems to have caused the migration of the parasites into the dwelling. Alt (1892), and two other persons, allowed themselves to be bitten by *reflexus* obtained from the abandoned pigeon-house. Slight pain, that came and went, followed, but nothing in particular occurred, excepting in one case, where, after four to five days, a painful nodule, the size of a pea, appeared at the seat of the puncture, but this disappeared soon afterwards. Two persons who suffered from urticaria also allowed themselves to be bitten; one of them remained unaffected, whilst the other developed general erythema after four hours, which subsided again in an hour. Brandes reports a case which was observed in 1884 at Aschersleben, where a man became so oedematous after four to five hours that his clothes had to be cut off. The oedema is said to have lasted three days in this case. The effects here noted seem to depend on a peculiar idiosyncrasy. Brandes believes that a poison is probably elaborated in the salivary glands of *Argas*. Alt, who injected three of them, which had been crushed, subcutaneously into a dog, produced symptoms of intoxication in the latter which were similar to those which are produced by small quantities of snake ("Puffotter") venom.

Terrenzi (1893, pp. 73—76) observed the effects of the bite on the hand as follows: After a few hours a yellowish vesicle appeared, and lymphangitis extended up the forearm, the course of the lymphatics appearing red and feeling hard and the skin rough (scabrosa); when morning had arrived the vesicle had grown five times in size and the lymphangitis worse, and the arm discoloured. The effects diminished and disappeared in 15 days, but a scar was visible a long time after. Gibert (1896, cited by Mosler and Peiper, 1904, p. 345) observed general symptoms follow the bite: nausea, vomiting, diarrhoea, irregular pulse, dyspnoea, etc. Ajutolo (1898) states it tormented persons in Bologna, and refers to it as "this terrible destroyer of poor pigeons."

Argas reflexus in Relation to Disease.

Until quite recently there has been no evidence to prove that *reflexus* is capable of conveying disease. Schellack (1908, p. 487) however, reports upon two experiments which he carried out with *A. reflexus* and *Spirochaeta marchouxi*. *Experiment I*: 4 *reflexus* were placed on a fowl with spirochaetes in its blood, and 7 days later they were placed on a clean fowl. Spirochaetes appeared in this fowl's blood after 16 days and it died of the disease. *Experiment II*: 6 infected *reflexus* were allowed to bite a clean fowl; the bird showed spirochaetes on the 8th day and it recovered; the ticks had fed on a sick fowl about 64 days before. It is interesting to note, therefore, that *Sp. marchouxi* may be transmitted by two species of *Argas* (*persicus* and *reflexus*) as well as by *Ornithodoros moubata* (*q.v.*).

That this tick may transmit other pathogenic micro-organisms is indicated by the following instance reported by Tonnel (1906, p. 552): A family moved into an apartment which had remained unused for four years having been previously occupied by a man who kept fowls and pigeons in the rooms. The father of the family had suffered from general furunculosis before moving into the dwelling. He was bitten by *reflexus* and so were his two children, who in consequence also developed abscesses and phlegmons starting at the points bitten by the ticks. The family moved out of the apartment because they considered it bug-infested (they took *reflexus* for bed-bugs), after which the trouble subsided. Within 48 hours another family moved into the apartment, with the result that two members of this family (father and child) suffered from the same effects as did the previous family. On searching the apartment *reflexus* were discovered, and, following a thorough disinfection of the premises the trouble ceased. It appears clearly demonstrated by this interesting case that *reflexus* may transmit pyogenic bacteria to healthy persons when they have previously had access to the skin of a person suffering from furunculosis.

ARGAS BRUMPTI.

Effects of Bite: Dr Brumpt communicated the following particulars to Professor Neumann (1907, p. 229) and to us:

The bite is somewhat more painful than that of *O. moubata*; it may wake the sleeper and causes pruritus, lasting several days. The puncture bleeds slightly and becomes covered by a small crust of dried blood beneath which a small drop of extravasated blood gathers. Within about 2 hours the puncture becomes surrounded by a violet-coloured circular ecchymosis 6—8 cm. in diameter resembling the mark following a leech-bite. The mark goes through the gradations of colour usual in ecchymoses, or bruises, and disappears in 6—8 days; but the centre remains indurated for a long time. Of 17 bites which were inflicted on Dr Brumpt in July 1901, five still exhibited an indurated centre in April 1908 (Letter to G. H. F. N.). He states that the small subcutaneous nodules may be felt on palpation and seem to be disappearing with the exception of one in the umbilical region, this nodule measuring 7 mm. in diameter. From time to time he still suffers from pruritus at the seat of these bites; one bite was inflicted on the neck, and this place is particularly subject to pruritus, owing, apparently, to the friction with the collar. All traces of the other 12 bites have disappeared.

Habitat: Dr Brumpt (9. v. 1908) informs us that he found *A. brumpti* in dusty sheltered hollowed out places beneath overhanging calcareous rocks, into which opened porcupine (*Hystrix* sp.) burrows. The ledges of rock were situated along the rocky bed of a torrent, and the floor of the hollows, which were about 5 ft. deep, consisted of fine dust about 15 cm. in depth, numerous bones of small mammalia lying upon it. After *A. brumpti* had fed it promptly buried itself in the dust. The ticks wander about at night and Dr Brumpt was unable to catch any during the daytime.

ORNITHODOROS MOUBATA.

Period required for the Egg to hatch: eggs kept at 29° C. (Newstead, 1905, p. 1697) became flattened on the 6th day and the legs and capitulum of the larva could be seen through the shell; on the 9th day the shell split and the larva was fully formed; on the 10—15th day the young nymph hatched out and on the 16th day the nymphs were observed to escape anteriorly from the larval exuviae. Some hatched out in 8—13 days. Wellman (1906–7) observed hatching after 15 days in Angola. Dutton and Todd (1905, p. 124) observed hatching after 18—23 days in the Congo (temperature 19·5—32° C.), whereas two or three days more were required when the eggs were kept at 19—22°C. (Laboratory experiments in Liverpool; Newstead, Dutton and Todd, 1907.)

Oviposition: as in other Argasidae we have studied (*A. persicus, O. savignyi, O. lahorensis*) the eggs are laid in batches, the eggs being agglutinated in masses and deposited upon the sand or in hollows burrowed out by the female. Dutton and Todd (1905 b, p. 125) note that the number of eggs is increased when the female has taken a large meal. They observed females which laid batches of 10—20 eggs at intervals of 1—2 weeks, although they were frequently disturbed. The largest total number of eggs laid by one female was 139. Newstead (1905, p. 1697) placed a female in a bottle with sand in which she rapidly buried herself after feeding. Placed at 29° C. in a dry incubator, she laid three batches of eggs, oviposition taking place at night. She rested upon the successive batches of eggs for a time; the batches numbered 17, 51, 26 (total 94), intervals of 3 and 8 days elapsing between the layings. Wellman (1906) observed oviposition in two females which were kept unfed in a dish with floor dust at the bottom: Tick I oviposited after 57 days, laying 49 eggs; she was removed from these eggs and laid 29 more by the next day. Tick II oviposited after 64 days, and laid three batches of eggs totalling 88. According to Wellman (in MS.) a fecundated female lays no eggs until she has had a meal of blood. Möllers (1907) saw a female lay 80 eggs, she buried herself and the eggs were pushed out so that they appeared upon the surface of the sand.

Longevity: under natural conditions *O. moubata* doubtless may live for several years. Specimens have been kept alive, though unfed, for

4—6 months or more by Newstead, Dutton and Todd, the ticks, nevertheless, being capable afterwards of infecting animals with the *Spirochaeta duttoni*. Unfed specimens have been kept alive for similar periods in Cambridge. Wellman (in MS.) saw females survive unfed for 4 to nearly 6 months after ovipositing and Möllers (1907, p. 278) states that adults may survive unfed for a year. Although fed regularly in captivity adults were seen by Möllers to gradually die off after the lapse of 2 years.

Natural enemies: as Livingstone (1857, p. 382) wrote: they are difficult to kill, "their skin is so tough and yielding, that it is impossible to burst it by any amount of squeezing with the fingers." This, combined with their colour and life habits (hiding in cracks and burying themselves in sand or dust), unquestionably affords them much protection. Nevertheless, under natural conditions in the Congo, Dutton and Todd (1905 b, p. 127) and Wellman (in MS.) state that they are devoured by chickens, rats and mice, and that ants carry off young ticks[1] and eggs. Wellman (1906 and 1907) has seen *Phonergates bicoloripes* Stal. attack and suck the blood out of *O. moubata*, and has figured the manner in which the bug seizes upon its prey. He has sent specimens of this tick-enemy to the British Museum (see Austen, 1906, p. 113) and to Cambridge. Dutton and Todd (1905 b) noticed, as have others, that when disturbed they often curl up their legs as if dead. "So lifeless do they seem that one might easily be deceived, especially since they sometimes lie motionless for hours." This habit doubtless affords them protection against enemies. Wellman (1906) states that in the Bihé District, Angola, he observed what appeared to be their destruction by a parasitic mould.

Feeding: Dutton and Todd (1905 b, p. 124) state that a large ♀ may remain attached to a monkey for 2—3 hours, others feed for half an hour. In feeding, the tick braces itself on the forelegs, depresses the capitulum and bores in its mouthparts. It may expel faecal matter, and it exudes clear fluid, in fairly large amount, from the 1st intercoxal space whilst attached to the host or after it has dropped off. According to Newstead, Dutton and Todd (1907) they will not feed well more often than every 7—10 days. Newstead weighed a female before and after feeding and notes that her weight increased ten times. Möllers (1907, p. 278) states that *moubata* feeds for ½ to 4 hours. Fed on laboratory animals in Cambridge during the day-time, the adults

[1] Wellman (in MS.) once saw a swarm of driver ants (*Dorylus nigricans* Illiger) bearing away *moubata* from a native kraal in Angola.

and nymphs were observed to feed for very variable periods; thus 15 ticks, of which accurate records were kept, fed respectively for 20, 20, 25, 30, 30, 40, 40, 40, 45, 55, 60, 80, 100, 100 and 125 minutes. Nymphs (1st stage), of which 5 were timed whilst feeding, took 10, 10, 25, 30 and 60 minutes before they dropped off the host. They usually feed at night under natural conditions, but they may attack persons by day as Wellman has observed in native huts in Angola (personal communication).

The effect of the bite has been repeatedly described:

Livingstone (1857, p. 383), who was bitten by the "tampan," states that the tingling sensation at the point bitten lasted for about a week. He refers to the fever which may follow the bite as being well-known to the natives. Murray (1877, p. 182) quotes Dr Welwitsch as stating "that the pain of the bite is not felt until two hours after it has been inflicted, but it makes up for the respite by continuing painful and inflamed for from 12 to 24 hours thereafter."

Brumpt (1901, pp. 578—580) was the first to study the effects of their bites, allowing himself to be bitten by 43 *moubata* collected in Somaliland, where "tick fever" prevailed. He suffered no ill effects and states that the bites were not troublesome except when they attack man in large numbers, producing anaemia consequent upon loss of blood.

Dutton and Todd (1905 b, p. 123) say that the bite even of a small tick is painful; they allowed a tick to bite a monkey: "Immediately after feeding, a small crust of serosanguinolent fluid forms at the site of the bite. Surrounding it is a roseola about 2 mm. in width. Two hours later the central clot is surrounded by 2 concentric zones, each 2 mm. in width; the first colourless, the second ecchymotic. Six hours later the clot has become almost black, and is placed at the apex of a slight, colourless wheal, bordered by an ecchymotic zone about 1·5 mm. in width."

Wellman (1906, 1907) writing from personal experience in Angola, states that the bite is very painful, the swelling and irritation (especially in Europeans) not subsiding for days. "The wheals are hard, raised, and itch and swell most disagreeably if scratched, and this even a week after being bitten. The bite of young ticks (nymphae) is said by the natives to be more severe than that of the adults." Wellman experimented upon himself and is convinced that this is generally the case. He states (in MS.) that in some natives, usually aged individuals, the bite may scarcely leave a mark. (From this it is evident, as is the case with mosquito bites, that immunity to its effects is acquired.)

Treatment of Bites: Wellman (in MS.) recommends prolonged bathing in very hot water, followed by the application of a strong solution of bicarbonate of soda, which is allowed to dry upon the skin. He states that this treatment is comforting. For severe itching he advises smearing the bites with vaseline, which is slightly impregnated with camphor or menthol. Medical aid should be sought when complications arise.

Prevention against being bitten: Livingstone (1857, p. 628) noted the danger of sleeping in native huts at Tete and (p. 382) wrote: "I had felt the effects of its bite in former years, and eschewed all native huts ever after." He was, nevertheless, bitten at Ambaca in a European house. Again he states (1874, p. 33) "the human tick, which infests all Arab and Suaheli houses," and, writing at Nyañgwé, the ticks "that follow wherever Arabs go, made me miserable, but the Arabs are insensible to them; Abed alone had a *mosquito curtain,* and he never could praise it enough."

Manson (1903, p. 714) writes that the natives in some districts "protect themselves against the tick by plastering the walls and floors of their huts with mud and cow-dung; a practice adopted by the Boers, the Bechuanas and nearly all the cow-keeping native tribes. They frequently smoke their huts to drive the ticks from their lodgement in the thatch."

The Portuguese always warn newcomers not to place beds on the ground and to search their mosquito nets before retiring at night.

Wellman (1906 and 1907) says the natives of Angola are at times forced to burn their huts to get rid of these ticks. The use of insecticide powders (Pyrethrum) has been recommended.

Wellman reports to the Government of Angola four recommendations, of which we quote three:

"(1) The tick in question should be regularly destroyed in crowded centres by disinfecting native houses, barracks and other permanent quarters, and by burning old camps, huts, etc.

"(2) Soldiers, labourers on plantations, etc., should be made to keep their houses clean, and to sleep in hammocks or in beds well raised from the floor and away from the wall. Natives should never be allowed to sleep in or near the quarters of Europeans.

"(3) Soldiers, porters, servants, plantation labourers, and other controllable bodies of natives should be compelled to observe regulations regarding regular bathing and washing of clothes."

Naturally whites should avoid sleeping in or near native kraals and servants' quarters should be established at a distance from the white lines. In travelling, old camp sites and resting places should as far as possible be avoided. "Native servants who are allowed to enter sleeping apartments of whites should be compelled to change their clothing on coming from native quarters." (Wellman MS.)

Ornithodoros moubata in Relation to Disease.

African Relapsing Fever in Man or "tick fever" occurs in German and British East Africa, in Central Africa, in the Congo Free State and Angola. The disease was referred to by Livingstone, and it has been mentioned by various travellers in Africa[1]. The main symptoms are headache (especially at the back of the head), vomiting, abdominal pain and purging, with severe fever, a pulse of 90—120, dry hot skin, congested eyes and shortness of breath. After a period of fever lasting about two days, there is a fall of temperature, but a fresh attack soon follows. These relapses occur more frequently than in European relapsing fever, being usually 5—6 in number, but there may be more. The attacks leave the patient in a weak condition for a long time after recovery which usually follows, but death occurs in about 6% of the cases. The fever attacks are due to protozoal parasites, the *Spirochaeta duttoni*, which multiply in the blood, the greatest number being present in the blood during the attacks of fever. The disease lasts 1—3 weeks or longer, depending upon the number of relapses.

The *Spirochaeta duttoni* is transmitted to man by the bites of infected *O. moubata*, as has been proved by scientific experiments. The natives of parts of Africa (Angola, Congo, Uganda, Abyssinia, Somaliland, German E. Africa) have for a long time attributed the fever to the bites of this tick. In describing the effect of the tick's bite, according to Christy (1903, p. 187), the natives in Uganda "invariably go through a pantomime indicative of vomiting, with pain in the head and abdominal region."

The attack of fever usually follows 5—10 days after the susceptible person has been bitten. The *Spirochaeta duttoni* was discovered by A. R. Cook (Jan. 1904; this author took it for *Sp. recurrentis*) and by Philip Ross and Milne (Nov. 1904, in Uganda), and the part played by the tick was demonstrated by Dutton and Todd (Feb. 1905, in the Congo), and subsequently by R. Koch (Nov. 1905, in German East

[1] See Hinde (1897, p. 3), Plehn (1902), etc., who state that the disease is referred to tick-bites by the natives.

Africa)[1]. When a female *O. moubata* sucks blood containing *Sp. duttoni,* the latter pass into the ovaries of the tick and penetrate the undeveloped eggs, within which they multiply. They persist in the tick which developes from the egg and pass out of its mouthparts when it feeds in the 1st nymphal stage upon the blood of a fresh host. Monkeys and rats in England have thus been infected with the disease through the agency of infected ticks brought from Africa. Dutton and Todd, in addition, found that the spirochaetes persist in the gut of the tick up to 5 weeks after it has fed. The tick, once infected, may harbour the parasite for months and transmit it when it has occasion to feed. Finally, Möllers (1907, p. 277) finds that the spirochaete is transmitted to the third generation of ticks, the second generation having been fed on blood free from spirochaetes; such ticks may infect animals (rats, monkeys) by their bites.

Filariasis in Man: Christy (1903, p. 187) considered that *O. moubata* is capable of transmitting *Filaria perstans* to man. In this disease the filarial embryos circulate in the blood. Feldmann (1905, p. 64), whose statements have been criticised by Kerr (1905, p. 126), advanced the extraordinary hypothesis that the ticks infected with filariae lay their eggs in bananas stored in native huts and in some way give off the worms which are eaten with the bananas by the natives. Wellman (1907 and MS.) states that he has observed a certain degree of development of *F. perstans* embryos in *moubata.* His results are very suggestive, since he worked with *moubata* which he raised from the egg. The matter requires further investigation.

Spirochaetosis in Fowls. It is interesting to note that Fülleborn and Mayer (1908, p. 31) have found that they could transmit *Spirochaeta marchouxi* (see p. 88) by means of *O. moubata* in experiments conducted in Hamburg. In the positive experiments which they report, the ticks had fed twice before upon infected fowls. The ticks were infective for 103 days after feeding on a fowl harbouring the spirochaetes in its blood.

Brumpt (1901, p. 578) observed that the parasites of tertian malaria degenerated inside the gut of *moubata* and ticks fed on himself after feeding on malarial blood produced no ill effects.

[1] Massey (1905, p. 225) and Wellman (1905, p. 97) also observed the spirochaetes in Angola. The epidemiology and history of the disease in German E. Africa are discussed by Werner (1906, p. 776).

ORNITHODOROS CORIACEUS.

Effects of bite and feeding habits: two females bit Mrs Z. Nuttall through her clothing and inflicted painful wounds, "their bites were intolerably sharp and painful, and both wounds bled a good deal—but notwithstanding, there has been intermittent irritation ever since" (this persisted after 4 months, and the seat of the bite was still discoloured and the puncture covered by a scab). Eight months after the bite was inflicted there remained a nodule which occasionally itched. The natives of Tehuantepec, Mexico, fear this tick for the reason that the bites are severe and often do not heal for a long time. The females immediately proceeded to feed, on arrival in Cambridge, when placed upon a fowl. They fed for 45 minutes and 1 hour 40 minutes respectively, and drew a large amount of blood. The bites caused intense ecchymosis, measuring about one inch in diameter. Whilst feeding the palps did not penetrate the wound as once observed in the case of *O. savignyi,* but both specimens exuded clear fluid as observed in *O. moubata.*

ORNITHODOROS TURICATA.

Effects of bite: the "turicata," as the Mexicans call it, may cause serious injury by its bite. According to Dugès (1876) it has been known to be fatal to pigs. This author also states that chickens fed on turicatas died about the third day. The effect of the bite in man is especially bad if the turicata's capitulum is torn off, and, where this occurs, Dugès recommends the use of the cautery, otherwise it causes severe itching, and an ulcer forms at the spot bitten, and this may persist for months, or there may develop erysipelatoid dermatitis, lymphangitis, the formation of bullae containing serum about the puncture, at times gangrene, subcutaneous abscesses, etc. In three cases he reports general symptoms following the bite. In two of these a vein had been punctured by a turicata. One patient had difficulty in speaking and swallowing, swelling and numbness spreading over the whole body, accompanied by vomiting and diarrhoea. In another patient all these symptoms subsided within an hour, when an urticaria made its appearance, accompanied by profuse perspiration. Dugès says people are reported as having died from the bites of turicatas, the noxious effects of which he attributes to a venom, a peculiar idiosyncrasy existing in certain individuals.

ORNITHODOROS TALAJE.

Habitat, Effect of bite, etc.: Sallé (1849, p. 342) and his companion, Jules, were severely bitten by *O. talaje* in May, 1847, at Casa Vieja de Gastoya. They were awakened out of sound sleep by "atrocious itching on the hands and face," and on lighting a candle found their hands were "covered with blood and blotches like large bites of bugs." The muleteer said the bites were due to "talajas." The ticks infest old houses, retreating into the crevices of the walls, which are built of bamboo and covered with mortar. The talajas bite at night and disappear by morning. Sallé states "my hands and ears were much swollen, and I suffered horribly"; a fortnight elapsed before he recovered from the effects. *O. talaje*, according to Guérin-Méneville (1849), causes intolerable itching and pain by its bite. Mégnin (1885) says its saliva may be venomous like that of a mosquito or tarantula. This stands in direct contradiction to his previously expressed views regarding *A. persicus* (*q.v.*).

ORNITHODOROS THOLOZANI.

Effects of bite: Mégnin (1882, and 1892, p. 66) claimed that the bite of this tick is harmless. He allowed one which had starved for years to bite his hand. It sucked itself full in about half an hour, the pain produced being less than that of a leech. The only effect was the formation of a violet ecchymosis 6 mm. in diameter about the bite. As Johannessen (1885, p. 347) very properly remarks, one experiment by Mégnin (in France) with a tick which had been kept starving for years, has no value as proving that its bite is innocuous under normal conditions.

ORNITHODOROS MEGNINI.

The life history of this species has been recently studied by Hooker (1908 a, pp. 40, 42, 45, 51) who placed bags over the ears of infested cattle and safeguarded the bags by cords tied about the horns so as to prevent their being displaced. The *larvae*, having gained entrance to the ear of the host, attach themselves deep down in the folds of the skin and gorge themselves. They moult upon the host after about 5 days and the *nymphs* continue feeding sometimes for months. In one case a nymph abandoned the host's ear 35 days after the larva had been introduced, in other cases the nymphs still remained attached after 98 days had elapsed. "After leaving the ears as nymphs, these ticks usually crawl up several feet from the ground and secrete themselves in cracks and crevices, where in about 7 days in September, after leaving the ear, they shed a membranous skin and appear as *adults* without spines." Fertilization then takes place and *oviposition* commences, after which the female dies. Eggs are not laid by unfertilized females and the latter may live a long time. In summer the *larvae* hatch out after 11 days.

As far as we know the life history of *megnini* is unique amongst the Ixodoidea since but one moult (larva to nymph) takes place upon the host and *the nymph stores up enough food to make it unnecessary for the adult to feed before fertilization and oviposition take place.* Hooker believes that the adults probably never feed, and we would note that this view gains support from the fact that the adult capitulum (Fig. 103) is very small and that the hypostome (see p. 73) is *unarmed*, no similar structure being known to us in other ticks. Even the structure of the digit appears modified in that the external article does not bear the usual outwardly directed teeth (see Fig. 104, digit of female). The peculiar habit of the replete nymph of creeping upward several feet from the ground before moulting appears to Hooker to be correlated with the tick's parasitic habits, for when the adults mate and the females oviposit, the larvae which issue from the eggs are placed in an advantageous position where they can readily gain access to the ears of their hosts.

Injurious Effects: Salmon and Stiles (1901, pp. 413, 414) write: "Judging from letters received by this bureau (The Bureau of Animal Industry, Washington, D.C.), the ear tick is accused of causing a variety of troubles. Some correspondents report sickness and even death among cattle as having been caused by the parasite, while others are not inclined to attach so much importance to its presence. Owing to their position in the ear, it is not possible to use any very drastic measures against them, but, as a rule, if any bland oil, such as linseed or olive oil, is poured into the ear, the ticks will soon vacate; they are not killed by this treatment, hence every tick caught should be crushed in order to prevent increase." Simpson (1901) readily removed a nymph from the ear of a gentleman by introducing a pledget of cotton containing a little chloroform into the ear.

Longevity (unfed): Mégnin (1885) states that he kept some *O. megnini* alive unfed for two years.

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CONTENTS OF VOL. I. NO. 2. (JUNE 1908.)

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TICKS

A MONOGRAPH OF THE IXODOIDEA

By

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By

GEORGE H. F. NUTTALL
and
CECIL WARBURTON

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PART II

CAMBRIDGE
at the University Press
1911

IXODIDAE

Section I. CLASSIFICATION
Section II. THE GENUS IXODES

by

GEORGE H. F. NUTTALL

and

CECIL WARBURTON

PREFACE TO PART II

WE greatly regret the delay which has occurred in the publication of this the second part of our work. The delay has not been due to any lack of diligence on our part but to various difficulties which we encountered in the preparation of our manuscript. For, when we came to make a careful study of *Ixodes*, we found it necessary to re-write almost all of the specific descriptions after personally examining such types as were accessible. This necessitated journeys to Berlin, Paris, Toulouse and London (British Museum), and a considerable correspondence with heads of Museums, owners of type specimens, and others in many places throughout the world.

We commence *Section I* of this part with (1) an historical review dealing with the classification of ticks. This, and the succeeding chapter (2), dealing with the superfamily Ixodoidea, might, perhaps, with more propriety have appeared at the commencement of Part I, but it is chiefly with regard to the Ixodidae that taxonomic difficulties have been encountered, and, moreover, Chapter 2 forms a necessary connecting link leading to the matter which follows. In Chapter 3 we have gone with some detail into the generic diagnoses of Ixodidae, these being illustrated in a manner not attempted hitherto if we except the crude figures accompanying the publication of Lahille.

Section II, which forms the bulk of Part II, concerns itself solely with the genus *Ixodes*, but for some of the matter contained in the appendices. At the commencement of the section, under Synonymy, we give our reasons for suppressing various generic and subgeneric names which have been applied to forms included by us in this genus. We definitely condemn many species which are merely nominal, and we have referred others to the category of "Doubtful Species," as will be seen by reference to the lists at the end. Under doubtful species we include such as are founded on immature forms or which have been imperfectly described; we propose to retain them in this category until they may have been properly described and shown to be valid by their authors or other workers. We do not consider it justifiable, in the present state of our knowledge, to found species on immature forms, a proceeding which might be warranted if the immature forms of all established species were known, whereas this is only true of 8 out of 51 species in the case of *Ixodes*. We agree in the main with Neumann in the synonomies of species, both valid and condemned, but we have in some instances arrived at different conclusions. Our lists of condemned genera and species and of doubtful species, which have been compiled by one of us (G. H. F. N.) with great labour, sufficiently demonstrate the difficulties we have encountered in separating the wheat from the chaff. These lists should at least prove useful to those desiring to avoid the giving of already preoccupied names to new species of *Ixodes*. Some of the synonyms must, from the nature of things, necessarily be regarded as tentative.

Of the innumerable species of *Ixodes* that have been described, we are only able to recognize 51, and there may be but 48 which are valid. As will be seen from the text, a number of species and their various stages are adequately described and figured by us for the first time.

The notes on Biology refer to matters of special interest relating to some of the species. We have added thereto two appendices dealing (I) with oviposition in *Ornithodorus moubata*, and (II) with the adaptation of ticks to the habits of their hosts. The appendices are reprinted from papers by Nuttall and Merriman and by Nuttall, which have recently appeared in *Parasitology*, Vol. IV (1911), and which bear directly upon the subject in hand.

Illustrations.

Curiously enough, some of the commonest species have never been accurately figured before, or figured at all: we have endeavoured to make good this deficiency.

The 94 new illustrations in the text, like our earlier ones, are in most cases reproduced from large drawings made from unmounted specimens preserved in alcohol. The drawings were made with the aid of a camera-lucida mounted on a Zeiss binocular microscope and used in conjunction with a Zeiss drawing-board. A scale drawn to one side of the figure usually indicates the magnification employed. Certain highly magnified figures of the capitulum, hypostome and other structures were drawn from specimens mounted in balsam, using a monocular microscope, any errors of interpretation due to the transparency of the chitin in the mounted specimen being corrected by reference to the opaque object. We lay great stress on the avoidance of errors due to the examination of mounted specimens; figures of ticks drawn from such specimens are exceedingly misleading. Where a figure is reproduced from a freehand drawing, it is referred to as a "sketch" in the accompanying legend. We attach much importance to the illustration of the main structural characters in conjunction with the descriptions, for they convey a much more accurate and rapid impression to the mind than any amount of description. There are certain structures which should be figured in nearly all instances, and we have included them in most of our illustrations.

The Part contains 202 text-figures (several being marked *A* and *B*) and 14 figures comprised in four plates, the total number of figures being 216.

Text-Figures.

Of the 94 new figures	84	were drawn by	G. H. F. Nuttall *
	6	,, ,,	F. M. Howlett *
	3	,, ,,	C. Warburton *
	1	was drawn by	L. E. Robinson *
Of the 107 previously published figures	48	are from publications by	Neumann
	32	,, ,,	Nuttall and Warburton, jointly, or as separate authors
	4	,, ,,	Wheler
	2	,, ,,	Salmon and Stiles
	1	is from a publication by	Evans
	1	,, ,,	Lewis
	2	are from publications by	Nuttall, Cooper and Robinson, and Nuttall and Merriman
	18	are reprinted from Parts I and II to illustrate matters treated of in the appendices	
	202		

Plate-Figures.

Of the 4 new figures	2	are from photographs by	E. G. Wheler
	2	,, ,,	L. E. Robinson
The	10	published figures are all from Wheler	
	14		

* We have made it a rule to consult together about most of our figures, with a view to ensuring their accuracy.

The figures reproduced from Neumann are mostly printed from the original blocks. These have all been purchased from the publishers of his papers, or they have been duplicated from the original blocks with the kind consent of Professor Neumann and of the editors of the various journals in which they were published. Mr E. G. Wheler has generously presented us with the blocks used in the illustration of his papers, together with numerous unpublished photographs of ticks. Of the figures by other authors, we have only chosen such as appear suitable for the purposes of this book.

We have decided to publish our whole *Bibliography* as it stands in the form of a separate fasciculus; should further references be necessary in connection with succeeding parts, short supplementary lists of references will be appended to the respective parts. We shall be much indebted to any of our readers who may draw our attention to errors and omissions.

Acknowledgments.

We are specially indebted to Professor L. G. Neumann, of Toulouse, for the generous aid he has given us throughout, not only in placing his valuable collection of types at our disposal, but also in helping us with his advice and counsel. Our thanks are also due to Geheimrath Professor W. Dönitz, of Berlin, for friendly encouragement and ready aid repeatedly given.

The following Institutions and gentlemen have helped us very materially by the loan of types and, in some cases, the gift of co-types: The Berlin Museum (gift of *I. schillingsi* Neumann co-types, through the courtesy of Geheimrath W. Dönitz and Professor Dahl); the Paris Museum (gift of "*I. transversalis* Lucas" co-types, through the courtesy of Professor Bouvier): the Hamburg Museum (loan of various types, through the courtesy of Professor Kraepelin); the Bureau of Entomology, U. S. Department of Agriculture, Washington, D.C. (gift and loan of various specimens (some of which were identified by Mr N. Banks) thanks to the courtesy of Dr L. O. Howard). The Hon. N. C. Rothschild presented us with a very extensive collection of ticks from all parts of the world, many specimens not having been identified. We, however, discovered that the collection included Neumann's *I. australiensis* (types) and *I. nitens* (types). The Rev. O. Pickard-Cambridge, F.R.S., sent us, on loan, the unique remaining type of *I. putus* (a nymph) in his collection. Professor A. Birula, of St Petersburg, presented a specimen

of *I. signatus* (type locality). Dr S. Hadwen, of Vancouver, British Columbia, presented various stages of *I. angustus* (types of ♂, o and larvae). Dr J. H. Ashworth and Mr W. Evans, of Edinburgh, presented us with our *I. caledonicus* (types of ♀, o and larva). Mr E. G. Wheler presented a valuable collection, including some types of *I. tenuirostris.* Numerous specimens have been sent to us by Mr C. P. Lounsbury, Union Entomologist, S. Africa. Much material has reached us in the form of collections sent for determination; we may especially cite the following sources: The Leland Stanford Junior University, California (courtesy of Professor Vernon L. Kellogg); the Dublin Museum (courtesy of Professor G. H. Carpenter and Dr Scharff); the Entomological Research Committee for Tropical Africa (our thanks are due to the Committee's Secretary, Mr Guy A. K. Marshall, for his uniform courtesy); the Indian Museum, Calcutta (courtesy of Dr N. Annandale). We have been permitted to retain specimens from these various collections.

We, are, moreover, personally indebted to numerous gentleman for aid, as stated in the notes on the specimens in our collection appended to the scientific descriptions.

The original literature on various species of *Ixodes,* whilst very extensive, is in nearly all instances quite useless to the systematist, because many descriptions are short and vague and others, whilst very lengthy, omit to mention the specific characters whereby the species can be distinguished from others. We, of course, except the excellent descriptions of Professor Neumann, from which we have obtained much help. Almost all recent papers dealing with ticks are merely compilations from Neumann. The publications of Dönitz are a marked exception to the rule. The papers by Banks have been of some assistance to us, though we have too often found his descriptions imperfect, and his illustrations greatly wanting in accuracy.

G. H. F. N.
C. W.

CAMBRIDGE,
May, 1911

ERRATA.

p. 107, lines 1 and 26,
for *Sarconyssus*
read *Sarconissus*

p. 134, line 4 from below,
for **Sarconyssus** Kolenati, 1857, p. 21
read **Sarconissus** Kolenati, 1856 and 1857, p. 21

line 5 from below
for **Dermanyssus** Kolenati, 1857, p. 20
read **Dermanissus** Kolenati, 1856 and 1857, p. 20

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OF

PART II

THE IXODIDAE

SECTION I

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SECTION II

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IN THE TEXT

(Figs. 115–138 with the names of parts indicated in accordance with the generic descriptions in the text.)

SECTION I

THE CLASSIFICATION OF TICKS.

I. Historical Review of the Subject[1].

Although the classification of ticks may be considered as dating from Linnaeus (1746, p. 479), who included them under Acari in the large genus *Acarus*, scientific nomenclature did not actually commence until the time of Latreille. This author (1795, p. 15) called the Acari "tiques" and divided them into 11 genera of which two were *Argas* and *Ixodes*. Later (1804, p. 46) he included these two genera with five others (*Sarcoptes*, *Uropoda*, etc.) under **Riciniae**. Hermann (1804, p. 63) included *Rhynchoprion* (*Argas*) and *Cynorhaestes* (*Ixodes*) under Acarina, but kept them far apart, not recognizing their close relationship. Leach (1815, p. 387) called the Acarina *Monomerosomata*, and divided them into 11 families, one of which, **Ixodides**, included *Argas*, *Ixodes* and *Europoda*. He was succeeded by von Heyden (1826, p. 608), who upset previous classifications and again separated *Argas* from *Ixodes*. Sundevall (1833) divided the Acari into six families, one of which, **Ixodides**, included ticks only, *viz.* *Argas* and *Ixodes*. Dugès (1834, p. 5) divided the group into seven families, one of which, **Ixodei**, included *Ixodes*, and **Gamasei** included *Argas*.

C. L. Koch (1844, p. 220; 1847, p. 13) ranked ticks in a special order distinct from the Acari, naming the order **Ricini**, which included three families: 1. **Argasiden** (Argasides, in English, with two genera: *Argas* and *Ornithodoros*); 2. **Ixodiden** (Ixodides, in English, with four genera: *Hyalomma*, *Haemalastor*, *Amblyomma* and *Ixodes*); and 3. **Rhipistomiden** (with four genera: *Dermacentor*, *Haemaphysalis*, *Rhipistoma* and *Rhipicephalus*); families 2 and 3 were distinguished from each other by the possession of long and short palps respectively. Koch's classification was generally adopted by subsequent authors, and has

[1] A number of classical authors refer to ticks. See Bibliography under Aristotle, Cato, Varro, Columella, Pliny, Sammonius, Aldrovandi.

stood the test of time, with some modifications, better than any other which has been advanced. GERVAIS (in Walckenaer and Gervais, 1844, p. 229), however, at the same period, divided Acarina simply into seven genera, of which one genus, *Ixodes*, included all the ticks. NICOLET (1855, p. 381) divided aerial and terrestrial (in contrast to aquatic) mites into five groups, one of which was **Ixodides.** FÜRSTENBERG (1861, p. 208) took over the classification of ticks from C. L. Koch, without making any change. DONNADIEU (1875) included *Argas* under **Ixodidés.** MÉGNIN (1876a, p. 293; 1877, p. 86; 1880, p. 117; and 1892, p. 25) gave the **Ixodidés** as one of eleven divisions of Acarina. MURRAY (1877, p. 185) divided mites into eight families, of which one, family 5, was the **Ixodidae.** KRAMER (1877, p. 215) likewise gave ticks family rank under the name **Ixodidae,** and MICHAEL (1883, p. 50) includes *Argas* in the family **Ixodidae.**

CANESTRINI and FANZAGO (1877, p. 110) divided the family **Ixodini** into four genera: *Ixodes, Hyalomma, Haemaphysalis* and *Rhipicephalus.* KARSCH (1879, p. 96) established the genus *Margaropus.* CANESTRINI (1890, p. 491) subsequently divided the family **Ixodidae** (or *Ixodinae*) into three groups: I. *Poliopli,* with almost the whole venter "corazzato," *i.e.* covered by chitinous plates, literally "cuirassed" (one genus: *Ixodes*), II. *Tetraopli,* with four adanal shields (two genera: *Hyalomma* and *Rhipicephalus*), III. *Anopli,* with naked venter (two genera: *Dermacentor* and *Haemaphysalis*). Ordered according to the structure of the palps, he divided the **Ixodidae** into two sections: A. *Cultripalpi* (Genera *Ixodes* and *Hyalomma*), and B. *Conipalpi* (Genera *Phaulixodes*[1] [Berlese], *Rhipicephalus, Dermacentor, Haemaphysalis* and *Herpetobia*[1] [Canestrini]). He confined his classification to the Italian ticks, of which he had a personal knowledge. CANESTRINI (1892, p. 563) places ticks under *Acaroidea* as an order **Metastigmata** comprising two families: 1. **Ixodidae,** 2. **Argasidae.** MARX (1892a, p. 233) follows, in a measure, the classification of C. L. Koch, but substitutes **Cynorhaestea** for **Ricini** (*Ricinus* being preoccupied), and ranks **Cynorhaestea** as a suborder instead of an order; he divided the suborder into two tribes, or groups: I. *Catastomata,* comprising two families: 1. **Argasidae** (with two genera: *Argas* and *Ornithodoros*), and 2. **Eschatocephalidae** (provisionally forming a "connecting link between the two tribes"); and II. *Antistomata,* comprising three families: 1. **Haemalastoridae** (with two genera: *Haemalastor* and

[1] Since condemned, recognized as nymphal forms: *Phaulixodes* = *Rhipicephalus*, *Herpetobia* = *Haemaphysalis*.

Sarconyssus), 2. **Ixodidae** (with three genera: *Ixodes*, *Amblyomma* and *Hyalomma*), 3. **Rhipistomidae** (with five genera: *Boophilus*, *Rhipicephalus*, *Dermacentor*, *Rhipistoma* and *Haemaphysalis*). Soon afterwards, BANKS (1894, p. 209) established the superfamily *Ixodoidea*, which we retain in this work.

NEUMANN (1896, p. 2) placed ticks (*Ixodidés*) as a family in the order Acari, and divided them into two subfamilies: I. **Argasinae** (with two genera: *Argas* and *Ornithodoros*), and II. **Ixodinae**; he subsequently (1897, p. 325 and 1899, p. 107) recognized three tribes under **Ixodinae**: Tribe 1. *Ixodae* (= *Cultripalpi* of Canestrini, including four genera: *Ixodes*, *Hyalomma*, *Amblyomma* and *Aponomma*); Tribe 2. *Rhipicephalae* (= *Conipalpi* of Canestrini, including three genera: *Rhipicephalus*, *Dermacentor* and *Haemaphysalis*); and Tribe 3 to include *Haemalastor*. By *Haemalastor* he meant to refer to forms like *Ixodes vespertilionis*, of which there are many bad species; he, however (1899, p. 166), recognised its close affinity to *Ixodae*, except for the structure of the ♂ capitulum, and gives *Haemalastor* only generic rank after *Ixodes*. He founded the genus *Aponomma* (1899, p. 180) to include Amblyomma-like forms, differing from *Amblyomma* in not possessing eyes, and in having broader bodies, besides occurring almost exclusively on *Ophidia* and *Sauria*. Neumann (1901, p. 318) briefly reviews the subject of classification, and notes the fact that C. L. Koch and himself were the only authors who based their classifications upon an extended study of actual specimens. He (p. 321) condemns *Phaulixodes* Berlese and *Herpetobia* Canestrini; *Haemalastor* Koch is referred to *Hyalomma*; *Sarconyssus* Kolenati is referred to *Eschatocephalus* Frauenfeld; (p. 276) *Boophilus* Curtice is united to *Rhipicephalus*; *Rhipistoma* Koch and *Opisthodon* Canestrini, *Gonixodes* Dugès are included under *Haemaphysalis*; *Caris* Latreille, *Crotonus* Duméril, *Cynorhaestes* Hermann are referred to as "des synonymes plus ou moins précis d'*Eschatocephalus* et d'*Ixodes*"; *Pseudixodes* Haller is referred to *Dermacentor*; *Ophiodes* Murray falls into synonymy (= *Aponomma*), *Xiphiastor* Murray, and *Adenopleura* Macalister are condemned as undeterminable, being possibly *Amblyomma* spp.; *Margaropus* Karsch is stated to be nothing more "qu'un individu anormal de *Rhipicephalus annulatus* (Say) var. *microplus*." After thus clearing the ground of a good deal of lumber, he (p. 322) reiterates that he is in agreement with most zoologists in regarding the **Ixodidae** as merely a family of the order Acarina, and he divides the family into ten genera which he groups into two subfamilies: I. **Ixodinae** divided into two tribes:

1. *Ixodae* (Genera *Ixodes, Eschatocephalus, Aponomma, Amblyomma* and *Hyalomma*), 2. *Rhipicephalae* (Genera *Haemaphysalis, Rhipicephalus* and *Dermacentor*); and II. **Argasinae** (Genera *Argas* and *Ornithodoros*).

SALMON and STILES (1901, p. 384), whilst following Neumann with regard to the grouping of the various genera, raise the ticks to the rank of a superfamily, as had been done by Banks. They simply raise Neumann's subfamilies and tribes to the rank of families and subfamilies respectively. Their classification is as follows: Superfamily **Ixodoidea** comprising two families: I. **Argasidae** (Genera *Argas* and *Ornithodoros*), and II. **Ixodidae**, including two subfamilies: 1. *Rhipicephalinae*[1] (Genera *Rhipicephalus, Boophilus, Haemaphysalis* and *Dermacentor*), and 2. *Ixodinae* (Genera *Ixodes, Eschatocephalus, Aponomma, Amblyomma* and *Hyalomma*).

NEUMANN next (1902, p. 115) established the genus *Ceratixodes*. In 1904, p. 444, he created the subgenus *Euixodes*, to include all *Ixodes* other than *Ceratixodes* and *Eschatocephalus*, both of which were degraded to subgenera. (We include all of these in the one genus *Ixodes* in this work, see pp. 133–135, and do not see a valid reason for retaining the subgenera.)

NEUMANN (1904, p. 444) attempted, further, to order the genera of his subfamily *Ixodinae* according to their real affinities, a task, as we have seen, previously attempted by Canestrini (1890), and Marx (1892). Nevertheless, the original order adopted by C. L. Koch (1844), depending upon the relative length of the palps, had hitherto been generally accepted, and was until now retained by Neumann.

As pointed out by Neumann (1904, p. 445), the relative length of a single structure like the capitulum does not give a safe basis for classification, since, in the absence of type specimens for purposes of comparison, it leaves too much to the personal judgment of the naturalist in defining what is "long" and what is "short." Although of undoubted use, the division of *Ixodinae* into the two tribes mentioned is unnatural and misleading, since it leads to misconceptions regarding the real relationships existing between the genera. Thus *Ixodes* and *Hyalomma*, included in Tribe 1, are not nearly so closely related as *Hyalomma* and *Rhipicephalus*, the latter serving as the type of Tribe 2. Moreover, the presence or absence of eyes, whilst of generic value, is of no value as a means of ordering the genera according to their affinities,

[1] Lahille (1905, p. 12) remarks that the subfamily should be styled **Dermacentorinae** and not **Rhipicephalinae**, if the rules of nomenclature are to be strictly adhered to, for *Dermacentor* (Koch, 1844, p. 235) has priority over *Rhipicephalus* (Koch, 1844, p. 238).

for it brings *Ixodes*, *Aponomma* and *Haemaphysalis* together on the one hand, and *Amblyomma*, *Hyalomma*, *Rhipicephalus* and *Dermacentor* on the other. Neumann considers it essential to take as a basis of classification some external feature which is determined by a difference in anatomical structure. Such a feature is to be found in the grooves on the ventral surface. This would lead us back to the principle adopted by Canestrini (*vide supra*), who was struck by the affinities existing between *Hyalomma* and *Rhipicephalus*. Canestrini did not include *Amblyomma* and *Aponomma* under his **Anopli**, because he confined himself to genera occurring in Italy. Neumann agrees that Canestrini's groups **Poliopli** and **Tetraopli** are homogeneous, but that this does not hold for the group **Anopli**, which includes *Amblyomma* (*Aponomma*[1]), *Dermacentor* and *Haemaphysalis*. (*Amblyomma* and *Aponomma* are obviously allied, but *Dermacentor* and *Haemaphysalis* remain disconnected.) Neumann attempted to represent the supposed affinities between the different genera by the following plan, wherein the position and length of the connecting lines indicate approximately the degrees of affinity:

```
        Ixodes-------------------------------------Haemaphysalis
                                                          |
        Hyalomma-----Amblyomma-------Aponomma
              |                       |
    Rhipicephalus-------Dermacentor
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Neumann adopts Canestrini's groups as sections in the subfamily **Ixodinae**, substituting names derived from type genera for the corresponding names given by Canestrini, thus:

Section 1. *Ixodeae* (for *Poliopli*).
„ 2. *Rhipicephaleae* (for *Tetraopli*).
„ 3. *Amblyommeae* (for *Anopli*).

Neumann characterizes the sections as follows:

1. **Ixodeae**: ♂ venter entirely covered by shields. Anal groove contouring the anus in front and independent of the genital grooves. Eyes absent. Capitulum elongate.

2. **Rhipicephaleae**: ♂ venter bearing two adanal shields, usually accompanied by accessory shields. Anal groove contouring the anus behind and usually joining the genital grooves in front. Eyes present. Capitulum long or short.

3. **Amblyommeae**: ♂ venter devoid of shields. Anal groove as under 2. Eyes often present. Capitulum as under 2.

[1] We regard *Aponomma* as simply a subgenus of *Amblyomma*.

Neumann (1907 a, p. 26), in his latest paper in which he deals with classification, includes the following genera under the various sections above mentioned: I. **Ixodeae** (*Ixodes*), II. **Rhipicephaleae** (*Rhipicephalus, Margaropus*[1], *Hyalomma*), and III. **Amblyommeae** (*Amblyomma, Dermacentor, Aponomma, Haemaphysalis*). Lahille (1905, pp. 11 *et seq.*) places ticks in a suborder, **Arpagostoma**[2], comprising two families: I. **Argasidae**, and II. **Ixodidae**; he divides the latter into three groups according to the ♂s: Group 1. **Anopli** (without ventral plates) including four genera: *Aponomma* and *Neumanniella* (eyeless = anommata) and *Amblyomma* and *Dermacentor* (ommata); Group 2. **Artiopli** (with an even number of ventral plates) including three genera: *Hyalomma, Rhipicephalus* and *Boophilus* (all possessing eyes); and, finally, Group 3. **Perissopli** (with five ventral plates), comprising three genera: *Ixodes, Eschatocephalus* and *Ceratixodes* (anommata). Lahille (p. 16) founded the genus *Neumanniella*, of which more presently, to include *Ixodes transversalis* Lucas, 1844; 1845, p. 61, Pl. I, Fig. 3 = *Aponomma transversale* (Lucas) Neumann, 1899, p. 188, Fig. 42.

Warburton (vii. 1907, p. 90) proposed the following classification:

- Ixodoidea
  - Argasidae
    - Argas
    - Ornithodoros[3]
  - Ixodidae
    - Prostriata
      - Ixodes
    - Metastriata
      - Brevirostrata
        - Group 1
          - Haemaphysalis
        - Group 2
          - Dermacentor
          - Rhipicentor[4]
          - Rhipicephalus
          - Margaropus
          - Boophilus
      - Longirostrata
        - Group 1
          - Hyalomma
        - Group 2
          - Amblyomma
          - Aponomma

Among the **Ixodidae** he separated widely *Ixodes* from the other genera as **Prostriata**, which refers to the anal grooves surrounding the anus *in front*, whereas in all the other genera the anal groove curves about the anus posteriorly. The latter are grouped under **Metastriata**, and are divided into two sections: **Brevirostrata** and **Longirostrata**, according as they possess a short or long capitulum; and each section naturally falls into two groups, as indicated above. Banks (viii. 1907,

[1] Meaning *Boophilus* Curtice, and including *Margaropus* Karsch.

[2] Should be *Harpagostoma* (from harpagon = a grappling iron).

[3] We have not hitherto adopted the latinized transcription *Ornithodorus* but shall do so henceforth in accordance with the rules laid down in *The International Code of Zoological Nomenclature*.

[4] Since added.

p. 62, as stated in Banks, 1908, pp. 13, 14) advanced another classification. He divides **Ixodidae** into two subfamilies: I. **Ixodinae** (*Ixodes* and *Ceratixodes*[1]), having the anal groove in front of the anus, and, II. **Amblyomminae** (including the other genera of ticks) having the anal groove posterior to the anus. He divides the **Amblyomminae** into four tribes as follows:

1. *Rhipicephalini* (including *Rhipicephalus* and *Margaropus*).
2. *Haemaphysalini* (*Haemaphysalis*).
3. *Dermacentorini* (*Dermacentor*).
4. *Amblyommini* (*Amblyomma*, *Aponomma* and *Hyalomma*).

Dönitz (1907 a, pp. 1–8, reprint) re-established the genus *Margaropus* Karsch, 1879, which Neumann (1901, p. 281) had regarded as a monstrosity of "*Rhipicephalus annulatus* var. *micropla*." Neumann has never recognized the genus *Boophilus* Curtice; he continued to include *Boophilus* under *Rhipicephalus* until he became convinced of the validity of the genus *Margaropus*, when he concluded that it had priority over *Boophilus*. Since then, he has referred species of *Boophilus* to *Margaropus*, but as we shall see, both genera are perfectly distinct and valid.

Nuttall and Warburton (1907, p. 398) founded the genus *Rhipicentor*.

Dönitz (1910, p. 400) passes under review the recent attempts at classification by Neumann, Lahille, Warburton and Banks. He agrees with us in condemning *Eschatocephalus* and *Ceratixodes* and referring them to *Ixodes*, and he also recognizes the genera *Boophilus* and *Margaropus* as distinct. He condemns *Neumanniella* Lahille, 1905, until there is better reason for recognizing such a genus. It will be remembered that Neumann (1899, p. 188) stated that *Aponomma transversale* (Lucas) Neumann possessed no anal groove, and might, consequently, be referred to another genus if another species resembling it were found. Lahille, however, founded the genus *Neumanniella* without ever having seen the types. Dönitz denies that we know enough of the relationship existing between the genera (apart from *Ixodes*) grouped under **Ixodidae** to reach any final conclusions regarding their arrangement in respect to each other; it is possible that differences of internal structure may prove of help in the future. He prefers, in a measure, the older classification of Neumann which arose out of that originally advanced by Koch. Koch, as we have seen, divided ticks

[1] Made a subgenus by Neumann, 1904, and now suppressed by us and by Dönitz, 1910.

into three families: **Argasidae**, **Ixodidae** (with long palps) and **Rhipistomidae** (with short palps). The relative length of these structures is certainly convenient in the practical work of determination. BANKS (1908, p. 12) objects to too much weight being laid on the relative length of the palps, partly on the ground that it hardly permits us to "distinguish some species of *Amblyomma* from *Dermacentor*." DÖNITZ does not approve of Neumann's subsequent adoption (1904) of the plan of Canestrini (1890), the latter's **Poliopli**, **Tetraopli** and **Anopli** corresponding to **Ixodeae**, **Rhipicephaleae** and **Amblyommeae** of Neumann. As Dönitz points out, *Amblyomma* are not **Anopli**; a number possess small chitinous plates[1] (analogous to the plates in *Ixodes*) situated posteriorly upon the ventral surface. Again, *Margaropus* has a ventral plate corresponding to the median plate in *Ixodes*, but *Margaropus*, by its general structure, is allied to *Boophilus* and *Rhipicephalus*, *i.e.* **Tetraopli** (**Rhipicephaleae**), and not to **Poliopli** (**Ixodeae**). BANKS (1908, p. 13) very properly criticizes the classification of Lahille (1905), which is based on the characteristics of the ♂, and thus separates *Hyalomma* widely from *Amblyomma*, most authors agreeing that they are allied, the ♀s being at times difficult to distinguish. Banks fails to see "the importance of secondary sexual characters" which lead to Lahille's classification, and considers that they "are certainly not of sufficient value to characterize groups higher than genera and are better employed for groups of lesser rank." DÖNITZ (1910, p. 401) likewise objects to Lahille's classification on the ground already stated that *Amblyomma* are not **Anopli**, and that *Margaropus* would be classed as **Perissopli**, whereas they are closely related to **Artiopli.** He agrees with Warburton and with Banks in separating the genus *Ixodes* widely from the other genera, because of the structure of the anal groove, apart from other important differences. Dönitz (p. 403) divides the **Ixodidae** into three divisions: I. **Ixodeae** (one genus, *Ixodes*), II. **Amblyommeae** (=**Longirostrata** of Warburton, with three genera: *Amblyomma*, *Aponomma*, *Hyalomma*), and III. **Rhipicephaleae** (=**Brevirostrata** of Warburton, with six genera: *Rhipicephalus*, *Boophilus*, *Margaropus*, *Dermacentor*, *Rhipicentor* and *Haemaphysalis*). BANKS (1908, pp. 13, 14) does not agree with the classification of Warburton in so far as the latter places *Dermacentor* with *Rhipicephalus*. Banks considers this ill-advised, and places *Dermacentor* close to *Amblyomma*. The genus *Rhipicentor* Nuttall and Warburton, 1907, however, directly links *Rhipicephalus* to *Dermacentor*, as is indicated by the

[1] "Plaques" in our descriptions, see Fig. 135 *a*.

name, and the discovery of this intermediate type confirms the view advanced by Warburton. Banks agrees with us in not placing *Hyalomma* near *Rhipicephalus*, as has been done by Neumann (1907 a, p. 26).

Summary.

The perusal of the foregoing account of the views held by different authors who have written upon the classification of ticks, shows that a great deal of confusion has undoubtedly existed. At a fairly early date, the Argasid and Ixodid ticks were recognized as possessing very distinctive features. The confusion that has arisen is mainly due to efforts in classifying the **Ixodidae**. The proposal to separate the latter into two distinct sections (Warburton, Banks) is based on anatomical grounds, *i.e.* the structure of the anal groove in the **Prostriata** in contrast to the **Metastriata**. In some ticks (*Boophilus*, *Margaropus*) the anal groove may be obsolete; they are, however, obviously related to other metastriate forms in general structure. It appears advisable, only as a matter of convenience, to give these sections the new names (suggested by Warburton), in view of the great confusion of subfamily, tribal, group, and other names, all of which have been based on the original generic names. The division of the **Metastriata** into **Brevirostrata** and **Longirostrata** is also one of convenience, and their subdivision into two groups each follows naturally when the characters of the genera are taken as a whole.

With regard to the genus *Neumanniella* Lahille, 1905, to which reference has been made in the preceding pages, we would state that we have examined the types of *Ixodes transversalis* Lucas and agree with Neumann in retaining the species under *Aponomma*. On very careful examination we have detected traces of an anal groove posterior to the anus. Consequently the genus *Neumanniella* falls into synonymy.

Superfamily IXODOIDEA Banks, 1894.

SYNONYMY AND LITERATURE:

Genus **Acarus** (in part) Linnaeus, 1746, p. 479.
Family **Riciniae** (in part) Latreille, 1804, p. 46; 1806, p. 151; 1829, p. 286. Risso, 1826, p. 180. Oudemans, 1896, p. 191.
Family **Ixodides** Leach, 1815, p. 396 (includes *Europoda*). Sundevall, 1833. Fuller, 1896, p. 763.
Family **Ixodea** Burmeister, 1837, p. 579. Grube, 1859, p. 455. Gerstaecker, 1860, p. 464.

Order **Ricini** Koch, 1844; also 1847, p. 5. Fürstenberg, 1861, p. 208. Canestrini, 1890, p. 482.
Genus **Ixodes** Gervais, in Walckenaer and Gervais, 1844, p. 229.
Family **Ixodida** Küchenmeister, 1855, p. 421. Kolenati, 1857, p. 19.
Group **Ixodides** Nicolet, 1855 (cited by Michael, 1883–1887).
Family **Ixodidae** Leach, in Gerstaecker, 1863, p. 343; 1873, p. 464. Murray, 1877, p. 185. Conil, 1877, p. 28. Kramer, 1877. Claus, 1880, p. 652. Michael, 1883, p. 50. Berlese, 1885, p. 131. Ludwig, 1886, p. 612. Riley, 1887, p. 744. Marx, 1892, p. 232. Trouessart, 1892, p. 28. Neumann, 1892b, p. 94. Railliet, 1893, p. 631. Braun, 1895, p. 257. Osborn, 1896, p. 255. Ward, 1900 (*a*), p. 193, and (*b*), p. 430. Neumann, 1901, p. 322. Stiles and Hassall, 1901, p. 1. Neumann, 1904, p. 444. Lahille, 1905, p. 16. Wheler, 1906, p. 400. Pocock, 1907, p. 190. Dönitz, 1907, p. 1. Neumann, 1907a, p. 26. Newstead, Dutton and Todd, 1907, p. 99. Bonnet, 1908, p. 247. Blanchard, 1909, p. 80.
Family **Ixodidés** Donnadieu, 1875. Mégnin, 1876a, p. 293; 1877, p. 86; 1880, p. 117; 1892, p. 25. Railliet, 1886, p. 495; 1895, p. 703. Neumann, 1888, p. 82; 1892a, p. 90; 1896, p. 1; 1897, p. 324; 1899, p. 107; and subsequently to 1910. Blanchard, 1890, p. 322; 1909, p. 5. Brumpt, 1910, p. 510.
Order **Metastigmata** Canestrini, 1892, p. 563.
Suborder **Cynorhaestea** Marx, 1892, p. 233.
Suborder **Arpagostoma** Lahille, 1905, p. 11. (Should be *Harpagostoma.*)
Superfamily **Ixodoidea** Banks, 1894, p. 209. Salmon and Stiles, 1901, p. 383. Warburton, 1907, p. 90. Banks, 1907, p. 62, and 1908, p. 7. Nuttall, Warburton, Cooper and Robinson, 1908, p. 1 (Part I of this work). Castellani, 1910, p. 460.

SUPERFAMILY CHARACTERS. *Acari of the suborder* **Metastigmata** (*the breathing apertures being somewhat posteriorly situated*) *characterized by the possession of a movable false head, or capitulum, of a special structure. It consists of a basal portion* (*basis capituli*), *a pair of palps, protrusible chelicerae with digits serrate externally, and a rigid hypostome almost always toothed on its ventral surface. All are blood-sucking mites, parasitic on animals.*

N.B. The **Acarina**, or Mites, are divided into the suborders **Vermiformia, Astigmata, Metastigmata, Helerostigmata, Prostigmata, Notostigmata.** Besides the *Ixodoidea*, the **Metastigmata** include the *Oribatidae* and the *Gamasidae*. The only mites in the least likely to be confounded with the *Ixodoidea* are the remarkable group of *Gekobiidae*, parasitic on lizards. Their mouth-parts strongly resemble those of the ticks, but they belong to the suborder **Prostigmata,** having their breathing orifices near the palps.

The Ixodoidea are divided into two families, I. the *Argasidae* (see Part I) and II. the *Ixodidae.*

II. Family IXODIDAE Murray, 1877.

SYNONYMY AND LITERATURE:

Family **Ixodei** Dugès, 1834 a, p. 15; 1834 c, p. 33.
Family **Ixodiden** Koch, 1844, p. 220; 1847, p. 13. Fürstenberg, 1861, p. 208.
Family **Ixodidés** Gervais and van Beneden, 1859, p. 460.
Family **Ixodidae** Murray, 1877, p. 185. Pavesi, 1884, p. 483. Canestrini, 1890, p. 530; 1892, pp. 563, 581; 1897, p. 468. Trouessart, 1892, p. 22. Supino, 1897 a, p. 241. Pocock, 1900 a, p. 48. Salmon and Stiles, 1901, p. 384. Banks, 1905, p. 42. Lahille, 1905, pp. 11 *et seq.* Banks, 1907, p. 62. Hunter and Hooker, 1907, p. 46. Manson, 1907, p. 205. Warburton, 1907, p. 89. Banks, 1908, pp. 12 *et seq.* Nuttall, Warburton, Cooper and Robinson, 1908, p. 1. Dönitz, 1910, p. 400. Stiles, 1910, p. 12.
Family **Ixodini** Canestrini and Fanzago, 1877, p. 110. Canestrini, 1890, pp. 475, 491; 1892, p. 558.
Family **Ixodinae** Karsch, 1880, p. 41.
Tribe **Ixodidés** Mégnin, 1880, p. 120.
Subfamily **Ixodidae** Berlese, 1885, p. 131.
Tribe **Ixodinés** Railliet, 1886, p. 495. Neumann, 1888, p. 89; 1892 a, p. 93.
Subfamily **Ixodinae** Trouessart, 1892, p. 38. Railliet, 1895, p. 704. Neumann, 1896, p. 2; 1827, p. 325; 1899, p. 107. Ward, 1900 (*a*), p. 196; (*b*) p. 435. Neumann, 1904, p. 444; 1907 a, p. 26. Howard, 1908, p. 89. Blanchard, 1910, pp. 55–77. Brumpt, 1910, p. 510.
Tribe **Ixodinae** Neumann, 1892 b, p. 96.
Group or Tribe **Antistomata** Marx, 1892 a, p. 233.

FAMILY CHARACTERS[1]. *Scutate ticks with terminal capitulum and spiracles posterior to coxae IV. Sexual dimorphism marked, the males being almost entirely covered by the scutum, and incapable of great distention; while the scutum of the distended female appears as a small shield behind the capitulum. Porose areas present on the ♀ capitulum. Where eyes are present they are situated laterally upon the scutum. The fourth article of the palp is reduced to form a tactile papilla.* Type genus: *Ixodes.*

[1] In this connection refer to Explanation of Terms and Signs used in the descriptions, p. 127.

CLASSIFICATION OF THE IXODIDAE.

There are nine genera: *Ixodes, Haemaphysalis, Dermacentor, Rhipicentor, Rhipicephalus, Margaropus, Boophilus, Hyalomma* and *Amblyomma* (including the sub-genus *Aponomma*). They present varying degrees of affinity, which may be indicated by arranging them into groups according to the following scheme:

- Ixodidae
  - Prostriata
    - 1. Ixodes
  - Metastriata
    - Brevirostrata
      - Group 1
        - 2. Haemaphysalis
      - Group 2
        - 3. Dermacentor
        - 4. Rhipicentor
        - 5. Rhipicephalus
        - 6. Margaropus
        - 7. Boophilus
    - Longirostrata
      - Group 1
        - 8. Hyalomma
      - Group 2
        - 9. Amblyomma (Aponomma)

Ixodes is clearly marked off from the other genera by a number of characteristics, of which the most striking are the anal groove surrounding the anus *in front* (*Prostriata*) and the absence of festoons. The remaining genera fall naturally into two divisions: the one characterized by a comparatively short, and the other by a comparatively long capitulum. Occasionally, forms are encountered which are aberrant in this respect.

SECTION I. PROSTRIATA.

With anal grooves surrounding the anus in front.

Genus (1) **Ixodes**: *inornate, without eyes and without festoons; spiracles round or oval*; palps and basis capituli of variable form; coxae either unarmed, trenchant, spurred or bifid; tarsi without spurs. *Sexual dimorphism pronounced,* especially with regard to the capitulum; *in the ♂ the venter is covered by non-salient plates*: one pregenital, one median, one anal, two adanal and two epimeral plates. Figs. 115–119.

Type species: *Ixodes ricinus* (Linnaeus).

IXODES

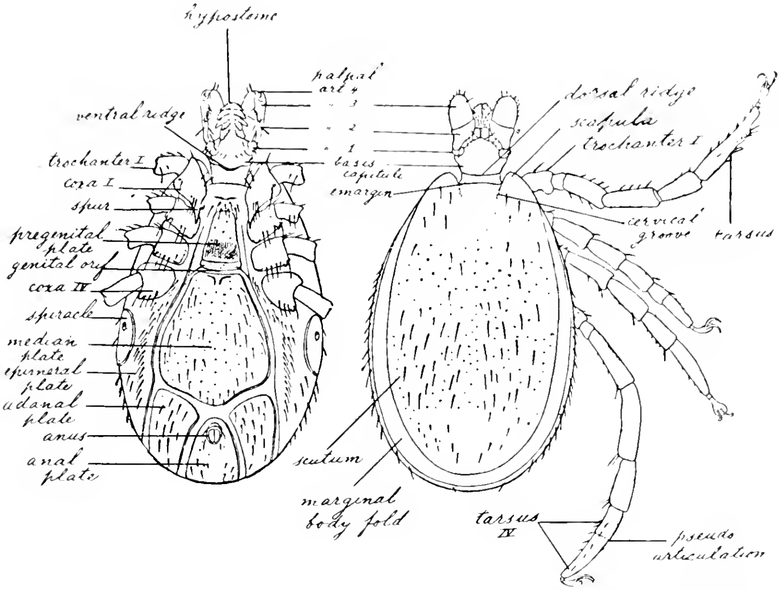


Fig. 115. *I. ricinus* (Linn.), ♂: in dorsal and ventral aspects (from Nuttall, 1908, G. H. F. N. del.).

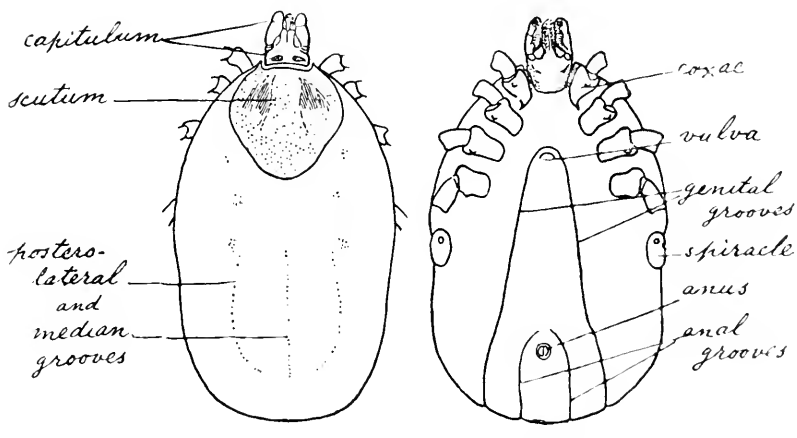


Fig. 116. *I. hexagonus* Leach, 1815, ♀ (replete): in dorsal and ventral aspects. (Original, G. H. F. N. del.)

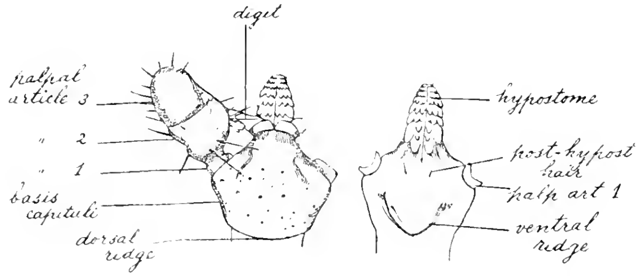


Fig. 117. *I. caripalpus* Nuttall and Warburton, 1908, ♂: capitulum in dorsal and ventral aspects (from Nutt. and Warb., G. H. F. N. del.).

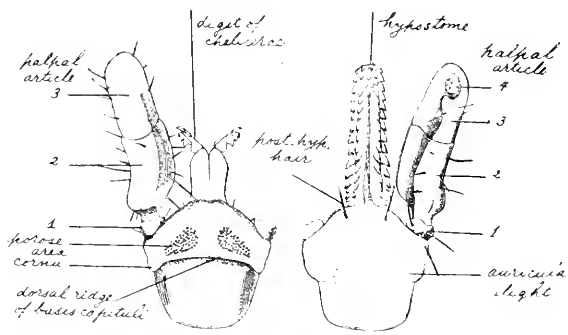


Fig. 118. *I. caripalpus*, Nutt. and Warb., 1908, ♀: capitulum in dorsal and ventral aspects (from Nutt. and Warb., G. H. F. N. del.).

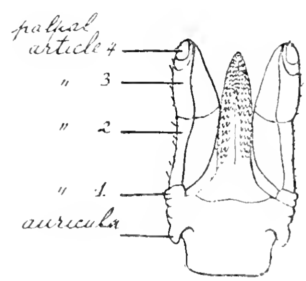


Fig. 119. *I. bicornis* Neumann, 1906, ♀: capitulum in ventral aspect to show auricula. (Neumann del.)

SECTION II. METASTRIATA.

With anal groove contouring the anus behind.

Note: In two genera, *Boophilus* and *Margaropus*, clearly attributable to this section by their general structure, the anal groove is faint or obsolete. Any tick in which the anal groove cannot be made out may with safety be referred to the *Metastriata*.

(*a*) *Brevirostrata.*

Group 1.

Genus (2) **Haemaphysalis**: *inornate, without eyes but with festoons; with usually short conical palps* whose second articles project laterally beyond the basis capituli, which is rectangular dorsally. With dorsal process on first trochanter. Usually of small size and but slightly chitinized. Sexual dimorphism slight. The ♂ shows no ventral plates or shields. Spiracles in ♂ usually ovoid or comma-shaped; in ♀, rounded or ovoid. Fig. 120.

Type species: *Haemaphysalis concinna* C. L. Koch.

HAEMAPHYSALIS

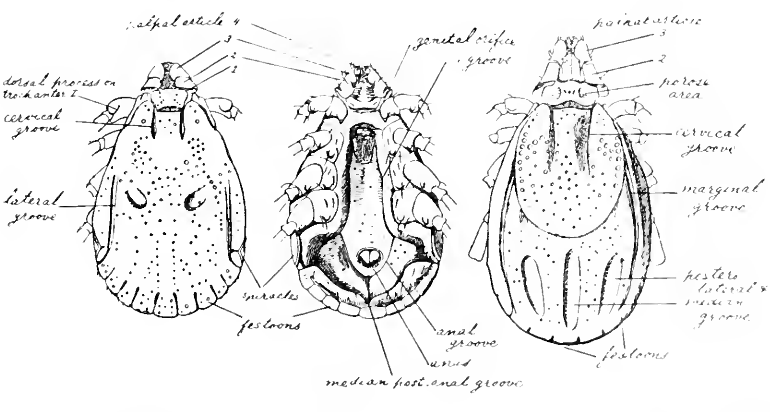


Fig. 120. *H. wellingtoni* Nuttall and Warburton, 1908, ♂ in dorsal and ventral aspects and ♀ in dorsal aspect (from Nutt. and Warb., E. W. del.).

Group 2.

Genus (3) **Dermacentor**: *usually ornate, with eyes and festoons*; with short, broad or moderate palps and *basis capituli rectangular dorsally*. In some species coxae I to IV of the ♂ increase progressively in size; in all species *coxa IV is much the largest*; the ♂, moreover, shows no ventral plates or shields. Coxa I bifid in both sexes. Spiracles sub-oval or comma-shaped. Figs. 121, 122.

Type species: *Dermacentor reticulatus* (Fabricius).

DERMACENTOR

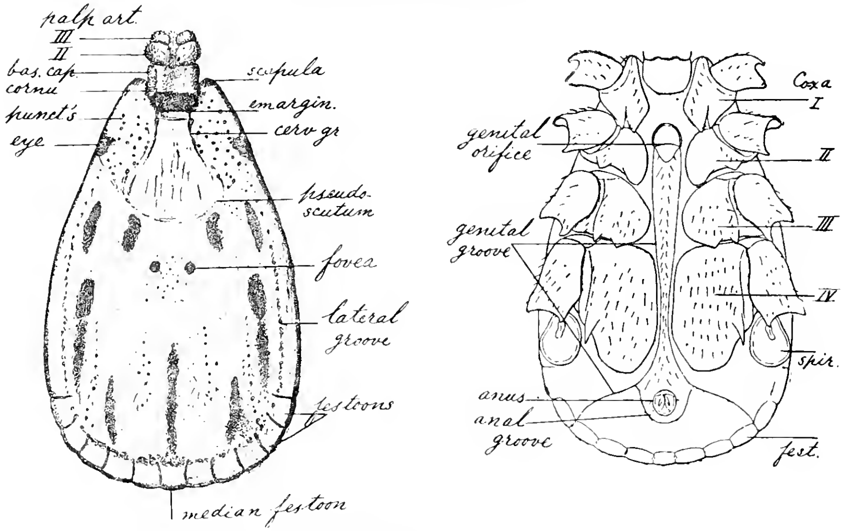


Fig. 121. *D. variegatus* var. *kamshadalus* Neumann, 1908, ♂: in dorsal and ventral aspects (from Neumann, 1908).

Fig. 122. *D. variabilis* (Say, 1821), ♀: capitulum and scutum (sketch from Salmon and Stiles, 1901; G. H. F. N. del.).

Genus (4) **Rhipicentor**: *inornate, with eyes and festoons*; with short palps, with *basis capituli hexagonal dorsally* and having very prominent lateral angles. Coxa I bifid in both sexes. *The ♂ resembles Rhipicephalus dorsally, Dermacentor ventrally; coxa IV is much the largest*; no ventral plates or shields. Spiracles sub-triangular (♀) or comma-shaped (♂). Figs. 123, 124.

Type species: *Rhipicentor bicornis* Nuttall and Warburton.

RHIPICENTOR

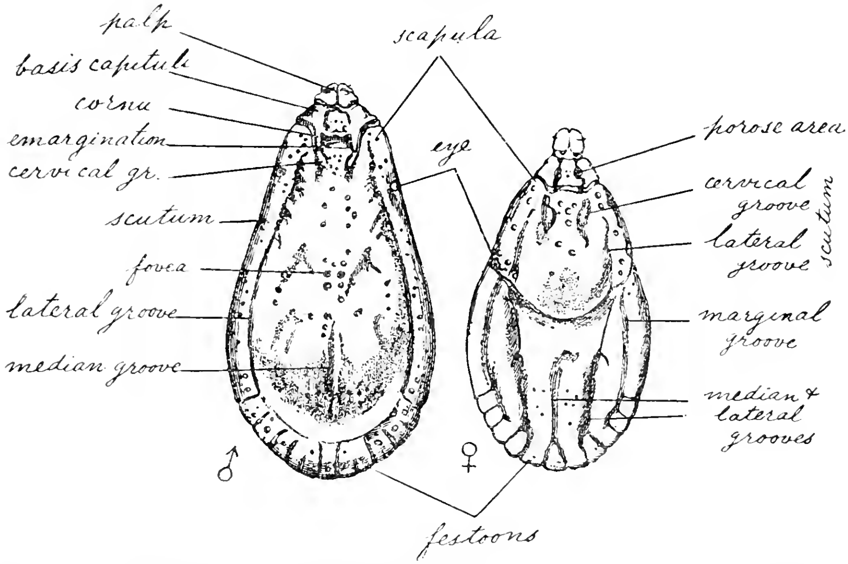


Fig. 123. *R. bicornis* Nuttall and Warburton, 1908, ♂ and ♀: dorsum (from Nutt. and Warb., E. W. del.).

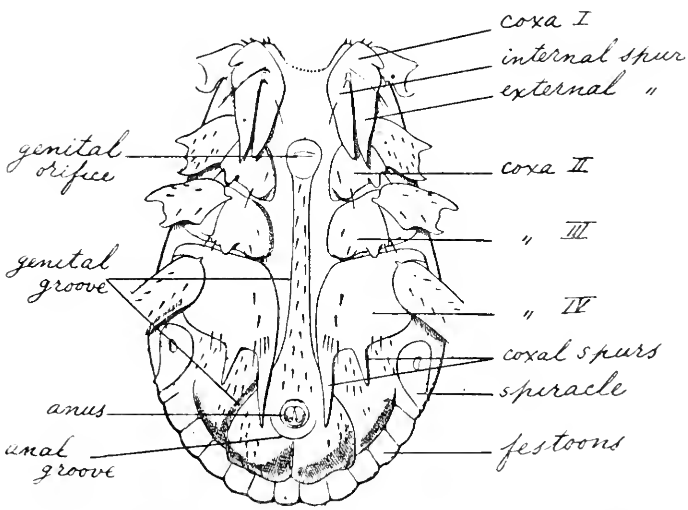


Fig. 124. *R. bicornis*, ♂: venter, etc., as under Fig. 123 (G. H. F. N. del.).

Genus (5) **Rhipicephalus** : *usually inornate, with eyes and festoons,* with short palps and *basis capituli usually hexagonal dorsally.* (The ♂ of one species, *Rhipicephalus pulchellus,* has a *Dermacentor*-like capitulum, and both sexes are ornate.) Coxa I bifid. The ♂ possesses a pair of *adanal shields and usually a pair of accessory adanal shields*; some ♂s, when replete, show a caudal protrusion. Spiracles bluntly or elongate comma-shaped. Figs. 125–127.

Type species: *Rhipicephalus sanguineus* (Latreille).

RHIPICEPHALUS

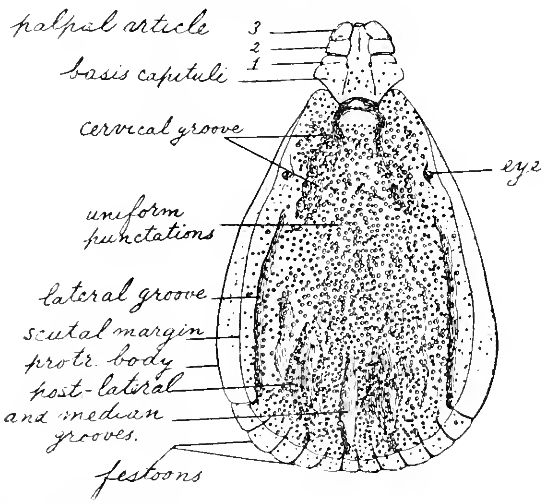


Fig. 125. *Rh. bursa* Canestrini and Fanzago, 1877, ♂: dorsum. (Original, L. E. R. del.)

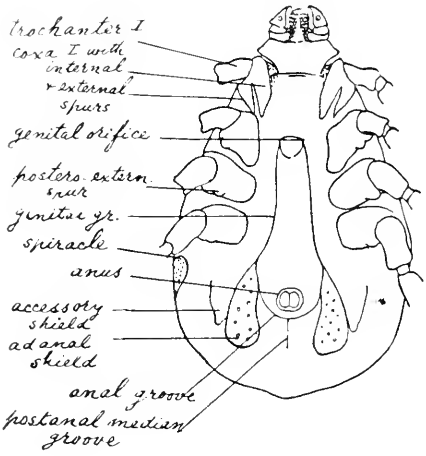


Fig. 126.

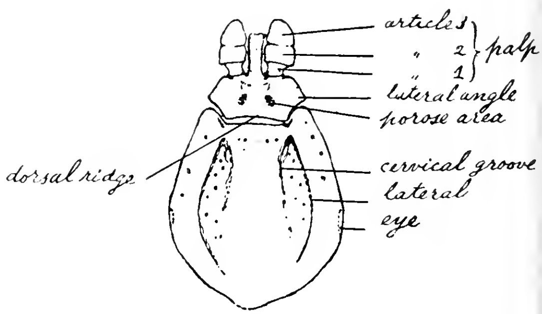


Fig. 127.

Fig. 126. *Rh. sanguineus* (Latreille, 1804), ♂: venter (from Warb. and Nutt., 1909, G. H. F. N. del.).

Fig. 127. *Rh. simpsoni* Nuttall, 1910, ♀: capitulum and scutum (from Nuttall, F. M. H. del.).

With anal grooves obsolete.

Genus (6) **Margaropus**[1]: *inornate, with eyes, but without festoons,* with short palps and capitulum intermediate between that of *Rhipicephalus* and *Boophilus; highly chitinized*; the unfed adults of large size. *The ♀ with very small scutum.* Coxae conical, unarmed but for a small spine posteriorly on coxa I. *The ♂ with a median plate prolonged in two long spines projecting beyond and to either side of the anus*; with coxae similar to those of ♀; legs increasing progressively in size from pair I to IV, *the articles especially of leg-pair IV greatly swollen.* When replete, the ♂ shows a caudal protrusion. Anal groove obsolete. *Spiracles rounded or short-oval in both sexes.* Figs. 128, 129.

Type species: *Margaropus winthemi* Karsch.

MARGAROPUS

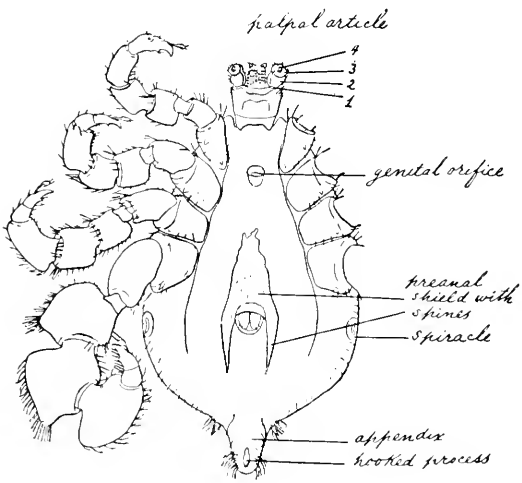


Fig. 128.

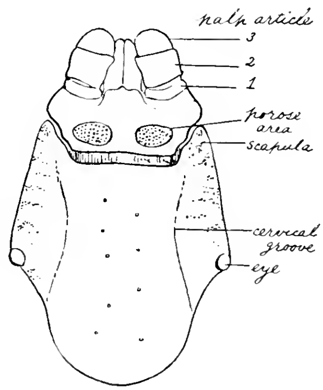


Fig. 129.

Fig. 128. *M. winthemi* Karsch, 1879, ♂: venter (from Neumann, 1907, Nu. del.).
Fig. 129. *M. winthemi* Karsch, 1879, ♀: capitulum and scutum. (Original, sketch by C. W.)

[1] This name has become established. It should read *Margaritopus*, signifying beady-legged.

Genus (7) **Boophilus**: *inornate with eyes, but without festoons*; with very short *compressed palps ridged dorsally and laterally; basis capituli hexagonal dorsally; slightly chitinized*; the unfed adults of small size. Coxa I bifid. Anal groove obsolete in ♀, faintly indicated in ♂. *The ♀ with a small scutum; the ♂ with adanal and accessory adanal shields. Spiracles rounded or oval* in both sexes. Figs. 130, 131.

Type species: *Boophilus annulatus* (Say).

BOOPHILUS

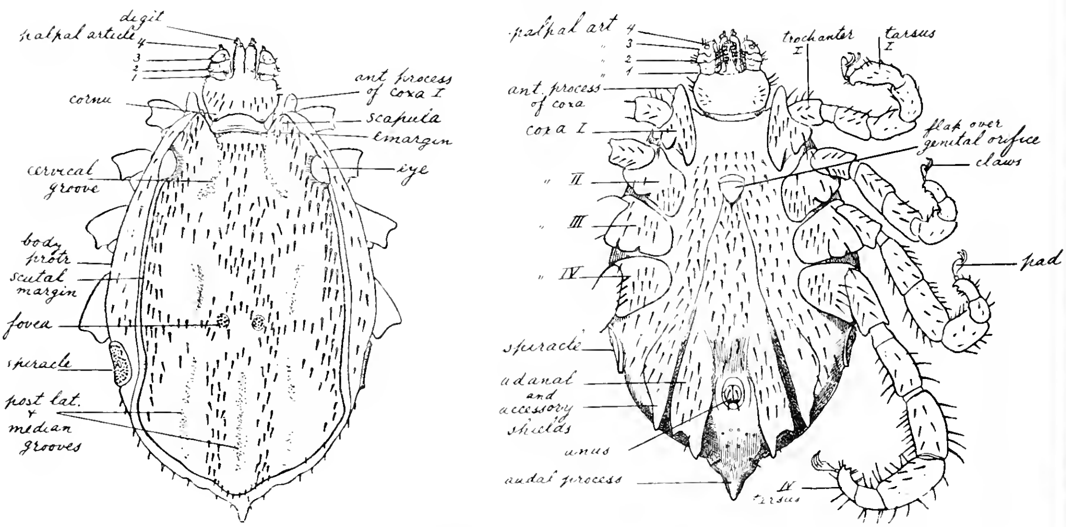


Fig. 130. *B. decoloratus* (Koch, 1844), ♂: dorsum and venter (from Warb. and Nutt., 1909, G. H. F. N. del.).

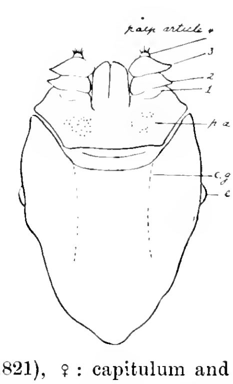


Fig. 131. *B. annulatus* (Say, 1821), ♀: capitulum and scutum (sketch from Salmon and Stiles, 1901, G. H. F. N. del.).

(*b*) *Longirostrata.*

Group 1.

Genus (8) **Hyalomma**: *ornamentation absent or present*, at times confined to the legs; *with eyes, with or without festoons*, with long palps (shorter in *Hyalomma monstrosum* ♂) and *basis capituli subtriangular dorsally.* The ♀ approaching *Amblyomma. The* ♂ *with a pair of adanal shields, and with or without accessory adanal shields and two posterior abdominal protrusions capped by chitinized points.* Coxa I bifid. Spiracles comma-shaped. Figs. 132, 133.

Type species: *Hyalomma aegyptium* (Linnaeus).

HYALOMMA

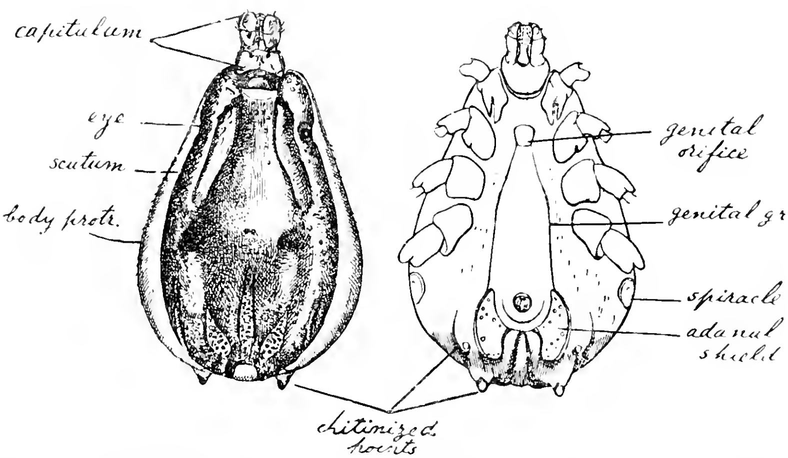


Fig. 132. *Hyal. aegyptium* (Linn.), ♂: dorsum and venter (from Warb. and Nutt. 1909, G. H. F. N. and E. W. del.).

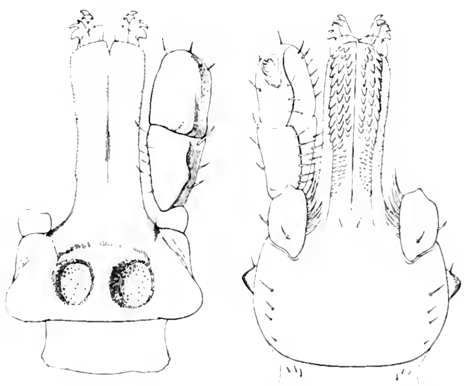


Fig. 133. *Hyal. aegyptium* (Linn.), ♀: capitulum in dorsal and ventral aspects. (Original, G. H. F. N. del.)

Group 2.

Genus (9) **Amblyomma**: *generally ornate, with eyes and with festoons.* With long palps, of which article 2 is specially long; *basis capituli of variable form. The ♂ without adanal shields, but small ventral plaques are occasionally present close to the festoons.* Spiracles subtriangular or comma-shaped. Figs. 134, 135 *a* and *b*.

Type species: *Amblyomma cajennense* (Fabricius).

Subgenus: **Aponomma** = *Amblyomma*, which are devoid of eyes, or in which the eyes are poorly developed. The body is frequently very broad. They occur almost exclusively on Reptilia.

AMBLYOMMA

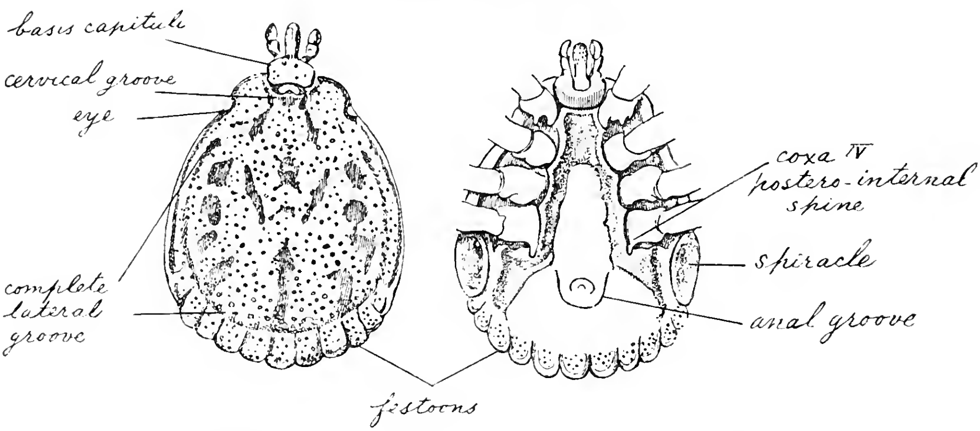


Fig. 134. *A. cooperi* Nuttall and Warburton, 1908, ♂: dorsum and venter (from Nutt. and Warb., E. W. del.).

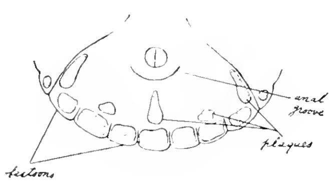


Fig. 135 *a*.

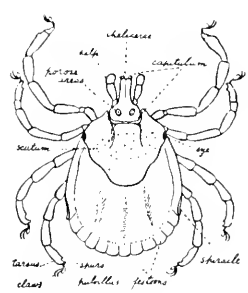


Fig. 135 *b*.

Fig. 135 *a*. *A. variegatum* (Fabricius, 1794), ♂: posterior part of venter, showing plaques. (Original, G. H. F. N. del.)

Fig. 135 *b*. *A. cooperi*, ♀: dorsum, schematized (from *Ticks*, Part I, G. H. F. N. del.).

Explanation of Terms and Signs.

Refer to Figures 115–138.

For the sake of brevity and precision, we have adopted certain signs and terms in our descriptions of Ixodidae, as follows:—

♂, ♀, o, L, signify male, female, nymph and larva respectively; ♂s, ♀s and os for plural.

? after the names of parts, like Hypostome, Chelicera, Tarsus, etc., means that these parts are missing in the type.

L. = the extreme length of the tick, excluding the capitulum and legs. We prefer to exclude the capitulum when measuring the length (from the scapulae to the posterior border) because the capitulum is frequently injured or tilted so as to render measurement difficult.

W. = its width at the widest part. Where the measurements are given as $x \times y$, measurement x stands always for the length and y for the breadth. (*l.* and *w.* refer to length and width of various structures.)

Capitulum = the "rostrum," "head" or "false head" of various authors.

Basis capituli, or, shortly, *base* = the basal ring, "Kragen" of some authors. It often shows a transverse elevated *dorsal ridge* with edge directed backward. The ridge may have protruding angles; the latter we term *cornua*. There may also be a *ventral ridge*. The *auricula* signifies a protruding retrograde process at the lateral angles of the ventral ridge posterior to the insertion of the palps. When the length of the capitulum is given it is measured from the tip of the hypostome to the *dorsal ridge* in the median line. Where the dorsal ridge is absent it is similarly measured to the *ventral ridge*. When the measurement is made ventrally this is stated, the dorsal measurement being usually employed. The clear space between the *porose areas* (only present on the ♀ capitulum) is spoken of as the *interval*.

Hypostome = the "maxilla," "radula," "labium," or "Unterkiefer" of various authors; a median ventral structure rising from the basis capituli, and bearing recurved teeth. The dentition is indicated by figures on either side of a vertical line. Thus 3 | 3 means three longitudinal files of teeth on each half of the hypostome. The hypostome may be pointed, rounded, or emarginated distally. It may be armed from tip to base with teeth or only bear teeth along a part of its length. An unarmed, protruding median ridge, which broadens basally, may run down the length of the hypostome, starting near the tip. When a hypostome is described as having a *corona*, the tip bears a number of very minute denticles.

Chelicerae = the "mandibles" or "pseudo-chelicerae" of some authors, paired structures lying dorsally to the hypostome. The terminology usually applied to the portions of the *digit* of the chelicerae appears to us wrong and confusing, and we prefer to recognize (1) an "internal article," the latter bearing a "dorsal process" which is a portion of it (not articulated), and (2) an "external article" which articulates with the internal article upon its outer side:

1. *Internal article* = "median apophysis" or "immovable finger" of some authors.
   Dorsal process = "internal apophysis" of some authors.
2. *External article* = "external apophysis" or "free" or "movable finger" of some authors.

We attach little importance to the description of the chelicerae in routine systematic work.

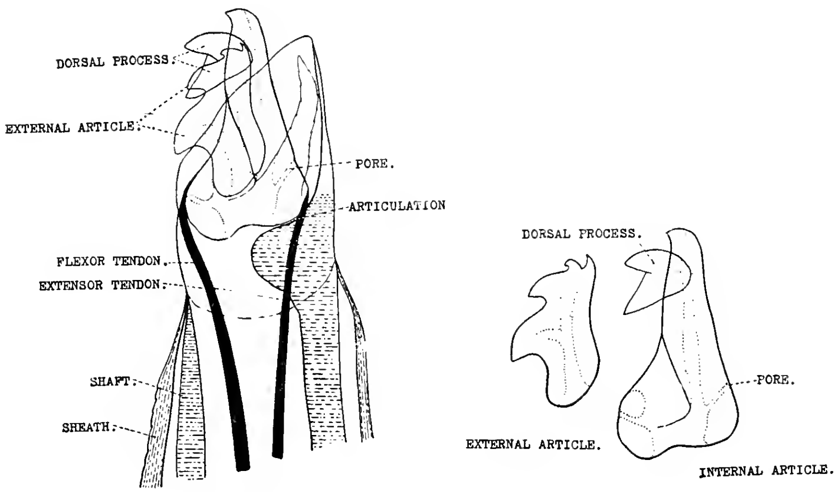


Fig. 136 *A*. Fig. 136 *B*.

THE DIGIT.

Fig. 136 *A*. Distal extremity of chelicera in dorsal aspect, showing articulation of digit and the two tendons (black) which move it laterally. *B*. Digit with articles separated. Illustrating the structures referred to in the descriptions. *Haemaphysalis punctata* ♀. (Nuttall, Cooper and Robinson, 1908, Figs. 7 and 8.)

Palps: articulating antero-laterally upon the basis capituli. Frequently cultriform so that when apposed they protect the hypostome and chelicerae. In ticks possessing long palps four palpal articles can usually be made out very distinctly. These are numbered 1 to 4, beginning with the basal article. In some ticks some of the articles, especially articles 2 and 3, may be fused. In all *Ixodidae* the 4th article is reduced to a small hair-crowned papilla lying in a cup-like hollow of article 3. The articles which are of importance in classification are Nos. 1, 2 and 3.

Dorsum = the whole dorsal surface of the body.

Scutum = the "dorsal shield," "Kopfschild," etc., of some authors. The size is stated by giving the length first, then the greatest width (including the eyes, if protruding), thus ·9 × ·7 mm.

Pseudoscutum = that portion of the ♂ scutum which corresponds in shape and position with the ♀ scutum, and is sometimes outlined by a ridge, punctations or hairs, without being a definite structure.

Emarginate means hollowed out for the reception of the capitulum. This portion of the scutum is styled the *emargination* in the figures.

Scapulae = the anterior angles or "shoulders" of the scutum projecting on either side of the emargination and included in measurements of the length.

Cervical grooves = the term commonly applied to the pair of grooves running backward from the inner angles of the scapulae.

Lateral grooves = grooves running along the sides of the scutum in both sexes. In the ♂ they may be prolonged backward and include one or more festoons; they are spoken of as "complete" if they are continuous along the anterior border of the festoons.

Marginal grooves run along the sides of the body in the ♀, starting at the postero-lateral scutal border (they correspond to the ♂ lateral grooves which are prolonged backward). The marginal grooves may include several festoons, or they may be "complete."

Median and postero-lateral depressions, grooves or furrows are more or less evident in some ♂s and most ♀s. They correspond to lines of attachment of the dorso-ventral bands of muscles.

Median and lateral fields = parts of the scutum lying (1) between the cervical grooves, and (2) external to the latter.

Festoons are the uniform rectangular areas into which the posterior margin of the body is divided up in most of the *Ixodidae*. They are most distinct in unfed specimens, but disappear more or less in distended females. The dividing grooves are sometimes referred to as the "intervals" of the festoons. The festoons frequently have distinct chitinous plates on their ventral surface. (Figs. 120, 121, etc.)

Foveae = the "submedian dorsal porose areas" of Salmon and Stiles, two small spots often observable near the middle of the scutum in the ♂; posterior to the scutum in the ♀. (Figs. 121, 123, 130.)

Marginal fold = a raised fold of the body, external to the scutum, as seen in *Ixodes* (see Fig. 115).

Venter = the whole ventral surface of the body.

Genital orifice: situated anteriorly, posterior to the capitulum, and in the median line. Called *vulva* for brevity's sake in the ♀.

Apron: a delicate chitinous flap arising in front of the sexual orifice which it covers.

Genital grooves: starting at either side of the genital orifice and running backward between the coxae, then externally to the anal grooves toward the posterior body-margin which they frequently attain.

Anus situated in the median line posterior to the coxae; the term applied for convenience' sake to the external anal apparatus consisting of a more or less evident ring within which are two laterally-moving valves.

Anal grooves in *Ixodes* (*Prostriata*) curve around the anus in front and run backward toward the posterior margin. Whereas, in most cases, the grooves fuse in a semicircle in front of the anus; in other cases they form an ogive, they are then termed "ogival" (like a gothic arch); in some species the grooves are not continuous anteriorly.

In *Metastriata* the anal grooves round the anus behind, and in most cases they run forward and outward toward the genital grooves, which they may attain. In some cases they are continuous with a postero-median groove from which they fork anteriorly.

Plates are large dense armour-like chitinous structures occurring in *Ixodes* ♂, not rising above the surface of the body (as do the shields, for instance, in *Rhipicephalus*, etc.); the plates are bounded by the ventral grooves above named, or by soft portions of integument. We distinguish 1 *pre-genital*, 1 *median*, 1 *anal plate* along the median line of the body; 2 *adanal plates* to either side of the anal plate; and 2 *epimeral plates* with indistinct external border extending forward outside the genital groove to near coxa IV.

Plaques are small chitinized plates occurring, for instance, in some species of *Amblyomma*, and situated ventrally in front of the festoons. (Fig. 135.)

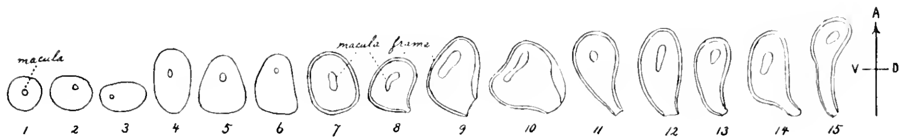
Shields (adanal and accessory) are salient chitinous structures occurring in the males of *Rhipicephalus*, *Boophilus* and *Hyalomma* on either side of the anus. A pair, close to the anus, are always present and are termed *adanal*. There is frequently a second pair external to these, and known as *accessory*; they are well developed in *Boophilus*.

Spiracle = the "peritreme," or "stigmal plate," etc., of various authors. A respiratory organ situated ventro-laterally posterior to coxa IV. It may be circular, oval or comma-shaped, and shows a more or less central structure which we term the *macula*—which may or may not represent a pore. The punctate surface may be enclosed by a more or less broad "frame" of chitin which is incomplete postero-dorsally in comma-shaped forms. The structure of the spiracle is of use in classification. (Fig. 137.)

Legs: *Coxae* are the immovable portions upon which the movable articles are articulated; of the latter especially the first (*trochanter*) and last (*tarsus*) articles are of importance in classification. All of these may bear spurs, spines, or teeth in various situations noted in the descriptions. When coxae are described as *bifid*, they bear two spurs and are deeply incised; when described as *trenchant* they have a knife-like margin. It is of importance to note the manner in which the *tarsi* terminate: if they taper, are humped, bear ventral spurs, etc. The length of the *claws* in relation to the *pads*, or suckers (*pulvillum*), should also be noted. (Fig. 138.)

Punctations are circular depressions dotting the integument, and frequently bearing hairs. The parts, scutum, capitulum, etc., on which punctations occur are referred to as finely or coarsely punctate, etc.

Ornamentation refers to enamel-like coloration which may be present on the scutum, capitulum and legs, etc. Ticks on which such ornamentation occurs are spoken of as ornate; for instance, *Amblyomma* and *Dermacentor* are usually ornate.



THE SPIRACLES.

Fig. 137, illustrating the spiracles of 15 species of Ixodidae to show the different forms they may assume. (Original, G. H. F. N. del.)

All the figures are orientated so as to show their positions on the tick's body: *A* pointing anteriorly, *V* and *D* ventrally and dorsally respectively.

Spiracle 1. Round as in *I. ricinus* ♀.

2. Bluntly oval as in *I. boliviensis* ♀ } long axis of spiracle transverse
3. Elongate sub-oval as in *I. tasmani* ♀ } to body axis.
4. ,, oval as in *I. angustus* ♀ } long axis normal, *i.e.*
5. Ovoid, flattened posteriorly (or sub-triangular) as in *I. angustus* ♂ } directed forward.
6. With slight postero-dorsal protrusion as in *Haemaphysalis hystricis* ♂.

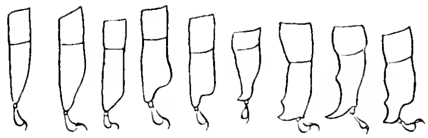
7—15. With distinct darkly chitinized *marginal frame* "complete" in 7, incomplete postero-dorsally in the remaining spiracles, which are comma-shaped; or (10) sub-triangular, with rounded angles.

7. Bluntly ovoid as in *Boophilus annulatus* ♀.
8. Short comma-shaped as in *Dermacentor variabilis* ♀.
9. ,, ,, ,, *Amblyomma longirostrum* ♀, with frame broadened dorsally.
10. Sub-triangular, with rounded angles and with frame broadening much dorsally as in *Amblyomma geoemydae* ♀.

11—15. *More or less elongate comma-shaped spiracles:*

11. As in *Rhipicentor nuttalli* ♂.
12. ,, *Dermacentor reticulatus* ♂, and *Rhipicentor bicornis* ♂.
13. ,, *Rhipicephalus sanguineus* ♂, and *Amblyomma versicolor* ♂.
14. ,, *Dermacentor andersoni* ♂.
15. ,, *Hyalomma aegyptium* ♂, and *Rhipicephalus sp.* ♂.

The "macula" is central in (1), eccentric in the others, being situated ventrally and anteriorly, and possessing a variable form.



1 2 3 4 5 6 7 8 9

TARSI.

Fig. 138, illustrating the tarsi of 10 species of Ixodidae to show different forms of Tarsus 4. (Original, G. H. F. N. del.)

The transverse line indicates the pseudo-articulation.

Tarsus 1. Tapering gradually as in *I. ricinus*.
2. ,, ,, ,, *I. signatus*.
3. ,, obliquely ,, *I. ornithorhynchi*.
4. Humped prior to tapering as in *I. hexagonus*.
5. Tapering abruptly as in *I. cordifer*.
6. ,, to one spur as in *Haemaphysalis cornigera*.
7. Ending bluntly with two spurs as in *Rhipicephalus masseyi*.
8. Tapering to a long spur as in *Margaropus winthemi*.
9. ,, abruptly and bearing two spurs as in *Amblyomma cooperi*.

SECTION II

Genus I. IXODES Latreille, 1795.

Synonymy and Literature.

"**Ricinus caninus**" Ray, 1710, p. 10 (? *I. ricinus*).

Acarus Linnaeus, 1746, p. 479, *pro parte*; also subsequent authors (de Geer, 1778; Fabricius, 1794; Panzer, 1795). See further under list of species of *Acarus*.

Ixodes 1796. Latreille, p. 179.—**1804.** Latreille, p. 46.—**1805.** Fabricius, p. 351.—**1806.** Latreille, p. 155.—**1807.** Chabrier, pp. 366 *et seq.* (oviposition).—**1815.** Leach, p. 397.—**1826.** von Heyden, p. 610; Risso, p. 182.—**1829.** Latreille, p. 287.—**1834.** Dugès, (*a*), p. 15 (classification).—**1837.** Burmeister, p. 579.—**1844.** Koch, p. 231; Gervais, p. 234; Sangalli, p. 831 (effects of bite); Gené, p. 751 (anatomy and biology).—**1847.** Koch, p. 20; Gervais, p. 351.—**1849.** Gené (translation of Gené, 1844).—**1857.** Kolenati, p. 24.—**1858.** Heller, p. 58 (sexual organs).—**1859.** Gervais and van Beneden, p. 460; Grube, p. 455.—**1861.** Fürstenberg, p. 208; Moquin-Tandon, p. 304; Pagenstecher, pp. 1–40 (anatomy, etc.).—**1863.** Gerstaecker, p. 344.—**1866.** Lucas, p. lvii; Verrill[1], p. 116.—**1877.** Canestrini and Fanzago, pp. 110, 178 *et seq.* (brief description); Murray, pp. 187 *et seq.*; Conil, p. 25.—**1878.** Conil, p. 99.—**1880.** Mégnin, (*a*), pp. 121, 320; (*b*) p. 603; Taschenberg, p. 150 (mouth-parts, O[2]).—**1881.** Haller, (*a*), p. 165; (*b*), p. 380 (mouth-parts).—**1882.** Haller, p. 309.—**1883.** Braun, p. 211.—**1885.** Berlese, p. 131; Raymondaud, p. 129.—**1886.** Ludwig, p. 612.—**1888.** Railliet, p. 496; Neumann, p. 89.—**1889.** Berlese, fasc. lv, n. 6 (classification).—**1890.** Canestrini, pp. 475 *et seq.*, p. 492; Blanchard, p. 323.—**1891.** Batelli, pp. 100 *et seq.* (respiration, mouth-parts, etc.); Trouessart, p. 290.—**1892.** Neumann, (*a*), p. 92; (*b*), p. 96; Canestrini, p. 581; Efisio[1], p. 256; Trouessart, pp. 20–47; Lewis, p. 449; Marx, (*b*), p. 232 (mouth-parts, classification); Bernard, p. 289 (respiration); Michael, pp. 204, 447 (mouth-parts).—**1893.** Railliet, p. 706.—**1894.** Brandes, p. 405 (anatomy).—**1895.** Mégnin, p. 354; Braun, p. 257.—**1896.** Oudemans, p. 191; Osborn, p. 262.—**1897.** Neumann, pp. 283, 325, 360, 384; Supino, (*a*), p. 241 (classification).—**1899.** Neumann, pp. 108 *et seq.*; Morgan[1], p. 138; Wheler, pp. 5 *et seq.* (classification, etc.); Nuttall, p. 402 (effects of bite).—**1900.** Ward, (*a*), p. 196; (*b*), p. 436; Brucker, p. 423 (mouth-parts).—**1901.** Salmon and Stiles, p. 459 (classification); Jourdain, p. 142 (mouth-parts).—**1902.** Neumann, p. 115 (genus *Eschatocephalus*

[1] Inaccessible, cited in bibliography by Salmon and Stiles, 1901.

[2] O denotes that the paper contains nothing worth noting.

maintained, and that of *Ceratixodes* created).—**1904.** Neumann, p. 444 (*Ixodes* to include 3 subgenera: *Euixodes*, *Ceratixodes* and *Eschatocephalus*, *vide infra*).—**1905.** Lahille, pp. 12, 28 (classification).—**1906.** Neumann, p. 195 (coitus and sexual dimorphism).—**1907.** Dönitz, p. 88 (useful); Pocock, p. 190 (classification); Hunter and Hooker, p. 54.—**1908.** Nuttall, pp. 385 *et seq.* (structure, biology, oviposition); Bonnet, p. 253 (descriptions condensed from Neumann; figures original, but poor); Banks, p. 55; Howard, p. 92.—**1909.** Rohr, p. 135 (quotes Neumann, also with regard to species enumerated); Blanchard, pp. 80 *et seq.* (brief descriptions and lists of species, largely drawn from Neumann and other authors since).—**1910.** Dönitz, pp. 400, 432 (classification discussed); Stiles, pp. 12–17 (classification); Brumpt, Fig. 353 (copulation).

Cynorhaestes Hermann, 1804, p. 66 (*pro parte*) and subsequent authors.—1826, Risso, p. 183; Heyden, p. 610.—1831, Treviranus, p. 188, after which the name fell into synonymy. (Referred to as *Cynorrhaestes* Hermann by Fabricius, 1805, p. 351, and Dugès, 1834 c, p. 33; as *Cynoraesthes* by Latreille, 1829, p. 287; as *Cynochaestes* by Mégnin, 1880, p. 120; as *Cynorhoestes* by Trouessart, 1891, p. 290.)

Crotonus Duméril, 1822, p. 56.—1829, p. 401 (*C. ricinus* = *I. ricinus* (Linn.)).

Haemalastor Koch, 1844, p. 223; 1847, p. 49 (type, *H. longirostris*). Used partly as equivalent to *Eschatocephalus* (*vide infra*) by Kolenati, 1857, p. 437; 1860, p. 578; Karsch, 1880, pp. 141 *et seq.*; Mégnin, 1880, p. 120 (*Haemalostor*) [*sic*]; and Neumann, 1899, p. 178.

Note: Haemalastor was established by C. L. Koch to include one species (*longirostris*), of which he only knew the ♀. Neumann, 1901, p. 290, discovered, however, upon examination of the type, that it possessed eyes, in consequence of which he referred it to the genus *Hyalomma*. Consequently, the genus *Haemalastor* disappears, together with the single species upon which it was founded. For list of species referred to *Haemalastor* by various authors, see List of condemned species.

Eschatocephalus Frauenfeld, 1853, p. 55. Recognized by L. Koch, 1877, p. 150; Joseph, 1882, p. 16; Neumann, 1899, p. 179, and 1901, p. 290 (name revived), and all subsequent authors except Dönitz, 1910. For a list of species referred to *Eschatocephalus* by various authors, see List of condemned species.

Note: Eschatocephalus was retained as a genus by Neumann (1902, p. 116) until 1904, p. 445, when he made it a subgenus of *Ixodes*, because he considered that the generic characters were insufficient to maintain the generic rank, the differences "being only specific." He states that "the ♂, by virtue of its claviform palps, which are circular on cross section, differs sufficiently from other *Ixodes* to place this species (meaning *I. vespertilionis*) in a subgenus." Still retained as a genus by Blanchard, 1909, p. 96. We are of the same opinion as Dönitz, 1910, p. 400, that there is no valid reason for retaining the genus, and we have condemned *Eschatocephalus* as a subgenus.

Dermanyssus Kolenati, 1857, p. 20 = *Ixodes* (*vide* List of condemned species).

Sarconyssus Kolenati, 1857, p. 21 (various "species" = *Ixodes vespertilionis*. See List of condemned species).

Hyalomma Pickard-Cambridge, 1878, p. 222, *Hyalomma puta* = *Ixodes putus q.v.*

Ceratixodes Neumann, 1902, p. 115. The main points whereby the genus can be distinguished were originally stated to be: the convex inner surface of the palp, and the pointed extremity of the third palpal article in the ♂; the slightly hollow internal surface and swollen ends of the palps in the ♀; anal grooves of ♂ as in *Ixodes*, but absent in the ♀; anal and adanal shields in the ♂. Neumann, 1904, p. 444, subsequently recognized that the ♀ (*I. putus q.v.*) differed so slightly from other ♀ *Ixodes*, that the genus could not be retained; the ♀ was found to possess an anal groove and the ♂ only differs from other ♂ *Ixodes* in respect to its palps. He therefore degraded *Ceratixodes* to a subgenus. Still retained as a genus by Blanchard, 1909, p. 97.

Euixodes Neumann, 1904, p. 444. A subgenus founded to include all *Ixodes* other than *Ceratixodes* and *Eschatocephalus* (the latter genera reduced to subgenera). Since we see no reason for retaining the latter subgenera, *Euixodes* falls into the synonymy of *Ixodes*.

GENERIC CHARACTERS. *Anal grooves embracing the anus anteriorly, and usually uniting in a pointed arch or the arc of a circle. Scutum always inornate, and without eyes. No festoons. Spiracles round or oval. Tarsi without spurs (except in* Ixodes putus). *The male scutum is always surrounded by a prominent marginal body-fold, and the male venter presents seven non-salient chitinous plates, namely, a pregenital, a median, an anal, two adanal and two epimeral plates. The genital aperture is comparatively posterior in both sexes, and in the distended female the legs occupy a very anterior position. There is marked sexual dimorphism as regards the hypostome.* Figs. 115–119.

N.B. In most species the second article of the palp is narrowed at the base, leaving a space between it and the hypostome, and this gives the ticks a peculiar facies easily recognized by the naked eye. There are, however, exceptions.

Type species: *Ixodes ricinus* (Linnaeus) Latreille, 1804.

Key for the determination of species of Ixodes.

Males.

There are 21 species of males recorded of which one (*pratti*, p. 174) has not been adequately described.

			PAGE
	Body with 5 posterior brushes of hairs	*putus*	256
	„ without such hairs	1	
1.	Legs inordinately long.	*vespertilionis*	272
	„ moderately „	2	
2.	Basis capituli with dorsal punctate excavation .	*coxaefurcatus*	270
	„ „ without „ „ .	3	

			PAGE
3.	Dorsum showing two lateral folds	4	
	„ „ one „ fold . . .	5	
4.	Anal grooves divergent	*loricatus*	266
	„ „ convergent	*holocyclus*	235
5.	Anal grooves convergent	6	
	„ „ parallel or divergent . . .	10	
6.	Anal grooves approaching but not uniting behind	7	
	„ „ uniting behind.	8	
7.	Anal plate oval, basis capituli with median point ventrally	*pilosus*	221
	Anal plate racket-shaped, basis capituli tricuspid ventrally	*schillingsi*	238
8.	Coxa IV with long internal spur	*cordifer*	233
	„ „ without long internal spur . . .	9	
9.	Tarsus 4 humped some distance from end . .	*rasus*	228
	„ „ tapering	*ugandanus*	230
10.	A single distinct spur on coxa I	11	
	Two spurs or none	12	
11.	Median ventral plate about as broad as long .	*hexagonus*	178
	„ „ „ much longer than broad .	*ricinus*	147
12.	Coxa I with two spurs	13	
	„ „ without spurs; at most slightly pointed .	16	
13.	Both spurs very long and close together . .	*gigas*	203
	„ „ otherwise	14	
14.	Both spurs short, subequal	15	
	Inner spur long and strong, outer short. . .	*boliviensis*	166
15.	Strong cornua; anal grooves short, divergent .	*minor*	164
	No cornua; anal grooves long, parallel . .	*angustus*	195
16.	Tarsi humped	*canisuga*	210
	„ tapering	17	
17.	Coxae trenchant	*tenuirostris*	246
	„ not trenchant	18	
18.	Punctations very fine, equal	*cavipalpus*	193
	„ unequal, nearly obsolete . . .	*rubicundus*	204

Females.

There are 48 species known by their females.

			PAGE
	Legs inordinately long (on bats)	*vespertilionis*	274
	Legs moderate	1	
1.	Anal grooves horseshoe shaped or closed behind	2	
	„ „ sub-parallel or divergent	8	
2.	Anal grooves horseshoe shaped	3	
	„ „ closed behind	5	
3.	Coxa I with two long sharp spurs; well-marked auriculae (Madagascar)	*lunatus*	226
	Coxa I otherwise	4	
4.	Coxa I with a long internal spine; auriculae (on monkeys, Africa)	*schillingsi*	239
	Coxa I with no internal spine; no auriculae (on cattle, S. Africa)	*pilosus*	222
5.	Anal grooves a circle (Africa)	*rasus*	229
	„ „ an oval, pointed behind	6	
6.	Coxa I with sharp internal spur	*ugandanus*	232
	„ „ without internal spur	7	
7.	Scutum broader than long, palps short, with article 1 much enlarged	*australiensis*	250
	Scutum longer than broad, palps long, normal (Australia)	*holocyclus*	236
8.	Coxae practically unarmed	9	
	Some of the coxae with distinct spurs	20	
9.	Scutum broadest quite in front (on marine birds)	*putus*	258
	„ „ near middle or posteriorly	10	
10.	Scutum broadest behind the middle	11	
	„ „ in middle or a little anteriorly	14	
11.	Scutum broader than long	12	
	„ longer than broad	13	
12.	Palps with article 1 greatly enlarged on ventral aspect	*tasmani*	244
	Palps with article 1 small	*ornithorhynchi*	242

			PAGE
13.	Anal grooves short, strongly divergent (Europe, on small mammals)	*tenuirostris*	247
	Anal grooves long, sub-parallel (Australia) . .	*fecialis*	248
14.	Article 1 of palps enlarged, cup-like (Australia) .	*vestitus*	252
	„ „ „ normal	15	
15.	Anal grooves short, divergent	16	
	„ „ long, sub-parallel	17	
16.	Scutum sub-circular; slight cornua	*japonensis*	208
	„ elongate; no cornua (on bats) . .	*simplex*	207
17.	Sharp spurs on trochanters (Africa) . . .	*cavipalpus*	194
	No trochantal spurs	18	
18.	Coxae trenchant; scutum smooth, with fine punctations (Africa)	*rubicundus*	206
	Coxal borders rounded; scutum rugose, with large punctations	19	
19.	Scutum slightly rugose; widest rather in front of middle (Europe)	*canisuga*	212
	Scutum very rugose; widest in middle (America)	*texanus*	214
20.	No internal spur, but a blunt external spur on coxa I	21	
	Coxa I with internal spur	23	
21.	Spurs on trochanters (? on birds, Nightingale Island)	*percavatus*	220
	No spurs on trochanters	22	
22.	Porose areas large, confluent, occupying most of basis capituli (on marine birds)	*unicavatus*	264
	Porose areas tranversely elongate, separate (on marine birds)	*signatus*	261
23.	Internal coxal spur long	24	
	„ „ „ short; a slight external spur or tooth	33	
24.	A strong external spur	25	
	External spur short or absent	27	
25.	Both spurs long, parallel, sub-equal (India) .	*acutitarsus*	202
	Internal spur much the longer	26	
26.	Anal grooves short, anus very posterior (Mexico).	*bicornis*	186
	„ „ long (Brazil)	*fuscipes*	169

			PAGE
27.	Cornua well marked, sharp	28	
	„ faint or absent	29	
28.	Porose areas large, near together (N. America)	*sculptus*	171
	„ „ small, far apart (America)	*diversifossus*	163
29.	Hypostome very long and pointed; anus very posterior (Italy)	*acuminatus*	161
	Hypostome normal	30	
30.	Punctations on scutum large and few; coxal spine very long (Sumatra)	*spinicoxalis*	171
	Punctations small and numerous	31	
31.	Anal grooves short; auriculae strong	*boliviensis*	167
	„ „ long; no auriculae	32	
32.	Porose areas transversely elongate (Madeira) (possibly identical with *ricinus*)	*nigricans*	159
	Porose areas less elongate	*ricinus*	150
33.	Scutum nearly as broad as long	34	
	„ elongate, distinctly longer than broad	36	
34.	Anal grooves pointed in front; tarsi humped	*hexagonus*	179
	„ „ rounded in front	35	
35.	Scutum oval; auriculae, but no cornua (America)	*dentatus*	162
	„ cordiform; cornua, but no auriculae (America)	*pratti*	174
36.	Article 1 of palp with anteriorly directed spur (on birds, Brazil)	*auritulus*	187
	No such spur	37	
37.	Basis capituli winged, pointed laterally (S. America)	*loricatus*	267
	Basis capituli normal	38	
38.	Tarsus 4 humped, or narrowing abruptly	39	
	„ „ tapering more or less gently	43	
39.	Anal grooves rounded in front	40	
	„ „ pointed „ „	42	
40.	Basis capituli elongate	*fossulatus*	201
	„ „ broader than long	41	
41.	Slight sharp cornua, porose areas oval, longer than broad (Chili)	*stilesi*	216
	No cornua, porose areas much broader than long (N. Zealand)	*neumanni*	218

			PAGE
42.	Scapulae long and sharp; basis capituli broadest anteriorly (Mexico)	*rubidus*	175
	Scapulae short and rounded; basis capituli triangular (America)	*marxi*	173
43.	Scutum nearly twice as long as broad (1·3 × ·7 mm.) with rounded sides (S. America) . . .	*minor*	165
	Scutum less elongate, with angular sides . .	44	
44.	Anal grooves not reaching posterior border; strong white hairs on scutum (on birds) .	*brunneus*	190
	Anal grooves reaching posterior border; scutal hairs short or absent	45	
45.	Basis capituli broader than long; porose areas almost confluent	*caledonicus*	198
	Basis capituli longer than broad; porose areas separate	46.	
46.	Sharp auriculae; anal grooves rounded in front (on mouse, Christmas Island)	*nitens*	185
	No auriculae; anal grooves pointed in front (America)	*angustus*	196

Nymphs.

N.B. Of the 22 nymphal forms recorded there are 19 species described sufficiently to be included in the following key. Not included are *fuscipes*, p. 170; *brunneus*, p. 190; *simplex*, p. 208.

	With legs inordinately long	*vespertilionis*	275
	„ „ otherwise	1	
1.	Scutum without cervical grooves	*tenuirostris*	248
	„ with „ „	2	
2.	Scutum with lateral grooves	3	
	„ without lateral grooves	9	
3.	Coxae unarmed	*vestitus*	254
	„ armed	4	
4.	Palp with article 1 large and pointing forward .	*angustus*	197
	„ „ „ „ otherwise	5	
5.	With anal grooves fused to a point behind . .	*holocyclus*	237
	„ „ „ otherwise	6	

			PAGE
6.	With anal grooves in the form of a horseshoe .	17	
	„ „ „ parallel or divergent . .	7	
7.	With long palps, concave externally . . .	*boliviensis*	169
	„ palps otherwise	8	
8.	With tarsus 4 tapering	*ricinus*	151
	„ „ „ humped	*rubidus*	176
9.	With coxae unarmed	10	
	„ „ armed	12	
10.	With tarsus 4 humped	*canisuga*	213
	„ „ „ otherwise	11	
11.	With very long scutum	*putus*	259
	With short, very broad scutum	*ornithorhynchi*	242
12.	Coxae with small blunt protuberance postero-externally	*hexagonus*	181
	Coxae with marked spurs postero-externally .	13	
13.	Without auriculae	*unicavatus*	265
	Otherwise	14	
14.	Trochanters with postero-external spur . .	15	
	„ without postero-external spur . .	*neumanni*	219
15.	With anal grooves horseshoe-like . . .	*schillingsi*	241
	„ „ „ otherwise	16	
16.	With scutum longer than broad	*signatus*	263
	„ „ as long as broad	*caledonicus*	199
17.	With scutum about as broad as long . . .	*pilosus*	224
	„ „ narrow, elongate	*loricatus*	268

Larvae.

N.B. There are 14 species whose larvae have been recorded, three of which (*fuscipes*, p. 170; *brunneus*, p. 190; *loricatus*, p. 268) have not been adequately described nor figured. The following key, therefore, relates to but 11 species.

	With legs inordinately long	*vespertilionis*	275
	„ „ otherwise	1	
1.	Scutum with cervical grooves absent . . .	*tenuirostris*	248
	„ „ „ „ present . . .	2	

2.	Scutum with lateral grooves	*vestitus*	255
	„ without lateral grooves	3	
3.	Coxae unarmed	4	
	„ with spurs	7	
4.	Palp with article 1 large and pointing forward .	*angustus*	197
	„ otherwise	5	
5.	Capitulum with dorsal ridge pointing out laterally	*pilosus*	224
	„ otherwise	6	
6.	Basis capituli with latero-ventral protuberances .	*canisuga*	213
	„ „ „ ventral ridge	*hexagonus*	181
7.	Basis capituli without auriculae	*unicavatus*	265, 266
	„ „ with auriculae	8	
8.	Scutum with cervical grooves diverging widely behind	9	
	Scutum with cervical grooves otherwise . . .	*signatus*	263
9.	Coxa IV with two spurs	*caledonicus*	200
	„ „ without two spurs	*ricinus*	152

SPECIFIC DESCRIPTIONS
OF VALID SPECIES OF IXODES
AND OF THEIR
VARIETIES AND SUBSPECIES

1. IXODES RICINUS[1] (Linnaeus, 1746 and 1758).

Pls. IV and VII, Text-figs. 115, 139–148.

Synonymy: not *Reduvius* Charleton, 1668, p. 49.

? *Ricinus caninus* Ray, 1710, p. 10 (Synon. in Walckenaer and Gervais, 1844, p. 236). ♀.

not *Acarus reduvius* Linnaeus, 1746, p. 479. *Syst. natur.* 1758, 10th edit., p. 616; 1788, 13th edit., p. 2925.

Acarus ricinus Linnaeus, 1746, p. 480; 1758, p. 615; 1788, p. 2925.

Regarding the synonymy of this species, Neumann (1901, pp. 281–282) writes as follows:

"Linnaeus, in his *Fauna suecica* (1746), describes under No. 1192 an *Acarus ovinus*, which he makes synonymous with *Reduvius* Charleton (*Onomasticon zooicum*, 1668) and *Pediculus ovinus* Rajus (*Historia insectorum*, 1710). In his *Systema naturae* (10th edit., 1758, p. 615), Linnaeus changes his *Acarus ovinus* to *Acarus reduvius*, and gives it under this new name as No. 1966 in *Fauna suecica* (2nd edit., 1761), retaining his synonymies. On referring to the text and the figures of the writers cited by Linnaeus, it is clearly evident that the writers mentioned were dealing with *Melophagus ovinus* and not one of the Acari. It is consequently due to an error that Linnaeus placed *Reduvius* or *Pediculus ovinus* in his genus *Acarus*. Whatever may have been the form to which he desired to attach the name *Acarus reduvius*, this name loses all taxonomic value, and it is necessary to revive the name of *Ixodes ricinus* (*Acarus ricinus* Linnaeus), which applies to the same species of tick and does not lead to confusion."

Acarus ricinoides de Geer, 1778, VII, p. 98; p. 101 (*reduvius*).

Ixodes ricinus Latreille, 1804, I, p. 156 (♀).

Ixodes reduvius Latreille, 1804, p. 51.

[1] According to Dubreuilh, 1900, p. 456, the word *Ricinus*, used to signify a tick by Pliny, gave its name to the castor-oil plant, as stated by Dioscorides, IV, 161, because the seeds of the latter resemble a tick (*i.e.* the gorged females).

Cynorhaestes reduvius Hermann, 1804, p. 65.
Cynorhaestes ricinus Hermann, 1804, p. 66.
Ixodes megathyreus Leach, 1815, XI, p. 398.
Ixodes bipunctatus Risso, 1826, V, p. 183.
Cynorhaestes hermanni Risso, 1826, V, p. 183.
Cynorhaestes megathyreus (Leach) Risso, 1826.
Crotonus ricinus Duméril, 1829, LIV, p. 401.
Ixodes trabeatus Audouin, 1832, XXV, p. 420 (♀).
Ixodes plumbeus Dugès, 1834, I (2), p. 20.
not *Ixodes plumbeus* Dugès, 1834 c, Pl. VII, Figs. 7–12 (=*Rhipicephalus* sp.).
Ixodes reduvius Hahn, 1834, II, p. 62.
Ixodes fuscus Koch, 1835, Heft XXXVII.
Ixodes lacertae Koch, 1835, Heft XXXIX; 1844, p. 234, larvae and nymphs, *fide* Canestrini, 1890, p. 497.
Ixodes rufus Koch, *Ixodes sulcatus* Koch, *Ixodes sciuri* Koch: Koch, 1835, Heft V, No. 11, Heft XXXVII, No. 8; 1844, p. 232; 1847, p. 21. The types examined by Neumann (1901, pp. 281–289) proved to be *I. ricinus* nymphs, all collected in Germany.
Ixodes reduvius Linn., in Koch, 1835, Heft V, No. 11.
Ixodes pustularum Lucas, 1866, VI; *Bull.*, p. lvii.
Ixodes fodiens Murray, 1877, p. 191. As synonym in Neumann, 1899, p. 122. Neumann, 1904, p. 45, rightly states that this name is Murray's, not Mégnin's, as stated by Murray, 1877, and quoted from the latter by Salmon and Stiles, 1901, p. 465.
Ixodes ovatus Neumann, 1899, p. 116; in part, see Neumann, 1904, p. 452, where he states the lot of *ovatus* was subsequently found to comprise *ricinus*.—Dönitz, 1905, p. 132.
Ixodes ovatus Neumann, 1899, as modified by Neumann, 1904, p. 452=*Ixodes ricinus* var. *ovatus* (Neumann) Nuttall and Warburton, 1911.
Ixodes reduvius (Linnaeus) in Railliet, 1895, p. 706; Neumann, 1899, p. 112, and many subsequent writers.

In N. Tyne Valley, where they occur commonly on sheep, they are locally known as "face ticks," since they are found in this situation on sheep (Wheler, 1899).

Styled the "Castor-bean tick" by Salmon and Stiles, 1901, p. 463, and several subsequent authors. The castor-bean is however much more like a gorged *Amblyomma* ♀. (See footnote, p. 143.)

The synonymy of this species might be extended almost indefinitely. We confine ourselves, however, to the names concerning which little doubt can be entertained.

Iconography: De Geer, 1778, Pl. V (*Ac. ricinoides*), Figs. 16–19, ♀ dorsum, part of capitulum, tarsus; Pl. VI (*Ac. reduvius*), Figs. 1–8, ♀ dorsum, spiracle (recognized as such), capitulum, tarsus, ♂ and ♀ in copula (recognized as coitus), ♂ dorsum, capitulum. Excellent, considering the date; better than some figures printed a hundred years later.—Audouin, 1832, Pl. XIV, Figs. 3 *a–n* (*trabeatus*).—Dugès, 1834, Pl. VII, Figs. 7–12 (*plumbeus*).—Hahn, 1834,

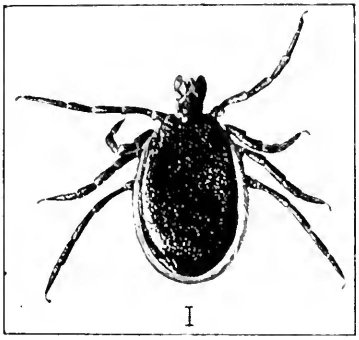


Fig. 1.

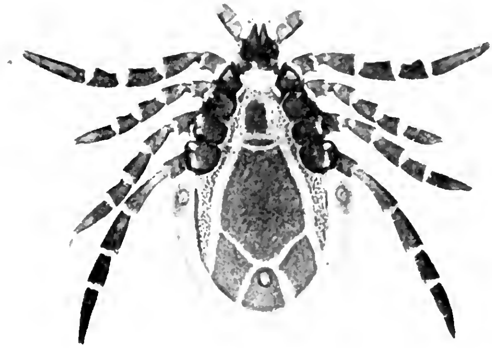


Fig. 2.

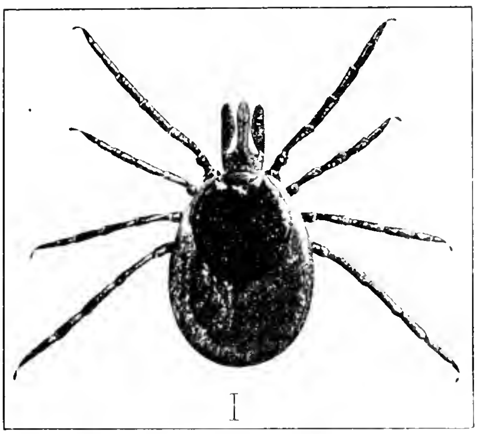


Fig. 3.

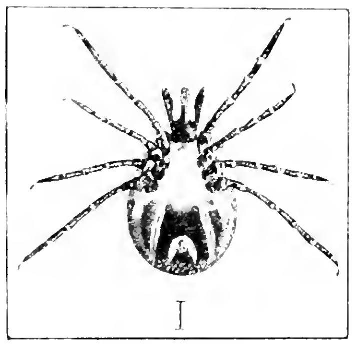


Fig. 4.

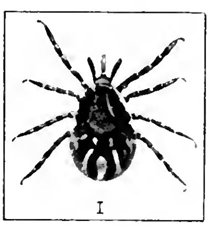


Fig. 5.

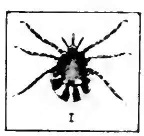


Fig. 6.

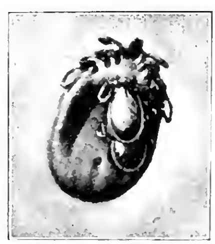


Fig. 7.

Figs. 1–7. *Ixodes ricinus.*

Fig. 1. ♂ dorsum, × 12. (Wheler, 1906, Fig. 16.)
Fig. 2. ♂ venter (mounted specimen). (Original, E. G. Wheler, phot.)
Fig. 3. ♀ dorsum, × 12. (Wheler, 1906, Fig. 17.)
Fig. 4. ♀ venter, × 9. (Wheler, 1906, Fig. 11.)
Fig. 5. o dorsum, × 12. (Wheler, 1906, Fig. 18.)
Fig. 6. L dorsum, × 12. (Wheler, 1906, Fig. 19.)
Fig. 7. ♀ with one ♂ coupled and a second ♂ "waiting his turn." (Wheler, 1906, Fig. 36.)

Reprinted (Fig. 2 excepted) from the original blocks illustrating the paper by E. G. Wheler, *Journ. Agric.* (Cambridge), Vol. I.

II, Pl. LXVI, Fig. 152 (♂).—Koch, 1835–44, Heft 5, Fig. 11 (*reduvius* ♀); Heft 37, Figs. 5–7 (*ricinus* ♂, ♀s), Fig. 8 (*sciuri*); Heft 39, Fig. 11 (*lacertae*), Figs. 3, 4 (*fuscus* ♂, ♀), Fig. 7 (*rufus*, ♀).—Pagenstecher, 1861, II, Pl. I, Figs. 1–10; Pl. II, Figs. 1–22. Really excellent figures of anatomy.—Mégnin, 1867, I, Pl. IV.—Murray, 1877, Fig. 2 (*fodiens*; figure useless).—Haller, 1882, Pl. V, Fig. 4 (*ricinus*).—Braun, 1883, Figs. 55, 56 (*ricinus*).—Railliet, 1886, p. 348 (*ricinus*).—Aurivillius, 1886, Figs. *a* and *b* of ♀; very poor.—Berlese, 1888, fasc. XLIX, Pl. VI (*reduvius*, ♀ dorsum, venter, capitulum and scutum, etc.; poor); 1889, fasc. LV, No. 16, giving generic characters of *Ixodes*: ♂ venter and spiracle; ♀ capitulum in ventral aspect, capitulum, scutum, spiracle; larva, ventral aspect; a digit. Outline figures, recognizable as *ricinus*.—Neumann, 1888, Fig. 47.—Canestrini, 1890, Pl. XLIII, Figs. 1–1 *g* (*I. reduvius*): ♂ venter, hypostome; ♀ dorsum (fed and unfed), part of capitulum, digit, etc. (very poor). Figs. 3–3 *b* "*Phaulixodes rufus* (Koch)" dorsum, digit, hypostome; scarcely recognizable.—Blanchard, 1890, Figs. 592–595 (*ricinus*).—Neumann, 1892, Figs. 53–55.—Mégnin, 1892, Fig. 4; outline figures of egg, larva, nymph and female, with details all very inaccurate.—Mosler and Peiper, 1894, Fig. 110 (*ricinus*).—Neumann, in Railliet, 1895, Fig. 481; reproduced by Salmon and Stiles, 1901, Fig. 222, and by other authors; ♂ venter, capitulum, tarsus 4 and foot. Somewhat schematic (*reduvius*).—Gené, in Railliet, 1895, Fig. 480 (♀ ovipositing, original figure by Gené).—Braun, 1895, Figs. 127, 128 (*ricinus*).—Mégnin, 1895, figs. worthless, of different stages.—Osborn, 1896, Fig. 155; poor.—Niles[1], 1898, Pl. IV, Figs. 3–6 (*ricinus*).—Morgan[1], 1899, Pls. VII, VIII, Figs. 1–5 (*ricinus*).—Neumann, 1899, Fig. 1, ♂ ♀ digits (*reduvius*); Figs. 2, 3, hypostome and digit of ♂ and ♀ (*ovatus*), here reproduced.—Wheler, 1899, pp. 38, 39 (*reduvius*), various stages, ♂, ♀, o and larva, from photographs of mounted and unmounted specimens; somewhat too freely retouched.—Lewis, 1900, figures illustrating process of copulation.—Salmon and Stiles, 1901, coloured Plate XCIII, Figs. 223, 224, ♀ (gorged), much enlarged, dorsum and venter; Pl. XCIV, Figs. 225, 226, ♀ capitulum in ventral aspect, capitulum and scutum, much enlarged (they omit lateral grooves on scutum).—Kossel, Schütz, Weber and Miessner, 1903, Pls. I–III, 18 excellent photomicrographs of all stages, with details of structure.—Mohler, 1905, Pl. I, Figs. 2, 2 *a*, 2 *b* (♀ sketchy, coloured).—Nordenskiöld, 1905, text-figures, illustrating anatomy and histology.—Wheler, 1906, Pls. VII, VIII, reproductions of photographs of (*a*) mounted specimens (♂ and ♀), poor; and (*b*) of unmounted (♂, ♀ dorsum and venter, o and larva; here reproduced); Pl. X, Fig. 38, shows an abnormality: a ♀ minus capitulum; Fig. 36 (♂ and ♀ in copula); other figures illustrate gorged ♀, and ♀ ovipositing.—Dönitz, 1907, Pl. VI, Figs. 34–36, 38, ♂ and ♀ capitula, ♂ venter; good.—Banks, 1908, Pl. II, Figs. 9, 10, 13; Pl. IX, Fig. 5, brief description of ♀ only; figures relate to ♀ and are poor.—Bonnet, 1908, p. 254, Figs. 15, 16; poor.—Nordenskiöld, 1908, Pls. XXVI–XXVIII, Text-figs. *a* and *b*; histology, important.—Nuttall, 1908, Figs 5–7, o, larva, ♂, reproduced here.—Blanchard, 1909, p. 91, Figs. 102–105 (after Neumann and Bonnet).—Samson, 1909 a, Pls. IX–XII, 18 text-figs. (anatomy, histology and biology); 1909 b, Pl. IX,

[1] Inaccessible, cited by Salmon and Stiles, 1901.

7 text-figs. (spermatogenesis).—Braun and Lühe, 1910, Figs. 89, 90. Original, ♂ venter and ♀ capitulum in ventral aspect. Good representations after drawings by A. Dampf.

Literature: **1710.** Ray, p. 10 (*Ricinus caninus*).—**1746.** Linnaeus, p. 480 (*Acarus ricinus*).—**1758.** Linnaeus, p. 615 (*Acarus ricinus*, not *Ac. reduvius*; latter confused with *Melophagus ovinus*).—**1778.** de Geer, pp. 98, 101 (*Acarus ricinoides*, *Ac. reduvius*; mechanism of bite described, coitus, etc.).—**1804.** Hermann, pp. 65, 67 (*Cynorhoestes reduvius* and *C. ricinus*). Latreille, p. 51 (*I. reduvius*); p. 156 (*I. ricinus*)[1].—**1805.** Fabricius, p. 351 (*I. ricinus*).—**1807.** Chabrier, p. 366; Illiger[2], p. 370.—**1815.** Leach, p. 398 (*I. megathyreus* on hedgehogs and dogs); p. 397 (*I. ricinus* on dogs).—**1817.** Müller[2], p. 278 (*I. ricinus*).—**1826.** von Heyden, p. 610; Risso, p. 183 (*I. bipunctatus*, *Cyn. hermanni*, *Cyn. megathyreus* (Leach)).—**1829.** Duméril, p. 401 (*Crotonus ricinus*); von Heyden, p. 288.—**1831.** Treviranus, p. 191.—**1832.** Audouin, p. 420 (*I. trabeatus*).—**1834.** Hahn, p. 62, O[3]; Dugès, p. 20 (*I. plumbeus*).—**1835-44.** Koch, Heft 37, No. 5 (♂); H. 5, No. 11; H. 37, No. 8 (*I. sciuri*); No. 3 (*I. fuscus* on deer); No. 7 (*I. rufus*, ♀, on deer); No. 11 (*I. lacertae*, o on *Lacerta agilis*, Munich).—**1837.** Burmeister, p. 579 (*I. marginatus*).—**1844.** Walckenaer and Gervais, p. 236; Gené, pp. 1 *et seq.*, a very valuable contribution to the biology and structure of *ricinus*; the first author to describe oviposition in ticks.—**1847.** Koch, p. 21 (*I. sciuri* and *I. fuscus*); p. 20 (*I. ricinus*); p. 22 (*I. lacertae*).—**1850.** von Siebold, p. 546, passages quoted by Leydig, 1855, p. 468 and Heller, 1858, p. 311 *re* spermatozoa. Also cited by Samson, 1909, p. 216.—**1855.** Küchenmeister, p. 422 (mere cited description of ♀ *I. ricinus*).—**1857.** Kolenati, p. 24.—**1858.** Milner[2], pp. 6, 13.—**1859.** Gervais and van Beneden, p. 411.—**1861.** Moquin-Tandon, p. 302. Pagenstecher, pp. 1–38, important regarding structure and biology; figs. often reproduced since, thus: Claus, 1887, p. 470, anatomy of body, and Braun, 1906, p. 364, etc.—**1863.** Gerstaecker[2], p. 344.—**1864.** Cox, p. 82 (on dogs and ferrets, but may have been *hexagonus*).—**1866.** Lucas, p. lvii (*I. pustularum*).—**1867.** Mégnin, p. 107.—**1869.** Packard[2], p. 613.—**1870.** Verrill[2], p. 118.—**1876.** Wagner, p. 129, O.—**1877.** Murray, p. 191 (*I. fodiens*); Canestrini and Fanzago, pp. 110, 180; Conil, p. 26.—**1877.** Murray, pp. 190, 193 (*I. fodiens*, *vide* synonymy); quotes Lucas, 1866, and Mégnin, 1867.—**1878.** Conil[2], p. 100.—**1879.** Cobbold, pp. 267, 350.—**1880.** Haller, p. 38; Mégnin, p. 127; Oudemans, p. xvii; Taschenberg, p. 151, O.—**1881.** Bertkau, p. 145 (copulation and oviposition); Haller, (*a*), p. 165.—**1882.** Haller, p. 309.—**1883.** Braun, pp. 211 *et seq.*; van Beneden, p. 142, ? *ricinus*, penetrating beneath the skin in man; thinks ticks do so normally!—**1885.** Johannessen, p. 401 (effects of bite on man).—**1886.** Railliet, p. 497. Aurivillius, (*a*), p. 105, 3 figures of ♀ (poor); (*b*), p. 139, same paper as preceding; tick beneath the skin of a fox. Ludwig, p. 612.—**1888.** Neumann, p. 90; Berlese, fasc. XLIX, n. 6; Winkler, p. 113 (anatomy).—**1889.** Berlese, figures.—**1890.** Canestrini, pp. 474 *et seq.*; Blanchard, pp. 324 *et seq.*—**1891.** Blanchard, p. 689 (penetration

[1] Most authors after this date refer to the species as either *ricinus* or *reduvius*.

[2] Cited in bibliography by Salmon and Stiles, 1901, unimportant.

[3] The sign O denotes that the publication referred to contains nothing worth noting.

beneath human skin, excision of a ♀ *ricinus*); Batelli, pp. 78 *et seq.* (physiology of digestion).—**1892.** Neumann, p. 95; Mégnin, p. 32; Efisio[1], p. 256; Janson and Tokishige[1], p. 349.—**1894.** Mosler and Peiper, p. 320; Dolly[1], p. 1000.—**1895.** Braun, p. 257; Neumann, in Railliet, p. 707 (figs.); Railliet, p. 706; Mégnin, p. 364; poor description and worse figures.—**1896.** Osborn, p. 262, brief mention; Oudemans, p. 191; Schneidemühl, p. 339; Dubreuilh and Beille, p. 69, O.—**1897.** Wood and Fitz[1], p. 346.—**1898.** Niles[1], pp. 29, 45; Weichselbaum, p. 325.—**1899.** Morgan, p. 129, O; Neumann, p. 116 (*I. ovatus* in part), p. 112 (*I. reduvius*); Wheler, pp. 38, 49 (biology and structure); Mosso[1], p. 20; Nuttall, 1899, p. 42, cites Dubreuilh, 1838, Desprès, 1867, and others re effects of bite.—**1900.** Kossel and Weber, relation to redwater in Finland. Ward, (*a*), p. 203; (*b*), p. 436. Lewis, p. 383 (copulation observed and figured).—**1901.** Salmon and Stiles, p. 262 (translation of Neumann); Neumann, p. 281; Lewis, p. 154 (mouth-parts); Perroncito, p. 562 (effects of bite).—**1902.** Kossel, pp. 853 *et seq.*, relation to redwater in Finland and Germany; Wheler, pp. 1–20, biology and structure.—**1903.** Kossel, Schütz, Weber and Miessner, pp. 39–50, relation to redwater, structure and biology.—**1904.** Mégnin, p. 569.—**1905.** Nordenskiöld, p. 485, figs. (excellent work upon the histology); Louping Ill and Braxy Committee's Report, pp. 21 *et seq.*, O. Mohler, 1905, p. 14, O.—**1906.** Wheler, p. 411; Vassal, p. 285, also Martin, p. 105 (experiments with trypanosome infection: negative); Braun, p. 364.—**1907.** Dönitz, p. 90; Pocock, p. 201 (cites Wheler, 1902).—**1908.** Nuttall (figures illustrating a lecture, reproduced here); Banks, p. 24, O; Bonnet, p. 254, O; Galli-Valerio, p. 611, biology; Nordenskiöld, p. 637, histology, important; Stockman (reprint, relation to redwater).—**1909.** Samson, (*a*), pp. 185–236; (*b*), pp. 486–499 (see under Iconography, Nordenskiöld, (*a*), p. 511 (spermatogenesis); (*b*), p. 30 (development); (*c*), p. 449 (anatomy and histology, important)). Blanchard, p. 91. Ashworth, p. 133.—**1910.** Braun and Lühe, p. 178, O; Samson, pp. 1 *et seq.*, dissertation, anatomy and biology.

Male (Pl. IV, Text-figs. 115, 139–142): average *L.* 2·45, *W.* 1·33 mm.[2]. Body dark red-brown, narrow in front, broadly rounded behind, very

[1] Cited in bibliography by Salmon and Stiles, 1901, unimportant.

[2] *Note regarding measurements*: The size of different specimens may vary, thus 6 ♂s, comprised in two lots collected in England (N. 933, 934), measured in mm.—

	Length, including capitulum	Body width	Scutum length	Scutum width
Lot 933	2·6	1·3	1·85	1·1
	2·5	1·4	2·0	1·2
	2·3	1·35	1·75	1·1
Lot 934	2·5	1·4	1·9	1·1
	2·4	1·3	1·8	1·0
	2·2	1·2	1·6	0·95

Wheler (xii. 1899), who has made numerous measurements, states that the length varies from 2·35 to 2·8 mm. Neumann (1899, p. 113) gives the size at 2·5 × 1·5 mm.

The size of the unfed ♀ is given at 2·85 × 3·25 mm., and that of the gorged ♀ at convex when gorged. Marginal fold slight, generally of lighter colour than the scutum. *Scutum* (average 1·8 × 1·1 mm.) glossy with very numerous fine punctations; cervical grooves very superficial; lateral grooves absent, or their commencement faintly indicated. Numerous fairly long scattered white hairs. Emargination moderate, scapulae blunt. *Venter*: genital orifice large, between coxae III; pregenital plate nearly twice as long as broad; median plate fairly broad with rounded sides, anal plate with lateral borders divergent, adanal plates narrowing posteriorly. Spiracles large, oval, with long axis directed

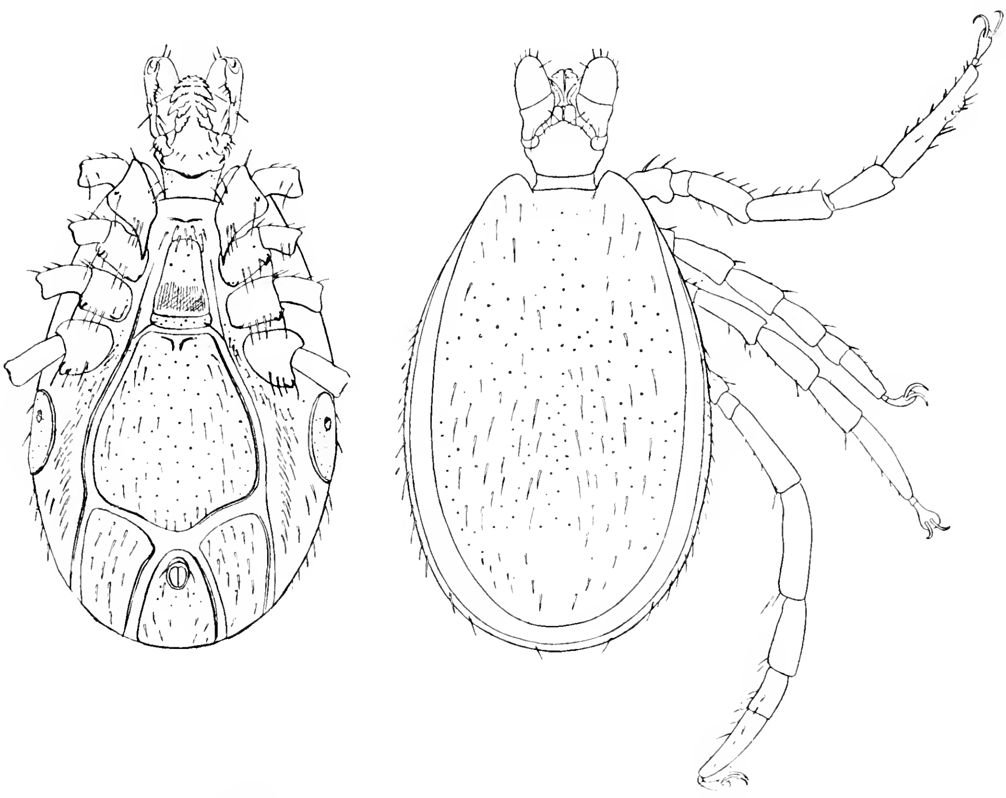
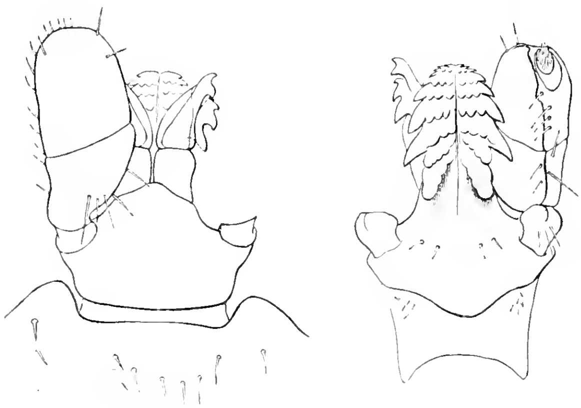


Fig. 139. *I. ricinus* ♂: venter and dorsum, × 30. Specimen from Coilessan, Scotland. (N. 933. Nuttall, 1908, Fig. 7, G. H. F. N. del.)

10 × 6·4 mm., by Wheler. Neumann states that the unfed ♀ measures 4 × 3 mm., the gorged ♀ from 10 × 6 to 11 × 7 mm. Two of the most replete specimens in our collection measure 10 × 7·5 and 10·5 × 6·5 mm. respectively. *Nymphs*, unfed, measure 1·5 × 1·68 mm., when gorged they attain 3·3 mm. in length (Wheler, 1899, p. 49).

forward and macula anterior. *Capitulum* 500 μ long; base trapezoid, broader in front, slightly convex behind, without cornua. Hypostome with six or eight marginal teeth, increasing in strength and connected by crenulations, two large basal teeth being directed ventrally. Palps broad, article 2 as broad as long, impressed dorsally, article 3 slightly longer than 2. *Legs*: long and strong; coxa I with internal spine overlapping coxa II, and slight external tooth. A single external conical tooth on coxae II–IV, the postero-internal angles of coxae II and III are sub-dentate. Tarsi long, tapering gradually.



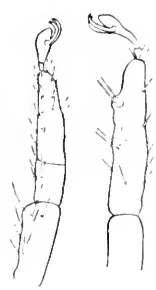


Fig. 140. *I. ricinus* ♂: capitulum in dorsal and ventral aspects, ×70. Specimen from Coilessan, Scotland. (N. 933. Original, G. H. F. N. del.)

Fig. 141. *I. ricinus* ♂: tarsi 1 and 4 seen in profile, ×33. (N. 930, drawn from balsam-mounted specimen. Original, G. H. F. N. del.)

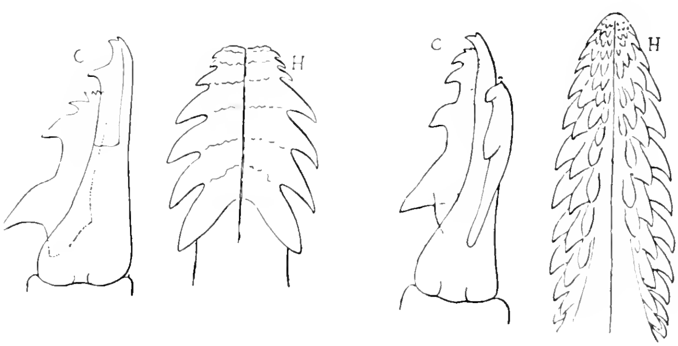


Fig. 142. *I. ricinus*: (*C*) digit ×155, and (*H*) hypostome ×100; (*C*) digit ×220, and (*H*) Hypostome ×75 of ♂ and ♀ respectively. (Neumann, 1899, Figs. 2, 3, illustrating the structures in *I. ovatus*. We find them identical in *I. ricinus*.)

Female (Pls. IV and VII, Text-figs. 142, 143, 144): Body oval, with numerous short, white hairs; when replete may attain 11 × 7 mm. *Scutum* (1·3 × 1·15 or 1·4 × 1·05 mm.) dark brown, sub-pentagonal, with rounded angles; emargination slight; scapulae rather pointed; cervical grooves superficial, barely reaching the posterior border; lateral grooves fairly distinct for about half the length of the *scutum*; numerous very fine punctations, especially on the posterior portion.

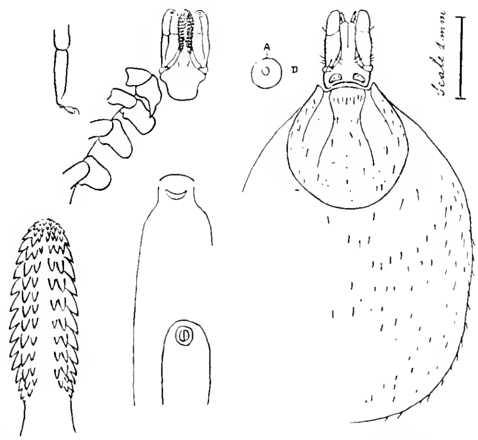


Fig. 143. *I. ricinus* ♀ (partly replete): dorsum, part of venter, tarsus 4, hypostome and spiracle. Specimen from Coilessan, Scotland, D. MacKenzie coll., iv. 1905. (N. 934. Original, G. H. F. N. del.)

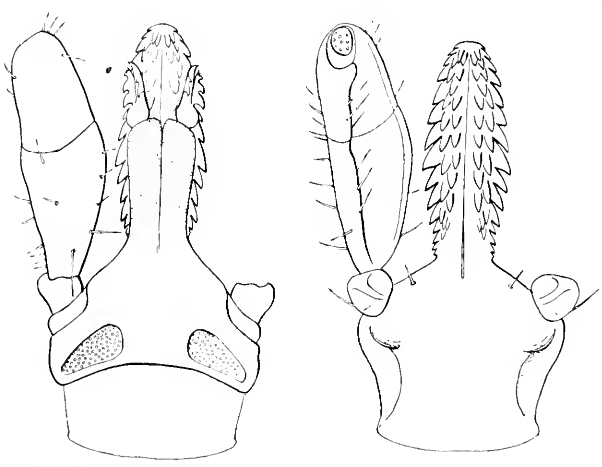


Fig. 144. *I. ricinus* ♀: capitulum in dorsal and ventral aspects, × 70. Specimen from Coilessan, Scotland. (N. 933. Original, G. H. F. N. del.)

Venter: vulva between coxae IV; spiracles circular, genital grooves only slightly divergent, anal grooves rounded in front, parallel behind anus. *Capitulum* long (800 μ). Base pentagonal with parallel sides and concave posterior border; no cornua; slight auricular ridges on its ventral surface. Porose areas piriform, the broader end internal, situated near the posterior border, the interval equal to their lesser diameter (see Fig. 143, exaggerated in Fig. 144). Palps long, article 2 nearly twice as long as broad, impressed dorsally, article 3 distinctly shorter than 2, rounded anteriorly. *Hypostome* long, with sides nearly parallel, dentition 3|3, about ten sharp teeth per file, the external the stronger. *Legs*: slender; coxae as in the ♂; tarsi long, tapering gradually.

Nymph (Pl. IV, Fig. 4, Text-figs. 145, 146): with the characteristics of the ♀, except that the lateral angles and the grooves of the *scutum* are more pronounced, and the postero-lateral angles of the basis capituli more pointed. The internal spine on coxa I is short, but distinct.

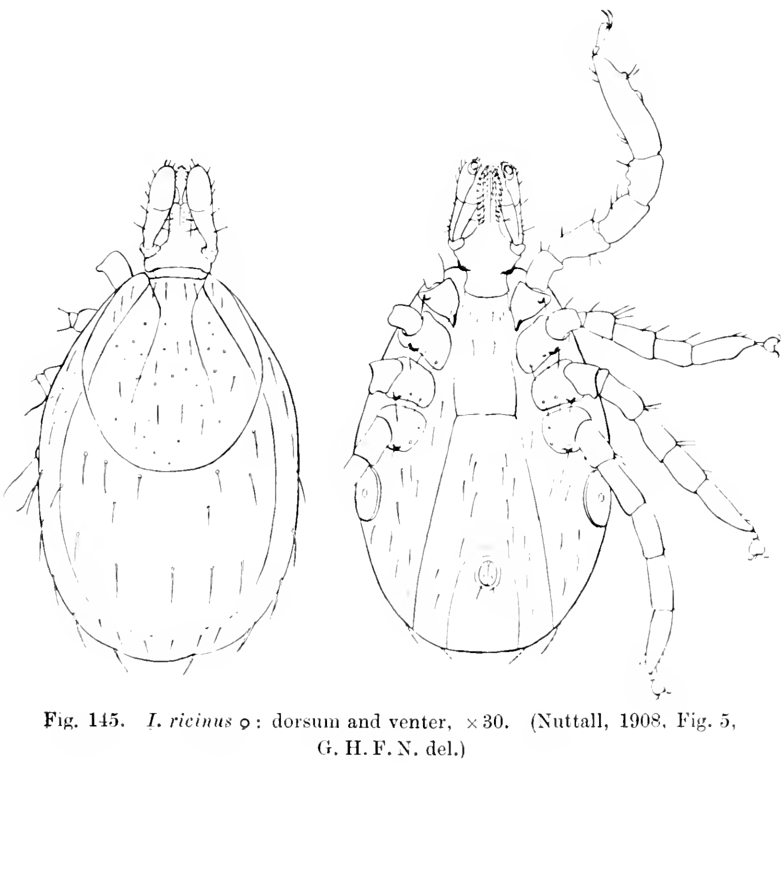


Fig. 145. *I. ricinus* ♀: dorsum and venter, ×30. (Nuttall, 1908, Fig. 5, G. H. F. N. del.)

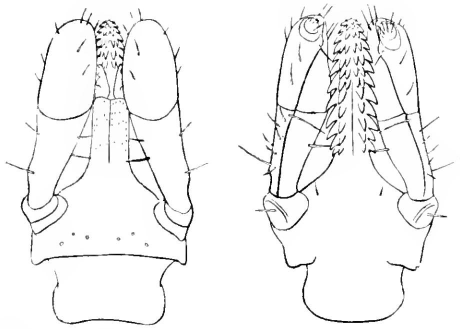


Fig. 146. *I. ricinus* ○: capitulum in dorsal and ventral aspects, ×70. (Original, G. H. F. N. del.).

Larva (Pl. IV, Fig. 5, Text-figs. 147, 148): with the essential characters of the ○.

See further under Notes on Biology (p. 294). Our description is based upon the examination of a large material, collected in different parts of the world.

Geographical Distribution.

Our collection contains specimens from the following places and hosts [observations by other authors are added in brackets]:

EUROPE: **Scotland**: From Blackaddie, Sanquhar, V. 1908 (N.[1] 400, 401, 417), ♂s ♀s, from *dog*, *cattle* and *sheep* (R. Bramwell); from Shelfhill Farm, Hawick, V. 1908 (N. 405), ♂s, ♀s, from *sheep* (J. Murray); Mr W. F. Cooper's collection also contains ♀s from *sheep* at Hawick, IV. 1906 (C. Grieve); from Auchenbrack, Tynron (N. 423), ♀s, ○s and larvae from *sheep*, V. 1908 (J. McMonnies); from Argyllshire (N. 1054), ♂ from *sheep*, V. 1910 (Captain Leschallus); from Thornhill, Dumfriesshire (N. 415, 416), from *cattle* and *lambs*, V. 1908 (J. R. Wallace); from Coilessan (N. 933), ♂s, ♀s, from *sheep*, IV. 1905 (D. MacKenzie); from Inverness-shire (N. 355), from *wild cat*, IV. 1907. In Dr J. H. Ashworth's collection, Edinburgh, we found specimens from *dog*, Obney Farm, Bankfort, VIII. 1904; from *deer*, near Crawford, X. 1908; from *wild cat*, no locality given; and from host ?, Perth.

[1] Numbers following the letter N. refer to specimens as catalogued in our collection in Cambridge.

Mr A. E. Shipley has brought us ○s and larvae for identification which were found on *grouse*[1]. [Mr W. Evans (I. 1907, p. 35) records this tick on *cows*, near Callander, mostly attached to udders and adjacent parts of legs (sexes in copula, 21 September); ○s found on head of *red-deer*

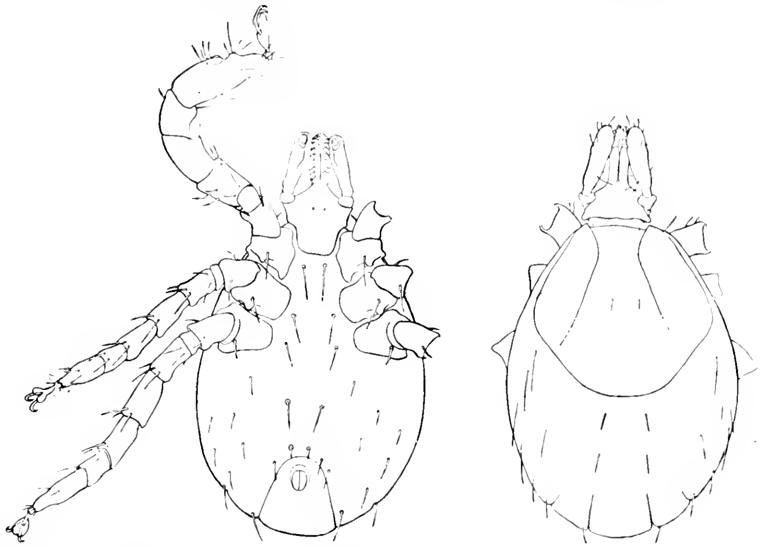


Fig. 147. *I. ricinus* larva: venter and dorsum, ×65. Specimen from Co. Cavan. (N. 929. Nuttall, 1908, Fig. 6, G. H. F. N. del.).

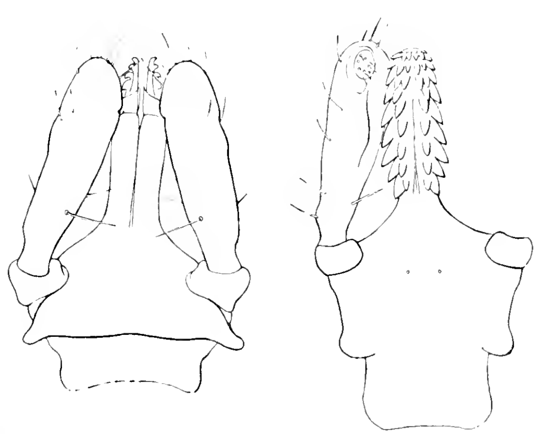


Fig. 148. *I. ricinus* larva: capitulum in dorsal and ventral aspects, ×200. Specimen from Co. Cavan. (N. 929. Original, G. H. F. N. del.).

[1] Neumann, 1901, p. 282, states that *ricinus* larvae have been found on the *martin*, but does not state the locality.

from Argyllshire (August); ♀s found under rocks at Oban and Aberfoyle (April); ♂ near Killin (Det. by Neumann)]. **England and Wales**: From Northumberland (N. 1039) ♂s, ♀s, o s, on *sheep*, V. 1905 (J. Hedley); from Huntingdonshire (N. 1037) ♀s, on *cat*, III. 1906 (E. C. Burleigh); from Grantchester, Cambs. (N. 123) o, 1906 (N. D. F. Pearce); from Longner Hall, Shrewsbury (N. 1036) ♀, on young *rat*, IV. 1906 (R. F. L. Burton); from Lyndhurst, Hants (N. 656), larva, on *Mustela erminea*, VII. 1900 (G. Tate; ex N. C. Rothschild coll.); from Tavistock, Devonshire (N. 963) ♂, ♀s, on *cattle* affected with piroplasmosis (redwater), I. 1910, and (N. 1041) IV. 1910 (G. H. Gibbings). [E. G. Wheler, 1899, p. 6, records the species on *sheep*, at Gowanburn Farm, N. Tyne Valley, ♀s in March, adults and o s being more numerous in April; specimens only occasionally found on *deer* and *dogs*; Kossel and Weber, 1900, found this tick associated with redwater in cattle in N. Wales.] **Ireland**: From Sligo (N. 1035) ♀s on *collie dog*, V. 1905 (Æ. F. Nuttall); from Timmer (N. 630) o s on *Sciurus vulgaris*, IV. 1901 (N. C. Rothschild); from Dallyhaise, Co. Cavan (N. 929), unfed larvae, VII. 1905 (J. W. Steen); (N. 1038) ♀s, on *cattle* affected with piroplasmosis, V. 1905 (A. E. Mettam); (N. 1185) ♂, on *dog*, Maam Cross, Co. Galway, 1. X. 1910 (G. H. F. Nuttall); Mr W. F. Cooper's coll. contains ♂s and ♀s from Roscommon, VIII. 1906. We determined specimens belonging to the Dublin National Museum as follows: from Glengariff, V. 1891; Clonbrock, IX. 1897; on *cattle*, Lochrea, VI. 1909; on *cattle*, Wexford; on *cattle*, Dingle, VI. 1909; Limerick, 1898; Cuppamore, Co. Limerick, IX. 1895; on *horse*, Stepaside, Co. Dublin, VI. 1909; on *cattle*, Cookstown, VI. 1909; Kenmure, 1898; on *dog*, Lugan, V. 1907; Achill, 1898; Glandore, 1895; Trillick, Co. Tyrone; Crookhaven, 1895; Roundstone, Ardagh, Castletown, VI. 1893; Kenmore, VII. 1898; Lough Corrib, 1905. **France**: [Fairly common in France, according to Neumann, 1899, p. 115, who records it from the *badger* and *genet*, at Nîmes (M. Mingaud)]. We have examined numerous specimens in the collection of Dr H. Brumpt: ♂, ♀s and o s, taken from *hedgehog* and *deer*, Chantilly, IX. and XI. 1909; and from the *roe-deer*, Halles (Paris), X. 1908. **Belgium**: (N. 631) ♀ from *Erinaceus europaeus* (E. A. Boulenger, ex N. C. Rothschild coll.). **Holland**: [larvae found on *Mus decumanus* (Oudemans)]. **Germany**: From Kittendorf and Schwandt, Mecklenburg-Schwerin, on various hosts, as follows: (N. 57) ♂, on *man*, IX. 1905; (N. 769, 770) ♂s, ♀s, on *Cervus elaphus*, VIII. 1909; (N. 771) ♂, ♀, o, on *Capreolus capraea*,

VIII. 1909; also (N. 58) in IX. 1905, all collected by G. H. F. Nuttall; and (N. 1182), in IX. 1910 (Count v. Schlieffen's gamekeeper). From the same place (N. 1169), ♀s, on *dogs*, VI–VII. 1910, and (N. 1170) on *fox*, VI. 1910 (G. v. Oertzen's gamekeeper); and from the neighbouring places: (N. 1183) ♀, from *horse*, at Vossfeld, VII. 1910, and (N. 1184) ♀, o, from a *dog*, at Rosenow, VII. 1910 (Count v. Schlieffen's gamekeeper). (N. 1124, 1181 and 1186 a) ♀s, from Godesberg on Rhine, on *dogs*, VI. VII. and IX. 1910 (Baron v. Rigal's gamekeeper; G. H. F. Nuttall). [*I. lacertae* Koch was found on *lizards* in Germany. Kossel, Schütz, Weber and Miessner, 1903, pp. 39–50, observed all stages on *cattle*, and demonstrated by experiment that *ricinus* conveys redwater in Germany.] **Heligoland**: [Neumann, 1899, p. 116, states it was found on *Regulus ignicapillus* and on *Strix brachyotus*, and os were taken from *Tringa pugnax*, according to G. Haller (Poppe coll.)]. **Italy**: [Canestrini, 1890, p. 497, obtained specimens on *cattle*, *dogs*, *goats* and *roe-deer* in the Trentino, and on *goats* and *roe-deer* in Veneto. He states that Richiardi found them on *Rhinolophus ferrum equinum* at Pisa, and Canestrini found a young ♀ on *Rh. euryale* at Pisa. He found young stages in Trentino, Istria, Veneto and Toscana on *Lacerta muralis* and *L. viridis*. Canestrini and Fanzago, 1877, p. 112, found many on *hunting dogs*, and on the *goat*, *roe-deer* and *wild cat* (p. 113, *I. rufus* on *Cervus dama* and p. 114 *I. lacertae* on *lizards*)]. **Spain**: [Neumann, 1901, p. 282, records its occurrence on lizards of different species]. **Galicia**: [Neumann, 1899, p. 116, records its occurrence on *dog*, *sheep* and *Myoxus avellanarius* (Bureau of Animal Industry coll., Washington, D.C.)]. **Albania and Rhodes**: [Neumann, 1901, p. 282, states that ♂s, ♀s and os have been found on *lizards*: *Lacerta agilis*, *L. arenicola* and *L. vivipera*)]. **Russia**: [The Hamburg Museum contains specimens (♂ and ♀) collected by Dickmann in Amur, according to Neumann, 1904, p. 452. He alsc records, 1899, p. 116, a o from Caucasia in the Mégnin collection (now at the Laboratoire de Parasitologie, Paris)]. **Finland**: [The prevalence of this species was established by Kossel and Weber, 1900, in connection with their studies on redwater in *cattle*. See also Kossel, 1902, p. 853; Kossel, Schütz, Weber and Miessner, 1903, p. 39; Nordenskiöld, 1905, p. 485].

To the foregoing list of European hosts we add, on the authority of Neumann, 1899, p. 115, the *cormorant*, *polecat* and *mole*, no locality being given.

AFRICA: From **Algeria**: (N. 998) ♂, ♀, on *dog*, Azazea, III. 1910

(G. H. F. Nuttall); (N. 1053 d) ♀, on *sheep*, Hammam-Meskoutine, v. 1910 (P. Deshabert); (N. 1178) ♀s, from *cattle*, Algiers, summer of 1910 (M. Serve); (in W. F. Cooper's coll.) ♀, on *cattle*, Maison Carrée, II. 1908. [Neumann, 1901, p. 282, reports ♂s and larvae, from *Lacerta ocellata* and *Tropidosaurus algirus*. **Tunisia** (Paris Mus.): Neumann, 1899, p. 116, records specimens from Algeria, collected by Simon (Paris Mus.).]

ASIA: **Transcaucasia**: (N. 799) ♀s, from Surnabad, VIII. 1903, collected by Dr E. Dschunkowsky, from whose collection we determined specimens taken in the same place from *fox*, *hare* and *sheep*, X. 1903. **Arabia**: [Occurrence on *lizards*; Neumann, 1901, p. 282]. **Japan**: [Occurrence on *horse* at Akita, and *hare* at Saga. Neumann, 1899, p. 116, and 1904, p. 452].

AMERICA: From California (N. 272) on *Felis concolor*, XII. 1894 (Gilroy), and (N. 291) on *mouse*, Palo Alto, III. 1893 (both presented by Prof. V. L. Kellogg); (in C. G. Hewitt's coll., Ottawa, determined by us) ♀, on *man*, Vancouver, British Columbia, 1907 (G. W. Boggs). [Osborn (1896, p. 262) states this species is common on *ground squirrels* in the Mississippi Valley (determined by Marx). Banks (1908, p. 25) states that the Marx collection in Washington contains specimens found on *sheep* in Kansas, and on *cattle* in Texas. He thinks the species may have been imported on the hosts, and adds: "Practically all of the previous records of this species in this country apply to *I. scapularis* or to *I. cookei*" (species which we degrade to mere varieties of *I. ricinus*). Neumann, 1899, p. 116, states that *ricinus* occurs in many parts of the United States (Bureau of Animal Industry coll., Washington, D.C., some perhaps are varieties of *ricinus*, *q.v.*) and mentions New Berne, Baltimore, Pennsylvania, Carolina, Florida, California, Kansas, Texas, the hosts being *Lepus sylvaticus*, *Felis pardalis*, *Bos taurus*, *opossum*, *grey fox*, *panther*, and *wild cat*.]

Ixodes ricinus var. scapularis (Say, 1821).

Fig. 149 (original).

Lit. and Synon.: *Ixodes scapularis* Say, 1821, pp. 59–82; 1859, pp. 19–22.
Ixodes affinis Neumann, 1899, pp. 120, 121, labelled *I. communis* by G. Marx (Bureau of Animal Industry coll., Washington, D.C.; also Neumann coll.), *fide* Banks, 1908, p. 26.

Ixodes scapularis Say, in Banks, 1904, p. 144 (occurrence in Florida); 1908, pp. 25, 26, Pl. IX, Figs. 1, 2; Pl. II, Fig. 15 (♀ unfed, inaccurate; sexes in copula (♂ attached too far posteriorly), ♀ venter and capitulum, details fairly accurate (Fig. 15 very sketchy). Hooker, 1908 a, observed copulation.

Male: (according to Banks, 1908, p. 25) "*L.* 2 mm. Dark coloured as in female; the palpi are very short, second and third joints no longer than broad; shield with subparallel sides, densely punctate and very hairy; legs and coxae as in the female; the stigmal plate large and elongate."

Female (Fig. 149): *Scutum* rather more elongate-oval than in the type, with grooves very faintly marked. *Capitulum*: base rather narrower than in the type, with more distinct cornua; porose areas rounder and nearer together; palps somewhat more pointed anteriorly. *Legs*: tarsus 4 tapering rather more abruptly.

Apparently common in the United States (Florida, Texas, Virginia, Iowa, N. Carolina, Maryland, Indiana), where it occurs on *man, dog, cattle,* and various wild mammals. Neumann's *affinis* was found by C. Curtice on *Felis pardalis* in Costa Rica.

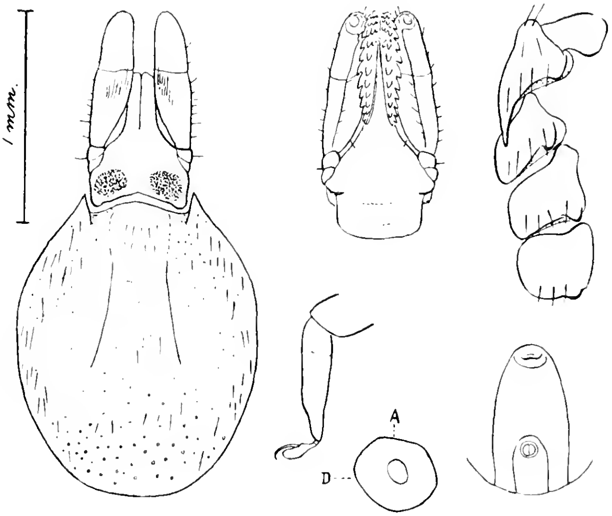


Fig. 149. *I. ricinus* var. *scapularis* ♀: capitulum and scutum, capitulum in ventral aspect, coxae, tarsus 4, spiracle, genital and anal grooves (less magnified). From specimen (N. 718) from Miami, Florida, U.S.A. (ex N. Banks coll. Original, G. H. F. N. del.).

We possess specimens (N. 626), ♂, ♀, from *Cariacus virginianus*, Craven County, N. Carolina, XI. 1897 (ex N. C. Rothschild coll.), and (N. 718), ♀, from Miami, Florida (ex N. Banks coll., presented by the U. S. Dept. of Agriculture). The collection of C. G. Hewitt, Ottawa, contains ♀ specimens (determined by us), taken in Canada from *man*, and found by M. Mahafty, VI. 1904, at Bracebridge, Ontario.

Neumann, in describing *I. affinis*, remarks on its similarity to *I. ricinus*. Banks gives it specific rank, and points out certain respects in which it differs from *I. ricinus*, in some of which we are unable quite to agree with him. We have very carefully examined four ♀ kindly given to us by the U. S. Dept. of Agriculture, Washington, D.C. and other specimens taken in Craven County, N. Carolina (Rothschild coll.). The form is certainly very near *I. ricinus*, and if found in Europe would be attributed to that species with little hesitation considering the variation revealed by the review of a very large number of typical *I. ricinus*. It seems to us impossible to accord it higher rank than that of a variety of *I. ricinus*.

Ixodes ricinus var. ovatus (Neumann, 1899).

Lit. etc.: *Ixodes ovatus* Neumann, 1899, p. 112, Figs. 2, 3. It was subsequently found that the lot described contained typical *ricinus*. The figs. of the ♂ and ♀ hypostomes and digits as in *ricinus*.

Ixodes ovatus Neumann, 1904, p. 452, species maintained (description quoted below).

Ixodes ovatus Neumann, in Dönitz, 1905, p. 132. Dönitz considers the species probably but a variety of *ricinus*.

Neumann (1904, p. 452) states that *ovatus* differs from *ricinus* in the following points:

Male: unknown.

Female: *Scutum* about as long as broad, cervical grooves very shallow and long, lateral grooves indicated by a slightly prominent ridge, parallel to the borders; porose areas oval, slightly longer than broad, converging anteriorly; coxa I with a very short internal spine, II unarmed, sharp on its posterior border, III and IV with a small external tuberosity; tarsi shorter than in *I. ricinus*.

Described from two ♀ found on a *horse* and a *dog* at Saga, Japan, by Yamaguchi. The differences noted only appear to us to be varietal.

Ixodes ricinus var. californicus (Banks, 1904).

Lit. etc.: *Ixodes californicus* Banks, 1904, p. 369, Pl. XLI, Fig. 57 (scutum and coxae)[1]; 1908, p. 24, Pl. II, Fig. 12 (♀ capitulum and scutum).

We have not seen this tick, which appears, from its description, to be specifically indistinguishable from *I. ricinus.* Banks states that the capitulum of *californicus* is much narrower, and that the two forms are separable by the different porose areas, but his description of the porose areas of *californicus* precisely applies to our specimens of *ricinus.* Moreover, the figures given by Banks do not appear to us to agree very well with his description. It is undoubtedly very near to *ricinus,* and it appears to be only a variety.

Male: (2 mm. *l.*) similar to *I. scapularis* ♂, but *scutum* with more nearly parallel sides. Spiracle nearly circular; palps very short; coxa 1 with long sharp posterior spine.

Female: *Colour*: Scutum yellowish-brown, legs darker brown, abdomen yellowish-grey. *Scutum* 1·2 mm. *l.*, but little longer than broad, somewhat trapezoidal, lateral "carinae" not distinct, but traceable, many fine punctations. Abdomen punctate, hairy. *Capitulum* not nearly as broad as in *I. ricinus,* posterior angles acute, porose areas subtriangular, broader than long, separated by about their length, the inner edge oblique; palps moderate, article 2 slightly longer than 3, the latter not twice as long as broad. Spiracle nearly circular, rather small, finely granular. *Legs*: coxa I with long sharp basal spine, coxae I–IV with minute tooth at apex behind; legs rather slender, very hairy ventrally, tarsus 1 fully one and one-half times the length of the metatarsus, tapering distally; tarsus 4 but little longer than metatarsus, tapering gradually.

Origin: California (Claremont, Santa Clara Co., Santa Cruz Mts., Redwood Creek, Humboldt Co.). *Hosts*: grey fox and black-tail deer.

The above description is that given by Banks, rearranged, as far as possible, in accordance with the method adopted in this work.

2. IXODES NIGRICANS Neumann, 1908.

Fig. 150 (original).

Lit. and Synon.: *Ixodes obscurus* Neumann, 1899, p. 121 (no figure).
Ixodes nigricans Neumann, VII, 1908, p. 75. Name given for the reason that *obscurus* was preoccupied (*I. obscurus* Fabricius, 1805, p. 55, suppressed).

Male: unknown.

[1] The earlier description by Banks (1904) applies, apparently, to a ♀ and o, when considered in conjunction with the figure. He states that coxa I has a "black hump" at the postero-external border, but no (*sic*) basal spine; coxae II and III with prominent spine, and coxa IV with small protuberance at the postero-external border. Found on *Toxostoma crissalis*, at Claremont, California (Baker). This description does not agree with the later one.

Female (Fig. 150): Body short oval, 7 × 5 mm. Dark brown all over. *Scutum* oval, borders rounded, 1·3 × 1·1 mm., glossy, dark, with a few hairs; cervical grooves long, barely visible; many very fine equal punctations. *Dorsum* bearing many punctiform prominences, some still surmounted by a hair. *Venter* bearing similar granulations and hairs; vulva facing the last intercoxal space; anal grooves slightly divergent; spiracles rounded, small, reddish. *Capitulum* 1 mm. long, digit[1], hypostome thick, tip slightly tapering, 4 | 4 files of 10–11 teeth, diminishing from outside inward, the external stout, pointed; the internal blunt, distant from their mates; palps flat, the external border straight, the internal border convex, article 3 as long as 2. *Legs* of medium length, slender, bearing long hairs on the ventral border; tarsi long, tapering gradually; pad almost equals the length of the claws.

Description (Neumann, 1889, p. 121) based on one gorged ♀ from Funchal, Madeira, collected by K. Kraepelin (Hamburg Museum).

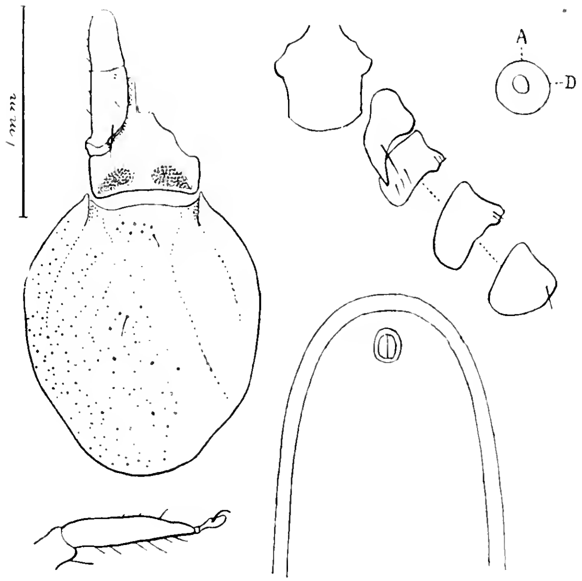


Fig. 150. *I. nigricans* ♀: capitulum and scutum; parts of venter, spiracle and tarsus 4. Drawn from the type. (Hamburg Mus. Original, G. H. F. N. del.)

Note: Through the courtesy of Professor Kraepelin we have been able to examine and figure the type (1 ♀). *I. nigricans* apparently differs from *I. ricinus* only in (*a*) the scutum, which is oval (without lateral angularity) and faintly grooved, and (*b*) the somewhat smaller spiracle. A review of a series of undoubted *ricinus* from a single batch reveals scutal variations which, in our opinion, render it quite possible

[1] Digit 175 μ long; dorsal process longitudinally crescentic; external article with five successive teeth, the last stout.

for *nigricans* to fall within that species, but the opinion of so high an authority as Professor Neumann leads us for the present to refrain from referring it to *I. ricinus*. (From *I. rasus*, to which Neumann states that it is allied, it is immediately distinguishable by the anal grooves.)

3. IXODES ACUMINATUS Neumann, 1901.

Figs. 151 and 152.

Lit. and Icon.: Neumann, 1901, pp. 287, 288, Figs. 7, 8 (here reproduced).

Male: unknown.

Female (Fig. 151), young: Body elongate oval, *L.* 2 mm., at least twice as broad (1·2 mm.) toward the posterior third as it is in front, yellowish red. *Scutum* longer than broad (1·3 × 0·9 mm.), lozenge-shaped oval, antero-lateral borders subrectilinear, divergent, the portion bounded by the posterior rounded border forming $\frac{2}{5}$ of its length; emargination slight: surface glossy, without cervical grooves, the latter fusing with the origins of the lateral rectilinear grooves, which are parallel to the borders and end at their posterior curved portion; punctations numerous, very fine; some scattered hairs. *Dorsum* covered by long hairs, especially in the posterior portion: deep marginal grooves

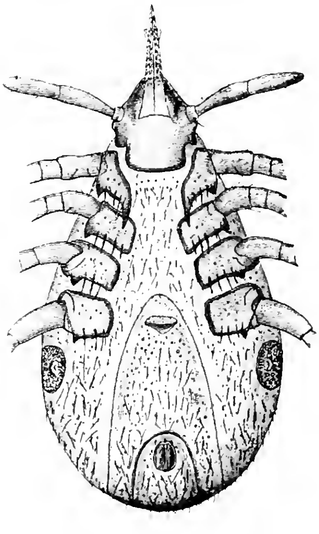


Fig. 151.

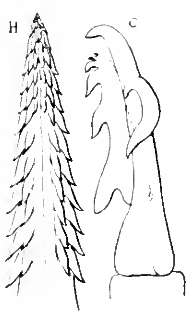


Fig. 152.

Fig. 151. *I. acuminatus* ♀: venter. (Neumann, 1901, Fig. 7.)
Fig. 152. *I. acuminatus* ♀: *H*, hypostome, *C*, digit, 120 μ *l*. (Neumann, 1901, Fig. 8.)

ending at the posterior curve of the border; *Venter* bearing similar hairs: vulva facing coxae IV; sexual and anal grooves but slightly divergent. Spiracles large, whitish, circular. *Capitulum* 0·8 mm. long; dorsal base almost as broad as long; lateral borders parallel, posterior border rectilinear, with slight cornua; porose areas circular, widely separated, near to the posterior border; ventral surface longer than broad, auricula short, flat, rounded. (Digit, see Fig. 152 *C*.) Hypostome (Fig. 152 *H*) lanceolate, very pointed, with 3 | 3 then 2 | 2 rows of sharp teeth; palps long, slender, narrow. *Legs* long, slender; coxae broad, flat, all bearing a short spur at the postero-external angle; coxa I bears besides a long slender spine internally. Tarsi long, slender, tapering gradually; pads as long as claws. Gorged female 4 mm. long, 2 mm. broad, red-brown, the coxae situated close together in the anterior fourth of the body.

Neumann's description based on 2 ♀s from *Mus agrarius* collected at Genoa by C. Parona (Neumann coll., Toulouse).

4. IXODES DENTATUS Marx, 1899.

Figs. 153, 154.

Lit. and Icon.: Neumann, 1899, p. 119, Figs. 4 and 5 (reproduced).
Ward (x. 1900, brief mention only on p. 204).
Banks, 1908, p. 28; Pl. IV, Fig. 6 (♀ capitulum, scutum, coxae), Pl. IX, Fig. 3 (♀ gorged, capitulum and scutum); inaccurate, since the two sets of figures completely disagree.

Male: unknown.

Female: Body oval, *L.* 6·2 mm., *W.* 3·5 mm. [? replete], broad, blackish brown. *Scutum* oval, scarcely longer (1 mm.) than broad, with sides rounded, posterior angle broad; cervical and lateral grooves well defined, the latter straight, almost united behind to the cervical grooves; many large punctations, especially abundant behind. *Dorsum* shagreened, with numerous punctations, each of which may bear a very short hair; grooves normal. *Venter* shagreened like the dorsum. Vulva facing coxae IV; sexual grooves very divergent. Anus toward the posterior third; anal grooves long, divergent. Spiracles small, rounded, in front of one-half the body length. *Capitulum* (Fig. 153) with dorsal base rectangular, slightly broader than long; porose areas small, far apart; auricula forming a retrograde tooth. Chelicera? Hypostome lanceolate, 4 | 4. Palps with article 2 slightly longer than 3. *Legs* short, maroon-brown. Coxae (Fig. 154) close together, not occupying the anterior quarter of the body length ; coxa I bears a long retrograde spur at the internal angle ; all the coxae bear a spiniform process at the postero-external angle. Tarsi medium, tapering gradually : pads almost equal to the claws in length.

The above description, from Neumann, is based on drawings by Marx, and a ♀, labelled by him *Ixodes dentatus*, found on the rabbit (Smithsonian Institution, Washington, D.C.).

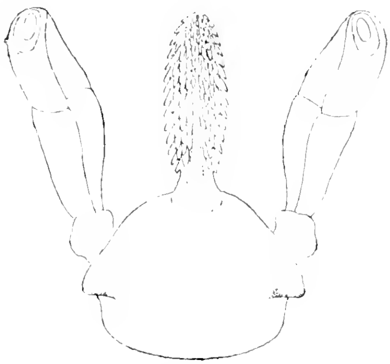


Fig. 153.

Fig. 154.

Figs. 153, 154. *I. dentatus* ♀ : capitulum in ventral aspect, coxae and trochanters I–IV. (Neumann, 1899, Figs. 4 and 5, G. Marx del.).

5. IXODES DIVERSIFOSSUS Neumann, 1899.

Lit. : *Ixodes diversifossus* Neumann, 1899, pp. 136, 137 (no figure).
Banks, 1908, p. 27, Pl. III, Figs. 12, 14 (♀ capitulum, scutum, spiracle, coxae I and II, tarsus I); not reproduced, as we do not trust their accuracy.

Male : unknown.

Female : Body oval, reddish yellow, 5 × 2·5 mm. [? partly gorged]. *Scutum* oval, 1·3 × 1·1 mm., with rounded borders, glossy, maroon-brown ; cervical grooves long, superficial ; lateral grooves well marked, straight, attaining the posterior border ; many punctations, large on the lateral and posterior borders, very fine elsewhere. *Dorsum* glabrous or nearly so, traversed by a marginal groove, very distant from the lateral and posterior borders, where it leaves a margin almost equal to one-quarter of the whole width. *Venter* : vulva facing the last intercoxal space. Anal grooves parallel, of medium length, reunited in an arc of a circle in front. Spiracles circular, large, whitish. *Capitulum* with base broader than long, with pointed cornua ; porose areas rounded, small, far apart ; auricula forming a retrograde spine. Chelicera? Hypostome 2|2 or 3|3, the marginal teeth stout. Palps long; article 1 with a short retrograde point ventrally, article 2 scarcely longer than 3. *Legs* long, brown; spurs on coxa I, the internal very long; a simple pointed prominence at the postero-external angle of coxae II–IV. Tarsi long, tapering gradually.

Description, by Neumann, based on 2 ♀s (mutilated) collected by Hassall from *Procyon lotor*, from New Mexico (Smithsonian Institution).

6. IXODES MINOR Neumann, 1902.

Figs. 155–159 (Figs. 156–159 original).

Lit. and Icon.: Neumann, 1902, pp. 109–111, Fig. 1 (reproduced).

Male (Figs. 155–158): Body: *L.* 1·45, *W.* 0·8 mm. at the posterior third, maroon-brown. *Scutum* convex, glossy, marginal fold very narrow with deep marginal groove; cervical grooves narrow, superficial, diverging and extending to about the middle of its length; punctations numerous, deep, uniform; hairs whitish, lying flat, scattered. *Venter*: sexual orifice broad, between coxae III; median plate longer than wide, pentagonal, with numerous large punctations; anal plate smooth, narrow anteriorly, broad posteriorly, with sides diverging considerably; adanal shields trapezoid, slightly broader anteriorly, with fine punctations; long

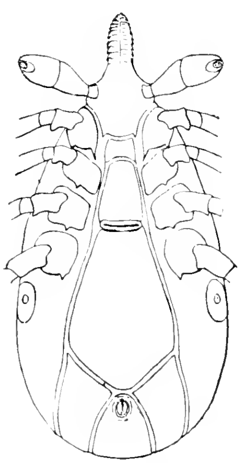


Fig. 155.

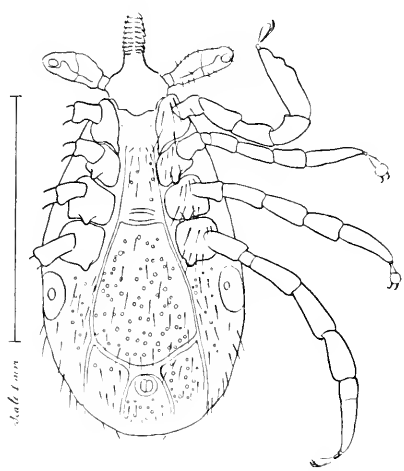


Fig. 156.

Fig. 155. *I. minor* ♂: venter. (Neumann, 1902, Fig. 1.)

Fig. 156. *I. minor* ♂: venter (*L.* 1·73 mm.), from the type mounted in balsam. (Neumann coll. Original, G. H. F. N. del.)

hairs fairly abundant over the whole ventral surface. Spiracles large, slightly oval. *Capitulum* (Fig. 157) long (0·45 mm.), with base about as broad as long, subrectangular, sides rounded, cornua very prominent. Hypostome (Fig. 158) long, slightly lanceolate, on each border two rows of 8 stout teeth, the internal connected ventrally by sinuous ridges. Palps relatively long, articles 2 and 3 of the same length. *Legs* relatively long; coxa I bearing a short pointed spur at the postero-internal angle, a blunter, shorter spur at the postero-external angle; coxae II–IV with a short spine toward the middle of the posterior border. Tarsi long, tapering gradually.

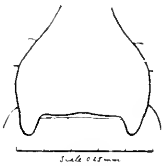


Fig. 157.

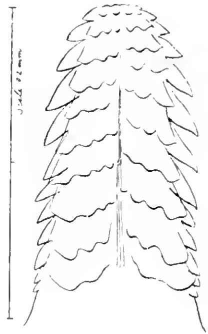


Fig. 158.

Fig. 157. *I. minor* ♂: base of capitulum, showing cornua. Drawn from the same specimen as Fig. 156. (Scale = 0·25 mm. Original, G. H. F. N. del.)

Fig. 158. *I. minor* ♂: hypostome, drawn from the same specimen as Fig. 156. (Scale = 0·2 mm. Original, G. H. F. N. del.)

Female (gorged, Fig. 159): Body elongated oval, *L.* 5, *W.* 2·5 mm., broadest at the posterior third, yellowish brown. *Scutum* oval, much longer than broad (1·3[1] × 0·7 mm.), with curved contours, emargination slight; cervical grooves superficial, almost obliterated anteriorly, very divergent posteriorly and extending to about the posterior third; lateral grooves faintly indicated by the marginal prominence; punctations numerous, uniform towards the posterior third and at the sides, finer and rarer in the middle; surface glossy, smooth, dark brown. *Dorsum* with scattered hairs, numerous punctations; three posterior superficial grooves. *Venter* with similar punctations and hairs; vulva small, opposite coxae IV; anal grooves diverging, ogival in front of the anus. Spiracles

[1] Neumann gives the length of the ♀ scutum as 1·10 mm., which is probably a misprint. He has kindly lent us the types, now mounted as microscopic preparations, and, as far as their present condition permits, we have corroborated his description.

small, circular, brown. *Capitulum* long (0·8 mm.); dorsal base subtriangular, with very prominent cornua; porose areas large, circular, separated by a space equal to their diameter; auricula forming a prominent horn. (Digit[1].) Hypostome (absent, but probably sharply lanceolate as in *I. acuminatus*). Palps long, slender, narrow; the first article slightly prominent externally on the ventral surface, the second slightly longer than the third. *Legs* close together anteriorly, similar to those of ♂, relatively slenderer.

Neumann's description is based on a ♂ and a ♀ found copulating upon *Hesperomys* sp.? (Muridae) in Guatemala by J. Rodriguez.

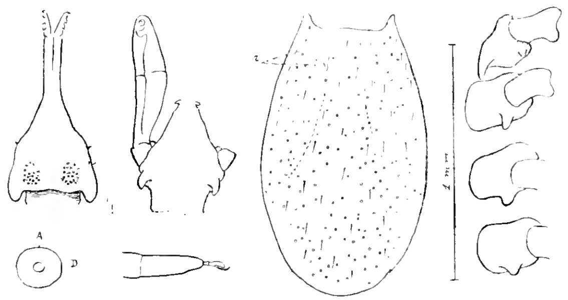


Fig. 159. *I. minor* ♀: capitulum in dorsal and ventral aspects, spiracle, tarsus 4, scutum and coxae. N.B. The dotted lines on the scutum indicate the lateral and cervical grooves as described by Neumann; they are invisible in the mounted specimen of the type. (Neumann coll. Original, G. H. F. N. del.)

7. IXODES BOLIVIENSIS Neumann, 1904.

Fig. 160 (original).

Lit.: Neumann, 1904, pp. 457, 458 (no figure).

Male (Fig. 160): Body oval, broader posteriorly, *L.* 1·6, *W.* 1·1 mm. *Scutum* convex, reddish brown, marginal fold narrow; cervical grooves almost obsolete; lateral grooves absent; two groups of deep punctations: one group tracing a pseudo-scutum, the other group on a median circle towards the posterior third, elsewhere almost obsolete; a few rather long sparse hairs. *Venter* reddish brown, with long hairs, especially lateral

[1] Digit, slender, 100 μ long; dorsal process crescentic, longitudinal and with retrograde points, external article with five teeth, larger and more separated proceeding toward the base (as in *I. acuminatus*).

to the genital grooves; median shield with deep punctations, anal shield a truncated oval, longer than wide, with sides curved and diverging: adanal shield narrower posteriorly than anteriorly. Spiracles large, short oval, whitish. *Capitulum* 525 μ long; the base slightly broader than long and broader anteriorly on the dorsal surface; its posterior border rectilinear; auriculae forming slight prominences. Hypostome long and broad, with lateral teeth united by transverse serrated ridges. Palps broad, flat, articles II and III of the same length. *Legs* long. Coxa I with two parallel spurs, the internal very long, the external short; two flat spurs, short and separated, on coxae II and III; a single external conical spur on coxa IV. Tarsi long, tapering gradually.

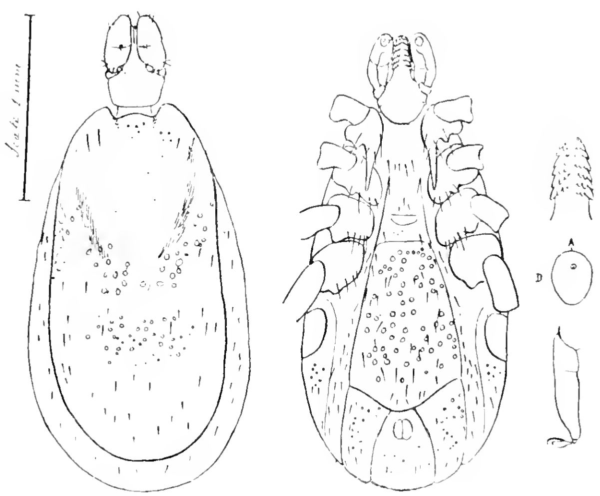


Fig. 160. *I. boliviensis* ♂ (type): dorsum and venter, hypostome, spiracle and tarsus 4. (Original, G. H. F. N. del.)

Female (Fig. 161): Body oval, sides rounded, *L.* 2·6, *W.* 1·9 mm. [partly fed], yellowish brown, the capitulum, scutum and legs maroon-brown. *Scutum* oval, sides convex, longer than broad (1·5 × 1·2 mm.): cervical grooves almost obsolete; lateral grooves represented by a slightly visible depression; fine punctations, mostly peripheral, a few hairs mostly on the sides; scapulae sharp and prominent. *Dorsum* with marginal grooves and some hairs. *Venter* with hairs scarcely more abundant; vulva between coxae IV; anal grooves slightly diverging, rounded in front. Spiracles large, circular, whitish. *Capitulum* 0·7 mm. long; base broader than long, with parallel sides, with slight cornua;

porose areas small, slightly broader than long, interval equal to their long diameter; auriculae prominent, slightly diverging, uncate. Hypostome (?). Palps long, broad, flat, the articles 2 and 3, almost equal.

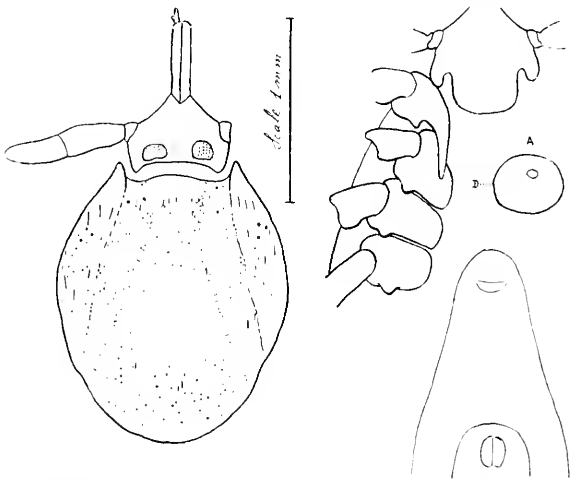


Fig. 161. *I. boliviensis* ♀ (type): capitulum and scutum; part of venter; spiracle. (Original, G. H. F. N. del.)

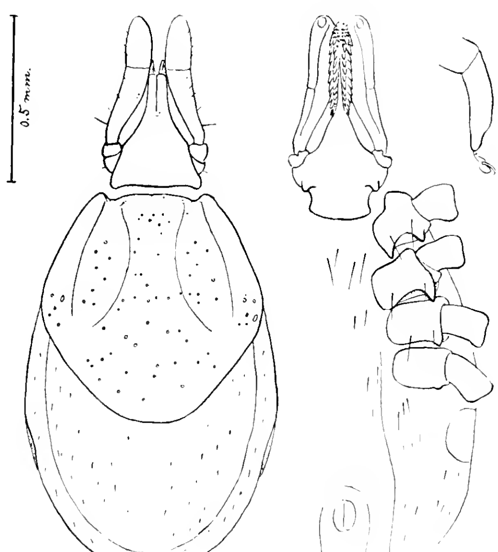


Fig. 162. *I. boliviensis* o (type, unfed): dorsum, part of venter, tarsus 4. Same origin as ♂ and ♀ in Figs. 160, 161. (Original, G. H. F. N. del.)

Legs: Coxa I with two parallel spurs, the internal very long, the external short; a small external tuberosity on coxae II–IV. Tarsi ?

Nymph (Fig. 162): Body oval, 1·1 mm. long. *Capitulum* very long (0·63 mm.); with narrow palps, cultriform; hypostome long, narrow, lanceolate, dentition 2 | 2. *Legs* long; coxa I with a stout internal spur, coxae II–IV as in ♀; tarsi long, narrow, tapering gradually.

Described from a ♂, a mutilated ♀ and a o, found on *Icticyon* (*Speothos*) *venaticus* (Canidae), at Charuplaya, Bolivia, 27. VI. 1901 (N. C. Rothschild coll., now in Neumann coll., No. 1251).

8. IXODES FUSCIPES Koch, 1844.

Figs. 163 and 164 (original).

Lit. etc.: *Ixodes fuscipes* Koch, C. L., 1844, p. 233; 1847, p. 106, Pl. XXI, Fig. 80, ♀.

Ixodes spinosus Neumann, 1899, pp. 146, 147 (no figure). Neumann, 1901, pp. 288, 289, identified *I. spinosus* with *I. fuscipes* after examining the type.

Male: unknown.

Female (Figs. 163, 164): Body short oval, broadly rounded behind, 4·8 × 2·4 mm., yellowish or reddish yellow. *Scutum* rounded, at least as broad (1·4 mm.) as long; glossy, dark brown in front and on the sides,

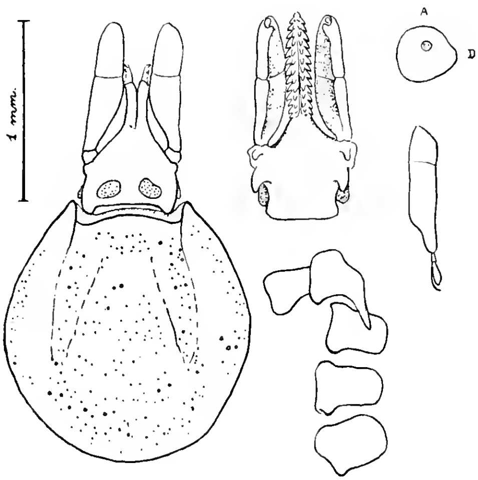


Fig. 163.

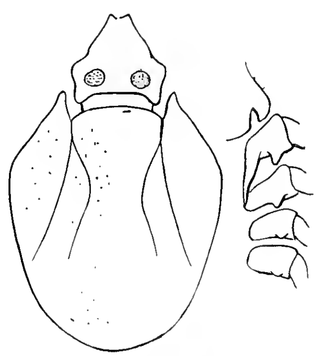


Fig. 164.

Fig. 163. *I. fuscipes* ♀: capitulum and scutum; capitulum in ventral aspect, coxae, spiracle and tarsus 4. Found on *Dasyprocta aguti*. (Neumann coll. 750. Original, G. H. F. N. del.)

Fig. 164. *I. fuscipes* ♀: capitulum (mutilated) and scutum, coxae and part of capitulum, showing auricula. (Sketch from specimen in British Mus. Original, C. W. del.)

brownish yellow between the cervical grooves; the latter shallow, attaining the posterior quarter; lateral grooves indicated by straight, nearly parallel raised margins which limit external declivities; punctations deep, equal, numerous, absent on the cervical grooves, and anterior border. Dorsum almost glabrous, showing a trace of a marginal groove. *Venter* with more numerous hairs. Vulva between coxae IV; sexual grooves but slightly curved, diverging little. Anus rather near the posterior border; anal grooves parallel. Spiracles large, rounded, whitish, situated about midway along the body-length. Capitulum long (0·9 mm.); base almost as broad as long, pentagonal; slight cornua, the anterior border narrowed, porose areas small, far apart; auricula forming a horn-like protrusion. Hypostome narrow, pointed in front, bearing 3 | 3 files of 13–14 teeth, decreasing inward in each transverse row, the internal files much separated from each other, especially behind.[1] Palps long, narrow, article 1 prolonged into a ventral retrograde spine; article 2 longer than 3. *Legs* long. Coxae bear some long hairs; a moderate protuberance at the postero-external angle; a long spine at the postero-internal angle of coxae I. Tarsi long on pairs I and IV, of ordinary size on pairs II and III, with almost parallel borders; the dorsal border abruptly tapering near the extremity; pads large, as long as the claws.

Nymph: Body short oval, *L.* 1·8, *W.* 1·5 mm., whitish. *Scutum* of the same form as in ♀; cervical and lateral grooves clearly defined. Capitulum 0·7 mm. long, similar to that of ♀; base broader in front than behind; no ventral spine on the first palpal article. *Legs* similar; the spine on coxa I shorter.

Larva: short oval, *L.* 1 mm. *Scutum* broader than long. *Capitulum* similar to that of o, hypostome less pointed; spine on coxa I shorter.

Neumann described this species as *Ixodes spinosus* from 4 ♀s, 7 os and 3 larvae collected by Goeldi in Brazil from *Dasyprocta aguti.* Subsequent examination of Koch's type of *I. fuscipes* (1 ♀ from Brazil) convinced him that the two species were identical. He has kindly lent us a ♀ from Goeldi's collection, and the above description has been altered in a few unimportant respects from that of Neumann of the ♀ of *I. spinosus* as the result of our study of this specimen. (Fig. 163). We have also examined an older ♀ in the British Museum, attributed by Neumann, probably correctly, to the same species, but it has a distinctly longer scutum (Fig. 164). This specimen was found on *Felis pardalis,* at Panama (Watson coll.).

[1] The dentition of the hypostome shown in Fig. 163 differs from that here described; the structure is doubtless variable.

9. IXODES SCULPTUS Neumann, 1904.

Lit.: Neumann, 1904, p. 462 (no figure).
Banks, 1908, p. 30, Pl. IV, Figs. 7 and 9 (♀ capitulum, scutum, coxae); not reproduced.

Male: unknown.

Female: Body oval, narrower anteriorly, brownish, *L.* 2, *W.* 1·3 mm. [? unfed]. *Scutum* as long as broad (1 mm.), subcircular; cervical grooves superficial throughout almost their whole length, deep at their anterior origin; whence the lateral grooves start, these latter deep, limited externally by a prominent ridge, which extends almost to the posterior border; numerous punctations, uniform, medium. *Dorsum* shows a deep complete marginal groove and numerous hairs. *Venter* with similar hairs; vulva narrow, between coxae III; genital grooves diverging, anal grooves ogival anteriorly; with sides almost parallel; spiracles brownish, circular. *Capitulum* medium (600 μ), with mitre-shaped base, with prominent cornua; porose areas large, deep, oval, scarcely longer than wide, close together. Hypostome narrow, lanceolate, dentition 2 | 2. Palps with second article almost twice as long as the third. *Legs* stout and strong. Coxa I with internal spur, long, stout, covering a part of coxa II; a short spur at the postero-external angle of all the coxae; tarsi short, broad, without dorsal protuberance, but tapering abruptly.

Description (from Neumann) from a specimen found with a ♀ *I. ricinus* (L.), from the Santa Cruz Mountains, California (G. Marx coll., Smithsonian Inst., Washington, D.C.). Banks, 1908, p. 31, states that he has seen ♀ specimens, differing but slightly from the type, found on the *rock squirrel* at Del Rio, Texas (Bishopp).

10. IXODES SPINICOXALIS Neumann, 1899.

Figs. 165 (original) and 166 (Nn.).

Lit. and Icon.: Neumann, 1899, pp. 123, 124, Fig. 6 (reproduced).

Male: unknown.

Female (Fig. 165): Body oval, capitulum, scutum and legs maroon-brown. *Scutum* oval, with rounded borders, 1·7 × 1·5 mm., glossy, dark on the sides, lighter in the median field; cervical grooves superficial, almost attaining the posterior border; punctations deep, subequal, distant, more crowded on the borders, where some whitish hairs may occur. *Dorsum*: grooves but slightly pronounced; whitish scattered hairs, mostly on the sides. *Venter*: many hairs; vulva on a line with the posterior border of coxae IV. Sexual grooves uniting in front of the vulva, straight and divergent. Anus not far from the posterior border; anal grooves almost parallel. Spiracles large, circular, whitish, equidistant from the vulva and anus. *Capitulum* long (1 mm.), with dark brown base, the appendages brown-red. Base about as broad as long, subtriangular; porose areas large; auricula forming a flattened retrograde tuberosity. (Digit[1].) Hypostome (Fig. 166) narrow, lanceolate, long, 4 | 4 then 3 | 3 files of 9–10 teeth, the external very stout, the median less so; the internal narrow, long and blunt. Palps long, broad, flat; article 3 almost as long as 2. *Legs* large, stout, the two last articles of pair 4 extending beyond the posterior border of the body, brown, except the distal extremity of the intermediary articles, which is white; short hairs on all the articles. Coxae large, contiguous; coxa I bears a long spine at the postero-internal angle; a very short spiniform prominence at each of the posterior angles of all the coxae. The movable articles are slightly larger distally. Tarsus 1 long, almost as long as articles 4 and 5 combined, tapering abruptly at the distal pseudo-articulation; tarsus 4 shorter, tapering abruptly; pad two-thirds the length of the claws.

Description based on 4 ♀s found on *Mustela flavigula* in Sumatra by H. O. Forbes (British Museum).

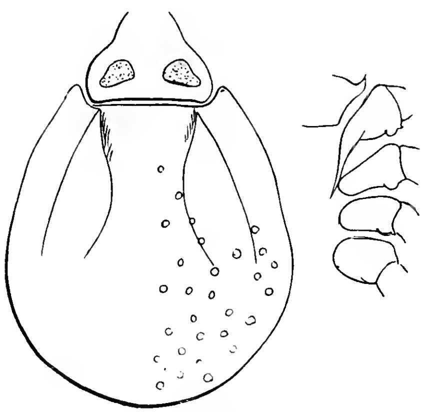


Fig. 165.

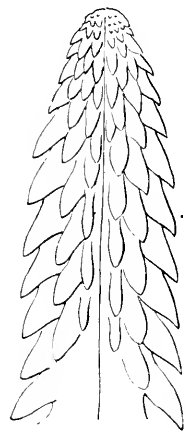


Fig. 166.

Fig. 165. *I. spinicoxalis* ♀: capitulum (mutilated) and scutum, coxae and part of basis capituli. (Sketch from the type in the British Mus. Original, C. W. del.)

Fig. 166. *I. spinicoxalis* ♀: hypostome ×115. (Neumann, 1899, Fig. 6.)

[1] Digit 160 μ long; dorsal process elongate, parallel to digit, crescentic, with two retrograde points; external article large, longer than half the digit, with six or seven teeth, the 3–4 anterior ones small, equal, the three others increasing in size, the basal very stout.

11. IXODES MARXI Banks, 1908.

Fig. 167 (original).

Lit. etc.: Banks, 1908, p. 32, Pl. IX, Fig. 8 (♀ dorsum, G. Marx del.), Pl. III, Fig. 10 (♀ capitulum, scutum and coxae; Banks del.).

Male: unknown.

Female (Fig. 167): *Scutum* (1·2 × 0·9 mm.), longer than broad, broadest rather in front of the middle (but not so anteriorly as in *I. canisuga*); cervical grooves broad and very shallow, only visible for about half the scutal length; no lateral grooves; scapulae rather rugose; scapular angles sharp; emargination moderate; a few fine, shallow punctations on the median area of the scutum. *Venter*: vulva between coxae III; anal grooves very ogival in front, the sides long, straight, slightly diverging, much nearer together than in *I. canisuga*; spiracle very small, circular. *Capitulum*: base subtriangular, concave posteriorly, with slight cornua, porose areas ill-defined, subcircular, far apart, and far from lateral border; slight laterally projecting auriculae, ventral surface of basis capituli flat; palps of medium length, rather narrow, article 2 rather longer than article 3, article 3 somewhat pointed anteriorly; hypostome short, narrow, lanceolate, 2|2, the outer teeth much the stronger, about 6 teeth per file. *Legs* like those of *I. canisuga*, but all the articles shorter; coxa I with slight internal spur, coxae II–IV unarmed; tarsi tapering abruptly, almost humped.

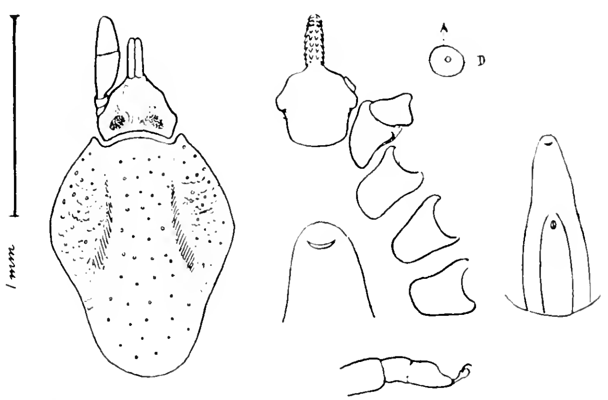


Fig. 167. *I. marxi* ♀: capitulum and scutum, ventral aspect of capitulum with coxae, tarsus 4, spiracle, genital and anal grooves. From specimen kindly loaned by Dr L. O. Howard, Government Entomologist, Washington, D.C., U.S.A. (Original, G. H. F. N. del.)

Described from a ♀[1] found on a squirrel, District of Columbia, U.S.A., kindly loaned by the U.S. Department of Agriculture, being one of the specimens doubtfully attributed by Neumann to *I. hexagonus* var. *inchoatus* (= *I. canisuga*). It is somewhat allied to *I. canisuga*, but can easily be distinguished from it by the different shape of the basis capituli, the more posterior position of the lateral angles of the scutum, the very small spiracles, and other minor characteristics.

This species occurs in Canada and the United States, having been found, according to Banks, on the *red squirrel* in Guelph, Ontario, Canada; Salineville and Waseon, Ohio; Portland, Michigan; Ithaca, New York; District of Columbia; and on the *fox* in Denver, Colorado.

12. IXODES PRATTI Banks, 1908.

Fig. 168 (original).

Lit. and Icon.: Banks, N., 1908, pp. 27, 28, Pl. IV, Figs. 1, 3–5.

Male: (according to Banks, 1908, p. 28) "*L.* 2 mm. Body very slender, more than twice as long as broad, dark brown, and very hairy; a deeply impressed lateral and posterior groove; surface densely punctate. Capitulum not broader behind than long in middle, sides parallel, posterior angles not prolonged; palpi short, but longer than width of capitulum, the third joint a little longer than broad, legs rather short, coxae I with a very long, slender spine behind, II with

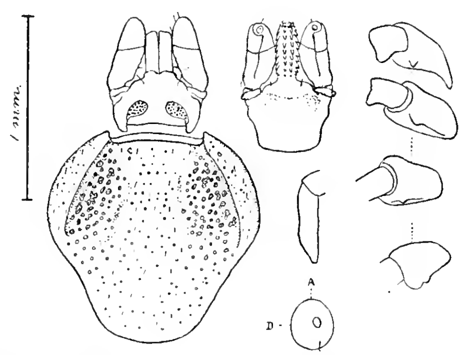


Fig. 168. *I. pratti* ♀: capitulum and scutum; capitulum in ventral aspect, tarsus 4 (claws missing in specimen), spiracle, coxae. Specimen from Death Valley, California, determined by N. Banks. Received from U.S. Dept. of Agricult. (N. 716. Original, G. H. F. N. del.)

[1] The tube containing the specimen also contained three labels bearing the inscriptions: (1) No. 47_{-3}, *Ixodes americanus* Marx, Squirrel, D.C. (Marx. coll.); (2) *Ixodes hexagonus* var. *inchoata* Neumann (Nn. det.); (3) *Ixodes marxi* Banks.

two humps behind, and III with one hump; venter punctate; stigmal plate twice as long as broad, finely granulate."

Female (Fig. 168): *Scutum* 1·2 × 1·1 mm., but slightly longer than broad, somewhat narrowly rounded behind, cervical grooves shallow, extending rather more than half the length of the scutum, lateral grooves bounded externally by a prominent dark ridge with a few fine punctations; the area beween this ridge and the cervical groove is strongly pitted with rather large, more or less confluent punctations; fine, discrete punctations over the rest of the scutum. *Capitulum*: base broader than long, with slightly convex sides and fairly strong cornua slightly curving inwards; porose areas piriform, the broader end internal, interval moderate, no auriculae[1]. Palps rather short and broad, article 1 strongly prominent ventrally. Hypostome strong, well covered with 2|2 files of strong teeth, with no median unarmed area. *Venter*: vulva facing the second intercoxal space; anal grooves rounded in front, diverging behind; spiracle rather small, nearly circular. *Legs*: coxa I with rather strong internal spur and a slight external spur; a faint indication of an external spur on coxae II–IV. Tarsus 4 tapering abruptly.

We have not seen the ♂ of this species, and therefore quote the description given by Banks. The description of the ♀ is from a specimen (N. 716) presented to us by the U.S. Department of Agriculture, Washington, D.C., and taken in Death Valley, California (? host). Banks records it from Kerrville, Texas; Sherwood, Texas (on a prairie dog); and from *Thomomys* (a rodent) in Death Valley, California.

13. IXODES RUBIDUS Neumann, 1901.

Figs. 169 and 170 (original).

Lit.: Neumann, 1901, p. 282 (no figure).

Male: unknown.

Female (Fig. 169; unfed): *Scutum* 1·4 × 1·3 mm., ovate, broadest at anterior third, glossy, hairless, convex, with lateral borders folded down, closely punctate and irregularly pitted; the punctations larger and more confluent in front, discrete and uniform behind. Cervical grooves long, reaching the posterior border, gradually diverging; no lateral grooves. Scapulae prominent. Dorsum with deep marginal grooves, ending where the genital grooves turn over the posterior border of the body; well-marked furrows in continuation of cervical grooves.

[1] The presence of large auriculae is indicated in Banks' figure, which is very inaccurate. We have not included the ♂ in our key, Banks' description being insufficient.

Venter: vulva between coxae III; genital grooves parallel at first, curving outwards behind coxae IV, then nearly parallel but slightly divergent to posterior border. Anal grooves ogival in front of anus. Spiracle large, nearly circular, with eccentric macula. *Capitulum*: (0·8 mm. *l.*), base pentagonal, about as broad as long; cornua indistinct, posterior border concave; porose areas medium, slightly broader than long, near posterior border, interval almost equal to their length. Palps medium, article 2 half as long again as article 3, their convex inner border somewhat beaded. Hypostome 2|2, about 6 teeth per file. *Legs* long, coxa I with long slender internal spine and short external spur; a small external spur on coxae II–IV. Tarsi strongly humped.

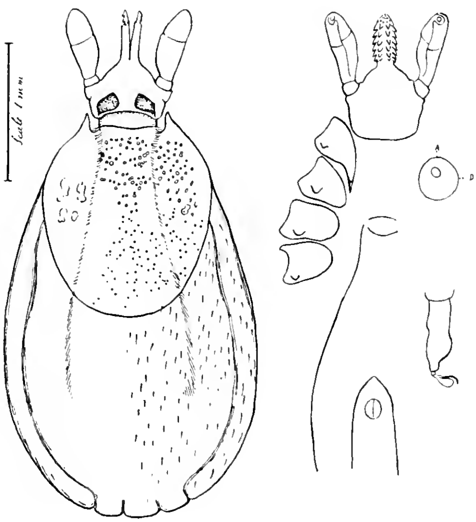


Fig. 169.

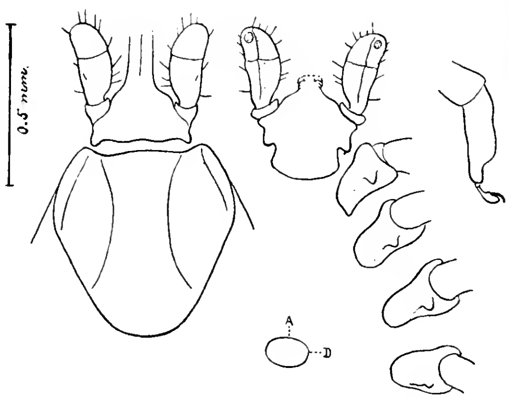


Fig. 170.

Fig. 169. *I. rubidus* ♀ (type, unfed): dorsum, part of venter, spiracle and tarsus 4. (Neumann, coll. 713. Original, G. H. F. N. del.)

Fig. 170. *I. rubidus* ○ (type, partly fed): capitulum and scutum; capitulum in ventral aspect with coxae, spiracle and tarsus 4. Same origin as ♀ previously figured. (Original, G. H. F. N. del.)

Nymph (Fig. 170): found in company with this ♀, agrees with it fairly well except that the scutum (0·6 × 0·5 mm.) differs in shape; the internal spur on coxa I is nearly absent and the basis capituli bears auriculae.

Our description is based upon the examination of one ♀ and of one of three ○ s collected by A. Dugès off *Bassaris astuta* at Guanajuato, Mexico (Types, No. 713 in Neumann coll.).

14. IXODES HEXAGONUS Leach, 1815.

Figs. 171–177 (original).

Synonymy: 1. *Ixodes hexagonus* Leach, 1815, XI, p. 397, on hedgehog.
2. *Ixodes autumnalis* Leach, 1815, XI, p. 398, on pointer dog[1].
3. *Ixodes erinacei* Audouin, 1832, XXV, p. 415 (♀)[1,2].
4. *Ixodes reduvius* Audouin, 1832, XXV, p. 422; *nec* Linné (♂)[1].
5. *Ixodes crenulatus* Koch, 1835–44, Heft 39[1].
6. *Ixodes vulpis* Pagenstecher, 1861, II, p. 40[1,2].
7. *Ixodes erinaceus* Murray, 1877, p. 190[1].
8. *Ixodes ricinus* Mégnin, 1880, p. 129[1].
9. *Ixodes sexpunctatus* Koch, 1847, p. 22 (nymphs found in Germany), types examined by Neumann, 1901, p. 283.
10. *Ixodes crenulatus* Koch, in Berlese, 1889, fasc. 55, Pl. IV, ♀ dorsum and venter.
11. *Euixodes hexagonus* (Leach) in Bonnet, 1908, p. 255. (*I. canisuga* Johnston, 1849; *I. cookei* Packard, 1869; *I. cruciarius* Fitch, 1872, are listed by Blanchard, 1909, p. 86, as synonyms; see our List of condemned species. We recognize *canisuga*.)

Iconography: Audouin, 1832, XXV, Pl. XIV, Figs. 2, 4.—Koch, 1835–44, Heft XXXIX, Figs. 5, 6 (♀ *I. sexpunctatus*); Figs. 8, 9 (♂ ♀ *I. crenulatus*).—Pagenstecher, 1861, II, Pl. I, Figs. 12, 13.—Berlese, 1889, fasc. 55, No. 4 (*I. crenulatus v.* Synon.); 1892, fasc. 61, No. 10; ♀ dorsum, venter, capitulum and scutum, spiracle and tarsus 4.—Canestrini, 1890, IV, Pl. XLIII, Fig. 2: ♀ tarsus 4 and foot 4, poor.—Railliet, 1895, Fig. 484: ♀ (gorged), dorsum and venter; Fig. 478, capitulum (after Delafond) poor (reproduced by Ward, 1900, Fig. 256). —Neumann, 1893, in Railliet, 2nd edit., fasc. 1, Fig. 485 (tarsus 4), same figure reproduced by Ward, 1900, Fig. 257, and Salmon and Stiles, 1901, Fig. 229.—Neumann, 1899, Fig. 10 (♂ venter) not reproduced, but replaced by our original figure.—Salmon and Stiles, 1901, Fig. 229, reproduce figures by Neumann, 1893 (*v. supra*) and 1899; also by Berlese (*v. supra*).—Wheler, 1899, various stages figured, reproductions of photographs of balsam-mounted specimens and details thereof; much retouched, and of little value (♀, o and larva).—Mohler, 1905, Pl. II, Figs. 4, 4*a*, 4*b* (sketchy, coloured).—Wheler, 1906, Pl. VIII, Fig. 22, ♂, rough sketch after Neumann, 1899, Fig. 10; Pl. VIII, Fig. 20: ♀ dorsum, good photograph of opaque object (reproduced).—Banks, 1908, Pl. III, Figs. 11, 13 (♀ coxae, capitulum and scutum), very inaccurate.—Bonnet, 1908, Figs. 14, 17–20 original, but bad.—Blanchard, 1909, Figs. 91–93 (from Neumann and Bonnet).

Literature: Some of the authors cited below doubtless refer to *I. canisuga*, but their descriptions are too vague to be certain. In most cases *I. hexagonus* is undoubtedly described, and this is rendered certain by reference to the Icono-

[1] Also included in Synonymy by Neumann, 1899, p. 129.
[2] Also included in Synonymy by Canestrini, 1890, p. 500.

graphy above given. The small numbers in brackets (2–11) accompanying the following citations refer to the names under which the authors described the species in the order given in the Synonymy; where no number is given the name *I. hexagonus* was used.

1815. Leach, p. 397; p. 398 (2).—**1832.** Audouin, p. 415 (3); p. 422 (4).—**1835-44.** Koch, Heft 39. (5, 9).—**1844.** Koch, p. 234; p. 233 (5, 9); Walckenaer and Gervais, p. 240; p. 241 (2); p. 242 (3).—**1847.** Koch, p. 23; p. 22 (5, 9).—**1859.** Gervais and van Beneden, p. 461 (2).—**1861.** Pagenstecher, p. 40 (6).—**1877.** Canestrini and Fanzago, p. 184 (5); Conil, p. 28 (6); Murray, p. 190 (3).—**1880.** Mégnin, p. 129 (8).—**1882.** Haller, p. 310 (3).—**1889.** Berlese, fasc. 55; Wheler.—**1890.** Canestrini, p. 481; p. 500 (9).—**1891.** Batelli, p. 78; p. 81 (physiology of digestion) p. 98 (3).—**1892.** Berlese, fasc. LXI. n. 10, description.—**1893.** Railliet, p. 709.—**1899.** Neumann, (*a*) p. 129; (*b*) p. 464.—**1900.** Ward, (*a*) p. 204; (*b*) p. 436 (but a few lines); Dubreuilh (occurrence on man).—**1901.** Salmon and Stiles, p. 467.—**1904.** Neveu-Lemaire, p. 152.—**1905.** Mohler, p. 15 (brief inaccurate description).—**1906.** Wheler, p. 412.—**1907.** Hunter and Hooker, p. 55.—**1908.** Banks, p. 31; Bonnet, 255 (11); Levendain (cited by Blanchard).—**1909.** Blanchard, p. 86.

Male[1] (Fig. 171): *L.* 3·5 to 4 mm. (capitulum incl.), *W.* 2 to 2·5 mm. (Nn.). Body oval, nearly as broad in front as behind. *Scutum* long oval, marginal fold moderate. Faint, strongly divergent cervical grooves. No lateral grooves. Three longitudinal posterior furrows (or, at least, areas devoid of punctations). A pseudo-scutum faintly indicated. Very numerous punctations. *Venter* finely punctate. Pregenital plate

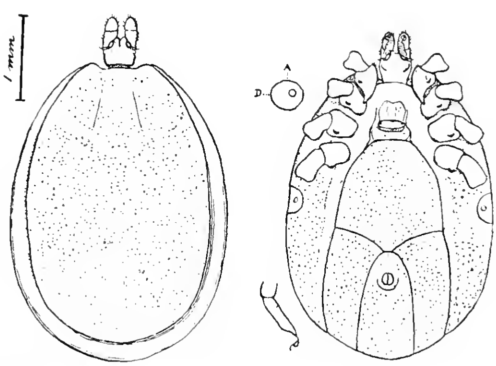


Fig. 171. *I. hexagonus* ♂: dorsum, venter, spiracle and tarsus 4. Specimen collected in France by E. Simon, 1896. (Neumann coll. 719. Original, G. H. F. N. del.)

[1] The male is extremely rare: although we possess hundreds of females we have only recently come into the possession of a male through the courtesy of Professor Neumann. The specimen is from the same lot as that shown in Fig. 171, and was taken in the Forêt de la Londe, Seine Inférieure. We have recently (7. III. 1911) captured one male in a hedgehog's nest near Cambridge. There are no males in the collections of the Museums in London, Paris and Berlin.

almost a regular hexagon, preceded by two small plaques behind coxae I; *median plate very broad*; anal plate ogival; adanal plates with nearly parallel sides, but rather broader in front. Spiracle rather large, rounded. *Capitulum* comparatively very small. Base pentagonal, narrowing posteriorly, slightly broader than long. Palps medium, articles 2 and 3 nearly equal in length. Hypostome of the same type as that of *canisuga* (Fig. 204), but not emarginate, it is bluntly rounded in front and the crenulations are more distinct and nearly meet in the middle line. *Legs*: coxa I with a strong, sharp spine on its internal border, and a very slight external spur; coxae II–IV with slight external and internal spur. Tarsi humped; pad small.

Female (Figs. 172–175): when gorged may attain 8 × 5 mm. *Scutum* (1·2 × 1·4, or 1·5 × 1·4 mm.) a regular hexagon, except that the posterior border is convex, broadest in the middle, scapulae sharp and prominent; cervical grooves faint, wavy, reaching posterior border; lateral grooves indicated by a slight ridge on the antero-lateral borders; numerous moderate punctations, often confluent in the anterior region; smaller and discrete in the posterior region; often a fairly distinct subcircular depression on either side of the middle of the scutum. Dorsum: punctations scarcely visible; numerous short, white hairs. *Venter*: vulva between coxae III; genital grooves nearly straight, slightly diverging; anal grooves ogival, with sides parallel. Spiracle large, subcircular. *Capitulum* of medium length; base rectangular, nearly twice as broad as long; porose areas pear-shaped, transverse, the broader end internal, or sometimes oval, interval equal to or less than their smaller diameter; postero-lateral angles slightly salient (in some

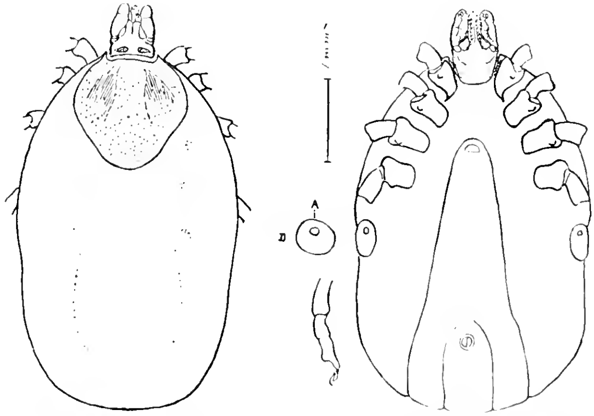


Fig. 172. *I. hexagonus* ♀: dorsum, venter, spiracle and tarsus 4. Specimen off *Mustella vulgaris*, Tring; F. J. Cox coll., 1908. (N. 668. Original, G. H. F. N. del.)

specimens amounting to slight cornua). Palps medium, article 2 slightly longer than 3; article 1 prominent ventrally. Hypostome large, with strong, equal teeth, 3|3 to 2|2. *Legs* as in the ♂, except that the internal spur on coxa I is shorter and directed somewhat more outwardly.

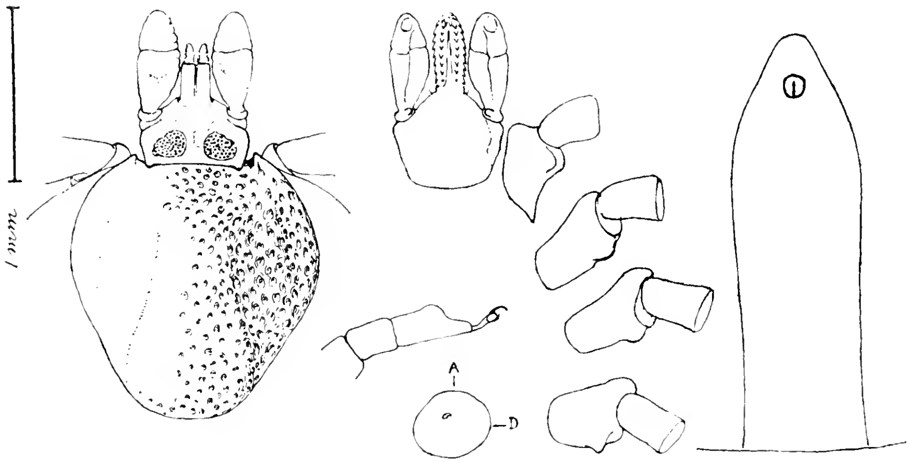


Fig. 173. *I. hexagonus* ♀ : capitulum and scutum, ventral aspect of capitulum with coxae, tarsus 4, spiracle and anal groove. Specimen from *Myopotamus coypu*, S. America. (N. 826. Original, F. M. H. del.)

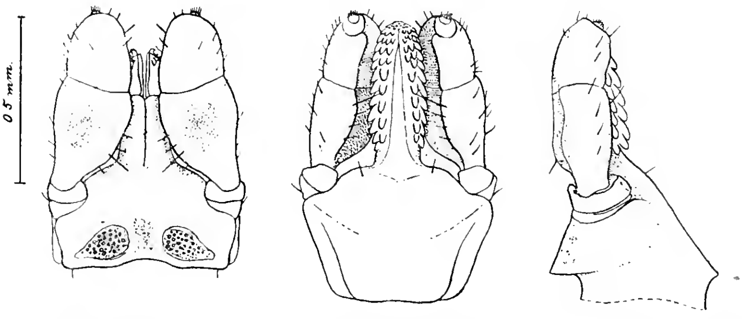


Fig. 174. *I. hexagonus* ♀ : capitulum in dorsal, ventral and lateral aspects. (Original, G. H. F. N. del.)

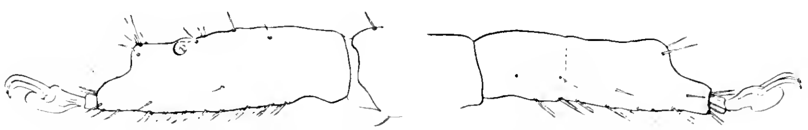


Fig. 175. *I. hexagonus* ♀ : tarsi 1 and 4, highly magnified, from mounted specimen. (British origin. Original, G. H. F. N. del.)

Nymph (Fig. 176): bears a close resemblance to the ♀, but the inner spur on coxa I is less marked, and the hypostome bears 2|2 files of 7–8 teeth.

Larva (Fig. 177): resembles the ⚲, but the coxae are unarmed, coxae I and II show a slight tuberosity at the postero-internal angle; tarsus 4 is less humped. Hypostome 2|2, with fewer teeth per file.

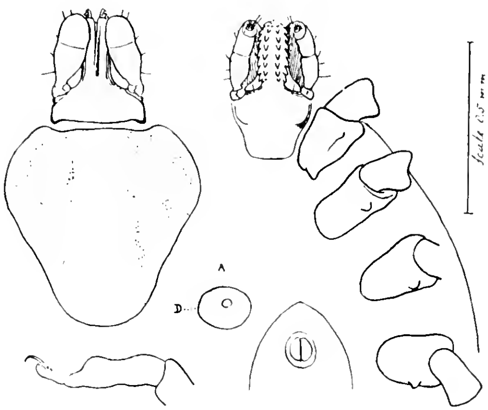


Fig. 176. *I. hexagonus* ⚲: capitulum and scutum, coxae and capitulum (ventral aspect), tarsus 4, spiracle and anal groove. Specimen found with the ♀ figured above. (Original, G. H. F. N. del.)

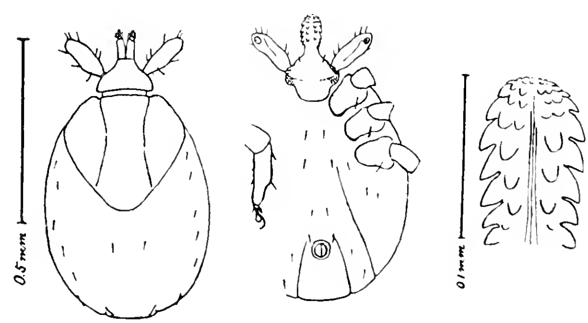


Fig. 177. *I. hexagonus* larva: dorsum, venter, tarsus 3; hypostome highly magnified. Drawn from specimen (N. 82) raised in the laboratory, Cambridge, from ♀ taken in Northumberland, 1904. (Original, G. H. F. N. del.)

Geographical Distribution.

Owing to the possible confusion, especially of immature stages, with other closely allied species, it appears inadvisable to cite the hosts and localities given by most authors. According to Neumann, 1899, p. 131, this tick is widely distributed in Europe, and occurs on many species of animals (mammals and birds).

Our collection contains ♀s, ○s and larvae from the following places and hosts [observations by other authors are added in square brackets]:

EUROPE: **Scotland**: Mr W. Evans' collection in Edinburgh contains ○s from the *polecat*, Ross-shire, XII. 1907, which we determined. [Mr Evans (I. 1907, p. 35) has already reported finding this tick (♀) on this host in January, whilst larvae were found on *Erinaceus europaeus*, both in Ross-shire (Neumann det.).] **England**: (N. 404) ♀s, ○s, from *Mustela putorius*, Holme, Peterborough, III. 1908 (W. Farren). (N. 60, 446, 599, 918, 1193) from *Erinaceus europaeus*: ♀s, Cambridge, IV. 1897 (N. C. Rothschild); ○s, Cambridge, VII. 1904 (G. H. F. Nuttall); ♀s, ○s, Madingley, near Cambridge, VII. 1908 (W. A. Harding); ♀, Grantchester, near Cambridge, VIII. 1906 (N. D. F. Pearce); ○s, Longnor Hall, Leebotwood, Salop, IX. 1910 (R. F. L. Burton). (N. 1160) Larvae from young *Canis vulpes*, Boxworth, Cambs., III. 1900 (N. C. Rothschild). (N. 262) ♀, from *Canis familiaris*, Cambridge, V. 1907 (G. S. Haynes). (N. 399) ♀s, ○s, from *Mustela erminea*, Histon, Cambs., V. 1908 (G. H. F. Nuttall). (N. 1067) ♀, from *Canis vulpes*, Boxworth, Hants., I. 1898 (N. C. Rothschild). (N. 600) from *Mustela putorius*, Boxworth, IV. 1900 (N. C. Rothschild). In W. F. Cooper's coll., ♀, from *ferret*, Canterbury, Kent, IV. 1908 (Spanton). From *Mustela erminea* in the following places: (N. 611) ○s and larvae, Lyndhurst, Hampshire, III. 1901 (G. Tate); (N. 603) Wigginton, Herts., V. 1903 (Barrett); (N. 607, 1159) ○s, Tring, Herts., IV. and IX. 1902; (N. 602, 610), ♀s, ○s and larvae, Tring, Herts., V. 1902, and V. 1903; all received from Hon. N. C. Rothschild. (N. 7) ♀, gorged, removed from a *woman*, Caxton, Cambs., VI. 1905 (Dr Giles, presented by Dr Wherry); (N. 604) *Mustela vulgaris*, Tring, Herts., III. 1902 (N. C. Rothschild); (N. 668) ♀s, ○s, from the same host and place, 1908 (F. J. Cox); (N. 128) from Shrewsbury, IX. 1906 (R. F. L. Burton); (N. 1194) ♀, ○s, Claverdon Leys, Warwick, IX. 1910 (E. G. Wheler); (N. 456, 598, 601) ♀s, from *Lutra vulgaris*; no particulars (N. C. Rothschild and W. A. Harding). **Wales**: specimens presented by the Hon. N. C. Rothschild from *Mustela putorius*, Aberystwyth: (N. 746) larvae, VIII. 1900; (N. 606) ♀s, os, larvae, XI. 1902; (N. 609) os, XII. 1902. **Ireland**: (N. 612) ♀s, os, from *Mustela erminea*, Inismore, III. 1902 (N. C. Rothschild). **Belgium**: (N. 597) from *Erinaceus europaeus* (E. A. Boulenger). **Germany**: (N. 1168) ♀s, os, from *ferrets*, Kittendorf, Mecklenburg-Schwerin, VI. 1910 (G. v. Oertzen's gamekeeper); (N. 608) from *Erinaceus europaeus*, Dernburg, IX. 1898 (N. C. Rothschild); (N. 1186 b) ♀, from *dog*, Godesberg, VII. 1910 (Baron v. Rigal's gamekeeper). **France**: We have examined 2 ♂s and a ♀ kindly sent to us by Prof. Neumann; the specimens were collected by Simon, in the Forêt de la Londe, Seine Inférieure. We possess a ♂ of this lot. [**Italy**: Canestrini, 1890, p. 500, states that it occurs by preference on *dogs*; he has examined ♀s from *dog*, *fox* and *hedgehog* in Trentino, Veneto, Liguria and Toscana. Canestrini, p. 502, records "*crenulatus*" from Borgotaro and Trentino, occurring on *Meles taxus*.]

AFRICA: In W. F. Cooper's coll., ♀, from *wild boar*, Algeria, 1908 (S. Williamson).

AMERICA: (N. 284) ♀, from *Sciurus* sp., La Honda, California, II. 1895 (ex V. L. Kellogg coll.). [Banks, 1908, p. 31, records this species (♀s) from *sheep*, Kansas (Neumann det.); from *rabbit*, Baltimore, Md. (Neumann det., ex Hassall coll.). He does not refer to his earlier statement (1904, p. 331) that it occurs in California (Santa Clara County, Palo Alto and Mt Shasta).] We have 2 ♀s from S. America found on *Myopotamus coypu* (ex Rothschild coll., no particulars).

Ixodes hexagonus var. cookei (Packard, 1869).

Syn.: *Ixodes cookei* Packard, 1869 a, p. 67.

Ixodes hexagonus var. *longispinosus* Neumann, 1901, p. 283.

Ixodes cookei Packard, in Banks, 1908, pp. 28, 29, Pl. IX, Figs. 1–5. (Larva, dorsum; palp of o (surely wrong!); ♀ capitulum, tarsus I.) Banks, 1908, p. 53, moreover, includes the following in his synonymy of *I. cookei*.

Ixodes cruciarius Fitch, 1871, p. 366. Banks, 1904, gives a poor figure (No. 81) of capitulum, scutum and spiracle.

Ixodes hexagonus in Salmon and Stiles, 1902, p. 467 (not *I. hexagonus* Leach, *fide* Banks).

Female: Coxa I provided with a long spine, which partially overlaps coxa II. The short spines of coxae II–IV a little shorter than in the type.

Evidently the N. American form of *I. hexagonus*.

Neumann examined 43 ♂s and 127 ♀s from various mammals in different parts of N. America, and could find no other constant characters distinguishing them from the type. Banks considers that the porose areas of the ♀ are shorter and less triangular than in the type, but in the specimen we have seen this is not noticeable.

Neumann (1899, p. 130) re-described *I. hexagonus*, giving it a long spine on coxa I. Later (1901, p. 283), he divides *hexagonus* into three varieties: the type, *longispinosus* and *inchoatus*. Banks (1908, p. 32), points out that *inchoatus* had already been named *canisuga* by Johnston in 1849. We agree with this opinion, but consider the form sufficiently different from *hexagonus* to deserve specific rank. There remains the question of *hexagonus* var. *longispinosus*. Banks (1908, p. 29) has compared Packard's type of *I. cookei* with Neumann's types of *I. hexagonus* var. *longispinosus*, and finds them identical. Dr L. O. Howard has very kindly sent us two alleged ♀s of *I. cookei* from the collection of Marx, identified by Banks. Unfortunately, the two specimens are quite clearly of different species, but one of them is no doubt the form intended. It agrees very closely with the typical European *hexagonus*, except for the stronger spine of coxa I, and is certainly no more than a variety of *hexagonus*. Banks is, we believe, correct in recognizing its identity with Neumann's var. *longispinosus*, but as Packard's *I. cookei* has priority, it becomes *I. hexagonus* var. *cookei*.

We therefore have:

Ixodes hexagonus Leach.
„ „ var. *cookei* Packard (Syn. var. *longispinosus* Neumann).
„ *canisuga* Johnston (Syn. *hexagonus* var. *inchoatus* Nn.).

N.B. We are convinced that the *I. hexagonus* in many collections of ticks will prove, on further examination, to be *I. canisuga*.

Neumann, 1901, p. 283, states that "var. *longispinosus*" was established by him on the basis of 42 ♂s and 113 ♀s, found on *Lutra, Mustela vison, sheep*, Texas; *Spermophilus*; *Felis domestica*, Maine; *fox*, Colorado; *weasel, porcupine* and *marmot* (Smithsonian Institution and Bur. Animal Industry, Washington, D.C.).

Banks, 1908, p. 31, states that specimens from the *pocket gopher*, Iowa, and *Spermophilus*, District of Columbia (Hassall coll.), labelled *I. hexagonus* by Neumann, are referable to *cookei*.

We have a ♀ in our collection (N. 717) from Iowa, U.S.A. (ex Marx coll., presented by the U.S. Department of Agriculture), and have determined a ♀ from a *dog*, Calabogie, Ontario, for Dr C. G. Hewitt, Government Entomologist, Ottawa (R. M. Reid coll., v. 1908).

15. IXODES NITENS Neumann, 1904.

Fig. 178 (original).

Lit.: Neumann, 1904, pp. 459, 460 (no figure).

Male: unknown.

Female: Body short oval, narrower in front, broader towards the posterior third, brownish, *L.* 2·5 to 3·5 mm., *W.* 1·5 to 1·9 mm. (partly fed). *Scutum* oval-lozenge-shaped, with antero-lateral borders almost straight, slightly emarginate, longer than wide (1 × 0·8 mm.), scapulae pointed; glossy; cervical grooves obsolete, lateral grooves faintly indicated; some very sparse and very fine punctations in the anterior angles. Dorsum bearing a very few short scattered hairs; marginal groove shallow. *Venter* almost smooth; vulva facing coxae IV; genital grooves straight and diverging; anal grooves rounded in front of the anus, scarcely diverging. Spiracles small, oval, whitish. *Capitulum* narrow, 750 μ long; base triangular, posterior border concave, twice as long as broad dorsally; auricula forming a flattened retrograde horn pointing outward at 45°. Porose areas oval, separated, broader than long. Hypostome long, narrow, sharp, with numerous anterior denticles, then 3|3 followed by 2|2 rows of teeth. Palps long, narrow, cultriform, the second article almost double the third. *Legs*: coxa I with two spurs, the internal longer, scarcely reaching to coxa II; a very short spur externally on coxae II–IV. Tarsi long, slender, tapering gradually; pad almost as long as claws.

Fig. 178. *I. nitens* ♀: capitulum (mutilated) and scutum, capitulum in ventral aspect, part of venter, spiracle, tarsus 4, anal groove. The figures to the left sketched, those to the right drawn to scale. (Original, from the type, G. H. F. N. del.)

Nymph: Similar to the ♀, but genital pore and porose areas absent.

Our description differs somewhat from Neumann's.

This species is based on two ♀s and one o found on *Mus macleari* at Christmas Island, Pacific Ocean (N. C. Rothschild coll.). Our figure is drawn from a type in our possession (N. 360).

16. IXODES BICORNIS Neumann, 1906.

Fig. 179.

Lit. and Icon. : Neumann, 1906, pp. 196, 197, Fig. 1 (reproduced).

Male: unknown.

Female: Body oval, red-maroon, 4 × 2·1 mm. (partly fed), broadest toward the posterior third. *Scutum* oval, 1·7 × 1·5 mm., dark brown, glossy, almost smooth, with extremely fine punctations, excepting about 20 large ones along the posterior border: cervical grooves barely visible; lateral grooves marked by a slightly prominent ridge. Dorsum: very short hairs near the lateral borders; marginal groove deep, limiting a prominent fold. *Venter* bearing long, whitish hairs or else glabrous Vulva between coxae IV. Anal grooves short, convex, divergent. Spiracles whitish, circular. *Capitulum* long (1 mm.); base pentagonal, with sides slightly diverging in front, cornua slight; porose areas circular or slightly elongated transversely, the interval almost equal to their diameter; auricula forming a stout spine which is slightly longer than broad. Hypostome long, narrow, pointed, dentition 4 | 4 followed by 3 | 3. Palps long (0·85 mm.), narrow, cultriform, article 1 salient ventrally, article 2 one and one-half times as long as 3. *Legs* long, maroon-brown, coxa I with two spurs, the internal longer than the article, and partly covering

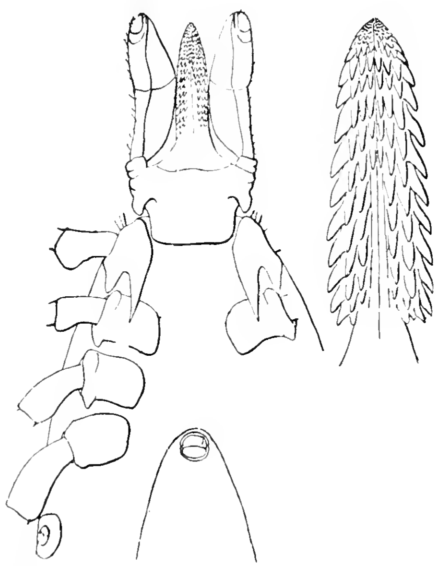


Fig. 179. *I. bicornis* ♀ : part of venter; hypostome. (Neumann, 1906, Fig. 1.)

coxa II; the external spur pointed, slightly longer than broad, almost parallel to the internal; a short spur at the postero-external angle of the other coxae, much reduced on pair IV. Tarsi long, narrow, tapering obliquely.

Description based on 3 ♀s, from Atoyac, State of Guerrero, Mexico: 2 found on *Felis onca L.*, the other on a *child*. This species, which is called "Conchuda" at Atoyac, is considered to inflict "a bite fatal to children" (A. Dugès coll., now in Neumann coll., Toulouse). *I. bicornis* is very closely allied to *I. fuscipes* Koch (*I. spinosus* Neumann). We possess (N. 637) 1 ♀ from *Felis concolor* (ex Rothschild collection; no further particulars as to origin) which we refer to this species. Banks (1908, p. 27) may be right in regarding *I. bicornis* Neumann as synonymous with *I. diversifossus* Neumann, 1899. In the absence of a figure of *I. diversifossus*, we would point out that the descriptions differ as follows:

	I. diversifossus.	*I. bicornis.*
Scutum:	1·3 × 1 mm.	1·7 × 1·5 mm.
Palps:	Article 2 scarcely longer than 3.	Article 2 one and one-half times as long as 3.
Hypostome:	2 | 2 or 3 | 3	4 | 4, followed by 3 | 3.

17. IXODES AURITULUS Neumann, 1904.

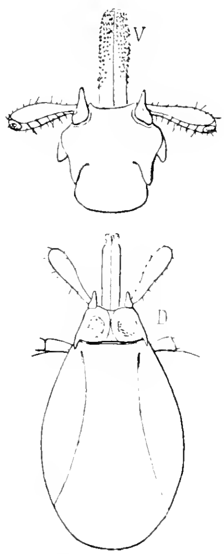
Figs. 180 and 181.

Lit., Icon. and Synon.: *Ixodes thoracicus* Neumann, 1899; not *Ixodes thoracicus* C. L. Koch, 1844, as described in Neumann, 1899, p. 149.
Ixodes thoracicus Neumann, 1899, pp. 149–151, Figs. 22, 24 (reproduced).
Ixodes auritulus Neumann, 1904, p. 450.

Male: unknown.

Female: Body short oval, swollen, 7 × 5·5 mm., dark reddish brown, legs reddish yellow. *Scutum* oval, with lateral borders almost straight along their anterior half, 1·3 × 1 mm., glossy brown in front and on the sides, yellow between the cervical grooves; the latter shallow, almost attaining the posterior border; lateral grooves indicated by a but slightly prominent thickened border; punctations very numerous, very fine, equal; short hairs near the lateral and anterior borders. Dorsum: grooves normal; some short hairs. *Venter*: hairs more numerous.

Vulva facing coxae III. Sexual grooves almost straight, divergent. Anus rather near the posterior border; anal grooves parallel. Spiracles small, rounded, whitish, placed in front of half the body-length. *Capitulum* of medium length (0·7 mm.); base broader than long, trapezoid, the posterior border straight and blackish, the laterals convergent in front; porose areas large, circular; well-marked cornua; auriculae stouter, closer together than cornua. Chelicera (?). Hypostome (Fig. 181) rounded or truncated in front, of uniform width, bearing 6 | 6, then 5 | 5 rows of pointed teeth, the external rows longest. Palps: *article* 1 *large, forming a horn-like protrusion directed forward,* concave externally for the insertion of article 2; article 2 longer than 3, from which it is not clearly separated. *Legs* medium; coxae brownish, glossy, bearing hairs at their posterior border; coxa I small, bifid, the outer spur strong; a short spur on the postero-external angle of coxae II–IV. A short spur at the posterior distal border of the trochanters. Tarsi long, narrow; tarsus 1 scarcely shorter than articles 4 and 5 united, without apparent pseudo-articulation; tarsus 4 slightly shorter and thicker; all tarsi taper gradually distally; pad $\frac{2}{3}$ the length of claws.



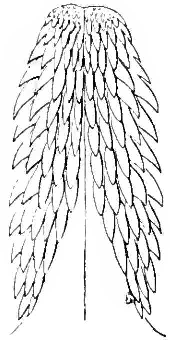


Fig. 180. *I. auritulus* ♀: capitulum and scutum; *V* ventral and *D* dorsal aspects. (Neumann, 1899, Fig. 22.)

Fig. 181. *I. auritulus* ♀: hypostome, ×65. (Neumann, 1899, Fig. 23.)

Description based on 4 ♀s collected at Punta-Arenas, Straits of Magellan, S. America, by Lebrun, from an undetermined bird (Paris Museum).

In the British Museum there are 2 ♀s, from *Trupialis militaris*, San Sebastian Settlement, Tierra del Fuego (Crawshay coll., October, 1906). The better specimen is mutilated, articles 2–4 of the palps being absent. The sides of the scutum are more angular than in Neumann's figure of the type, and correspond more to our figure of *I. brunneus* (Fig. 182).

18. IXODES BRUNNEUS Koch, 1844.

Figs. 182, 183.

Lit. etc.: *Ixodes brunneus* C. L. Koch, 1844, p. 232; 1847, p. 99, Pl. XX, Fig. 74 (♀ from N. America).

Ixodes avisugus Berlese, 1890, fasc. LV, No. 5. Latin description. Figures of dorsum, venter, capitulum and scutum.

Ixodes frontalis (Panzer), in Neumann, 1899, p. 133, Fig. 11 (reproduced).

Ixodes avisugus Berlese, in Canestrini, 1890, p. 505.

not *Ixodes bifurcatus* Neumann, 1899, p. 122, as stated by Neumann, 1901, p. 347, in relation to a ♀ specimen he subsequently named *Dermacentor bifurcatus* (Neumann, 1904, p. 453).

Ixodes brunneus Koch, in Neumann, 1904, p. 454, who gives description, sent to him by Dahl, of the type (1 ♀).

Ixodes kelloggi Nuttall and Warburton, 1907, p. 396, Figs. 6–8 (reproduced).

Ixodes brunneus Koch, in Banks, 1908, p. 26, Pl. III, Fig. 9 (♀ capitulum and scutum; figures inaccurate).

? *Acarus frontalis* Panzer, 1795, fasc. 59, Fig. 23.

? *Ixodes pari* Leach, 1815, p. 399, found on *Parus major*.

? *Ixodes pallipes* Koch, 1835–1844, Heft 39, Fig. 10, found on *Sitta europaea* (Larva).

? *Ixodes sturni* Pagenstecher, 1861, p. 40 (Larva).

Note: The foregoing synonymy is doubtful with regard to the names preceded by (?), but in these cases the ticks were found on birds, and may well have been *brunneus*. In the absence of any accurate figures, it is easy to understand the confusion which has arisen regarding this species. The type, a single ♀ (Berlin Museum), has been mounted in balsam. Professor W. Dönitz, who has kindly compared the structures in the type with specimens we sent him, agrees with us as to the identity of *kelloggi* with *brunneus*. Banks (1908, p. 26), after seeing our figures of *kelloggi*, expressed a similar opinion. We agree with Neumann in degrading *avisugus* to a synonym; our specimens agree with Neumann's specimens of "*I. frontalis* (Panzer)" Neumann, 1899.

The following description is the one which we gave of *kelloggi*, with a few slight additions:

Male: unknown.

Female (fully fed): *L.* 7 to 8, *W.* 5·2 mm. Body brown, with numerous white hairs. *Scutum* (Fig. 182) very long, 1·4 × 1·1 mm., somewhat diamond-shaped, with a few conspicuous white hairs; scapular angles sharp, no lateral grooves; cervical grooves well marked but not deep, slightly converging at first, then diverging to reach the margin nearly half-way along its postero-lateral border; several large shallow punctations, in part confluent, from some of which hairs have fallen. *Venter*: with numerous white hairs; spiracles slightly oval, brown, macula central; vulva between coxa III; anal grooves parallel or slightly divergent, rather short, terminating far from the posterior border. *Capitulum* (Figs. 182, 183) of medium length (0·8 mm.); base triangular, cornua slight; porose areas large, transverse, of indefinite form; palps rather long and narrow, article 2 the longest; blunt auriculae; ventral base broad and rectangular posteriorly; hypostome pointed, 3 | 3, followed by 2 | 2 [1]. *Legs* (Fig. 182 *B*) medium, coxa I with two spurs wide apart, coxae II–IV with short outer spurs and inner edge trenchant; tarsi tapering (as in *I. pilosus* ♂, Fig. 217).

Nymph: resembles the ♀ (Neumann).

Larva: *Scutum* as broad as long (Neumann).

The species occurs on birds in Europe, Africa and North America. The type in the Berlin Museum (1 gorged ♀) was found on *Fringilla albicollis* Gmelin, from North America. The larva described by Koch (1844) as *I. pallipes* was found on *Sitta coesia* by Panzer (1795), and Leach (1815) found the ♀ on *Parus major*. Berlese (1890) states that he frequently encountered this species on *Passerines*, fixed to the head near to the auditory orifices, and in the country about Florence and Venice on *Anthus arboreus*, *A. pratensis*, *Erythacus rubicula*, *Merula nigra*. Canestrini (1890) possessed two specimens found on *Praticola rubetra* and *Emberiza schoeniclus*.

The description of *frontalis* by Neumann (1899) is based on specimens collected in Corsica on *Turdus* (E. Simon coll.); 3 ♀s from *Crex pratensis* from the Lower Loire (Trouessart coll.), from *Saxicola rubicola*

[1] In Neumann's figure (Fig. 183 of *frontalis*, here reproduced) the dentition ranges from 4 | 4 to 3 | 3, 2 | 2. The shape of the hypostome is different from ours, possibly owing to pressure of the coverglass on the specimen. His Fig. *C* (basis capituli and coxae I) is obviously drawn from a balsam mount, and consequently somewhat misleading, as such preparations generally are.

(Paris Mus.), *Turdus aonalaschkae* Pallasi, from Baltimore (Bureau of Animal Industry); 1 ♂ from a *goose* in Paris (Trouessart coll.); 1 larva from *Turdus merula* from Saintes.

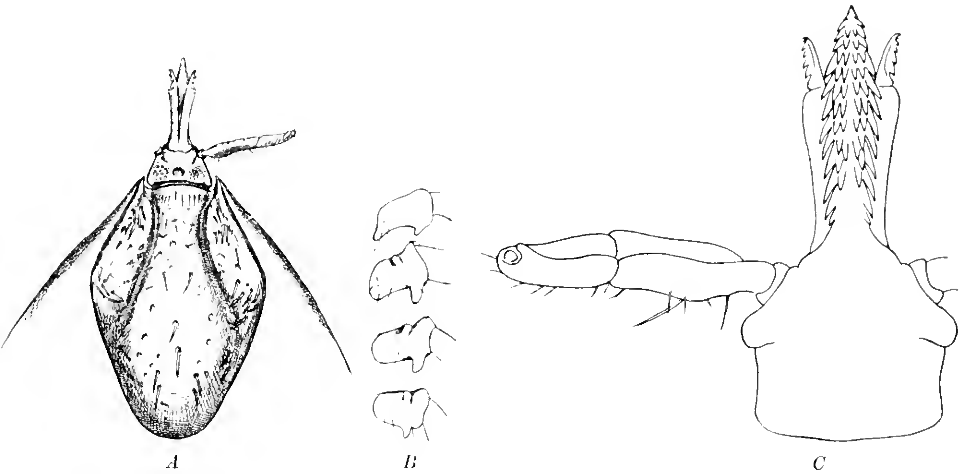


Fig. 182. *I. brunneus* ♀: *A*, capitulum and scutum, ×20; *B*, coxae I–IV; *C*, capitulum in ventral aspect, ×70. (Nuttall and Warburton, 1908, Figs. 6–8 of *I. kelloggi*. G. H. F. N. and E. W. del.)

Fig. 183. *I. brunneus* ♀: *A*, digit, ×220; *B*, hypostome, ×80; *C*, ventral aspect of basis capituli and coxae I, ×40. (Neumann, 1899, Fig. 11, of *I. frontalis* (Panzer). See footnote to p. 190.)

We possess, or have examined, females from *France*: (N. 523) from *Passer montanus*, St Génis de Malgoire (Gard), XI. 1908 (A. Hugues coll.; presented by Hon. N. C. Rothschild); *England*: (N. 224) from *owl*, Cambridge, 1904 (G. S. Graham-Smith); *California*: (N. 279[1]) from *Cyanocitta stelleri frontalis*, XII. 1895 (R. C. Snodgrass); (N. 280[1]) from *thrush*, Palo Alto, XI. 1895; (N. 282) from *Piranga ludoviciana* Sunol, V. 1896; (N. 283) from *Habia melanocephala* Sunol, V. 1896; from "a bird[1]," and from *Carpidacus* sp., Palo Alto, V. 1891 (Snodgrass coll., now in Leland Stanford University coll.). We are indebted to Professor V. L. Kellogg for the specimens from California.

A specimen (♀) has recently reached us from *Africa*, having been found on a dove (*Haplopelia johnstoni* Shelly) at Mlange Mountain, Nyasaland (5500 ft.), V. 1910, by S. A. Neave (No. 150, Ent. Committee; determined by us).

Banks (1908) records 2 ♀s from a *tufted tit*, Raleigh, North Carolina (Brimley coll.); 1 ♀ from a *hermit thrush*, Baltimore, Maryland (Hassall coll.) "this being the specimen named by Neumann *Ixodes frontalis*"; 1 ♀ from a "*chipping bird*," probably at Amherst, Mass.

Note: Neumann (1899) describes a form which he regards as a variety, as follows, the same being a young ♀ specimen found at Toulouse on *Ramphocelus coccineus*, from Santa Fé de Bogotá (Lacomme coll.): Body 5 × 3 mm. (capitulum included), reddish brown. *Scutum* oval, longer (1·6 mm.) than broad, darker reddish brown, glossy, with sides rounded, posterior angle broad; cervical grooves broad, shallow, only attaining one-half the length; lateral grooves indicated by their external prominence; slightly curved, attaining the limits of the posterior angle. Punctations large, very numerous, only absent in front between the cervical grooves. Surfaces finely shagreened, the dorsal glabrous, the ventral bearing a few white hairs. Spiracles whitish, in front of half the body-length. *Capitulum* 1 mm. long. (Digit 145 μ long.) The rest as in the type.

19. IXODES CAVIPALPUS Nutt. and Warb. 1907.

Figs. 184–186.

Lit. and Icon.: Nuttall and Warburton, 1907, p. 396, Figs. 1–5 (reproduced).

[1] Described by us as *I. kelloggi*.

Male (Figs. 184, 185): *L.* 1·9, *W.* 1·2 mm. Body long-oval (Fig. 184). *Scutum* accurately long-oval, broadest in the middle, glossy, hairless; marginal fold very narrow in front and gradually broadening posteriorly; no lateral grooves; cervical grooves[1] and punctations very faint. *Venter* brown with long hairs; sexual orifice between coxae III; pregenital shield longer than broad, narrow in front; anal grooves slightly divergent; anal shields slightly broader in front; spiracles oval, white. *Capitulum* (Fig. 184 *A*, *B*) short (0·5 mm.), like that of *I. ricinus* in general appearance; basis capituli with median posterior point ventrally; hypostome with six well-marked transverse ridges of teeth giving the effect of dentition 3|3; large basal teeth. (Digit; see Fig. 185 *B*.) *Legs* moderately strong; coxa I with a slight spur, coxae II–IV unarmed, but for a very slight tubercle at the external angle of coxa IV; tarsi tapering gradually.

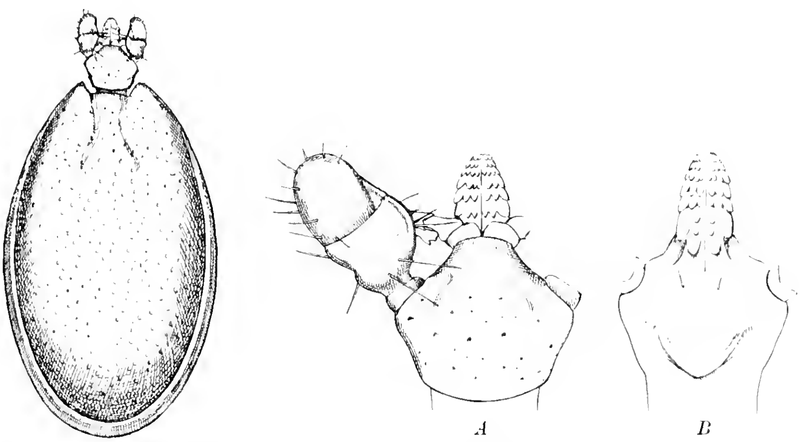


Fig. 184. *I. cavipalpus* ♂: dorsum; *A* and *B*: capitulum in dorsal and ventral aspects. (Nuttall and Warburton, 1908, Figs. 1 and 2.)

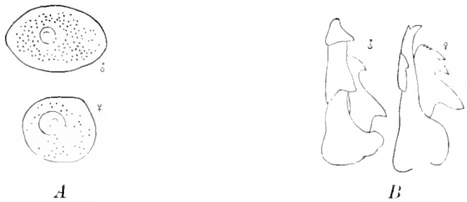


Fig. 185. *I. cavipalpus*: (*A*) ♂ and ♀ spiracles, respectively, measuring 370 μ and 270 μ *l.* orientated so that the tick's capitulum was to the left and the dorsum above; the ♀ spiracle shows a slight angularity postero-dorsally. (*B*) ♂ and ♀ digits, respectively, 138 μ and 140 μ *l.*, viewed from the dorsal surface. (Nuttall and Warburton, 1908, Figs. 4 and 5.)

[1] Accentuated in Fig. 184.

Female (Figs. 185, 186), more or less fed: *L.* 2·9 to 5, *W.* 1·8 to 3·3 mm. Body brown, with a few scattered hairs. *Scutum* (*l.* 1·3 to 1·4, *w.* 1 to 1·2 mm.) dark brown, long oval with slightly sinuous posterior border; cervical grooves shallow, almost reaching the margin; no lateral grooves; numerous fine shallow punctations. *Venter* brown, with scattered hairs, long at the sides; vulva between coxae IV; anal grooves nearly reaching the posterior border and slightly divergent; spiracles round, whitish. *Capitulum* (Fig. 186) fairly long (0·9 mm.), base triangular, with piriform porose areas far apart; palps with article 2 concave externally (whence "cavipalpus") owing to lateral prominence proximally; hypostome long and narrow with a crown of small teeth followed by dentition 2 | 2. (Digit; see Fig. 185 *B*.) *Legs* as in ♂, but coxae I–II close together, III distant from II, and IV more distant from III; coxa I pointed, II–IV with straight posterior borders.

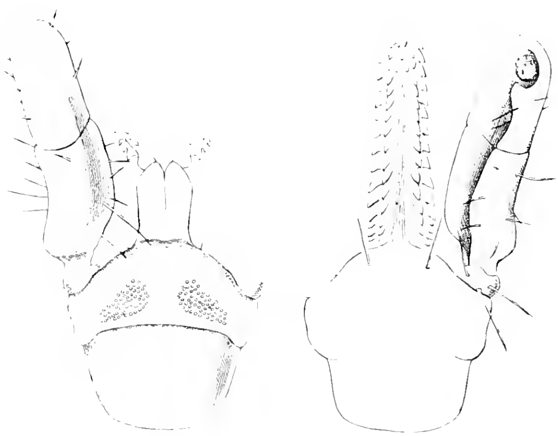


Fig. 186. *I. cavipalpus* ♀: capitulum in (*A*) dorsal and (*B*) ventral aspects. (Nuttall and Warburton, 1908, Fig. 3.)

Description based on (N. 245) 2 ♂s and 7 ♀s from a baboon (*Cynocephalus babuin*), Kansanshi, N.W. Rhodesia, I. 1907 (Dr A. Yale Massey); (N. 353) 1 ♂ from a *native baby*, Benguella Hinterland, Angola, XII. 1907 (Dr F. Creighton Wellman); and (N. 394) ♂s, ♀s from the last-named source, 1908.

This species strongly resembles *I. pilosus* (p. 221), but may be readily distinguished from it by the anal grooves and the absence of a lateral groove on the ♀ scutum.

20. IXODES ANGUSTUS Neumann, 1899.

Figs. 187–190 (original).

Lit. etc.: *Ixodes angustus* Neumann, 1899, p. 136 (no figure).

not *Ixodes angustus* Neumann, 1901, p. 284, Fig. 4 (digit of ♀). In this paper Neumann re-described what he took to be *angustus* from 2 ♀s found on *Didelphys azarai*, Buenos Ayres (C. Berg coll.). Banks (1908, *v. infra*) has pointed out that this second description relates to an entirely different form which Neumann (1910, p. 30) has since recognized as *I. loricatus*. In consequence of this mistake Neumann (1910) suppresses the species *angustus*, but this does not appear to us to be permissible, for the type specimen first described (1899) still exists, and is a perfectly distinct species.

Ixodes angustus Neumann, in Banks, 1904, p. 331; 1908, p. 29, Pl. IV, Fig. 2 (♀ capitulum, scutum, coxae and spiracle; sketchy, but not very inaccurate).

Male[1] (Fig. 187): oval, rather narrower in front, broadest in the middle. *Scutum* (1·4 × ·9 mm.) convex, marginal fold moderate; numerous fine, shallow punctations and short white hairs; a rather well-defined pseudo-scutum; cervical grooves shallow, divergent; lateral grooves indicated by slight marginal ridges on the pseudo-scutum. *Venter*: genital orifice opposite the second intercoxal space; pregenital plate of irregular form, short; median plate sub-trapezoid, longer than broad, narrower in front; anal plate with sides very slightly diverging; adanal plates rhomboidal. Spiracle sub-circular, its ventral border somewhat pointed. *Capitulum*: base trapezoid, broader in

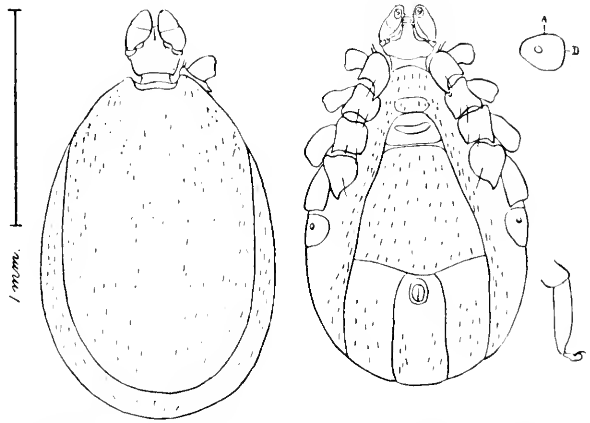


Fig. 187. *I. angustus* ♂: dorsum, venter, spiracle and tarsus 4. From specimen (N. 1065) found on squirrel, Mt Lehman, British Columbia, S. Hadwen coll. (Original, G. H. F. N. del.)

[1] Banks, 1908, p. 30, appears to have seen the male; his description covers five lines and is quite inadequate. The ♂ and larva have not been hitherto figured or described.

front, punctate; palps short, with very convex inner contour and slightly convex outer contour; article 2 broader anteriorly than long, article 3 about equal in length to article 2, article 1 somewhat sharply prominent ventrally; hypostome small, armed only on its anterior third with 3 | 3 rather obscure sub-equal teeth, about 4 per file. *Legs*: coxae all bidentate, the inner spur of coxa I fairly long and strong; small internal and external spurs on coxae II–IV, internal spur on IV almost obsolete. Tarsi moderate, tarsus 4 tapering obliquely; pad long.

Female (Fig. 188): Body elongate, with numerous fine punctations and short white hairs. *Scutum* (1·5 × 1·1 mm. Nn.) much longer than broad, broadest at the anterior third, where there are distinct lateral angles; cervical grooves shallow, long, diverging gradually; lateral grooves indicated by straight ridges reaching the border near the posterior end of the scutum; numerous small punctations, most evident posteriorly; scapular angles very sharp and prominent; a few scattered hairs. *Venter*: vulva between coxae III; anal groove rather ogival in front, with sides nearly parallel; spiracle transversely oval. *Capitulum*: base triangular dorsally, slightly longer than broad, the posterior border straight, cornua absent. Porose areas large, of rather indefinite contour, the interval less than their length. Palps long, article 2 half as long again as article 3, article 3 rather pointed in front. Hypostome long, sharply pointed, 2 | 2 then 3 | 3 sharp teeth. *Legs* as in the ♂, except that the internal spine on coxa I is rather shorter and coxae III and IV are without the internal spurs.

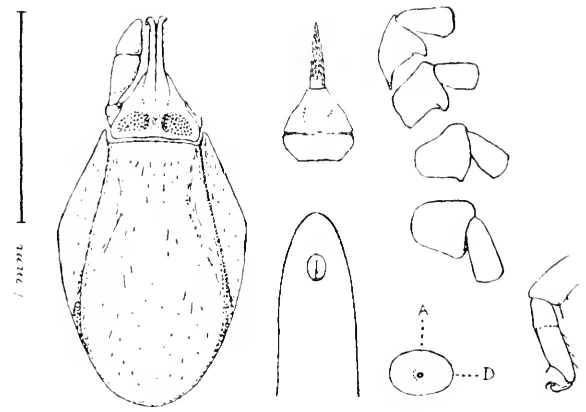


Fig. 188. *I. angustus* ♀: capitulum and scutum, capitulum in ventral aspect, coxae, anal groove, spiracle and tarsus 4. Drawn from specimens N. 506 and 991. (Original, F. M. H. del.)

Nymph[1] (Fig. 189): differs remarkably from the ♀ in several respects. *Scutum* as broad or broader than long, with lateral angles, and with lateral grooves not attaining the posterior border. *Capitulum*: base with pointed cornua, and large, laterally projecting auriculae; palpal article 1 projecting forward and inward in a long pointed process. *Legs*: coxae resembling those of adults; tarsi short, slightly humped distally, where they taper abruptly.

Larva[1] (Fig. 190): resembles the o to some extent. *Scutum* broad, without lateral grooves, the cervical grooves attaining the posterior border; emargination very slight. *Capitulum*: base devoid of cornua and auriculae; palpal article 1 projecting forward as in the o, but also outward and backward ventrally.

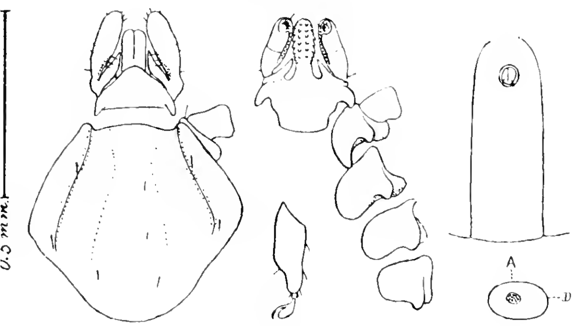


Fig. 189.

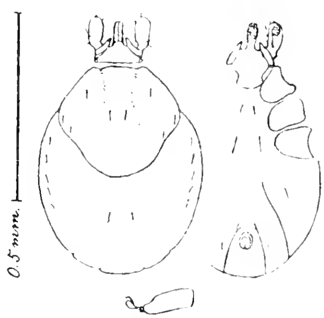


Fig. 190.

Fig. 189. *I. angustus* o: capitulum and scutum; capitulum in ventral aspect with coxae, tarsus 4, anal groove and spiracle. Drawn from specimens (N. 1134) found on squirrels, Mt Lehman, British Columbia, Canada, 1910; S. Hadwen coll. (Original, G. H. F. N. del.)

Fig. 190. *I. angustus* larva: dorsum and venter, tarsus 3. Same origin as the nymph in Fig. 189. (N. 1134. Original, G. H. F. N. del.)

Described from 1 ♂ (N. 1065) from *Sciurus hudsonius douglasi*, Mt. Lehman, British Columbia, Canada (S. Hadwen coll., III. 1910), and several ♀s found on the same host and in the same locality (T. Bowhill, XII. 1908, and S. Hadwen, XII. 1909 and IX. 1910, N. 506, 991, etc.). Mr S. Hadwen has sent us (N. 1195) a ♂ and ♀ which copulated in confinement, the ♂ having been taken on *Lepus dalli* and the ♀ on the

[1] Were it not for the kindness of S. Hadwen, D.V.Sci., who has raised this tick through the various stages and sent us the specimens he has raised, we should not have been in a position to associate the nymphal and larval form with the adults. It is true that Dr Hadwen had found the immature forms on the same hosts with the adults, but they differ so much from the latter that we could not refer them to *angustus* on the strength of their structure.

squirrel aforementioned, VIII. 1910. We have also received a ♀ (N. 678) from *Tamias townsendi*, Chilliwack, British Columbia (III. 1900, N. C. Rothschild coll.), a ♀ (N. 284) from *Sciurus* sp., La Honda, California (II. 1895, V. L. Kellogg coll.), a ♀ (N. 715) from ? host, Glacier Bay, Alaska, IV. 1909 (gift of the U.S. Department of Agriculture), and finally a ♀ from "a mouse, Jeffrey, N.B., C. H. McNutt, X. 1908" (sent to us by C. G. Hewitt, Ottawa, Canada, for identification). Neumann (1899) first described the species from 1 ♀ (mutilated, without complete capitulum and legs) from *Neotoma occidentalis*, Shoshone Falls, Idaho (coll. Bureau of Animal Industry, Washington, D.C.). Banks (1904) records 2 ♀s "from Siskiyou County, California, also received from Massett, British Columbia."

See further under Notes on Biology (p. 315).

21. IXODES CALEDONICUS Nuttall, 1910.

Figs. 191–193.

Lit. and Icon.: Nuttall, XII. 1910, pp. 408–411, Figs. 1–3 (reproduced).

Male: unknown.

Female (gorged): Body 7·8 × 4 mm., oblong, with sides almost parallel, posterior border broadly rounded, covered with a few short white hairs. *Scutum* (1·3 × 1 mm.): glossy, sub-oval, longer than broad, emargination slight, cervical grooves beginning as deep pits (giving the effect of sharp scapulae), then deep and distinct for about two-thirds the length, but slightly divergent and fading away toward the postero-lateral borders; no lateral grooves; very fine, uniform punctations, except for a few larger ones along the anterior and antero-lateral borders; a few very small, short hairs. *Capitulum*: base sub-rectangular, broader than long, with slightly concave raised and trenchant dorsal ridge continuous with the slight (trenchant) cornua; porose areas not depressed, large, ovoid, almost confluent. Palps short, far apart basally, converging and rounded distally, with thick internal border and broadly rounded tips, articulations between articles 2 and 3 obsolete; thumb-like in profile; ventral surface of basis capituli flattened, pentagonal, blunt auriculae protruding laterally; palpal article 1 with ventral angle; hypostome inclined ventrally, rounded in front, dentition 2|2, with 8–9 blunt teeth per file, and a narrow unarmed median ridge. *Venter*: vulva slightly posterior to a line connecting the posterior borders of coxae II; genital grooves rounded in front, diverging slightly, then sub-parallel, finally diverging slightly to the posterior border; anal grooves rounding the anus anteriorly, then parallel, and slightly divergent behind. Spiracle circular, macula median. *Legs*: coxa I visible dorsally, bidentate; with stout external spur and short internal spur; a stout external spur on coxae II and III, smaller on coxa IV; trochanters 1–3 with short spur at postero-external angles; tarsus 4 long, tapering obliquely at the distal third of its terminal portion; claws much longer than the pad.

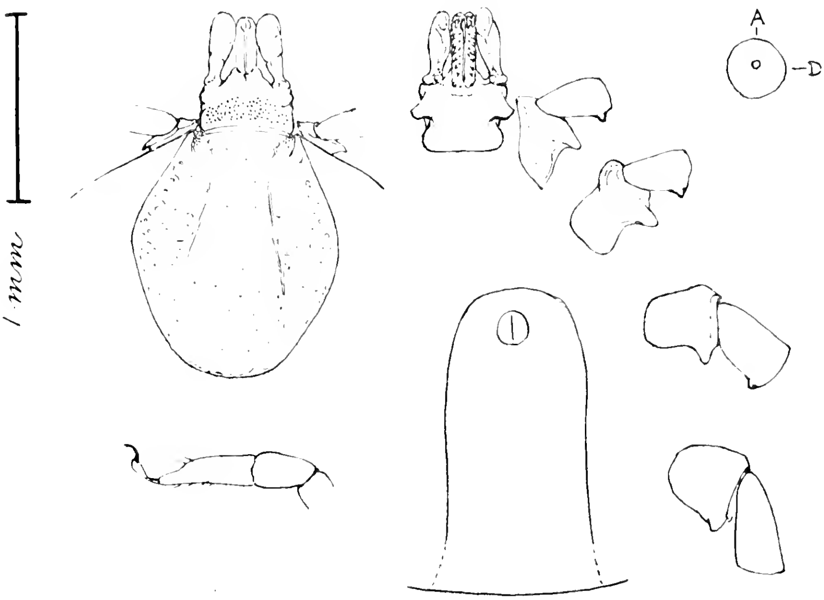


Fig. 191. *I. caledonicus* ♀: capitulum and scutum, capitulum in ventral aspect with coxae, anal groove, tarsus 4 and spiracle. (Nuttall, 1910, Fig. 1, F. M. H. del.)

Nymph (Fig. 192): differs but slightly from the ♀: a few short (caducent) hairs on the scutum, longer hairs, in moderate numbers, on the body. *Scutum* as broad as long (0·7 × 0·7 mm.) with lateral angles rounded, with antero- and postero-lateral borders sub-rectilinear; cervical grooves attaining the posterior border. *Capitulum* with marked, trenchant cornua protruding outward and continuous with the turned upward dorsal ridge. Hypostome 2|2, with eight pointed teeth in the external files. *Venter*: spiracle bluntly oval. Otherwise resembling the ♀.

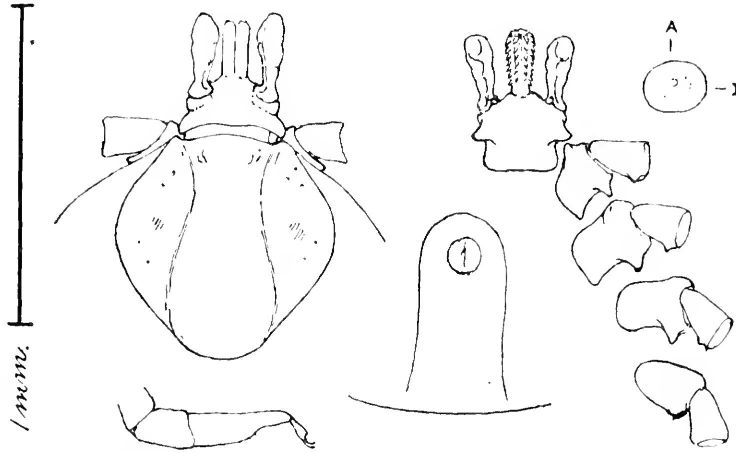


Fig. 192. *I. caledonicus* ♂: capitulum and scutum with dorsal aspect of first leg-pair, ventral aspect of capitulum with coxae, tarsus 4, anal groove and spiracle. (Nuttall, 1910, Fig. 2, F. M. H. del.)

Larva (unfed, Fig. 193): Body 0·8 mm. long, resembles the ♀ and ♂ in its chief characters (coxae, trochanters, tarsi). *Scutum* more rounded (0·4 × 0·4 mm.) than in the ♂, with deep cervical grooves. *Capitulum*: hypostome 2 | 2, with six teeth in the external files.

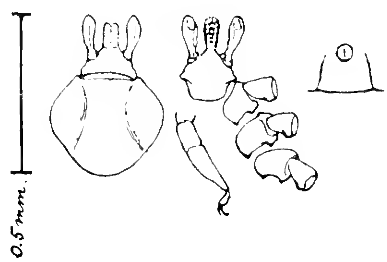


Fig. 193. *I. caledonicus* larva: capitulum and scutum, ventral aspect of capitulum with coxae, tarsus 3, anal groove. (Nuttall, 1910, Fig. 3, F. M. H. del.)

Described from 1 ♀ (N. 961) found on rocks below a dove's nest, Fastcastle, Scotland, 6. IX. 1909, by Messrs J. F. Cormack and J. Waterston and communicated by Dr J. H. Ashworth (Edinburgh); 1 ♂ and 3 larvae (N. 1142) found on young domestic *pigeon*, from a dovecot at Dunipace, Stirlingshire, Scotland, 18. IV. 1910, and 1 ♀ and 4 ♂s (N. 1200) from the same source, 9. VIII. 1910, communicated by Mr William Evans (Edinburgh).

22. IXODES FOSSULATUS Neumann, 1899.

Fig. 194 (original).

Lit.: Neumann, 1899, p. 120 (no figure).

Male: unknown.

Female: Body oval, narrowed in front, broadly rounded behind, 5 × 3 mm. *Scutum* oval, 1·3 × 1 mm., with rounded borders, glossy; scapulae pointed, cervical grooves attaining the posterior border; lateral grooves but slightly curved, joining the border at about the posterior third of the length; margin raised; many fine equal punctations, coarser posteriorly in the median field. Dorsum shagreened by numerous punctations; glabrous, without marginal groove; three grooves in the posterior half. *Venter* shagreened like dorsum; vulva narrow, facing coxae IV; anal grooves curved, not reaching the posterior border. Spiracles distant from coxae IV, placed in front of the middle of the body-length, oval, with short axis directed forward, macula slightly eccentric. *Capitulum* with dorsal base twice as long as broad; with slight cornua; porose areas large, ovoid, with long axis oblique, with an interval equal to their width. Auricula forming a spine directed backward and outward. Chelicera and hypostome? Palps long, narrow. *Legs* normal. Coxae small, not extending beyond the anterior quarter of the body-length; coxa I with two spurs, the internal longer; coxa II conical internally; a short spur at the postero-external angle of coxae II–III, almost obsolete on coxa IV. Tarsi long, tapering abruptly near their tips; pads large, almost as long as the claws; the latter short and thick. *Colour*: body and legs reddish brown.

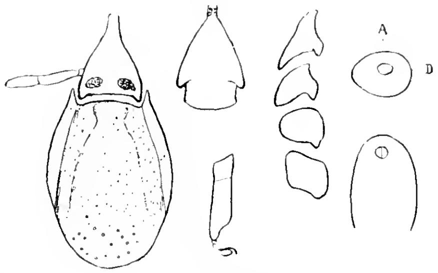


Fig. 194. *I. fossulatus* ♀: capitulum (mutilated) and scutum, ventral aspect of capitulum, tarsus 4, coxae, spiracle and anal groove. Sketch from type specimen from Ecuador. (Berlin Mus. Original, G. H. F. N. del.)

Our description of the type, a single dry specimen, from Ecuador, S. America (Berlin Mus.), differs from that of Neumann in several respects.

23. IXODES ACUTITARSUS (Karsch, 1880).

Fig. 195.

Lit., Synon. and Icon.: *Haemalastor acutitarsus* Karsch, 1880, p. 142 (Latin description in five lines; quite insufficient).

Ixodes laevis Neumann, 1899, p. 148, Fig. 21 (reproduced); recognized as *I. acutitarsus* by Neumann (1901, pp. 285, 290) after examining Karsch's type.

Ixodes acutitarsus Karsch, in Neumann, 1899, p. 180; 1901, p. 286.

Eschatocephalus acutitarsus Karsch, in Neumann, 1901, p. 290.

The following description is based partly on Neumann's *I. laevis* (Paris Mus.), which we have examined. We see no reason why the species should have been regarded as an *Eschatocephalus*, since the legs are not of inordinate length.

Male: unknown.

Female (unfed): dark brown, *very large*, 7·5 × 3·8 mm. (Karsch's type measured 8 × 3·3 mm.); body oval, dorsum convex, broadest behind coxae IV. *Scutum* cordiform, as broad as long (2·5 mm., Nn.), the antero-lateral borders slightly convex, one-half the length of the postero-lateral borders which are straight or but slightly concave; rounded posteriorly; cervical grooves parallel, then divergent, shallow, attaining the postero-lateral borders; traces of lateral grooves; surface glossy, a few fine punctations situated toward the anterior angles. Dorsum convex, smooth; marginal groove deep and broad, limiting a broad marginal fold which is slightly incised by the dorsal extension of the ventral grooves; a few very short hairs. *Venter*: vulva facing coxae IV, sexual grooves subrectilinear, divergent; anal grooves rounded

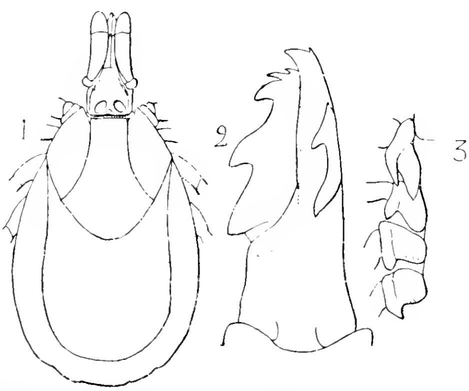


Fig. 195. *I. acutitarsus* ♀: (1) dorsum; (2) digit, 265 μ *l.*, and (3) coxae. (Neumann, 1899, Fig. 21 of *I. laevis* Nn.)

in front, widely divergent behind; short hairs, mostly behind the coxae. Spiracles large, subcircular, with macula eccentric (anterior). *Capitulum* long (2 mm., Nn.), with base slightly broader than long; dorsal ridge subrectilinear (no cornua) and lateral borders parallel; porose areas oval, with long axis oblique, the interval nearly equal to their width. (Digit; see Fig. 195 (2).) Hypostome narrow, lanceolate, as long or slightly longer than the palps; dentition 4 | 4, then 2 | 2 rows of 10–12 teeth, which are widely separated by a median ridge. Palps long; external border concave posteriorly, article 1 projecting outward like a knot, article 2 twice as long as 3. *Legs* large, strong (pair 4 extend one-half their length beyond the posterior border of the body in unfed ♀), and bearing short hairs. Coxa I bidentate, the internal spur thick and overlapping coxa II, the external spur short; a short external spur on coxae II–IV. Tarsus 4 tapering gradually; pad about one-half as long as claws.

Origin: Karsch's type came from Japan (1 ♀, D. Hilgendorf coll.), Neumann's *I. laevis* came from Sikkim, India (1 ♀, Harmand coll., Paris Mus.). Neumann has since recorded 2 ♀s from Sikkim (Berlin Mus.), and we have seen 2 ♀s from Japan and S. Formosa (Brit. Mus.).

24. IXODES GIGAS Warburton, 1910.

Fig. 196.

Lit. and Icon: Warburton, 1910, p. 397, Figs. 1 and 2 (reproduced).

Male: *L.* 5, *W.* 3 mm. Body oval, broadest near the hind end, marginal fold uniformly broad. *Scutum* chestnut coloured, darker on the scapulae and sides, glossy and smooth except for a few small punctations on the scapulae and between the cervical grooves; the latter parallel at first, then sharply diverging; no lateral grooves. *Capitulum* moderate; base rather long, pentagonal, without cornua. Palps of medium length, article 2 rather prominent laterally and about twice the length of article 3. Hypostome 2 | 2, seven or eight teeth per file. *Venter*: pregenital plate elongate, rather indented anteriorly; median plate much longer than broad, the sides slightly diverging; anus rather near the posterior border; anal plate with sides curved and slightly diverging; genital orifice facing the third intercoxal space. Spiracles rather large, oval or slightly reniform. *Legs* long; coxae I bidentate, like that of a *Rhipicephalus* or *Hyalomma*, protruding in front of the body and visible dorsally; coxae II–IV with a slight external spur and a blade-like internal edge; all the coxae close together and occupying little more than the anterior third of the body-length; tarsi long and tapering, only slightly gibbous dorsally. Legs 4 extend beyond the posterior end of the body by their two distal articles.

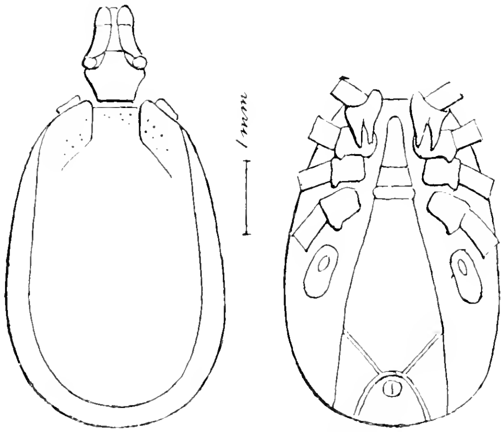


Fig. 196. *I. gigas* ♂: dorsum and venter. (C. Warburton, 1910, Figs. 1 and 2.) The anal grooves are somewhat too divergent in the figure.

Female: unknown.

Described from two specimens in the India Museum, Calcutta (No. $\frac{5092}{10}$ and No.?), taken at Punkabani, Darjiling District, E. Himalayas (no host recorded).

This fine species—the largest male *Ixodes* known—may very likely prove to be the ♂ of *Ixodes acutitarsus* (Karsch, 1880), but it is unsafe at present to attribute it to that species. Its coxal armature is unique in this genus.

25. IXODES RUBICUNDUS Neumann, 1904.

Figs. 197 (Nn.) and 198 (original).

Lit. and Icon.: Neumann, 1904, pp. 460–462, Fig. 2 (reproduced).
Howard, C. W., VIII. 1908, p. 97, Pl. IV, Fig. *l* (*a*, *b*), translation from Neumann and copy of his figure.

Male (Fig. 197): Body 2·3 mm. long (capitulum included), contour oval, narrower anteriorly, 1·2 mm. broad toward the posterior third, maroon-brown. *Scutum* convex, glossy, glabrous, marginal fold broader posteriorly than on the sides; cervical grooves narrow, superficial, divergent, extending to about the middle of the body-length; numerous punctations, small, unequal, regularly distributed. *Venter*: genital pore broad, between coxae III. Pregenital plate long, triangular; median plate much longer than broad, with sparse, shallow punctations; anal plate oblong, sides parallel, longer than wide, very finely punctate; adanal plates longer than broad, sides parallel; no hairs. Spiracles circular. *Capitulum* short (0·5 mm.); with trapezoid base, broader anteriorly and broader than long, no cornua, posterior angles protruding on ventral surface, separated by a similar median protuberance. Chelicera thick, 135 μ long (dorsal process with two stout, successive teeth, the posterior stouter; external article with three teeth, the anterior small, the posterior very stout). Hypostome broad, the teeth fused on each half in four transverse ridges of three or four denticles, followed by a row of four or five teeth and on each side by a very stout tooth. Palps short, articles 2 and 3 of about the same length. *Legs* of medium length, brick-red. Coxa I with internal spur almost obsolete, coxae II–III unarmed but trenchant, coxa IV also trenchant but with a slight postero-external spur. Tarsi of medium length, tapering gradually.

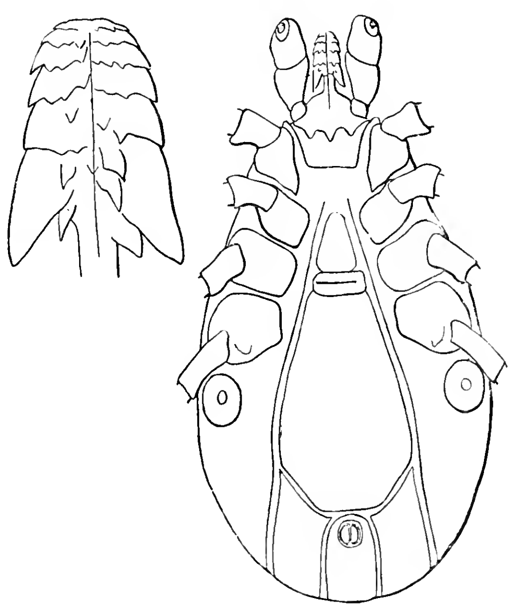


Fig. 197. *I. rubicundus* ♂: venter and hypostome. (Neumann, 1904, Fig. 2.)

Female (gorged, Fig. 198): Body elongate oval, may attain *L.* 10 mm., *W.* 6·5 mm. toward the posterior third, brick-red in specimens of small size, maroon-red in others. *Scutum* a short oval, scarcely longer than broad (1·6 × 1·4 mm.), with lateral borders at first slightly convex and diverging, then rectilinear and converging to the rather narrow posterior angle; emargination slight, cervical grooves well marked, reaching almost to the lateral borders at their re-entering angles; lateral grooves well marked up to the lateral border, numerous fine punctations, slightly unequal, rarer in the lateral fields; surface glossy, glabrous, maroon-brown. Dorsum with sparse hairs (caducent); punctations very superficial; three posterior grooves. *Venter* with similar punctations and hairs; vulva between coxae IV[1]; anus fairly anterior; anal grooves long, parallel, united in a flat curve in front of the anus. Spiracles small, circular, whitish. *Capitulum* 0·85 mm. long; dorsal base subrectangular, much wider than long; porose areas piriform, oblique, converging anteriorly, placed near the lateral borders and separated by a space equal to their width; auriculae slight and blunt. (Chelicera with digit 140 μ long; dorsal process long, parallel to the shaft; external article with 5 teeth growing progressively larger antero-posteriorly.)

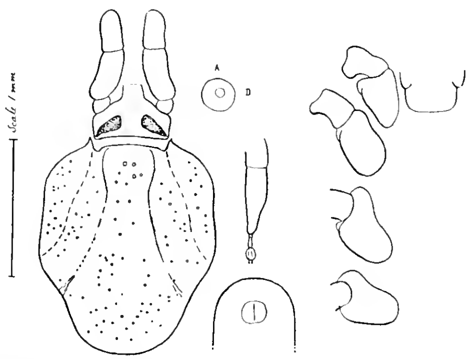


Fig. 198. *I. rubicundus* ♀: capitulum (mutilated) and scutum, spiracle, tarsus 4, anal groove, coxae and base of capitulum, ventral aspect. From a gorged ♀ from *Ovis aries*, Neumann coll. 1253. (Original, G. H. F. N. del.)

Hypostome long, narrow, sublanceolate, dentition 3 | 3, the internal file short, of 6 or 7 teeth, the median almost as long as the external; the latter extending from apex to base, with 15–16 teeth. Palps long, fairly slender, concave externally, second article longer than third. *Legs* tapering, brick-red; coxae I, II and III flat, unarmed, posterior border trenchant; coxae IV more swollen, with a small tuberosity on the external third of the posterior border. Tarsi long, slender, tapering gradually.

[1] In the specimen examined by us the vulva is placed just behind coxae III.

Description based on two ♂s and seven ♀s found on *sheep* in Eastern Cape Colony (Lounsbury coll.). We have examined specimens kindly lent us by Prof. Neumann and others (in W. F. Cooper's coll., determined by us) from *goats*, Albert District, S. Africa, 1905 (H. E. F.). This tick is supposed to inoculate an obscurely defined disease characterised by anaemia.

Ixodes rubicundus var. limbatus Neumann, 1908.

The subspecies, according to Neumann (IV. 1908, p. 22), differs from the type as follows:

Male: unknown.

Female: *Scutum* smaller (1·3 × 1·15 mm.); reddish brown, lighter along the lateral borders; cervical grooves very shallow; lateral grooves indicated by a slight external elevation; punctations finer, subequal. *Capitulum* smaller (0·73 mm. *l.*); hypostome with fewer teeth per file.

Description based on six ♀s from *Ovis aries* and *Capra hircus*, Katanga, Congo Free State (coll. of the Special Committee, Katanga).

26. IXODES SIMPLEX Neumann, 1906.

Fig. 199 (original).

Lit.: Neumann, 1906, pp. 197, 198 (no figure).

Male: unknown.

Female: Body oblong, with lateral borders parallel, slightly narrowed on a level with the spiracles, rusty yellow, 4 × 3 mm. *Scutum* longer than broad, 1·2 × 0·9 mm., broader toward the middle, the postero-lateral borders slightly concave, red-brown or yellowish, glossy, with widely separated punctations, which are fine and larger in the lateral fields; cervical grooves obsolete; no lateral grooves. Dorsum covered by many long hairs. *Venter*: hairs short and fewer, except on the sides. Vulva between coxae III. Anal grooves relatively short, divergent, ogival in front. Spiracles brownish, subcircular. *Capitulum* short; base triangular, without cornua; porose areas elongate transversely, separated by a median depression, interval equal to half their width; auriculae absent. Hypostome and chelicera? Palps short, articles 2 and 3 of nearly equal length, about as broad as long; article 1 cylindrical. *Legs* slender, long. Coxae flat, all unarmed. Tarsi long, tapering obliquely.

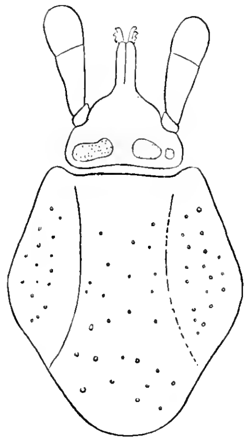


Fig. 199. *I. simplex* ♀: capitulum and scutum. Sketch from type in British Mus. (Original, G. H. F. N. del.)

Description based on one gorged ♀, habitat unknown; one ♀ and one o from *Rhinolophus ferrum-equinum* (Schreb.) from Shanghai; one ♀ from *Vespertilio* sp. (? from Gaboon, French Congo: British Museum).

27. IXODES JAPONENSIS Neumann, 1904.

Figs. 200, 201 (original).

Lit.: Neumann, 1904, pp. 458, 459 (no figure).

Male: unknown.

Female: Body oval, narrow in front, broader at the posterior third, brownish yellow, *L.* 2, *W.* 1·5 mm. *Scutum* subcircular, as broad as long (1·1 mm.); cervical grooves far apart; lateral grooves limited by a very marked ridge; very fine punctations; some very long hairs. Dorsum bearing some long scattered hairs; a distinct marginal groove. *Venter* with numerous long hairs; vulva facing the last intercoxal space. Genital grooves straight, divergent. Anal grooves slightly ogival, with sides diverging greatly. Spiracles large, sub-circular, whitish. *Capitulum* 0·55 mm. long; base pentagonal, broader anteriorly, posterior margin straight, with slight cornua, nearly twice as broad as long on the dorsal surface; porose areas well defined, oval, longer than broad, the space between them equal to their breadth; ventral surface uniform, slight auriculae. Hypostome long, narrow, 4|4 near the tip (corona), then 2|2 with a median unarmed ridge. Palps medium, article 2 scarcely longer than 3. *Legs*: coxae unarmed; coxa I with internal angle sharp, all, especially coxa II, trenchant on their posterior border. Tarsi long, slender, tarsus 4 tapering gradually, the others somewhat humped; pad almost as long as the claws.

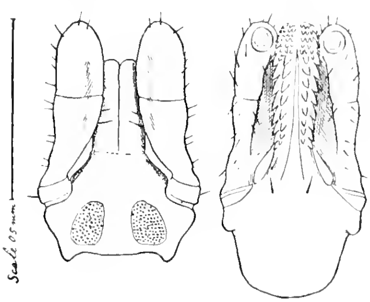


Fig. 200.

Fig. 201.

Fig. 200. *I. japonensis* ♀: capitulum in dorsal and ventral aspects. Drawn from the unique type in the Paris Mus. (Original, G. H. F. N. del.)

Fig. 201. *I. japonensis* ♀: dorsal aspect of body, venter, spiracle and tarsus 4. The same specimen as the one to which the preceding figure relates. The scutum is injured, there being a triradiate crack in the centre, indicated in the figure. (Original, G. H. F. N. del.)

Our description is based on one ♀ (type) collected in the vicinity of Tokio, Japan, by J. Harmand, 1901 (Paris Museum).

28. IXODES CANISUGA Johnston, 1849.

Figs. 202–209 (original).

Lit. and Synon.: *Ixodes canisuga* Johnston, 1849, p. 371; Evans, 1907, p. 36; Banks, 1908, p. 32.

Ixodes plumbeus, in Wheler, 1899; see Wheler, 1906, p. 413.

Ixodes hexagonus var. *inchoatus* Neumann, 1901, p. 283; Wheler, 1906, p. 413.

We feel justified in reviving the overlooked species of Johnston, to which attention was drawn by Mr William Evans (1907) to whom we are indebted for an abstract of the author's original description. The latter is not accompanied by a figure and is very brief, but he distinguishes *canisuga* from *hexagonus* (to which it is "nearly allied"), and describes the scutum of the former as "heart-shaped, with base forward and widely emarginate, chestnut-brown, punctured, obsoletely foveolate on each side." Johnston's specimens were taken from the pointer, and were sent to him as "the dog-tick." Neumann (1906), in correspondence with Mr Evans, doubtfully refers to *canisuga* as possibly synonymous with *hexagonus* var. *inchoatus*. Judging from the numerous specimens which have reached us from Scotland, England and Ireland, *canisuga* appears to be pre-eminently "the dog-tick" of this country and we have no doubt, despite his insufficient description, that Johnston had this species in view. Banks (1908, p. 32) appears to have come to the same conclusion.

Male (Figs. 202–205): Broad oval. *Scutum*: 1·9 × 1·1 to 2·3 × 1·5 mm., oval, only slightly narrower in front, marginal fold fairly broad; very finely punctate, cervical grooves chiefly visible as elongate divergent depressions, far from the anterior border; lateral grooves absent; two other elongate, parallel depressions on either side of the middle of the scutum. Emargination moderate; scapular angles blunt and rather rugose. *Venter*: genital orifice facing the second intercoxal space, pregenital plate ill-defined; median plate fairly broad, widest just behind the spiracles; anal plate with sides only slightly divergent; adanal plates long, with sides nearly parallel. Spiracle nearly circular. *Capitulum*: very small; base rectangular, broader than long dorsally, the posterior border slightly concave; no cornua; a slight median ridge or prominence. Palps very short, convex dorsally, article 2 barely longer than article 3. Hypostome (Fig. 204) bifid, with about eight

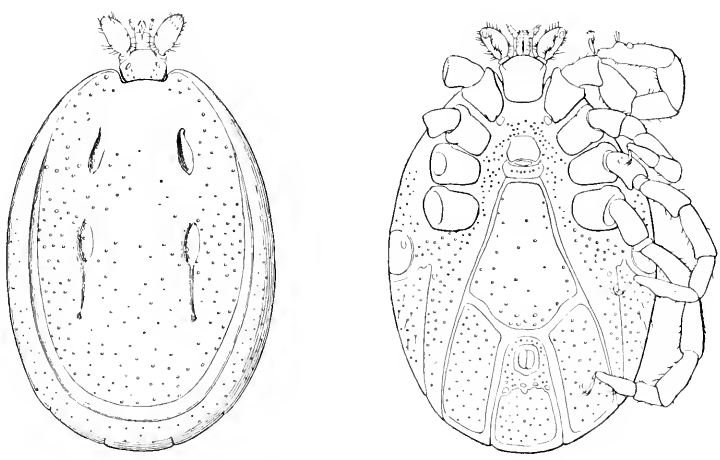


Fig. 202. *I. canisuga* ♂: dorsum and venter, ×20. The slight protuberances at the postero-lateral angles of coxae II–IV omitted through an oversight. Specimen collected in Northumberland, 1905, by E. G. Wheler. (N. 1079 ex W. F. Cooper coll. Original, G. H. F. N. del.)

fairly distinct lateral teeth on either side and corresponding ventral crenulations (varies somewhat in structure, see Fig. 203). *Legs*: coxae practically unarmed, coxa I only bluntly prominent at its internal angle, slight protuberances at the postero-lateral angles of coxae II–IV. Tarsus 4 fairly long, prominent dorsally at some distance from its extremity.

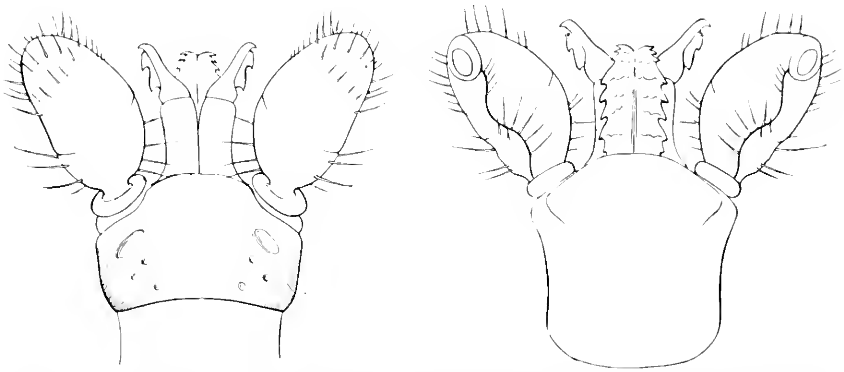


Fig. 203. *I. canisuga* ♂: capitulum in dorsal and ventral aspects, ×43. In the ventral view the capitulum is tilted slightly backward. From the same specimen as Fig. 202. (Original, G. H. F. N. del.)

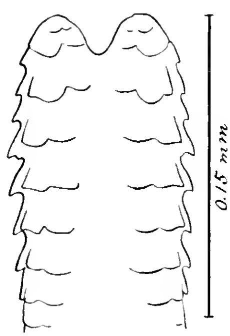


Fig. 204.

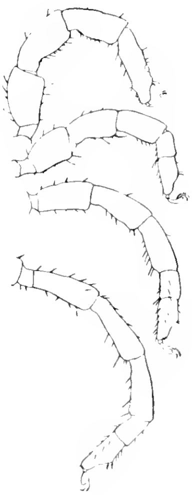


Fig. 205.

Fig. 204. *I. canisuga* ♂: hypostome. Drawn from specimen (N. 1123) from Gowanburn, N. Tyne, 1901. Presented by Mr E. G. Wheler. (Original, G. H. F. N. del.)

Fig. 205. *I. canisuga* ♂: legs 1–4 in profile, ×20. (Original, G. H. F. N. del.)

Female (Figs. 206, 207): unfed, 2·1 mm. *l.*, may attain 8 × 5 mm. *Scutum*: 1 × 0·9 to 1·1 × 1 mm., cordiform, scarcely longer than broad, broadest much in front of the middle, postero-lateral borders straight or somewhat concave; cervical grooves shallow, wavy, reaching the

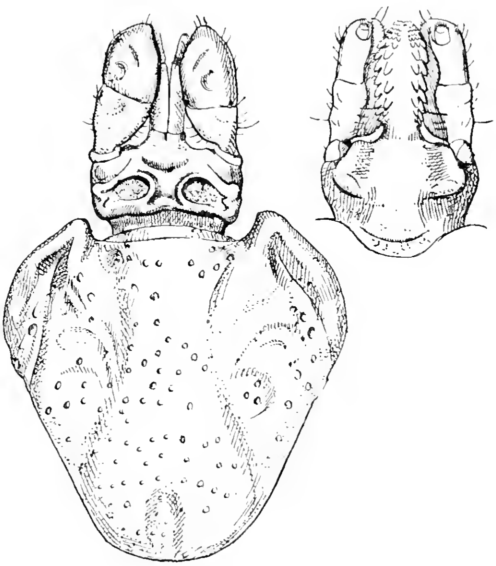


Fig. 206.

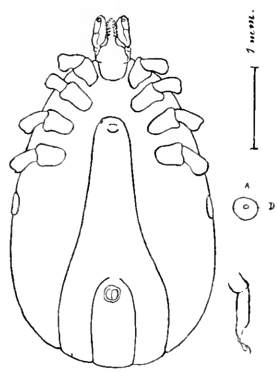


Fig. 207.

Fig. 206. *I. canisuga* ♀: capitulum and scutum; capitulum in ventral aspect. Found on dog, Tynron, Scotland, by J. McMonnies, VII. 1908. (N. 447. Original, G. H. F. N. and E. W. del.)

Fig. 207. *I. canisuga* ♀ (replete): venter, spiracle, tarsus 4. Same specimen as in Fig. 206. (Original, G. H. F. N. del.)

posterior border, lateral grooves short, the ridge external to them terminating just beyond the lateral angles; punctations large and confluent in the lateral fields, giving a rugose effect, moderate and more discrete in the median field; emargination moderate; scapular angles blunt. Dorsum only slightly punctate, with very short, white hairs. *Venter*: vulva facing the second intercoxal space; genital grooves nearly parallel at first, then separating, and terminating parallel to one another. Anal grooves rounded or slightly ogival in front (often discontinuous), with parallel sides. Spiracle sub-circular, but with major axis transverse. *Capitulum*: base rectangular dorsally, twice as broad as long; no cornua; slight auricular ridges ventrally; porose areas large, deep, oval, the interval less than their diameter. Palps short, broad, article 2 about equal in length to article 3 (asymmetry in Fig. 206). Hypostome 2 | 2, about 7–8 teeth per file, with a wide unarmed median area. *Legs*: coxae as in the ♂; tarsi distinctly humped.

Nymph and **Larva** (Figs. 208, 209): strongly resemble the ♀, especially in the shape of the scutum, the legs, and ventral grooves.

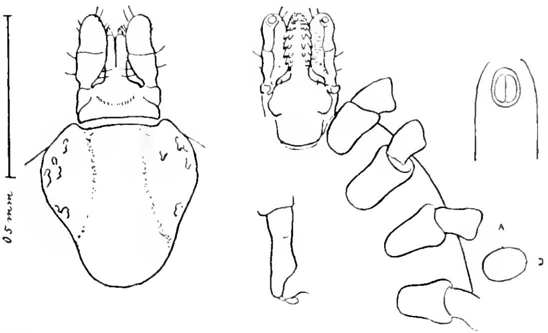


Fig. 208. *I. canisuga* ○: capitulum and scutum; coxae and ventral aspect of capitulum; tarsus 4; anal groove and spiracle. Specimen from dog, Tynron, Scotland, J. McMonnies coll., VII. 1908. (N. 447. Original, G. H. F. N. del.)

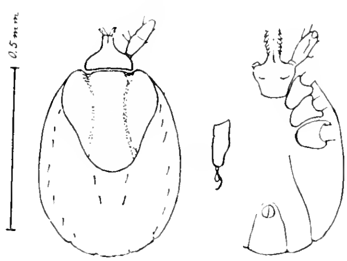


Fig. 209. *I. canisuga*, larva: dorsum, venter and tarsus 3. Specimen (British) received from Mr E. G. Wheler. (N. 1044. Original, G. H. F. N. del.)

Our collection contains numerous specimens collected chiefly in this country:—**Scotland**: (N. 414, ♀s), from *dog*, Thornhill, Dumfriesshire, V. 1908 (J. R. Wallace); (N. 422, 447, ♀s, ○s) from *dogs*, Auchenbrack, Tynron, V. and VII. 1908 (J. McMonnies); (N. 402) ♀s from *sheep*, Blackadie, Sanquhar, V. 1908 (R. Bramwell). [Evans (I. 1907, p. 35) found them on *dogs*; especially young collies, mostly attached about neck, shoulders and sides, and behind forelegs, Pentlands and Moorfoot districts, Scotland; ○s and ♀s (March, April); no ♂ found. (Det. by Neumann)]. **England**: (N. 1123, ♂), Gowanburn, N. Tyne, V. 1901, and (N. 1046, ♀) from *dog*, same locality, V. 1901 (E. G. Wheler); (N. 1079, ♂, ♀) from *dog*, Alnwick, Northumberland E. G. Wheler); (W. F. Cooper's coll. ♀), from *dog*, Stanhope, Durham,

IX. 1905 (D. Robertson); (N. 501, ♀), from *horse*, Cambridge, V. 1908 (G. A. Banham); (N. 1068, ♂s, ♀s) from *nest* of *Cotile riparia*, Lyndhurst, Hants, VII. 1900 (N. C. Rothschild); (N. 605) from *Cotile riparia*, Warsbrough Bridge, Barnsley, VII. 1906 (A. Whittaker; ex N. C. Rothschild coll.); (N. 1051, ♀), from *grass*, on the Downs, Lizard, IX. 1909 (L. Cobbett); (N. 19, ♀), from *dog*, Longner Hall, Shrewsbury, IV. 1906 (R. F. L. Burton.) The last-named gentleman has, moreover, sent us from the same locality (N. 499, larva) from *mole*, XI. 1908; (N. 1137, ♀s, o), from *ferrets*, VI. 1910, and (N. 1141, 1143, many ♂s, ♀s, o s) from *nests* of three *sand-martins* (*C. riparia*) on the banks of the River Severn, Shrewsbury, VII. 1910. **Ireland**: (N. 62, ♀s) from *dog*, Sligo, IX. 1905 (Æ. F. Nuttall). **Germany**: (N. 768, ♀s), from *dog*, Kittendorf, Mecklenburg-Schwerin, VIII. 1908 (G. H. F. Nuttall). **France**: [Neumann, 1901, records (♀) "*inchoatus*" from the *fox* (R. Blanchard coll., Paris); from the *dog*, Toulouse (Neumann coll.); and *badger* (Railliet coll., Alfort)]. **N. America**: [Banks, 1908, p. 32, records the species (2♀s) as occurring either on the *red squirrel* or *fox*, but does not state the locality].

See further under Notes on Biology (p. 316).

29. IXODES TEXANUS Banks, 1909.

Figs. 210, 211 (original).

Banks, VI. 1909, p. 172, Figs. 16, 17 (♀ capitulum, coxa I, tarsus 4 and spiracle. Inaccurate).

Male: unknown.

Female: *Scutum* as long as broad[1], hexagonal, with posterior border broadly rounded, broadest about the middle. Cervical grooves broad, shallow, nearly parallel, far apart, reaching the posterior border, the parts external to them, and especially the scapulae, being rugose, the area between them pitted with deep punctations, more or less confluent. No lateral grooves. Scapulae moderately prominent. Dorsum with very short white hairs; punctations inconspicuous. *Capitulum*: base sub-trapezoid, narrower in front, very rugged, its sculpture rendering the porose areas ill-defined. Porose areas irregular, separated by about their breadth, the interval rugged; no distinct auriculae. Palps rather short and broad, with straight external and very convex internal contours, the internal contour very rugose, giving a beaded effect; article 1

[1] The scuta of our three specimens measure respectively $1{\cdot}1 \times 1{\cdot}2$, $1{\cdot}2 \times 1{\cdot}1$, and 1×1 mm. Our most replete specimen measures $4{\cdot}9 \times 3{\cdot}3$ mm. Banks gives the body-length at 6·5 mm., but does not state if this is the maximum length which may be attained in gorged females.

rather sharply prominent ventrally. Hypostome thick and strong, with 2 | 2 files of strong teeth along its whole length. *Venter*: vulva between coxae III; anal grooves rounded in front and very slightly diverging. Spiracles small, sub-circular or short oval. *Legs*: coxae almost unarmed, except that coxa I is slightly prominent at its internal angle, and there is a faint indication of an external spur on all the coxae. Their posterior borders are trenchant. Tarsi rather short and humped,

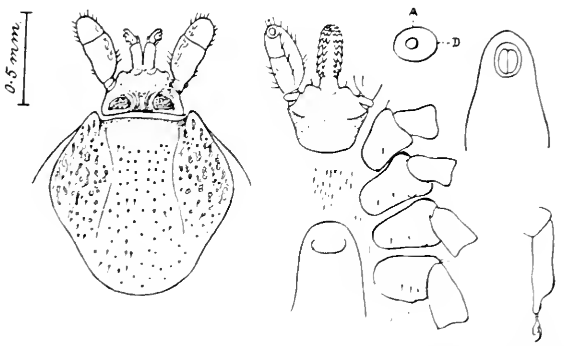


Fig. 210. *I. texanus* ♀: capitulum and scutum, part of venter, spiracle, anal groove and tarsus 4. Found on coon, Mt Lehman, British Columbia, I. 1910, by S. Hadwen. (N. 992. Original, G. H. F. N. del.[1])

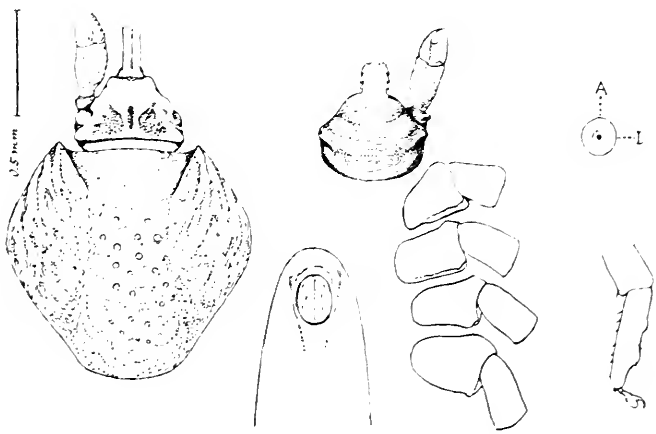


Fig. 211. *I. texanus* ♀: capitulum and scutum, capitulum in ventral aspect, coxae, anal groove, spiracle and tarsus 4. Drawn from specimen found on grey squirrel, King's river, California, VIII. 1896. (N. 270. Received from V. L. Kellogg and identified by N. Banks. Original, F. M. Howlett del.[1])

[1] The differences shown in these figures are partly due to individual variations in the specimens and partly to the position (this applies more particularly to the palps) in which they were drawn.

descending almost perpendicularly in tarsi 1–3, and with a slight slope in tarsus 4.

Described from (N. 270) 2 ♀s taken from a Californian *grey squirrel*, King's river, California, VII. 1896 (V. L. Kellogg's coll.), and (N. 992) 1 ♀ from *Procyon lotor*, at Mt Lehman, British Columbia, Canada, I. 1910 (S. Hadwen). The two Californian specimens, which we were unable to identify, were sent to Banks, who recognized them as a species he has since described very briefly as *I. texanus*, from a *raccoon*, Live Oak County, Texas (Mitchell and Bishopp).

30. IXODES STILESI Neumann, 1911.

Fig. 212.

Lit., Icon. and Synon.: *Ixodes elegans* Neumann, 1910, p. 191, Fig. 1 (reproduced). *Ixodes stilesi* Neumann, 1911. Species renamed, *elegans* being preoccupied (personal communication; see List of Condemned Species, p. 284).

Male unknown:

Female (unfed): Body oval, sides sub-rectilinear, maroon-brown, 5 to 7 × 2 to 3 mm., slightly constricted on a level with the spiracles. Dorsum bearing short sparse hairs, faint marginal grooves, and three shallow longitudinal grooves. Replete specimens attain 9 × 7 mm. (5 mm. dorso-ventrally), ovoid or piriform. *Scutum* elongate, 1·5–1·65 × 1–1·14 mm., scapulae prominent, sides diverging as far as their anterior fourth, then slightly converging and rounded behind; dark brown, with light median field, very glossy; cervical grooves shallow, barely attaining the posterior third; lateral grooves faintly indicated by a straight ridge; a few small punctations, chiefly in the lateral fields and along cervical border, bearing minute hairs. *Venter*: hairs longer and more numerous than on dorsum; vulva facing coxae III; anus distant from the posterior border; anal grooves long, straight, parallel, uniting in a semicircle anteriorly; spiracles slightly oval, transverse. *Capitulum* 1·2 mm. *l.*, base, viewed dorsally, pentagonal, lateral borders parallel; cornua short and pointed; porose areas oval, longer than broad, the interval barely equal to their width; auriculae slight. Hypostome long, narrow, 3 | 3, 14–16 stout teeth per file, the inner files little shorter than the external; digit 210 μ *l.* (see Fig. 212). Palps 1 mm. *l.*, narrow, cultriform; article 1 with ventral point and a long basal hair; article 2 nearly twice as long as 3. *Legs* of medium length; coxa I bifid, the spurs far apart, somewhat flat, the inner spur slightly longer; a short postero-external spur on coxae II–IV; tarsi slightly humped distally; pads large, almost as long as claws.

Fig. 212. *I. stilesi* ♀: capitulum and scutum, left digit in dorsal aspect, palp in profile, inner aspect. (Neumann, 1910, Fig. 1.)

Described (condensed after Neumann) from 14 ♀s (2 replete), found on *Pudua humilis* (Cervidae), Chili (E. Porter coll., Paris Mus.).

31. IXODES NEUMANNI n.sp. Nuttall and Warburton.

Figs. 213, 214 (original).

Lit. and Synon. *Ixodes eudyptidis* Maskell, 1885, in Neumann, 1899, pp. 128, 129 (no figure).
not *Ixodes signatus* Birula, 1895, p. 357.
not *Ixodes parvirostris* Neumann, 1901, p. 284.
Ixodes praecoxalis Neumann, 1899, p. 121; 1902, pp. 119–121; 1904, p. 451 (no figures).
Ixodes intermedius Neumann, 1899, p. 132; 1904, p. 451 (no figure).
not *Ixodes eudyptidis* var. *signata* Neumann, 1904, p. 451.

Note: This species was described by Neumann, 1899, p. 128, as *Ixodes eudyptidis* Maskell, without, as it seems to us, sufficient reason, Maskell's description and figures being so exceedingly poor that it is impossible to recognize the species with which he was dealing. Maskell's type has not been available for study, consequently the only safe procedure seems to be to describe the tick under consideration as a new species, and we name it after Professor Neumann who utilised it in his description of *I. eudyptidis.* Our description differs in some respects from that of Neumann, who kindly lent us his types for purposes of study.

Neumann (1904, p. 451) has himself degraded *I. praecoxalis* and *I. intermedius* to the rank of synonyms of his *I. eudyptidis* Maskell. We recognize *I. signatus* Birula (= *I. parvirostris* Neumann, 1901, and *I. eudyptidis* var. *signata* Neumann, 1904) as a distinct species, after examining the type specimens so named.

Male: unknown.

Female: Body attains 8 × 5·5 mm. *Scutum* dark brown, much longer than broad (1·7 × 1·2 mm.[1]), hexagonal[2], with rounded posterior border, broadest rather in front of its anterior third, slightly corrugated on its anterior and antero-lateral borders, elsewhere marked with very small discrete punctations; cervical grooves shallow, broad, wavy (Fig. 213), the anterior commencement of lateral grooves faintly indicated; scapulae rounded and not prominent in front. Short white hairs present in anterior portion, probably caducent elsewhere. Dorsum with a few

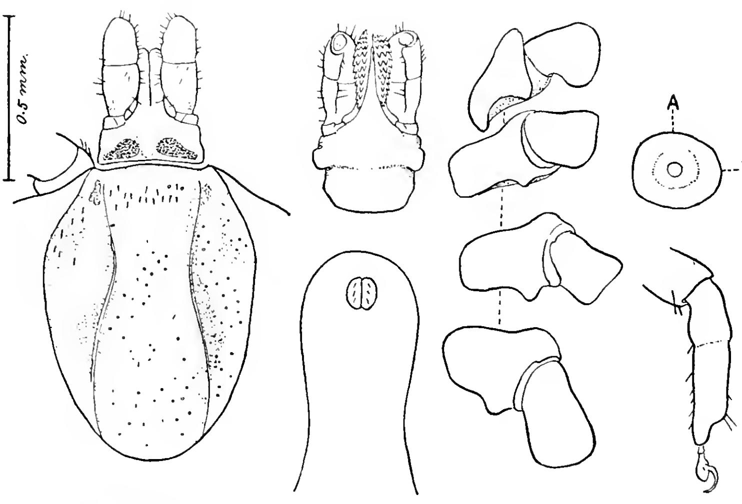


Fig. 213. *I. neumanni* ♀: capitulum and scutum; ventral aspect of capitulum, anal groove, coxae, spiracle and tarsus 4. (There should be a slight ventral spur on trochanters 1, 2 and 3). From New Zealand, ex Trouessart coll., 1894. (Neumann coll. 710. Original, G. H. F. N. del.)

[1] The scutum of *I. intermedius* Neumann, 1899, p. 132, measures 1·5 × 1 mm., that of *I. praecoxalis* Neumann, 1899, p. 121; 1902, p. 119, measures 1·2 × 1 mm.

[2] The postero-lateral borders are more rectilinear than is shown in the figure.

white hairs; punctations inconspicuous. *Venter*: very finely striate, without punctations, but with numerous short, white hairs; vulva facing the second intercoxal space. Anal grooves semicircular in front, with sides reaching the posterior border and approaching each other somewhat midway. Spiracles large, transversely oval. *Capitulum*: (0·8 mm. *l.*) base twice as broad as long, with parallel sides and straight posterior border; destitute of cornua; porose areas pear-shaped, transverse, the broader end internal, interval less than their narrower diameter, well-marked blunt auriculae, visible dorsally. Palps of medium length, broad, outer border straight, inner border roughly parallel with it but with an indentation at the junction of articles 2 and 3. Article 2 longer than article 3. Hypostome long, very slightly spatulate, with large corona behind which there is a broad unarmed median area; dentition 4 | 4 in front to 2 | 2 behind, the outermost teeth (10 per file) much the strongest[1]; this and the next row extend nearly the whole length of the hypostome; the two internal rows short and progressively smaller. *Legs* medium, coxa I bidentate, the inner spur broad and curved; trochanter I without dorsal projection but with very slight ventral spur; coxae II–IV trenchant and with slight postero-external spur; trochanters 2 and 3 slightly spurred ventrally at their distal extremities. Tarsi fairly long, tapering abruptly; claws and pads small.

Nymph: resembles the ♀, but for the absence of the vulva and porose areas, and the smaller spiracle (Fig. 214).

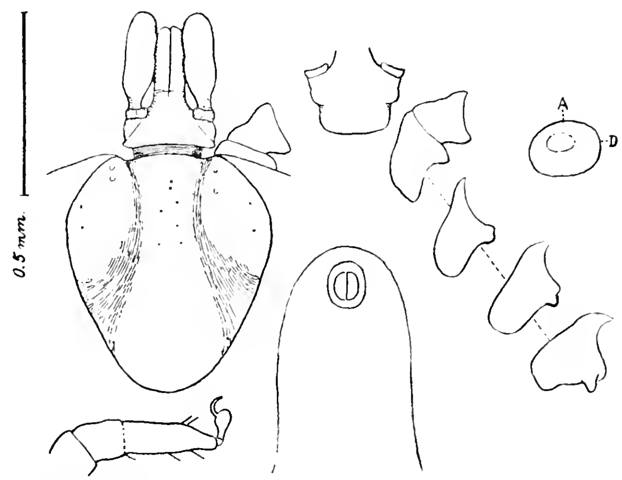


Fig. 214. *I. neumanni* ○: capitulum and scutum; parts of venter, spiracle and tarsus 4. Same origin as preceding. (Original, G. H. F. N. del.)

[1] Neumann (1902, p. 119) gives the dentition of *I. praecoxalis* as 4 | 4, that of *I. intermedius* as 2 | 2.

Our description is based on 1 ♀ and 1 o, part of a lot of 7 ♀s and 12 o s, collected in New Zealand by Suter and presented to Neumann by Trouessart in 1894.

Neumann's specimen of *I. intermedius* (1 ♀) was collected by Dr Schauinsland from *Phalacrocorax* sp., and *I. praecoxalis* (2 ♀s, 1 o) from *Æstrelata cooki* in New Zealand.

32. IXODES PERCAVATUS Neumann, 1906.

Figs. 215, 216.

Lit. and Icon.: Neumann, 1906, pp. 200, 201, Figs. 4, 5 (reproduced).

Male: unknown.

Female: Body oblong, lateral borders parallel, reddish brown, 6 × 3 mm. *Scutum* oval-lozenge-shaped, broadest slightly in front of the middle of its length, 1·6 × 1·3 mm.; cervical grooves very evident, attaining the posterior border; no lateral grooves; punctations very fine, numerous only peripherally, where there are some short hairs. Dorsum with fairly numerous short hairs; traces of a marginal groove. *Venter* with fewer hairs. Vulva between coxae III. Anal grooves long, parallel, shortly ogival in front. Spiracles whitish, subcircular, slightly elongate transversely. *Capitulum* short (shorter than in the figure); base trapezoid, broader behind, with slight cornua; porose areas very large[1], almost occupying the whole width, tangential in the median line;

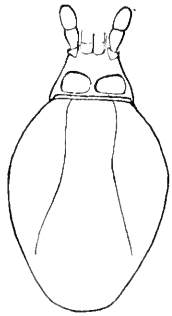


Fig. 215.

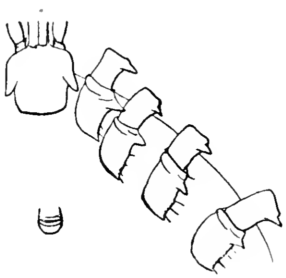


Fig. 216.

Figs. 215, 216. *I. percavatus* ♀: capitulum and scutum; forepart of venter. (Neumann, 1906, Figs. 4 and 5.)[1]

[1] N.B. Neumann's figures are slightly inaccurate in two respects: the porose areas occupy a greater proportion of the basis capituli, leaving only a narrow band in front; and the spur on trochanter 4 is smaller (not larger) than that on trochanter 3.

auricula forming a stout retrograde process. Digit? Hypostome narrow, rounded distally, 4 | 4, teeth equal. Palps short, article 2 barely longer than 3, article 1 triangular ventrally, with an anterior point internally and a posterior point. *Legs* of medium length, dark red-brown. Coxae I–III bear spurs at the postero-internal angle, the spurs diminishing in size and absent on coxa IV; coxa I bears an external spur which is slightly longer than broad, short, pointed, almost transverse; a shorter spur at the postero-external angle of coxae II–IV. *A retrograde ventral spur on the distal border of trochanters* 1–4 (see Fig. 216). Tarsi of medium length tapering obliquely, those of pair 1 long and slender.

Description based on four dried gorged ♀s, slightly mutilated, from Nightingale Island, of the Tristan d'Acunha group (W. of the Cape of Good Hope; Brit. Mus.). Species allied to *Ixodes neumanni* Nuttall and Warburton.

Ixodes percavatus var. rothschildi n. var. Nuttall and Warburton.

Male: unknown.

Female: differs from the type in the following respects: Cornua strong, and recurved dorsally; porose areas smaller, the interval equal to half their width; no retrograde spur on trochanter 4.

Nymph: resembling the ♀ in all respects, except sexual characteristics.

Described from (N. 634) 2 ♀s and 3 os, taken from a *puffin* (ex Rothschild coll., no locality recorded).

33. IXODES PILOSUS Koch, 1844.

Figs. 217–221 (original).

Lit. and Icon.: Koch, 1844, p. 233; 1847, p. 105, Pl. XXI, Fig. 79 (♀)
Neumann, 1899, p. 151; 1901, p. 288.
Lounsbury, 1900 a, p. 47; 1900 c, p. 32; 1904, p. 29.
Mally, 1904, p. 7.
Howard, C. W., 1908, p. 94.
Dönitz, 1910, p. 435, Pl. XVI b, Fig. 6 (♀: capitulum, ventral aspect; good).

The "Paralysis Tick" or "Russet Tick" of Cape Colony.

Male (Fig. 217): long-oval, 2·8 × 1·6 mm. *Scutum* oval, leaving a narrow marginal fold; cervical grooves shallow, parallel at first, then diverging; no lateral grooves; numerous unequal punctations, especially evident in the median field. Emargination moderate, scapular angles blunt. *Venter*: genital orifice between coxae III; pregenital plate twice as long as broad: median plate long, its postero-lateral borders very oblique; anus very near the posterior border; anal plate almost pear-shaped, rounded in front, narrowing behind; adanal plates with their oblique anterior border much longer than their posterior border. Spiracles very large, long-oval. *Capitulum*: base trapezoid dorsally, broader anteriorly, finely punctate, produced to a median retrograde point ventrally; palps fairly long and broad dorsally, the outer contour straight, the inner convex; hypostome strongly armed for half its length with 4 | 4 teeth, about 5 per file, terminating basally with 4 strong teeth, 2 on either side, the external the stronger. *Legs* strong, coxa I with short trenchant internal spur, coxa IV with a slight indication of an external spur; coxae II and III without spurs, but with posterior border very trenchant

Fig. 217. *I. pilosus* ♂: dorsum and venter, spiracle and tarsus 4. The ♂ to the left (N. 927) is unfed, that to the right (N. 1111) is replete. Specimens from Cape Colony, received (N. 927) from C. P. Lounsbury, and (N. 1111) from A. H. N. Pillers. (Original, G. H. F. N. del.)

Female (Figs. 218, 219): Body red-brown, with numerous rather long, white hairs. *Scutum* longer than broad, broadest at its anterior third, cordiform; lateral grooves straight, meeting the lateral borders just behind the rounded lateral angles; cervical grooves fairly distinct for about two-thirds of the scutal length, and often perceptible to the posterior margin, at first converging, then diverging gradually; emargination slight, scapular angles short but fairly sharp; punctations numerous, discrete, fairly deep, of moderate size. *Venter*: vulva between coxae IV; genital grooves nearly straight, slightly diverging; anus very posterior; anal groove short, horseshoe-shaped; spiracle fairly large, transverse-oval. *Capitulum* (Fig. 219): base sub-triangular, much broader than long, with slightly concave posterior border and with sides parallel for a short distance; cornua absent; porose areas elongate-pear-shaped, the broader ends internal, the interval fairly broad; fairly distinct auricular ridges ventrally. Palps long, the external contour noticeably concave, article 2 half as long again as article 3 which terminates bluntly. Hypostome as long as the palps, 2 | 2, but a short additional internal row of teeth (3 per file) on either side in the anterior portion; median unarmed area fairly large, especially posteriorly. *Legs* fairly strong, coxae rather elongate, coxa I with very slight internal spur, coxae II–IV without spurs, but with trenchant posterior borders, especially coxae II and III; tarsi tapering gradually, the terminal much longer than the basal segment.

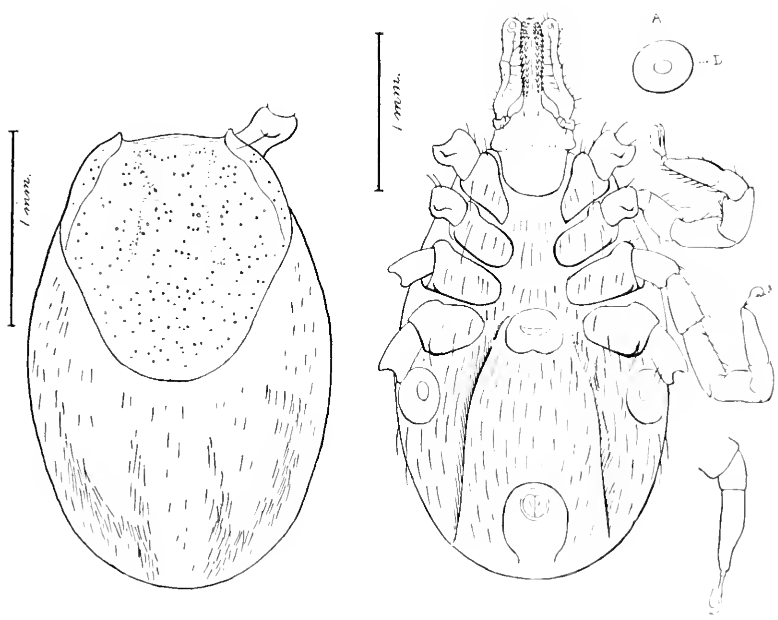


Fig. 218. *I. pilosus* ♀ (unfed): dorsal aspect of body, venter, spiracle, tarsus 4. (N. 927. Original, G. H. F. N. del.)

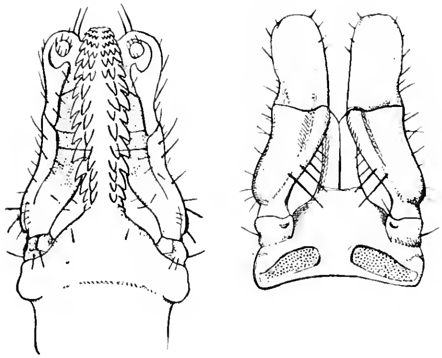


Fig. 219. *I. pilosus* ♀ : capitulum in ventral and dorsal aspects. From the same ♀ as in Fig. 218. (Original, G. H. F. N. del.)

Nymph (Fig. 220): resembles the ♀, especially in the horseshoe-shaped anal groove and a slight external concavity of the palps. The scutum is somewhat more angular, and the coxae have a fairly distinct external spur.

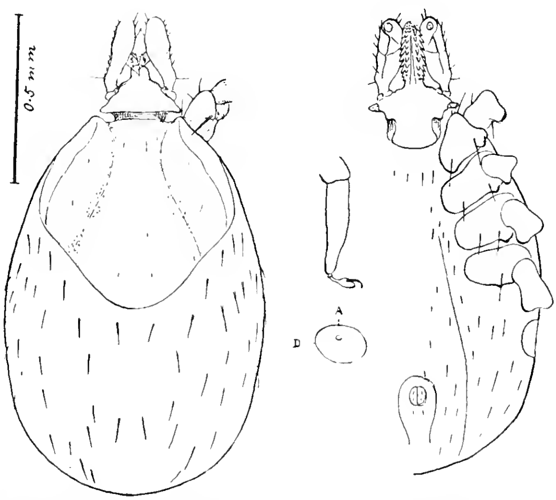


Fig. 220. *I. pilosus* o (unfed): dorsum, part of venter, tarsus 4, spiracle. Specimen from Cape Colony, sent by C. P. Lounsbury, 1906. (N. 921. Original, G. H. F. N. del.)

Larva (Fig. 221): the palps are slightly concave externally. The anal groove is generally obsolete, but when visible it conforms in shape to that of the ♀ and o.

See further under Notes on Biology (p. 316).

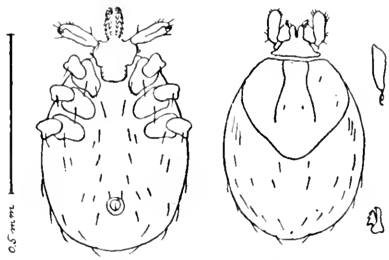


Fig. 221. *I. pilosus* larva (unfed): venter, dorsum, tarsus 3, digit. Same source as o in Fig. 220. (N. 919. Original, G. H. F. N. del.)

Origin: Koch's type, a ♀, came from S. Africa. Neumann (1899) described the species from 3 ♂ and 5 ♀ specimens from Cape Colony (E. Simon coll.), and subsequently reported (1901), after examining specimens from C. P. Lounsbury's collection, that *pilosus* is found abundantly in Cape Colony on *cattle, mules, horses* and *pigs*. Lounsbury (1900 a) observed specimens in copula on *cattle, horses, goats* and *hogs*, and (1900 b), records them as occurring at Stellenbosch; he successfully reared large numbers of larvae on *goats*; he, moreover, states (1904) that the "russet tick" is common on dogs at Stellenbosch. Mally (1904) states they occur on *sheep* in the E. Province, Cape Colony. Howard (1908) adds *man*, the *cat, leopard* and *bush-buck* to the list of hosts, and Dönitz (1910) records the species from the *civet cat* at Umtali. According to Howard and Lounsbury, it occurs in grass districts both in Cape Colony and the Orange Free State. Mr W. F. Cooper's collection contains ♀s from the *duikerbok*, Gonubie Park, S. Africa, XII. 1908.

Our drawings have been made from numerous specimens of all stages kindly presented by Mr C. P. Lounsbury, in 1906 (N. 919–923), and we have received other specimens from Cape Colony through the courtesy of Messrs E. G. Wheler (N. 924–927) and A. H. Noël Pillers (N. 1111).

Neumann has described a variety of *I. pilosus* under the name of *I. pilosus howardi*, which appears to us doubtfully good for the following reasons:

We possess numerous specimens received from Lounsbury (in whose collection Neumann, 1901, p. 288, found Koch's *I. pilosus* in abundance), and these were sent to us as co-types of *I. pilosus*. On measuring them it was found that they agreed better with Neumann's description of the var. *howardi*.

Neumann, however (in a letter dated July 27th, 1910), admits that he was mistaken in the length of the ♂ *I. pilosus*, which averages 2·8 mm. (and not 3·15 mm. as given in his description), so that the varietal differences almost disappear. The only specimen he was able to send us of *I. pilosus* var. *howardi* was a microscopic preparation of the ♀, which appears to us identical with the specimens of *I. pilosus* from Lounsbury's collection. His description of the variety is as follows:

Ixodes pilosus var. howardi Nn. 1908.

Lit.: Neumann, 17. vi. 1908, p. 125.

Howard, C. W., 17. vi. 1908, p. 126; also viii. 1908, p. 95, Pl. IV, Figs. a–k; describes ♂, ♀, larvae, eggs; figures ♂ and ♀ and details thereof somewhat sketchily.

Male: resembles the type, but is smaller, 2·3 × 1·2 mm. (type measures 3·15 × 1·6 mm.; average length 2·8 mm., see top of this page).

Female: differs from the type as follows: *Scutum* longer than broad (1·27 × 1·1 mm.), oval; cervical and lateral grooves less marked; punctations finer, less deep, more numerous; hairs less numerous on dorsum and venter. Anal grooves with branches closer together and forming an open ellipse posteriorly. *Capitulum* smaller, 0·7 mm. (instead of 0·85 in type; porose areas smaller, shallower, wider apart. *Legs* much feebler, especially the coxae. General colour, unfed, orange-red.

Description based on 2 ♂s and 12 ♀s, found on *dogs* at Leydsdorp, Transvaal, by Dr Copland and at Durban, Natal, by Dr Theiler, and sent to Neumann by C. W. Howard (Pretoria). The latter subsequently took specimens in various parts of the Transvaal, *i.e.* in the Marico, Rustenburg, Pretoria, Barberton and Zoutspansberg Districts, and at Piet Retief and Durban in more or less dry or very arid places. Howard states that "most of the localities are in the low bush veldt, but those places on the high veldt (about 4000 feet) where the tick is common, are those parts which are covered with bush, and the tick is apparently lacking in the high grass."

The principal host is the *dog*, but Howard has found specimens on a *cat*, *Erinaceus frontalis* and *Rhinolophus* sp.

34. IXODES LUNATUS Neumann, 1907.

Figs. 222, 223.

Lit. and Icon.: Neumann, v. 1907, pp. 88–90, Figs. 1 and 2 (here reproduced).

Male: unknown.

Female: *L.* 2·7, *W.* 1·8 mm., body oval, at least twice as broad behind as in front, brownish, broadest towards the posterior third. *Scutum* 1·57 × 1·39 mm., narrow, elliptical, maroon-brown, glossy, glabrous; cervical grooves faintly marked, extending two-thirds the length; lateral grooves indicated by a scarcely visible linear ridge; punctations very fine, numerous, widely separated. Dorsum covered by fairly numerous short hairs; no trace of a marginal groove. *Venter* with similar hairs, vulva between coxae IV; anal groove horse-shoe-shaped; spiracles, sub-circular, brownish, nearer to the vulva than to the anus. *Capitulum* long (mutilated in the type, but about 0·94 mm. long); basis capituli triangular, with slight cornua; porose areas medium, oval, longer than broad, the interval equal to their length, a slightly salient ridge running externally to them; auricula forming a pointed retrograde process; digit? hypostome? Palps 0·84 mm. long, narrow, cultriform, article 2 slightly longer than 3. *Legs* slender, long (pair 4 about 2·5 mm. long); coxa I bears two sharp spurs, divergent, separated, the inner longer; a shorter spur at the postero-external angle of coxae II–III, very short on coxa IV; tarsi long, tapering obliquely, pair 1 long and slender; pad almost as long as the claws.

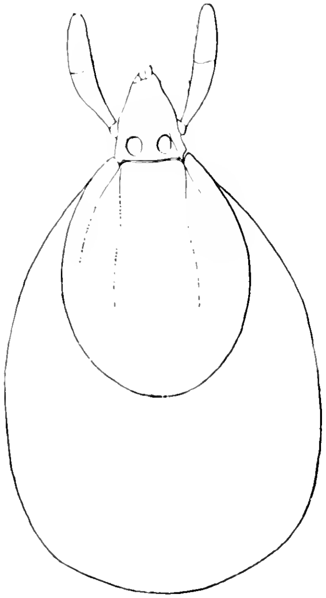


Fig. 222.

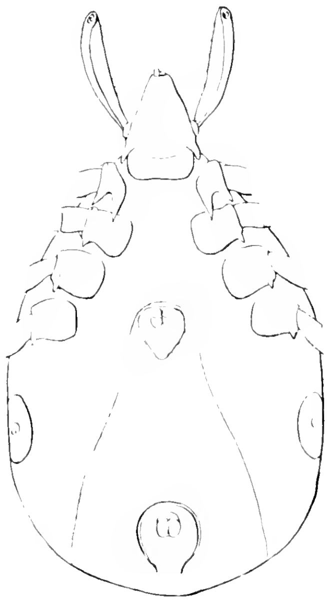


Fig. 223.

Figs. 222, 223. *I. lunatus* ♀: dorsum and venter. (Neumann, 1907, Figs. 1 and 2.)

Description based on 1 ♀ from *Hallomys audeberti* Jent. (Muridae), Madagascar (Leyden Natural Hist. Museum).

35. IXODES RASUS Neumann, 1899.

Figs. 224–226 (Fig. 225 original).

Lit. and Icon. : Neumann, 1899, pp. 137–139, Figs. 12–14 (reproduced); 1901, p. 285.

Male (Fig. 224): Body oval (2·7 × 1·6 mm., Nn.), broader behind, with posterior border rounded. *Scutum* convex, reddish brown, marginal fold narrow (0·1 mm.), uniform. Cervical grooves faint, at first parallel, then divergent. Very numerous fine, equal punctations, distributed over the whole surface. *Venter*: sexual orifice broad, opposite the second intercoxal space; pregenital plate quadrangular and finely punctate; pre-anal plate very large, broad posteriorly, punctate; *anal plate circular*, the anus eccentric, nearer the anterior rim of the circle. Spiracles large and long-oval, almost twice as long as broad, slightly tapering behind. *Capitulum* short (0·55 mm.), slightly longer than broad, broadest just behind the palps. Hypostome (Fig. 224 *C*) short and broad, sometimes slightly indented, dentition 4 | 4 to 3 | 3, the teeth increasing in size posteriorly, the rows are irregular, and the internal teeth are flat and blunt, while the external teeth are pointed, the last externals very large. (Digit; see Fig. 224 *B*.) Palps short, broadest at junction of articles 2 and 3, which are almost equal in length. *Legs* long, the last two articles of pair 4 extending beyond the abdomen. Coxae large, the first three noticeably glossy, the last punctate. A short, blunt spur at the postero-internal angle of coxa I and at the postero-external angle of coxa IV. Coxae II and III unarmed.

A *B* *C*

Fig. 224. *I. rasus* ♂: *A* venter; *B* digit, ×210; *C* hypostome, ×135. (Neumann, 1899, Fig. 12.)

Female (Figs. 225–226): Body rather short-oval, broadest at the posterior third. *Scutum* (1·9 × 1·5 mm., Nn.), reddish brown, oval, glossy, dark brown, with very numerous fine, equal punctations; cervical grooves superficial but nearly attaining the posterior border; lateral grooves barely indicated by a slightly prominent margin. Dorsum with three posterior longitudinal grooves, and with numerous punctations studded with short hairs. *Venter* with similar punctations and hairs. Vulva between coxae IV; *anal groove circular*, with anus eccentric, as in ♂. *Capitulum* long (1·3 mm., Nn.), base an equilateral triangle, with slight cornua. Porose areas oval, size variable, converging in front, the interval about equal to their breadth; auricula forming a stout retrograde process (variable in size, see Fig. 225). Hypostome lanceolate; teeth 4 | 4, then 3 | 3, finally 2 | 2, the externals stout and pointed, the internals blunt; the inner files far apart. Palps flat, cultriform, the outer border nearly straight, the inner convex; article 2 twice as long as 3. (Chelicera, see Fig. 226 *A*.) *Legs* of medium length; coxae I and II near together, the coxae somewhat separated. The coxae resemble those of ♂, but the spurs tend to become obsolete in large ♀s.

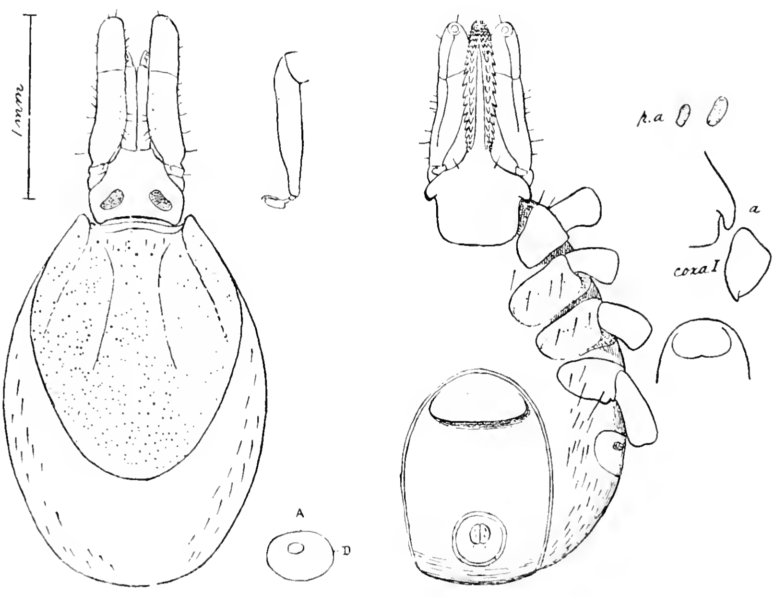
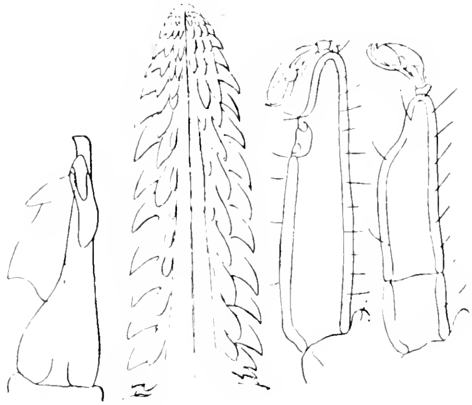


Fig. 225. *I. rasus* ♀ unfed: dorsum, part of venter, tarsus 4, spiracle. Details (to right) showing variation (*p.a.*) in size of porose areas; *a* in size and form of auricula; in coxa I (note spur) and vulval flap or apron, as observed in another specimen out of the same lot. Collected from *man* and *dog*, Kumasi, Ashanti, by W. Graham, x. 1907. (N. 928. Original, G. H. F. N. del.)



A B C D

Fig. 226. *I. rasus* ♀ : *A* digit, ×210 ; *B* hypostome, ×70 ; *C*, *D* tarsi 1 and 4. (Neumann, 1899, Figs. 13 and 14.)

Tarsi long, tapering fairly gradually; tarsus 1 nearly as long as articles 4 and 5 together; pad almost as long as the claws.

Neumann (1899, p. 139, and 1901, p. 285) records specimens from the Congo (from *Hyrax* sp., ♂ ♀ in copula, Mocquerys coll., now in Neumann coll.); from the Cameroons (Zenker and Conradt coll.); from German East Africa (Kummer and Conradt coll.), one specimen having been taken from an *Ichneumon*; and from Togo (Berlin Mus.).

Neumann, 1907 a, p. 18, reports 1 ♀, from Kilimandjaro, Kibonoto (1300–1900 metres), 17. x. 1905; 1 ♀, from Kilimandjaro, 8. x. 1905; 1 ♀, from Meru (3000–3500 metres), Regenwald, collected by the Sjöstedt Zoological Expedition, German East Africa.

We have received examples (N. 877 d) from Uganda, taken from *cattle*, which came from Bukedi to Mpumu IX. 1909 (Sir D. Bruce); from (N. 503) Obuasi, S. Ashanti, from *leopard*, and (N. 928) from Kumasi, C. Ashanti, from *man* and *dog* (Dr W. M. Graham, 1907–8).

Our description differs from that of Neumann.

36. IXODES UGANDANUS Neumann, 1906.

Figs. 227, 228.

Lit. and Icon.: Neumann, 1906, pp. 198–200, Figs. 2, 3 (reproduced).

Male (Fig. 227): Body 2·2 × 1·2 mm., contour oval, narrow in front, broadest toward the posterior third, maroon-brown. *Scutum* convex, glossy, glabrous, marginal fold narrow, about as broad on the sides as behind; cervical grooves narrow, superficial; punctations many, distant, very fine (inconspicuous). *Venter*: genital orifice broad, between coxae III. Pregenital plate rectangular, longer than broad, emarginate in front; median plate pentagonal, large, very broad behind, very finely punctate; *anal plate almost circular*, forming a very short point behind, coarsely punctate; adanal plates somewhat longer than broad, with many punctations. Spiracles large, oval, much longer than broad. *Capitulum* short (0·5 mm.), with pentagonal base, broader than long, the sides diverging in front, no cornua, the postero-ventral border undulating; no auriculae. Hypostome (Fig. 227) short, broad, 2 stout marginal teeth, the posterior stouter; the other teeth forming saw-like ridges, as figured. Palps short, articles 2 and 3 of about equal length. *Legs* of medium length, dark. Coxae broad, contiguous; a short, blunt spur at the postero-internal angle of coxa I and at the postero-external angle of coxa IV. Tarsi of medium length, tapering gradually.

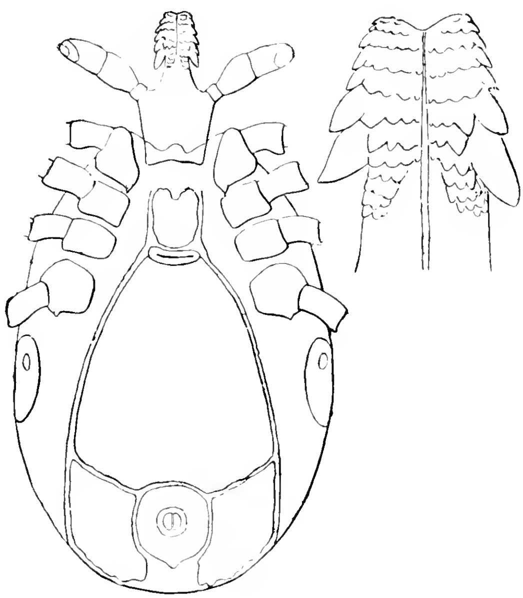


Fig. 227. *I. ugandanus* ♂: venter and hypostome. (Neumann, 1906, Fig. 2.)

Female (Fig. 228): Body short oval, 6 × 4 mm., dark brown. *Scutum* oval-lozenge-shaped, longer than broad (1·3 × 1·1 mm.), broadest slightly behind the anterior third, dark brown, glossy, slightly emarginate[1] in front, very fine punctations, slight lateral grooves[1], cervical grooves very superficial and extending beyond half the scutal length. Dorsum with many clearly visible punctations, few scattered hairs, tegumentary folds very marked and undulating; traces of three posterior grooves. *Venter* bears similar punctations, hairs and folds; vulva small, between coxae IV; *anal groove encircling the anus,* converging behind and uniting in an elongated point. Spiracles larger than coxa IV, slightly oval, with long axis transverse to the body axis. *Capitulum* narrow, 0·92 mm. long. Dorsal base rectangular, much broader than long; very slight cornua; porose areas oval (but variable), oblique, slightly converging in front, almost tangential to the posterior border, the interval equal to their width; no auriculae. Hypostome long, narrow, lanceolate, with 2 (? 3) marginal rows of teeth on each side, leaving the middle portion free. Palps long, slender, article 2 at least twice as long as 3. *Legs* slender, relatively short, maroon-brown. Coxa I prolonged by an internal spur, which is fine, about three times as long as broad at the base; coxae II–III unarmed; coxae IV with a very small external tuberosity. Tarsus 4 tapering obliquely, with a slight swelling at its base.

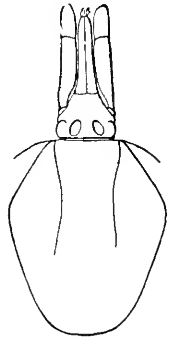


Fig. 228. *I. ugandanus* ♀: capitulum and scutum. (Neumann, 1906, Fig. 3.)

[1] Neumann states that the ♀ scutum is not emarginate and does not possess lateral grooves; that the spiracle is small, and the porose areas oval.

Neumann's original description was based on 1 ♂ and 1 ♀ in coitus, found on *Aulacodus* sp., from Uganda, collected by E. Degan (British Mus.). Neumann, 1907 a, p. 18, has since reported 1 ♂, 1 ♀, from Kilimandjaro, Kibonoto, Regenwald (2000–3000 metres), collected by the Sjöstedt Zoological Expedition, German East Africa. We have received specimens of this tick (N. 1215, ♀s), taken from a *large rodent*, Oshogbo, Eastern Province of S. Nigeria, W. Africa, 28. II. 1910 (J. J. Simpson coll., for Entomol. Res. Committee); (N. 1216, ? o), taken from *sheep*, Ibesha, W. Africa, 7. II. 1910 (J. J. Simpson).

We have modified Neumann's description of the ♀, in the light of the numerous specimens we have received.

Ixodes ugandanus subsp. djaronensis Neumann, 1907.

Lit.: Neumann, 1907 a, p. 18 (no figure).

Male: Body 1·7 mm. *l.* Capitulum 0·3 mm. *l.*, auriculae almost obsolete; digit 90 μ *l.*, with external article strongly bidentate and having two minute distal teeth.

Female: Body attaining 4·6 mm. (capitulum included) × 3·3 mm. Colour varying from yellowish white to maroon-brown. Scutum 0·95 × 0·68 mm. Capitulum 0·6 mm. *l.*, auriculae slight.

The foregoing is abstracted from the author's description. The subspecies is stated to differ from the type in being smaller, and having slight auriculae.

Described from 1 ♂ and 10 ♀s, found on *Genetta suadelica* Mtsch., 23. VII. 1905, Kilimandjaro, Kibonoto, and 1 ♀, from Meru, Regenwald (3500 metres), collected by the Sjöstedt Zoological Expedition, German East Africa. We possess (N. 1222) 1 ♀, found on *Procavia brucei*, Harar, Abyssinia, 1901, collected by Dr H. Brumpt, which we refer to this subspecies.

37. IXODES CORDIFER Neumann, 1908.

Fig. 229.

Lit. and Icon.: Neumann, VII. 1908, p. 73, Fig. 1 (reproduced).

Male: Body oval, twice as broad behind as in front; 3·5 × 2 mm. (width at spiracles). *Scutum* brownish yellow, glossy, slightly convex, covering the whole dorsum; cervical grooves very short and very shallow; punctations fine, numerous, finer and less numerous longitudinally over the whole median third, the punctations absent in two symmetrical, longitudinal and sinuous depressions occupying the anterior two-thirds, where they are limited outwardly by a linear prominence indicating a lateral groove. *Venter* concave; hairs few and very short; genital orifice broad, between coxae II; pregenital plate short, rather broader than long; median plate quadrangular, narrow in front, much longer (1·7 mm.) than broad (1·1 mm. posteriorly); anal plate cordiform, as broad as long, with anterior border straight, sides convex and forming a point behind, with fine punctations; adanal plates twice as broad at the posterior border as in front[1], finely punctate and fused behind the point of the anal plate; spiracles large, oval, much longer than broad. *Capitulum* yellowish, short (0·6 mm.), with pentagonal dorsal base, as broad as long; lateral borders slightly diverging in front, ending at the insertion of the palps; posterior borders straight, without salient angles; no auriculae; hypostome short, broad, 2 | 2, with rounded teeth. Palps short, broad; article 1 transverse; articles 2 and 3 apparently fused, constricted at the base and very broad dorsally along most of the length. *Legs* dirty yellow, long, stout; coxae broad,

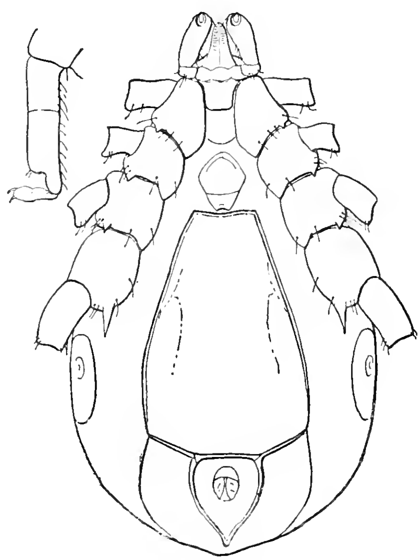


Fig. 229. *I. cordifer* ♂: venter and tarsus 4. (Neumann, 1908, Fig. 1.)

[1] Neumann's figure, reproduced here, appears to be inaccurate in this respect.

contiguous, with four long hairs at the posterior border; a spur at the postero-external angle, increasing in size from I–IV, where it is about thrice as long as broad; a short flat spur at the postero-internal angle on coxae I–III, decreasing in size backward. Tarsi long, tapering abruptly (step-wise); claws long, pad almost as long.

Female: unknown.

From description by Neumann, based on 1 ♂ from Sekroe, New Guinea, collected by S. Schädler (Leyden Mus. Nat. Hist.). In general form this species approaches *I. holocyclus* (which is Australian) rather than *I. rasus* (which is African).

38. IXODES HOLOCYCLUS Neumann, 1899.

Figs. 230–232.

Lit. and Icon.: Neumann, 1899, pp. 151–155, Figs. 24–26 (reproduced).

Male (Fig. 230): Body oval, broader behind, posterior border rounded, 3 × 2 mm., reddish yellow all over. *Scutum* convex, marginal fold narrow; cervical grooves short, continuous in front with the lateral grooves which attain the posterior border. No punctations nor hairs. *Venter*: sexual orifice broad, facing the second intercoxal space. Pregenital plate hexagonal, one-third broader than long. Anal plate longer than broad; anal grooves at first straight and parallel, then curved and converging backward without uniting at the posterior border. Median plate very long, very broad behind, covered with short hairs. Adanal plates in the form of oblique parallelograms. Spiracles almost twice

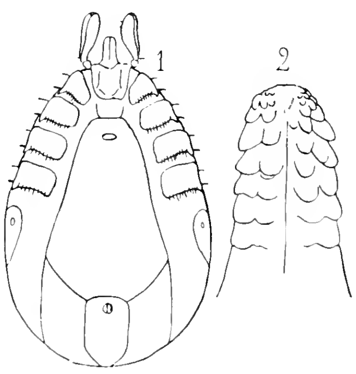


Fig. 230. *I. holocyclus* ♂: 1, ventral aspect; 2, hypostome, × 75. (Neumann, 1899, Fig. 24.)

as long as broad, tapering much behind, whitish. *Capitulum* short (0·6 mm.), its base quadrangular, scarcely broader than long. (Digit, see footnote[1].) Hypostome (Fig. 230) short and broad, with some blunt denticles in front, then 2 | 2 files of 5–6 blunt teeth. Palps as in ♀ but shorter, scarcely twice as long as broad. *Legs* with coxae contiguous, with spur slightly stouter than in ♀; legs thicker, with shorter articles, more enlarged distally.

Female (Fig. 231, unfed): Body flat, oval, yellowish, 3·2 × 1·7 mm., a complete marginal groove limiting a marginal fold of equal width throughout. When fully gorged, the body is oval, broader behind, contracted on a line with the spiracles, the largest specimen 15 × 11 mm., and 9 mm. thick. Integument finely striated, with short hairs, few and scattered. *Scutum* reddish yellow, almost oval, slightly longer (2·3 mm.) than broad (2 mm.), flat in the median field, the sides convex; cervical grooves convergent, short and superficial; lateral grooves clearly marked, attaining the posterior border, accentuated by an external ridge; punctations very numerous, subequal, confluent in places. Dorsum: grooves normal. *Venter*: vulva behind the level of coxae III (variable). Sexual grooves very divergent, then curving toward each other at the level of the anus, ending on the posterior border. Anus rather posterior, in an elongate depression; anal grooves parallel, then convergent behind, where they unite in a point on the median line. Spiracles very small, circular, reddish, placed toward the middle of the length, distant from coxae IV. *Capitulum* long (1·3 mm.), reddish yellow; base short, pentagonal, broader than long, posterior border fairly straight, lateral borders sub-parallel, then convergent in a cone anteriorly; porose areas deep, oval, elongate in the direction of the axis; auricula forming a retrograde horn. (Digit, see footnote[2].) Hypostome (Fig. 231) long, narrow, lanceolate, numerous small sharp teeth, followed by 3 | 3 files of 12–13 stout teeth, increasing[3] in size from within outward in each transverse series, the median files far apart. Palps much longer than hypostome; article 1 thick, salient outward near the base; article 2 at least twice as long as 3, the whole palp cultriform, broadened dorsally, concave

[1] Digit 160 μ long; dorsal process (?); external article 4-toothed, the two anterior teeth very small, the others strong.

[2] Digit 210 μ long; dorsal process a longitudinal crescent, with retrograde teeth, prolonged down to the lower third of the digit by its shaft of insertion; external article elongate, with five teeth of increasing size.

[3] Neumann states they diminish outwardly, but this does not agree with the figures nor with our specimens.

outside: article 4 very small, subterminal. *Legs* reddish yellow, long. Coxae large, trapezoid, separated by intervals almost equal to their width, a postero-external spur decreasing in size from coxae I to IV; long white hairs on the posterior coxal border. Similar hairs on the ventral border of the other articles. Tarsus 1 as in *I. ornithorhynchi* (see Fig. 237); tarsus 4 almost four times as long as broad, abruptly tapering, the pseudo-articulation nearer the proximal extremity of the article; claws short, the pad almost reaching their tips.

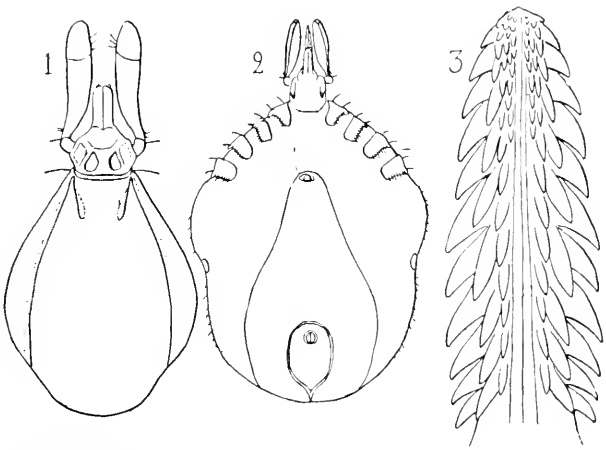


Fig. 231. *I. holocyclus* ♀ (partially gorged): 1, capitulum and scutum in dorsal aspect; 2, venter; 3, hypostome, ×75. (Neumann, 1899, Fig. 25.)

Nymph (Fig. 232): differs from ♀ as follows: Body oval, 2·6 × 1·3 mm. (broadest on a line with the spiracles). *Scutum* 1 × 0·7 mm. *Capitulum* 0·88 mm. long (dorsally); base more conical. (Digit, see footnote[1].) Hypostome narrower, sharper, with 2 | 2 files of 13–14 teeth, the external stout, pointed, the internal blunt Palps without apparent articulation separating articles 2 and 3. *Legs* 4 extending beyond the posterior border of the body to at least the length of the tarsi; coxal spurs feebler.

Description based on 2 ♀s and 1 ♂ collected from Australian sheep; 1 ♀ from *Phascogale penicillata* (Marsupial Tree-shrew) at Port Stephens, Australia; 1 o from *Sciurus variabilis* in India (British Museum); 1 gorged ♀ from a *dog* in Queensland (Bur. Animal Industry, Wash.); 2 gorged ♀s of unknown origin (Hamburg Museum); 1 unfed ♀ from N. S. Wales, and 1 o from E. India (?) (Berlin Museum); 1 microscopic specimen of a o from a *red squirrel* from

[1] Digit 115 μ long; dorsal process a subterminal hook at the end of a narrow shaft.

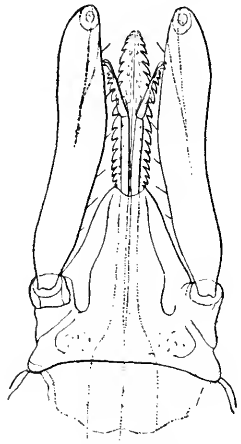


Fig. 232. *I. holocyclus* ○: dorsal aspect of capitulum, × 88 μ *l.* (Neumann, 1899, Fig. 26.)

India (R. Blanchard coll.). Neumann (1901, p. 288) states it has been found on *calves* in N. S. Wales (Bur. of Agr., N.S.W.). We have received (N. 644) 2 ♀s from W. Australia, VII. 1900, from *Macropus* sp., also (N. 643) 2 ○s from W. Australia which we attribute to this species (ex Rothschild coll.). W. F. Cooper's collection contains specimens (♀) from Lismore, Tweedline, Queensland, x.1907 (S. R. Scott) and (♂, ♀) received from the Dept. of Agriculture, Brisbane, Queensland.

39. IXODES SCHILLINGSI Neumann, 1901.

Figs. 233 (Neumann) and 234, 235 (original).

Lit. and Icon.: Neumann, 1901, pp. 288, 289 (♀, no figure).
Neumann, 1910, pp. 170–172, Fig. 10 (♂, reproduced).

Male (Fig. 233): Body oval, 2·3 × 1·38 mm., broadest in front of the spiracles about midway along body-length. *Scutum* maroon-brown, slightly glossy, convex, glabrous, marginal fold bearing very short hairs; cervical grooves doubtful; very many large, subequal punctations, absent only on three small areas situate on the posterior third; two symmetrical punctate depressions midway along the length; deeply emarginate; scapulae prominent. *Venter* flat, very short equidistant hairs; sexual orifice facing the second intercoxal space; median plate pentagonal, narrowing in front, longer than broad (0·89 × 7·2 mm.); anal plate small, racket-shaped, with quadrangular prolongation behind adanal plates with straight anterior border, the convex external and concave internal borders uniting in a point behind; all the plates bear shallow medium punctations. Spiracles large, oval, orientated lengthways to body. *Capitulum* dark, short (0·5 mm. *l.*); dorsal base pentagonal, as broad as long, lateral borders slightly diverging in front, posterior border straight, no cornua; auriculae pointed, with median point arising from ventral ridge (tricuspid appearance); digit 135 μ *l.* (see Fig. 233). Hypostome short, broad, with six transverse rows of 6–8 rounded teeth and a large basal tooth on each side equal in length to the others collectively. Palps short, broad dorsally; article 2 broader than long, barely as long as 3. *Legs* maroon-brown, pair 4 very long, the last two articles extending beyond the posterior border of the body. Coxae with trenchant posterior border; coxa I triangular, with very small spur postero-internally; II and III subquadrangular, likewise with small spur as on I; IV longer than broad, with small postero-external spur. Tarsi long, tapering abruptly (see Fig. 233); pad almost as long as claws.

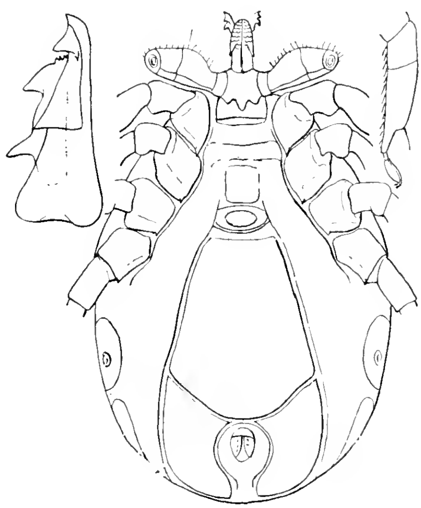


Fig. 233. *I. schillingsi* ♂: venter, left digit in ventral aspect, tarsus 4. (Neumann, 1910, Fig. 10.)

Female (Fig. 234): Body relatively short, narrowed in front, much dilated toward the middle of its length in front of the spiracles, rounded posteriorly; *L.* 4·3 mm., *W.* 3·5 mm., yellowish white. *Scutum* reddish brown, much longer than broad (1·5 × 1·1 mm.), broadest toward the anterior third; emargination slight; cervical grooves superficial at first, then fairly deep and diverging slightly to the middle of the postero-lateral border; no lateral grooves, punctations very numerous, deep, equal. Dorsum bearing a few scattered hairs, finely striated. *Venter* with hairs more numerous, similar striations. Vulva facing coxae IV; sexual grooves nearly straight, slightly divergent, then slightly convergent posterior to the anus. Anus situated far posteriorly; *anal plate forming an ellipse,* disappearing posteriorly in a short prolongation. Spiracles subcircular, whitish, very posterior, far from coxae IV. *Capitulum* 0·9 mm. long; base an equilateral triangle; porose areas subtriangular, broadened transversely, large, shallow, the interval wide; auricula forming a sharp retrograde hook. Hypostome long, narrow, lanceolate, pointed anteriorly, with pointed teeth, numerous and small in front, then 3 | 3, followed by 2 | 2 files of 12–13 teeth extending almost to the base, the internal files much separated, especially posteriorly. Palps long, narrow, widest in the middle of article 2, scarcely extending beyond the hypostome, much separated at their base, then curving inward; article 3 elongate, nearly as long as article 2. *Legs* of medium length. Coxa I with a very sharp, narrow, internal spur and short strong external spur; II and III trenchant on their posterior border; the trenchant edge ending abruptly externally; coxa IV with a slight

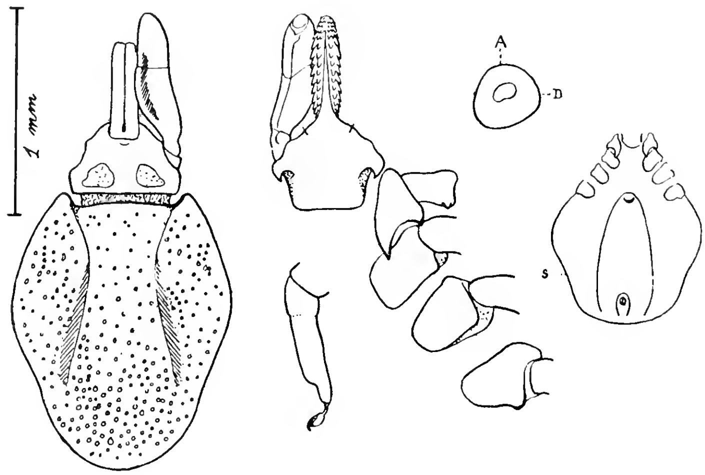


Fig. 234. *I. schillingsi* ♀: capitulum and scutum, capitulum in ventral aspect with coxae, tarsus 4, spiracle, slightly magnified view of venter, *s* indicating position of spiracle. Drawn from (N. 1171) co-type; presented by the Berlin Museum. (Original, G. H. F. N. del.)

indication of a spur at the postero-external angle. A very slight tooth, ventrally, at the distal extremity of the trochanters of each leg. Tarsi long, especially those of pairs 1 and 4, tapering fairly abruptly near to their extremities; pad almost as long as the claws.

Nymph (Fig. 235): resembles the ♀ but the scutum is broader; the punctations on the scutum, though deep, are not so numerous, and there is a slight external spur on all the coxae.

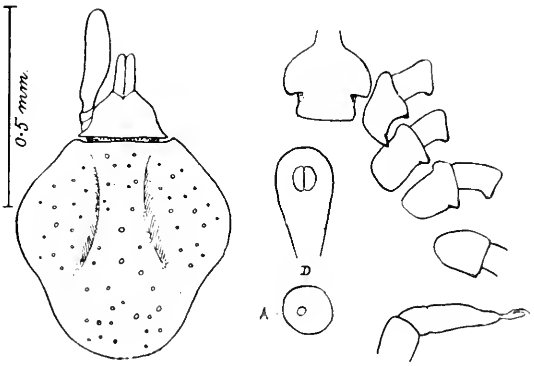


Fig. 235. *I. schillingsi* o: capitulum and scutum, ventral aspect of (mutilated) capitulum with coxae, anal groove, spiracle and tarsus 4. Specimen from the same source as preceding. (Original, G. H. F. N. del.)

Our description of the ♀ and o is based on (N. 1171) 1 ♀ and 2 os presented by the Berlin Museum from among Neumann's types (12 ♀s, etc.) from *Colobus caudatus*, a monkey, from German East Africa (Schillings coll.). According to Schillings, as stated by Neumann, this tick fixes itself exclusively on the eyes, especially in young monkeys, one eye being often lost. Neumann, 1907 a, p. 18, reports 2 ♀s and 1 o, found on *Colobus caudatus*, Kilimandjaro, Kibonoto, 3. VII. 1905, and 1 ♀ found in the same locality on *grass*, 12. VII. 1905, collected by the Sjöstedt Zoological Expedition, German East Africa. Neumann (1910, p. 171) has recently described the ♂ from a specimen found in copula, collected by G. Vasse in 1907, in Mozambique, Province of Gorongoza (Paris Mus.); the description we give of the ♂ is condensed from Neumann, who states that the 2 ♀s collected with the ♂ were somewhat larger than the types (7 mm. *l.*, including capitulum).

40. IXODES ORNITHORHYNCHI Lucas, 1845.

Figs. 236–238 (Fig. 236 original).

Lit. and Icon.: Lucas, 1845, p. 58, Pl. I, Figs. 3, 3 a, 3 b, ♀ dorsum and venter. Pagenstecher, 1861, p. 40, Pl. II, Fig. 25, hypostome and digit (nymphs). Neumann, 1899, pp. 142–144, Figs. 18, 19 (reproduced).

Male: unknown.

Female (Fig. 236, gorged): Body long and narrow, with lateral borders almost straight and parallel, attaining 7 × 4 mm., body, capitulum and legs earthy yellow. *Scutum* considerably shorter than broad (1·2 × 1·9 mm.), only slightly emarginate; antero- and postero-lateral borders very divergent, slightly convex, posterior angle very broad and rounded; cervical grooves shallow, divergent, broad, disappearing anteriorly; very many very fine equal punctations; no lateral grooves. Integument very finely wrinkled, covered by fine short hairs. Dorsum: a complete marginal groove only visible in the unfed tick close to the border (Fig. 236). *Venter*: vulva narrow, facing the second intercoxal space; sexual grooves very long, sinuous, only slightly divergent, attaining the posterior border; anus situated far behind, anal grooves slightly or not divergent. Spiracles large, almost circular, milky white. *Capitulum* short, with pentagonal or subtriangular base at least twice as broad as long; porose areas very large, rounded. (Digit, see Fig. 238 *C*.) Hypostome (Fig. 238 *H*) short, bearing 3 | 3 files of 7–8 teeth. Palps thick, with base distant from the hypostome; article 2 about twice as long as 3. *Legs* long, grouped in the anterior third of the body in gorged specimens. Coxae elongate, unarmed, punctate, flat, trenchant at the posterior border; legs long, relatively narrow, haired. Tarsus 1 (Fig. 237) thrice as long as broad, cylindrical, slightly humped near the tip, with obsolete pseudo-articulation; tarsus 4 four times as long as broad; the basal pseudo-article broader than the distal, which tapers dorsally. Claws short, pad two-thirds the length of the claws.

Nymph (*Ixodes ornithorhynchi* Pagenstecher): resembles ♀. Body relatively broader (3 × 1·5 mm.), oval, the colour varying from brownish yellow to earthy yellow. *Capitulum* with base relatively shorter and broader, without porose areas. Digit 85 μ long, as in ♀. Hypostome with 2 | 2 files of 5 teeth.

Neumann was the first to describe the species adequately from (*a*) six ♀s, from the Paris Museum, of which five were from the *Ornithorhynchus* (Lucas coll.), and one from the Marianne Islands, collected

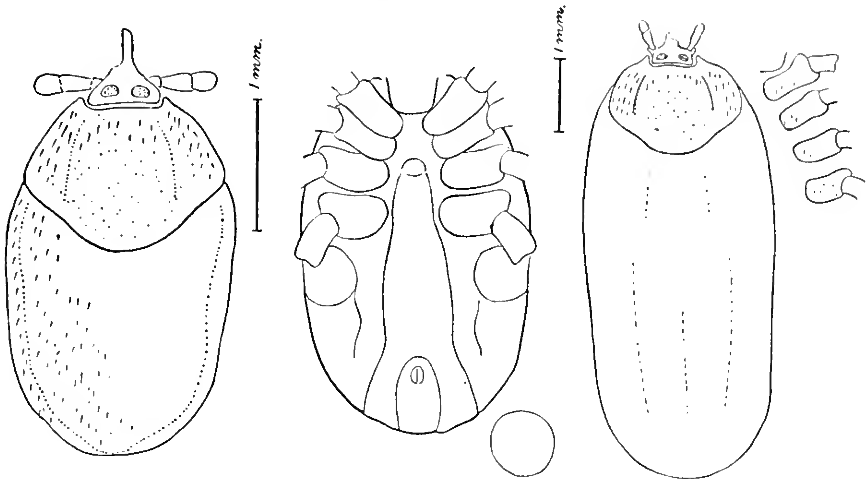


Fig. 236. *I. ornithorhynchi* ♀: to left, an unfed ♀, dorsum, venter and spiracle. Type in Paris Mus. To right, a replete ♀, dorsum and coxae (the latter not to scale), from specimen in Mégnin coll.; body 5·5 mm. *l.* (Coll. Lab. de Parasitol., Paris. Original, G. H. F. N. del.)

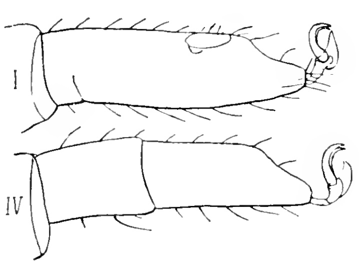


Fig. 237.

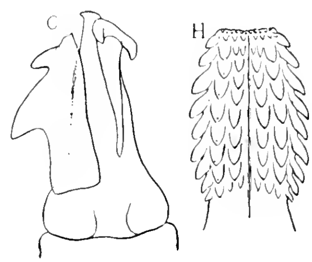


Fig. 238.

Fig. 237. *I. ornithorhynchi* ♀: tarsi 1 and 4, ×45. (Neumann, 1899, Fig. 19.)
Fig. 238. *I. ornithorhynchi* ♀: *C*, left digit viewed dorsally to one side, 150 μ *l.*; *H*, hypostome, ×75. (Neumann, 1899, Fig. 18.)

by A. Marche. (Lucas states that this species attaches itself especially to the sides of the belly near the anal and genital regions, and also on the back); (*b*) 30 ♂s, collected by Jules Verreaux in Tasmania in 1843 (Paris Museum). (Pagenstecher records several from *Ornithorhynchus*; he took them for females); (*c*) three ♀s, from the *Ornithorhynchus* (Mégnin coll.). Neumann (1901, p. 285) states that this tick has also been found on the legs of *Ornithorhynchus* (coll. Bureau of Agriculture, N. S. Wales). Our figures are drawn from Lucas' types and specimens in the Mégnin collection (now in the Lab. de Parasitol., Paris).

41. IXODES TASMANI Neumann, 1899.

Figs. 239 (Neumann) and 240 (original).

Lit. and Icon. : Neumann, 1899, pp. 144, 145, Fig. 20 (reproduced).

Male: unknown.

Female (unfed): Body flat, oval, reddish yellow, the scutum, capitulum and legs being darker; 3·2 × 1·6 mm. (greatest breadth on a line with coxae III). Dorsum with complete marginal groove, limiting a marginal fold of uniform width. When gorged, the body is ovoid, swollen dorsally, almost as thick as broad, broader behind, 10 × 7 mm., yellowish brown, glabrous, or bearing short hairs. Integument transversely striated, covered by small, regularly disposed varrucosities. *Scutum*[1] slightly broader (1·5 mm.) than long, the antero-lateral borders divergent, subrectilinear, with rounded lateral angles, and short, wavy postero-lateral borders soon disappearing in the broadly rounded posterior border; cervical grooves shallow, divergent; many fine and equal punctations; no lateral grooves. The dorsum shows traces of the usual grooves. *Venter*: vulva narrow, facing the antero-internal angle of coxae III; sexual grooves divergent, very long, extending slightly over on to the dorsum. Anus toward the posterior third; anal grooves parallel, then approaching each other slightly behind, where they also extend over on to the dorsum. Spiracles whitish, transversely oval. *Capitulum* short (750 μ), base twice as broad as long, hexagonal (due, apparently, to the fusion of the enlarged basal article of the palp with the basis capituli); porose areas large, oval, close together. Digit ? Hypostome (Fig. 239 *B*) markedly spatulate, with broad corona, bearing 3|3 files of 9–10 teeth, of about equal size in each transverse row, decreasing in size from in front backward, and continued by 4–5 rows of blunt and salient teeth. Palps flattened, much separated and narrow at their base, very broad at their distal half; the articulations between articles 2–3 obsolete, article 1 forming a curious structure surrounding the hypostome. *Legs* of medium length, grouped, in gorged specimens, on the anterior quarter of the body, the tips of the fourth pair scarcely extend beyond the spiracles, the movable articles being cylindrical. Coxae trenchant; tarsi almost identical with those of *I. ornithorhynchi* (Fig. 237). Claws short; pad almost reaching their free extremities.

[1] There is a noticeable variation in the shape of the scutum in the types. Those collected by Verreaux in 1843 (Paris Mus.) have a scutum very much as figured by Neumann (see Fig. 239 *A*).

Neumann's description was based on one unfed and two gorged ♀s, collected by Verreaux, the ornithologist (1847), in Tasmania; one unfed and one gorged ♀ from the Island of St Pierre (Ponafidin ?) (Paris Mus.), and one gorged ♀, of unknown origin (Berlin Mus.). Hosts probably birds.

We have somewhat altered the description given by Neumann, after having examined the types, one of which we figure.

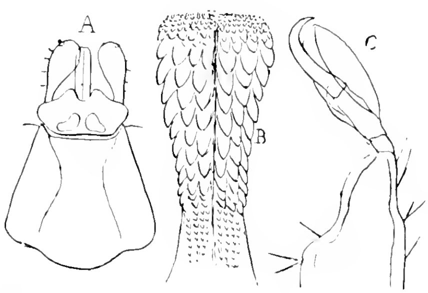


Fig. 239. *I. tasmani* ♀: *A*, capitulum and scutum; *B*, hypostome, ×105; *C*, tarsus 1, ×70. (Neumann, 1899, Fig. 20.)

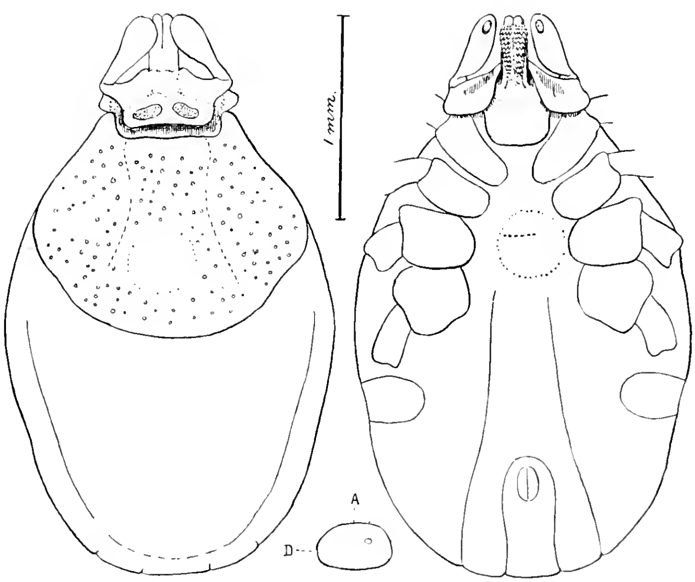


Fig. 240. *I. tasmani* ♀ (type, unfed): dorsum and venter, spiracle. Verreaux coll., 1847; a pinned specimen. (Paris Mus. Original, G. H. F. N. del.)

42. IXODES TENUIROSTRIS Neumann, 1901.

Pl. V, Figs. 1, 2, original. Figs. 241–244 (242–244 from Neumann, 241 original).

Lit., etc.: *Ixodes tenuirostris* Neumann, 1901, p. 286, Figs. 5, 6 (♀, reproduced).
Ixodes tenuirostris Neumann, 1902, p. 119, Fig. 5 (♂, reproduced).
Ixodes tenuirostris in Wheler, 1890, p. 40; 1906, p. 414, Figs. 23, 24 (♀ capitulum, ♂ dorsum, photographed).
? *Ixodes triangulieeps* Birula, 1895. See Notes on Doubtful Species (p. 293).

Male (Pl. V, Fig. 1; Figs. 241, 242): Body regularly oval, small, reddish yellow all over. *Scutum*: 1·5 × 0·8 mm., glossy, convex, marginal fold narrow; very slightly emarginate; cervical grooves very faint, shallow, divergent; no lateral grooves; some very short sparse hairs on the posterior border; punctations extremely minute and inconspicuous. *Venter*: sexual orifice large, facing the posterior borders of coxae II; median plate scarcely longer than broad; anal plate very narrow anteriorly, very broad posteriorly, almost triangular, with sides very divergent and subrectilinear; adanal plates trapezoid, considerably broader in front than behind; a few inconspicuous short hairs. Spiracle rather large, subcircular, with its posterior border rather straight. *Capitulum* short (0·33 mm. Nn.), with base slightly broader in front than behind, shagreened, with lateral and posterior margins ridge-like. Hypostome short and broad, some denticles distally, followed by 2|2 files of 3 to 4 short stout teeth succeeded by squamiform teeth. Palps short, thick, convex dorsally, much separated at the base, with long axes converging in front. *Legs*: coxae rather short and broad, without spurs, but with posterior borders somewhat trenchant; tarsus 4 rather long, tapering gradually.

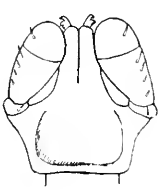


Fig. 241.

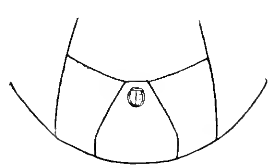


Fig. 242.

Fig. 241. *I. tenuirostris* ♂: capitulum in dorsal aspect. From the type at the British Museum. (Original, sketch by G. H. F. N.)

Fig. 242. *I. tenuirostris* ♂: posterior part of venter. (Neumann, 1902, Fig. 5.)

Fig. 1.

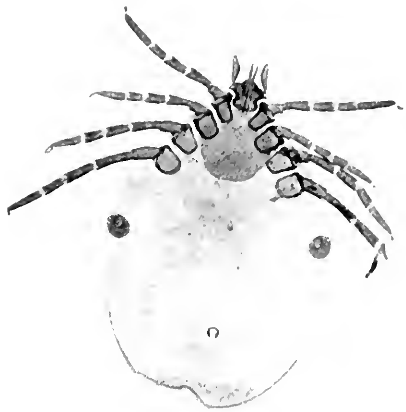


Fig. 2.

Fig. 3.

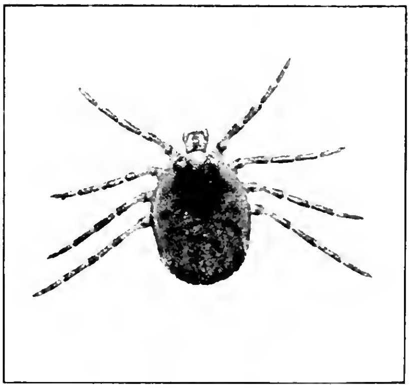


Fig. 4.

Figs. 1, 2. *Ixodes tenuirostris.*

Fig. 1. ♂ venter. (Original, E. G. Wheler, phot.)
Fig. 2. ♀ venter, mounted specimen, ×11. (Original, E. G. Wheler, phot.)

Figs. 3, 4. *Ixodes putus.*

Fig. 3. ♂ dorsum, ×7. (Wheler, 1906, Fig. 26.)
Fig. 4. ♀ dorsum, ×7. (Wheler, 1906, Fig. 25.)

(All specimens of British origin.)

Female (Pl. V, Fig. 2; Figs. 243, 244): Body lead-coloured, elongate-oval, may attain 8 × 5 mm. in fully gorged specimens. *Scutum*: 0·8 × 0·7 mm., broadest near the posterior end; antero-lateral borders subrectilinear, divergent, united by a broadly rounded posterior border; emargination slight; surface uniform, glossy, without cervical grooves, punctations inconspicuous; lateral grooves straight, parallel to the borders, very fine. Dorsum covered by fine hairs, short, scattered; in the posterior third a horseshoe-shaped groove open posteriorly, and in the space which it circumscribes a median groove extending more posteriorly. *Venter* with hairs somewhat more abundant. Vulva large, facing coxae III. Sexual and anal grooves very divergent, the latter ogival in front of the anus; spiracles whitish, rather obliquely oval, narrowed antero-dorsally. *Capitulum* small (0·5 mm. Nn.); base (+ article 1 of palps which are fused with it) subtriangular dorsally, twice as broad as long, the sides rounded, the posterior border somewhat concave, porose areas round, covering the greater part of the dorsal surface, the interval equal to about half their diameter. Hypostome narrow, with 2 | 2 files of 7–8 blunt teeth. Palps narrow, the first article in the form of a stout spur, directed transversely outward and fused with the base, article 2 very narrow at its base and widening gradually, twice as long as 3. *Legs* weak, short. Coxae as in the ♂; tarsi slender, tapering gradually; pad almost as long as claws.

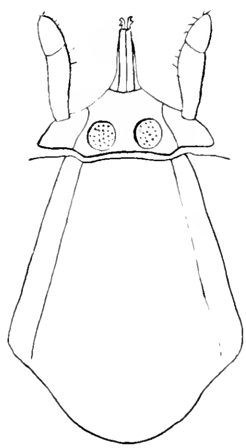


Fig. 243.

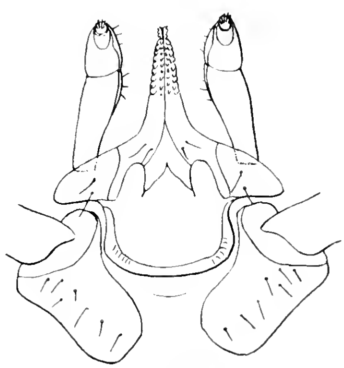


Fig. 244.

Fig. 243. *I. tenuirostris* ♀ : capitulum and scutum (too long). (Neumann, 1901, Fig. 5.)
Fig. 244. *I. tenuirostris* ♀ : capitulum and coxae I. (Neumann, 1901, Fig. 6.)

Nymph: resembles the ♀ in its essential characters, except that the spur on article 1 of the palp is more salient ventrally than laterally.

Larva: resembles the o, but the scutum is comparatively shorter and broader.

This species appears particularly to infest small Mammalia. Neumann first recorded the tick (three ♀s, two os) from *Evotomys glareolus*, Island of Rügen (Lemm coll., Berlin Mus.) and (one ♀) from "*Arvicola pratensis*," Painswick, Gloucestershire, England (E. G. Wheler's coll., 1893). The ♂, first described by Neumann, was found on *Evotomys glareolus*, Swansea, Wales (type, C. Oldham coll., British Mus.). Evans (1907, p. 36) found the o on *Arvicola amphibius* var. *ater* in Kincardineshire, Scotland (October). We have received specimens from the following hosts and localities:

Great Britain: (N. 623, ♀) from *Microtus agrestris* (field vole), Tring, Herts.[1] (N. 1165, ♀s), from *field vole*, Longner Hall, Shrewsbury, VIII. 1910 (R. F. L. Burton). (N. 622, ♀), from *Microtus amphibius* (water vole), England, IV. 1892[1]. (N. 620, ♀) from *Mus minutus* (harvest mouse); no particulars[1]. (N. 356, larvae), from *Sorex minutus* (pigmy shrew), Grippetts, Gloucestershire, I. 1908 (E. A. Wilson). (N. 621, os), from *Sorex vulgaris* (common shrew), Bevendean, Sussex, VI. 1899[1].

Switzerland: (N. 624, 625, 1069, a ♂ captured with mouthparts buried in ♀'s body close to anus, ♀s and os) from *Microtus arvalis*, Campfer, St Moritz, Engadine, VII. 1904 (K. Jordan)[1]. (N. 619, ♂ and ♀), from *Evotomys glareolus* (bank vole), Campfer, St Moritz, Engadine, VII. 1904 (K. Jordan)[1]. (N. 1161, ♀), from Tarasp, summer of 1901[1].

43. IXODES FECIALIS Warburton and Nuttall, 1909.

Fig. 245.

Lit. and Icon.: Warburton and Nuttall, 1909, pp. 58, 59, Figs. 1 and 2 (reproduced).

Male: unknown.

Female (gorged): Body long, cylindrical, 8 × 4 mm., dark brown, with yellow scutum, capitulum and legs. *Scutum*[2] rather longer than broad (1·5 × 1·3 mm.), broadest near the posterior end; uniformly punctate except along the cervical grooves, which are otherwise obsolete; the

[1] Ex N. C. Rothschild coll.

[2] Recalling a conventional form of heraldic shield, hence *fecialis*.

sides straight and diverging posteriorly; lateral grooves indicated by a prominent ridge of darker colour, sparsely punctate and parallel with the lateral border; scapulae blunt; emargination moderate. Dorsum minutely punctate, and thickly studded, especially in the posterior portion, with very short white hairs. *Capitulum*: base, a triangle, longer than broad, with wing-like lateral projections hollowed dorso-laterally to receive the palps; porose areas long-oval, rather near together, very close to the posterior border, which is somewhat sinuous; palps medium, flat, the second article twice as long as the third; hypostome truncate, with parallel sides, 2|2 equidistant files of stout teeth, 9 per file. *Venter*: vulva between coxae IV; spiracle rather small, transverse oval, somewhat pointed dorsally, far from coxae IV; anal groove long, ill-defined in front but apparently somewhat ogival; the sides nearly parallel. *Legs* yellow, slender. Coxae unarmed but with posterior border somewhat blade-like; coxa I with strong anterior projection embracing the *basis capituli* collar-wise, its posterior edge straight; coxae II–IV with posterior edge increasingly curved, coxa IV being subcircular. Tarsi tapering gradually.

Described from (N. 650) one gorged ♀ from *Dasyurus geoffroyi*, Cranbrook, W. Australia, III. 1900, presented by the Hon. N. C. Rothschild.

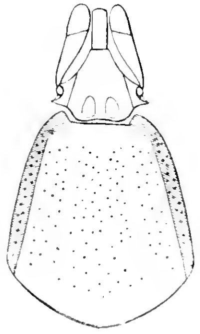


Fig. 245 *A*.

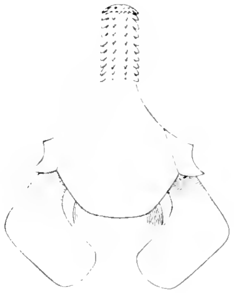


Fig. 245 *B*.

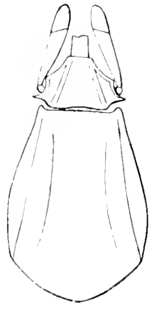


Fig. 246.

Fig. 245. *I. fecialis* ♀; *A*, capitulum and scutum; *B*, ventral aspect of capitulum with coxae I. (Warburton and Nuttall, 1909, Figs. 1, 2. Sketch by C. W.)

Fig. 246. *I. fecialis*, var. *aegrifossus* ♀: capitulum and scutum. (Warburton and Nuttall, 1909, Fig. 3. Sketch by C. W.)

Ixodes fecialis var. aegrifossus Warburton and Nuttall, 1909.

Fig. 246.

Lit. and Icon.: Warburton and Nuttall, 1909, pp. 59, 60, Fig. 3 (reproduced).

Male: unknown.

Female (Fig. 246): differs from the type in the following respects: *Scutum* narrower (1·4 × 1 mm.), more pointed posteriorly, with punctations almost obsolete. *Capitulum*: base with the median triangular region distinctly marked off by ridges from the lateral regions; porose areas hardly visible (*aegrifossus*); hypostome?

Described from (N. 339) three mutilated ♀s taken from an *opossum*, Tamberine Mountain, Logan river, S.E. Queensland, IV. 1907, and labelled "Scrub-ticks," sent by Professor R. T. Hewlett (London), who received them from the Bacteriological Institute, Brisbane. We also possess (N. 1213) a ♀ found on *Perameles obesula*, at Bannister, W. Australia, 21. VIII. 1900 (ex N. C. Rothschild coll.).

N.B. The porose areas were at first believed to be absent, the median area of the *basis capituli* appearing to be uniformly finely granular in texture. They were distinctly though faintly apparent, however, in a microscopic preparation.

These ticks possess a type of scutum, broad posteriorly, which appears to be somewhat characteristic of Australian forms. It is observable in *I. australiensis*, *I. ornithorhynchi* and *I. tasmani*, and the scutum of the nymph of *I. vestitus* is of this shape, though, in the adult female, it tends to become more circular. *I. tenuirostris* alone of extra-Australian species conforms to this type. The species here described most clearly resembles *I. vestitus* in general characteristics.

44. IXODES AUSTRALIENSIS Neumann, 1904.

Figs. 247–249 (Figs. 247, 248, original).

Lit. and Icon.: Neumann, 1904, pp. 456, 457, Fig. 1 (reproduced).

Male: unknown.

Female: Body a short oval, usually broadest on a level with coxae IV, more or less dark brown; *L.* 2·5 to 3·25 mm., *W.* 1·9 to 2·7 mm. *Scutum* hexagonal, with rounded angles, shorter than broad

(1 × 1·35 mm.), glossy; cervical grooves superficial, reaching the posterior border; no lateral grooves; punctations fine, numerous; longitudinal parallel striae mixed with the punctations, well marked especially in the lateral fields. Dorsum uniform, very finely punctate, glabrous, with a complete marginal groove. *Venter* smooth; vulva broad, between coxae III. *Anal grooves closed posteriorly*; oval, tangential to the

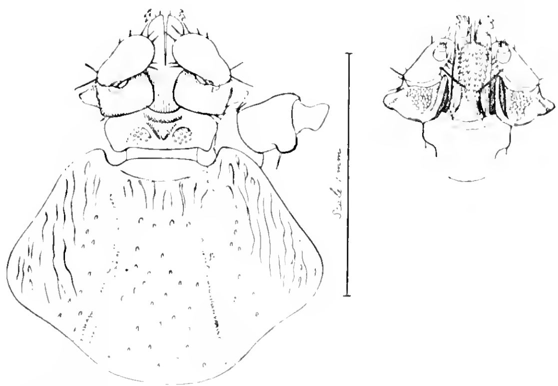


Fig. 247. *I. australiensis* ♀: capitulum and scutum, capitulum in ventral aspect. Specimen found on *Bettongia lesueuri*, Kogonup, W. Australia, 1900. (N. 646. Original, G. H. F. N. del.)

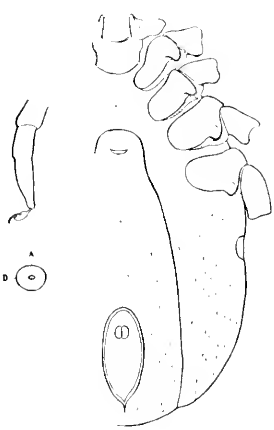


Fig. 248.

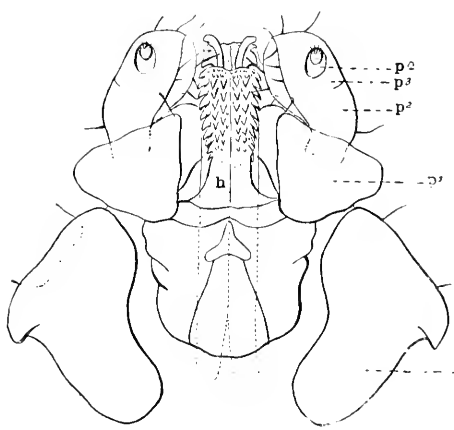


Fig. 249.

Fig. 248. *I. australiensis* ♀: part of venter, tarsus 4, spiracle. (The same specimen as in Fig. 247. Scale = 1 mm. Original, G. H. F. N. del.)

Fig. 249. *I. australiensis* ♀: capitulum in ventral aspect, coxae I. Obviously drawn from a mounted specimen. (Neumann, 1904, Fig. 1.)

anal ring anteriorly, forming a short point at their union posteriorly. Spiracles small, circular, whitish, placed somewhat posteriorly to the middle of the length. *Capitulum* very short (540 μ), with very short sub-rectangular base, at least twice as broad as long on the dorsal surface, as long as wide on the ventral surface; auricula a small tuberosity; excavate on the anterior border; porose areas medium, somewhat triangular, separated by an interval equal to their breadth; in front of them a triangular median pit. Hypostome spatulate, dentition 3|3 or 4|4. Palps much separated at the base, claviform; article 1 large, hollowed out on the inner side to surround the chelicerae and hypostome like a cuff; the second article convex externally at the base, its articulation with the third but slightly visible. *Legs* of medium length. Coxae flattened, not winged, increasing in size from I to IV, all bearing a sharp spur at the postero-external angle, internal angle unarmed. Coxa I visible dorsally. Tarsi long, tapering gradually; pads half as long as claws.

The species was described by Neumann from five ♀s, from *Canis* sp., West Australia (N. C. Rothschild coll.). The specimens we possess are doubtless the types, for they were derived from the Hon. N. C. Rothschild's collection. Our specimens, two ♀s (N. 645, 646), were found on *Canis familiaris*, at Cranbrook, IV. 1900 (J. T. Young), and on *Bettongia lesueuri* (marsupial rat-kangaroo), at Kogonup, XI. 1900. Our figures are drawn from the latter.

45. IXODES VESTITUS Neumann, 1908.

Figs. 250–253 (Figs. 251–253 original).

Lit. and Icon.: Neumann, IV. 1908, p. 7, Fig. 2 (reproduced), Fig. 3 (part of venter; omitted).

Male: unknown.

Female (Figs. 250, 251): Body oblong, with lateral borders parallel, reddish yellow, *L.* 3·7 mm. (capitulum included), *W.* 2·2 mm. *Scutum* cordiform[1], with rounded sides, broadest (1·35 mm.) toward the middle, 1·25 mm. long; cervical grooves absent, replaced by two elongated depressions (Fig. 250) separated from the anterior border by a distance

[1] The antero-lateral borders of the scutum in the type are very ill-defined. They appeared to us almost rectilinear (as in the accompanying figures of the nymph and larva) but Neumann's figure, here reproduced, coincides with the appearance of a specimen in our possession.

equal to their length, and midway between the centre and the lateral border; lateral grooves very fine, without external raised area; punctations fine, unequal, fewer in the median field, abundant external to the lateral grooves; surface glabrous, glossy. Dorsum covered by stiff whitish hairs, which are absent just behind the scutum and in three longitudinal grooves; of these the laterals extend along the whole body-length; the median groove is shorter. *Venter* covered by similar hairs posterior to the vulva and coxae; no hairs in the genital grooves and over the greater part of the space bounded by the anal grooves; vulva facing the second intercoxal space; anal grooves parallel, wide apart, relatively short, curving in front of the anus; spiracles whitish, subcircular. *Capitulum* short (0·7 mm.); base (+ article 1 of palps which are fused with it) twice as broad as long, without cornua; porose areas deep, oval, considerably broader than long, almost contiguous; no distinct auriculae. Hypostome narrow, with parallel borders, 2 | 2, 7–8 stout teeth per file, the median files much separated; chelicerae (?); palps relatively short and broad, article 1 very broad,

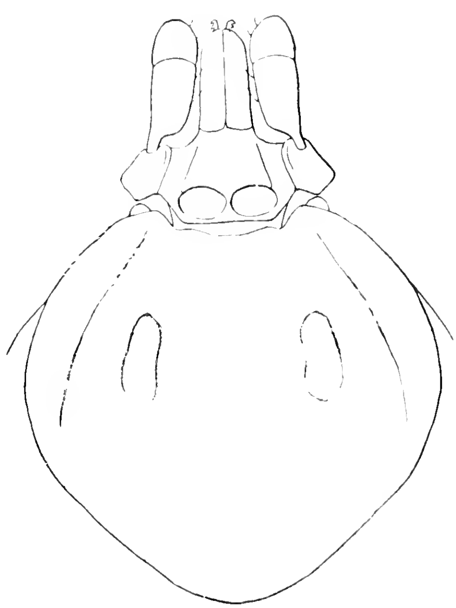


Fig. 250. *I. vestitus* ♀: capitulum and scutum. (Neumann, 1908, Fig. 2.)

almost discoidal, salient outwardly, fused with the base; article 2 constricted basally, then broadening abruptly, almost twice as long as article 3; article 4 very small, terminal. *Legs*[1] very short and thick, coxae unarmed, flat, transversely elongated, with posterior border trenchant; coxa I prolonged forward, the anterior portion slightly visible dorsally; tarsi short, humped near the tips, which taper somewhat abruptly.

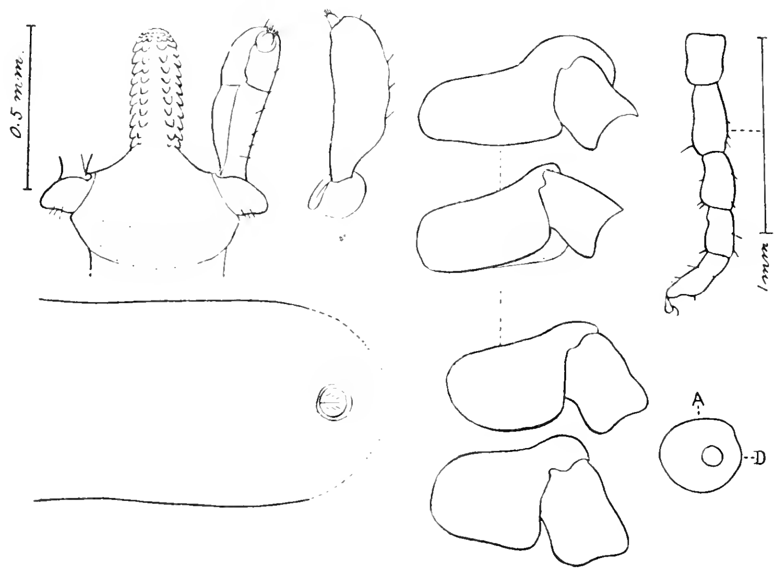


Fig. 251. *I. vestitus* ♀: capitulum in ventral aspect, palp (lateral view), coxae, anal grooves, spiracle. Leg 4 (less magnified). Found on *Diemenia superciliosa* (brown snake), Herdman's Lake, near Perth, W. Australia. B. H. Woodward coll. (N. 642. Original, G. H. F. N. del.)

Nymph (Fig. 252): resembles the ♀ except in the shape of the scutum, which is of the *I. fecialis* type, being broadest near its posterior extremity. The dorsum is thickly clothed with strong white hairs.

[1] Neumann notes that leg 3, and especially coxa III, on the right side are atrophied in the type; the coxa is only half as large as the one of the opposite side.

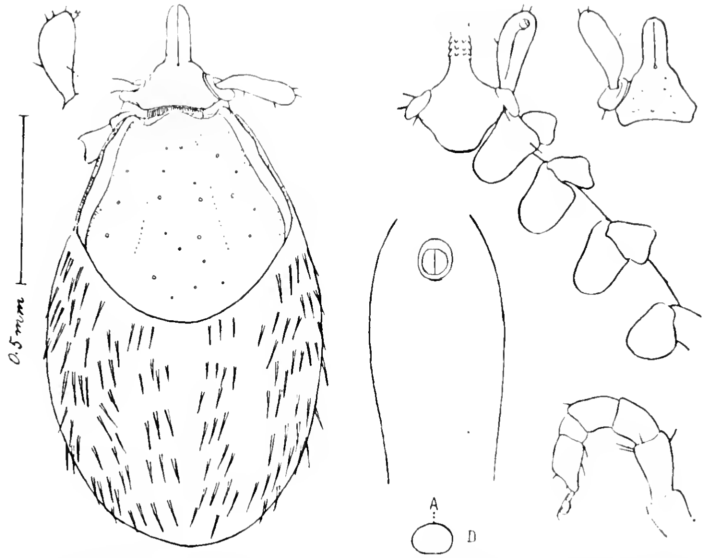


Fig. 252. *I. vestitus* ○: dorsum (the capitulum being slightly foreshortened); palp (side view), part of venter, anal grooves, capitulum (dorsal aspect), spiracle and leg 4: same origin as the ♀ in Fig. 251. (N. 642. Original, G. H. F. N. del.)

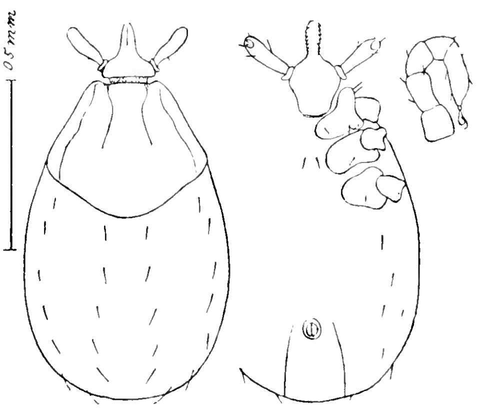


Fig. 253. *I. vestitus* larva: dorsum, venter, leg 3. Same origin as the ♀ in Fig. 251. (N. 642. Original, G. H. F. N. del.)

Larva (Fig. 253): resembles the ○. Four longitudinal rows of white hairs on the dorsum.

Description based on one ♀ from *Myrmecobius fasciatus* Waterhouse (Dasyuridae), West Australia (Neumann's type, British Museum). Our collection contains (N. 642) ♀, ○ and larvae from *Diemenia superciliosa* (a snake), Herdman's Lake, near Perth, W. Australia (B. H. Woodward, ex N. C. Rothschild coll.).

46. IXODES PUTUS (Pickard-Cambridge, 1878).

Plate V, Figs. 3 and 4; Text-figs. 254–260 (Figs. 254, 255, 260, original).

Lit. etc.: *Hyalomma puta* Pickard-Cambridge, 1878, p. 222, Pl. XIII, Fig. 4 (o). We are indebted to the author for sending us one of his types to examine in VII. 1910. It proved to be an unfed o, bleached pale yellow by long immersion in alcohol. His figures, which are very sketchy, represent the dorsum, venter, and dorsal aspect of the o's capitulum. Without having seen the type it would have been impossible to refer it to the species described as *putus* by Neumann.

Ixodes borealis Kramer and C. J. Neuman, 1883, p. 518, Pl.

Ixodes fimbriatus Kramer and C. J. Neuman, 1883, p. 518. Cited by L. G. Neumann, 1899, p. 127, as a good species. We are, however, convinced, from the authors' description, that *fimbriatus*=*putus* ♂. (It measured 4 × 3·5 mm.)

Ixodes putus (Cambridge) in Neumann, 1899, pp. 125–127, Figs. 7–9 (reproduced), description of ♀; 1901, p. 283.

Ceratixodes putus (Cambridge) in Neumann, 1902, p. 117, Fig. 4 (capitulum of ♂, dorsal and ventral aspects, palp in profile, somewhat inaccurate, consequently not reproduced. Lahille, 1905, p. 26, reprints description of ♂, ♀ and o given by Neumann; on pp. 138–148, more detailed description (original), gives many measurements, etc., Pl. XIII, coloured Figs. 1–13 of ♀ and o with details.

Ceratixodes putus Cambridge, in Wheler, 1906, pp. 415, 416, Figs. 25 (♀) and 26 (♂) photographs (reproduced).

Ixodes borealis Kramer and Neuman, in Evans, 1906, pp. 85, 86, Fig. of ♀ (reproduced).

? *Ixodes uriae* White, 1852, p. ccx, found on *Uria troile*, Baffin's Bay (P. C. Sutherland).

? *Ixodes eudyptidis* Maskell, 1885 (see Notes on Doubtful Species, p. 291).

Male (Pl. V, Fig. 3; Text-fig. 254): very large (3·7 mm. *l.*, including capitulum), larger than the unfed ♀, narrow in front, the lateral borders diverging for about one-third of the length, then parallel, the posterior border only slightly convex. *Scutum* (3·3 × 2·1 mm.), broadly oval, very convex, with postero-lateral borders slightly concave, marginal fold moderate; cervical grooves fairly long, shallow, divergent, terminating in a large shallow depression on either side, behind which two smaller circular pits are often visible; no lateral grooves; very numerous unequal punctations, and very short white hairs, generally caducent, except on the posterior portion of the scutum. Emargination very deep; scapular angles very prominent, but blunt. Dorsum:

beyond the marginal fold are seen dorsally five distinct posterior ridges (in reality borne by the ventral plates) bearing tufts of strong, equal, white hairs or bristles, the external ridges being twice the length of the three median. *Venter*: Sexual orifice facing the first intercoxal space; pregenital plate semilunar, median plate elongate, rather narrow, anal plate rounded in front, its sides sub-parallel, delimiting the median tuft of hairs; adanal plates with very convex external border; the anal and adanal plates deeply punctate. Spiracle very large, very near coxa IV, subcircular. *Capitulum* very small; base twice as broad as long, broader in front, the posterior border straight, the anterior border excavate; palps horn-like and curved upwards, tapering to their extremity, article 1 conspicuous dorsally, article 2 beset with stiff bristles, longer than article 3, the articulation between articles 2 and 3 very obscure; article 4 projects ventrally from the base of article 3. Hypostome very rudimentary, short, bifid, with faint indications of six teeth, the anterior more external. *Legs*: coxae contiguous, unarmed, very convex ventrally; all the articles except the tarsi of legs 1, 2 and 3 extremely stout and strong; leg 4 conspicuously thinner and somewhat longer. All the tarsi weak and tapering gradually; tarsi 2–4 with small terminal spur; pad one-third as long as claws.

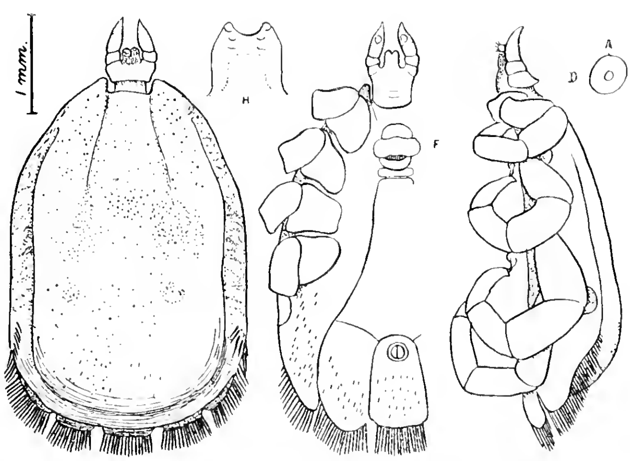


Fig. 254. *I. putus* ♂: dorsum, venter and side view; *H*, hypostome, spiracle. The apron or flap over the sexual orifice is indicated by the letter *F* in the middle figure. From specimen (N. 968) found on cliffs at Rhosilly, Gower, Glamorganshire, 1909, by Dr J. W. W. Stephens. (Original, G. H. F. N. del.)

Female (Pl. V, Fig. 4; Text-figs. 255–259): *L.* 3·3 mm., including capitulum; when gorged may attain 11 × 7 mm. Body light grey when alive, thickly clothed with white hairs. *Scutum*: (1·6 × 1·1 mm.) dull yellow-brown, a few short hairs or hairless, much longer than broad, broadest near its anterior end; cervical grooves well marked, long, reaching the posterior border; no lateral grooves; numerous moderate, deep punctations; emargination almost absent; scapulae often somewhat rugose. *Venter*: very hairy in young specimens: the hairs are absent in the region corresponding to the anal plate of the male, and are caducent in the anterior portion in older specimens. Vulva facing the second intercoxal space; genital grooves sub-parallel for half their length, then slightly divergent; anal grooves slightly divergent; spiracle (Fig. 259) nearly circular. *Capitulum* (0·3 mm. *l.*), base much broader than long, slightly broader in front; porose areas oval or semilunar, the interval very narrow; palps far apart at their base, article 1 conspicuous dorsally, article 3 broader than article 2, giving the palps a clavate appearance (articulations 2, 3, indistinct). Digit (see Fig. 258). Hypostome strong, well covered with 2 | 2 strong equal teeth, about 8 per file. *Legs*: long and more slender than in the ♂, leg 4 not conspicuously differing from the others; coxae unarmed, coxae I, II and III rather elongate and triangular, coxa IV rounded; tarsi distinctly humped; pad short.

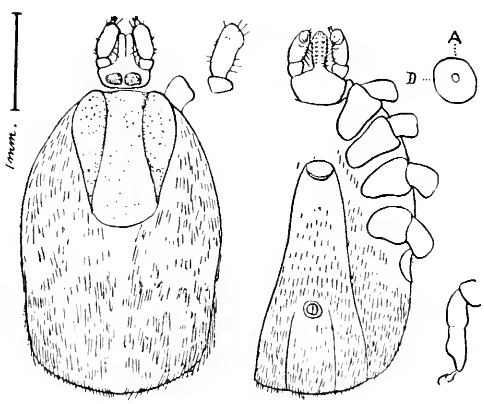


Fig. 255.

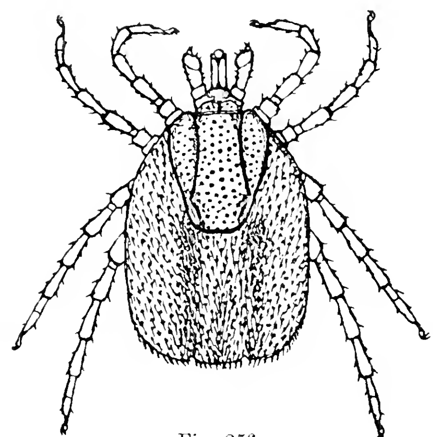


Fig. 256.

Fig. 255. *I. putus* ♀: dorsum, venter, right palp in profile, spiracle and tarsus 4. Same origin as the ♂ in Fig. 254. (N. 968. Original, G. H. F. N. del.)

Fig. 256. *I. putus* ♀: dorsum, × 12. (From Evans, 1906, p. 85; described as *I. borealis* Kramer and Neuman, 1883.)

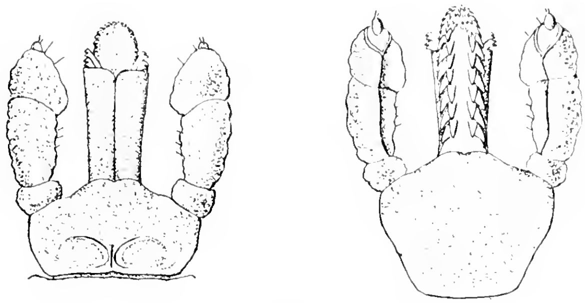


Fig. 257. *I. putus* ♀: capitulum in dorsal and ventral aspects. (Neumann, 1899, Fig. 8, G. Marx del.)

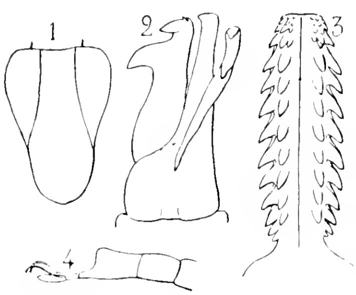


Fig. 258.

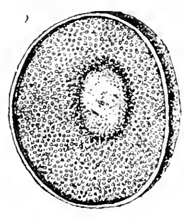


Fig. 259.

Fig. 258. *I. putus* ♀: 1, scutum; 2, left digit; 3, hypostome; 4, tarsus 4. (Neumann, 1899, Fig. 9.)

Fig. 259. *I. putus* ♀: spiracle, G. Marx del. (Neumann, 1899, Fig. 7.)

Nymph (Fig. 260): bears an unmistakable resemblance to the ♀. *L.* 1·25 mm. unfed (type), may attain 3·5 mm. when replete.

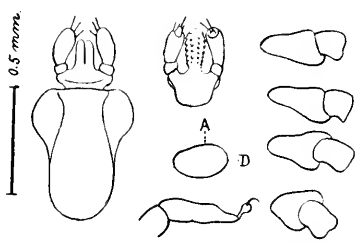


Fig. 260. *I. putus* o: capitulum and scutum, capitulum in ventral aspect, coxae, spiracle and tarsus 4. Same origin as the ♂ and ♀ above figured. (N. 968. Original, G. H. F. N. del.)

Our description of *I. putus* is based upon numerous specimens (♂, ♀, ○) found in Great Britain, one ♀ from Bering Island and one of the type (○) from Kerguelen Island.

The species has a remarkably wide geographical distribution. As yet it has only been found parasitic on marine birds or infesting their breeding places, where it occasionally attacks man.

England: It has been recorded from the following localities by E. G. Wheler (1906): ○s on *guillemots*; ♀s on *puffins*, Morthoe, N. Devon (Pocock); ♂s, ♀s, on cliffs frequented during the nesting season by *guillemots* and other sea-birds, at Bempton and Buckton on the Yorkshire coast (Mr Howett, of York, occasionally found sexes in copula beneath stones); on Pinnacle Rocks, Farne Islands (found by Mr Wheler, who has kindly presented us with some of these specimens: N. 935, 936, 937). We have adults (N. 454, ♂, ♀) found on ledges frequented by *guillemots*, Bempton Cliffs, Yorkshire, VI. 1908, by Mr O. Grabham, who states that the jackdaws feed on the ticks with avidity. **Wales**: (N. 968, ♂ ♀ ○) found on cliffs, Rhosilly, Gower, Glamorganshire, "*guillemots, razorbills* and *puffins* breeding there," VI. 1909 (sent us by Dr J. W. W. Stephens). **Scotland**: (N. 459, ♀) from *seagull*, Handa Island, Sutherland, VIII. 1908 (presented by Dr W. L. H. Duckworth); Mr W. Evans, of Edinburgh, has kindly sent us specimens he collected: (○) from a *gannet*, Bass, VI. 1910, and (♀) from a *puffin*, Firth of Forth, VII. 1910. He has himself (1906, p. 85) recorded the occurrence of the tick (♀, ○) from St Kilda, on young *puffins* and *fulmars*, attached to "the bare skin at the angles of the mouth below the bill, and in the corners of the eyes"; also on stones and loose turf frequented by the birds. The bites of these ticks are feared by the natives. Wheler possessed specimens from the Hebrides. **America**: Neumann (1899, p. 127) described specimens (♀, ○) from the Islands of St Pierre and Miquelon, Newfoundland coast (Baron coll.); St Paul's Island, Alaska (G. Marx coll., Smithsonian Institution, Washington, D.C.); Cape Horn (E. Simon's coll., now Neumann's). Neumann (1901, p. 283) records ○ and larvae found on *cormorants* and *penguins*, in Tierra del Fuego and the Antarctic (Belgian Antarctic Expedition). Lahille (1905, pp. 26, 138–148) recorded specimens (♀) from *Phalacrocorax verrucosus* (Cab.) Scl. and Salv., Navarin Island, Beagle Channel, Tierra del Fuego, II. 1900, and (♀, ○) from *penguins* (*Spheniscus magellanicus* [Forst.] Steph.), Port William, Tussac Island (L. Valette coll.). The ticks were found attached chiefly to the birds' heads and necks. Lahille was struck by the absence of ♂s. **Asia**

and Australasia: The specimens (♂ and ♀) described respectively as *fimbriatus* and *borealis* by Kramer and Neuman were found on BERING ISLAND, Bering Sea, by the Vega Expedition; we are indebted to the U.S. Department of Agriculture for a typical specimen (N. 714, ♀) of *putus* from Bering Island. Neumann (1899, p. 127) records (♀, o) the tick from CAMPBELL ISLAND, S. of New Zealand (Filhol coll., Paris Mus.) and from KING ISLAND (Tasmania ?). The types (o s) described by Pickard-Cambridge (1878, p. 222) were found on *Pygosceles taeniatus* and in rock crevices, KERGUELEN ISLAND, Indian Ocean, by A. E. Eaton (Transit of Venus Expedition). We have received a ♀ taken from a *wild duck* (N. 617; no particulars, ex N. C. Rothschild coll.).

See further under Notes on Biology (p. 317).

47. IXODES SIGNATUS Birula, 1895.

Figs. 261–264 (original).

Lit., Synon. and Icon.: *Ixodes signatus* Birula, 1895, pp. 357, 358, Pl. I, Figs. 10–13 (♀ capitulum in dorsal aspect, tarsus 1, scutum, coxa I, drawn from a mounted specimen and consequently difficult to recognize from the figures—that of the capitulum being especially misleading): recognizable from tarsus 1, coxa I and scutum.

Ixodes parvirostris Neumann, 1901, p. 284.

Ixodes eudyptidis var. *signata* Neumann, 1904, p. 451.

Ceratixodes signatus (Birula) Banks, 1908, p. 21, Pl. II, Figs. 1–3; ♀ scutum and coxae, tarsi 1 and 4, capitulum (diagrammatic only). (Why *Ceratixodes*?)

Note: As will be seen by reference to *I. neumanni* N. and W. (p. 217), there has been considerable confusion about this species. We have examined the type of *Ixodes parvirostris* (Nn. coll.) and of *I. eudyptidis* var. *signata* (Hamburg Mus.), and find them to be identical with a mutilated ♀ specimen (identified by Banks as *signatus*) from Pacific Grove, California (U.S. Dept. of Agriculture), and with specimens of our own (N. 290) from the same locality as the last. Our figures are drawn from the specimens (♀, o) in the Hamburg Museum and (L) from California.

Male: unknown.

Female (Figs. 261, 262): Body (6 × 3·5 mm. when replete), elongate, yellow (in young specimens). *Scutum*: 1·7 × 1·2 mm., yellow-brown or maroon, subject to considerable variation both of shape and of texture, normally long-oval, with rounded sides and somewhat pointed posterior angle, but sometimes considerably narrower and somewhat angular laterally; anterior border ill-defined, scapular angles prominent and often slightly divergent, so that the scutum is somewhat narrower immediately behind them; some large confluent punctations or rugosities in the posterior portion of the lateral fields, the rest of the scutum finely punctate and sometimes rather rugose; cervical grooves very distinct for half the scutal length; no lateral grooves. *Venter*: vulva just behind coxae II; genital grooves sub-parallel; anal grooves rounded in front of the anus, the sides somewhat converging to the posterior border. Spiracle large, nearly circular. *Capitulum*: base very short and broad, its posterior border straight with lateral prominences which hardly amount to cornua, salient laterally in its ventral aspect; porose areas elongate piriform, the broader ends internal; interval very small; palps short, far apart at their base, converging anteriorly, excavate dorsally (especially article 3), article 2 barely longer than article 3; hypostome narrow, lanceolate, 3 | 3 small teeth, then 2 | 2, about 6 subequal, blunt teeth per file, a large unarmed median area. *Legs*: yellowish brown, rather long; coxae with trenchant posterior borders and with a short, strong, blunt external spur, decreasing in strength from coxa I to coxa IV; a very small ventral spur at the distal end of trochanters 1 and 2. Tarsi long; tarsus 1 rather humped, tarsus 4 long, especially its distal article, which tapers obliquely far from its termination; pads small.

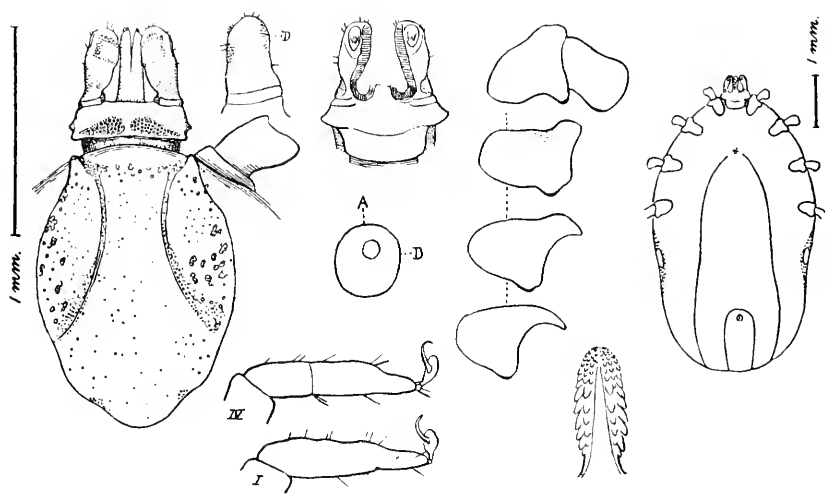


Fig. 261. Fig. 262.

Figs. 261, 262. *I. signatus* ♀: capitulum and scutum, left palp in profile, capitulum in ventral aspect (mutilated), coxae, spiracle, tarsi 1 and 4. The hypostome (highly magnified) and venter of a second specimen are shown to the right. (From specimens in the Hamburg Museum. Original, G. H. F. N. del.)

Nymph (Fig. 263): very elongate, closely resembling the ♀. The scutum is comparatively somewhat shorter, the basis capituli has ventral auricular ridges, and the spiracle is transverse-oval.

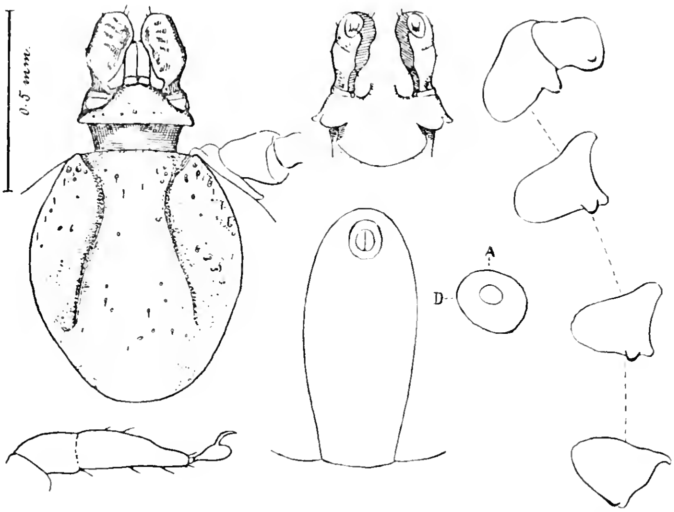


Fig. 263. *I. signatus* o : capitulum and scutum, ventral aspect of capitulum (mutilated), coxae, spiracle, anal grooves and tarsus 4. Same origin as the ♀s in Figs. 261, 262. (Original, G. H. F. N. del.)

Larva (Fig. 264): the scutum is angular laterally, with postero-lateral borders concave. The main characteristics of the ♀ are recognizable in the shape of the capitulum, the armature of the legs, and the anal groove.

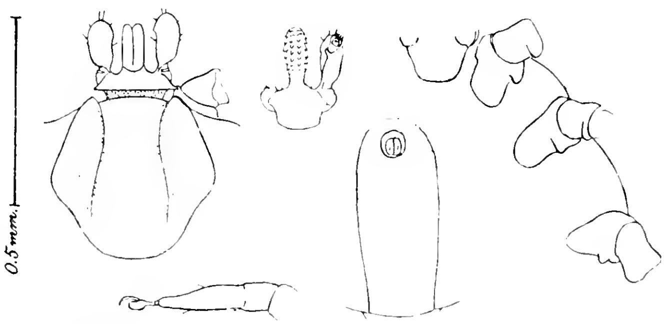


Fig. 264. *I. signatus* larva (replete): capitulum and scutum, capitulum in ventral aspect (foreshortened to show hypostome), parts of venter, tarsus 3. From Brandt's *cormorant*, Pacific Grove, California, 1894, ex V. L. Kellogg collection. (N. 290. Original, G. H. F. N. del.)

Described from numerous specimens (N. 290, ♀s, ○s, larvae) from *Phalacrocorax penicillatus* (Brandt's cormorant), Pacific Grove, California, 1894 (V. L. Kellogg coll.); a specimen (N. 1227, ♀) from Unalaska, Aleutian Islands, kindly presented by Professor A. Birula, of St Petersburg; the specimens in the Hamburg Museum and others from the Neumann collection were kindly sent to us for study.

The types of Birula (♀, ○) came from the Island of Unalaska (Wosnessenski coll., 1847). Neumann's description of *I. parvirostris* was based on specimens (eight ♀s) found on *Phalacrocorax pelagicus*, Yezo, Japan (Hamburg Mus.).

48. IXODES UNICAVATUS Neumann, 1908.

Figs. 265–267 (Figs. 266, 267, original).

Lit. and Icon.: Neumann, IV. 1908, p. 1, Fig. 1 (♀, reproduced).

Male: unknown.

Female (Fig. 265): Body oblong, blood-red, *L.* 6·5 mm. (capitulum included), broadest (3·2 mm.) in front of the middle of the length. *Scutum* oval lozenge-shaped, 1·5 mm. *l.*, broadest (0·8 mm.) in front of the middle; cervical grooves shallow, attaining the sides posterior to the lateral angles; no lateral grooves; many sub-equal and fine punctations; surface glabrous, glossy, reddish brown. Dorsum finely striate, giving it a satiny appearance; a hemispherical protrusion opposite the scapular angles of the scutum posterior to coxa I; very short, fine and sparse hairs. *Venter*: integument and hairs as on dorsum; vulva between the posterior borders of coxae II; genital grooves commencing behind the vulva, diverging at their posterior third; anal grooves long, parallel, very slightly approaching each other behind, united in a semicircle in front of the anus. Spiracles glossy, smooth, dark, subcircular, very little broader transversely. *Capitulum* short (0·65 mm.); base short, almost thrice as broad as long; a small dorsal point protruding laterally on each side; without cornua; porose areas fused in a single transverse depression, which covers almost the whole dorsal surface of the base; ventral surface with a slight transverse linear protrusion posterior to each palp; hypostome slightly lanceolate, 3 | 3 then 2 | 2, the two median anteriorly placed rows being composed of small teeth, the outer pairs of rows being composed of 8–10 stout teeth; chelicera (?); palps widely separated basally, relatively short and broad, uniformly broad along their length; article 2 half the length of 3; article 4 terminal, clearly visible. *Legs* relatively long and slender, the intermediate articles whitish distally; coxa I without internal spur, with an external spur longer than broad and an anterior spiniform prolongation; coxae II–IV with external spur and anterior prolongation as in coxa I, the anterior spine growing progressively smaller on coxae II–IV; tarsi long, tapering obliquely distally.

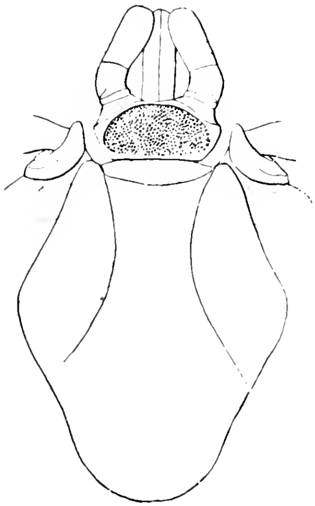


Fig. 265.

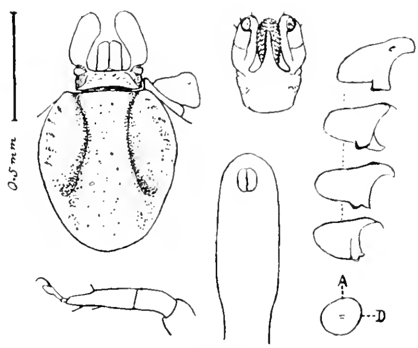


Fig. 266.

Fig. 265. *I. unicavatus* ♀: capitulum and scutum. (Neumann, 1908, Fig. 1.)

Fig. 266. *I. unicavatus* ♂: capitulum and scutum, capitulum in ventral aspect, coxae, spiracle, anal grooves and tarsus 4. Drawn from specimen found on *gannet*, Bass, Scotland, vi. 1910. (W. Evans coll. Original, G. H. F. N. del.)

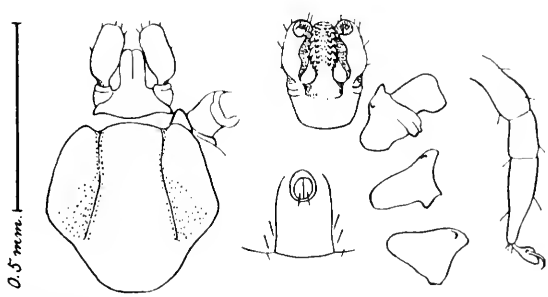


Fig. 267. *I. unicavatus* larva: capitulum and scutum, capitulum in ventral aspect, coxae, anal grooves and tarsus 3. Drawn from specimen found on *cormorant*, Fidra Point, Firth of Forth, Scotland, xi. 1906. W. Evans coll. Found with ♀ and ♂. (N. 1132. Original, G. H. F. N. del.)

Nymph (Fig. 266): similar to ♀, except for the scutum, which is more rounded.

Larva (Fig. 267): resembling both the ♀ and ♂, but the scutum, whilst comparatively broad, approximates more closely to that of the ♀.

Neumann described the species from a ♀ and a ♂ found on *cormorant* (*Phalacrocorax carbo* L.) from the mouth of the Forth, Scotland, collected by W. Evans, of Edinburgh. Although he mentions that the lot included a larva, he does not describe it.

Our collection contains specimens from **Great Britain**: (N. 652) ♂, from *shag*, Plymouth, IX. 1897, and (N. 667), ♀s, ♂s, from *Phalacrocorax graculus*, Cromarty, III. 1898 (W. Roy); both lots presented by Hon. N. C. Rothschild. The collection of Mr W. Evans, of Edinburgh, contains the type specimens (♀, ♂ and larvae, examined by us) from the *cormorant*, Fidra Point, Firth of Forth, XI. 1906.

Note: In a tube labelled "*I. eudyptidis* No. 13" at the British Museum we discovered three ♀ specimens agreeing very closely with Neumann's description and figure of *I. unicavatus*. The specimens were determined as *I. eudyptidis* by Neumann in 1905; only one of the specimens possesses a hypostome. The ticks measure 8 × 5 mm., and were collected from a cormorant by J. E. Harting (locality unrecorded). The specimens differ from the type as follows: cervical grooves well-marked; the hemispherical protrusion opposite the scapular angles is not visible in all the specimens; the porose areas show a slight indication of division in one or two specimens; the palpal articles 2 and 3 are apparently of equal length, but the separation is indistinct. In all other respects the specimens agree with Neumann's description and figure, so that we refer them to *I. unicavatus*.

49. IXODES LORICATUS Neumann, 1899.

Figs. 268, 269.

Lit. and Icon.: Neumann, 1899, pp. 139–142, Figs. 15–17 (reproduced).
Neumann, 1901, p. 285.
Lahille, 1905, p. 29 (reprints description by Neumann, 1899).
Ixodes angustus Neumann, 1901, p. 284 (see *I. angustus* Neumann, 1899, on p. 195 of this work); Neumann, 1910, p. 30.

Male (Fig. 268): Body oval, narrow, broader and rounded behind, 4·6 × 2·3 mm. or 3·7 × 1·8 mm. of the same colour as the unfed ♀.

Scutum narrow, barely covering more than half the width of the dorsum, bearing on the pseudoscutum more clearly marked cervical grooves, but similar lateral grooves and similar punctations to those of ♀; over the rest of the dorsum the punctations are coarser, distant. A deep marginal groove; marginal fold glabrous. *Venter*: plates highly chitinised, well defined, maroon; sexual orifice facing the anterior border of coxae III; pregenital plate rectangular, twice as long as broad, with rounded angles; median plate elongate, relatively narrow; anal and adanal plates elongate, not attaining the posterior border. Spiracles large, oval, maroon. Scattered hairs over the whole surface, shorter on the plates. *Capitulum* 0·7 mm. long; dorsal base slightly broader than long, similar to that of ♀ (Fig. 269), the porose areas replaced by a not clearly defined roughened surface, the lateral points but slightly marked. Chelicera? Hypostome and palps similar to those of ♀. *Legs* similar to those of ♀, the coxal spurs slightly weaker.

Female (unfed): Body oblong, sides parallel, 3·8 × 1·9 mm., rounded behind, yellowish white, scutum, capitulum and legs brown. *Scutum* oval, extending beyond the middle of the back, 1·8 × 1·2 mm. (emargination almost absent), glossy, convex, maroon, glabrous; cervical grooves slightly marked; lateral grooves distinct, straight; punctations many, equal, very fine. Dorsum with a deep marginal groove, which limits a thick prominent fold; numerous ruddy hairs. *Venter*: vulva facing coxae III; sexual grooves broad, straight, divergent; anal ring maroon, anus posterior; anal grooves slightly convergent behind; spiracles large, slightly elongate in the ventro-dorsal direction, whitish peri-

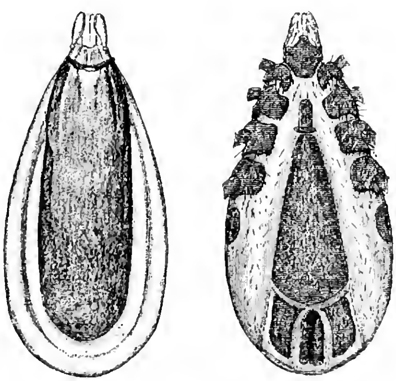


Fig. 268.

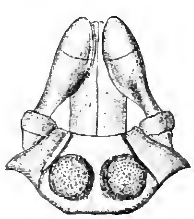


Fig. 269.

Fig. 268. *I. loricatus* ♂: dorsal and ventral aspects. (Neumann, 1899, Figs. 15, 16.)
Fig. 269. *I. loricatus* ♀: capitulum, dorsal aspect. (Neumann, 1899, Fig. 17.)

pherally, maroon centrally, placed in front of the posterior third of the body-length; hairs longer. *Capitulum* (Fig. 269) 1 mm. long, dorsal base broader than long, divided into three zones by lateral ridges which converge in front; a median trapezoid zone almost completely occupied by the contiguous porose areas; two lateral triangular zones with salient angle. (Digit 125 μ long, resembling that of *I. ricinus.*) Hypostome lanceolate, bearing 2 | 2 files of 10–12 teeth, the marginal stout, pointed; the internal weak, blunt and separated from the median line, especially behind. Palps of medium length, dilated at their internal border, especially at the second article, which is longer than the third. *Legs* long, stout, the two last articles of the fourth pair extending beyond the abdomen. Coxae broad, brownish, hairy; coxa I bears a flat spur at each of the posterior angles; a similar spur at the postero-external angles of the others. Tarsi long, tapering somewhat abruptly distally; pad about as long as the claws.

A gorged female measures 5·5 × 3·2 mm.; general colour maroon-brown; no marginal groove; hairs whitish; anus more anterior and anal grooves longer than double the interval which separates them. Four other ♀s measured 10 × 7 mm.; the greatest width at the posterior third, the anterior part being narrow; colour dark brown; dorsum glabrous, finely punctate, without characteristic depression.

Nymph: Body oblong, narrowed in front, rounded behind, slightly constricted on a level with the spiracles, may attain 4·5 × 2 mm., yellow or reddish yellow all over. *Scutum* narrow, elongate, with borders but slightly convex, posterior angle slightly ogival; 0·67 × 0·46 mm., without punctations; cervical grooves long, lateral grooves straight, parallel, attaining the posterior border. Dorsum excavated by five longitudinal grooves; two anterior short, three posterior longer, and a median groove prolonged further backward; short, scattered hairs. *Venter* but slightly concave; sexual grooves widely separated in front, divergent backward; anus distant from the posterior border; anal grooves long, slightly convergent behind; hairs as on the dorsum. Spiracles small, rounded, placed about midway along the body-length. *Capitulum* short (0·3 mm.), conforms dorsally with that of ♀. *Legs* similar to those of ♀; coxae distant, with smaller spurs.

Larva (hexapod): similar to o, 1·9 × 0·8 mm.

Neumann's description is based on two ♀s and one ♂ from *Didelphys quica* from Brazil, and two os from S. Brazil (Goeldi coll., now in Neumann coll., Toulouse); two os and one larva found on *Microdidelphys sorex* (?) from Rio Grande do Sul, Brazil (Brit. Mus.); five small ♂s, and four gorged ♀s from Buenos Ayres, Argentine (C. Berg coll.).

Neumann (1901, p. 283) examined a gorged ♀ from Tierra del Fuego (C. Berg coll., now in Neumann's coll., Toulouse). Our collection contains specimens presented by Hon. N. C. Rothschild, as follows: (N. 640) from *Ateles melanochoerus*, Tabasco de la Frontera, Mexico; (N. 641) from *Didelphys aurita*, Brazil, XI. 1901; (N. 638) ♂, ♀, from *Didelphys* sp., Sapucay; W. F. Cooper's collection contains a ♂ from Estancia Cooper, Paraguay, VI. 1906 (Foster).

Ixodes loricatus var. spinosus Nuttall, 1910.

Fig. 270.

Lit. and Icon.: Nuttall, XII. 1910, p. 411, Fig. 5 (reproduced).

Male: unknown.

Female: differs from the type as follows:

It is larger and less hairy generally. The *scutum* (1·6 × 1·25 mm.) is broader and less punctate, there being about 20 rather coarse punctations situated chiefly in the posterior half of the median field. *Capitulum* broader (0·7 mm.) and relatively shorter, more massive, the ventral surface of the base showing a broad **U**-shaped depression extending across the base posteriorly, the arms of the **U** reaching forward toward the base of the palps. *Venter*: spiracles larger (0·55 mm. *l.*)

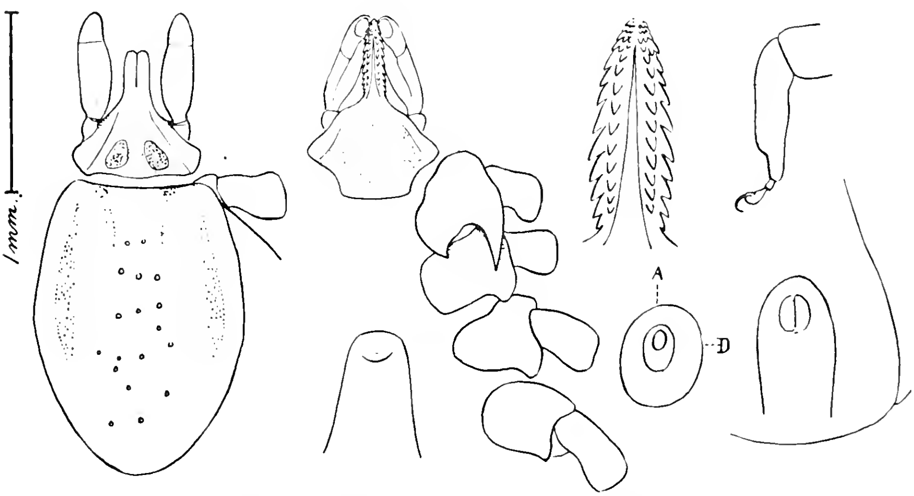


Fig. 270. *I. loricatus* var. *spinosus* ♀: capitulum and scutum, ventral aspect of capitulum with coxae, vulva with commencing genital grooves; hypostome (highly magnified); spiracle, tarsus 4 and anal grooves. (Nuttall, 1910, Fig. 5. G. H. F. N. del.)

than coxa IV, and much nearer to the coxa. *Legs* more massive, *coxa I with larger postero-external spur* prolonged in a point overlapping coxa II, with sharp internal angle; coxa II angular internally (round in the type). Tarsi tapering less gradually.

Described from (N. 647) 3 ♀ s, taken from a large *opossum*, Tabasco de la Frontera, Mexico, in the month of May (ex Hon. N. C. Rothschild's collection).

50. IXODES COXAEFURCATUS Neumann, 1899.

Fig. 271 (original).

Lit.: Neumann, 1899, p. 127 (no figure).

Male: Body elongate, narrow, sides parallel, 3·7 × 1·7 mm. *Scutum* glabrous, marginal fold narrow at the sides and broad behind; punctations large, distant; cervical grooves short, superficial; faint traces of lateral grooves; scapulae rounded. *Venter*: plates glabrous, with punctations as on scutum; sexual orifice facing the second intercoxal space; pregenital plate triangular, longer than broad, with summit rounded; anal plate almost twice as long as broad, with sides arcuate;

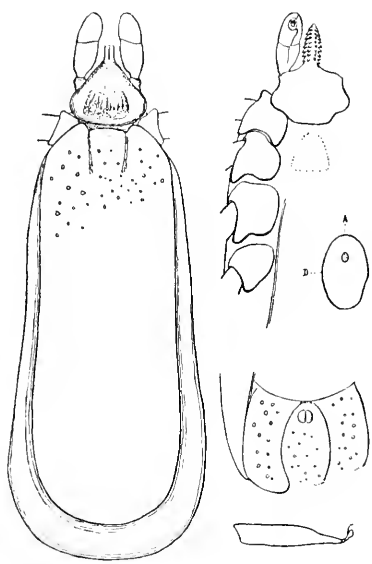


Fig. 271. *I. coxaefurcatus* ♂: dorsum, parts of venter, spiracle and tarsus 4. Sketched from the type in the Berlin Museum. (Original, G. H. F. N. del.)

adanal plates with their sides curved and parallel. Spiracles large, oval, with long axis directed forward and macula eccentric. *Capitulum* with dorsal base broader than long, posterior border convex; a median broad, depressed, roughly circular rugose area. Hypostome with sharp point, dentition 2|2, with 7 teeth per file. Palps short and broad. *Legs* of medium length; coxae bearing long hairs; coxa I with a short, stout spur at both posterior angles; coxae II–IV with a similar flattened spur at the postero-external angle. Tarsi tapering gradually. *Colour*: scutum, shields and legs dark maroon-brown, the venter and the marginal fold light maroon.

Female: unknown.

Our description is based on an examination of the type, a dried, pinned, and somewhat mutilated and shrunken specimen from a virgin forest, Sierra Geral, Brazil[1] (Hensel coll., Berlin Mus.).

51. IXODES VESPERTILIONIS Koch, 1844.

Figs. 272–282 (Figs. 272, 273, 277, 280, 281 original). See also Pl. VI, Figs. 1 and 2 (♀s).

Synonymy: *Ixodes vespertilionis* Koch, 1844, H. 37, Fig. 9 (♀); 1844, p. 232, listed; 1847, p. 21.

Ixodes flavipes Koch, 1844, H. 39, Fig. 2 (? ♀); 1844, p. 232, listed; 1847, p. 21.

Ixodes troglodytes Schmidt, 1853 (*vide* Frauenfeld, 1853, p. 57) (♂).

Eschatocephalus gracilipes Frauenfeld, 1853, p. 57, Pl. (♂: dorsum, venter, capitulum; ♀: dorsum and capitulum. Sketchy, but resembling *I. vespertilionis*); 1857, Pl. II (♀).

Haemalastor gracilipes Frauenfeld, 1854, p. 23, Pl. Figs. 4, 5 (♀).

Sarconissus flavipes Kolenati, 1856, p. 21, 1857, p. 21, Pl. I, "♀," immature stages. See Neumann, VIII. 1910, p. 191.

Sarconissus hispidulus Kolenati, 1856, p. 21 (♀).

Sarconissus brevipes Kolenati, 1856, p. 21 (♀).

Sarconissus kochi Kolenati, 1856, p. 21 (♀); 1860, p. 573, Pl. II, Fig. 4 (♂).

Sarconissus flavidus Kolenati, 1856, p. 21 (♀).

Sarconissus exaratus Kolenati, 1856, p. 22; 1860, p. 757, Pl. I, Fig. 2 (Neumann det. VIII. 1910, p. 191).

Haemalastor gracilipes (Frauenfeld) Kolenati, 1860, p. 573. Neumann, det. VIII. 1910, p. 191.

Eschatocephalus frauenfeldi L. Koch, 1872, p. 26, Pl. II, Figs. 29–32 (♂); 1877, p. 150.

[1] Neumann erroneously states that the specimen came from Siwa, Egypt.

Eschatocephalus seidlitzi L. Koch, 1872, p. 26 (♂); 1877, p. 151.
Ixodes longipes Lucas, 1872, p. lxxiv. (♂).
Ixodes siculifer Mégnin, 1880, p. 132 (♂).
Haemalastor vespertilionis (C. L. Koch) Neumann, 1899, p. 169; see further under Literature.
Eschatocephalus vespertilionis (Koch) Neumann, 1901, p. 290; 1902, p. 116.
? *Sarconissus nodulipes* Kolenati, 1860, p. 576, Pl. I, Fig. 3.
? *Eschatocephalus flavipes* (Koch) in Bonnet, 1908, p. 325 (probable).

Lit. and Icon.: Besides the foregoing, see:

1854. Frauenfeld, p. 29 (♂).—1858. Heller, Pl. II, Figs. 7–9; Pl. III, Fig. 21.—1877. Murray, p. 195 (*Sarconyssus*).—1890. Canestrini, p. 504, Pl. XLIII, Fig. 5 (♀: dorsum, poor).—1892. Berlese, fasc. LXI, No. 9 (♀, gorged: dorsum, capitulum and scutum, fairly accurate); Marx, p. 235 (*Sarconyssus*).—1897. Rollinat and Trouessart, p. 136.—1899. Neumann, p. 169, Figs. 27–34 (♂: Fig. 27, venter; Fig. 28, ventral aspect of capitulum (these two figures not reproduced), hypostome and digit, leg 1, foot; ♀: capitulum in dorsal and ventral aspects, hypostome and digit; larval digit (all of these reproduced)).—1901. Neumann, p. 290.—1902. Neumann, p. 116.—1906. Wheler, Pl. VIII, Fig. 19 *a* (♀: photograph of dorsum of unmounted specimen, reproduced).—1909. Blanchard, p. 96, Figs. 107–110 (after Neumann).—1910. Dönitz, p. 400 (*Eschatocephalus* discussed).

See further under *Eschatocephalus* and *Haemalastor*, pp. 134, 281.

Male (Figs. 272–276): Body long-oval, narrower in front, yellow. *Scutum* (3·5 × 2·1 mm.), very long and narrow, indistinctly defined, not covering the whole dorsum (which is concave in the specimen described), convex along the median line; emargination slight; faint, rapidly diverging cervical grooves commencing at some distance behind the anterior border; no lateral grooves in the usual situation. Coarse punctations forming a single longitudinal median row and two lateral rows; numerous very fine punctations over the rest of the scutum. *Venter* (Fig. 272): genital orifice facing the second intercoxal space; median plate pentagonal, fairly broad; anal plate long-oval; adanal plates very long; all the plates with numerous punctations. Spiracles very large, subcircular. *Capitulum* (Fig. 273; 0·65 mm. *l.* dorsally) comparatively small, base about as broad as long, dorsal ridge convex, the dark raised ridge extending for a short distance along the lateral borders. Palps clavate, convex dorsally, with numerous long hairs, article 2 about equal to article 3. Hypostome (Fig. 274 *A*) ill-defined, practically smooth, but with indications of a few small scale-like teeth distally. Digit (see Fig. 274). *Legs* (Figs. 275, 276) of inordinate length, every article, except the coxa, being remarkably elongate. Coxae unarmed.

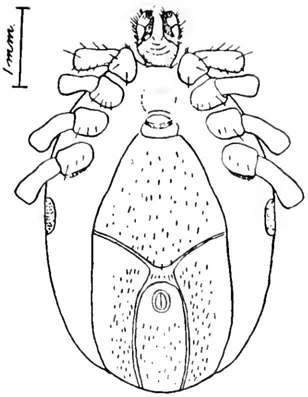


Fig. 272.

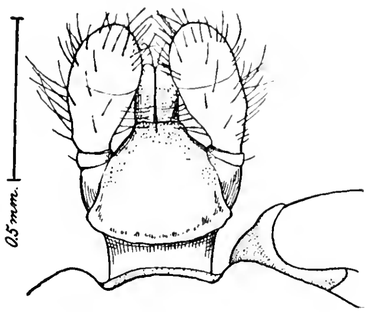


Fig. 273.

Fig. 272. *I. vespertilionis* ♂: venter. Specimen from Grotto of Alsasua, E. Simon coll., 1896. (Neumann coll. 760. Original, G. H. F. N. del.)

Fig. 273. *I. vespertilionis* ♂: capitulum. Same specimen as Fig. 272. (Original, G. H. F. N. del.)

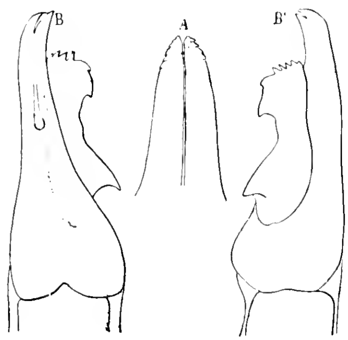


Fig. 274.

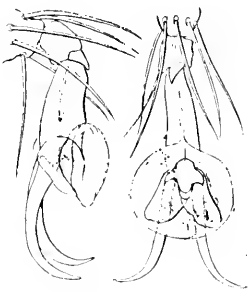


Fig. 276.

Fig. 274. *I. vespertilionis* ♂: *A*, hypostome, ×84; *B*, *B'*, right digit in dorsal and ventral aspects, ×238. (Neumann, 1899, Fig. 29.)

Fig. 276. *I. vespertilionis* ♂: ambulacrum, ×110. (Neumann, 1899, Fig. 31.)

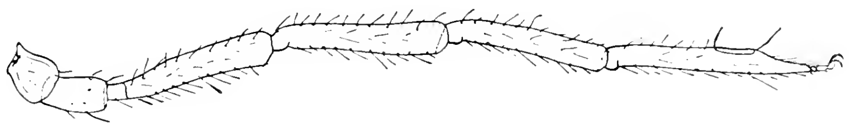


Fig. 275. *I. vespertilionis* ♂: leg 1, ×18. (Neumann, 1899, Fig. 30.)

Female (Pl. VI, Figs. 1 and 2; Figs. 277–279; gorged): *Scutum* much longer than broad (1·9 × 1·3 mm.), broadest in the middle; no lateral grooves, cervical grooves only visible in their hinder portion, where they diverge and meet the postero-lateral borders of the scutum at its posterior third. Numerous small shallow punctations. *Venter*: vulva between coxae III; anal groove elliptical in front, with parallel

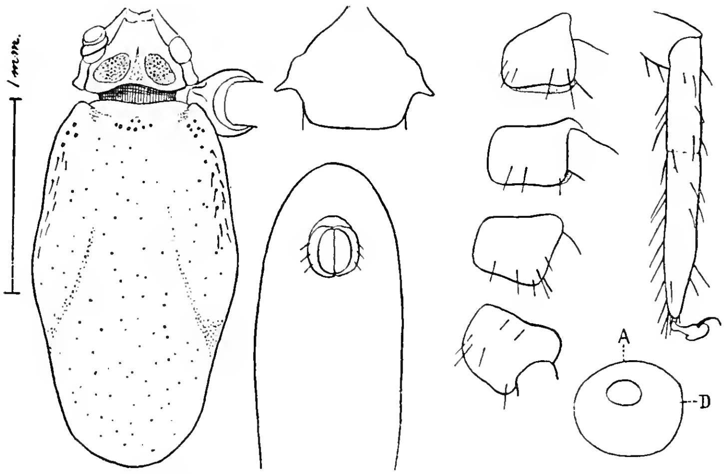


Fig. 277. *I. vespertilionis* ♀: capitulum (mutilated) and scutum, base of capitulum (ventral), anal grooves, coxae, spiracle, tarsus 4. Found on *bat*, Banyuls, France, by Trouessart, 1896. (Neumann coll. 766. Original, G. H. F. N. del.)

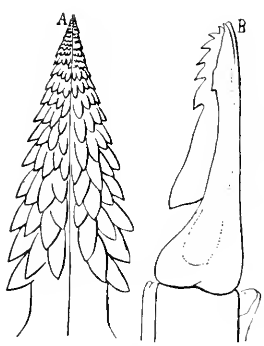


Fig. 278.

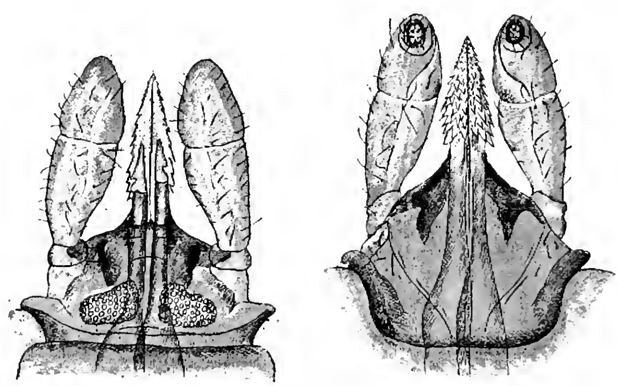


Fig. 279.

Fig. 278. *I. vespertilionis* ♀: *A*, hypostome, × 85; *B*, left digit in dorsal aspect, × 225. (Neumann, 1899, Fig. 33.)

Fig. 279. *I. vespertilionis* ♀: capitulum in dorsal and ventral aspects, × 40. Drawn from mounted specimen. (Neumann, 1899, Fig. 32.)

sides; spiracle as in ♂. *Capitulum*: base shorter and broader than in the ♂, with salient lateral points; porose areas large and near together; palps normal; hypostome tapering to a point, 4|4, merging to 3|3 posteriorly, the teeth are very pointed and the hypostome posterior to the basal teeth is constricted (see Figs. 278 *A* and *B* (digit), 279). *Legs* (Pl. V, Figs. 1 and 2) long and thin, with the same characteristics as in ♂, but comparatively smaller.

Nymph (Fig. 280): resembling the ♀ in all essential parts, the capitulum with blunt auricular protrusions and no latero-dorsal ridge.

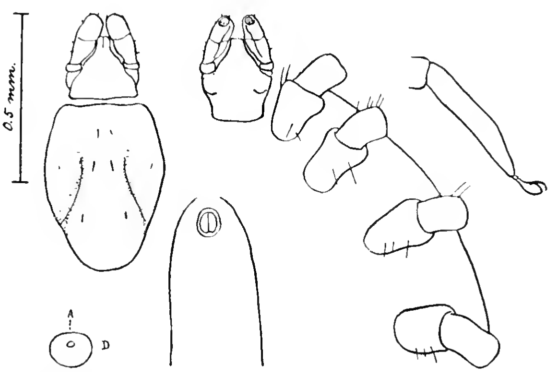


Fig. 280. *I. vespertilionis* o: capitulum and scutum; ventral aspect of capitulum, with coxae, spiracle, anal grooves and tarsus 4. (Same origin as ♀ in Fig. 277. Original, G. H. F. N. del.)

Larva (Figs. 281, 282): resembling the o, but with broad scutum; lateral angles and capitulum more elongate and possessing no auriculae.

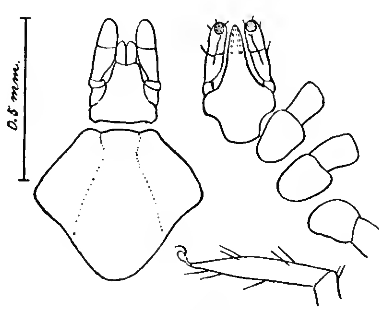


Fig. 281.

Fig. 282.

Fig. 281. *I. vespertilionis* larva: capitulum and scutum; ventral aspect of capitulum, with coxae, tarsus 3. Specimen found on *Rhinolophus* sp. by Trouessart, 1896. (Neumann coll. 768. Original, G. H. F. N. del.)

Fig. 282. *I. vespertilionis* larva: left digit in dorsal aspect, ×590. (Neumann, 1899, Fig. 34.)

Described from 1 ♂, 1 ♀, 1 o and 1 larva kindly lent by Professor Neumann.

This species appears to be widely distributed geographically. It has hitherto only been found on *Cheiroptera* and in their haunts (in caves, grottoes and the like).

EUROPE: **N. Wales**: 1 ♀ from a bat, Cefn, 1896. (Sent to Mr E. G. Wheler for determination by Professor Newstead, of Liverpool, being the first specimen, apparently, recorded in this country. Communicated in a letter from E. G. W. to G. H. F. N., I. 1906.) **Ireland**: 1 ♀ from Eden Vale Cave, Co. Clare, VII. 1902 (Dublin Nat. Hist. Mus., specimen determined by us.) **France**: One of us (G. H. F. N.) examined a number of mounted specimens in the Mégnin collection through the kindness of Professor R. Blanchard (Paris). They had mostly been sent to Mégnin by H. Gadeau de Kerville, of Rouen, during II–V. 1883; ♀s and o from *Plecotus auritus*, grotte de la Briqueterie, 10. III.; os and larvae from *Rhin. ferrum equinum*, grotte Cuvette, 10. III.; larvae from *Rhin. hipposideros*, grotte de Dieppedalle, Seine inferieure, 10. III.; larvae, no particulars, 25. II.; larvae from *Rhin. hipposideros*, Carrian de la Londe, 14. V.; all of these were labelled *I. longipes* by Mégnin, 1 ♀, labelled "*I. aculeifer* Mégn.," from *Rhin. ferrum equinum*, Vincennes, 15 X. 1878 (Gilnicki); a larva, from *Vesperugo pipistrellus*, Rouen, 20. I. 1884, H. Gadeau de Kerville. Rollinat and Trouessart, 1897, p. 136, record this tick from *Rhin. ferrum equinum* (it was attached to the lip), captured in a cave near Banyuls, by Dr H. Brumpt (det. by Neumann); Neumann, 1899, p. 176, reports the tick (♀, o and larva) on bats from the same place (Trouessart coll.) and o and larva on bats from Bitche. Neumann, 1899, p. 175, records 9 ♂s from caves and grottoes in the following places: Abeille, Ariège; Aspradels and Espezel, Pyrenees; les Baux, near Arles; Penne, Tarne; Serres, Hautes Alpes; 3 ♀s respectively from Bize and Minerve, Hérault, and from Puivert, Aude; all of these specimens then in the Simon collection. Ch. Janet found 2 ♂s in a subterranean chalk-pit, near Beauvais. **Spain**: 2 ♂s from Alsasua, Guipuzcoa and Orduña, Biscay, are recorded by Neumann, 1899, p. 175 (Simon coll.). **Italy**: ♀ found on *Rhinolophus ferrum equinum* by Canestrini (1890, p. 504; it measured 8 × 5·4 mm., length of fourth leg = 5·5 mm.). Berlese, 1892, records the tick from the same host. **Germany**: C. L. Koch's types of *vespertilionis* and *flavipes* were found on *Rhin. ferrum equinum*. L. Koch's 2 ♂s were found respectively in the Rosenmüller cave, near Muggendorf, IX. 1869, and in caves near Almas, Fränkischer

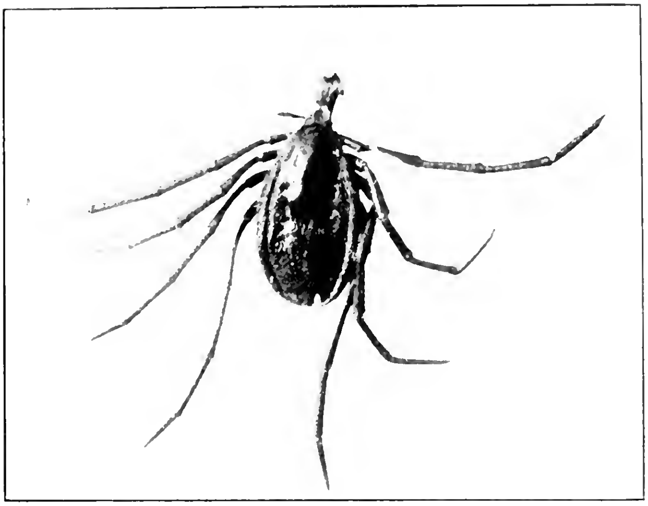


Fig. 1.

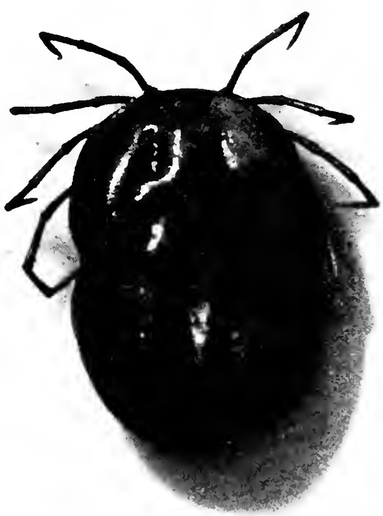


Fig. 2.

Figs. 1, 2. *Ixodes vespertilionis.*

Fig. 1. Unfed ♀, dorsum, ×7; with piece of bat's skin still attached to the mouthparts. (British specimen. Wheler, 1906, Fig. 19 *a*.)

Fig. 2. Replete ♀, dorsum. Specimen from Co. Clare, Ireland, VII. 1902. (Dublin Mus., Original, L. E. Robinson, phot.)

Jura. **Austro-Hungary**: ○s and larvae have been found on *Rhin. ferrum equinum* and *Rhin. euryale*, grotto of Karstes, near Trieste, by A. Poppe (determined by Neumann, 1899, p. 176). Frauenfeld (1853, p. 57) found specimens in the Adelsberg cave, Carniola, as Schmidt had done before him. He states (1854, p. 28) that *E. gracilipes* had been found in various caves in Carniola and at Adelek in Hungary; he mentions the cave of Goba dol, and some were collected at the caves of Skednenza, Mokrizberg. Joseph found specimens in almost all the habitats of bats in caves in Carniola, clinging to stalactites, but not attached to the bats (*R. ferrum equinum*). Finally, Kolenati's numerous "species" were either found in the habitats of bats or attached to the fleshy parts of the flanks of *R. ferrum equinum*, *R. hippocrepis*, *R. euryale*, *R. blasius* and *R. clivosus*, in Moravia.

AFRICA: 1 ♂ is recorded from Ain-Fezza, near Tlemcen, Algeria, having been collected by Simon (Neumann, 1899, p. 175). Whilst visiting Algiers in February, 1910, one of us (G. H. F. N.) saw a living ♀ which had been taken from a bat in Dr Sergent's laboratory at the Institut Pasteur.

AUSTRALIA: 1 ○ in our collection (N. 649), from *Vesperugo tricolor*, Kingwilliamstown, S. Australia (Hon. N. C. Rothschild coll.).

GEOGRAPHICAL DISTRIBUTION OF THE GENUS.

Some species in the appended list appear to possess special hosts, judging from their having been found thereon several times. Such hosts are given in the column to the right:

	Special Hosts.
EUROPE.	
ricinus: Distribution general.	
hexagonus: ,, ,,	
canisuga: ,, ,,	
brunneus: ,, ,,	Birds.
vespertilionis: ,, ,,	Bats.
tenuirostris: Great Britain, Switzerland, Island of Rügen.	Small mammals.
acuminatus: Italy.	
putus: Great Britain.	Marine birds.
unicavatus: Great Britain.	Marine birds.
caledonicus: Scotland.	Birds.
AFRICA.	
NORTH AFRICA:	
ricinus: Algeria, Tunisia.	
hexagonus: Algeria.	
vespertilionis: Algeria.	Bats.
nigricans: Madeira (perhaps = *ricinus*, see text).	
CENTRAL AFRICA:	
rasus: E. and W.	
ugandanus: E. and W.	
ugandanus var. *djaronensis*: Abyssinia.	
schillingsi: E.	
rubicundus var. *limbatus*: Congo Free State.	
cavipalpus: Angola, N.W. Rhodesia.	
SOUTH AFRICA:	
rubicundus: Cape Colony.	
pilosus: Cape Colony.	
percavatus: Tristan d'Acunha Islands (W. of Cape Colony).	
MADAGASCAR:	
lunatus.	
ASIA.	
ricinus: Transcaucasia, Arabia, Japan.	
ricinus var. *ovatus*: Japan.	
acutitarsus: India, S. Formosa, Japan.	
signatus: Japan, Unalaska (Aleutian Islands).	Marine birds.
japonensis: Japan.	
simplex: Shanghai (China).	
spinicoxalis: Sumatra.	
nitens: Christmas Island (Indian Ocean).	
putus: Kerguelen's Land (Indian Ocean), Bering Island (Bering Sea).	Marine birds.

AUSTRALASIA.

	Special Hosts.
cordifer: New Guinea.	
australiensis: Australia.	
vestitus: ,,	
holocyclus: ,,	
fecialis: ,,	
fecialis var. *aegrifossus:* Australia.	
vespertilionis: Australia.	Bats.
tasmani: Tasmania, Island of St Pierre.	
ornithorhynchi: Tasmania and Marianne Islands.	Ornithorhynchus.
putus: Campbell and King's Islands.	Marine birds.
neumanni: New Zealand.	Birds.

AMERICA.

North America:

putus: Alaska, Newfoundland.	Marine birds.
angustus: Alaska, Canada, United States.	
ricinus: Canada, United States.	
ricinus var. *scapularis:* Canada, United States.	
marxi: Canada and United States.	
texanus: Canada and United States.	
hexagonus var. *cookei:* Canada and United States.	
hexagonus: United States.	
canisuga: ,,	
brunneus: ,,	
signatus: ,,	Marine birds.
pratti: ,,	
sculptus: ,,	
diversifossus: ,,	
dentatus: ,,	
ricinus var. *californicus:* United States.	
rubidus: Mexico.	
bicornis: ,,	
loricatus var. *spinosus:* Mexico.	
minor: Guatemala.	
fuscipes: Panama.	

South America:

fossulatus: Ecuador.	
elegans: Chili.	
boliviensis: Bolivia.	
fuscipes: Brazil.	
hexagonus: Locality not stated.	
coxaefurcatus: Brazil.	
loricatus: Brazil, Paraguay, Argentina, Tierra del Fuego.	
auritulus: Straits of Magellan.	
putus: Tierra del Fuego, Cape Horn and thereabouts, Antarctic.	Marine birds.

LIST OF

CONDEMNED AND DOUBTFUL SPECIES OF IXODES,

INCLUDING THEIR SYNONYMY AND LITERATURE.

The species are ordered according to the genera to which they have at various times been referred. The list of good species will be found on p. 346. See also further under the synonymy of *Ixodes*, p. 133.

Acarus Linnaeus, 1746.

americanus Linn., 1758, p. 615 ; Fabricius, 1794, p. 428 (given as synonym of *Ixodes americanus* by Fabricius, 1805, p. 355, and many subsequent writers) = *Amblyomma americanum* (Linn.) Koch, 1844.

frontalis Panzer, 1795, H. 59, n. 23 = ? *I. brunneus* Koch (undeterminable).

hirudo Fabricius, 1795, p. 485 (undeterminable).

holsatus „ 1794, p. 428 = *I. holsatus* (Fabr.), condemned, see p. 285.

lipsiensis „ 1794, p. 427 = *I. lipsiensis* (Fabr.) condemned, see p. 286.

pallipes „ 1794, p. 426 = ? *I. brunneus* Koch, 1844.

plumbeus Panzer, 1795, H. 90, n. 22 (undeterminable).

reduvius Linnaeus, 1746, p. 479, see p. 143 of this work.

ricinoides de Geer, 1778, p. 98, Pl. V, 16 = *I. ricinus* (Linn.) ♀.

ricinus Linnaeus, 1746, p. 480 = *I. ricinus* (Linn). ♀.

tristriatus Panzer, 1795, H. 59, n. 24 = *I. tristriatus* (Panzer), condemned, see p. 290.

undatus Fabricius, 1794, p. 427 (undeterminable).

Ceratixodes Neumann, 1902.

putus (Cambridge), 1878, in Neumann, 1902, p. 117 = *I. putus* (Pickard-Cambridge).

putus Cambridge, in Banks, 1908, p. 21 = *Ixodes putus* (Pickard-Cambridge).

signatus Birula, in Banks, 1908, p. 21 = *I. signatus* Birula, 1895.

Crotonus Duméril, 1822.

ricinus Duméril, 1822, p. 56 = *I. ricinus* (Linn.).

Cynorhaestes Hermann, 1804.

reduvius Hermann, 1804, p. 65, Pl. VII, Fig. 3, as figured by Hermann, shows festoons, consequently it cannot be an *Ixodes*. Genus undeterminable. (Given as synonym of *I. ricinus* by Neumann.)

ricinus Hermann, 1804, p. 65, possibly = *I. ricinus* (Linn.).

hermanni Risso, 1826, p. 183 = *I. ricinus* (Linn.).

Dermanissus Kolenati, 1856.

rubiginosus Kolenati, 1857, p. 20, Pl. I = *I. rubiginosus* (Kolenati), in Neumann, 1899. Condemned, see p. 288.

Eschatocephalus *Frauenfeld*, 1853.

aeutitarsus (Karsch), in Neumann, 1901 = *I. aeutitarsus* (Karsch).

brevipes Neumann, 1899, p. 179 (*crassipes* Joseph, 1882, renamed) = *I. brevipes* (Neumann). See Notes on Doubtful Species, p. 291.

crassipes Joseph, 1882, p. 16. See *brevipes* above.

flavipes (Koch) in Bonnet, x. 1908, p. 325 = probably *I. vespertilionis* Koch.

frauenfeldi L. Koch, 1872, p. 26, Pl. II, Figs. 29–32 (♂); 1877, p. 150 = *I. vespertilionis* Koch, 1844.

gracilipes Frauenfeld, 1853, p. 55. Pl. = *I. vespertilionis* Koch, 1844.

seidlitzi L. Koch, 1872, p. 26 (♂); 1877, p. 151 = *I. vespertilionis* Koch, 1844.

vespertilionis (Koch) Neumann = *I. vespertilionis* Koch, 1844.

(See *Sarconyssus.*)

Haemalastor Koch, 1844.

acutitarsus Karsch, 1880, p. 142 = *I. acutitarsus* (Karsch), from Japan.

brevipes Neumann, 1899, p. 179 = *I. brevipes* (Neumann), see p. 291, Notes on Doubtful Species.

crassipes Kolenati, 1857, p. 437 ; 1860, p. 578, Pl. II, 5 ; Neumann, 1899, p. 178, and 1901, p. 290. Found on *Rhinolophus clivosus*, in Egypt. Description insufficient.

crassitarsus Karsch, 1880, p. 141 = *Amblyomma longirostre* (Koch), Neumann, 1905, p. 231, not *Amblyomma crassitarsus* (Karsch) Neumann, 1901, p. 315; not *Hyalomma crassitarsus* (Karsch), as stated in Neumann, 1899, p. 293. Original description insufficient ; from Caracas.

longirostris Koch, 1844, p. 233 ; 1847, p. 49 = *Amblyomma longirostre* (Koch) Neumann, 1905, p. 231, not *Hyalomma longirostre* (Koch) as stated in Neumann, 1901, p. 315.

Hyalomma

puta Pickard-Cambridge, 1878, p. 222 = *I. putus* (Pickard-Cambridge).

Ixodes Latreille, 1796.

acanthoglossi Lucas, 1878, p. xxxv ; description insufficient. Specimens from New Guinea, parasitic on *Acanthoglossus bruijnii.*

aegyptius (Linn.) Fabricius, 1805, p. 353 ; also Gervais, 1844, p. 244 (who gives *Ac. aegyptius* Linnaeus and *Cyn. aegyptius* Hermann as synonyms) = *Hyalomma aegyptium* (Linn.).

aegyptius Audouin, 1827, p. 428, wrongly renamed *I. savignyi* by Gervais, 1844, p. 245. See *savignyi* = *Hyalomma aegyptium* (Linn.).

aequalis Banks, 1909. See Notes on Doubtful Species.

affinis Neumann, 1899, p. 120 = *Ixodes ricinus* var. *scapularis* (Say) Nuttall and Warburton, 1910.

africanus Mégnin, 1876, p. 831 = *Hyalomma aegyptium* (Linn.), *fide* Neumann, 1899, p. 286.

albipictus Packard, 1867, p. 65 = *Dermacentor variabilis* (Say), 1821, p. 77 ; Banks, 1907, *fide* Stiles, 1910, p. 31. Packard's description and figures are very poor. Tick found on moose. *I. albipictus* also referred to as attacking man by Holland, 1898, p. 96.

algeriensis Mégnin, 1880, p. 121, Pl. II. Undeterminable : see Neumann, 1901, p. 314.

ameirae Pagenstecher, 1861, p. 41, Pl. II, Figs. 23, 24, hypostome and part of basis capituli with mandibles; probably an *Amblyomma* or *Aponomma*, from Mexico, as rightly suggested by Neumann, 1899, p. 159.

"*americana*" (Linn.) Koch, of Murray, 1877, p. 194=*americanus*, see below.

americanus (Linn.) Fabricius, 1805, p. 355=*Amblyomma americanum* (Linn.) *fide* Salmon and Stiles, 1901, p. 475.

americanus Gervais, 1844, p. 247=*Amblyomma americanum* (Linn.) *fide* Neumann, 1897, p. 366.

angustus Neumann 1901, p. 284=*Ixodes loricatus* Neumann 1899.

annulatus Say, 1821, p. 75; 1859, p. 19=*Boophilus annulatus* (Say) Curtice, 1891. Original description useless; found on *Cervus virginianus*, Florida.

aptericola Maskell, 1897, p. 292, Pl. XVII, Figs. 7, 8; included in Neumann, 1899, p. 163. We find the description and figures so poor as to render even the determination of the genus impossible. ♀ tick, found on *Apteryx australis*, Dusky Sound, New Zealand.

apteridis Maskell, 1897, p. 291. The figures represent a capitulum of the *I. putus* type. The ticks (?♂, ♀) were found on *Apteryx mantelli*, inland from Mt Egmont, New Zealand, and may be the same as the preceding.

"*aquilae*" (in Hamburg Museum)=*Amblyomma decoratum* Koch, 1844, p. 230; 1847, p. 94, Pl. XVIII, Fig. 67. See Neumann, 1899, p. 245.

arcticus Osborn, 1899, p. 553, in Banks, 1908, pp. 23, 53, who states that the type is lost, and the species only recorded (No. 3500) in the type catalogue of the Division of Insects, U. S. National Museum. He quotes Osborn's description as indicating "that the species is a good one." We consider the description too vague to be of any use, and unhesitatingly condemn the species. Hooker, 1909, p. 483, contrary to Banks, states that the type is in the U. S. National Museum.

arenicola Eichwald, 1830, p. 63, Pl. II, Fig. 18 (after Gervais). Insufficiently described; found on sand, shores of Caspian Sea and in Podolia.

aureolatus (Fabr.) Fabricius, 1805, p. 355 (*Acarus aureolatus* Fabricius, 1794, p. 428)=*Amblyomma aureolatus* (Fabr.).

auricularius Conil, 1878, p. 99, Pl. IX, Fig. 1 (*I. auricularis* Conil, in Neumann, 1899, p. 166). Insufficiently described for identification, although the author has been to great pains with his measurements, etc.

auriscutellatus Koningsberger, 1900=*Amblyomma testudinarium* Koch, 1835–1844, Heft XI, 1; *fide* Neumann, 1901, p. 303.

australasiae Fabricius, 1805, p. 355=? *Amblyomma*.

autumnalis Leach, 1815, p. 398=*hexagonus* Leach, 1815.

avisugus Berlese, 1890, fasc. LV, No. 5=*brunneus* Koch, 1844.

bengalensis Supino, 1897, p. 15, Pl. II, Figs. 6–10; 1897, p. 268, Pl. XII, Fig. 4 (tarsus). Description insufficient, from Burma.

berlesei Birula, 1895, p. 359, Pl. II, Figs. 1–6. Description and figures insufficient; a ♀ *Ixodes* from E. Africa.

bibroni Gervais, 1842, p. xlviii; Walckenaer and Gervais, 1844, p. 248; Packard, 1867, p. 68; also Neumann, 1899, p. 157. Probably an *Amblyomma*; from S. America.

bifurcatus Neumann, 1899 (♀), not *I. brunneus* Koch, as stated in Neumann, 1901, p. 347 = *Dermacentor bifurcatus* Neumann, 1904, p. 453.
bimaculatus Denny, 1843, p. 312, Pl. XVII, Fig. 1 (♀) = *Amblyomma hippopotamense* (Denny).
bipunctatus Risso, 1826, p. 183. Nominal species, see Neumann, 1899, p. 158. From S. France.
birmanensis Supino, 1897, p. 12, Pl. I, Figs. 6–10; 1897, p. 247, Pl. XII, Fig. 2 (tarsus 1); see also Neumann, 1897, p. 164. Description insufficient; from Burma.
boarum Stoll, 1886–1893, p. 18, Pl. XIII, Fig. 4 = *Amblyomma dissimile* Koch. See Neumann, 1899, p. 227 (o).
borealis Kramer and Neuman, 1883, p. 518 = *I. putus* (Pickard-Cambridge).
bovis Riley, 1869, p. 168 = *Boophilus annulatus* (Say 1821) Curtice, 1891.
brevipes Murray, 1877, p. 194. Original description comprised in three lines! Nominal species.
brevipes (Neumann), 1899; see Notes on Doubtful Species, p. 291.
cajennensis (Fabricius) Fabricius, 1805, p. 354. (*Acarus cajennensis* Fabr., 1794, IV, p. 427), undeterminable.
calcaratus Birula, (?), p. 137 = *Boophilus annulatus* (Say) Curtice, 1891.
californicus Banks, 1904, p. 369, Pl. XLI, Fig. 57; 1908, p. 24, Pl. II, Fig. 12 = *I. ricinus* var. *californicus* (Banks) Nuttall and Warburton, 1911.
camelinus Fischer von Waldheim, 1823, p. 13, Pl., Figs. 1 and 2 = *Hyalomma aegyptium* (Linn.).
cenereolus Lucas, 1840, pp. 47, 48, Pl. VII, Fig. 10 (after Gervais, 1844, p. 244). Insufficiently described; see Neumann, 1899, p. 165; from Canary Islands.
chelifer Mégnin, 1880, p. 132 = *Haemaphysalis concinna* Koch, 1844.
chordeilis Packard, 1867, p. 67 = *Haemaphysalis leporis palustris* (Packard), *fide* Neumann, 1897, p. 343, but stated to be a distinct species of *Haemaphysalis* by Banks, 1908, p. 34.
cinctus Fabricius, 1805, p. 356; undeterminable.
cinctus Lucas, 1840, pp. 47, 48, Pl. VII, Fig. 12 (after Gervais, 1844, p. 243). Insufficiently described; from Canary Islands.
columbae Fabricius, 1805, p. 356 = *Argas reflexus*.
"*communis*" Marx (label: no date) = *I. ricinus* var. *scapularis* (Say) Nuttall and Warburton, 1911.
cookei Packard, 1869 a, p. 67 = *hexagonus* var. *cookei* (Packard) Nuttall and Warburton, 1911; not *Haemaphysalis concinna* Koch, as stated in Neumann, 1897, p. 338.
cornuger Kolenati, 1857, p. 431, Pl. VI, Fig. 52 (very poor) = *Hyalomma aegyptium* (Linn.) (♂) found on camel, dog, sheep, on the steppes of Kisil-Kum, Sea of Aral.
coxalis Gervais, 1842, p. 47; Walckenaer and Gervais, 1844, p. 249. Judging from original description may be a *Dermacentor* ♂; from New Holland.
crenatus Say, 1821, p. 76; 1859, p. 20. Original description useless.
crenulatus Koch, 1835–1844, H. 39, Figs. 8, 9; 1844, p. 232 (listed); 1847, p. 22 = *I. hexagonus* Leach, 1815, from Germany. "*I. crenulatus* Koch," as described by Canestrini and Fanzago, 1877, p. 116, is undeterminable.

cruciarius Fitch, 1872, p. 366 (=*I. cookei fide* Banks, 1908, p. 53)=*I. hexagonus* var. *cookei* Nuttall and Warburton, 1911.

decorosus L. Koch, 1867, p. 241=*Aponomma decorosum* (L. Koch) Neumann, 1899, p. 194.

distipes Murray, 1877, p. 194. Purely nominal species; see Neumann, 1899, p. 161. From Tunis.

dugesii Gervais, 1844, p. 242 (Walckenaer and Gervais), *I. plumbeus* Dugès renamed=? *Rhipicephalus sanguineus* (Latreille), as suggested in Neumann, 1897, p. 385, but undeterminable from description. On dogs in France.

dugesii Gervais, in Mégnin, 1880, p. 126, Fig. 44=*Boophilus* sp.

elegans Guérin, 1829–1843, p. 16, Pl. VI, Fig. 1=*Amblyomma variegatum* (Fabricius), 1794; in Neumann, 1899, p. 268.

elegans Neumann, 1910, p. 191, Fig. 1 = *I. stilesi* Neumann, 1911 (original name preoccupied; species renamed.)

elephantinus (Linn.) Fabricius, 1805, p. 351 (*Ac. elephantinus* Linn.)=? *Amblyomma elephantinus* (Linn.).

erinacei Audouin, 1832, p. 415, Pl. XIV, Fig. 32 (♀)=*I. hexagonus* Leach, 1815, in Neumann, 1899, p. 129.

erinaceus Murray, 1877, p. 190=*hexagonus* Leach, 1815.

erraticus Say, 1821, p. 77; 1859, p. 20. Original description useless; found in S. United States.

eudyptidis Maskell, 1885. See Notes on Doubtful Species, p. 291, and *I. putus.*

eudyptidis Maskell, 1885, in Neumann, 1899, p. 128=*I. neumanni* Nuttall and Warburton, 1911.

eudyptidis var. *signata* Neumann, 1904, p. 451=*I. signatus* Birula, 1895.

exilipes Lucas, 1846, p. 63, Pl. I, Fig. 5. Undeterminable; on *Lacerta ocellata*, from Algiers.

fabricii Audouin, 1827, p. 428 (description of plates)=*Hyalomma aegyptium* (Linn.).

fimbriatus Kramer and Neuman, 1883, p. 518 = *Ixodes putus* (Pickard-Cambridge, 1878).

flavidus Koch, 1844, p. 233; 1847, pp. 22, 103, Pl. XXI, Fig. 77 (♀); Neumann, 1899, p. 227, states that it is a o from Rio de Janeiro=*Amblyomma dissimile* Koch.

flavipes Koch, 1835–1844, H. 39, Fig. 2; 1847, p. 21 (Germany)=*I. vespertilionis* Koch, 1844.

flavomaculatus Lucas, 1846, p. 56, Pl. I, Fig. 1 (♂); 1851, p. 120; 1867, p. lxxii=*Aponomma exornatum* (Koch) 1844, in Neumann, 1899, p. 186.

fodiens Murray (not Mégnin), 1877, p. 191=*ricinus* (Linn.) Latreille, 1806.

forskåli Audouin, 1827, p. 430. An undeterminable *Argas*; see our Part I, p. 6.

fuscolineatus Lucas, 1847, p.c. Description useless; from India.

fuscomaculatus Lucas, 1873, p. xxi. Probably an *Amblyomma*. See Neumann, 1899, p. 160; from S. America.

fuscous (*fuscus*) Say, 1821, p. 79; 1859, p. 22. Original description useless.

fuscus Koch, 1835–1844, H. 39, Figs. 3, 4; 1844, p. 232 (listed); 1847, p. 21=*ricinus* (Linn.), in Neumann, 1899, p. 112.

gervaisi Lucas, 1847, p. xciv = *Aponomma gervaisi* (Lucas), in Neumann, 1899, p. 182.

globulosus Supino, 1897, p. 18, Pl. III, Figs. 11–15 ; 1897, p. 249, Pl. XII, Fig. 7, (tarsus). Description insufficient ; from Burma.

globulus Lucas, 1860, p. 538. Insufficiently described, may be an *Aponomma*.

gracilentus Lucas, 1845, p. 58, Pl. I, Fig. 2 (o) = *Hyalomma aegyptium* (Linn.), in Neumann, 1899, p. 286.

granulatus Supino, 1897. See Notes on Doubtful Species, p. 291.

herrerae Dugès, 1887 ? p. 487 ; 1891, Pl. VIII, Fig. 5 (♂) = *Amblyomma cajennense* Koch, 1844.

hexagonus Leach, in Salmon and Stiles, 1901, p. 467. See synonymy of *I. hexagonus* var. *cookei*.

hexagonus var. *inchoatus* Neumann, 1901, p. 283 = *canisuga* Johnston, 1849, p. 371.

hexagonus var. *longispinosus* Neumann, 1901, p. 283 = *I. hexagonus* var. *cookei* (Packard) Nuttall and Warburton, 1911.

hippopotamensis Denny, 1843, p. 313, Pl. XVII, Fig. 2 (♂) = *Amblyomma hippopotamensis* (Denny), in Neumann, 1899, p. 256.

hirsutus Birula, 1895, p. 356, Pl. I, Figs. 7–9 ; Neumann, 1899, p. 162. Description and figures insufficient. From Aleutian Islands and E. Siberia. Given as synonym of *I. putus* by Banks, 1908, p. 54.

hispanus (Fabricius) Fabr., 1805, p. 353 (*Acarus hispanus* Fabricius, 1794, p. 426) = probably *Hyalomma aegyptium* (Linn.).

hispanus Kolenati, 1857, p. 431, Pl. VI, Fig. 52 (♀)? = *Hyalomma aegyptium* (Linn.), in Neumann, 1899, p. 286.

histrio (Fabricius) Fabr., 1805, p. 352 (*Acarus histrio* Fabricius, 1794, Suppl., p. 571). Undeterminable.

holsatus (Fabricius) Fabr. 1805, p. 355 (*Acarus holsatus* Fabr.); 1794, p. 428. Undeterminable, probably young of *ricinus* or *hexagonus* ; see Neumann, 1899, p. 157.

holsatus Fabricius, in Kolenati, 1857, p. 24, Pl. II = *Dermacentor reticulatus* (Fabricius, 1794) in Neumann, 1897, p. 360. We agree in referring it to this species after consulting the original description.

humanus Koch, 1844, p. 233 ; 1847, p. 104, Pl. XXI, Fig. 78 (♀) = *Amblyomma dissimile* Koch ; see Neumann, 1899, p. 227 ; a o, from Brazil.

hydrosauri Denny, 1843, p. 314, Pl. XVII, Fig. 4 = *Amblyomma hydrosauri* (Denny), in Neumann, 1899, p. 197.

iguanae (Fabr.) Fabricius, 1805, p. 354 (*Acarus iguanae* Fabr., 1794, IV, p. 427) = *Amblyomma iguanae*.

imperfectus Neumann, 1899, p. 118. See Notes on Doubtful Species, p. 292.

indentatus Gamgee, 1869 = *Boophilus annulatus* (Say), in Neumann, 1897, p. 408.

indus (Linn.), *Syst. nat.*, II, 1022 ; Fabricius, 1794, p. 428 (*I. indus*); 1805, p. 355. Undeterminable.

inermis Neumann, 1901, p. 283. See Notes on Doubtful Species, p. 292.

intermedius Neumann, 1899, p. 132 ; 1904, p. 451 = *I. neumanni* Nuttall and Warburton, 1911.

juvenis Neumann, 1899, p. 124. See Notes on Doubtful Species, p. 292.

kelloggi Nuttall and Warburton, 1907, p. 396 = *I. brunneus* Koch, 1844.

lacertae Koch, 1835–1844, H. 39, Fig. 11; 1847, p. 22 (Germany) = *ricinus* (Linn.), in Neumann, 1899, p. 112. "*Ix. lacertae*" in Pagenstecher, 1861, p. 41, Fig. 22; may be the same.

laevis Neumann, 1899, p. 148 = *acutitarsus* (Karsch), 1880.

lagotis Gervais, 1849, p. 49. Insufficiently described; may be a *Haemaphysalis.*

leachii Audouin, 1827, p. 428. (Savigny, Pl. IX, Fig. 9) = *Haemaphysalis leachi* (Audouin).

leporis-palustris Packard, 1867, p. 67 = *Haemaphysalis leporis-palustris* (Packard).

lineatus (Fabricius) Fabr., 1805, p. 354. (*Acarus lineatus* Fabricius, 1794, p. 428.) Undeterminable.

linnei Audouin, 1827, p. 428; Savigny, 1825, Pl. IX, Fig. 12; Walckenaer and Gervais, Pl. XXXIII, Fig. 1 = *Rhipicephalus* sp.? Undeterminable.

lipsiensis (Fabricius) Fabr., 1805, p. 354. (*Acarus lipsiensis* Fabricius, 1794, pp. 427, 428) = young of *ricinus* or *hexagonus*; see Neumann, 1899, p. 157.

lividus Leach, 1824, II, in Koch, 1844, p. 234 (undeterminable) = young of *ricinus* or *hexagonus* in Neumann, 1899, p. 157.

lividus van Beneden, 1873, XL. A purely nominal species from *Vesperugo.* No description; see Neumann, 1899, p. 160.

longipes Lucas, 1872, p. lxxiv = *vespertilionis* Koch, 1844, p. 232; in Neumann, 1899, p. 169.

luteus Koch, 1844, p. 232; 1847, p. 102, Pl. XX, Fig. 75 (♀). Species based by Koch on one ♂ from S. Africa. Neumann, 1899, p. 146, and 1901, p. 285, referred a ♀ to this species, the tick having been taken from a wild dog in Africa (Paris Museum). Insufficiently described.

marginalis Hahn, 1834, p. 63, Pl. LXVI, Fig. 153. Useless description, undeterminable.

marginalis in Gervais, 1844, p. 242 = ? (Salmon and Stiles, 1901. Synonymy of *I. ricinus*).

marginalis Koch, 1835–1844, II, p. 63, Pl. LXVI, Fig. 53 (after Gervais). Insufficiently described; see Neumann, 1899, p. 165.

marginatus (Fabricius) Fabr. 1805, p. 354 (*Acarus marginatus* Fabricius, 1794, p. 427) = *Argas reflexus* (Fabr.) Latreille, 1796.

marginatus Burmeister, 1837, p. 579 = *I. ricinus, fide* Oudemans, 1896, p. 191 in Salmon and Stiles, 1901, p. 466.

marmoratus Risso, 1826, p. 183 = *Dermacentor reticulatus* (Fabricius) 1794, in Neumann, 1897, p. 360.

maskellii Kirk, 1887, p. 66. Undeterminable, description useless. Found on Albatross (*Diomedia exulans*), New Zealand.

megathyreus Leach, 1815, p. 398 = *I. ricinus* (Linn.).

mixtus Moniez, 1896, p. 497 = *Amblyomma mixtum* Koch = *Amblyomma cajennense* (Fabr.), in Neumann, 1901, p. 348 (Index).

moreliae L. Koch, 1867, p. 241 = *Amblyomma moreliae* (L. Koch), according to Neumann, 1899, p. 258. Description insufficient to make it a good species, however, in our opinion. Found at Brisbane on *Morelia argus* var. *fasciolata* Jan.

naponensis Packard, 1867, p. 65 = *Dermacentor electus* Koch in Neumann, 1897, p. 366; but *electus* = *D. variabilis* (Say, 1821) *fide* Stiles, 1910, p. 29.

nigrolineatus Packard, 1867, pp. 66, 67 = *Dermacentor nigrolineatus* (Packard) Banks, 1907, *fide* Stiles, 1910, p. 51. Insufficiently described by Packard, who appeared to describe a ♂ as a ♀; doubtfully referred to *Haemaphysalis concinna* Koch by Neumann, 1897, p. 338.

nigua (de Geer) Latreille, 1804, p. 52 = *Amblyomma americanum* (Linn.) Koch, 1844; *fide* Salmon and Stiles, 1901, p. 475.

nigua Guérin = *Amblyomma americanum* (Linn.) Koch, 1844, in Neumann, 1901, p. 342 (Index).

obliquus Koch, 1844, p. 232; 1847, p. 99, Pl. XX, Fig. 73 (♀ and its scutum). Insufficiently described.

obscurus Fabricius, 1805, p. 355. Undeterminable.

obscurus Neumann, 1899, p. 121 = *nigricans* Neumann, 1908, p. 75. (Renamed, name preoccupied.)

ophiophilus Müller, 1831, p. 233, Pl. LXVII = ? *Aponomma gervaisi* (Lucas), 1847, in Neumann, 1899, p. 182.

orbiculatus Say, 1821, p. 76; 1859, p. 20. Original description useless. Found on *Sciurus capistratus*, S. United States.

"*oregonensis*" (label), in U. S. National Museum = *Dermacentor salmoni* Stiles, 1910, pp. 55, 60.

ovatus Neumann, 1899, p. 116, Figs. 2, 3 = in part *ricinus* (Linn.), says Neumann, 1904, p. 452.

ovatus Neumann, 1899, p. 112, 1904, p. 452 = *I. ricinus* var. *ovatus* (Neumann). Nuttall and Warburton 1911.

pallens Fabricius, 1805, p. 356. Undeterminable.

pallipes (*Acarus pallipes* Fabr., 1794, p. 426) referred to in Koch, 1835, H. 39, 10; 1847, p. 22 (Germany) = ? *I. brunneus* Koch, 1844 (larva).

pallipes Lucas, in Webb and Berthelot, 1840, pp. 47, 48, Pl. VII, Fig. 9 (after Gervais, 1844, p. 243). Undeterminable.

pari Leach, 1815, p. 399, on "*Parus major*" = ? *I. brunneus* Koch, 1844.

parvirostris Neumann, 1901, p. 284 = *I. signatus* Birula, 1895.

perpunctatus Packard, 1867, p. 68. Probably an *Amblyomma*; see Neumann, 1899, p. 159. From S. America.

phascolomys Macalister, 1871, p. 163, Fig. A purely nominal species; see Neumann, 1899, p. 160.

pictus Gervais, 1844, p. 239 = *Dermacentor reticulatus* (Fabricius), in Neumann, 1901, p. 265.

pilosus var. *howardi* Neumann, 1908, p. 125 = *I. pilosus* Koch.

plumbeus (Panzer) in Fabricius, 1805, p. 353 (*Acarus plumbeus* Panzer). Undeterminable.

plumbeus Leach, 1815, p. 397; 1824, p. 11. Undeterminable = *I. lividus* Koch, in Neumann, 1901, p. 348; 1899, p. 157; see *lividus* in this list. On *Hirundo riparia.*

plumbeus Dugès, 1834 c, Pl. VII, Figs. 7–12 = *Rhipicephalus* sp., as clearly indicated by the figures (= *I. ricinus*, according to Neumann's synonymy). Also figured by Wagner, 1841, Figs. XII, XIII (unrecognizable).

plumbeus in Wheler 1899 = *Ixodes canisuga* Johnston, 1849.

poortmani Lucas, 1850, p. xli ; Belval, 1861, p. 97, Pl. =*Amblyomma hebraeum* Koch, in Neumann, 1899, p. 266.

praecoxalis Neumann, 1899, p. 121=*I. neumanni* Nuttall and Warburton, 1911.

pulchellus Lucas, 1845, p. 61, Pl. I, Fig. 4 ; 1849, p. lxxx ; 1849, p. 582 (♂, good figure of capitulum)=*Amblyomma dissimile* Koch, in Neumann, 1899, p. 227.

punctulatus Say, 1821, p. 78 ; 1859, p. 21. Original description useless, said to resemble "*I. variabilis*"=*Dermacentor variabilis* (Say, 1821).

punctulatus Canestrini and Fanzago, 1877–1878, pp. 115, 183 ; Canestrini, 1890, p. 502. Doubtful if it is an *Ixodes* ; see Neumann, 1899, p. 160. From Europe.

pustularum Lucas, 1866, p. lvii=*Ixodes ricinus* (Linn.), in Neumann, 1899, p. 113.

pygmaeus Koch, 1844, p. 233 ; 1847, p. 107, Pl. XXII, Fig. 81 (♀), from Brazil and Mexico. Types examined by Neumann (1901, p. 289), and found to be *Amblyomma* nymphs, of undetermined species.

quinquestriatus Fitch, 1870, p. 366=*Dermacentor variegatus* Marx and Neumann, in Neumann, 1901, p. 266.

reduvius Audouin, 1832, *nec* Linnaeus (♂), p. 422, Pl. XIV, Fig. 4=*I. hexagonus* Leach, 1815.

reduvius Hahn, 1834, p. 62, Fig. 152=*I. ricinus* (Linn.), in Neumann, 1899, p. 112.

reduvius de Geer, in Mégnin, 1880, p. 126=*I. ricinus* (Linn.).

reduvius (Linn.)=*ricinus* (Linn.), in Neumann, 1901, p. 348, and numerous other authors, this incorrect, see p. 143.

reflexus (Latreille) Fabricius, 1805, p. 352=*Argas reflexus* (Fabr., 1794, p. 426) Latreille, 1796. (See our Part I, p. 22.)

reticulatus Latreille, 1804, p. 157=*Dermacentor reticulatus* (Fabricius), 1794, in Neumann, 1897, p. 360.

reticulatus (Fabr.) Fabricius, 1805, p. 355 (*Acarus reticulatus* Fabr., 1794, p. 428). Undeterminable.

reticulatus Koch, 1856, p. 413. Insufficiently described ; see Neumann, 1899, p. 166.

reticulatus Koch, in Rosenhauer, 1856, p. 412. Undeterminable, found on *Lacerta ocelata*, in Spain.

rhinocerinus Denny, 1843, p. 313, Pl. XVII, Fig. 3=*Dermacentor rhinocerotis* (de Geer), in Neumann, 1897, p. 370.

rhinocerotis Fabricius, 1805, p. 351=*Dermacentor rhinocerotis* (de Geer), 1778.

rhinocerotis Gervais, 1844, p. 246 (Walckenaer and Gervais)=*Dermacentor rhinocerotis* (de Geer) 1778, in Neumann, 1897, p. 370.

ricinus Mégnin, 1880, p. 129 *nec* Latreille=*I. hexagonus* Leach, 1815 ; see Neumann, 1899, p. 129.

rostralis Moniez, 1896, p. 496=*Gonixodes rostralis* Dugès, 1888, p. 129=*Haemaphysalis leporis-palustris* (Packard) in Neumann, 1901, p. 348 (Index).

rubiginosus (Kolenati), Neumann, 1899 (*Dermanyssus rubiginosus* Kolenati, 1857, p. 20, Pl. I). Probably an *Ixodes*, says Neumann, 1899, p. 158. Found on *Plecotus auritus*.

rufipes Fabricius, 1805, p. 354. Undeterminable.

rufus Koch, 1835–1844, H. 39, Fig. 7; 1844, p. 232 (listed); 1847, p. 22; o s, types examined by Neumann, 1901, p. 282 = *I. ricinus* (Linn.).
sanguineus Latreille, 1804, p. 157 = *Rhipicephalus sanguineus* (Latreille) in Neumann, 1897, p. 385.
sanguisugus (Fabricius) Fabr., 1805, p. 353 (*Acarus sanguisugus* Fabr., 1794, p. 426). Undeterminable.
savignyi Gervais, 1844, p. 244. Atlas, Pl. XXXII, Fig. 1; XXIII, Fig. 2 = *Hyalomma aegyptium* (Linn.) (*I. aegyptius* Audouin renamed, as he thought, judging from published figures, that it differed from *Cynor. aegyptius* Hermann).
scapularis Say, 1821, p. 78; 1859, p. 21 = *I. ricinus* var. *scapularis* (Say) Nuttall and Warburton, 1911. Original description useless.
scapulatus Mégnin, 1880, p. 132. Undeterminable.
sciuri Koch, 1835–1844, H. 35, 8; 1844, p. 232 (listed); 1847, p. 21 (Germany) = *I. ricinus* (Linn.) o s, types examined by Neumann, 1901, p. 282. *I. sexpunctatus* Koch, 1835–1844, H. 39, 5, 6; 1844, p. 232 (listed); 1847, p. 22 = *I. hexagonus* Leach; see Neumann, 1901, p. 283, who examined the types (o s). Canestrini and Fanzago, 1877, p. 114, described a ♀ (?) as *sexpunctatus*, but their description is useless.
siculifer Mégnin, 1880, p. 132 = *I. vespertilionis* (Koch) 1844.
spinosus Neumann, 1899, p. 146 = *fuscipes* Koch, 1844.
5-*striatus* Fitch; see *quinquestriatus*.
sturni Pagenstecher, 1861, p. 40 = ? *I. brunneus* Koch, 1844 (larva).
sulcatus Koch, 1844, p. 233; 1847, pp. 22, 108, Pl. XXII, Fig. 82 (♀) = *I. ricinus* (Linn.) o s. Types examined by Neumann, 1901, p. 282.
sylvaticus Gervais, 1778, p. 162, Pl. 38, Fig. 7 = *Amblyomma sylvaticum* (de Geer), in Neumann, 1899, p. 274. On tortoise, Cape of Good Hope. May attack man.
testudinis Conil, 1877, p. 25 = *Amblyomma testudinis* (Conil), see Neumann, 1905, p. 234.
testudinis Supino, 1897, p. 11 = *Amblyomma supinoi* Neumann, 1905, p. 234.
testudinis Leydig, 1855, p. 382, Pl. XV, Fig. 51, also p. 395; 1857, p. 111 = *Hyalomma syriacum*, no doubt.
thoracicus Koch, 1844, p. 232; 1847, p. 98, Pl. XIX, Fig. 72 (♀). May have been an *Amblyomma*, as Neumann, 1904, p. 450, rightly suggests.
"*thoracicus* Koch" in Neumann, 1899, p. 149 = *auritulus* Neumann, 1904, p. 450.
trabeatus Audouin, 1832, p. 420, Pl. XIV, Fig. 3 (♀) = *I. ricinus* (Linn.), in Neumann, 1899, p. 112.
trachysauri Lucas, 1861, p. 125 = *Aponomma trachysauri* (Lucas).
transversalis Lucas, 1844, and in Murray, 1877, p. 195 = "*Neumanniella transversalis* (Neumann)" Lahille, 1904 = *Aponomma transversale* (Lucas) Neumann, 1899, p. 188.
trianguliceps Birula, 1895, p. 358. See Notes on Doubtful Species, p. 293.
trilineatus Lucas, 1840, pp. 47, 48, Pl. VII, Fig. 11. Insufficiently described, Canary Islands.
trimaculatus Lucas, 1878, p. lxxvii = *Aponomma trimaculatum* (Lucas), in Neumann, 1899, p. 187.

tristriatus (Panzer), 1795, H. 59, n. 24; Koch, 1835-1844, fasc. 59, Fig. 24; 1844 p. 234 (listed) = young of *ricinus* or *hexagonus*; see Neumann, 1899, p. 157.

troglodytes Schmidt, 1853; see Frauenfeld, 1853, p. 57 = *I. vespertilionis* Koch.

undatus (Fabricius) Fabr., 1805, p. 353 (*Acarus undatus* Fabricius, 1794, p. 427). Undeterminable.

"*unipictus* Packard," of Verrill, 1870, p. 118 (lapsus for *unipunctata* (*q.v.*) *fide* Salmon and Stiles, 1901, p. 476).

unipunctata Packard, 1867, p. 66 = *Amblyomma americanum* Koch, in Neumann, 1899, p. 209.

uriae White, 1852. Nominal species, found on *Uria troile* at Baffin's Bay. Description and figure inadequate; may = ? *I. putus*.

varanensis Supino, 1897, p. 13, Pl. II, Figs. 1-5 = *Aponomma gervaisi* (Lucas), in Neumann, 1899, p. 182.

varani L. Koch, 1867, p. 241 = *Aponomma decorosum* (L. Koch), in Neumann, 1899, p. 194.

varani Lewis 1892, p. 10, Pl. I = *Aponomma exornatum* (Koch) 1844.

variabilis Say, 1821, p. 77; 1859, p. 21. Original description useless, said to resemble *erraticus* and *punctulatus*. Listed, however, by Banks, 1895, p. 433, as occurring at Fort Collins = *Dermacentor variabilis* (Say) Banks, 1907, *fide* Stiles, 1910, p. 29.

variegatus Lucas, 1852, p. lxxxviii = *Amblyomma albopictum* Neumann, in Neumann, 1899, p. 244.

variegatus (Fabricius) Fabr., 1805, p. 353 (*Acarus variegatus* Fabricius, 1794, IV, p. 572) = *Amblyomma variegatum* (Fabricius).

variolatus Gervais (Walckenaer and Gervais), 1844, p. 249. Probably an *Amblyomma*. From Brazil, on a reptile.

vibrans (Fabr.) Fabricius, 1805, p. 356, No. 28 (1794, p. 428, 20: *Acarus vibrans*). Undeterminable.

viperarum Koch, 1844, p. 234; 1847, p. 102, Pl. XX, Fig. 76 (larvae). From Greece, undeterminable.

vulgaris Fabricius, 1805, p. 352 = *I. ricinus* or *hexagonus*.

vulpis Pagenstecher, 1861, p. 40, Pl. I, Figs. 12, 13 = *hexagonus* Leach, 1815.

walckenaeri Gervais, 1842, p. xlvii; 1844, p. 246, Pl. XXXIV, Fig. 11 = ? *Amblyomma*. Undeterminable.

Sarconissus Kolenati, 1856 (*Sarconyssus* Kolenati, in Murray, 1877, p. 195; Marx, 1892, p. 235, etc., referred to *Haemalastor* and then to *Eschatocephalus* by Neumann).

brevipes Kolenati, 1856, p. 21 = *I. vespertilionis* Koch.

exaratus Kolenati, 1856, p. 22; 1860, p. 757, Pl. I, Fig. 2 = *I. vespertilionis* Koch, *vide* Neumann, VIII. 1910, p. 191, who examined type, a nymph.

flavidus Kolenati, 1856, p. 21 = *I. vespertilionis* Koch.

flavipes Kolenati, 1856, p. 21 = *I. vespertilionis* Koch. (Neumann 1910, p. 192, states the types were not adults.)

hispidulus Kolenati, 1856, p. 21 = *I. vespertilionis* Koch.

kochi „ „ p. 21; 1860, p. 573, Pl. II, Fig. 4 = *I. vespertilionis* Koch, ♂.

nodulipes Kolenati, 1860, p. 576, Pl. I, Fig. 3 = probably *I. vespertilionis* Koch.

NOTES ON DOUBTFUL SPECIES OF IXODES.

Ixodes aequalis Banks, XI. 1909, p. 276; 1910, p. 6, Pl. III, Fig. 23 (♀ capitulum and scutum, sketchy). The author's description and figure are inadequate: the essential data which we glean therefrom are as follows:

MALE: unknown.

FEMALE: *Scutum* 1 mm. *l.*, nearly diamond shaped, antero- and postero-lateral borders subequal, many uniform punctations, lateral carinae distinct. Spiracle circular. *Capitulum* subtriangular, porose areas rather large, sub-circular, the interval less than half their diameter. *Legs*: coxae I–IV with minute spur at postero-external angle, coxa I with short internal spine; tarsi tapering abruptly.

HOST: *Otospermophilus beecheyi* (California ground squirrel), Berkeley, California (Drs Wellman and Wherry). Banks states that *aequalis* differs from *angustus* in having a shorter and differently shaped scutum, more circular porose areas, shorter tarsi, etc. According to Hooker, 1909, p. 423, the type is in Banks' collection, Washington, D.C.

Ixodes brevipes (Neumann), 1899 (*Eschatocephalus crassipes* Joseph, 1882, p. 16, renamed owing to *crassipes* being preoccupied); only ♂s found on stalactites in caves (Ihanska jama, Goba dol, etc., Krain, Austria), the hosts probably being bats. Insufficiently described; said by Joseph to have shorter legs than *I. vespertilionis.*

Ixodes eudyptidis Maskell, 1885, pp. 19, 20, Pl. VIII, Figs. 12–14. The only points given in the author's bad description, and which might be utilized, may be summarized as follows: *Scutum* hairless, glossy; many fine, shallow punctations. As the author says, it is "evidently a true tick," and that is all that we can say about it. It was found "in the gape of the penguin," at Dusky Sound, New Zealand. See also Synonymy under *I. neumanni* N. and W. Judging from the bad figures, it is possible that *eudyptidis* = *I. putus.*

Ixodes granulatus Supino, 1897, p. 16, Pl. III, Figs. 1–10, and 1897, p. 250, Pl. XII, Figs. 5, 6. Also Neumann, 1899, p. 164; 1902, p. 125. Supino's description and figures are insufficient. Neumann found what Supino described as a ♂ to be either a ♀ or o. Neumann supplements Supino's description, and regards the species as allied to *I. minor.* The points which may serve for determination are as follows:

FEMALE: *L.* 4·5, *W.* 3·5 mm. *Scutum* regularly oval (1 × 0·75 mm.); cervical grooves scarcely visible; lateral grooves indicated by a faintly marked ridge running parallel to the borders; many fine and uniform punctations; emargination very slight. Anal grooves diverging widely behind. *Capitulum* long, with dorsal base subtriangular, porose areas rounded, divergent. Hypostome long, narrow, lanceolate, 3|3, 10–11 sharp teeth per file; digit slender (110 μ *l.*), external article 5-cusped; palps slender, inserted very low down, article 2 almost twice as long as 3. *Legs*: coxa I with short spur at each posterior angle, the inner spur longer; a tuberosity external to the others, scarcely visible on coxa IV. Legs slender, relatively long, tarsi tapering, pad two-thirds the length of claws.

Found on *Sciurus gordoni*, *S. rufigenis*, *S. striatus* and *Felis tigris*, at Bhamo, Mooleyis, Tarrawaddy and Terinzo in Upper and Lower Burma, according to Supino.

Ixodes imperfectus Neumann, 1899, p. 118 (no figure); species founded on 2 *nymphs*, having the following characters (condensed from Neumann):

NYMPH: Body 2·1 × 1·2 mm. *Scutum* oval, glossy (0·56 × 0·51 mm.), with lateral borders almost straight along their anterior half; cervical grooves well marked, almost attaining the posterior border; lateral grooves clearly defined, straight, divergent behind; punctations fine, distant. *Venter*: sexual grooves divergent, straight, long; anal grooves parallel behind; many fine punctations. *Capitulum* (0·33 mm. *l.*) with base broader than long, narrowed conically in front; pointed cornua; auricula forming a retrograde spine beneath the postero-dorsal angle; hypostome narrow, lanceolate, 2 | 2, the external teeth long, pointed; palps long, narrow, article 2 longer than 3. *Legs* long; coxae with a spine at the postero-external angle, decreasing in size from pair I to IV; a stouter spine at the postero-internal angle of coxa I; tarsi thick, long on pairs I and IV, tapering gradually; pads as long as claws.

HOST: *Didelphys pusilla*, Brazil (Goeldi coll.).

Ixodes inermis Neumann, 1901, p. 283 (no figure). Included under doubtful species because the description is inadequate.

MALE: unknown.

FEMALE: Body 4 mm. long (capitulum included), yellowish. *Scutum* reddish brown, light-coloured, glabrous, as broad as long, lozenge-shaped (the lateral angles toward the middle of the length), no lateral grooves, punctations numerous; surface slightly shagreened. Dorsum and venter bearing short hairs; anal grooves diverging considerably. Base of capitulum more than twice as broad as long; hypostome lanceolate, bearing two marginal rows of stout teeth and numerous denticles in front; palps relatively short. Coxae unarmed; tarsi fairly long, humped near their extremities.

From Neumann's description, based on 3 ♀s and 4 os collected by Z. Wagner, locality not given (Berlin Museum). (Two ♂s identical with *Ixodes ricinus* were found in the same lot, but differed too much from the ♀s to permit of their being considered as belonging to the same species.)

Ixodes juvenis Neumann, 1899, p. 124 (no figure). Species founded on 6 *nymphs* and 1 *larva*, having the following characters (condensed from Neumann):

NYMPH: Body ovoid (2 × 1·1 mm.), dark brown. *Scutum* rounded, slightly broader than long, of the same colour as the rest of the body; punctations few, very fine; some short hairs; cervical grooves attaining the posterior border. Dorsum bearing long hairs, especially on the borders; marginal groove superficial, almost forming the lateral border. *Venter* glabrous, or almost so; sexual grooves straight, divergent, attaining the posterior border; anal grooves parallel, united in an arc in front. Spiracle large, circular. *Capitulum* 0·35 mm. *l.*, base rectangular, broader than long; hypostome elongate, lanceolate, 2 | 2, 10–11 teeth per file, the external pointed, the internal blunt. Palps of medium length, article 3 equal to 2. *Legs* of medium length, dark brown; coxae almost contiguous, glossy, with some very short hairs; a tuberosity at each of the two posterior angles, more pronounced on coxa I, almost obsolete on coxa IV. Tarsi elongate, slightly tapering at their tips; pad almost as long as claws.

LARVA: similar to ⚬, but shorter (1·2 mm.), hexapod.

HOST: *Holotropis* (Iguana) from New Grenada (Paris Mus.).

Ixodes trianguliceps Birula, 1895, pp. 358, 359, Pl. I, Figs. 14, 15 (♀ capitulum, coxa). This species appears to be closely related to, if not identical with, *I. tenuirostris* Neumann. Birula's figures are obviously drawn from a mounted specimen and consequently it is impossible to reach any conclusions as to its identity. We wrote to Professor Birula (St Petersburg) for the loan of the (unique) type, but he feared it might be lost in transit. Should Birula's specimen prove to be identical with Neumann's type, then *trianguliceps* would have priority. Birula's description of the scutum of *trianguliceps* as being as broad as long may be due to distortion in the mounted specimen.

NOTES ON THE BIOLOGY OF IXODES

By G. H. F. NUTTALL.

Introductory.

Of the 51 species which we recognize as valid, there are but two about which we are still somewhat in doubt, namely, *bicornis*, which may be identical with *diversifossus*, and *nigricans*, which may be but a variety of *ricinus*. This leaves 49 well-established species. Of these, the life-histories of but 8 are known in so far as both sexes, the nymphs and larvae have been recorded. Only a few of the latter have actually been raised experimentally through some of their stages. Partial raising experiments have been carried out in Cambridge with *ricinus*, *hexagonus* and *canisuga*, the evidence afforded being sufficient to make it possible to identify the different stages of these species. Lounsbury, at the Cape, has raised *pilosus* experimentally; and Hadwen, in British Columbia, has made partial raising experiments on *angustus*. Of the remaining species whose various stages are known (*tenuirostris*, *vespertilionis* and *loricatus*), the close resemblance between the various stages encountered upon the same host has been accepted as sufficient evidence for their belonging to the same species. This method of identification has been applied to nearly all the other species we recognize in which the life-histories are less completely known. Strictly speaking, the identification of males and females as belonging to one species should depend upon their being found in copula; but failing this, we are obliged to rely upon the evidence afforded by their morphology and their both occurring together upon a host.

In the list of recognised species, given in the table at the end of this fasciculus, the table serving likewise as an index, the various stages of each species known to science are indicated by the signs ♂, ♀, O, L, which stand for male, female, nymph and larva respectively. From this list it will be seen, if we exclude varieties of some of the species, that the

♂, ♀, O and L	are	known	in	8	species.
♂, ♀ and O	,,	,,	,,	4	,,
♂ and ♀	,,	,,	,,	6	,,
♂	is	,,	,,	3	,,
♀	,,	,,	,,	20	,,
♀ and O,	are	,,	,,	4	,,
♀, O and L,	,,	,,	,,	6	,,

It follows that these species are known by 21 ♂s, 48 ♀s, 22 Os and 14 larval forms.

Outline of the life-history in Ixodes.

Before proceeding further, it appears expedient to briefly outline the life-history of an *Ixodes* as typified by *Ixodes ricinus*. I shall leave out of consideration the changes which take place in the internal anatomy of the ticks whilst attached to the host and subsequently, for these matters will be considered in a special section of this work. I propose here to merely outline the main facts in the life-history.

Ixodes ricinus.

Commencing with the adult stages: *males* and *females* are both present upon the host, and they are frequently found thereon in copulation. Pairing may, however, take place before the sexes have attached themselves to a host; this has as yet only been observed in unfed adults in captivity. A female may pair with several males in succession. The males, which are relatively scarce, remain attached to the host only for a few hours and if they feed they can do so but moderately, their external structures not permitting more than a limited amount of distention. The males wander about the host in search of females during the intervals when they are not feeding[1]. The females, on the other hand, after having attached themselves to a host, remain *in situ*, hanging on by their mouthparts for 7–14 days and possibly longer in cold weather. During this time the females are sought by the males and gradually grow in size owing to the distention of their bodies with blood derived from the host. Shortly before they abandon the host they swell rapidly and attain their maximum degree of distention. Females in all degrees of distention are found coupled with males. At times, one or more additional males may be observed about the female whilst one male has its mouthparts fixed in the vulva. It would appear as if the other males were waiting their turn to enter into copulation. We shall presently describe the process of copulation more fully.

The fertilized and fully gorged female now releases herself from the host and falls to the ground[2]. I have frequently observed females

[1] Although *I. ricinus* ♂ may attach itself to a host it has not as yet been demonstrated that it actually sucks blood for there is no record of the intestinal contents having been examined after a male has detached itself from the host. It is conceivable that the attachment may be mechanical, but the matter requires further investigation. It appears worth noting here that we have seen males of *Hyalomma syriacum* bury their mouthparts deeply into a cork whilst confined in a bottle after their removal from a tortoise.

[2] That the dropping of gorged females from the host may be influenced by temperature was once observed to a remarkable degree when experimenting with *Boophilus decoloratus* which was being raised by me in Cambridge. A cow infested with this tick, many females being replete, was taken out of the warmed experimental stall into the cool air of a courtyard. The females immediately began dropping off and "rattled like peas" on the ground. In nature it is a common matter to pick up ticks along the paths pursued by cattle or game, and this observation on *Boophilus* suggests a possible explanation why these paths should at times be particularly infested, for it is along them that animals like cattle frequently return from pasture in the cool of the evening. In nature, the female will at most wander a foot or two from the path pursued by the host from which she fell, and will lay her eggs at the foot of the vegetation bordering the path. The offspring would, therefore be literally "put in the way of finding their food."

which have thus dropped from the host mate again with one or more males placed in a vessel. It is probable that this occurs in nature, since it has been observed in other species (*canisuga, angustus, putus*). Having fallen upon the ground, and being abandoned by the male, the female proceeds to find shelter beneath the surface vegetation or stones, or she may burrow into the loose soil. She is fairly active at first and can climb up smooth surfaces like glass to an astonishing degree considering the hugely augmented weight, due to the great amount of blood which she has ingested. If placed in a glass jar covered with gauze and containing earth at the bottom, in the centre of which is placed a tuft of grass, which is occasionally sprinkled with water, it will be seen that the females congregate about the grass roots in chinks and crevices in the earth, and that they lie there very quietly for days or weeks before the eggs begin to appear. The time when oviposition takes place is largely influenced by temperature, being greatly retarded by cold. We shall presently consider the mechanism of oviposition and its duration, for the latter is also markedly influenced by temperature. The eggs are next observed in small heaps lying upon the antero-dorsal surface of the female and their number increases from day to day. Slightly gorged females lay fewer eggs than do the fully gorged specimens, and the few eggs they lay usually do not hatch out. From this it may be gathered that such females are not fertilized or that their eggs are otherwise imperfect. The eggs are usually very numerous, numbering hundreds or a thousand or more (see Pl. VII, p. 310).

Following upon an interval of varying length, this again depending upon temperature, the process of hatching commences. From the egg-shells emerge vast numbers of *larvae*. If they hatch out in a glass vessel containing grass the larvae climb up the grass blades and congregate in masses upon the tips of the leaves, or form clusters on the under side of the gauze which encloses them in the vessel. In nature they behave in a similar manner, that is, they climb to the tips of the grass blades and the adjacent vegetation.

The larva is hexapod, and possesses neither respiratory nor sexual organs. After it emerges from the egg its chitin requires some time to harden and darken, and during this period it assimilates the yolk-mass derived from the egg. When the larva has exhausted this reserve food-supply, it attaches itself to a host and proceeds to suck blood. When replete, after 4 to 5 days[1], it releases its hold, and, falling to the ground,

[1] It is possible that the period of attachment to the host may be prolonged in the various stages by cold weather. Observations in this respect are lacking.

proceeds to undergo its metamorphosis. This process is much influenced by temperature, being retarded by cold and accelerated by warmth. At first the replete larva is quite active, but when it has begun its metamorphosis it lies still. Beneath the larval skin a series of profound changes takes place. The nymphal exoskeleton developes beneath that of the larva. The first three pairs of legs are formed within the larval legs, and a fourth pair appear posterior to these, as can readily be seen in mounted specimens of the ticks at a period shortly before they emerge from the larval skin.

The *nymph* possesses two spiracles, similar to those of the adults in general structure, from which branching tracheae spread to all parts of the body. When matured, the nymph withdraws its legs from the larval skin which encloses the first three pairs, it ruptures the old skin, emerges, and abandons the exuviae. The nymph differs from the female in two essential points of external structure: it does not possess an external sexual orifice, although there may be an indication (*Anlage*) of where it will be situated in the adult, and the nymph does not possess porose areas upon the dorsal surface of the basis capituli. The nymph takes some ten days to harden and darken after casting the larval skin, and it is now ready to attack a fresh host upon which it behaves similarly to the larva, dropping off gorged after three to five days.

The *adult* develops within the nymphal skin and emerges from it after a variable interval of time (weeks or months). The sexual organs in both sexes begin to appear in the nymph but they do not attain their full development in the female until she has sucked blood. The adults, having hardened, proceed to attack a fresh host, thus completing the cycle.

It will be noted that *ricinus*, in common with most *Ixodidae*, requires three hosts upon which to feed in the larval, nymphal and adult stages.

Duration of parasitism upon the host.

Larvae and Nymphs. The following experiments may be cited to show the behaviour of this tick when raised in the laboratory. On July 5, 1905, some gorged ♀s, taken from cattle in Co. Cavan, Ireland, were received in Cambridge. The ticks were placed at room temperature in a receptacle containing sand which was occasionally dampened. Large masses of eggs had been laid by the end of July from which innumerable larvae issued in September.

Experiment I.	10. X. 1905.	Many larvae were placed on a hedgehog in a tick-proof cage.
	13. ,,	68 larvae dropped off gorged.
	14. ,,	365 ,, ,, ,, ,,
	16. ,,	60 ,, ,, ,, ,,
	18. I. 1906.	Nymphs began to emerge from the larval skins.
	3. VI. ,,	Thirty of these nymphs were placed on a hedgehog.
	7. ,,	10 nymphs dropped off gorged.
	8. ,,	11 ,, ,, ,, ,,
Experiment II.	18. X. 1905.	Many larvae were placed on a hedgehog.
	23. ,,	250 larvae dropped off gorged.
	24. ,,	26 ,, ,, ,, ,,
	18. I. 1906.	Nymphs began to emerge.
	1. VIII. 1906.	50 nymphs were placed on a hedgehog.
	5. ,,	20 ,, dropped off gorged.

It follows that the larvae remain attached to the host for 3–6 days, and the nymphs for 4–5 days, when raised on hedgehogs in the laboratory at a temperature of about 15° C.

These results are in agreement with the statement by Kossel, Schütz, Weber and Miessner (1903, p. 40), that larvae remain 3–6 days and nymphs remain 3–5 days upon the host before they become replete. These authors raised the ticks on cattle and guinea-pigs. Samson (1909, p. 186) reports that larvae and nymphs remain attached for four days to man, and as long as 10–14 days to lizards.

Adults. Bertkau (1881, p. 145) reports that he once placed a hungry ♂ and ♀ upon his arm, with the result that the ♂ remained attached for only eight hours whilst the ♀ remained upon him for eight days. Kossel and his colleagues once saw hungry ♂s readily attack a guinea-pig upon which they were placed; they state that the ♀ remains attached for a week. According to Samson (1909, p. 216), the ♀ remains upon the host for 8–14 days. The fact that the ♂ remains attached to the host but for brief periods explains why it has not as yet been observed to attack the host under other than experimental conditions.

Site of attachment on the host. Kossel and his colleagues (1903, p. 39) state that all stages of the tick may be observed on cattle. The larvae and nymphs attack the beast about the head on the muzzle, eyelids and ears, and likewise on the udder. When placed experimentally upon cattle they attack any part of the host's body. Adult ticks attach themselves chiefly on the flanks, inside the legs, on the neck, udder, and in the pit about the anus and vulva. Males are frequently found running about upon the skin, but they have not been found sucking blood from cattle. They are frequently found *in coitu* with attached females. I have found these ticks attached in similar situations on deer and roe-deer. On dogs they occur frequently about the head and neck. They attach themselves to guinea-pigs and rabbits inside and outside the ears and upon the eyelids and in other situations. Incidentally, I may mention that I have for several years utilized hedgehogs for raising experiments with very good results, since the bristles protect the ticks against injury from the host.

The time required for Metamorphosis.

Hatching of the eggs. A variable period of time elapses between oviposition and the hatching out of the eggs. According to Chabrier (1807, p. 366), the larvae issue from the egg after 2–3 weeks, but more recent observers record a longer period:

Larvae emerge after:

about	6	weeks	(Kossel, Schütz, Weber and Miessner, 1903, p. 40).
,,	7	,,	from 17. VI. to 4. VIII. (Bertkau, 1881, p. 148).
,,	8	,,	,, 25. V. to 19. VII. at 65° F. (Wheler, XII. 1899).
,,	22	,,	,, 4. V. to 12. X. (Meek and Smith, cited by Wheler).
,,	36	,,	,, IX. to VI. (Ashworth, 1909, p. 133).

As first noted by Gené (1844), the hexapod larva, when it issues from the egg, is almost transparent. It subsequently grows darker as the chitin hardens. Having exhausted its reserve food-supply, derived from the yolk of the egg, it attacks a host and sucks blood, abandoning the host when replete.

Gorged larvae metamorphose into nymphs after a period which may be considerably prolonged by low temperature.

Nymphs emerge after:

(in summer)	1	month	(Kossel, Schütz, Weber and Miessner, 1903, p. 40).
(in winter)	5	months	(,, ,, ,, ,, ,, ,, ,,).
(,,)	3	,,	(in a room; Nuttall, 1905, *v. supra*).

As in the case of the larvae, the nymphs darken and harden for some days after they emerge from the larval skin. They in turn attack a host and abandon it when replete.

Gorged nymphs metamorphose into adults after a period which likewise varies according to temperature:

Adults emerge after:

(in summer)	2	months	(Kossel, Schütz, Weber and Miessner, 1903, pp. 40, 43).
(,,)	$2\frac{3}{4}$	,,	: 29. V. to 19. VII. (Wheler, XII. 1899).
(in winter)	7	,,	(Kossel, Schütz, Weber and Miessner, 1903, p. 43).
(kept cool)	12	,,	: 14. VIII. 1899 to 4. VIII. 1900 (Wheler, 1902).

Adults take about 10 days to harden and darken, remaining very quiet until this is accomplished and they are ready to attack a host (Wheler, XII. 1899). According to Kossel and his colleagues (1903, p. 40) the males emerge prior to the females.

Longevity.

The duration of life of ticks, removed from the host, varies greatly according to the conditions under which they are kept. They are soon *killed by desiccation*: thus Wheler, (XII. 1899) found all stages did not survive over two to three days when placed in a dry empty bottle *They resist cold*: Wheler (1899, p. 7) found that females survived after exposure to "several degrees of frost"; and Kossel and his colleagues (1903, p. 43) convinced themselves that all stages survived exposure to the rigours of a German winter. The fact that the different stages hibernate accounts for the occasional occurrence of piroplasmosis amongst stall-fed cattle in winter, for bedding containing pathogenic ticks may at times be brought into cattle-sheds from tick-infested places. All stages may survive unfed for a considerable length of time in bottles containing dampened moss, filter paper, sand, or earth, as shown by the following records.

Larvae (unfed) hatched 4. VIII. 1898 were alive and active on 7. VI. 1899: $10\frac{1}{3}$ months (Wheler 1899, p. 50).
survived 19 months (Wheler, 1902).
,, for months (Kossel, Schütz, Weber and Miessner, 1903, p. 40).

Nymphs (unfed) survived 5 to 7 months (Nuttall, 1905, *v. supra*).
,, ,, ,, 18 ,, (Wheler, 1902).

Adults (unfed) survived 15 to 27 months, having been derived from nymphs which took 12 months to undergo metamorphosis into adults (Wheler, 1902).
partially-fed females, taken from a dog, survived one to three months, and two males placed in a vessel with cherries, died in 50 days (Galli-Valerio, 1908, p. 611).

The time required to complete the Life-cycle.

Wheler (XII. 1899) says that this species will, in fine, warm seasons, probably pass through at least two stages of its life in one year, but that in cold weather and when there is delay in finding a host, one stage may occupy a whole season. The term of its whole existence may, therefore, vary from $1\frac{1}{2}$ to 3 years, and will in the majority of instances last $1\frac{1}{2}$ to 2 years. It seems, however, possible that a whole generation may be evolved in one season under very favourable conditions.

Allowing only ten days for a tick in the larval and pupal stages in which to harden after metamorphosis and to find a host, and 11 weeks for metamorphosis thereafter, Wheler calculates the time occupied as follows:

Larva	13 weeks	($1\frac{1}{2}$ free, $\frac{1}{2}$ on host, 11 gorged).
Nymph	13 ,,	($1\frac{1}{2}$,, $\frac{1}{2}$,, 11 ,,).
Adult ♀	$7\frac{1}{2}$,,	($1\frac{1}{2}$,, 2 ,, 4 ,,).

In one case the larvae fasted 40 weeks, and allowing 11 weeks for metamorphosis after an assumed feeding, practically a whole year would be accounted for. According to Kossel and his colleagues (1903, p. 43) it takes *at least* five months for a generation to develop; our estimate, based on the following figures, gives the shortest period at about six months.

On the basis of the observations here recorded, I would calculate the time it takes for a generation to develop on a warm-blooded host as follows:

	Days required	
	Shortest period	Longest period
Fecundated ♀ abandons the host.		
♀ begins to oviposit after	8	27
Larvae hatch out from the eggs after ...	42	49–252
Larvae harden and wait to attack host No. 1 after	10	300–570
Larvae remain upon the host for	3	6
(Larvae, having abandoned the host, undergo metamorphosis.)		
Nymphs issue from the larval skin after ...	28	84–140
Nymphs harden and wait to attack host No. 2 after	10	200–540
Nymphs remain upon the host for... ...	3	5
(Nymphs, having abandoned the host, undergo metamorphosis.)		
Adults issue from the nymphal skin after	56	210–360
Adults harden and wait to attack host No. 3 after	10	450–810
Adults (♀s) remain upon the host for ...	8	14
Fecundated ♀ abandons the host		
	Total = 178 days.	1345–2724

About 170 days probably represents the shortest possible time required for the completion of the life-cycle, if we deduct a few days from the usual time which appears to be necessary for hardening after ecdysis at each stage. It is quite clear that the time required may be very much prolonged under unfavourable conditions, and it is probable that in nature it is not infrequently prolonged to two and even three years. It should be noted that after very prolonged fasting we have frequently found various species of ticks too feeble to feed upon a host.

Influence of Season and Local Conditions, etc.

According to Kossel, Schütz, Weber and Miessner (1903, p. 39), *ricinus*, in Germany, occurs chiefly on damp water-logged land with rank vegetation comprised of long grass and bushes. Larvae and nymphs are found in large numbers on cattle, especially in May and June; few ticks in these stages are found on cattle at other seasons. The nymphs are the more commonly found throughout the year, and are more prone to attack man than the other stages. In the spring the larvae are encountered in masses on the ends of grass or twigs upon which they have climbed from the ground where the eggs were deposited by the female. Larvae, nymphs and females may be captured in a free state at the end of April, proving that all stages may hibernate. They are readily captured by dragging a woollen cloth over infested grass and bushes. Samson (1909, p. 185) netted all stages from high grass along paths in damp woods about Berlin in the spring of the year. Kossel and his colleagues state that they are readily captured in the woods during the spring to autumn; they are so numerous in some localities that when the cows return from pasture in the evening the farmers collect the ticks by the litre and feed them to chickens.

Copulation.

A survey of the literature shows that the process of copulation (or what I shall by preference term coupling[1]) in *I. ricinus* was observed at a very early date. De Geer (1778, p. 104) was the first to describe and figure the sexes coupled. In de Geer's figure the male is shown fixed with its venter upon the venter of the female, with its palps widely separated, and its chelicerae and hypostome deeply implanted in the female genital orifice, or vulva. Müller (1817, p. 278) also observed coupling in captive specimens, and stated that the sexes might remain thus united for a week. Gené (1844, p. 771) observed coupling during

[1] The introduction of the ♂ mouthparts into the vulva, hereinafter described, constitutes only a stage in the process of copulation; see pp. 318 *et seq.*

May to October. He noted that the vulva appeared open in some females, whilst in others it appeared closed "as by a hymen," these being presumably virgins. He placed males with the latter and observed them enter into copulation. On turning the males over he saw that nought but the mouthparts had penetrated the vulva. He states that he actually saw three males coupling at once with one female: "fatto del quale non trovasi altri esempio negli annali della scienza[1]." Gené (p. 774), on closely observing coupling males, several times saw "two fusiform bodies, turgid and pearly white, protruding one on the right the other on the left of the median line close to the hypostome." When the male was disturbed these organs collapsed and were retracted into the interior of the mouthparts; they could be clearly seen when they were slowly retracted. He concluded that these must be fecundating organs, but could not explain their mechanism. (We shall see that Lewis has also observed these organs.) C. L. Koch (1835–1844, p. 218) also expressed the belief that the male copulating organs are situated in the mouthparts.

Von Siebold's (1850) statement that two fine ducts lead forward from the testes to the mouthparts of the male has never been confirmed. Pagenstecher (1861, p. 38), who described the male sexual organs, believed that the seminal fluid escapes from the male genital orifice when the sexes are apposed venter to venter, the genital orifices being approximated in some way for the purpose. Mégnin (1878, p. xcii) affirms that the males possess a penis (!) which is directed toward the vulva by the male mouthparts. Claus (1876, p. 574 and 1880, p. 652) wrongly states that the male capitulum is bent backward when coupling takes place, the reverse being the case. Bertkau (1881, p. 147) observed coupling, and he states that he found spermatozoa in all the females which had coupled under natural conditions or in captivity. Most of the females, on the other hand, which were found in a free state were found not to be fertilized. Bertkau holds that coupling constitutes copulation but does not explain how this can be the case. Wheler (1899, p. 7) states that he observed two pairs couple in a bottle after they had been captured on rushes. He also saw a male coupling with a gorged female after the specimens had been taken from a deer. He adds (XII. 1899) that coupling takes place between unfed adults and between replete females and males either upon the host or otherwise. He considered that the female became impregnated through the male

[1] No subsequent author records any similar observations; two of the males were, perhaps, only "crowding" the third. (See Pl. VII, p. 310.)

mouthparts. Wheler sent specimens to Lewis (1900, p. 382) to study. The latter placed males and females together several times and repeatedly saw coupling occur. The male crept upon the venter of the female and probed about with its mouthparts, the palps being in their normal position whilst being passed to and fro across the vulva "until at length the female, which had remained hitherto entirely passive, began to show signs of responding: a slight, but very distinct alteration in colour of the surrounding parts took place, this being shortly followed by a relaxation of the peculiar crescent-shaped, flap-like opening. The palpi of the male were now immediately separated as widely as possible, the extremity of the rostrum was inserted under the flap and gradually pushed home until the entire organ was buried to its base." This union lasted some hours. Lewis gives figures of the sexes thus united, and of the ♀ and ♂ hypostomes in ventral and lateral aspects.

With regard to the ♂ hypostome he adds: "A little below the position of the last marginal teeth there are, however, what appear in a dry specimen to be two reflexed teeth, one on either side of the

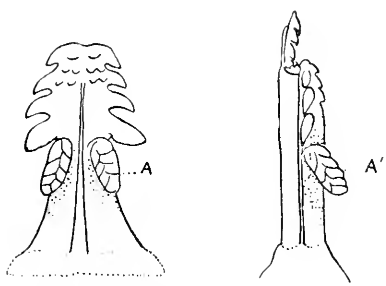


Fig. 283. Hypostome of *Ixodes ricinus* ♂ in ventral and lateral aspects, showing at A, A^1, the "tubular papillae" described by Lewis (1900, p. 385, Pl. XXI, Figs. 4 and 5).

median line, these being of larger size, thicker at the base and longer but not so sharp, and differing also in apparent structure from any others of their kind. On forcibly separating a male and female and examining the rostrum of the former immediately after its withdrawal from the vulva, I saw at once that these supposed teeth had increased in size and now presented the appearance of *flexible semi-transparent tubular papillae,* which conveyed the impression to my mind that here, possibly, were the organs by means of which the actual impregnation took place. I killed this tick without loss of time, and removing the entire capitulum before it had time to dry or contract, mounted it forthwith in glycerine. As thus mounted, with no preparation and no pressure other than that of the coverglass, these papillae can still be seen in their distended condition under a $\frac{1}{2}$-inch objective" (see Fig. 283).

Lewis (21. VI. 1901) quotes a letter from Wheler in which the latter describes more fully his observations (previously referred to) made upon ticks placed in a bottle and which entered into union in the manner already described: "After about an hour I killed one pair with chloroform and examined the female, without result. A second pair separated after a couple of hours. In this case plenty of spermatozoa were present in the female. There seems no doubt that I had separated the first pair prematurely. The third pair were still attached after 18 hours."

Neumann (1906, p. 195) says correctly that coupling has actually been observed in but few species of *Ixodes*, but that in view of the homogeneity of the group it has been concluded that it is the rule in Ixodoidea: "the sperm being removed from the genital pore by the ♂ rostrum and introduced into the ♀ pore." Neumann notes, as we have done, that in no other genus of Ixodoidea are specimens received in which the sexes have died united and remained coupled in the preservative fluid in which they were placed. He attributes this to the peculiar sexual dimorphism affecting the hypostome in *Ixodes*, meaning doubtless that the hypostomal teeth in the ♂s are especially prominent. I agree that this appears to be the cause of the prolonged union not observed in any other genera and of many coupled pairs dying *in situ*. I may note, however, that in *I. putus* ♂ the hypostome is practically unarmed, but that nevertheless the sexes couple as do other Ixodes. The subject certainly needs further study on living ticks (see further on pp. 317, 334–345).

We have received many specimens of *ricinus* in alcohol which have died coupled, and frequently observed the coupled sexes alive on different hosts. Unfed and partially fed or replete females in captivity are promptly sought by the males. Under these conditions a male may be repeatedly driven away from a female and it will repeatedly return. At times the male is readily separated from the female; at other times it dies *in situ*. Bertkau's observation, cited above, that females captured in a free state are rarely fertilized is doubtless explained by what Wheler (1906, p. 426) states regarding his never having found unfed females and males coupling under natural conditions upon herbage. On the other hand, when the unfed sexes were placed in a bottle, which was warmed by being carried in the pocket, coupling usually took place and lasted for hours. Samson (1909, p. 186) states that unfed ♂s may copulate and that ♀s may copulate several times; moreover that ♀s will only attach themselves to a host when fertilized, *i.e.* during or after copulation. The last statement requires confirmation. This author (p. 217) denies that the penetration of the ♂ mouthparts into the ♀ genital orifice (what we term coupling) represents coitus. On examining a ♀ which had been coupled for an hour with a ♂, her gonoduct was found to be empty and no spermatophore was found in the ♂ excretory ducts. That coitus should take place by means of the mouthparts of the ♂ is difficult to understand because (*a*) the ♂ mouthparts cannot be brought in contact with the ♂ genital orifice so as to receive the sperm therefrom; (*b*) the structure of the ♂ mouthparts shows no adaptation for this function; and (*c*) the ♂ mouthparts are immediately introduced into the vulva when the sexes meet. On one occasion *what appeared to be true copulation* was observed: a coupled pair had been observed for upwards of an hour when the ♂ was seen to suddenly withdraw his mouthparts from the vulva and advance his body along that of the ♀, gripping her anterior pairs of legs and body, thus bringing the sexual orifices into apposition. The ♂ remained about two minutes in this position, then retreated to his original position and pushed his mouthparts forward to the anterior border of the vulva "as if he were pushing something in." The movement was repeated about 20 times, after which he again introduced his mouthparts for about 15 minutes and then finally abandoned the female. Samson assumes that the ♂ emitted a spermatophore when the genital orifices were apposed, and that it pushed it home with its mouthparts so that it should not slip out again. Coupling, therefore, would only serve to keep the sexes together, the introduction of the ♂ mouthparts serving to enlarge the ♀ parts for the reception of the spermatophore. Samson does not state that the ♀ was subsequently examined for the presence of a spermatophore which, unfortunately, robs the observation of a considerable part of its value.

Samson does not refer to the collapsible organs situated near the base of the ♂ hypostome and which were described by Gené and especially by Lewis (*vide supra*). We shall seize the earliest opportunity that offers to study these organs in living *ricinus* in the hope of being able to determine their function.

It is obvious from the foregoing that the process of copulation in ticks requires further study. We prefer the term *coupling* to that of copulation when referring to the condition when males attach themselves to females by introducing their mouthparts into the vulva, this in the light of the evidence above presented. It is established that the male fertilizes the female by means of spermatophores which are received into the spermatheca, and from this point the spermatozoa pass up into the ovaries and fertilize the eggs (Bertkau, 1881, p. 147; Samson, 1909, p. 216, and ourselves). The entrance of the spermatophores would necessarily be facilitated by the dilatation of the female sexual orifice brought about by the entrance into it of the male mouthparts. It is interesting to mention, in this connection, that we once observed a male *Ixodes tenuirostris* with its mouthparts deeply embedded (as in coupling) in the body of the female to one side of the anus outside the genital groove. It is conceivable that the female had received some injury at this point and that the male had mistaken the wound for the vulva.

Note: We append a description of the process of copulation in *Ornithodorus moubata* as recently observed by Nuttall and Merriman, since it bears directly on this subject. See Appendix I, p. 318.

Oviposition.

Frisch (1724, p. 42, judging from a footnote in Fischer's translation of Gené (1849, p. 17), wherein Frisch is quoted verbatim) appears to have been the first to observe oviposition in *Ixodes*, the "Hunds-Laus" as he calls it. Frisch wrote, "Das Geburtsglied ist nicht ganz unten am Bauch, sondern etwas gegen die Mitte desselben. Es lässt das Weiblein im Eierlegen zugleich einen hellen Saft aus dem Maul (!) womit es die Eier am Leibe behalten, und bis an das Maul hinaufziehen, ja theils gar über dasselbe auf den Halsschild bringen und in einem Klumpen beisamen behalten kann, in denen es also steckte und darinnen starb." Chabrier (1807, p. 367), who observed oviposition in a pinned ♀ *ricinus*, considered that the eggs were extruded through the oral aperture and it is not difficult to understand how the mistake arose in view of what actually takes place. He cites (p. 368) a communication from Kalm, who observed oviposition in "*Ixodes americanus*" and believed the eggs issued from the edge of the scutum. Chabrier, who subsequently examined this species, convinced himself that there was no opening at the edge of the scutum from which eggs could issue. Müller (1817, p. 278) likewise observed oviposition in a pinned specimen of *ricinus*. The tick began to lay eggs 44 days after it was collected. He saw the ovipositor protrude eggs.

The process of oviposition in *I. ricinus* was first clearly observed and fully described by Gené (1844, pp. 767–777). He described how the vagina is everted and protruded forward and the egg issuing therefrom is received by a delicate bilobed, bladder-like organ which is protruded over the depressed capitulum from beneath the scutum. Each heart-shaped lobe possesses a finger-like protrusion anteriorly on the inner side. This organ, to which Nuttall (1908, p. 398) gave the name of *Gené's organ,* in honour of its discoverer, completely envelops the egg as it emerges from the everted vagina. According to Gené it takes

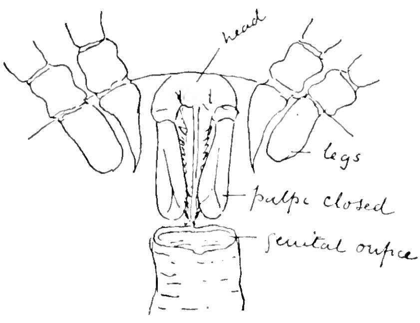


Fig. 284.

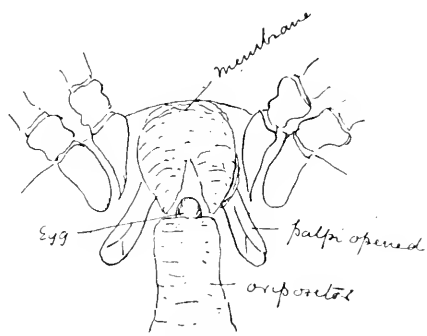


Fig. 285.

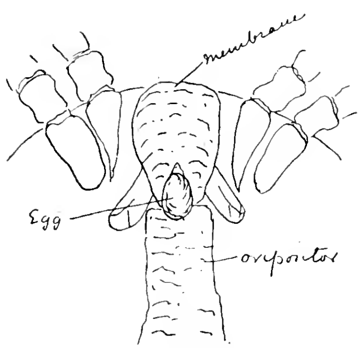


Fig. 286.

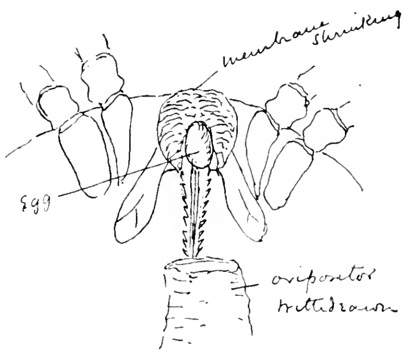


Fig. 287.

Figs. 284–287. Oviposition in *Ixodes ricinus* (Wheler, 1899, Fig. 20; also 1906, Pl. V, Fig. 3). We reproduce these figures from the author's original blocks as they very well illustrate the successive stages of the process. In Fig. 284 the capitulum ("head") is bent downward to meet the advancing ovipositor. In Fig. 285 the palps are separated; the hypostome is hidden behind the ovipositor which has advanced still further and is protruding an egg; Gené's organ ("membrane") is protruded to receive the egg as it emerges from the ovipositor. Fig. 286 shows Gené's organ enveloping the egg between its lobes. In Fig. 287 the ovipositor is being withdrawn and the hypostome appears; Gené's organ is collapsing and carrying along the egg toward the basis capituli. These are the only figures hitherto published adequately illustrating the process of oviposition in *ricinus*.

about 40 seconds for each egg to issue from the female. After the egg issues, the vagina is retracted within the body and Gené's organ is also retracted. Gené records that he once observed the process of oviposition in the case of a female whose capitulum had been torn off when the tick was removed from a dog. To study the process, he placed the ticks upon their backs and cut off their legs so as to render them immovable. The female, according to Gené, at first depresses the capitulum so that it is applied to the ventral surface of the body. The palps and chelicerae being divaricated, Gené's organ is then alternately protruded and retracted "in a hesitating manner," after which it is rapidly protruded to its full extent, hiding the capitulum whilst it receives the egg from the protruded vagina, or ovipositor. Gené's organ is quite clearly stated to emit a sticky secretion upon the surface of the eggs whilst it overlaps them for a period of four to five minutes. If the organ is pricked with a needle, oviposition ceases for a while, and when continued the eggs are laid directly from the oviduct; but eggs laid in this manner are not glossy and they soon dry up and become shrivelled. Gené supposed that, in addition to covering the eggs with the sticky secretion, which may serve to harden the chitinous envelope of the egg, that the organ may convey spermatozoa in some way from the female's uterus to the egg as she is laying. He did not, however, pretend to explain how fertilization actually takes place[1]. The ovipositor and Gené's organ having been retracted, the egg is left lying upon the capitulum, which now resumes its normal position and shovels the egg backward on to the scutum. This curious process is then repeated as long as the tick continues to oviposit; the newly-laid eggs push the older ones backward in a heap upon the dorsum of the tick, the anterior part of the tick thus gradually disappearing in the heap of eggs.

Bertkau (1881, p. 148) repeated the experiment of pricking Gené's organ, and confirmed the observation that eggs laid without being covered by its secretion subsequently shrivel up. This result was also obtained

[1] Railliet (1895, p. 706, Fig. 480) reproduces a figure of an ovipositing *ricinus* from Gené (1848), and briefly refers to the process and to the everted vagina or oviduct serving as an ovipositor or "oviscapte"; he refers to Gené's organ as the "bourse seminale de Gené," or "vessie bilobée." Wheler (1899) calls it the "dorsal gland." Samson (1909, p. 223) calls it the "Subscutalblase." Dutton and Todd (1905 b, p. 17) describe and figure the same structure in *Ornithodorus moubata* as a "pulmonary sac" and Brumpt (1910, p. 523, Fig. 363) calls it the "cephalic gland," following Christophers (1906, p. 95), who gave this name to the structure in *O. savignyi*. None of these names adequately describes Gené's organ. We give pre-eminence to Gené's observations because they have been generally ignored by writers on the subject.

Ixodes ricinus. Numerous females ovipositing in a glass dish at room temperature. 4th week; most of the females appear shrivelled and smaller than the masses of eggs they have laid. $\times \frac{4}{5}$. (Original, L. E. Robinson, phot.)

when Gené's organ was not pricked but simply made to retract itself by being touched with a small rod. The eggs which then appeared had dried up in 6–8 hours, whilst eggs laid normally remained fresh for weeks[1]. Wheler (1899, p. 110, Fig. 20, republished 1906, Pl. V, Fig. 3, here reproduced—see Figs. 284–287) has described and also figured oviposition in *ricinus*. He notes that in unfed or partly fed females the capitulum protrudes forward but that in fully gorged females it is depressed. It may, in fact, point slightly backward, especially when they are ovipositing. Wheler's description agrees with those of Gené and Bertkau which were unknown to him. The female he observed took three minutes to lay an egg, after which there occurred a rest of six minutes before the process was repeated. Samson (1909, pp. 221–223, Fig. 14) also describes the process in the same manner as Gené. She states that the egg is turned to and fro for about two minutes by Gené's organ, and she describes the internal glandular structures which are connected with the latter.

Regarding the duration of oviposition and the number of eggs laid by Ixodes ricinus, we glean the following notes on the subject from the literature:

Gené (1844, p. 775) states that oviposition lasts 10–30 days, during which time a female may lay 1000 to 3000 eggs. Oviposition ceases when the female is disturbed.

Bertkau (1881, p. 147) observed a gorged ♀, which dropped of her own accord from a hedgehog on May 28th; by June 9th she had laid 211 eggs. She then continued laying until June 20th, when she was killed, having laid 847 eggs.

Wheler (XII. 1899) observed a ♀, collected on April 15th, which began to oviposit on May 12th (interval of 27 days). As in other ticks we have observed, the ♀'s body at this time showed yellowish streaks (due to the increased excrement contained in its malpighian glands). This ♀ laid 2050 eggs.

Kossel, Schütz, Weber and Miessner (1903, p. 40) state that oviposition commences 8 days after the replete fertilized female has dropped from the host, and that it lasts 8–14 days, during which period 100 to 1000 or more eggs may be laid.

Galli-Valerio (1908, p. 611, with figure) illustrates, by means of a

[1] Schlechtendal (1891, p. 11) gives a very imperfect description of oviposition observed in the case of a female of undetermined species, belonging apparently to the Ixodidae, which was received in a consignment of fossils from Persia. He observed the protrusion and retraction of Gené's organ and thought it might be a glandular structure.

photograph, a number of females which have oviposited in a dish. He states that oviposition lasts one month.

Samson (1909, p. 221) states that oviposition commences about 14 days after the ♀ has abandoned the host.

Note: As stated by Nuttall (1908), the process of oviposition in the other genera of Ixodoidea is essentially similar to that in *Ixodes*, having been observed by him in *Argas*, *Ornithodorus*, *Ixodes*, *Amblyomma*, *Boophilus* and especially in *Haemaphysalis*, the process being illustrated by a series of sketches in the case of *Haemaphysalis punctata*. Lewis (1892) has illustrated the process in *Amblyomma*, likewise by a series of sketches. Samson (1909, p. 223) notes the fact that the process is similar in *Rhipicephalus*, but this author's description is very imperfect. As all the other *Ixodidae* possess a similar anatomical structure to the foregoing, it is safe to conclude that they also oviposit in a similar manner.

Relation to Disease.

Redwater in Cattle: *Ixodes ricinus* is the only species of *Ixodes* of which we have a conclusive demonstration that it plays a part in the spread of disease. This tick appears to be the chief carrier of redwater (piroplasmosis) in cattle in northern Europe. Its association with redwater was first observed in Finland by Kossel and Weber, in 1910, and subsequently Kossel, Schütz, Weber and Miessner (1903) demonstrated experimentally that bovine piroplasmosis could be conveyed through *ricinus*. These authors (pp. 50 *et seq.*) removed engorged and fecundated *ricinus* from German cattle suffering from the disease, and collecting the larvae that had hatched out from the eggs laid by the infected females, placed them upon susceptible cattle. Kossel and his colleagues carried out six experiments with larval *ricinus*, and they record that the cattle developed redwater 8–14 days after they had been infested with the larval ticks. In one of these experiments, carried out in June, 1902, the infective larvae were derived from eggs laid by females collected from cattle in the previous year (May–June, 1901). The ticks had been exposed to all the rigours of a German winter. Kossel and his colleagues also record an experiment in which a cow was successfully infected through the agency of *ricinus* nymphs which had fed on infected cattle in the larval stage.

It is probable that *ricinus* is the carrier of redwater in Norway, and it has been found associated with the disease in Great Britain and

Ireland. Kossel found *ricinus* in N. Wales in redwater districts, and specimens have reached me from various redwater localities in Ireland and England, having been removed, in some instances, from cattle suffering from piroplasmosis. Stockman (1908) also notes the association of this disease with the presence of *ricinus* in England.

Note: Schaudinn (1904, p. 428) records in three lines that a blood parasite of lizards (*Karyolysus*) develops in a mite ("Milbe"). Doflein (1909, p. 331), Blanchard (1909) and Christophers (1906, 1907) quote Schaudinn as having observed the development of *Karyolysus lacertarum* in *I. ricinus* and that the tick transmits the parasite. None of these authors gives a reference. Prof. Doflein, who referred me to the passage from Schaudinn above cited, kindly informs me that he believes Schaudinn told him his "Milbe" was *ricinus*. In view of Schaudinn's death it will be necessary to repeat the investigations he refers to quite casually in his paper since we can draw no conclusions from the little he says on the subject.

Effects of the bite of Ixodes ricinus: The following cases of injury consequent upon the bite of this tick are recorded in the literature which we have sifted. Perroncito (1901, p. 562) cites earlier authors like Ercolani, de Geer and Dubini as stating that psoriasis-like eruptions, or gangrenous pustules may follow upon the bites of *ricinus*. It is possible, however, that *I. hexagonus* or *I. canisuga* are also concerned, as earlier determinations of species are open to doubt. We add the following instances: Dubreuilh (1838) cites several cases of phlegmonous inflammation following *ricinus* bites in man. Raspail (1840), Cosson (1856), Moquin-Tandon (1862), Desprès (1867) and Liegois all record ill effects of *ricinus* bites in man. Sangalli (1884) records the case of a boy who was bitten on the scrotum and soon after suffered violent pain with swelling, heat and redness of the part. According to Raymondaud, of Limoges, grave effects may follow the bite. Johannessen (1885) describes a case in a boy where the tick's body was removed but the capitulum remained embedded in the skin at the back of the head. Swelling followed at the point of injury, accompanied by headache, stiffness and cramp in the muscles of the one side, partial loss of memory, and polyuria; the pupils became dilated, etc. The boy made a slow recovery. Blanchard (1891, p. 689) states that accidents of a grave character occasionally follow *ricinus* bite, the wound serving as a centre from which infection may spread to the rest of the body. Mauvezin (cited by Railliet, 1895) says the bite may produce gangrenous inflammation in sheep, whilst in man the bite may be followed by abscess, oedema, lymphangitis, etc., accompanied with febrile symptoms. Cao (1898) made a few experiments with *ricinus* and *B. anthracis* and *Staphylococcus*. He removed these ticks from the ear of a small dog and inoculated their contents, with negative results, into another dog, as well as into a rabbit. He then injected a mixed culture of *Staphylococcus pyogenes aureus* and *albus* into the jugular vein of the same dog and removed the ticks at intervals of 12–36 hours, making plate cultures of their contents. He found cocci in the ticks after 12 hours had elapsed since the injection. After 16 hours they were very numerous; after 20 hours less so; after 24 hours they had disappeared from within the ticks. In a second experiment he injected *B. anthracis* into the jugular vein of a dog and removed the ticks at intervals of 4–48 hours, plating their contents. His results in this case were negative, that is, no anthrax bacilli grew upon the plates. It is evident from the first experiment that bacteria circulating in the blood may gain access to the body of the tick, but there is nothing to prove that ticks are capable of communicating a bacterial infection. Mégnin (1892, pp. 26–28) denied that any ill effects followed the bites of *ricinus*. Although this is incorrect, it is certainly the rule that little injury follows the bite, and a tick may hang on for days without being perceived.

Penetration of Ixodes ricinus beneath the skin: For reasons which we do not at present understand the tick in the larval, nymphal or adult (♀) stage may occasionally penetrate beneath the skin of the host and cause local injury. A number of instances are recorded in the widely scattered literature, as follows:

Dubreuilh (1838, cited by Nuttall, 1899) reported the presence of *ricinus* in a pustule in the mastoid region in man. Trillebert (1863, *Réc. vétérin.*, cited by Megnin, 1892) observed a cyst at the end of a dog's ear which contained a tick supposed to be *ricinus*. Van Beneden (1883, p. 142) recorded the penetration of (?) *ricinus* beneath the skin in man and regarded it as a normal occurrence. Aurivillius (1886 b, p. 139) records the presence of *ricinus* beneath the skin of a fox. Blanchard (1891, p. 689) describes a much-quoted case of a tumour of the size of a nut on a man's abdomen. The tumour had the feel of a sebaceous cyst, there was no external lesion of the skin to be seen and the tumour had existed some weeks. On opening the tumour a female *ricinus* 8 mm. in length and in a living condition was discovered.

H. Beauregard is quoted as having once observed a similar tumour beneath a man's clavicle, and Dr Choupe has seen several such cases in his practice. According to Blanchard nymphs occasionally penetrate beneath the skin of horses, producing furunculosis. He is doubtless referring to the case reported by Mégnin (1867, *Réc. véterin.*, redescribed 1892, p. 56; in the earlier paper he referred the ticks to a new species: "Ixode pénétrant"). In this case a horse at Versailles was suffering from numerous pustules on the legs. These pustules are stated to have been due to *ricinus* nymphs; a nymph was extracted from beneath the scab on each pustule after which the horse recovered. Mégnin (1892, p. 62) attributes the penetration of this tick beneath the skin to the structure of its mouthparts. Kossel, Schütz, Weber and Miessner (1903, p. 40) state that the nymphs and larvae occasionally bore themselves beneath the skin of cattle.

The penetration of ticks beneath the skin is certainly an unusual proceeding. It is interesting to note, especially in the case reported by Blanchard, that a tick may survive being embedded beneath the skin for a considerable period of time.

Ixodes ricinus var. scapularis.

Hooker (1908 a, p. 43), in the United States, records that he has observed the sexes of this species coupling both on and off the host. He writes: "An unengorged, unattached ♀, taken in the field from a hunting dog and placed in a pill-box with unattached ♂s taken from the same dog, was shortly after found coupling with one of the latter. From this it would appear that it is unnecessary, for the ♀ of this species at least, to take food prior to fertilization."

Ixodes angustus.

According to personal communications received from Dr S. Hadwen, this species occurs in all stages upon squirrels at Duncan's, in British Columbia. The ♂s are scarce. He succeeded in raising adults from nymphs captured on squirrels by transferring them to rabbits in captivity and allowing them to feed upon the rabbits.

Coupling has been repeatedly observed by Dr Hadwen. In one case it lasted 15 minutes after the ticks were placed together in a tube. When the ♂ withdrew his mouthparts from the vulva the vagina was seen to be slightly everted. Slight pressure applied subsequently to the

♀ caused the vagina to be completely everted. After the ♂ had freed himself he immediately attached himself to a second ♀. He rooted around "like a pig" for 20 minutes before he succeeded in inserting his mouthparts into the vulva. This second coupling lasted 10 minutes.

Dr Hadwen only once detected a ♂ beneath a ♀ upon a host but the sexes were not coupled. He has only captured 8 or 9 ♂s and believes that copulation takes place mainly off the hosts, mostly in the squirrels' nests, "for the squirrels are infested with almost an equal number of ticks the year round."

Ixodes pilosus.

Relation to Disease: According to C. W. Mally (IX. 1904), Cape of Good Hope, the farmers around Carlisle Bridge have no doubt but that this tick produces "paralysis" in sheep, especially in merinos. Cooper's dip applied to "paralysis flocks" is stated to check the disease at once. The tick is, however, frequently found on healthy sheep.

Behaviour of ♂ and ♀ on the host: Mally states that the ♀ is sought by the ♂. The ♀ prefers to attach herself on sheep "around the mouth, under the chin and throat, on the bare patches under the legs and along the edges of the wool, in the wool on the legs, along the belly and near the udder." The ♀ appeared to be ready for the ♂ after being attached to the host for two days, but females can wait indefinitely in this situation whilst they are gradually becoming replete. After the replete females dropped from the host they died readily on being subjected to transportation. The ♂s are very scarce, and when not attached to the ♀ are usually found wandering about. Males were twice found attached to the skin. Coupling was observed to last from 3½ to 24 hours.

Nymphs and Larvae were found engorged in the ears of sheep, but they were scarce (Mally).

Ixodes canisuga.

In contrast to *ricinus*, the males of *canisuga* have never been recorded as occurring upon the host. Whereas hundreds of females and nymphs have reached us, we never received a male taken from an animal. The only male which Mr E. G. Wheler ever saw came from a dog-kennel at Gowanburn, on the North Tyne, and all the males we otherwise possess have come from the nests of the sand-martin or bank-swallow. Mr Wheler kindly informs us that *canisuga* swarms on collie dogs throughout the North Tyne district and probably throughout the borderland, and adds: "This is partly accounted for by the fact that the dog-kennel is one of the chief features of a hill farm, and the dogs all lie together, and there is every opportunity for the ticks to multiply." Mr Wheler was the first to observe copulation in this species, to which he provisionally gave the name of *I. plumbeus*? in 1899.

Through the courtesy of Mr. R. F. L. Burton, of Longner Hall, Shrewsbury, who kindly supplied me with many living specimens (including some 16 males), I was able to observe that copulation took place readily in captivity and that it occurred as in *ricinus*. The males sought the females, the latter being both unfed and in various stages of repletion. It is obvious that collectors desiring to obtain males will have to search the habitats of the hosts if they wish to secure them.

Wheler (XII. 1899) kept the unfed larvae of this species alive for ten months (9. X. 1898–VIII. 1899), after they had hatched out from eggs laid 4. VIII. 1898. The larvae were confined in a bottle containing moss and damp sand.

Ixodes putus.

This species, whilst apparently confined to marine birds as hosts, is known to occasionally attack man and inflict painful bites. The males have never been found upon the host, and the almost unarmed hypostome of the male indicates that it may perhaps not suck blood, behaving similarly to *Ornithodorus mégnini* in this respect. The males have only been found in the nests of the birds or in their vicinity. Copulation in this species has been observed both by Wheler (1906, p. 425) and Hewitt; it takes place as in *ricinus*. I am indebted to Mr Wheler for allowing me to see a letter from Mr W. Hewitt regarding the latter's observations on *putus* in June–July, 1902. He found the ticks plentifully on the cliffs at Bempton and Buckton, in Yorkshire. He found two or three pairs in copula beneath stones, and once saw a male in copula, whilst four or five near by were seeking to copulate; this on a narrow ledge of cliff 320–400 feet high, facing the sea, and frequented during the nesting season by tens of thousands of birds (guillemots, razorbills, puffins, jackdaws, with a few herring-gulls and kittiwakes).

APPENDIX I

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THE PROCESS OF COPULATION IN *ORNITHODORUS MOUBATA*.

By GEORGE H. F. NUTTALL, F.R.S. and
GORDON MERRIMAN.

Although the literature on ticks is very extensive, we have failed to find any satisfactory description therein of the process of copulation. Most authors state that the male mouthparts are introduced into the female genital orifice, or vulva, and that this constitutes copulation, leaving it to the reader's imagination to determine how the seminal secretion gains access to the female generative organs. The mechanism of copulation, in other words, remains to be described, and we propose, in this paper, to give an account of what we have observed in *Ornithodorus moubata*. We shall describe the process in Ixodidae in a later paper, but may state here that, as far as our knowledge goes, it is essentially the same as in *moubata*, that is, impregnation takes place by means of spermatophores.

We have repeatedly observed the process in *moubata* in Cambridge, and the description which follows is based on the study of several pairs in copulation. When a male and female *moubata*, which are ready to copulate, are placed in a dish, the male creeps about upon the female and presently seeks to creep beneath her, usually to one side between the second and third legs. The posterior part of the female's body is now raised, and the male advances so as to bring his body into line with the female's, the ventral surfaces of the pair being apposed. The male clings with his legs to the basal joints of the female's legs, his pair I in front of pair I of the female, and pair II in front of pair II of the female, and so on. The male all the while feels about with his mouthparts for the female's genital orifice.

The process that follows can, with careful handling of the ticks, be most conveniently observed by placing the pair in a pit made with the end of a pencil in a ball of modelling-wax (plasticine). The ball may measure an inch or more in diameter, and can be rolled about to the desired position, being fixed there at any moment by slight pressure against the glass dish in which it is contained. The female always

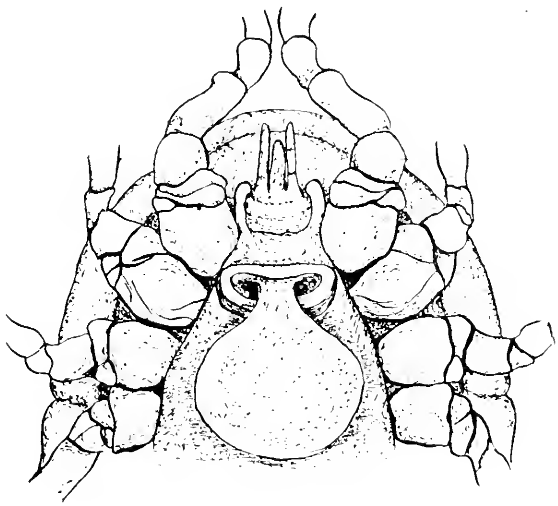


Fig. 288 [1]. *Ornithodorus moubata*, ♀. Showing the emptied portion of the spermatophore with the neck-shaped portion attached within the female sexual orifice. Drawn with the aid of a camera-lucida (G. M. del.).

seeks to regain her natural position upon a horizontal surface, so it is necessary to immobilize her sufficiently to prevent this without hampering the male. This can be done by modelling the wax about the edge of the pit so that it holds the female in place. Observations on free pairs shows that this manipulation, if done carefully, in no way interferes with the process. All of our observations were made with the aid of a Zeiss binocular microscope which can be inclined at any desired angle.

The male, having found the female's genital orifice by feeling about with his mouthparts, immediately introduces all of these (hypostome, chelicerae and palps) together into the orifice. The mouthparts are pushed in and withdrawn with a sawing motion, the capitulum being alternately protruded and retracted from his body whilst it is directed backward almost at a right angle to the long axis of the male's body. The mouthparts penetrate more and more deeply but not further than the basal article of the palps. At each movement of partial withdrawal the male mouthparts are tilted forward so that friction against the anterior lip of the vulva takes place. The chelicerae are all the while being actively protruded and retracted within their transparent sheaths, the distance which they travel in their movement to and fro corresponding about to the length of the second palpal article; the chelicerae usually move alternately. Presently the male capitulum is more and more depressed so that the hypostome points slightly backward whilst the dorsal surface of the basis capituli comes to be placed on a line traversing the first pair of coxae about midway along their length when viewed ventrally. (When disturbed at this stage it is seen that the male and female sexual apertures are in apposition.) The ventral surface of the female, together with the thick-lipped vulva, has, up to this, been somewhat prominent, but now the area about the vulva, and especially posterior to it between the first pair of coxae, becomes markedly depressed. At the moment when the female venter becomes depressed the male withdraws his mouthparts completely from the vulva and at the same time separates his body somewhat from that of the female to which it has hitherto been closely applied. The male's capitulum is now directed forward, whilst the palps and chelicerae are working actively, the digits being moved about rapidly. (When the sexes are separated at this stage it is found that the spermatophore is issuing from the male sexual orifice. The spermatophore, viewed as a whole, is flask-shaped, with a long thin neck, which is the first part to issue from the orifice; the tip of the neck of the flask when it issues adheres to the tip of the male hypostome. The spermatophore is ejected rapidly and lies along the venter of the female with the neck directed toward the vulva into which it is immediately inserted by the hypostome of the male. A moment later a large amount of clear-watery fluid emerges from the coxal glands of the male.) When viewed from in front, the ticks not being disturbed, a large amount of clear fluid now floods the space between their venters; the male reintroduces his mouthparts into the vulva, and the ticks again bring their bodies close together. The male mouthparts are worked to and fro very much as they were at first, and, after two or three minutes, they are finally withdrawn and the male abandons the female.

The ventral surface of the female is found bathed with coxal secretion, the depression about the vulva has disappeared, and the collapsed spermatophore is found attached to the vulva with its neck pushed into the vagina. The whole process of copulation lasts about 15 minutes from the moment that the male inserts his mouthparts for the first time.

The spermatophore, immediately after it has been expelled by the male, appears as a smooth, glistening, very flexible body completely filled with slightly milky contents. (On one occasion when the male was disturbed and the spermatophore was found doubled up on the venter of the female, the spermatophore literally shot out its long thin neck when touched with a fine camel's hair brush in the effort to remove it uninjured.) The end of the neck of the spermatophore appears closed and rounded, whereas the expanded portion of the spermatophore is usually bilobed. When the ticks separate without interference the spermatophore neck appears shorter and the flask collapsed, and somewhat spoon-shaped with the concavity on the side where the male's body had rested upon it whilst *in coitu*. The neck of the spermatophore is firmly attached within the vagina and force is required to remove it; on seizing the spermatophore with a fine forceps the female can be lifted by it without rupturing the structure. On exerting more force the neck of the flask tears loose at the point of entrance into the vagina and the "mouth" of the spermatophore appears spread out and frayed. The full spermatophore is crowded with "prospermiums" and secretion rich in granules; when almost collapsed, a few male elements may still be found therein. The spermatophore, very soon after coitus has taken place, contracts, flattens and hardens, the edges of the "spoon" remaining upturned. We possess several females in our collection which have died or been preserved, with usually one, but at times two or even three empty spermatophores still adhering. The flask-like covering of the spermatophore is exceedingly tough, and tested with 10 % caustic potash, it is found to be composed of *chitin*. The freshly expelled spermatophore, with fully extended neck, measures about 3 to 3·5 mm. in length and about 1·7 mm. in width at the widest part. When dried and attached to a female, to whom it may remain attached for some days, or even for weeks, it measures about 1·6 mm. in length.

Although there are several points still to be elucidated with regard to this interesting process, we consider that what we have observed explains in the main how coitus takes place. The introduction of the male mouthparts necessarily dilates the female sexual orifice and doubtless excites the female. It is possible that a sticky secretion is given off by the male mouthparts which serves to attach the neck of the spermatophore so that its contents are fully voided into the vagina. The male brings his sexual aperture practically into apposition with that of the female, and when she is ready for impregnation, he withdraws his mouthparts and expels the spermatophore which issues with the neck directed forward so that it adheres to the tip of his hypostome and is promptly pushed into the vagina. The male removes his venter from that of the female so as to give space for the spermatophore to pass, and the female venter at the same time becomes concave for the same purpose. The flood of secretion from the male coxal glands serves to prevent the too rapid drying of the chitinous envelope of the spermatophore and keeps it highly flexible until its contents have been discharged —this may be especially necessary in such ticks as *O. moubata* which live in arid climates. The male reintroduces his mouthparts so as to "plant" the neck of the spermatophore in the vagina and he appears to rupture the tip of the spermatophore so that the contents escape into the spermatheca when the bodies of the ticks are brought together again closely and press upon the spermatophore, thus pumping out its contents.

Judging from the fact that we have not as yet observed empty spermatophores adhering to the external genitalia of female ticks belonging to other species, we must conclude that in other cases the spermatophores are introduced *in toto* into the spermatheca. This may be the case in *O. savignyi*, for Christophers (1906, p. 42) states that he found the "spermatozoa" (prospermiums) in this species "included in cyst-like spermatophores" within the spermatheca of the female. He figures two such spermatophores of *savignyi* and also flask-shaped spermatophores in the spermatheca of *Rhipicephalus sanguineus*. Christophers found spermatozoa in the oviducts of *O. savignyi*. Samson (1909, p. 186) has made a suggestive observation on *Ixodes ricinus*, which indicates that copulation takes place in an analogous manner in this species; she merely states, without giving any particulars, that the male impregnates the female by means of spermatophores. In this species, Bertkau (1881, p. 147) and Samson (1909 a, p. 216) have found that the spermatozoa pass up from the spermatheca into the ovaries and there fertilize the eggs. We have also observed them in this situation. Samson (1909 b, p. 495) states that the spermatozoa in *O. moubata* only attain their full development in the ovary.

We have dwelt thus at length upon the process of copulation in *O. moubata*, because until now it has never been understood how the male impregnates the female.

As bearing on the process of copulation in Ixodidae we would add the following remarks :

We have stated elsewhere that the genus *Ixodes* (group Prostriata) is widely separated from the other genera of Ixodidae (group Metastriata) in important points of anatomical structure. In *Ixodes* the anal grooves surround the anus in front, the sexes show marked dimorphism in respect to the structure of the hypostome, and in certain species the sexes are frequently found coupling upon the host. In *Ixodes* the male inserts his mouthparts into the female sexual orifice as a part of the sexual act. In none of the Metastriata has a similar method of coupling been observed; here the males remain attached for longer periods to the host and they do not appear to wander about upon it as do some species of *Ixodes* whose males infest the host together with the females. In Metastriata the females and males are found attached to the host so that in many cases the venters of the sexes are apposed.

We have discovered that in the Metastriata (including the genera *Haemaphysalis*, *Dermacentor*, *Rhipicentor*, *Rhipicephalus*, *Boophilus*, *Margaropus*, *Hyalomma*, *Amblyomma* and *Aponomma*) all the males possess a chitinous apron or flap covering the sexual aperture. The apron arises from the integument anteriorly to the sexual aperture and is directed backward over the aperture; it is frequently serrated along its rounded posterior border which is free. The apron can be readily lifted by inserting a fine needle between it and the body surface; it is very thin at the free margin, whereas it grows gradually thicker toward its origin. The apron is absent or rudimentary in the females.

Now we find that in *Ixodes* the males do not show an apron, or it is very rudimentary in character. On the other hand the apron, though very thin, may be very well developed in the females; it is best seen in young specimens.

The presence of the apron in the males of Metastriata and its absence in *Ixodes* is very suggestive, and, taken together with the other differences, indicates that copulation may possibly take place in another manner in the Metastriata to what it does in *Ixodes*. The mechanism of copulation in Metastriata still remains to be determined and the significance of the apron requires to be explained.

APPENDIX II

[Reprinted (with a few slight alterations) from *Parasitology*, Vol. IV, No. 1, pp. 46–67, March, 1911.]

ON THE ADAPTATION OF TICKS TO THE HABITS OF THEIR HOSTS[1].

By GEORGE H. F. NUTTALL, F.R.S.

In the course of the extended investigation upon ticks which we have been conducting for some years, a very large number of specimens have reached us from all parts of the world, thanks to the generous aid which we have received from numerous collectors. In addition to studying this material, the literature on ticks has been sifted for any information which might throw light upon these parasites. A study of the data relating to the structure and habits of ticks and of their host relationships has brought to light certain facts which possess considerable interest and consequently appear to me worth recording in this Journal.

The superfamily *Ixodoidea* is divided into two families, the *Argasidae* and *Ixodidae*, which are distinguished from each other by their external structure as well as by their habits[2].

General considerations regarding the Biology of the Argasidae and Ixodidae.

The *Argasidae* are mostly inhabitants of warm climates. When they occur in colder parts of the world they seek hosts whose habitats afford them protection, and insure them possibly a certain degree of

[1] Read before the *Cambridge Philosophical Society* Meeting, 20 February, 1911.

[2] The main structural differences are described by Nuttall and Warburton (1908) in *Ticks*, Part I, p. 1.

warmth from proximity to animals upon which they feed. Thus, *Argas reflexus* and *Argas vespertilionis*, which occur in colder climates, are parasitic on pigeons and bats respectively, and they obtain shelter in pigeon coops and the retreats of bats.

Like all other ticks, they pass through larval and nymphal stages before attaining maturity. In some Argasidae the *larvae* suck blood (as in Ixodidae); in others they do not. Where the larvae suck blood they remain attached to the host for 5–10 days or more (as in Ixodidae). There are two or more *nymphal stages* in Argasidae (one only in Ixodidae), and the nymphs, with one exception, *Ornithodorus megnini*, are rapid feeders, that is, they usually feed on blood to repletion within 20–30 minutes (the nymphs of Ixodidae take several days to become gorged). The *adults* are not only rapid feeders, but they may feed repeatedly (not so in ♀ Ixodidae, though possibly in ♂s).

The nymphs[1] and adults of Argasidae are *rarely* carried away from the habitats by their hosts because they feed rapidly. They are mostly nocturnal feeders, attacking the host when the latter is sleeping or resting. All species of Argasidae would appear to shun the light, especially when waiting for a host. When hungry they may leave their hiding places during the daytime if they become aware of the proximity of a host. The Argasidae infest the habitat of the host.

The nymphs and adults of *Ixodidae* behave in a very different manner. The nymphs attach themselves to the host, and are carried about for several days, and possibly longer. This likewise holds for the adults of both sexes in a large number of species. The duration of their parasitism upon the host may be much prolonged, especially when the host is a cold-blooded animal; thus, species of *Amblyomma*, *Aponomma* and *Hyalomma*, occurring on Reptilia, may remain attached to the host for many months. On the other hand, we shall see that there are species of *Ixodes* in which the males are unknown or in which they are only recorded as having been found in the habitats of their hosts.

In the Argasidae the females lay eggs in batches after successive feeds, and the total number of eggs laid by a female is comparatively small, say 200. In the Ixodidae, the eggs may number one or more thousands. The explanation of this difference in the number of eggs laid appears obvious when we consider the life habits of the two families. The Argasidae are essentially *ticks of the habitat* in their nymphal[1] and adult stages; the females lay their eggs in and about

[1] *Ornithodorus megnini* excepted.

their host's retreat and naturally the offspring have a good chance of finding the host when their turn for feeding arrives.

With the Ixodidae the case is different: the fertilized and replete females must frequently drop from the host when it is on its wanderings, and the offspring may be left stranded in places where they may never find a host. The loss of life in nature must be enormous in the majority of species, for in most species the larva, nymph and adult must each seek a host. The loss of life should be less in those requiring but one host, as in *Boophilus*, where the tick attacks the host in the larval stage and undergoes its metamorphosis up to the adult stage upon a single animal. The greatest loss of life must of necessity occur in such species as are parasitic upon hosts having no fixed habitat. In other cases, owing to the fact that the host returns to a burrow, nest, or the like, it is probable that there may be less loss of life than in the case where an animal with wandering habits is chosen as a host. It would be interesting to make some numerical determinations of the progeny, especially of various species of Ixodidae, with this point of view in mind.

The large progeny of the Ixodidae secures their survival in nature in the face of the many difficulties the ticks must encounter in finding their hosts. In the Argasidae these difficulties are much smaller and the progeny is proportionately less numerous.

ARGASIDAE.

In the following table I have included all the Argasidae: *Argas* (*A.*) and *Ornithodorus* (*O.*) of which we know the host relationships. The list includes 12 species and 1 variety:

Argasidae	Hosts and habitat etc. of Tick	Geographical distribution (as far as known)
A. persicus ...	Birds: fowls, ducks, geese, turkeys, ostriches, quail, wild doves, canaries. Infests chicken coops, etc. Man: prevalent in Persia where it infests native dwellings. It also occurs in houses in Egypt.	Africa, Asia, Australia, N. & S. America.
A. reflexus ...	Birds: pigeons, fowls. Man: occasionally entering dwellings from pigeon coops, or attacking persons having to do with pigeons.	Europe, N. Africa.
A. vespertilionis	Bats: several species[1]; adults found in the abodes of bats.	Europe, N. Africa.

[1] See *Ticks*, Part I, p. 39, where the bats are listed. A variety infests penguins at Queenstown, Cape Colony.

Argasidae	Hosts and habitat etc. of Tick	Geographical distribution (as far as known)
A. brumpti ...	Porcupine: found infesting dusty burrows of *Hystrix* sp. in Africa. Man: attacks man when sleeping on the ground; hides in dust during the day-time.	Africa.
O. savignyi ...	Man, camel, horse: attacks them in their resting places, hides in dust or sand, etc.	Africa, India.
O. moubata ...	Man: infests native dwellings and resting places along caravan routes. Domesticated animals: dogs, pigs kept in styes, goats, sheep.	Africa.
O. turicata ...	Man: at times infesting native dwellings; attacks at night. Domesticated animals: pigs in styes, cattle, llama, horse. Wild animals: infesting burrows of tortoise and gopher.	N. & S. America.
O. talaje ...	Man: infesting native houses; attacking at night.	N. & S. America.
O. talaje var. *capensis*	Birds: found in penguin's and other nests.	Islands of Cape Colony, St Paul's Isl., Siren Isl.
O. parimentosus	Man: resting places infested.	Africa.
O. tholozani ...	Fowls and camels: infests chicken coops.	Persia.
O. lahorensis ...	Sheep: no particulars as to manner in which sheep are kept.	India.
O. megnini ...	Man and domesticated animals: horse, ass, ox, are all the hosts recorded; occurring chiefly in the ears.	N. America.

Of the foregoing species the life-histories of only five are known (*A. persicus*, *A. reflexus*, *O. moubata*, *O. savignyi*, and *O. megnini*), the ticks having been raised experimentally. The various stages of *A. vespertilionis* are known, and nymphal or adult stages (or both) of some of the other species are more or less known to science. In *A. persicus*, *A. reflexus*, *A. vespertilionis* and *O. megnini* the larvae attack the host. In *O. moubata* and *O. savignyi*, in which the eggs are correspondingly large, the larva is formed within the egg, but it is incapable of attacking a host; the larva in both of these species is inactive, and very soon after the egg-shell splits and whilst it remains in (*moubata*) or near (*savignyi*) the egg-shell it rapidly undergoes metamorphosis and emerges from the larval skin as a nymph. It is as a nymph that both the latter species first attack the host.

The larvae of	remain attached to the host for
A. persicus	5 and 10 days in warm and cool weather respectively (Nuttall).
A. reflexus	7 days (Brumpt, 1910, p. 528).
A. vespertilionis	Some days at least (Nuttall)[1].
O. megnini	5 days (but they stay on as nymphs upon the host).
The first stage nymphs of	
A. persicus	1½–2 hours (Nuttall).
O. moubata	10 minutes–1 hour (Nuttall).
O. megnini	35–98 days, or more (Hooker); abandons the host as a late stage nymph and does not attack a host as an adult.
The later stage nymphs and adults of	
A. persicus	5 minutes–2 hours (Nuttall). (Usually less than ½ hour.)
A. reflexus	20–27 minutes (Alt, Boschulte).
O. moubata	20 minutes–2 hours (Nuttall).
O. coriaceus	45 minutes–1⅔ hours (Nuttall).
O. turicata	Feed more rapidly than the last (Nuttall).
O. tholozani	30 minutes (Mégnin).
O. lahorensis	25 minutes–2⅓ hours (Nuttall).
O. savignyi	Feed like *O. moubata* (Nuttall).

We may divide the ticks above enumerated into three classes, according to their biology:

Group 1. *A. persicus, reflexus,* and *vespertilionis.*
„ 2. *O. moubata* and *savignyi.*
„ 3. *O. megnini.*

Group 1. A. persicus, reflexus and vespertilionis.

In this group the larvae are parasitic upon the host for, say, 5 to 10 days. In *persicus,* and this probably holds for the two other species, the nymphs feed about as rapidly as the adults, *i.e.* in less than 2 hours; at times in 20–30 minutes. This explains why these stages are infrequently found upon the host; they are rapid feeders and quickly abandon the host when replete. *Argas persicus* and *reflexus* are essentially parasitic on birds. There is no trustworthy record[2] of the larval stages having been found on man or upon other mammalian hosts. Without denying the possibility of their attacking mammals, it

[1] Although I have examined many bats, I have never found *A. vespertilionis* adults and nymphs upon them. On the other hand, larvae, in various stages of repletion, were not infrequently encountered. I conclude from this that the larval stage must remain attached to the host for some days at least. Doubtless, the duration of parasitism is influenced by the surrounding temperature.

[2] It is reported that Starcovici once found *reflexus* larvae on the horse in Roumania (*vide Ticks*, Part I, p. 27), but I feel warranted in doubting the statement.

appears reasonable to suppose that when they infest human dwellings it is because of birds being harboured there. The birds on which the ticks have been found are nearly all domesticated. The natural hosts of *persicus* and *reflexus* are commonly fowls and pigeons which doubtless have served to spread the tick amongst other birds in their vicinity. The thin skin of the bird seems peculiarly adapted for the successful attack of the small larval tick, and the nesting or roosting habit of the birds permits the ticks to drop off in situations adapted to the feeding and other life habits of the nymphs and adults. Both species in their mature stages are essentially night feeders, that is, they feed when the birds are in the dark and asleep, and the ticks retreat into crevices and dark places during the day-time. Where the ticks attack man they do so at night-time. I assume that *O. talaje* var. *capensis*, which has been found in penguin's and other birds' nests, will be found to have a similar life-history to the above; the larvae should be found on the birds in localities infested by the tick.

Argas vespertilionis has never been found on other animals than bats[1]. Here we have a host which retreats to dark places during the day-time. The retreats of bats (hollow trees, beneath roofs of houses, in caves and grottoes) are more or less permanent dwellings where the ticks find shelter very much as do the Argasids above mentioned which attack birds. It is clear that to secure the adult stages of this tick the habitats of bats are the places in which to search for them.

Group 2. O. moubata and O. savignyi.

In this group the larvae are inactive, and the first stage nymph attacks the host. This nymph feeds as rapidly (in the case of *moubata*) as does the adult, *i.e.* in 10 minutes to one hour. *Ornithodorus moubata* and *savignyi* seem to be peculiarly adapted to their hosts and the habits of their hosts. All of the latter, *i.e.* man and the domesticated animals possess thick skins. Man appears to be the chief host, at any rate of *moubata*. The hairless human skin, coupled with man's ability to remove his ectoparasites, renders prolonged parasitism difficult. Man herds his animals into a limited space in immediate proximity to his dwellings or resting places along routes of travel. Both species live in hot dry climates where there is a largely unclothed human population. The ground is for long periods of the year covered deeply with a layer of dry dust or sand both in and out of dwellings.

[1] See footnote, p. 326.

Both species, if they had active larvae, would labour under a considerable disadvantage under these conditions and an enormous number of larvae would be lost in the dust or sand, and would die from desiccation. It may be noted that the females in captivity burrow and lay their eggs above them on or near the surface of sand. To overcome these conditions they must be provided with a thick integument to protect them against desiccation; they must possess mouth-parts capable of penetrating a thick skin and of drawing blood rapidly; an increase in size and

Fig. 289 [1–8]. Eggs of Ixodoidea showing their relative size in some species belonging to different genera. Outlines drawn with a camera-lucida and reduced. The scale to the right = 1 mm. (Original. G. M. del.):

1. *Ixodes hexagonus* 575 × 450 μ.
2. *Haemaphysalis punctata* 570 × 380 μ.
3. *Hyalomma aegyptium* 550 × 425 μ.
4. *Rhipicephalus evertsi* 550 × 400 μ.
5. *Boophilus decoloratus* 625 × 400 μ.
6. *Amblyomma hebraeum* 625 × 525 μ.
7. *Argas persicus* 625 × 575 μ.
8. *Ornithodorus moubata* 950 × 750 μ.

strength will render them more capable of dealing with the dust problem. The larval stage is, therefore, inactive. The females lay larger eggs (and fewer) than any other ticks, so that they contain enough reserve upon which the nymphs may develop. The first stage nymphs are rapid feeders, and very resistant to drought and prolonged starvation, although somewhat less so than the later stages.

Group 3. *O. megnini.*

Ornithodorus megnini is quite aberrant in its habits, and appears highly specialized in its adaptation to a life of parasitism. As in Group 1, the larva attacks the host and remains attached thereto for about five days, by which time it is replete. It moults *in situ*, and re-attaches itself to the host for 35–98 days, or more, slowly growing in size and doubtless moulting as do the nymphs of other Argasidae. The larvae and nymphs are especially prone to attack the ears of their hosts. When replete, the nymphs abandon the host, crawl up several feet on posts, trees, or the like, and hide in chinks and crevices. After about seven days, in summer, the adults emerge, but they do not seek a host. During their long period of parasitism as nymphs they have doubtless undergone internal changes leading to maturity, otherwise they would not emerge so rapidly as adults from the nymphal skin. The adults, without further feeding, mate; the females oviposit in the chinks and crevices, and the larvae which emerge from the eggs await the coming of a host. Hooker, to whom we are indebted for most of what is known of this curious life-history, very naturally regards the habits of this tick as correlated with its peculiar form of parasitism in the ears of its hosts. He does not, however, discuss the subject.

Animals rubbing their ears or heads against infested posts or trees ("rubbing places") would necessarily pick up the waiting larvae. I would add that the structure of the mouth-parts, and especially the presence of an unarmed hypostome in the adults, indicate that they can scarcely be blood-suckers. It would be a matter of considerable interest, it seems to me, to examine the internal anatomy of the adults of this species to see in how far it is modified, especially with regard to the pharyngeal pump, salivary glands and digestive organs.

The life-history of *O. megnini* is that of an animal highly specialized to a life of parasitism chiefly in the ears of its hosts. The larvae issue from eggs laid on rubbing posts or trees, and the like, some feet above the surface of the ground, so that they may readily gain access to the heads of their hosts. The larvae enter the ear unperceived. It would be a matter of increasing difficulty for succeeding stages to "cast anchor in such a small harbour" a second time for, apart from their increasing size, which would militate against their re-entering the ear, the number of ticks of later stages which survive even from a large batch of larvae (in all species of ticks) is very small and grows progressively smaller toward the period when maturity is reached. The tick, having entered the ear where it is safe for an unlimited time, takes advantage of the protection afforded and only leaves it once when it abandons it as a large nymph almost ready to cast its skin and emerge as an adult. The period of parasitism as a larva is normal, but that of the nymphal stages inordinately prolonged so that the tick only needs to go in and out once through the small aperture of the ear. It is owing to the choice of the ear for its place of feeding upon the host that the life-history of this tick has become so peculiarly modified. Its spiny integument, to which it owes its name of "spinose ear tick," may be of use in connexion with its parasitism in the ear in lessening its chances of adhering with a large body-surface to the cerumen within the ear.

Of the other species of Argasidae which have been enumerated in the list on pp. 326, 327, too little is known to permit of much comment. It would seem to me as if *A. brumpti*, *O. turicata* and *O. pavimentosus* may prove, on investigation, to have a life-history similar to that of *O. moubata* and *O. savignyi*; *O. talaje* and *O. tholozani* may possess life-histories like *A. persicus*, and this appears highly probable for *O. talaje* var. *capensis*. It is to be hoped that the life-history of *O. lahorensis* will be worked out in India. We are studying *O. turicata* and *O. talaje* var. *capensis*.

Note on the structure of the Hypostomes in Argasidae.

The dentition of the hypostome is in accord with what I have stated regarding the feeding habits of the Argasidae. This is illustrated by typical examples in the accompanying figures. Thus, in *A. persicus, reflexus* and *vespertilionis*, where the larvae attach themselves to the host for some days, or longer, the larval hypostome is

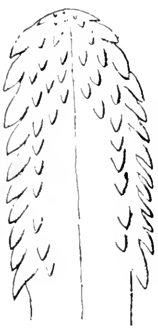


Fig. 290[1].

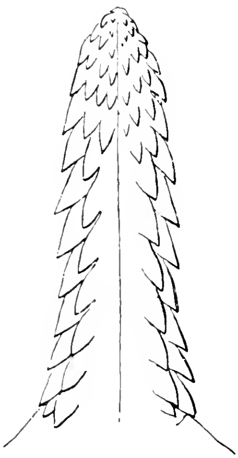


Fig. 291.

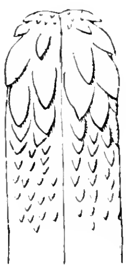


Fig. 292.

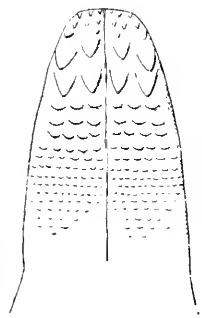


Fig. 293.

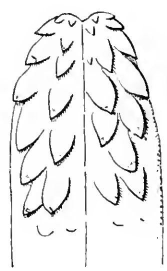


Fig. 294.

Fig. 290. *A. persicus*, larva (similar in larva of *A. reflexus*)
Fig. 291. *A. vespertilionis*, larva.
Fig. 292. *A. persicus*, adult.
Fig. 293. *A. reflexus*, adult.
Fig. 294. *A. vespertilionis*, nymph.

[1] Figs. 290–297 are reproduced from *Ticks*, Part I.

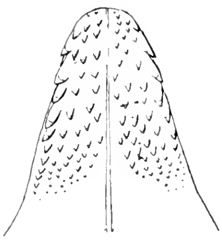


Fig. 295.

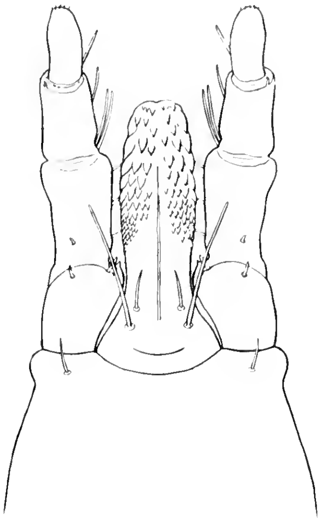


Fig. 296.

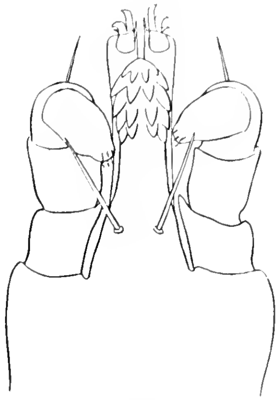


Fig. 297.

Fig. 295. *O. savignyi*, adult. Fig. 296. *O. moubata*, adult.
Fig. 297. *O. moubata*, 1st stage nymph.

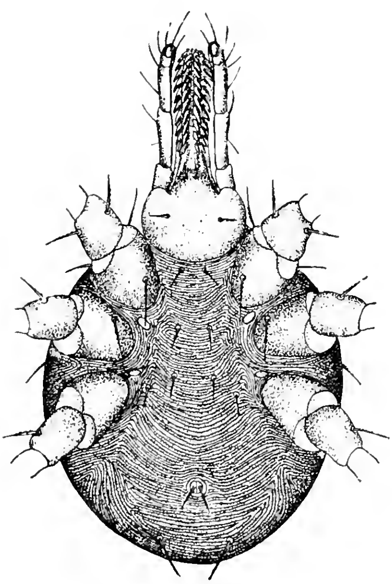


Fig. 298[1].

Fig. 298. *O. megnini*, larva.

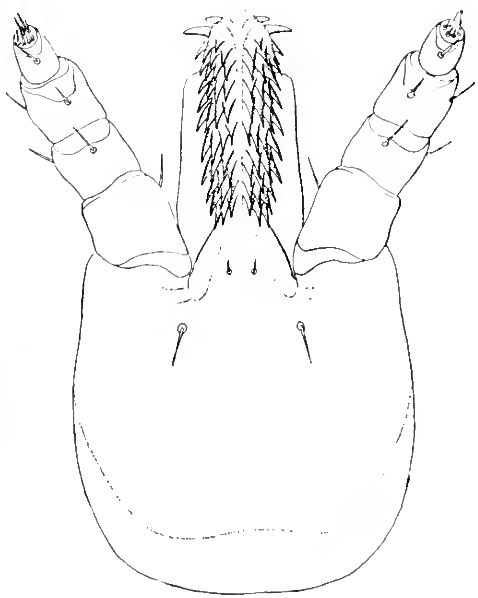


Fig. 299[1].

Fig. 299. *O. megnini*, nymph.

[1] Figs. 298, 299 are reproduced from Salmon and Stiles, 1901, Figs. 99 and 102 (17*th Ann. Rep., B. A. I., U. S. Dept. Agricult.* and from *Ticks*, Part I).

armed with long pointed teeth running down to its base (Figs. 290, 291). The adults or nymphs of these species (Figs. 292, 293, 294) show a considerable reduction in the armature of their hypostome. In *O. savignyi* and *O. moubata,* where the larvae are inactive and the nymphs and adults are both rapid feeders, the dentition of the hypostome is reduced (Figs. 295, 296, 297). In *O. megnini* the larval hypostome (Fig. 298) is powerfully armed, and the same is the case with that of the nymph (Fig. 299), which we have seen remains attached for a long time to the host. The hypostome of the adults, which do not suck blood, is *unarmed,* and the capitulum, as a whole, is quite exceptionally small. The figures are reproduced from *Ticks,* Part I, without regard to the relative magnifications employed.

IXODES.

When we come to consider the biology of *Ixodes,* which are clearly marked off from other Ixodidae structurally, there are two points which are very striking in respect to the adult stages: (1) the considerable number of species in which the females only are known, and (2) the fact that the males of some species are frequently found in copula on their hosts (in some species the sexes remain in copula even when they are dropped into spirit). In no other genus of *Ixodoidea* is this the case. On the other hand, in those species in which both sexes are known, some are found in copula upon the host, whilst others are not. I have sought a reason for these peculiarities in *Ixodes,* and believe I have found an explanation of these differences. I shall begin by discussing the host relationships in *Ixodes.*

Of the 51 species listed we have no data regarding the hosts of nine, namely, *nigricans, fossulatus, acutitarsus, gigas* (♂), *japonensis, percavatus, cordifer* (♂), *tasmani* and *coxaefurcatus* (♂). We nevertheless include two of these (*percavatus* and *tasmani*) in the subjoined lists because the presumption appears justified that they came from birds: *percavatus* came from isolated islands in the Pacific inhabited by birds, and we possess a variety of this species, taken from a puffin; *tasmani* was collected on the Island of St Pierre, and by the celebrated ornithologist, Jules Verreaux, in Tasmania. We therefore are able to list 44 species in relation to their hosts, there being but two of these (*percavatus* and *tasmani*) with regard to which the evidence is not quite satisfactory.

In the appended lists I have grouped the various species of *Ixodes* as follows:

I. Species of which both the ♂ and ♀ are recorded as occurring upon the host.

(*a*) Species in which the sexes have been found in copula upon the host.

(*b*) Species in which the sexes have been found near together upon the host.

II. Species of which the females only have been found upon the host.

III. Species of which the females only are known.

The immature stages of these ticks are left out of consideration in these lists. Alongside the name of the hosts are placed certain signs:

+ denotes a host possessing wandering habits.

0 denotes a host with fixed habitat for more or less prolonged periods; the habitats being burrows, nests, caves, hollow trees, etc.

± is used in the case of *Canis familiaris*, as in some places it may be fittingly described as a wandering host, in others as a host with fixed habitat (the kennel).

A consideration of the data tabulated in the following pages brings out certain striking facts. The ticks included under Group 1 (*a*) are, in most cases, encountered upon (+) *wandering hosts*. In the case of *ricinus*, our records show that it has been found 63 times on wandering hosts and only 10 times on hosts which burrow. Being a very prevalent and hardy species, it is natural that it should occasionally occur on a variety of hosts. The tick may at times infest dog kennels, thus taking advantage of the fixed habitat of the host. The three varieties of *ricinus* (var. *scapularis, ovatus* and *californicus*) appear to follow the same rule, and in the case of *pilosus* we appear to have a striking example of a tick occurring upon wandering hosts.

Group 1 (*b*). The species included in this group occur, in some cases, on wandering hosts, in others not. Thus, *angustus* and *tenuirostris*, according to my notes, occur solely on nesting and burrowing animals. In *angustus* we have a form in which the males occur very rarely upon the host, and in which the male hypostome[1] is poorly armed; *angustus* may, therefore, be regarded as an intermediate form in respect to its adaptation. In *tenuirostris* we have a tick which, as far as we know, only

[1] The variations in this structure in male *Ixodes* will be discussed presently.

I. *Species of Ixodes of which both ♂ and ♀ are recorded as occurring upon the host.*

(*a*) *Species in which the sexes occur in copula upon the host.*

Species	Host's habits	Host	Number of times found thereon	Geographical distribution of tick
I. ricinus	+	Bos taurus	13	Europe, N. Africa, W. Asia, W. America.
	+	Ovis aries	13	
	±	Canis familiaris	13	
	+	Cervus elaphus	5	
	+	,, capreolus ...	4	
	+	,, dama	1	
	+	Capra hircus	2	
	+	Equus caballus	6	
		Homo sapiens	2	
	+	Felis concolor	1	
	+	Genetta sp.	1	
	+	Lepus europaeus... ...	2 } 63	
	0	Erinaceus europaeus ...	2	
	0	Mustela putorius ...	1	
	0	,, erminea... ...	1	
	0	Meles taxus	1	
	0	Mus decumanus	1	
	0	"Mouse"	1	
	0	Myoxus sp.	1	
	0	Talpa europaea	1	
	0	Ground squirrel	1 } 10	
		Larvae and nymphs on lizards (10) and birds (5) of different species.		
I. ricinus var. *scapularis* (♂ ♀ known)	+	Cattle		N. America, Costa Rica.
	+	Deer		
	±	Dog		
		Man		
I. ricinus var. *ovatus* (only 2 ♀s known)	+	Horse		Japan.
	±	Dog		
I. ricinus var. *californicus*	+	Black-tail deer		N. America.
	0	Grey fox		
I. pilosus	+	Capra hircus	3	S. Africa.
	+	Bos taurus	2	
	+	Equus caballus	3	
	+	Sus scrofa domestica ...	2	
	+	Ovis aries	1	
	+	Duikerbok	1	
	+	Tragelaphus sylvaticus ...	1	
	±	Canis familiaris	1	

Species	Host's habits	Host	Number of times found thereon	Geographical distribution of tick
I. pilosus	+	Felis domesticus... ...	1	S. Africa.
	+	Viverra civetta	1	
	+	Felis pardus	1	
		Homo sapiens	1	
I. pilosus var. *howardi* (♂ ♀ known)	+	Cat		S. Africa.
	0	Erinaceus frontalis		
	0	Rhinolophus sp.		
I. boliviensis ...	?	Icticyon (Speothos) venaticus (Canidae)	1	Bolivia.
I. schillingsi ...	+	Colobus caudatus (monkey)	2	E. Africa.
I. rasus	+	Bos taurus		E. & W. Africa.
	+	Felis pardus		
	±	Canis familiaris		
	0	Herpestes ichneumon		
	0	Hyrax sp.		
		Homo sapiens		
I. ugandanus ...	+	Ovis aries		E. & W. Africa.
	0	Aulacodus sp.		
		"Large rodent" (? Aulacodus)		
I. ugandanus var. *djaronensis* (♂ ♀ known)	?	Genetta suahelica ...		E. Africa.
	0	Procavia brucei		

(*b*) *Species in which the sexes have been found together upon the host.*

I. angustus ...	0	Sciurus hudsonius douglasi		N. America.
	0	Tamias townsendi (Sciuridae)		
	?	Lepus dalli		
	0	Neotoma occidentalis (Muridae)		
	0	"Mouse"		
I. tenuirostris ...	0	Evotomys glareolus ...	3	Europe.
	0	Arvicola amphibius ...	2	
	0	,, pratensis ...	1	
	0	Microtus agrestis ...	2	
	0	,, arvalis	1	
	0	Sorex vulgaris	1	
	0	,, minutus	1	
	0	Mus miniatus	1	
I. minor ...	0	Hesperomys sp. (Muridae)	1	Guatemala.
I. cavipalpus ...	+	Cynocephalus babuin ...	1	Africa (Rhodesia & Angola).
		Homo sapiens	1	
I. rubicundus ...	+	Ovis aries	1	S. Africa.
	+	Capra hircus	1	

Species	Host's habits	Host	Number of times found thereon	Geographical distribution of tick
I. rubicundus var. *limbatus* (♀ only known)	+	Sheep	1	C. Africa (Congo).
	+	Goats		
I. holocyclus ...	+	Bos taurus		Australia, India.
	+	Macropus sp.		
	±	Canis familiaris		
	0	Sciurus variabilis		
	0	Phascogale penicillata (Marsupial tree shrew)		
I. loricatus ...	+	Ateles melanochoerus		S. America.
	0	Didelphys aurita		
	0	,, opossum		
	0	,, sp.		
	0	Microdidelphys sorex (O & L[1].)		

occurs as a parasite on small mammals which burrow; these burrows are, however, near the surface of the ground and *liable to be destroyed* or flooded, consequently, for the maintenance of the species, it is essential that both sexes should be carried about upon the host as in the case of ticks occurring on hosts with wandering habits. The other species follow the same general lines as 1 (*a*) with regard to their host relationships; the majority of the hosts have wandering habits. In *minor* (only found once) the sexes may occur together on the host for the reasons stated above for *tenuirostris*; *loricatus* appears to be an exception.

If the reader will run his eye down the column of + and 0 signs in the lists I (pp. 336–338) and II (pp. 339–340) of the hosts of the different species of *Ixodes*, he cannot but be struck by the differences. The hosts enumerated in II, under "Species of which the females only have been found upon the host, the males being known," are nearly all animals which burrow or nest. Thus, we record the finding of *hexagonus* no less than 40 times on such hosts, once each on three wandering hosts (if we include man), and three times on the dog. The list of hosts of *hexagonus* var. *cookei* (taken from Banks) falls in with that of *hexagonus*. In the case of *canisuga*, the dog is the most prominent host, simply because nearly all of our specimens from the dog came from the north of England where the shepherd dogs are largely confined in kennels. The dog in these regions is a host with a fixed habitat, as with most of the other hosts; in only two instances out of 23 has this species been recovered from a wandering host.

[1] O and L signify that nymphal and larval stages only were found.

II. *Species of which the females only have been found upon the host, the males being known.*

Species	Host's habits	Host	Number of times found thereon		Geographical distribution of tick
I. hexagonus ...	0	Erinaceus europaeus ...	9		Europe, N. Africa, N. & S. America.
	0	Mustela erminea	8		
	0	,, vulgaris	7		
	0	,, putorius	6		
	0	,, furo	2		
	0	Lutra vulgaris	1	40	
	0	Meles taxus	1		
	0	Lepus cuniculus	1		
	0	Myopotamus coypu ...	1		
	0	Sciurus sp.	1		
	0	Canis vulpes	3		
	±	Canis familiaris	3		
	+	Ovis aries	1		
	+	Sus scrofa	1		
		Homo sapiens	1		
I. hexagonus var. *cookei* (♂ ♀ known)	0	Lutra			N. America.
	0	Mustela vison			
	0	Spermophilus			
	0	Weasel			
	0	Porcupine			
	0	Marmot			
	0	Pocket gopher			
	±	Dog			
	+	Cat			
	+	Sheep			
I. canisuga ...	±	Canis familiaris	12		Europe, N. America.
	0	,, vulpes	2		
	0	Cotile riparia (bank-swallow)	3		
	0	Mustela furo	1	21	
	0	Meles taxus	1		
	0	Sciurus	1		
	0	Talpa europaea (larva) ...	1		
	+	Equus caballus	1	2	
	+	Ovis aries	1		
I. putus. On marine birds only (♂ only found in nests or beneath rocks and soil near nests).					
	0	Phalacrocorax verrucosus ...			Europe, N. & S. America, Asia, Australasia.
	0	Pygosceles taeniatus			
	0	Spheniscus magellanicus			
	0	Fratercula arctica ...	3		
	0	Penguin sp.	2		
	0	Uria troile	1		
	0	Sea-gull sp.	1		
	0	Sula bassana	1		
	0	Fulmarus glacialis ...	1		
	0	Cormorant sp.	1		
	+	Man (occasionally, see text, p. 340)			

Species	Host's habits	Host	Number of times found thereon	Geographical distribution of tick
I. vespertilionis.	Bats only (♂ found in caves etc. inhabited by bats).			
	0	Plecotus auritus ...	...	Europe, Africa, Australia.
	0	Rhinolophus hipposideros		
	0	,, ferrum equinum		
	0	,, euryale		
	0	,, hippocrepis		
	0	,, blasius.		
	0	,, clivosus		
	0	Vesperugo pipistrellus		
	0	,, tricolor.		

Ixodes putus and *vespertilionis* are solely parasites of birds and bats, although *putus* may occasionally attack man when he approaches the infested birds' nests.

With the exception of *I. hexagonus*[1], including var. *cookei*, of which we have no particulars, *the males of these species have never, apparently, been captured upon the host.* On the other hand, the males of the other species have been found in the habitats of their hosts: *canisuga* in the nests of sand-martins (bank-swallows) and in a dog kennel, *vespertilionis* in caves inhabited by bats, *putus* in and about the nests of marine birds. In such localities the males would have ample opportunities of feeding upon their hosts for brief periods after the manner of male Argasidae, assuming that they do feed. It is conceivable, however, that such habitat-infesting males may not be blood-suckers at all. We have seen that *Ornithodorus megnini* ♂ does not feed, and that it nevertheless fertilizes the female. The same may hold for certain Ixodidae ♂s. The matter requires further investigation. The sexes of *canisuga* and *putus* have often been observed in copula apart from the host, and it appears probable that this is the usual occurrence in nature[1].

List III (p. 341) is likewise very striking. It includes all the species (26) of which the males are still unknown. With the exception of three species (*bicornis, stilesi* and *australiensis*), all of the females have been found solely on birds, burrowing or nesting hosts, and bats. Of *I. bicornis* only three females are known; they were found on as many hosts. *Ixodes stilesi* has only been found once, and all the specimens (14 females) were found upon a single host. *Ixodes australiensis* was found once on a dog (±), and once on the marsupial rat-kangaroo (0). It is true that many of the species are represented only by one or two females, or by few specimens, and consequently there may be an error in certain cases in attaching much importance to the character of the type host—nevertheless, there is a very remarkable co-relation between the absence of males on the host and the life habits of the host.

[1] See note on p. 345.

III. *Species of which the females only are known*[1].

Species	Host's habits	Host	Geographical distribution of tick
I. acuminatus	0	Mus agrarius (only 2 ♀s known) ...	Italy.
I. dentatus	0	Rabbit (1 ♀ known)	N. America.
I. diversifossus	0	Procyon lotor (2 ♀s recorded) ...	N. America.
I. fuscipes	0	Dasyprocta aguti (? Felis pardalis) ...	C. & S. America.
I. sculptus	0	"Rock squirrel"	N. America.
I. spinicoxalis	0	Mustela flavigula (4 ♀s known) ...	Sumatra.
I. marxi	0	Red squirrel and fox (few ♀s known)...	N. America.
I. rubidus	0	Bassaris astuta (1 ♀ known) ...	Mexico.
I. nitens	0	Mus macleari (2 ♀s known)	Christmas Island, Pacific Ocean.
I. bicornis	+	Felis concolor, F. onca, Homo sapiens (may = diversifossus, only 3 ♂s known)	Mexico.
I. auritulus	0	Trupialis militaris and another bird, sp.?	S. America.
I. brunneus	0	Birds: many species	Europe, N. America.
I. caledonicus	0	Domestic pigeons	Scotland.
I. simplex	0	Rhinolophus ferrum equinum, Vespertilio	China.
I. texanus	0	Grey squirrel, Procyon lotor (few ♀s known)	N. America.
I. stilesi	+	Padua humilis (Cervidae); (14 ♀s found once)	Chili.
I. neumanni	0	Marine birds (10 ♀s known)... ...	New Zealand.
I. percavatus	0	Marine birds (presumably)	Tristan d'Acunha Island.
I. percavatus var. *rothschildi*	0	Marine bird (puffin)	No locality given.
I. lunatus	0	Hallomys audeberti (1 ♀ known) ...	Madagascar.
I. ornithorhynchi	0	Ornithorhynchus (found 5 times) ...	Tasmania.
I. tasmani	0	Probably birds (Verreaux coll.) ...	,,
I. fecialis	0	Dasyurus geoffroyi (1 ♀ known) ...	Australia.
I. fecialis var. *aegrifossus*	0	Opossum (3 ♀s); Perameles obesula (1 ♀)	,,
I. australiensis	±	Canis familiaris (found once) ...	,,
	0	Bettongia lusueuri (marsupial rat-kangaroo), (found once)	
I. vestitus	0	Myrmecobius fasciatus (Dasyuridae), (found once)	,,
		Diemenia superciliosa (snake), (found once)	
I. signatus	0	Phalacrocorax	Asia, N. America.
I. unicavatus	0	Phalacrocorax graculus and P. carbo....	Great Britain.

[1] Nymphal and larval stages are known in many of these species.

On the structure of the hypostome in ♂ Ixodes.

There are 18 species of *Ixodes* of which the males and females are known. About one of these (*pratti*, Banks) we have no information such as we require for this discussion. Of the 17 remaining species, the sexes have been found together upon the host in 13 (I (*a*) and (*b*)), and in 4 (II) only the females have been found upon the host:

I (*a*). In six the sexes have been found in copula upon the host, namely, *ricinus, rasus, ugandanus, schillingsi, pilosus* and *boliviensis.* The hypostomes in the males of the first five species are characterised by prominent basal teeth; *boliviensis* has a well-armed hypostome.

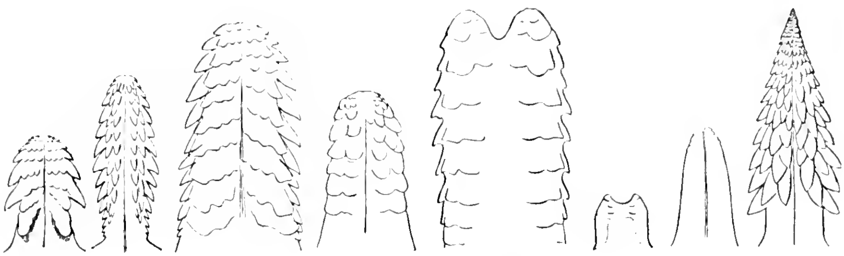
I (*b*). In seven species (*cavipalpus, rubicundus, minor, loricatus, tenuirostris, angustus* and *holocyclus*) both sexes have been found upon the host, but there is no specific mention of their having been found in copula. The hypostomes of the first two species possess prominent basal teeth; *minor, loricatus* and *tenuirostris* possess hypostomes which are well armed with pointed teeth; in *angustus* and *holocyclus* the hypostome is only moderately armed.

II. In four species (*hexagonus, canisuga, putus* and *vespertilionis*) there is no record of the males having been found upon the host. In the first two the hypostome is but moderately armed, whereas in *putus* and *vespertilionis* it is almost unarmed.

The structure of the male mouthparts, therefore, bears a direct relation to the presence or absence of the male upon the host and the occurrence of the sexes in copula upon the host. Of the six species (I (*a*)) which have been found in copula upon the host no less than five possess hypostomes with prominent basal teeth. It is probable that some of the species placed in the following division (I (*b*)) will yet be found in copula when they have been more carefully observed. In Group I (*a*) and (*b*) there are 13 species enumerated in only two of which the hypostome may be described as moderately armed. In Group II, regarding which there is no record of the males having been found upon the host, the male hypostome is but slightly armed in two and practically unarmed in two species.

Figures illustrating the hypostomes of Ixodes.

The accompanying figures show the marked sexual dimorphism which is observable in some species of *Ixodes,* and also types of male hypostomes which show considerable modifications of structure.



300 301 302 303 304 305 306 307

Figs. 300, 301 represent the hypostomes of *I. ricinus* ♂ and ♀. That of the ♂ may be taken as the type of a hypostome with large basal teeth as observed also in the males of *rasus, ugandanus, schillingsi, rubicundus, cavipalpus* and *pilosus,* the basal teeth being less prominent in the last two species mentioned. In *boliviensis* ♂ the basal tooth, whilst prominent, is much less developed.

Fig. 302 represents the hypostome of *I. minor* ♂, with well-developed outer files of teeth. (The hypostome of *tenuirostris* and *loricatus* approximate to the type of structure fornd in the females.)

Fig. 303 represents the hypostome of *I. holocyclus* ♂. It is poorly but relatively better armed than that of *canisuga* which follows.

Fig. 304 represents the hypostome of *I. canisuga* ♂, poorly armed, and much emarginated distally. That of *hexagonus* is similar but not emarginated.

Fig. 305 represents the hypostome of *I. putus* ♂, practically unarmed, emarginated, and so reduced in length as to be useless for attaching the tick to a host. This structure alone suggests that the male of this species is probably incapable of sucking blood.

Figs. 306, 307 represent the hypostomes of *I. vespertilionis* ♂ and ♀; that of the ♂ practically unarmed; that of the ♀ illustrating the dimorphism existing between the sexes.

The figures are chosen from the series illustrating this work, without regard to the magnifications employed.

N.B.—It is a striking characteristic of *hexagonus, canisuga, putus* and *vespertilionis* males that the capitulum is *much smaller* compared to the size of the body than in any other male *Ixodes* that are known. The size of the capitulum apparently bears a direct relation to the dentition of the hypostome and to the habits of the male with regard to copulation and parasitism on the host.

Summary.

A consideration of the facts presented in the foregoing pages appears to warrant certain conclusions which must, however, be regarded in part as provisional and subject to revision when our knowledge of the various species of ticks has become more extended. The views here expressed may prove of practical use in the study of the Ixodidae.

The *Argasidae* represent the relatively primitive type of ticks because they are less constantly parasitic than are the Ixodidae. Their nymphs and adults are rapid feeders and chiefly infest the habitat of their hosts. In certain Argasidae (*O. moubata* and *O. savignyi*) the disadvantage of their possessing an "active" larval stage has resulted in the development of an "inactive" larva, *i.e.* the young nymph being the first to suck blood. In *O. megnini* we have a considerable adaptation brought about by the difficulty there must be in the tick entering the small aperture of the ear more than once. Owing to the Argasidae infesting the habitats of their hosts, their resistance to prolonged starvation and their rapid feeding habits, they do not need to bring forth a large progeny, because there is less loss of life in the various stages, as compared to Ixodidae, prior to their attaining maturity.

The *Ixodidae* are more highly specialized parasites than the preceding. The majority are parasitic on hosts having no fixed habitat and consequently all stages, as a rule, occur upon the host. In the genus *Ixodes* we find an adaptation of certain species according to the habits of the hosts upon which they are parasitic. In the species which usually occur upon wandering hosts both sexes are found upon the host, whereas in other species which occur on hosts possessing more or less fixed habitats the males are rarely or never found upon the host. The males of species of *Ixodes*, both sexes of which occur upon the host, are characterized, as a rule, by the possession of hypostomes with prominent teeth, the reverse being the case in forms wherein the males do not occur upon the host. Where species occur upon a wandering host it is essential, for their propagation in nature, that both sexes should be carried about upon the host.

It appears to follow that the copulation of ticks upon the host is an indication of a higher degree of specialization to a life of parasitism. When copulation does not take place on the host, we have merely the retention of a primitive character as found in Argasidae. From the fact that many species of *Ixodes* are only known to science in their female and immature stages, it would appear probable, if my theory holds, that this is merely due to the males not having as yet been sought for in the habitats of their hosts[1].

A great many males belonging to *Haemaphysalis, Dermacentor, Rhipicephalus, Amblyomma* (and *Aponomma*) are known, these genera of Ixodidae being rich in species. The males of *Boophilus*, *Hyalomma*, *Rhipicentor* and *Margaropus*, of which there are few species, are likewise known. In all of these genera the males are found close to the females and attached to the host. *These genera are chiefly parasitic on animals with wandering habits,* and the males of these genera do not exhibit hypostomes which are markedly dissimilar to those of the females; the hypostomes are well armed in both sexes. It is only in the genus *Ixodes* that we find well-marked sexual dimorphism in respect to the structure of the hypostome.

[1] As a further confirmation of the views here expressed, I would state that we have recently (March, 1911) discovered a male of *Ixodes hexagonus* in the nest of a hedgehog. This is the first male we have captured, whereas we possess hundreds of females, nymphs and larvae found on various hosts. (The rarity of the male is rendered evident by the fact that there is not a single specimen of a male in the Museums in London, Paris and Berlin.) When the male was placed in a receptacle with an engorged female from the same nest, copulation occurred after a few minutes and was repeated several times.

INDEX TO VALID SPECIES OF IXODES

Together with a List of the Collections in which the Types are to be found.

Names of Species, Authors and Date	Collections which include the Types	Stages of each species which are known	Page
acuminatus Neumann, 1901	Toulouse, 2 ♀s	♀	161, 341
acutitarsus (Karsch, 1880)	Berlin[1], 1 ♀	♀	202
**angustus* Neumann, 1899	Washington (*a*), 1 ♀; Cambridge, ♂ O L	♂ ♀ O L	195, 315, 334 *et seq.*
auritulus Neumann, 1904	Paris (*a*), 3 ♀s; Toulouse, 1 ♀, co-type	♀	187, 341
**australiensis* Neumann, 1904	Cambridge, 2 ♀s; Toulouse, 1 ♀, co-type	♀	250, 341
bicornis Neumann, 1906	Toulouse, 3 ♀s	♀	186, 341
boliviensis Neumann, 1904	Toulouse, 1 ♂, 1 ♀, 1 O	♂ ♀ O	166, 334 *et seq.*
**brunneus* Koch, 1844	Berlin, 1 ♀ (in balsam)	♀ O L	189, 341
**caledonicus* Nuttall, 1910	Cambridge, 1 ♀, O L Edinburgh, 1 ♀, O L	♀ O L	198, 341
**canisuga* Johnston, 1849	Lost, but substitutes in Cambridge: ♂ ♀ O L; Toulouse	♂ ♀ O L	209, 316, 334 *et seq.*
**cavipalpus* Nuttall and Warburton, 1907	Cambridge, ♂s, ♀s	♂ ♀	192, 334 *et seq.*
cordifer Neumann, 1908	Leyden, 1 ♂	♂	233
coxaefurcatus Neumann, 1899	Berlin, 1 ♂	♂	270
dentatus Marx, 1899, in Neumann, 1899	Washington (*b*), 1 ♀	♀	162, 341
diversifossus Neumann, 1899	Washington (*c*), 2 ♀s	♀	163, 341
**fecialis* Warburton and Nuttall, 1909	Cambridge, ♀	♀	248, 341
**fecialis* var. *aegrifossus* Warburton and Nuttall, 1909	Cambridge, ♀	♀	250, 341
fossulatus Neumann, 1899	Berlin, 1 ♀	♀	201
fuscipes Koch, 1844	Berlin, ♀; Toulouse, O L	♀ O L	169, 341
**gigas* Warburton, 1910	Calcutta, 1 ♂; Cambridge, 1 ♂	♂	203
**hexagonus* Leach, 1815	London, ♀	♂ ♀ O L	177, 330, 334 *et seq.*
**hexagonus* var. *cookei* (Packard, 1869)	Harvard, ♀	♀	183, 334 *et seq.*
**holocyclus* Neumann, 1899	London, Paris (*a*), Toulouse, Berlin, ♀s, Hamburg	♂ ♀ O	235, 334 *et seq.*
japonensis Neumann, 1904	Paris (*a*), 1 ♀	♀	208

[1] Determined by Karsch, but not the type, which is neither in Berlin nor Munich, and cannot be traced.

* Species contained in the Cambridge collection; types, and others which have been compared with the types.

[1] Not in Upsala: only *Hyalomma aegyptium* still in the Linnean Collections, 1911.

* Species contained in the Cambridge collection; types, and others which have been compared with the types.

Names of Species, Authors and Date	Collections which include the Types	Stages of each species which are known	Page
**unicavatus* Neumann, 1908	Edinburgh, ♀ O L; Cambridge, L	♀ O L	264, 341
**vespertilionis* Koch, 1844	Berlin, 1 ♀	♂ ♀ O L	271, 334 *et seq.*
vestitus Neumann, 1908	London, 1 ♀; Cambridge, O L	♀ O L	252, 341

* Species contained in the Cambridge collection; types, and others which have been compared with the types.

The important collections, judged by the number of types they contain, are to be found in the following cities (the figures in parentheses indicate the number of types in the cities enumerated): Toulouse (16), Cambridge (15), Berlin (11), Washington (10, in five collections), London (9), Paris (8), Hamburg (4). Under types are included the different stages of each species which have been first described from the various collections.

Note: In the second column of the foregoing list the whereabouts of the collections is but briefly indicated:

Berlin	signifies	Entomologische Abteilung, Zoologisches Museum, Berlin.
Calcutta	,,	Entomological Department, Indian Museum, Calcutta.
Cambridge	,,	Collection of Professor G. H. F. Nuttall, F.R.S., Quick Laboratory, University of Cambridge.
Edinburgh	,,	Collection of Mr W. Evans, F.R.S.E., Edinburgh.
Hamburg	,,	Naturhistorisches Museum, Hamburg.
Harvard	,,	Museum of Comparative Zoology, Cambridge, Mass., U.S.A.
Katanga	,,	Special Committee's Collection, Katanga, Congo Free State.
Leyden	,,	Natural History Museum, Leyden, Holland.
London	,,	Entomological Department, British Museum (Natural History), Cromwell Road, London.
Paris (*a*)	,,	Musée d'histoire naturelle, rue Buffon, Paris.
,, (*b*)	,,	Laboratoire de Parasitologie, École de Médecine, Paris.
Pickard-Cambridge	signifies	Collection of Rev. O. Pickard-Cambridge, F.R.S., Wareham, Dorset, England.
Pretoria	signifies	Collection of Mr C. P. Lounsbury, Acting Union Entomologist, Union Department of Agriculture, Pretoria, Transvaal, S. Africa (late Government Entomologist, Cape Town).
St Petersburg	,,	Collection of Professor A. Birula, K. Akad. Wiss., St Petersburg.
Sjöstedt	,,	Collection of the Sjöstedt Zoological Expedition.
Toulouse	,,	Collection of Professor L. G. Neumann, Laboratoire d'Histoire naturelle, École Nationale Vétérinaire, Toulouse, France.
Washington (*a*)	signifies	Bureau of Animal Industry, U.S. Department of Agriculture, Washington, D.C.
,, (*b*)	,,	National Museum, Washington, D.C.
,, (*c*)	,,	Collection of Mr N. Banks, of the Bureau of Entomology, U.S. Department of Agriculture.
,, (*d*)	,,	Bureau of Entomology, U.S. Department of Agriculture.
,, (*e*)	,,	Collection of Dr A. Hassall, of the Bureau of Animal Industry, U.S. Department of Agriculture.

(The distribution of types in the collections in Washington is given by Hooker, 1909, pp. 423–425.)

PARASITOLOGY

A SUPPLEMENT TO THE

JOURNAL OF HYGIENE

Edited by GEORGE H. F. NUTTALL, F.R.S., Quick Professor of Biology in the University of Cambridge, and A. E. SHIPLEY, F.R.S., Master of Christ's College.

When the *Journal of Hygiene* was founded it was announced that papers on Parasitology "in relation to hygiene and preventive medicine" would be published in its pages. It has however been felt for some time that the Journal was becoming unduly burdened with papers dealing with the anatomy of mosquitoes, fleas, protozoa and other parasites—of great importance in themselves—but having only an indirect relation to hygiene and preventive medicine.

The remarkable development of parasitology in recent years, and the increase in our knowledge of the part played by parasites in human and animal diseases, demand a means of publication, in the English language, of original papers dealing with the subject in its widest sense. It is proposed in future to relegate all such papers to *Parasitology*.

Papers on the subjects we have mentioned are now scattered in journals of widely different character, into some of which they are but grudgingly admitted. We trust that *Parasitology* will fulfil the purpose the editors have in view, of encouraging the study of parasitology, especially in relation to disease, by providing a means for the publication of papers relating to pathogenic and disease-transmitting parasites.

It is therefore hoped that this publication will appeal not only to medical men at home and abroad, but to veterinarians, zoologists and agriculturalists.

Parasitology, though a supplement to the *Journal of Hygiene*, will be issued in the form of a separate yearly volume of four to five hundred pages. The parts will be issued when sufficient material has accumulated. The first three volumes are now ready. The subscription price is £1. 1*s.* per volume (post-free), payable in advance. *Subscribers to the Journal of Hygiene* may obtain single numbers of *Parasitology* at the reduced price of 5*s.* net, or may become subscribers at the reduced rate of 15*s.* Subscriptions may be sent to any Bookseller, or to MR C. F. CLAY, MANAGER, Cambridge University Press, Fetter Lane, London, E.C. (The Contents of the last number of *Parasitology* is given on the next page)

PARASITOLOGY (*continued*)

CONTENTS OF VOL. IV, NO. 1 (MARCH 1911)

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TICKS

A MONOGRAPH OF THE IXODOIDEA

By

GEORGE H. F. NUTTALL, M.A., M.D., Ph.D., Sc.D., F.R.S., Fellow of Magdalene College, Quick Professor of Biology, University of Cambridge
CECIL WARBURTON, M.A., F.Z.S., Christ's College, Zoologist to the Royal Agricultural Society
W. F. COOPER, B.A., F.Z.S., F.L.S., and L. E. ROBINSON, A.R.C.Sc. (Lond.), of the Cooper Laboratory for Economic Research, Watford

PART III

THE GENUS HAEMAPHYSALIS

BY

GEORGE H. F. NUTTALL, F.R.S., AND C. WARBURTON

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AT THE UNIVERSITY PRESS

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CONTENTS OF VOL. XV, NO. 1 (July 1915)

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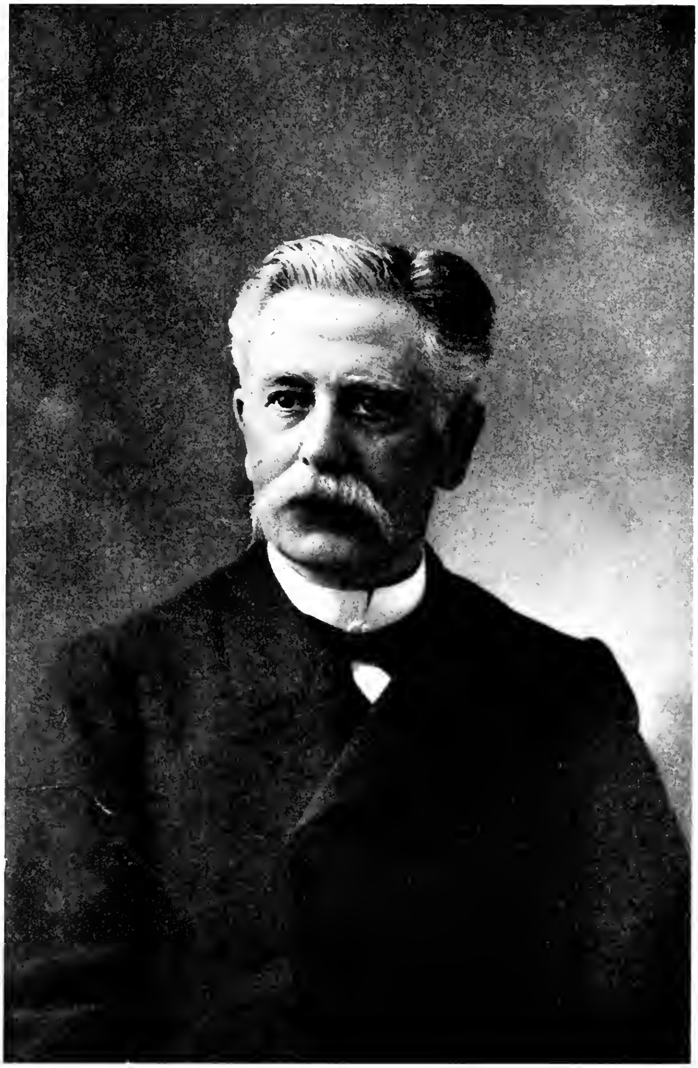

Prof. L.-G. NEUMANN of Toulouse

To whom we dedicate this fasciculus in grateful acknowledgment
of the help he has given us

TICKS

A MONOGRAPH OF THE IXODOIDEA

By

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L. E. ROBINSON, A.R.C.Sc. (Lond.), of the Cooper Laboratory for Economic Research, Watford

PART III

Cambridge:
at the University Press
1915

IXODIDAE

Part III. The Genus Haemaphysalis

by

GEORGE H. F. NUTTALL

and

CECIL WARBURTON

PREFACE TO PART III

WE have little to add to what has been stated in the Preface to Part II. The present fasciculus follows in order and deals with the genus *Haemaphysalis* of which we recognize 50 species and varieties; three species (*spinulosa*, *obtusa* and *numidiana*) being included although we are somewhat doubtful as to their validity. Many species hitherto regarded as valid are noted in our synonymic lists.

All of our descriptions are original; they include three new species and three new varieties, aberrant forms and numerous hitherto undescribed stages of known species.

The terms and signs used are the same as in Part II, pp. 127–132, to which the reader is referred.

Illustrations.

We again lay stress upon the illustrations. Those appearing in the six plates are republished from papers by Nuttall, Cooper and Robinson, and Nuttall respectively, and comprise 29 figures in addition to 144 figures in the text, making a total of 173 figures illustrating this Part. Of these figures, 24 are taken from other authors, the impressions being made from the original blocks. The majority of the new text-figures were drawn under our direction by Mr N. Cunliffe.

The genus *Haemaphysalis* has been very poorly illustrated hitherto and we have sought to make good this deficiency, many species, including their immature stages, being now figured for the first time.

Of the 72 new text-figures	45	were drawn by	N. Cunliffe
	24	,, ,,	G. H. F. Nuttall
	2	,, ,,	N. Cunliffe and E. Wilson
	1	was drawn by	C. Warburton
Of the 72 previously published text-figures	21	are from publications by	C. Warburton
	21	,, ,,	L. G. Neumann
	17	,, ,,	C. Warburton and G. H. F. Nuttall
	9	,, ,,	G. H. F. Nuttall
	2	,, ,,	W. Dönitz
	1	is from a publication by	L. E. Robinson
	1	,, ,,	Nuttall, Cooper and Robinson
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Most of the figures were drawn to scale, others, not so drawn, are described as "sketches."

Acknowledgments.

We gratefully acknowledge the generous gift of £100 from Mr and Mrs P. A. Molteno towards the expenses of publishing this work.

We are especially indebted to the following gentlemen and institutions for access to material: Professor L.-G. Neumann (lately of Toulouse) has kindly lent us all of his types and has presented us with co-types wherever possible in exchange for similar specimens from our collection. We have to thank Dr L. Lavarra (Rome), Professor Gestro (Genoa Museum), Professor A. Brauer (Berlin Museum), Professor S. Schenkling (Deutsches Entomologisches Museum, Berlin-Dahlem) and Mr S. Hirst (British Museum) for the gift of co-types. We have received numerous specimens from the Imperial Bureau of Entomology (Mr Guy A. K. Marshall, Secretary) and from the many gentlemen whose names are mentioned as collectors in the text.

The bracketed numbers accompanying the records of specimens from different countries relate to catalogues in particular collections severally indicated by a letter or the name of the collection before the number. Thus all numbers preceded by "N" relate to specimens in our collection; those preceded by "E" relate to specimens received for identification from the Imperial Bureau of Entomology, London. Other collections we have examined and determined are as follows: (Ashworth) = Dr J. H. Ashworth, Zoological Department, University of Edinburgh; (Berlin Mus.) = Zoologisches Museum, Berlin; (D.E.M.) = Deutsches Entomologisches Museum, Berlin-Dahlem; (Genoa Mus.) = Museo Civico di Storia Naturale, Genoa; (Gowdey) = Mr C. C. Gowdey, Government Entomologist, Entebbe, Uganda; (Ind. Mus.) = Indian Museum, Calcutta; (K.) = Mr N. B. Kinnear, Bombay Natural History Society; (Knuth) = Professor Knuth, Tierärztliche Hochschule, Berlin; (Liverpool) = Liverpool School of Tropical Medicine; (Schüffner) = Dr W. Schüffner, Deli, Sumatra; (Sweet) = Dr Georgina Sweet, University of Melbourne, Australia. Where two numbers are connected by = (thus E. 692 = N. 3153) the sign indicates that the specimens have been divided between the two collections E. and N.

As stated in Part II, we shall be grateful to readers who may draw our attention to any errors and omissions.

G. H. F. N.
C. W.

CAMBRIDGE,
September, 1915.

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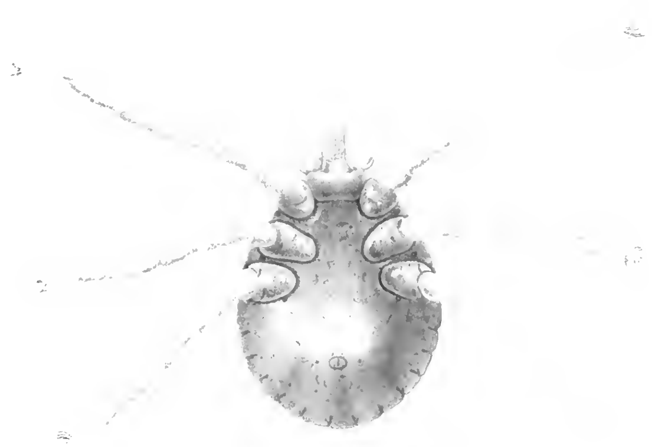
OF

PART III

II. THE GENUS *HAEMAPHYSALIS* C. L. KOCH, 1844.

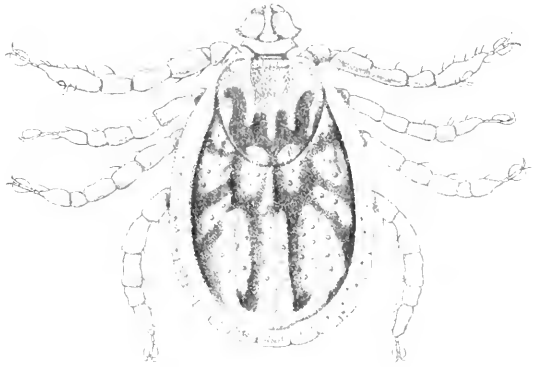
dorsal aspect



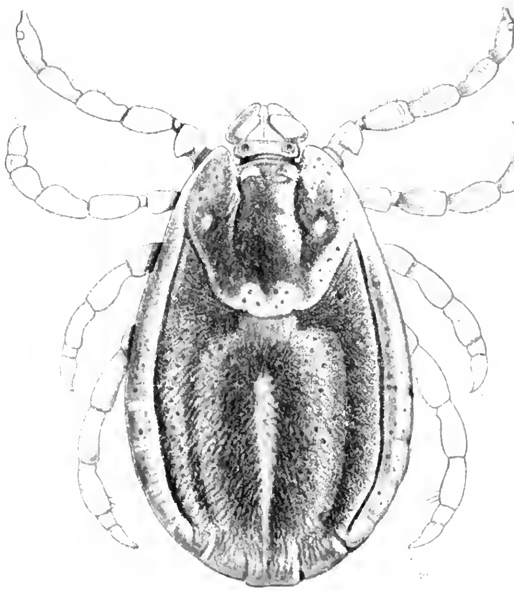
ventral aspect

E. Wilson, Cambridge.

HAEMAPHYSALIS PUNCTATA Can & Fan
THE LARVA



Nymph



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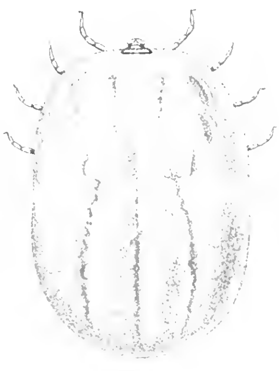
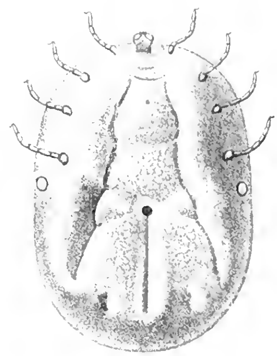
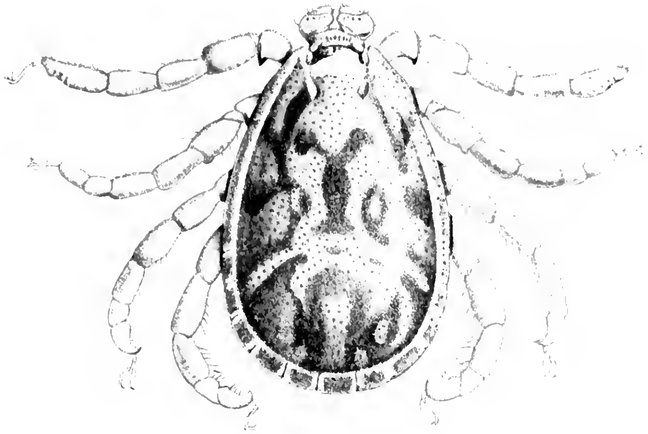




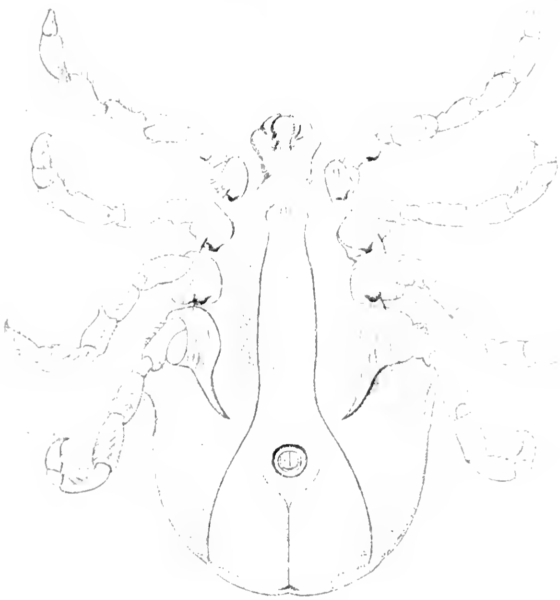
dorsal aspect Female *(replete)* *ventral aspect*

HAEMAPHYSAL

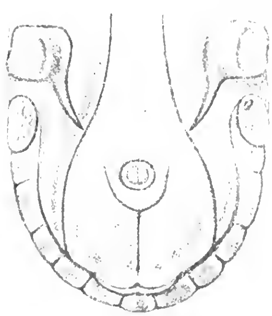
PLATE IX



Male



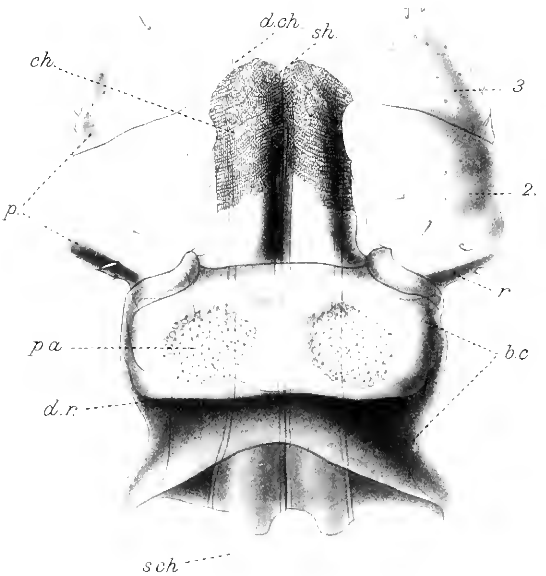
Male *(replete)*



Male *(unfed)*

NCTATA Can. & Fan.

...lith. Cambridge



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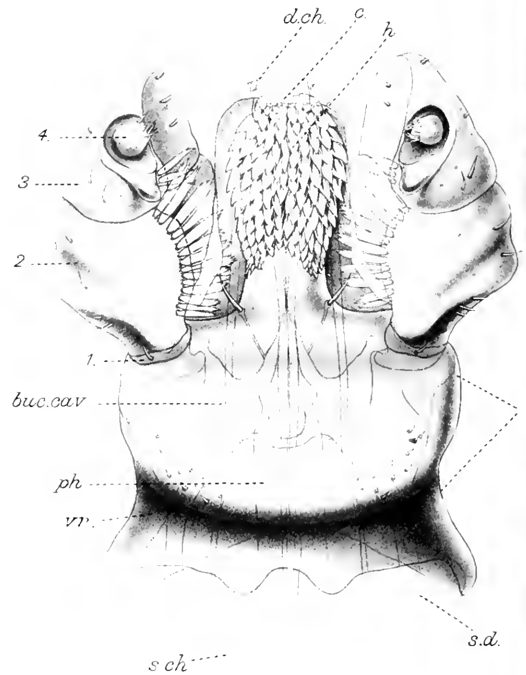

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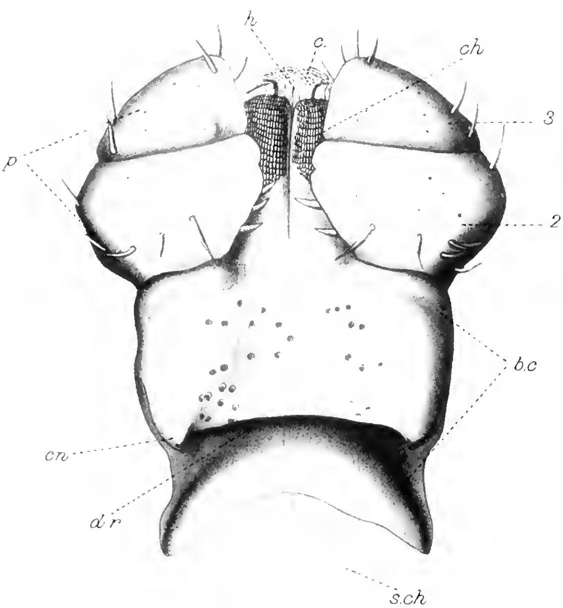
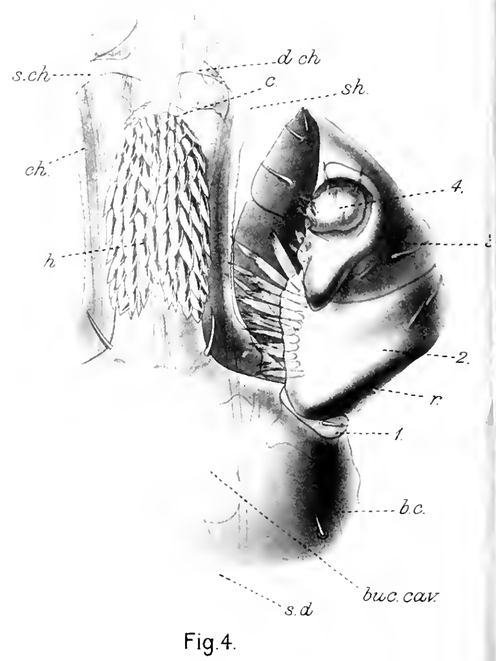


L E R. and J.Ford del

Fig.3.



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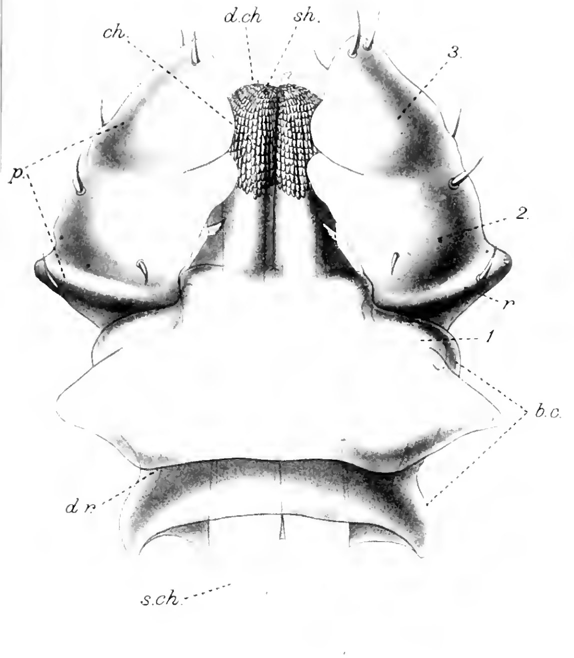

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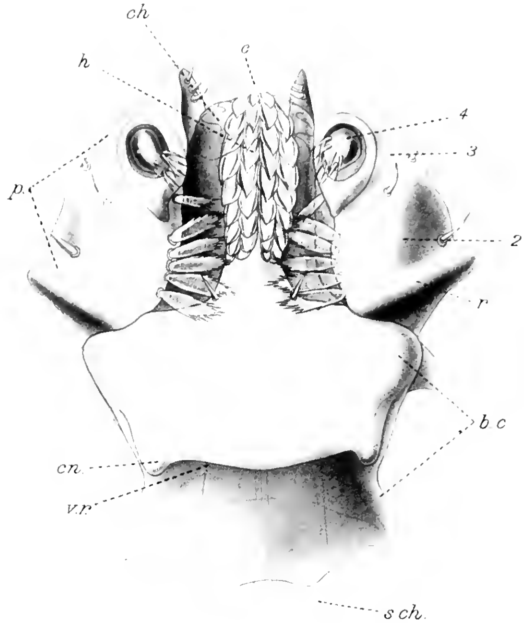

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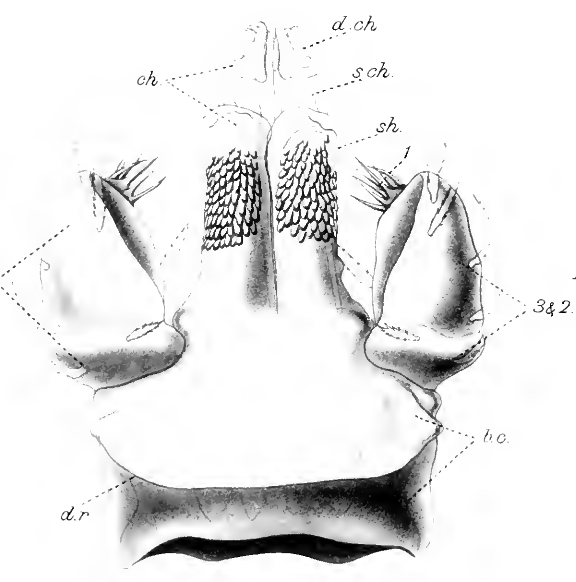

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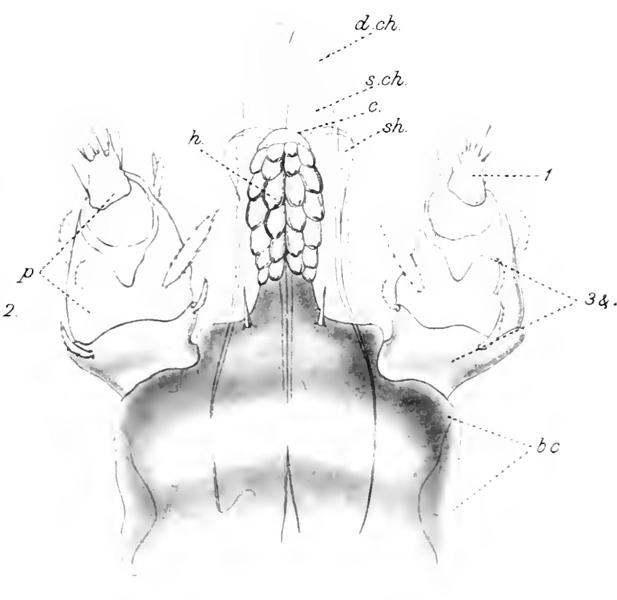
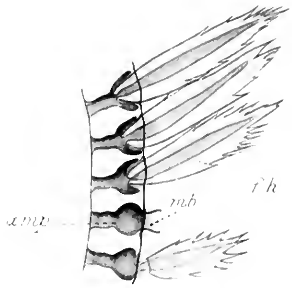


Fig.8.

Morgan & Kidd Richmond Colloty



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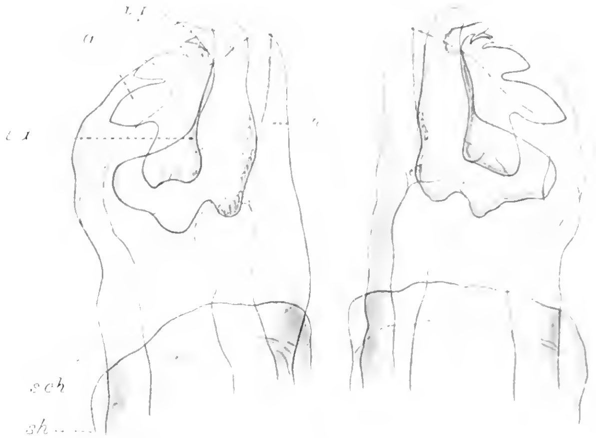

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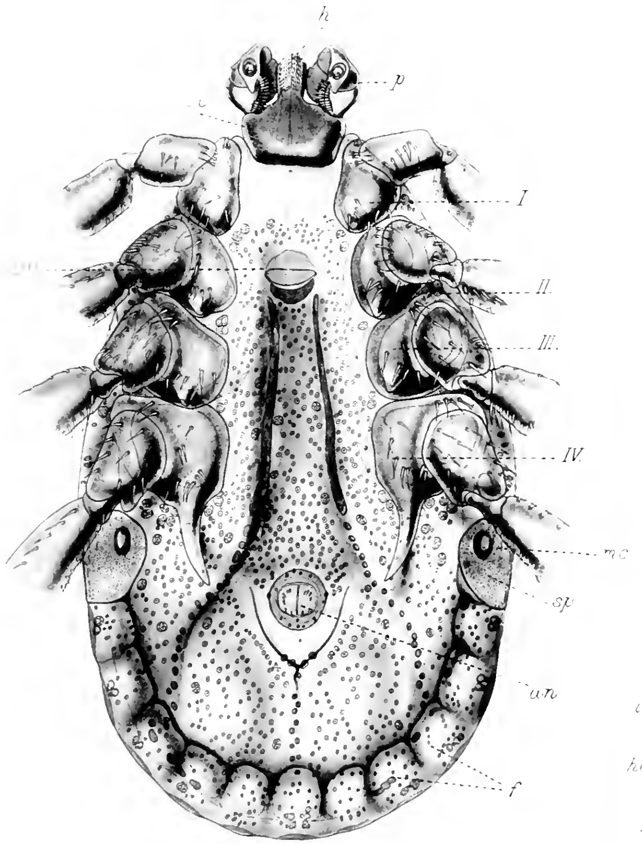

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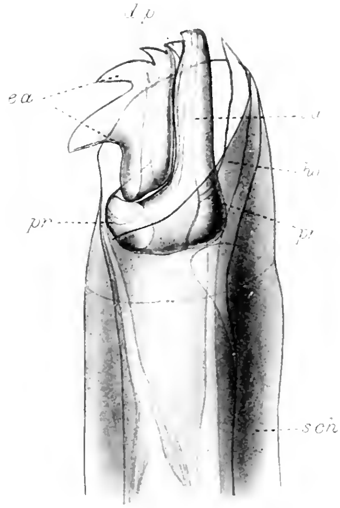

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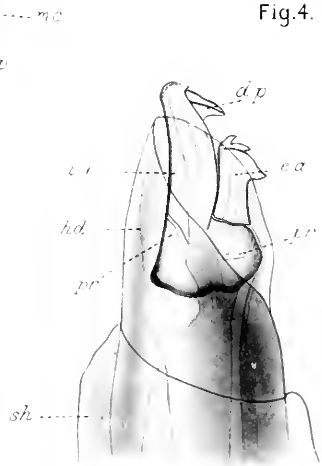

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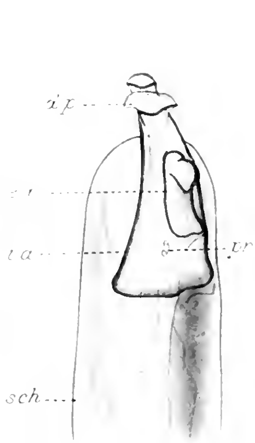

Fig. 6.

J.E.R. and J. Ford del.

Morgan & Kidd Richmond Collotype

Fig. 1

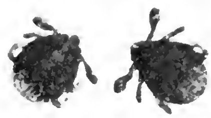

Fig. 2

Fig. 3

Fig. 4

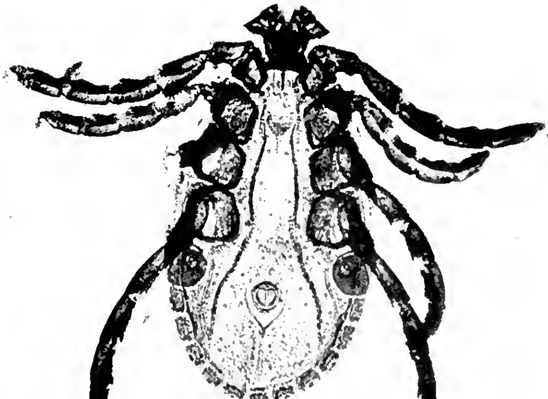

Fig. 5

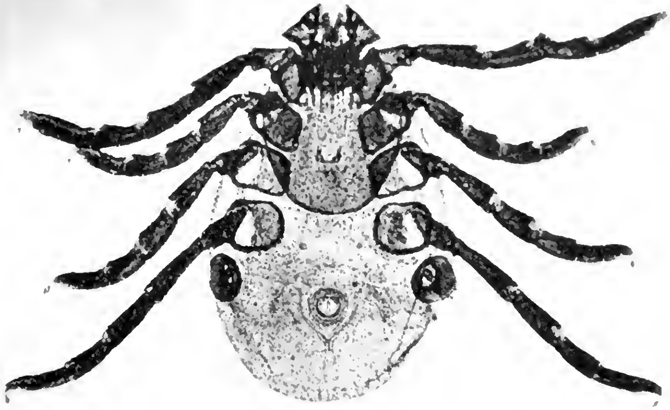

Fig. 1

Fig. 2

LIST OF ILLUSTRATIONS

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Larva: dorsal and ventral aspects, × 62.
Drawn from living specimen by J. Ford.

Plate IX. *Haemaphysalis cinnabarina* var. *punctata*

Nymph in dorsal aspect, × 30.
Female unfed, in dorsal aspect, × 20.
,, gorged, in dorsal aspect, × 5 detail of surface more highly magnified to left.
,, gorged, ventral aspect, × 5. Spiracle to right.
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,, replete, ventral aspect, × 20.
,, unfed. Posterior portion of ventral surface, showing appearance of festoons for comparison with those of the replete male, × 20.
Drawn from living specimens by E. Wilson.

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Fig. 4. ,, ,, ,, median portion with left palp, in ventral aspect, × 125.
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Fig. 6. ,, ,, ,, ventral aspect, × 220.
Fig. 7. ,, ,, Larva, dorsal aspect, × 400.
Fig. 8. ,, ,, ,, ventral aspect, × 400.

[1] N.B. Plates VIII—XI are reprinted from Nuttall, Cooper and Robinson, vi. 1908 (Pls. VIII and XI); Plates XII and XIII are reprinted from Nuttall, iv. 1904 (Pls. XII and XIII).

IN THE TEXT

Genus II. HAEMAPHYSALIS C. L. Koch, 1844.

Synonymy and Literature.

The following references only relate to publications which deal with the *genus* or cognate matters.

Ixodes 1827. Audouin, p. 428 (*I. leachii* = *H. leachi*).——**1849.** Gervais, p. 49 (*I. lagotis* = *Haemaphysalis* sp.).——**1869.** Packard, p. 67 (*I. chordeilis* = *H. cinnabarina* Koch ; *I. leporis-palustris* = *H. leporis-palustris*).——**1880.** Mégnin, p. 132 (*I. chelifer* = *H. concinna* Koch ♂). See further under our list of condemned species.

Haemaphysalis 1844. Koch, p. 237 (genus first defined. Four species : 1 *H. rosea*, 2 *cinnabarina*, 3 *sanguinolenta*, and 4 *concinna*, of which *cinnabarina* and *concinna* are good species).——**1847.** Koch, p. 25.——**1877.** Canestrini and Fanzago, p. 110 ; Murray, p. 199.——**1890.** Canestrini, pp. 483, 493.——**1892.** Canestrini, p. 581 ; Marx (*a*), p. 233, (*b*), p. 283 ; Trouessart, p. 47.——**1895.** Railliet, p. 714 (nothing original).——**1897.** Neumann, pp. 326, 358 (key for determination) ; Supino, pp. 241, 243.——**1900.** Ward (*a*), p. 200 (nothing original).——**1901.** Salmon and Stiles, pp. 457–459, figs. 219–221 (from Neumann, 1897 ; they give short generic diagnosis, synonymy, bibliography and translation of Neumann's key).——**1905.** Lahille, pp. 14, 15, 44, 154.——**1906.** Buy, p. 118 (generic characters tabulated) ; Wheler, p. 420.——**1907.** Dönitz, pp. 15, 67, 111 ; Hunter and Hooker, p. 52 (incomplete generic diagnosis) ; Pocock, p. 190 (key to genera of ticks) ; Warburton (*a*), p. 92, pl. VII, fig. 2 (classification briefly treated).——**1908.** Banks, pp. 13, 20, 32 ; Bonnet, p. 259 (condensed from Neumann), figs. 28–30 (poor) ; Nuttall (VII), p. 16 (oviposition described and figured) ; Nuttall, Cooper and Robinson, p. 155 ; Warburton (IV), p. 508 (difficulties of classification discussed).——**1909.** Blanchard, pp. 145–147 (generic characters defined, key to species following Neumann) ; Hunter (VI), p. 255 (thinks ground birds disseminate immature stages) ; Rohr, p. 141 (nothing original, quotes Neumann and Aragão).——**1911.** Neumann (*a*), p. 105 (gives key to 13 species recognised as valid together with brief notes on 13 doubtful species ; four species comprise nine subspecies) ; Nuttall, p. 67 (habits of ticks in relation to hosts ; behaviour of male considered) ; Nuttall and Merriman, p. 44 (males of this genus, in common with other Metastriate ticks, have a chitinous flap over the sexual orifice) ; Nuttall and Warburton, p. 119 (of this book ; generic characters freshly defined and figured).——**1912.** Hooker, Bishopp and Wood, p. 89 (nothing original) ; Warburton (VII), p. 122 (generic characters discussed).——**1913.** Nuttall, p. 195 (structure of hypostome and variability observed in the genus) ; Patton and Cragg, p. 627 (genus defined and key for determination taken from Neumann, 1911 *a*).

Wrongly spelt *Haemophysalis* by Canestrini, 1884, p. 113, and by a few other authors.

Haemaphysalis concinna Koch, designated as the *type* of the genus by Neumann, 1901, p. 340.

Rhipistoma 1844. Koch, p. 239 (two species: 1 *R. leachii*, 2 *R. ellipticum*).——**1847.** Koch, p. 27 (but on p. 135 *R. ellipticum* is transferred to the genus *Rhipicephalus*; both *ellipticum* and *leachii*, however, = *Haemaphysalis leachi* (Audouin, 1827).——**1861.** Fürstenberg, p. 208.——**1878.** Karsch, p. 337 ("*R. leachii*").——**1888.** Dugès, p. 129.——**1890.** Canestrini, p. 483.——**1892.** Marx (*a*), p. 233; (*b*), p. 283.——**1896.** Osborn, p. 261 (*R. leporis* which = *Haemaphysalis leporis-palustris* (Packard, 1869)).——**1897.** Neumann, p. 326 (given as a synonym of *Haemaphysalis*).——**1901.** Salmon and Stiles, p. 457 (follow Neumann as do also subsequent authors).

Wrongly spelt *Rhipidostoma* by Karsch, 1878; Dugès, 1888; also misspelt *Rhiphistoma* by Osborn, 1896, and the authors who quote him and the spelling of the foregoing writers.

Rhipistoma leachii Koch, may well be designated as the *type* of the genus although *R. ellipticum* might serve as well; since they are synonymous. Salmon and Stiles, 1901, p. 457, cite Marx as if he had designated "*H. leachii*" as the type, but he did not do so.

Rhipicephalus 1847. Koch, p. 135 (*R. llipticus* = *H. leachi*).——**1877.** L. Koch (*b*), p. 196 (*R. expositicius* = most probably *H. cinnabarina* var. *punctata* (Canestrini and Fanzago, 1877).

Gonixodes 1888. Dugès, p. 129.——**1897.** Neumann, p. 343 (as a synonym of *Haemaphysalis*; subsequent authors agree with Neumann. *Gonixodes rostralis* Dugès, the only species = partly *Haemaphysalis leporis-palustris* (Packard, 1869)).

Herpetobia 1890. Canestrini, pp. 486, 493, 527.——**1891.** Canestrini, p. 719.——**1897.** Neumann, pp. 327, 329 (as a synonym of *Haemaphysalis*; we agree with Neumann. *Herpetobia sulcata* Canestrini, the only species = probably *Haemaphysalis cinnabarina* var. *punctata* (Canestrini and Fanzago, 1877); immature stages which Canestrini, 1891, p. 719, supposed might prove to belong to one of the already established genera).

Opisthodon 1897. Canestrini, p. 468 (*O. cuscobius* the *type* = *H. cuscobia*, a nominal species). Supino (*a*) and (*b*), p. 252, gives the following 3 species: 1 *O. asiaticus*, which Neumann regards as a nominal species: we have examined the type and find it to be *H. leachi*; 2 *O. canestrinii*, and 3 *O. gestroi* Supino = likewise *H. leachi*. Neumann, 1897, p. 326, gives *Opisthodon* as a synonym of *Haemaphysalis*, with which we agree.

Wrongly spelt *Opistodon* by Wheler, 1906, p. 420, and other authors.

Prosopodon 1897. Canestrini (*a*), p. 417 (name proposed as a substitute for *Opisthodon* which the author found to be preoccupied; one species, *P. cuscobius* = merely a nominal species). Merely listed by Blanchard, 1909, p. 150, and Neumann, 1911*a*, p. 105.

Not **Pseudixodes** Haller, 1882, p. 311, as stated by Canestrini, 1890, pp. 485–526.

GENERIC CHARACTERS: Metastriata, *i.e., with anal grooves embracing the anus posteriorly. Usually of small size.* Scutum inornate and without eyes, *and in the female, without lateral grooves.* Capitulum *with base sub-rectangular, and with palps normally short and conical, broadest near the posterior end of article 2, which (except in rare cases) projects laterally beyond the base. Sexual dimorphism slight, the male possessing no ventral plates or shields. Coxa I never bifid; trochanter I with a blade-like dorsal retrograde process.*

The chief difficulties presented by the genus *Haemaphysalis* arise from the absence of characteristics—such as eyes, colour-markings, anal armature in the ♂, etc.—which are of great specific value in other genera. The prevailing colour is yellow, in ungorged specimens, and the general integument is rather highly chitinised, so that those structures which in most ticks are conspicuous by their comparative

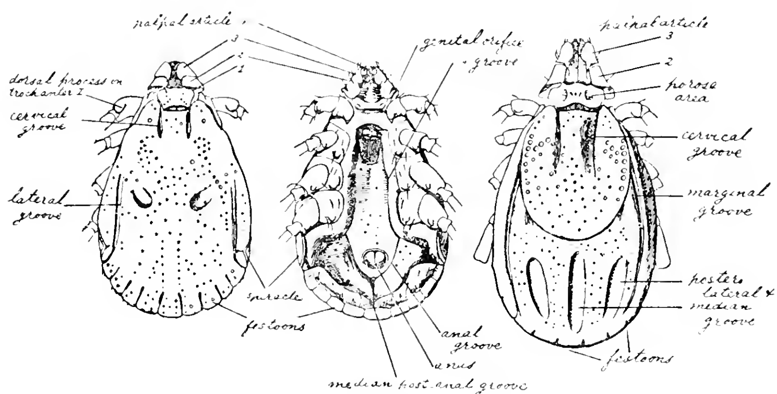


Fig. 308. *Haemaphysalis wellingtoni* ♂ in dorsal and ventral aspects, ♀ in dorsal aspect. (Reprinted from Part II, Fig. 120.) To show the generic characters and nomenclature of parts.

hardness stand out in less salient relief. Thus, the scutum of an unfed nymph is sometimes only visible after rather close examination. The capitulum is in most cases much alike in the ♂ and ♀ so that in many species identification is almost equally easy from either sex. There are exceptional cases, however (e.g. *H. concinna*, *H. cornigera*, etc.), in which the ♂ palps have striking peculiarities not found in those of the ♀. The sexes are more frequently dimorphic as regards the coxal armature. Wherever the coxal spines are strongly developed in the ♂ their peculiarities are only very faintly echoed in the ♀. There is what may be considered a normal coxal armature to which a large number of species of *Haemaphysalis* conform in both sexes (Fig. 360). It consists of a moderate internal spur on coxa I (which is subtriangular), a slight spur at the middle of the posterior borders of coxae II and III, and at the internal angle of coxa IV. If a ♀ specimen possesses anything more pronounced than this in the way of coxal armature it is pretty certain that the ♂ coxae will be unusually spinose.

All species of *Haemaphysalis* have a blade-like dorsal retrograde spur on trochanter I. Some species have *ventral* retrograde spurs on all or some of the trochanters, and these are excellent specific characters usually to be found both in the ♂ and in the ♀. Many forms have a hardly perceptible prominence in that position, but we shall only speak of the trochanters as "spurred" if this characteristic is readily recognizable.

Species belonging to the genus *Haemaphysalis* are less readily identified than *Ixodes* by means of a dichotomic key, because, as already stated, there are few salient features which serve to differentiate them. The diagnosis has frequently to be based on numerous minor points which, in the aggregate, permit of the identification of a species, due regard being paid to individual differences which may be fairly marked. Stress must be laid for this reason upon accurate figures to accompany the text.

Although Neumann (1901, p. 340) designated *H. concinna* Koch as the *type* of the genus, the ♂ of this species is atypical in that its palps are unlike those of any other member of the genus. Of the four species originally included by Koch, who founded the genus *Haemaphysalis*, only a second species, *H. cinnabarina*, remains which would take priority over *H. concinna* and might, with better right, be designated as the type of the genus.

We have attempted a linear arrangement of the species, beginning with atypical forms like *H. inermis*, with the palps simple and non-salient laterally, and proceeding by degrees to species like *H. dentipalpis* with complex, strongly salient palps. No such arrangement can be more than partially successful, but it is hoped that nearly allied species will in most cases be found in tolerably close juxtaposition.

Key for the determination of species of Haemaphysalis[1].

Some varieties are included under the type, others are directly determinable by the key. The species which include varieties are indicated by (*v*) after the specific name. There are 45 species and varieties whose ♂s are known.

Males.

			PAGE
	Palps not salient laterally, i.e. no wider than the basis capituli	1	
	Palps more or less salient laterally	2	
1.	No lateral grooves or cornua, dentition 2 | 2 (Europe, Transcaucasia)	*inermis*	362
	Lateral grooves and cornua, dentition 4 | 4 (Asia)	*warburtoni*	369
2.	No lateral grooves	3[2]	
	Lateral grooves present	5	
3.	Palpal article 2 with marked lateral salience curving forwards (Malaya)	*vidua*	495
	Palpal article 2 only slightly salient and scarcely larger than article 3	4	
4.	Palpal article 3 with dorsal retrograde spur (Asia)	*hystricis*	422
	„ „ 3 without spur (Burma)	*birmaniae*	415
5.	Coxal spurs normal and inconspicuous	16	
	One or more coxae strongly spurred	6	
6.	All the coxae with strong subequal spurs	7	
	Coxae II and III only feebly spurred	10	
7.	All trochanters with ventral spurs	8	
	Only trochanters I and II spurred; tarsi humped (Africa)	*calcarata* (*v*)	442, 444
8.	Palpal article 2 much longer than 3; body protruding behind scutum (Madagascar)	*elongata*	498
	Palpal articles 2 and 3 sub-equal, each with a ventral retrograde spur	9	

[1] For explanations of terms and signs used see pp. 127–132 (*Ticks* Part II), and p. 361.

[2] See *H. obtusa*, from Réunion, which is *leachi*-like in other particulars.

			PAGE
9.	Palpal article 2 with external spur, on lateral salience (Borneo)	*calvus*	445
	Palpal article 2 with spur at internal angle (India)	*montgomeryi*	395
10.	Coxa IV with 2 long spurs close together (Asia)	*cornigera* (*v*)	501
	„ „ „ 1 long spur	11	
11.	Coxae I and IV with long spurs (India, Ceylon, Judea)	*spinigera* (*v*)	447
	Only coxa IV with a long spur	12	
12.	Lateral grooves long	13	
	„ „ short	14	
13.	Palps rounded laterally, very short (Europe, N. Africa, Asia Minor, Transcaucasia) . .	*cinnabarina* var. *punctata*	380
	Palps salient laterally, curving forwards (America)	*cinnabarina*	373
14.	Palpal article 2 with ventral spur (New Guinea, Queensland) . . .	*spinigera* var. *novae-guineae*	449
	Palpal article 2 without spur	15	
15.	Coxa IV with needle-like spur; palpal article 3 as broad as 2 (Africa)	*aciculifer*	411
	Coxa IV with stouter and more tapering spur; palpal article 2 broader than 3 (Asia) .	*flava*	408
16.	Palpal article 3 with dorsal spur, more or less erect	17	
	„ „ 3 with no such spur	21	
17.	Lateral grooves very short (Africa)	*parmata*	418
	„ „ fairly long	18	
18.	Cornua very strong, as long as basis capituli .	19	
	„ moderate	20	
19.	Palpal article 2 very long, much longer than 3 (India, Ceylon)	*aculeata*	440
	Palpal articles 2 and 3 sub-equal (Ceylon) .	*cuspidata*	438
20.	Scutum long-oval, finely punctate (Asia, E. Africa, N. S. Wales)	*bispinosa* (*v*)	427, 433
	Scutum somewhat truncate posteriorly, coarsely punctate, a small species (India, Ceylon) .	*parva*	435

PAGE

21. Palps pincer-like, article 3 being long and incurved (Europe) . . . . . . *concinna* 453
Palps otherwise 22

22. Palpal article 2 with several processes at posterior margin (Malaya) . . . . . *dentipalpis* 505
Palpal article 2 otherwise 23

23. Palps only slightly salient laterally, articles 2 and 3 sub-equal 24
Palps strongly salient at the base of article 2 . 28

24. Trochantal spurs strong; lateral grooves very short (Ceylon) . . . . *turturis* 410
Trochantal spurs absent or inconspicuous . . 25

25. Scutum with surface irregular, very coarsely punctate[1] (Asia) . . . . *papuana* 404
Scutum otherwise 26

26. Lateral grooves very short; palpal article 3 with very strong ventral spine (S. America) . *kochi* 413
Otherwise 27

27. Hypostome 6 | 6; trochantal spurs very slight (Formosa, Burma) . . . . . . *formosensis* 400
Hypostome 5 | 5; trochantal spurs absent (Japan) *japonica* (*v*) 402, 403

28. Basis capituli with ventral cornua; hypostome 3 | 3 (N. and S. America) . . . . . *leporis-palustris* 388
Basis capituli without ventral cornua; hypostome with more teeth 29

29. Scutum markedly elongate 30
„ short-oval 32

30. Each palp long and narrow (Australia) . . . *humerosa* 496
„ „ conical, article 2 being broad basally . 31

31. Lateral grooves very short; tarsi humped (Madagascar) . . . . *simplex* 458
Lateral grooves long; tarsi tapering (Africa, Asia, N. S. Wales) . . . . . . *leachi*[2] 462

[1] Regarding an atypical form from Malaya which is devoid of coarse punctations, see p. 405.

[2] See also *H. numidiana*, from Algeria, p. 478.

			PAGE
32.	Palpal article 3 recurved to a point at postero-internal angle	33	
	Palpal article 3 straight along posterior border .	34	
33.	Lateral contour of palp much curved (Africa)	*hoodi* (*v*)	483
	or (Australia)	*bancrofti*[1]	487
	Lateral contour of palp nearly straight (a very small species, Asia)	*wellingtoni*	479
34.	Lateral salience of palp projecting almost at a right angle (small species, Singapore) .	*doenitzi*	482
	Lateral salience a gentle curve, capitulum bell-shaped	35	
35.	Hypostome 6 | 6; tarsi tapering (India) . .	*howletti*	493
	„ 4 | 4; tarsi humped (Asia) . .	*campanulata*	491

Females.

There are 41 species and varieties of which the ♀s are known.

	Palps not salient laterally, no wider than basis capituli	1	
	Palps more or less salient laterally . . .	3	
1.	Tarsi humped; coxal spurs rather strong and blunt (Asia)	*warburtoni*	370
	Tarsi not humped; coxal spurs small and pointed	2	
2.	Hypostome 3 | 3 (Transcaucasia, Caucasia, France)	*inermis* (*v*)	364, 367
	„ 4 | 4 (Formosa, Burma)	*formosensis*	401
3.	Trochantal spurs distinct	4	
	„ „ feeble or absent . . .	8	
4.	Trochanters all spurred	5	
	Distinct spurs on some trochanters only . .	7	
5.	Scutum broader than long (Borneo) . . .	*calvus*	446
	„ longer than broad	6	
6.	Palps strongly salient; hypostome 3 | 3 (Madagascar)	*elongata*	500
	Palps very slightly salient; hypostome 5 | 5 (India)	*montgomeryi*	396

[1] These two species should be differentiated by reference to the descriptions.

			PAGE
7.	Trochanters: only I and II bear conspicuous spurs (Africa)	*calcarata* (*v*)	443
	Trochanters: only II and IV bear conspicuous spurs (India)	*howletti*	494
8.	Palpal article 3 with distinct dorsal spine, more or less erect	9	
	Palpal article 3 without dorsal spine, but posterior border may protrude	14	
9.	Palpal article 2 much longer than 3 (India, Ceylon)	*aculeata*	441
	Palpal articles 2 and 3 sub-equal	10	
10.	Lateral salience of palpal article 2 with ventral retrograde process (India, Ceylon, Judea)	*spinigera* (*v*)	448
	Lateral salience of palpal article 2 without such a process	11	
11.	Dorsal spine on palpal article 3 very strong; cornua very strong (Ceylon)	*cuspidata*	438
	Dorsal spine on palpal article 3 moderate; cornua moderate	12	
12.	Scutum longer than broad (chiefly Asia)	*bispinosa* (*v*)	428, 433
	or (India, Ceylon)	*parva*[1]	436
	„ at least as broad as long	13	
13.	Basis capituli thrice as broad as long, broadest posteriorly (Africa)	*parmata*	419
	Basis capituli twice as broad as long, rectangular (Asia)	*hystricis*	424
14.	Scutum much longer than broad	15	
	„ only slightly or not longer than broad	19	
15.	Palp with lateral salience protruding sharply almost at right angles to axis (Singapore)	*doenitzi*	483
	„ with lateral contour straight or only slightly curved	16	
16.	Palp much longer than broad	17	
	„ short cone-shaped, as broad as long (Africa, Asia, N. S. Wales)	*leachi*[2]	464

[1] Not at present distinguishable in the ♀.

[2] See also *H. spinulosa*, from Uganda (p. 476) and *H. numidiana*, from Algeria (p. 478).

			PAGE
17.	Capitulum base with ventral cornua; hypostome 3 | 3 (N. and S. America)	*leporis-palustris*	390
	Capitulum base normal; hypostome with more teeth	18	
18.	Lateral grooves very long; hypostome 5 | 5 (Australia)	*humerosa*	497
	Lateral grooves half the scutal length; hypostome 4 | 4 (Asia)	*wellingtoni*	479
19.	Palpal article 3 as broad or broader than article 2	20	
	„ „ 3 distinctly narrower than article 2	21	
20.	Scutum broader than long; tarsi very long (Abor Country)	*aborensis*	398
	Scutum cordate; tarsi moderate (Africa)	*aciculifer*	412
21.	Scutum broadest in front; porose areas large	22	
	„ „ „ middle; porose areas moderate	23	
22.	Palps rounded laterally (Europe, N. Africa, Asia Minor, Transcaucasia)	*cinnabarina* var. *punctata*	381
	Palps with more pronounced lateral salience procurved (America)	*cinnabarina*	374
23.	Hypostome 6 | 6 (Europe)	*concinna*	454
	„ less than 6 | 6	24	
24.	Palpal article 3 with distinct ventral spur	25	
	„ „ 3 „ no spur or at most a slight point	30	
25.	Palpal article 2 widest distally (India)	*kinneari*	397
	„ „ 2 „ basally	26	
26.	Scutum cordate, narrowing posteriorly; tarsi humped (Asia)	*campanulata*	492
	Scutum sub-circular or with sides sub-parallel; tarsi tapering	27	
27.	Coxa I with long sharp spur (Asia)	*cornigera*	503
	„ I „ slight spur	28	
28.	Basis capituli thrice as broad as long; porose areas far apart	29	
	Basis capituli twice as broad as long; porose areas reniform, closer together (Brazil)	*kochi*	414

			PAGE
29.	Scutum finely punctate; cervical grooves shallow (Africa)	*silacea*	416
	Scutum coarsely punctate; cervical grooves deep (Asia)	*papuana*	406
30.	Palps rounded laterally, widest at middle of article 2 (Asia)	*flava*	409
	Palps with strong lateral salience at base of article 2	31	
31.	Palpal article 2 with posterior border straight and horizontal (Africa)	*hoodi* (*v*)	484
	Palpal article 2 with posterior border contour broken (Australia)	*bancrofti*	489

Nymphs.

There are 19 species and varieties of which the Os are known.

	Palps narrow basally, not salient laterally (Europe, Transcaucasia)	*inermis*	365
	Palps salient laterally beyond the basis capituli .	1	
1.	Body very elongate and narrow; palpal article 2 produced backward (Australia)	*humerosa*	497
	Otherwise	2	
2.	Basis capituli with ventral cornua	3	
	„ „ without ventral cornua . . .	5	
3.	Basis capituli rectangular (N. and S. America) .	*leporis-palustris*	391
	„ „ with pointed projecting sides .	4	
4.	Occurring in Europe, N. Africa, Asia Minor, Transcaucasia	*cinnabarina* var. *punctata*	382
	Occurring in N. and S. America	*cinnabarina*	375
5.	Palp with lateral salience slight, articles 2 and 3 sub-equal	6	
	Palps with lateral salience marked	10	
6.	Cornua very strong (Ceylon)	*cuspidata*	439
	„ inconspicuous	7	
7.	Palpal article 3 longer than 2 (Asia)	*wellingtoni*	481
	„ „ 2 at least as long as 3	8	

			PAGE
8.	Scutum broader than long (Africa)	*parmata*	420
	„ sub-circular	9	
9.	Basis capituli shorter than palps; lateral palpal salience rounded (Asia)	*papuana*	406
	Basis capituli as long as palps, lateral salience pointed (Asia, E. Africa, New South Wales)	*bispinosa*	430
		or (India, Ceylon) *parva*	437
10.	Palp with lateral salience bearing a ventral retrograde point	11	
	„ without such a point	13	
11.	Coxal spurs distinct and sharp (Africa) . . .	*calcarata*	443
		or *c.* var. *houyi*[1]	445
	„ „ weak and inconspicuous	12	
12.	Refer to Figure (Africa, Asia, N. S. Wales) .	*leachi*	465
	„ „ „ (New Guinea, Queensland) .	*spinigera* var. *novae-guineae*	450
13.	Trochantal spurs present (Queensland) . . .	*bancrofti*	490
	„ „ absent	14	
14.	Basis capituli with sides rounded; no cornua (Europe)	*concinna*	455
	Basis capituli rectangular; with distinct cornua .	15	
15.	Tarsi humped (Madagascar)	*simplex*	458
	„ otherwise (Africa)	*hoodi*	485

Larvae.

We know the larvae of 14 species and varieties. All known larvae have hypostomes with dentition 2 | 2.

	Basis capituli with ventral cornua (America)	*leporis-palustris*	391
	Basis capituli otherwise	1	
1.	Palps, when joined, forming an obtuse angle (Africa, Asia, N. S. Wales)	*leachi*	465
	Palps otherwise	2	
2.	Palpal article 2 not protruding laterally (Europe, Transcaucasia)	*inermis*	365
	Palpal article 2 protruding	3	

[1] *H. calcarata* var. *houyi* has a slight ventral spur on trochanter I which is not discoverable in the type ♂.

			PAGE
3.	Basis capituli without distinct cornua	4	
	,, ,, otherwise	6	
4.	Basis capituli without projecting lateral angles	5	
	,, ,, with projecting lateral angles (Europe, N. Africa, Asia Minor, Transcaucasia)	*cinnabarina* var. *punctata*	383
	or (America)	*cinnabarina*	375
5.	Basis capituli with posterior border straight (Europe)	*concinna*	456
	(Asia, E. Africa, N. S. Wales)	*bispinosa*	431
	(Africa)	*parmata*	420
	(India, Ceylon)	*parva*	437
	Basis capituli with posterior border concave (Asia)	*wellingtoni*	481
6.	Coxa I spinose	7	
	,, I with blunt tuberosity (Africa)	*hoodi*	485
7.	Coxae II and III unarmed (Ceylon)	*cuspidata*	439
	,, II and III slightly armed	8	
8.	Basis capituli broader than long (Queensland)	*bancrofti*	490
	,, ,, narrow (Asia)	*papuana*	407

Note to Terms and Signs.

Ventral cornua is a new term whereby we describe processes protruding from the postero-lateral angles of the ventral surface of the basis capituli. So far we have only observed them in *H. leporis-palustris* (all stages ; see Figs. 325, 326, 328, 329), and in *H. cinnabarina* (♂ and *L* ; see Figs. 319, 320), as well as in its var. *punctata* (♂ and *L*, Fig. 324).

Spiracle. The letters A and D, in connection with the figures of the spiracle, indicate its orientation with regard to the body of the tick : A = anterior, D = dorsal.

The explanation of the other terms and signs will be found in Part II. pp. 127–132.

SPECIFIC DESCRIPTIONS

OF VALID SPECIES OF HAEMAPHYSALIS AND OF THEIR VARIETIES

1. HAEMAPHYSALIS INERMIS Birula, 1895.

Figs. 309–312.

Lit., Synon. and Icon.:

Haemaphysalis inermis Birula, 1895, pp. 360, 361, Pl. II, Figs. 7–9 (♀ capitulum, showing porose areas, anus, coxa I; evidently drawn from balsam-mounted specimen, therefore misleading); Latin description of ♀ only. Neumann, 1901, p. 264; gives French translation of Birula's description. Neumann, 1911 *a*, p. 116; listed as a doubtful species.

Haemaphysalis ambigua Neumann, 1901, pp. 262, 263 (not figured); the description given by the author agrees in all essentials; he only refers to the ♀, the description being based on 6 ♀ probably of French origin, from E. Simon's collection. Neumann, 1906, p. 217; describes a more highly chitinized ♀ in which he thought he perceived a trace of eyes (specimen in British Museum). Bonnet, 1908, p. 260; describes the ♀ in two lines and states that it probably does not occur in France, being Asiatic; his Fig. 30, of the ♀ capitulum, is bad. Blanchard, 1909, p. 148, Fig. 178; species merely listed and figure reproduced from Bonnet. Neumann, 1911 *a*, p. 109, states the species occurs in France.

Male (Fig. 309): *Scutum* 2·7×1·9 to 1·74×1·24 mm.[1], fairly glossy, convex, dark, with very many small discrete punctations, rather linearly

[1] The scutums of 10 ♂, collected by Brumpt in France, measured in mm.:

2·4 × 1·6	2·2 × 1·6
2·38 × 1·7	2·03 × 1·35
2·3 × 1·6	2·0 × 1·45
2·25 × 1·6	2·0 × 1·4
2·23 × 1·55	1·74 × 1·24

arranged towards the posterior end, and leaving a few non-punctate islands, the largest being median and longitudinal; *no cervical or lateral grooves*; festoons short and ill-defined. *Capitulum* very small, and departing widely from the form normal to *Haemaphysalis*; base rectangular, with rounded angles, broader than long, deeply pitted on its dorsal surface; palps clavate; article 1 easily visible dorsally; articles 2 and 3 not clearly separated, *not salient at the base*, broadest

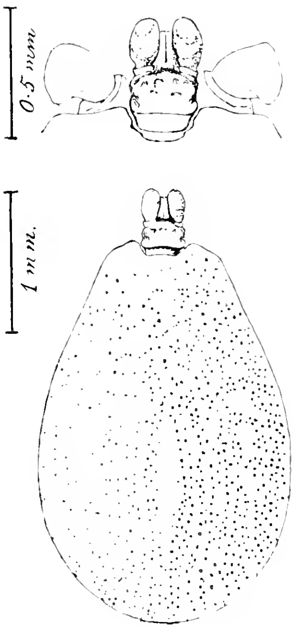


Fig. 309. *H. inermis* ♂ (N. 739 *d*). Dorsum, and more highly magnified detail of capitulum and legs. Specimen found on fox at Surnabad, Transcaucasia, 1903, by Dr E. Dschunkowsky. Original, N.C. del.

towards the distal end; hypostome 2 | 2. *Venter*: genital orifice between coxae II; spiracle very large, elongate, tapering only slightly. *Legs* fairly long and strong; all the coxae with a single short pointed spur, internal on coxae I and IV, median on coxae II and III; trochanter I very large, with broad, blunt dorsal retrograde spur; tarsus IV swollen in the middle and tapering gradually; pad short.

Female (Fig. 310): *Scutum* broader than long or the reverse, 1·24 to 0·9 mm. long[1], with rather sinuous contour; punctations numerous, uniform, discrete; cervical grooves far apart, shallow and inconspicuous. Dorsal surface of *body* closely and finely punctate; festoons distinct when unfed. *Capitulum* departing widely, as in the ♂, from the normal *Haemaphysalis* form; the base sub-rectangular but rather salient postero-laterally; no cornua; porose areas very large, deep, circular, separated by their diameter, a triangular pit in the posterior part of their interval. Palps as in ♂, but longer. Hypostome 3|3. *Venter*: vulva between coxae III; spiracles large, short comma-shaped; anal grooves ogival. *Legs* as in ♂.

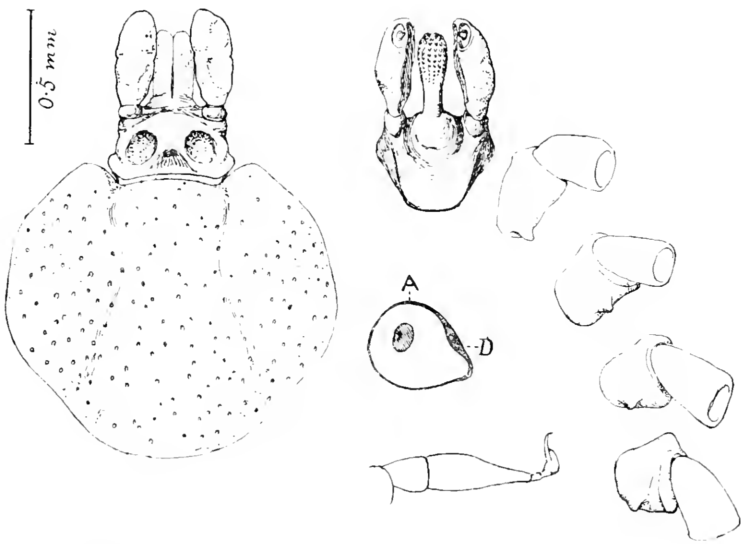


Fig. 310. *H. inermis* ♀ (N. 788). Scutum and capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. Same origin as ♂ in Fig. 309. Original, N. C. del.

[1] The scutums of 19 ♀, collected by Brumpt in France, measured in mm.:

1·24 × 1·0	0·98 × 1·44	The bodies of 3 unfed ♀ (marked * in the adjoining scutum-measurements) measured respectively in mm.:
1·2 × 1·2	0·97 × 1·15*	2·32 × 1·8
1·18 × 0·9	0·96 × 1·33	2·5 × 1·85
1.13 × 1·10	0·95 × 1·12*	2·57 × 1·8
1·12 × 0·96	0·94 × 1·16	
1·1 × 1·1	0·93 × 0·95	
1·1 × 1·05	0·9 × 1·16*	
1·07 × 1·06	0·9 × 1·15	
1·07 × 0·95	0·9 × 1·09	
1·0 × 1·08		

Nymph (Fig. 311): *Body* dark brown, broad, with large deep punctations, uniformly distributed; sharply defined median groove and festoons; about 1·6 × 1·3 mm., when unfed, attaining about 2·5 × 2·1 mm. when replete. *Scutum* about 0·44 × 0·65 mm.[1], cordate, with slight emargination, strongly shagreened in texture; cervical grooves well-marked to the posterior border. *Capitulum*: base fairly long, without cornua but projecting laterally at its posterior border in rounded

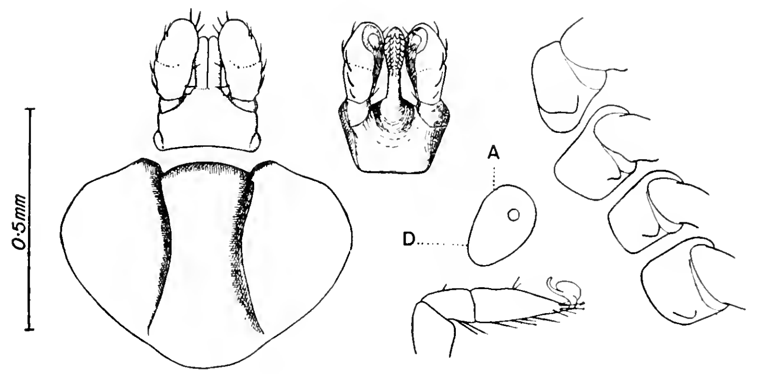


Fig. 311. *H. inermis* ○ (N. 2762). Scutum, capitulum in dorsal and ventral aspects, coxae, spiracle and tarsus IV. Specimen from France, received from Dr Brumpt, 1911. Original, N. C. del.

prominences. Palps massive, rounded externally, widest at the base of article 3. Hypostome relatively long and narrow, lanceolate, dentition 2 | 2. *Venter*: spiracle ovate, the narrow end directed dorsally. *Legs*: coxae with short blunt spurs in the normal position; the dorsal retrograde spur on trochanter I short and rounded; tarsus IV tapering gradually; pad medium.

Larva (Fig. 312): *Body* broad, with a few scattered punctations and long, sharply defined festoons; about 0·9 × 0·8 mm., when unfed;

[1] The scutums and bodies of 5 ○, collected by Brumpt, measured in mm.:

Scutum	Body	
0·47 × 0·65	2·5 × 2·1	gorged
0·45 × 0·66	1·3 × 1·12	unfed
0·44 × 0·65	1·45 × 1·2	,,
0·43 × 0·66	1·6 × 1·36	,,
0·43 × 0·60	1·6 × 1·3	,,

attaining about 1·8 × 1·3 mm. when replete. *Scutum* about 0·3 × 0·45 mm.[1], like that of the o, but with shallow, more parallel cervical grooves. *Capitulum*: base without cornua or lateral projections, its antero-lateral edges rounded. Palps as in the o, except that articles 2 and 3 appear fused. Hypostome and *Legs* as in the o.

Our description of this species is based on the examination of many specimens chiefly derived from France (vide infra). The type of the ♀ is in Birula's collection, Petrograd, those of the ♂, o and *L* are

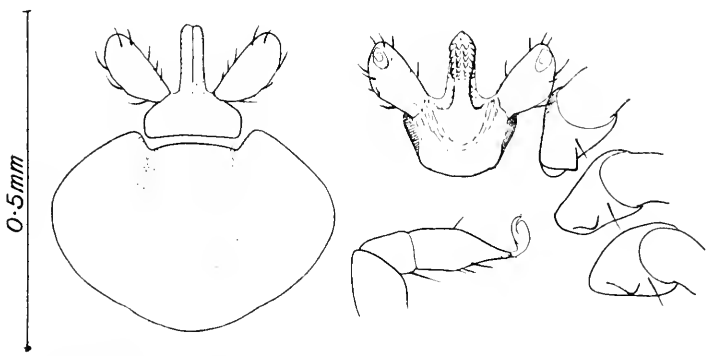


Fig. 312. *H. inermis* larva (N. 2757 *a*). Scutum, capitulum in dorsal and ventral aspects, coxae and tarsus III. Specimen raised by Dr Brumpt. Original, N. C. del.

in Cambridge (N. 789, 2762, 2757 *a*), the latter stages not having hitherto been described. The species is so remarkable that Neumann (1901, p. 263) stated that he would have referred it to *Aponomma* were ti not for the resemblance to *Haemaphysalis* in the leg structure.

Geographical Distribution and Hosts.

Caucasia: We are indebted to Prof. A. Birula for (N. 1226) a ♀ received XI. 1910. Birula (1895, p. 360) founded the species on 1 ♀ supposedly derived from the Caucasus, the host not being recorded. **Transcaucasia**: We have examined many specimens collected at Surnabad by Dr E. Dschunkowsky who kindly allowed us to retain (N. 781) 6 ♀ found on *cattle*, and (N. 788, 789) 3 ♂ 1 ♀ found on *fox* in

[1] The scutums and bodies of 4 *L*, collected by Brumpt measured in mm.:

Scutum	Body	
0·3 × 0·47	0·9 × 0·8	unfed
0·3 × 0·45	0·86 × 0·8	,,
0·3 × 0·43	1·8 × 1·3	gorged
0·28 × 0·42	0·85 × 0·73	unfed

company with *H. cinnabarina* var. *punctata* and *Boophilus*. **France**: Neumann (1901, p. 262) appears to have been the first to record the species from France, describing it under the name of *H. ambigua*, of which 6 ♀ were collected in 1894 by E. Simon. Neumann has presented us with a co-type (N. 2881). Dr E. Brumpt has sent us his unpublished records relating to the occurrence of the tick on *deer*, on which he found adults on 13 occasions (9 times with *H. concinna* and once with *H. cinnabarina* var. *punctata*) at Fontainebleau, Dépt. Seine-et-Marne, and in the Dépts. Vienne and Indre in Western and Central France respectively. We have examined all of Brumpt's material, including specimens which he raised in the laboratory, and he has allowed us to retain numerous examples of all stages (N. 1525–1528, 2752, 2753, 2756–2759, 2762); further particulars regarding them will be found in the Section on Biology. [**Japan**: Neumann (1906, p. 217) records 1 ♀ from *Naemorhaedus crispus* Temm., found in company with *Ixodes* and *Haemaphysalis* spp.[1]]

See further under Section on Biology (p. 545). The biology of the species is remarkable.

Haemaphysalis inermis var. aponommoides Warburton, 1913.

Fig. 313.

Lit. and Icon.: Warburton, VII. 1913, pp. 128–130, Fig. 8 (reproduced).

Male: unknown.

Female (Fig. 313): *Scutum*: broader than long, 1 × 1·4 mm., broadest at the anterior third, and much more narrowed posteriorly than in the type; glossy, but with numerous discrete, medium-sized punctations; cervical grooves broad sub-parallel tracts without any initial pits; emargination slight. *Capitulum*: even more *Aponomma*-like than in the type; base bluntly salient at the sides, almost destitute of cornua; porose areas large sub-circular, bounded externally and anteriorly by sub-rectilinear ridges, the interval about equal to their diameter; palps long and narrow, their outer border straight and not convex as in the type; article 1 well visible; articles 2 and 3 not distinctly separated, article 2 corrugated dorsally, and without any trace of lateral salience. Hypostome spatulate, dentition

[1] Probably *H. inermis* var. *aponommoides*, q.v.

3 | 3. *Venter*: spiracle short comma-shaped, the narrow end postero-dorsal; anal grooves semicircular. *Legs*: as in the type; coxa I without definite spur, but with its internal end truncated and the corners slightly

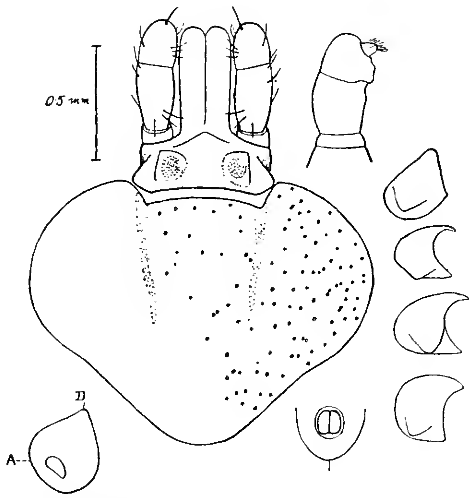


Fig. 313. *H. inermis* var. *aponommoides* ♀. Capitulum and scutum, profile of right palp, coxae, spiracle and anus with anal grooves. (N. C. del.) Warburton, 1913, Fig. 8.

protuberant; coxae II–IV with a slight protuberance in the middle of the posterior border; tarsus IV rather long and tapering (as in *H. howletti* ♀, see Fig. 434).

Described from (N. 1566) 23 ♀ taken from a Himalayan *Zebu* (*Bibos* sp.) at Belgachia, Calcutta, **India**, III. 1912, in company with *Boophilus australis*, by Col. F. Raymond, F.R.C.V.S. We have since determined (Berlin Mus. 173) 1 ♀ found on a *horse* at Fukoka, **Japan.**

Types in Cambridge; we have presented co-types to the Berlin Museum and to Prof. Neumann's collection in Toulouse.

H. inermis Birula, 1895, has hitherto been considered the most aberrant form of *Haemaphysalis*, and its attribution to that genus would be extremely doubtful were it not for such intermediate forms as *H. warburtoni* Nuttall, 1912. The present variety still further departs from the normal *Haemaphysalis* type, and still more closely approaches *Aponomma*. The genus *Haemaphysalis* and sub-genus *Aponomma* have normally little in common, except the negative characteristics of the absence of eyes and anal plates, and we should not have expected any question to arise as to which of them a newly discovered form belonged. Yet a grave question does arise in the present case, and though we judge the tick here described to be a *Haemaphysalis*, its resemblances to an *Aponomma* are more than superficial. It possesses one *Haemaphysalis* characteristic never found in *Aponomma*—the blade-like dorsal retrograde spur on trochanter I. Moreover, it is found on a mammal, whereas *Aponomma* is essentially parasitic on reptiles. The long palps need not trouble us much, as we know of several species of *Haemaphysalis* almost equally aberrant in this respect[1]; and, though the palps are long and very *Aponomma*-like when viewed dorsally, they do not recall that genus when viewed in profile (see Fig. 313). The *Aponomma*-like shape of the scutum, also, is of little importance, for there is a great range of scutal design in *Haemaphysalis*. It must be admitted, however, that not only the dentition (3 | 3) but the whole appearance of the hypostome is more like that found in *Aponomma* than in *Haemaphysalis*, and that coxa I, though not distinctly bifid, displays a tendency in that direction.

2. HAEMAPHYSALIS WARBURTONI Nuttall, 1912.

Figs. 314, 315.

Lit. and Icon.: Nuttall, 1912, pp. 55–57, Figs. 5, 6 (reproduced).

Male (Fig. 314): *Scutum* 2·5 × 1·8 to 2·3 × 1·6 mm.[2], narrow in front, broadest on a line with the spiracles; cervical grooves short, convergent pits; lateral grooves include two festoons and extend forwards to $\frac{2}{3}$ the body-length; posteriorly a median groove and two lateral depressions, two longitudinal grooves anterior to the latter extending forward to $\frac{1}{2}$ the length; festoons short; punctations few, inconspicuous. *Capitulum*: 0·4 to 0·5 mm. long, base sub-rectangular, with concave dorsal ridge connecting stout, somewhat convergent cornua

[1] See *H. warburtoni* (Fig. 314), *leporis-palustris* (Fig. 326), *aculeata* (Fig. 371), *wellingtoni* (Fig. 417), *humerosa* (Fig. 436).

[2] Five ♂ gave the following measurements in mm.:

Scutum	Capitulum (length, measured dorsally)
2·5 × 1·8	0·5
2·4 × 1·7	0·5
2·4 × 1·7	0·5
2·4 × 1·6	0·5
2·3 × 1·6	0·4

having rounded points; the base bulges ventrally; palps longer than broad, being broadest at the distal end of article 2, which is about $\frac{1}{3}$ longer than article 3; hypostome broad, 4 | 4, with corona followed by 8 distinct teeth per file. *Venter*: genital orifice between coxae II; spiracle longer than broad, with recurved dorsal margin. *Legs* short,

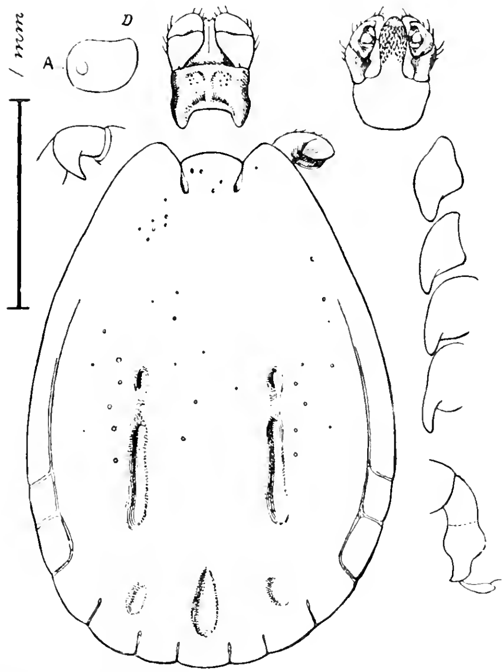


Fig. 314. *Haemaphysalis warburtoni*, ♂. Capitulum in dorsal and ventral aspects, scutum, spiracle, trochanter I seen from in front (and, attached to body, from above), coxae, tarsus IV. (G. H. F. N. and E. W. del.) Nuttall, 1912, Fig. 5.

stout; coxae I–IV each bearing a stout spur, longest on coxa IV and concave externally; trochanter I with a very large dorsal blade; *tarsi remarkable,* the distal portion bulging dorsally and ventrally, tapering rapidly, bearing a spur; pad half as long as the claws.

Female (Fig. 315): *Body,* unfed, 2·3 mm. long[1] with marginal groove including the second festoon and almost attaining the scutum. *Scutum*:

[1] None of the ♀ were fully gorged, the most swollen specimen measured 6·1 mm. in length.

Scutum	Capitulum (length, measured dorsally)
1·6 × 1·4	0·9
1·5 × 1·6	0·8
1·5 × 1·6	0·9
1·2 × 1·6	0·8

$1 \cdot 6 \times 1 \cdot 2$ to $1 \cdot 2 \times 1 \cdot 6$ mm., cordiform, cervical grooves not attaining the posterior border, postero-lateral border almost straight, few inconspicuous punctations. *Capitulum*: 0·8 to 0·9 mm. long, base broader than long, with sides angular, the antero-lateral borders converging, dorsal ridge concave, wavy, connecting short stout cornua; porose areas long-oval, converging anteriorly, far apart, in some specimens separated by a median depression; viewed ventrally the base bulges markedly. *Palps atypical*, very long, with article 1 distinctly visible dorsally, article 2 about twice as long as 3, the palps being broadest where articles 2–3 join. Hypostome broadly spatulate, 4 | 4 or 5 | 5, with emarginate

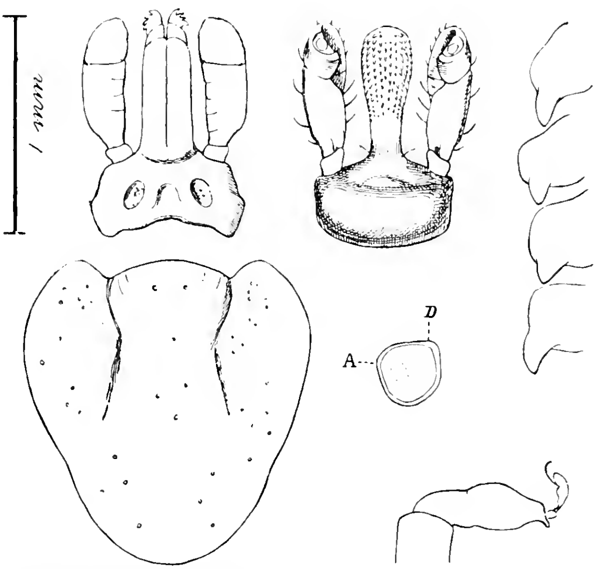


Fig. 315. *Haemaphysalis warburtoni* ♀. Capitulum in dorsal and ventral aspects, scutum, coxae, spiracle and tarsus IV. (G. H. F. N. and E. W. del.) Nuttall, 1912, Fig. 6.

corona, about 10 distinct teeth per file. *Venter*: vulva between coxae II when unfed, facing second intercoxal spaces when replete; spiracle as long as broad, somewhat angular, with slightly marked postero-dorsal angle. *Legs* resembling those of the ♂, the spur on coxa IV less developed.

Described from (N. 1400) 5 ♂ and 9 ♀ taken from *Serow goat*, at Wen-chwan-hsien, near Si-ho-hsien, **China**, and purchased, VII. 1911, from Mr T. V. Sherrin, Taxidermist, Hampton. We have since received (N. 2914 c), 1 ♂ taken from *cattle* at Taihoku, Formosa, 16. VII. 1909, coll. Dr M. Miyajima, and have determined (Berlin Mus. 160) 1 ♀ from Tscholesmantal, Altai Mts., Western **Siberia,** 10. IX. 1907, coll. C. Wache and Dr Biedermann.

Types in Cambridge; we have presented co-types to Neumann's collection, Toulouse.

3. HAEMAPHYSALIS CINNABARINA Koch, 1844.

Figs. 316–320.

Lit., Icon. and Synon.:

Haemaphysalis cinnabarina C. L. Koch, 1844, p. 237 ; 1847, p. 123, Pl. XXVI, Fig. 97, ♀. When in Berlin in 1909, one of us (G. H. F. N.) examined and drew the unique type from Brazil, and, after consultation with the late Prof. Dönitz, concluded that it was closely allied if not identical with *H. punctata* Canestrini and Fanzago. We have since been able, however, to identify it with the American form known as *H. chordeilis* (Packard) which therefore falls into synonymy. Koch spelt the name correctly at first (1844), but later (1847) misspelt it *cinnaberina*, doubtless having in mind the German word "Zinnober"; the original spelling has not been followed by other authors hitherto[1]. The body of the type specimen is still red, like cinnabar. Koch's original (coloured) figure is scarcely recognisable as that of a *Haemaphysalis.*

Haemaphysalis sanguinolenta C. L. Koch, 1844, p. 237 ; 1847, p. 124, Pl. XXVII, Fig. 98, ♀. The coloured figure is poor, the scutum too elongated. Nuttall examined the unique type in the Berlin Museum in 1909, and identified it with *H. cinnabarina* ; the scutum is slightly more elongate than in the type. The specimen came likewise from Brazil.

Ixodes chordeilis Packard, 1869, p. 67.

Haemaphysalis punctata var. *cinnaberina* (Koch) Neumann, 1905, p. 237.

Haemaphysalis punctata cinnaberina (Koch) Neumann, 1911 *a*, p. 108.

Haemaphysalis chordeilis (Packard) in Banks, 1908, p. 34, Pl. IV, Fig. 11 (describes the ♀ ; figures capitulum and scutum, coxae I and IV, tarsus IV, spiracle ; he studied the types). Banks, 1908, p. 54 (listed). Hunter and Hooker, 1907, p. 53 (casual mention). Hooker, 1909, p. 423, brief reference to distribution.

"*Haemaphysalis chordeilis* Banks, 1908," only listed by Blanchard, 1909, p. 148.

Haemaphysalis chordeilis (Packard) listed as a doubtful species by Neumann, 1911 *a*, p. 115.

"*Haemaphysalis chordeilis* Packard," Hadley, 1909, p. 606 ; recorded as killing turkeys in Vermont. Hunter and Bishopp, 1911, p. 229. Bishopp, 1911, pp. 207–208, describes ♂ (not figured) and raised the species. Hooker, Bishopp, and Wood, 1912, pp. 97-102, Pl. VII, Figs. 7–10 (♂ dorsum

[1] Neumann, 1897, p. 331 and other authors.

and venter; o replete, dorsum and venter; all stages described, hosts distribution, biology).

Haemaphysalis punctata Canestrini and Fanzago, in Hadwen, 1912, p. 98.

Not *Haemaphysalis leporis-palustris* (Packard), as stated by Neumann, 1897, p. 343.

Male (Fig. 316): *Scutum*: 1·9 × 1·3 to 2·7 × 1·5 mm., elongate, strongly and irregularly punctate, the punctations being coarse and often confluent in the middle region; cervical grooves very short, well marked; lateral grooves very long and deep, including three festoons; festoons short; dorsal, median and postero-lateral grooves are present,

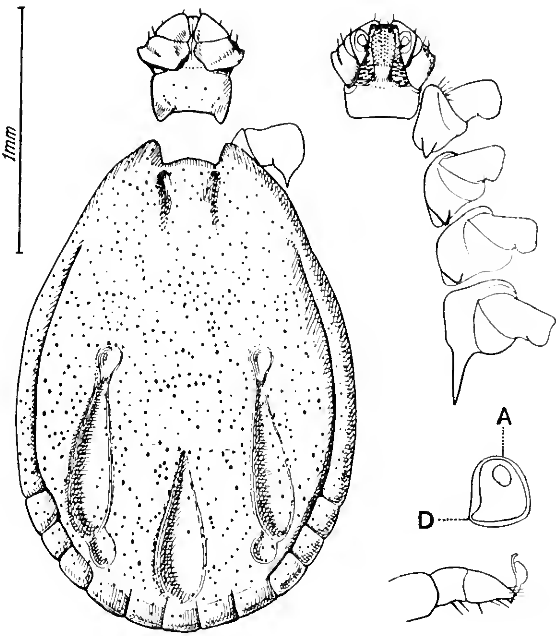


Fig. 316. *H. cinnabarina* ♂. Dorsum, ventral aspect of capitulum, coxae with trochanters, spiracle and tarsus IV. (Specimen, N. 2452, raised in Cambridge, parents from cattle, Winnipeg, Canada.) Original, N. C. and E. W. del.

recalling those of *Rhipicephalus*. *Capitulum*: base not much broader than long, punctate, with strong cornua; palps massive; article 2 slightly salient laterally; no dorsal spines; a slight ventral retrograde point under article 3 at its inner angle; hypostome: dentition 4 | 4 to 5 | 5; very small sharp teeth without any median interval. *Venter*: spiracle large, short, comma-shaped. *Legs*: coxal spurs strong, longest on coxa IV; tarsus IV short, tapering rather abruptly.

Female (Figs. 317, 318): *Scutum*: 0·9 × 0·9 to 1·6 × 1·2 mm., usually distinctly longer than broad, broadest near the anterior border, punctations coarse ; cervical grooves deep and converging to the middle

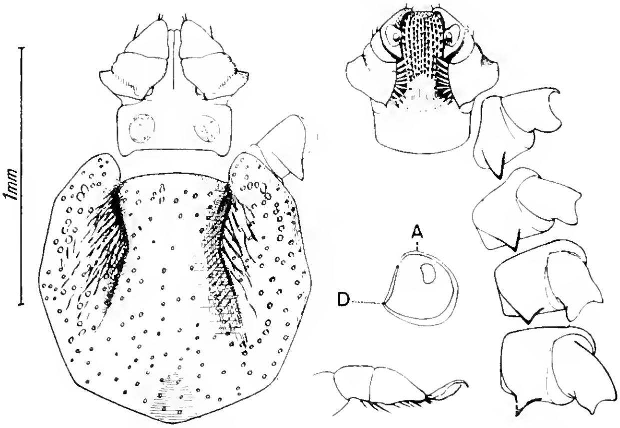


Fig. 317. *H. cinnabarina* ♀. Scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. (Same source as ♂ in Fig. 316.) Original, N. C. del.

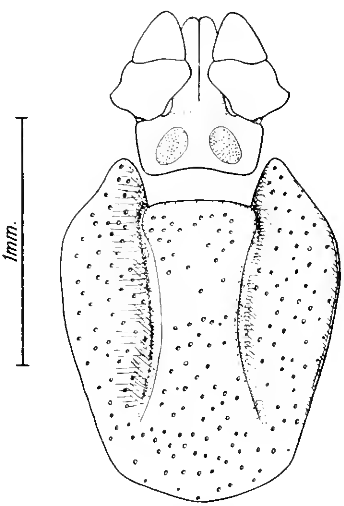


Fig. 318. *H. cinnabarina* ♀. Scutum and capitulum in dorsal aspect (N. 2833, received from Mr F. C. Bishopp, Victoria, Texas). Original, N. C. del.

of the scutum, then shallower and diverging. *Capitulum*: base twice as broad as long; cornua very slight and blunt; porose areas large, almost reaching the posterior border, not always definite, *except where* *bounded by the lateral ridge*; but in some specimens distinctly oval, converging in front; palps and hypostome as in the ♂. *Venter*: spiracle large, sub-circular, with distinct dorsal process. *Legs*: as in the ♂, except that the spur on coxa IV is short. (Replete specimens may attain 9 × 6·6 mm., according to Hooker, Bishopp and Wood.)

Nymph (Fig. 319): *Scutum*: 0·62 × 0·6 to 0·45 × 0·55 mm., variable, generally cordate, with few punctations and well-marked cervical grooves. *Capitulum*: *base hexagonal, with lateral angles*, and with ventral cornua; palps recalling those of the adult; dentition of

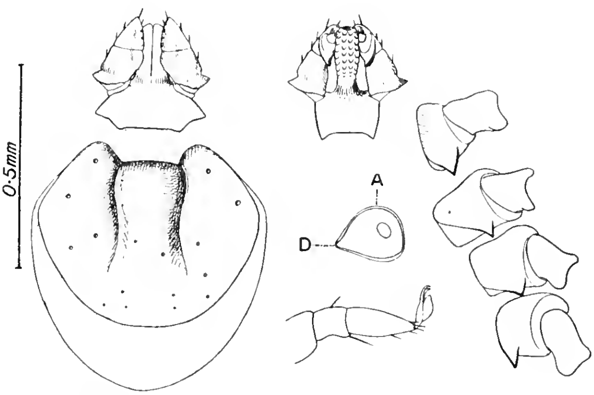


Fig. 319. *H. cinnabarina*, nymph. Capitulum in dorsal and ventral aspects, scutum (variations in shape indicated by second contour), coxae with trochanters, spiracle, tarsus IV. (Same source as ♂ in Fig. 316.) Original, N. C. del.

hypostome 2 | 2, about 8 teeth per file. *Venter*: spiracle ovoid, with distinct dorsal process. *Legs*: as in the ♀, with coxal spurs unusually well-marked for a nymph.

Larva (Fig. 320): *Scutum*: 0·24 × 0·3 to 0·21 × 0·26 mm., cordate broader than long; cervical grooves fairly distinct, parallel. *Capitulum*: base with lateral angles and with distinct ventral cornua; palps with slight lateral salience; hypostome: dentition 2 | 2, about 7 teeth per file. *Legs*: coxa I with slight spur, coxa II flanged, coxa III unarmed; tarsus III tapering.

Our description is from specimens reared in Cambridge, being the progeny of (N. 2452) 2 ♀s, from *cattle*, Winnipeg, Canada, collected by Mr J. R. N. Harrison. It is evident, however, from other specimens since received from Mr F. C. Bishopp (N. 2833, 2834, 2 ♂ 2 ♀, from *Sturnella magna*, Victoria, Texas, 1909), that well-developed and strongly chitinised individuals may depart rather widely from the description here given, the tendency in such specimens being towards elongation. The larger measurements we give relate to the specimens

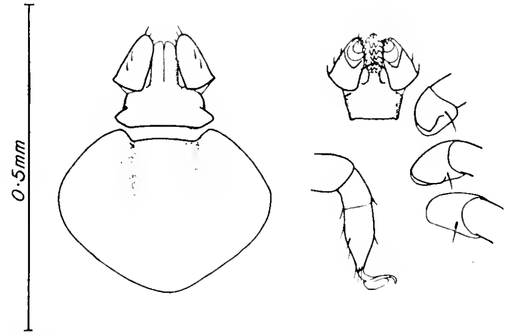


Fig. 320. *H. cinnabarina*, larva. Capitulum in dorsal and ventral aspects, scutum, coxae, tarsus III. (Same source as ♂ in Fig. 316.) Original, N. C. del.

received from Mr Bishopp, see Fig. 318 showing the long scutum of the ♀.

Type, a dried ♀, from Brazil, in the Berlin Museum. The types (2 ♀) of Packard's *H. chordeilis* are in the Museum of Comparative Zoology, Harvard University, Cambridge, Mass., where they were examined by N. Banks; ♂ in Bishopp's collection, o and *L* in our collection.

Geographical Distribution and Hosts.

H. cinnabarina appears to be widely distributed on the continent of North America. The specimens we raised in Cambridge (N. 2452) were derived from replete females found on *cattle* in Winnipeg, **Canada**, IX. 1913, by J. R. N. Harrison; similar specimens (N. 934) were found by Dr S. Hadwen, XI. 1909 (same host and place). We have furthermore received (N. 3023) ♂s ♀s from *cattle*, Ashern, Manitoba, 17. IX. 1914, J. R. N. Harrison coll.; (N. 3026) 2♂ 2♀ from *cattle*, Stonewall, Manitoba, 14. IX. 1911, J. D. Ross coll. and (N. 3027) a ♂ found attached to the arm of a *man*, at Kamloops, British Columbia, IX. 1914, both lots having been presented by Dr S. Hadwen. Packard's types (two replete ♀s) were found on the night-hawk (*Chordeiles popetue*), at Milton, **Massachusetts**. Banks (1908, p. 34) records 1 ♀ from a *turkey*, Taftsville, **Vermont**. Hadley (1909, p. 606) states that in June, 1909, this tick was observed on two farms at Norwich, Vermont, in May, where it killed off 40 out of 46 young *turkeys* before the ticks were finally destroyed by hand-picking. Many immature and adult ticks, the latter to the number of 70–80 per bird, were found attached chiefly to the birds' necks; the ticks were determined by Banks. Hooker, Bishopp and Wood (1912, pp. 97–102) state that the tick chiefly infests ground-inhabiting birds, the immature stages usually occurring on the top of the birds' heads, around the eyes and ears, and at times beneath the bill. It is often found together with *H. leporis-palustris.* Other hosts are the *meadow-lark, jackdaw, red-winged blackbird, marsh-hawk.* In **Texas** the meadow-lark is chiefly infested; Hunter (VI. 1909, p. 252), with J. D. Mitchell, found what appeared to be the O and *L* on a quail (*Colinus virginianus*) at Brownsville, in the autumn of 1907, and O and *L* (also *L* skins) were found on the heads of *quails* and *larks* (*Sturnella magna neglecta*) at D'Hannis (an adult which developed from a replete O was identified as *H. chordeilis* by N. Banks). From 12 *quails* dropped into bags after being shot in Victoria County in December, 1907, Mitchell reports that over 500 ticks were collected: "that there were 1000 ticks upon the 12 quail would be a conservative estimate." The author adds that some of these ticks may have been *H. leporis-palustris.* We have received specimens (N. 2833, 2834) from the *meadow-lark* (*Sturnella magna*), Victoria, Texas, 1909, presented by Mr F. C. Bishopp. Bishopp (VI. 1911, p. 208) states that J. D. Mitchell found the tick three times on *meadow-larks* in Victoria County, Texas: 1 ♂ on 23. III. 1910; 1 ♂ 4 ♀ on 12. XI. 1911; 5 ♂ 4 O 23 *L* on 25. XI. 1911. In the autumn, nearly all the ground-feeding birds are infested with the O and *L* as observed by Mitchell in Victoria County, and at Grand Cane, **Louisiana** and in Quincy and Hawthorne, **Florida**. Hooker (1909, p. 423) states that the tick occurs also in the State of **New York**; we have received (N. 2737) 1 ♀ from *ruffed grouse,* Catskill Mts., VIII. 1909, presented by Dr L. O. Howard.

As previously stated, Koch's type ♀ came from **Brazil.**

Remarks regarding H. cinnabarina, "H. punctata" and "H. chordeilis."

It was only after having described and drawn the forms known commonly as *H. punctata* in the Old World and *H. chordeilis* in the New that we became convinced that their differences were merely varietal. This conclusion, together with the undoubted priority of the name *cinnabarina*, has forced upon us a change of nomenclature which we only adopt with reluctance in view of the large amount of literature connected with the name *H. punctata*. The specimens of "*H. chordeilis*" to which we first had access did not, in their general facies, strongly recall "*H. punctata*," though when examined point by point their differences were unimportant.

Koch's type of *H. cinnabarina* is a dried specimen not well preserved, and it was with some hesitation that we admitted its identity with "*H. punctata*." This hesitation is explained as soon as it is recognised that there are two varieties of the species, and that the type specimen, which came from Brazil, belongs to the American variety. The American form thus necessarily becomes the type variety. Under the circumstances we have thought it better to depart from our usual procedure in dealing with a variety, and instead of merely indicating the points which distinguish it from the type form, we have allowed to stand the full description we had prepared of *H. punctata*—now *H. cinnabarina* var. *punctata*—when we believed "*H. chordeilis*" to be generically distinct.

Varietal Differences: The main differences between *H. cinnabarina* and *H. cinnabarina* var. *punctata* will be seen at a glance by reference to the figures. In the type the body of the ♂ is broader, the dorsal furrows more distinct, palpal article 2 more protruding, the spur on coxa IV straighter. In the ♀ palpal article 2 has a more sharply protruding external angle. In the o and *L* the differences are slight.

Haemaphysalis cinnabarina var. punctata (Canestrini & Fanzago, 1877).

Plates VIII–XI and Text-figs. 321–324.

Lit., Icon. and Synon.:

Haemaphysalis punctata Canestrini and Fanzago, 1877, p. 121 (reprint) and 1877–1878, p. 189. The original description refers only to the ♂ and ♀ and is so brief that it would be impossible to recognise the species by it.——**1890.** Canestrini, pp. 523, 525, Pl. XLI, Figs. 6 and 6*a*, gives a fairly accurate description, especially of the ♀; the figures of the ♂ venter and capitulum are inaccurate but show the main characters. All the points in his description, except a few measurements, are included in Neumann, 1907, pp. 327–330.——**1891.** Berlese, fasc. 58, Pl. X, gives an inaccurate coloured figure of the ♂, also poor figures of the ♂ venter, capitulum, palp, spiracle and of the ♀ dorsum venter and spiracle.——**1895.** Pocock, p. 326, records it in England. Railliet, p. 714; brief mention.——**1897.** Neumann, p. 237, Figs. 1, 2 gives the first good description, the illustrations, however, only relate to the hypostome (♂) and digit (♂ ♀).——**1905.** Nuttall, Cooper and Smedley, pp. 439–441, give a description of the buccal apparatus. Cooper, pp. 3, 4, describes 19 accompanying photomicrographs of all stages showing details of the mouthparts, microscopic sections, etc., which served to illustrate the foregoing paper by Nuttall, Cooper and Smedley. Lahille, p. 44; merely lists the species.——**1906.** Wheler, p. 421, Pl. X, Figs. 31, 32 (photographs); describes all stages briefly and records it on sheep and hedgehog in England. The figures of the ♂ and ♀ show the general character. He gives some accurate measurements.——**1907.** Coward, p. 323; states that Oldham found it at Dungeness in England. Dönitz, p. 71; quotes Neumann.——**1908.** Bonnet, p. 261; poor description, condensed from Neumann, 1897; his Fig. 29 of ♀ capitulum is original but bad. Nuttall (VII), pp. 16–18 and (VIII), pp. 398–399, describes and figures the process of oviposition. Nuttall, Cooper and Robinson, pp. 152–181, Pls. XII–XVI, Text-Figs. 1–9; give the biology, synonymy, iconography, distribution and a full illustrated account of the external structures of all stages together with a bibliography to 1908 inclusive. Nuttall (IX), pp. 514, 522; biology and part played in disease transmission. Nuttall, Cooper and Robinson (X), pp. 238–242, Pl. XVIII, Text-Fig. 1; describe and illustrate the structure of Haller's organ. Nuttall, Cooper, and Robinson (XII), pp. 347–351, Pls. XXII, XXIII; describe and figure the structure of the spiracle. Stockman (VIII), reprint, p. 8, records the species on cattle and sheep and demonstrates by experiment that it may convey piroplasmosis (redwater) to cattle.——**1909.** Blanchard, pp. 154–157, Figs. 192–194, gives some more recent data regarding distribution; his figures are taken from Bonnet and Neumann, q.v. Rohr, p. 142; quotes Neumann.——**1911.** Knuth, reprint 12 pp., illustrated by figures taken from Nuttall, Cooper and Robinson, q.v.; records its presence on cattle in Northern Germany. Nuttall (X), p. 180, illustrates its type of parasitism graphically. Stockman, pp. 23–32; account of the biology. Yakimoff and Kohl-Yakimoff, p. 418; record occurrence in Gouv. Cherson, Russia, and in Caucasia.——**1912.** Eysell, Figs. 5, 6; buccal apparatus, copied from Nuttall, Cooper and Robinson, q.v.——**1913.** Nuttall (IV), pp. 99–105; full account of the biology (incorporated in our text). Patton and Cragg, p. 630; description translated from Neumann 1911, q.v.; p. 648 brief reference to Nuttall and Stockman's experiments.

Haemaphysalis sulcata Koch, in Canestrini and Fanzago, 1877, p. 120, may well be included here, although doubtfully, the description being somewhat vague. Berlese, 1889, fasc. LV, N. 1 describes it. Berlese, 1891, fasc. LV, Pl. I, figures a replete ♀ inaccurately, the capitulum shows the chelicerae situated ventrally.

Rhipicephalus expositicius L. Koch, 1877 *b*, pp. 196–198, certainly agrees very closely in its description with that of *H. cinnabarina*; the author gives no figure. We agree with Neumann, 1897, p. 327, in condemning the species.

Haemaphysalis rhinolophi Canestrini and Fanzago, 1877, p. 189 ; Canestrini, 1890, p. 526 ; Neumann, 1897, p. 332. According to Neumann this is a good species distinguishable from *H. punctata* through having a non-punctate scutum. One of us (G. H. F. N.), in 1910, examined the only existing type specimen through the courtesy of Prof. Carazzi of the Zoological Institute, Padua, a ♀ without capitulum and anterior third of the body and with only three legs remaining. The specimen proved to be only a poorly chitinised *H. cinnabarina* var. *punctata*.

Haemaphysalis punctata punctata Canestrini and Fanzago in Neumann, 1911 *a*, pp. 107–108, Figs. 50, 52. The figures show the ♂ in dorsal and ventral aspects, the palp seen ventrally.

Haemaphysalis crassa Warburton, 1908, pp. 516–517, Fig. 8 (reproduced) ; see discussion in our text.

Not *Pseudixodes holsatus* (Fabricius) in Haller, 1882, p. 311, Pl. V, Fig. 5 (♂ capitulum) as stated by Canestrini, 1890, pp. 485, 526, who includes it in his synonymy of *H. punctata* ; Neumann, 1897, p. 360, appears justified in referring the tick to the synonymy of *Dermacentor reticulatus* (Fabricius 1794).

Male (Text fig. 321, Plates IX, X[1], Figs. 3, 4 ; XI, Figs. 2, 5, 6) : *Scutum* : elongate, narrowed in front ; size variable, averaging about 3 × 2 mm. but ranging from 3·3 × 2·0 down to 2·4 × 1·5 mm.[2]; colour usually dark brown ; cervical grooves rather short, concave externally ; lateral grooves very long, beginning at the level of legs II, and including from one to three festoons ; punctations very numerous and small over the whole surface, some of them confluent ; two lateral furrows (in ungorged specimens), sometimes resolved into a series of shallow pits, and often connected posteriorly by three shallow pits in front of the festoons ; festoons short and ill-defined ; emargination deep and abrupt. *Capitulum* small ; base rectangular, about twice as broad as long, punctate ; cornua short and blunt ; palps short, the lateral salience slight, not angular, but rounded ; article 1 hardly visible ; article 2 massive, and longer than article 3 ; the inner contour of articles 2 and 3 rectilinear, and their dorsal surface somewhat corrugated ; no dorsal spurs, but a strong ventral retrograde spur under article 3 ; hypostome 5 | 5 (with sometimes an extra pair of files for part of the length). *Venter* : spiracles large, elongate, with blunt dorsal process ; anal grooves very slightly ogival. *Legs* strong, coxa I short, with blunt internal spur ; coxae II and III with a blunt spur in

[1] For description of Plates see p. ix.

[2] Variation determined on over 60 ♂ collected in England and Schleswig-Holstein, or raised in Cambridge. The proportion of length to width varies, thus the scutum may measure 3·0 × 1·8, 2·95 × 1·7, 2·9 × 1·8, 2·9 × 1·6, 2·6 × 1·4, 2·4 × 1·5 mm., etc.

the middle of the posterior border; a long, strong, sharp, inwardly curved spur on coxa IV, as long as the article itself (see note on

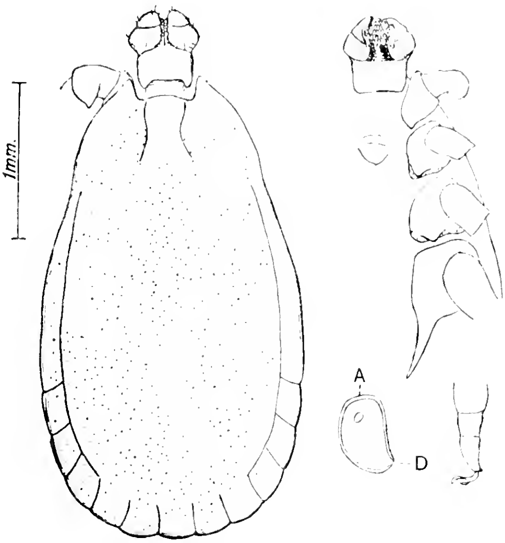


Fig. 321. *H. cinnabarina* var. *punctata* ♂. Dorsum, part of venter, spiracle and tarsus IV. Specimen (N. 2708) from Germany. Original, G. H. F. N. del.

Transcaucasian forms, p. 384); trochantal spurs faintly indicated; tarsus IV, small and tapering; pads short.

Female (Text figs. 322, 323; Plates IX; X, Figs. 1, 2; XI, Figs. 1, 4): *Body*, when unfed, measures 2·7 to 3·2 × 1·8 to 2 mm., attaining, when fully gorged, 13 × 8 mm. *Scutum* about 1·3 × 1·2 mm., ranging from 1·4 × 1·2 down to 1·25 × 1 mm.[1], sub-cordate, but the evenness of the contour usually broken by slight postero-lateral angles; cervical grooves well-marked for about two-thirds of the scutal length; punctations medium, irregular, not very numerous. *Capitulum*: base rectangular, nearly thrice as broad as long, without cornua; porose areas large, rather indefinite, far apart, with a slight depression in the interval; palps with lateral salience more angular and more posterior than in the ♂, and with shorter spur under article 3; hypostome more spatulate than in the ♂, with similar dentition, ordinarily 5|5, but frequently 6|6. *Venter*: spiracle rounded, with

[1] As in the ♂, the proportions vary. The range, determined on about 50 ♀, varied being 1·4 × 1·2, 1·3 × 1·2, 1·3 × 1, 1·25 × 1·1 mm., etc. Nuttall, Cooper and Robinson (1908, p. 157) record the length as 1·08–1·37, the breadth as 1·05–1·31 mm.

short dorsal process and large macula; anal grooves slightly ogival. *Legs*: coxae I–III armed as in the ♂, but the spur on coxa IV is only represented by a spur somewhat stronger than on coxa III.

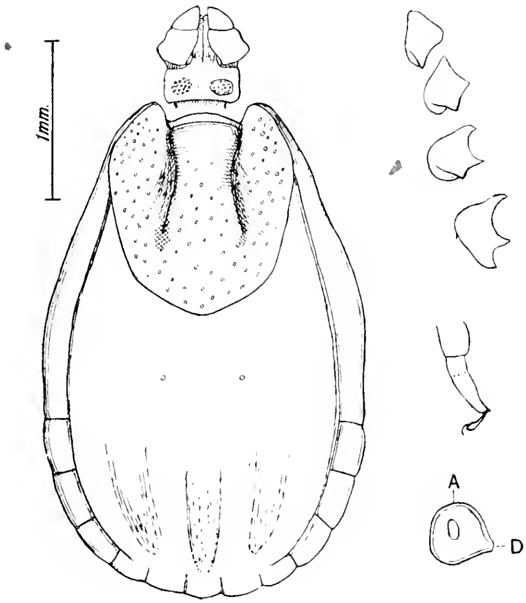


Fig. 322.

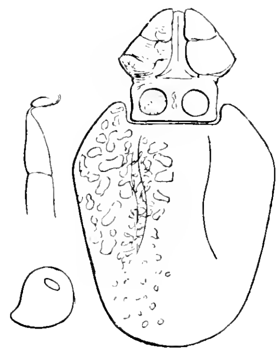


Fig. 323.

Fig. 322. *H. cinnabarina* var. *punctata* ♀. Dorsum, coxae, spiracle and tarsus IV. Specimen (N. 2706) from Germany. Original, G. H. F. N. del.

Fig. 323. *H. cinnabarina* var. *punctata* ♀. Capitulum and scutum, spiracle and tarsus IV. Warburton 1908, Fig. 8. Sketch of *H. crassa* Warb. Specimen from Transcaucasia with unusually rugose scutum.

Nymph (Text fig. 324; Plates IX; X, Figs. 5, 6): *Body*: 1·32 × 0·85 to 1·26 × 0·8 mm. *Scutum*: 0·37 × 0·4 up to 0·55 × 0·57 mm.[1], as broad as long or broader than long; like that of the ♀ but less angular and appearing broader in proportion to its length, with very faint punctations; cervical grooves long, broad, sub-parallel. *Capitulum*: base hexagonal dorsally, *the sides being produced to sharp lateral points*; ventral cornua but no dorsal cornua; hypostome 2 | 2; palps like those of the ♀ but with article 2 more sharply recurved at its lateral angle and less clearly

[1] The scutums of 5 ○ raised in Cambridge (N. 2780) measured in mm.:

0·57 × 0·57	0·5 × 0·53
0·53 × 0·53	0·5 × 0·51
0·5 × 0·54	

marked off from article 3. *Venter*: spiracle sub-circular. *Legs* as in the ♀, except for the tarsi (see Figs.). When gorged, the nymph may attain a length of 3 mm.

Larva (Plates VIII; X, Figs. 7, 8; XI, Fig. 3): *Body*, when unfed, measures about 0·56 × 0·45 mm., when fully gorged the larva may measure 1·6 × 1 mm. *Scutum* broad in front, 0·25 × 0·32 to 0·23 × 0·3 mm., narrowing and rounded posteriorly; cervical grooves

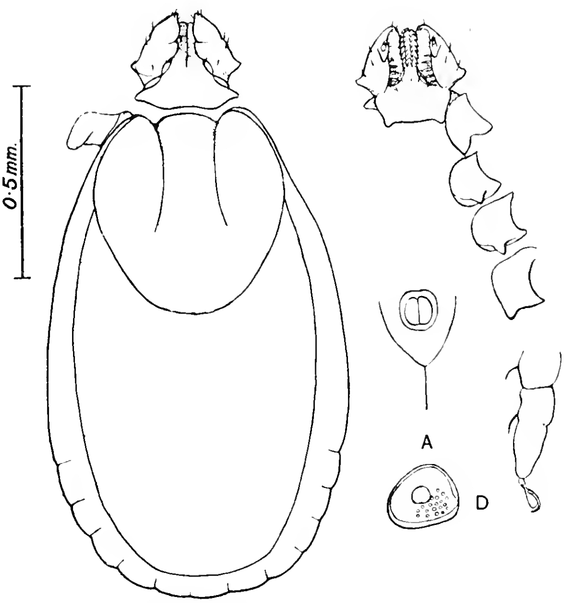


Fig. 324. *H. cinnabarina* var. *punctata* ○. Dorsum, ventral aspect of capitulum, coxae, anus and anal grooves, spiracle and tarsus IV. Specimen (N. 814) raised in Cambridge. Original, G. H. F. N. del.

deep and parallel. *Capitulum*: base with slight lateral points; hypostome 2 | 2; palps like those of the ○.

Described from numerous specimens collected and raised experimentally by us in England.

See further under Notes on Biology, p. 518.

NOTE ON TRANSCAUCASIAN FORMS OF *H. CINNABARINA*.

In the collection of ticks left with us for determination by Dr Dschunkowsky of Surnabad, we have found a number of specimens of typical *H. cinnabarina* var. *punctata* intermixed with forms in which the characteristic long spine on the fourth coxa of the ♂ is either reduced in size or practically absent; these specimens conform to the type in other respects. Details regarding these specimens will be found in the section relating to Asia under Geographical Distribution (see p. 387). One lot especially (N. 780) contained transition forms: a typical long-spined ♂, 1 ♂ with a moderate spine and 5 ♂s with very short spines. We have received precisely similar specimens from Smyrna (N. 2554) 1 ♂ 2 ♀ taken from sheep, but the ♂ had the usual long spine.

Haemaphysalis crassa Warburton, 1908. While examining the ticks in the British Museum in 1907, we found, in a tube labelled "No. 254. *H. papuana*," two gorged ♀s which certainly did not belong to this species and which we were then unable to identify. One of us described them under the name of *H. crassa* (see Fig. 323), in allusion to their unusually rugged appearance. They were taken from *cattle* at Surnabad and presented to the Museum by Dr Dschunkowsky to whom we have since been indebted for the opportunity of studying all the material he collected in Transcaucasia. After due consideration we believe that *H. crassa* represent only aberrant forms of *H. cinnabarina* var. *punctata*.

Geographical Distribution and Hosts.

Although widely distributed, *H. cinnabarina* var. *punctata* is a relatively uncommon tick. It occurs in Europe, Asia, and Africa as the following records show. [Records by other authors are enclosed in square brackets.]

EUROPE: England: We have received all our adult specimens from *sheep* in Kent, as follows: (N. 2151) Lydd, 13. III. 1905, S. T. Sellens coll.; (N. 899 and 1564), ditto, III. and IV. 1905; (N. 2780) ditto, 25. V. 1914; (N. 2152) Littlebourne, 5. IV. 1905; (N. 1565) Herne, IV. 1905; (N. 1207) Ashford, V. 1906, Mr Spanton coll.; all of these specimens were collected at the instance of Mr W. F. Cooper. Prof. R. T. Hewlett has presented (N. 304) specimens from sheep, found at New Romney, IV. 1907, and Mr J. Davidson found (Liverpool No. 5) specimens on sheep at Lydd, III. 1910. [Pocock, 1900, p. 326, reports that F. Pickard-Cambridge collected specimens from shingle on the beach and from *hedgehog* at Dungeness. Coward, 1907, p. 323, records the finding of a gorged ♀ on Dungeness beach, Kent, in the nest of a plover, *Oedienus scolopax*, the tick having been found lying on the ground beneath two young birds by C. Oldham, VI. 1903. Apparently the first record of the tick in England is that of Neumann[1], 1897, p. 330, who refers to a specimen found on sheep (coll. Bur. Animal Industry, Washington D.C.)] **Wales**: (Liverpool No. 11) from grass on cliffs, Gower, Glamorganshire, S. Wales, V. 1909, Dr J. W. W. Stephens coll. **France**: We have seen (Brumpt No. 9) a ♂ found on *deer* at Fontainebleau, 13. II. 1912, Baron Lestrange coll. [Neumann[1] records specimens from a *bull*, found at Alfort, near Paris, Railliet coll.; specimens from Digne and Beaune, E. Simon coll.; from Villefranche in Aveyron; from *sheep* and *cattle* at St-Jean-de-Luz; nymphs and larvae were found in Aveyron on *horse, hare, red* and *grey partridge* (Neumann coll.)] **Holland**: (Neumann[1] records a ♀ from *Numenius arquatus* (Curlew); a o from *Plecotus auritus*, found at Utrecht[1]; a ♀ from *Erinaceus europaeus*; all in Oudemans' coll.[2]). **Denmark**: We have determined (D.E.M. No. 22) a ♀ collected at Fanö, VII. 1913 by W. Horn. **Germany**: [L. Koch, 1877 *b*, p. 196, states that his type of *Rhipicephalus expositicius* (= ? *H. c.* var. *punctata*) was found near Nürnberg]; the tick was first recorded by Knuth in 1911–1913, who found it in North Schleswig-Holstein. Through the courtesy of Prof. Knuth we have been able to examine his numerous specimens, some of which he has allowed us to retain. The specimens were collected in four districts as follows: (*a*) in Kreis Apenrade: (Kn. Nos. 11, 12) ♂ from *cattle* and *sheep*, Schmedaggar, XI. 1911; (Kn. No. 15) 15 ♂ from *cow* dying of "Milzuptur," an obscure disease, Schmedaggar, 1. XI. 1911; (Kn. No. 14 = N. 2710) 3 ♂s from *cattle* Kassö-Hof, XI. 1911; (Kn. No. 16) 1 ♂ 3 ♀ from *cattle*, Reppel, Gemeinde Schmedaggar, no date; (Kn. No. 7 = N. 2708) 16 ♂ from *cattle*, Krassö-Feld, IX. 1912. (*b*) In Kreis Apenrade and Tondern: (Kn. No. 5) 2 ♂ 40 ♀ from *cattle*, IX. 1912. (*c*) In Kreis Tondern: (Kn. No. 10 = N. 2709) 4 ♂ 1 ♀, from *cattle*, Bau, IX. 1912; (Kn. No. 13) 1 ♂ from *cattle*, Fanderup, IX. 1912; (Kn. No. 9) 1 ♂ 6 ♀, from *cattle*, Braderup, 22. IX. 1913. (*d*) In Kreis Husum: (Kn. No. 8) 1 ♀ with *I. ricinus* ♀, from *cattle*, 21. IX. 1913. (*e*) In East Friesland:

[1] Neumann, 1897, p. 330. [2] Neumann, 1901, p. 260.

(Kn. No. 1 = N. 2705) ♂s ♀s from dairy *cattle*, Island of Norderney, 30. x. 1913; (Kn. No. 6 = N. 2707) ♂s ♀ from *cattle*, Sportplatz, Island of Norderney, 3. xi. 1913; (Kn. No. 3 = N. 2706) ♂s ♀s from *cattle*, Island of Juist, 22. xi. 1913. Prof. Knuth dwells on the notable absence of ♀s in some cases; presumably the ♂s remained upon the hosts after the ♀s had dropped off. **Russia** (South): (N. 3008 and Berlin Mus. No. 353) 2 os found on *Turdus viscivorus* L., in Gouv. Poltawa, 20. iv. 1907, have been recently determined by us. [Yakimoff and Kohl-Yakimoff, 1911, p. 418, record the species from Ananiewsk District, Gouv. Cherson, and from the Caucasus. Their specimens were doubtless determined by Neumann.] **Italy**: (N. 2544 *b*) gorged ♀s from *sheep*, Tuscany, xi. 1913, Prof. A. Berlese coll. [According to Canestrini, 1890, p. 528, and Berlese, 1891, the tick is fairly common on *sheep, goat,* and *fallow-deer*. "*Herpetobia sulcata*" Can. and Fan. also favours these hosts. The tick attaches itself to sheep mainly behind the ears. "*Haemaphysalis rhinolophi*" Can. and Fan. was found on *Rhinolophus ferrum-equinum*. The Italian authors state that the immature stages of "*H. sulcata*" occur on *Lacerta viridis*, and Neumann, 1901, p. 260 records os from *Vipera aspis* (C. Parona coll., Genoa).] **Spain**: Rev. L. Navas of the College de Salvador, Saragossa, sent us for determination a ♀ captured on the ground in the environs of Saragossa, v. 1897. **Hungary**: (N. 1695) ♂s ♀s from *Equus caballus*, Budapest, vi. 1912, Prof. von Rátz coll. **Croatia** and **Dalmatia**: [Neumann, 1897, p. 330, records a ♂ from Fiume, E. Simon coll. Canestrini and also Berlese state that nymphs and larvae occur on *Lacerta muralis* var. *pelagosae* in Dalmatia.] **Roumania** and **Greece**: [Neumann records specimens from Jassy, Léon coll.[1] and from Athens[2].] **Islands in the Mediterranean**: [Neumann records specimens from Corsica[1], E. Simon coll.; nymphs and larvae found on lizards on Cyprus, now in his collection[1]; adults from the Cyclades and Crete, without mention of hosts[2]].

AFRICA: **Canary Islands**: (N. 2080, 2081) ♂s ♀s from goats, Puerto Orotava, Teneriffe, ii. 1913, G. V. Perez coll. [Neumann states that there are specimens in the Paris Museum from the islands and ♂s ♀s collected at Orotava and at Funchal, **Madeira** by Kraepelin (Paris Museum[1]).] **Algeria**: [Neumann records the species as having been found on stones and on a lizard, *Acanthodactylus vulgaris*, at Oran, Dumergue coll.; on *cattle* and *goat* at Blida and Médéa; a

[1] Neumann, 1897, p. 330.
[2] Neumann, 1901, p. 260.

♀ from Marnia[1]; nymphs and larvae from *Lacerta ocellata* var. *tingitana,* at Djebel Ksel, collected by Dumergue[2]. **Egypt:** We have received specimens through the courtesy of Dr M. A. Ruffer (N. 1926, 1928) ♀s from *sheep* and *goat,* Alexandria, XI. 1912; (N. 1929) ♂s ♀s from *sheep,* Mersyne, 1912. [Neumann states that the Smithsonian Institution coll., Washington, D.C., contains specimens taken from sheep in Egypt[1].]

ASIA: Asia Minor: We have received two lots from Smyrna (N. 2552 *a*) ♀ from *horses* and *cattle*; (N. 2553 *a*) ♂s ♀s from *goats*; both collected, XI. 1913 by Mr W. H. J. van Heemstra. **Transcaucasia:** Dr E. Dschunkowsky has sent us numerous specimens for determination that were collected by him about Surnabad from *sheep,* X. 1903 and III. 1904; (N. 782) from *hare,* X. 1903 and III. 1904; (N. 783) from *hare* including typical forms and 4 ♂ without spined coxa IV; (N. 784) 4 ♂ 5 ♀ from *fox,* 1. X. 1903, ♂s without spined coxae; (N. 787) 6 ♂ from *bear,* VIII. 1903, ♂s without spined coxae; (N. 780 *a*) ♂s with spine on coxa IV of normal size, medium size and practically absent; (N. 789) ♂s ♀s from *fox,* 1903, normal ♂s and 5 ♂s without spines. We refer to these forms in the text, p. 384. **Japan:** [Neumann[1] records a ♀ from a *horse,* taken at Aomori. Determination correct ?]

4. HAEMAPHYSALIS LEPORIS-PALUSTRIS (Packard 1869).

Figs. 325–329.

Lit., Synon. and Icon.:

Ixodes leporis-palustris Packard, 1869 *a*, p. 67.

Not *Ixodes chordeilis* Packard, 1869 *a*, p. 67; as stated by Neumann, 1897, p. 343.

Gonixodes rostralis Dugès, 1888, p. 129, Fig. 2. (The author describes under this name an unfed ♀ which he regarded as a ♂, whilst the ♀ and *L* he describes and figures appear to be either *Hyalomma* or *Amblyomma*, but the poor description and figures leave the matter in doubt.) It appears clear that his *G. rostralis* ♂ = *H. leporis-palustris* ♀).

Rhipistoma leporis Osborn, 1896, p. 261, with poor text-figures of ♀, capitulum and tarsus of ♀; wrongly states it is called the "Lone Star Tick" (= *Amblyomma americanum*!).

Haemaphysalis leporis (Packard) in Neumann, 1897, p. 343, Fig. 9; 1901 *a*, p. 111, Fig. 54 (condensed from previous description, the figure also reproduced. We reproduce Neumann's figure). Lahille, 1905, p. 45 (quotes Neumann's

[1] Neumann, 1897, p. 330.
[2] Neumann, 1901, p. 260.

description and states the species (?) occurs in Argentina). Blanchard, 1909, p. 154 (scarcely more than listed; follows Neumann).

Haemaphysalis leporis Packard in Rohr, 1909, pp. 144–146 (merely quotes Neumann's description).

Haemaphysalis leporis-palustris Packard in Hunter and Hooker, 1907, pp. 53, 54. Text-Figs. 7 and 8, Pl. III, Fig. 2; (species not described, brief mention of distribution, biology, hosts; Fig. 7 of ♀ capitulum and scutum is inaccurate; Fig. 8 shows ♂ and ♀ coxae; the plate figure is a poor photomicrograph of a mounted ♀). Hooker, 1908*a*, pp. 47, 48 (referred to as "the rabbit tick of this country" (U.S.A.) and treats of its biology). Banks, 1908, pp. 33, 54, Pl. IV, Figs. 8, 10, and Pl. X, Figs. 2, 6 (♂ and ♀ described, notes geographical distribution; the o described in 14 words; Fig. 8 of ♂ capitulum; Fig. 10 of ♀ capitulum, scutum, spiracle, coxa I and tarsus I; Fig. 2 of ♂ dorsum, ♀ capitulum in ventral aspect; Fig. 6 of ♀ dorsum, unfed and replete). Hooker, 1909, p. 423 (geographical distribution), Hunter and Bishopp, 1911, pp. 228, 229 (brief notes on distribution, hosts and feeding habits). Hooker, Bishopp, and Wood, 1912, pp. 89–96, Pl. VII, Figs. 1–6; (important in that the authors raised the tick experimentally; the figures are photomicrographs of unfed o and *L*, replete o, replete and partly fed ♀, venter of ♂; the photomicrographs are from balsam-mounted specimens excepting those of the replete o and ♀; Fig. 5, a map, giving distribution in the United States and Mexico; they confer the [superfluous] vulgar name of "rabbit tick" upon the species).

Haemaphysalis proxima Aragão, in Rohr, 1909, pp. 100–110, 146, 201, Pl. II, Figs. 12, 13, 16. (Rohr states that Aragão had thus named, but not as yet described, the supposed new species. Rohr gives details regarding its biology and distribution; his figures, microphotographs, illustrate the spiracle, etc. Not to be confused with *Haemaphysalis proxima* Warburton and Nuttall, which = *H. cornigera* Neumann, 1897; see further under following paragraph.)

Haemaphysalis leporis var. *proxima* Aragão, 1911, p. 167, Pl. XI, Figs. 4, 5 (we have seen the type and do not consider the variety should be recognised; the figure is of the ♂).

Haemaphysalis leporis-palustris (Packard) in Hadwen, 1912, pp. 97, 98 (records the tick in Canada; raised the species experimentally and has kindly sent us specimens).

Male (Fig. 325): *Scutum* about 2 × 1·3 mm.[1], widest at the posterior third, punctations coarse and confluent but not deep; a pseudo-scutum

[1] The scutums of 8 ♂ measured as follows in mm.:

N.			N.		
1196	from Canada	1·95 × 1·34	384	from Texas	1·6 × 1·2
1196	,, ,,	1·9 × 1·30	1144	,, Canada	1·6 × 1·17
719	,, Texas	1·9 × 1·3	1144	,, ,,	1·56 × 1·12
384	,, ,,	1·75 × 1·25	1954	,, California	1·14 × 0·8

Banks, 1908, p. 33, states that the ♂ is 1·6 mm. long. Hooker, Bishopp and Wood, 1912, p. 89, give the size of the ♂ (capitulum included?) as ranging from 2·25 × 1·25 down to 1·6 × 1·0 mm.

generally indicated; cervical grooves rather long, convergent and deep throughout their length; lateral grooves commencing behind the pseudoscutum and therefore short, well-marked to the spiracle and faintly continued to include two or three festoons: festoons rather broad. *Capitulum*: base broadest in front, the sides nearly straight and converging posteriorly; cornua slight, but *there are also ventral cornua*: palps longer

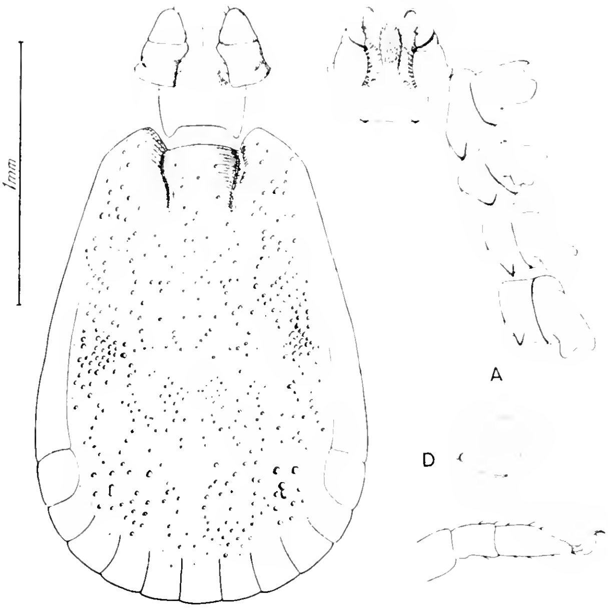


Fig. 325. *H. leporis-palustris* ♂. Dorsum, capitulum in ventral aspect, coxae with trochanters, spiracle and tarsus IV. Drawn from (N. 719) a specimen from Texas. Original, N. C. del.

than broad, sub-cylindrical, article 2 very salient beyond the base, but the lateral contours of articles 2 and 3 form normally nearly a straight line, only slightly recurved at the base of article 2[1]; no dorsal spurs, but a slight point under article 3; hypostome 3|3. *Venter*: anal grooves slightly ogival; spiracle large, with slight dorsal process. *Legs*: two short spurs, internal and external, on coxa I; a slight spur on coxae II–IV; very slight trochantal spurs; tarsus IV long, stout, tapering rapidly.

[1] We have, however, received specimens (N. 1144) from Canada which are undoubtedly *H. leporis-palustris*, but in which article 2 of the palp is much more recurved at the base.

Female (Figs. 326, 327): *Scutum* about 0·9 × 0·8 mm.[1], appearing

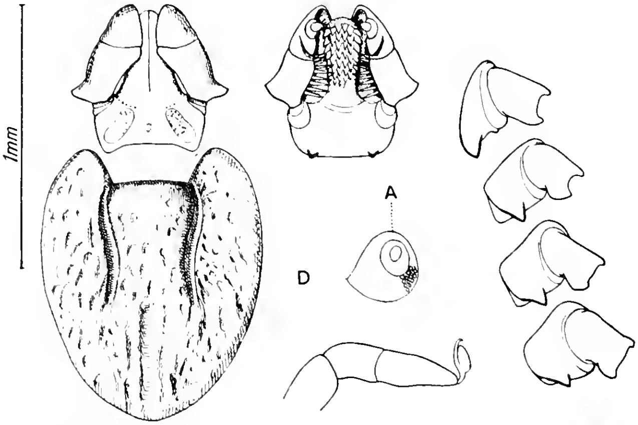


Fig. 326. *H. leporis-palustris* ♀. Scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. Drawn from (N. 719) a specimen found with the ♂ in the foregoing Fig. Original, N. C. and E. W. del.

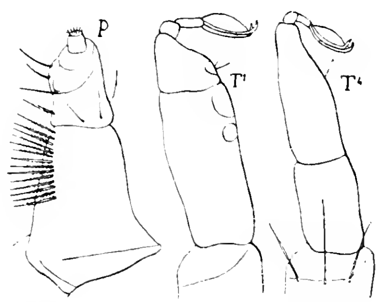


Fig. 327. *H. leporis-palustris* ♀. (*P*) Palp of left side in ventral aspect, (T^1 and T^4) tarsi I and IV. × 80. Neumann, 1897, Fig. 9. (Reprinted from original block.)

[1] The scutums of 9 ♀ measured as follows in mm.:

N.			
1196	from	Canada	1·1 × 1·0
1144	,,	,,	0·9 × 0·82
719	,,	Texas	0·9 × 0·8
384	,,	,,	0·9 × 0·8
1144	,,	Canada	0·85 × 0·8 — the *body* of this specimen (unfed) measured 1·7 × 1·2 mm.
1954	,,	California	0·72 × 0·65
,,	,,	,,	0·72 × 0·6
,,	,,	,,	0·7 × 0·64
,,	,,	,,	0·66 × 0·56

Hooker, Bishopp and Wood, 1912, p. 89, give the size of the ♀ (capitulum included ?) as ranging from 2·5 × 1·5 down to 2·25 × 1·25 mm., when unfed, and attaining 6 × 3·5 to decidedly longer than broad, oval, narrowing posteriorly, with coarse confluent punctations: cervical grooves long and deep. *Capitulum*: base broader than in ♂; porose areas oval, converging anteriorly, far apart; cornua slight, *ventral cornua well-marked*; palps with all the characters of the ♂ but relatively longer. *Venter*: spiracle sub-circular, with slight dorsal process. *Legs* as in the ♂. When replete, the ♀ may attain 11·3 × 7·5 mm.

Nymph (Fig. 328): *Scutum* relatively broader than in the ♀. Hypostome 2 | 2. Other characters as in the ♀; the dorsal and *ventral cornua* being even emphasized. When replete the o may attain 2·5 × 1·75[1].

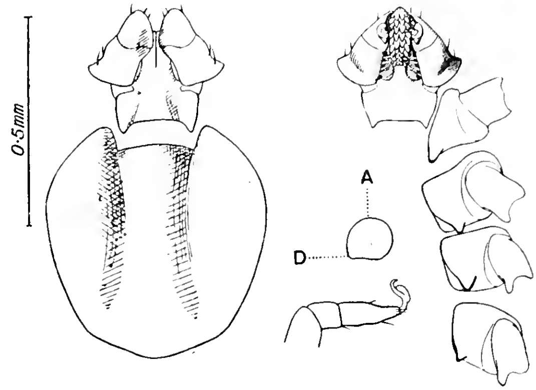


Fig. 328. *H. leporis-palustris* o. Scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. Drawn from (N. 2324) Texan specimen. Original, N. C. del.

Larva (Fig. 329): resembles the o, with still shorter palps and broader, almost diamond-shaped scutum: the latter measuring

11·3 × 7·5 × 5·3 mm. when replete. Banks, 1908, p. 33, states that the scutum is 0·9 mm. long.

[1] The following measurements, in mm., were made from (N. 2324) nymphs received from Mr Bishopp:

Scutums	Body (unfed)
0·44 × 0·44	1·0 × 0·32
0·44 × 0·43	
0·44 × 0·42	
0·43 × 0·44	
0·43 × 0·42	

Hooker, Bishopp and Wood, 1912, p. 89, give the size of the o (including capitulum?) as 1·33 × 0·8 when unfed, 2·5 × 1·75 when replete; scutum 0·42 × 0·43; capitulum 0·22 long (between tips of cornua and palp).

0·26 × 0·3 mm.[1] Capitulum with *ventral cornua*. *Legs*: coxae feebly armed. When replete the *L* may attain 1·33 × 0·9 mm.

Our descriptions of the ♂ and ♀ refer more particularly to Texan specimens (N. 719) named by Mr N. Banks, whilst the o and *L* are described from specimens (N. 2322–2324) raised in Texas by Mr F. C. Bishopp, who kindly presented us with them.

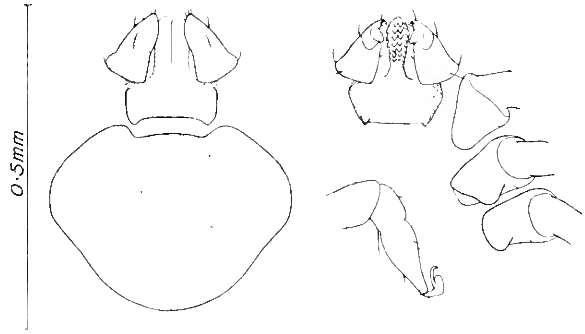


Fig. 329. *H. leporis-palustris*, larva. Scutum, capitulum in dorsal and ventral aspects, coxae and tarsus III. Drawn from (N. 2321) Texan specimen. Original, N. C. del.

This is the only known species of which the ♂ and ♀ have ventral cornua or points projecting postero-laterally from the basis capituli as well as dorsal cornua. Such ventral cornua occur, however, in the immature stages of *H. cinnabarina* and *H. cinnabarina* var. *punctata*, which are nearly allied forms.

See further under Notes on Biology, p. 530.

[1] The following measurements, in mm., relate to larvae:

	Scutums	Bodies (unfed)		Bodies (replete)
N. 2322	0·26 × 0·31	0·55 × 0·45	N. 2323	1·2 × 0·38
	0·26 × 0·3	0·53 × 0·45		1·15 × 0·37
	0·26 × 0·3			1·09 × 0·37
	0·25 × 0·3			1·05 × 0·35
				1·05 × 0·35

Hooker, Bishopp and Wood, 1912, p. 89, give the size of the scutum at 0·24 × 0·3 mm., that of the unfed larvae (capitulum included?) at 0·53 × 0·38 mm., the replete larvae attaining 1·33 × 0·9 mm. Capitulum 0·16 mm. long. The larvae we received from Mr Bishopp were somewhat shrivelled by preservation in alcohol, consequently our measurements of the replete os are no doubt too low.

Geographical Distribution.

According to American authors, *H. leporis-palustris* is widely distributed in the **United States**, occurring in the following States: Alabama[8,7]; Arizona[5,6], uncommon[8]; Arkansas[8]; California[8,6], in Kern County[5], it is uncommon on *rabbits*[7], though Marx states it is common[3,2]; Colorado[8,5,6]; Florida[8,6]; Idaho[8]; Illinois[8]; Kansas[8,6], being common[3] and having been found on *hare* by Marx[2]; Louisiana[8,6], at Shreveport[5]; Massachusetts[8,6]; Minnesota[8,6]; Montana[8,7] where it occurs in large numbers on *rabbits* in and about the State. Mr W. V. King is stated to have killed 2 *Lepus bairdi* at Florence, 3. IV. 1911, which were infested with 1033 ticks, many of which were replete ♀s; New Mexico[8], uncommon; New York[8,6], in Keene Valley and Dunnemora[5]; North Carolina[8,5,6], Packard[1] describes the species from a ♀ found on *Lepus palustris* at Fort Macon; Nevada[8,6]; Oklahama[8,6]; Oregon[8]; Tennessee[8]; Texas[6], where it was first collected by Marx[2], uncommon in the western portion of the State[8], it occurs at Columbus, Victoria and Maverick[5], stated to be common by Marx[6], and found on a *horse* by Curtice[2,4], found chiefly on the ears of *hare* and *rabbit* in 1906–1907[4]; Virginia[5,6,8]; Washington[8]; Wyoming[8].

American authors[9] record the following hosts of the tick in the United States: Besides the type-host, *Lepus palustris*, the tick occurs on 6 other species of *hare* and *rabbit*, these appearing to be the chief hosts. Adults also occur on *Felis domestica*, *robin*, *quail* and *meadow-lark*. Immature stages are abundant on quail and meadow-lark, scarcer on *chaparral cock* and *Brewer's blackbird* (assuming that they were rightly determined, the immature stages are also found on thrush, field-lark, jackdaw, blue jay, magpie and pine squirrel). Rabbits are nearly always infested about the head, on the crest and occasionally about the ears and eyes; when heavily infested[10] the rabbits are often much weakened and can be easily captured.

[1] Packard, 1869 *a*, p. 67.

[2] Neumann, 1897, p. 343, who examined Marx's specimens in the Bureau of Animal Industry collection and in the Paris Museum.

[3] Marx, cited by (4) who give no reference; his specimens examined by (2).

[4] Hunter and Hooker, 1907, pp. 53–54.

[5] Banks, 1908, p. 33.

[6] Hooker, 1909, p. 423.

[7] Hunter and Bishopp, 1911, p. 228.

[8] Hooker, Bishopp and Wood, 1912, pp. 90–96.

[9] Hooker, Bishopp and Wood, 1912, p. 90.

[10] Hunter and Bishopp, 1911, p. 228, give fewer hosts than the authors previously cited.

Mexico: [Dugès, 1888, p. 129, found his *Gonixodes rostralis* (see our synonymy) at Guanajuato. Curtice is stated to have also found the tick in Mexico[1]. Assuming that the determinations were correct, immature stages have been found on birds in Tamaulipas and Monterey[2].]

We have received or determined specimens from the following countries:

UNITED STATES: from **Texas**: (N. 719) ♂ ♀ from Victoria, presented by the U.S. Dept. of Agriculture; (N. 384) ♂ ♀ found on *rabbit,* Maverick County, v. 1906, presented by Mr W. D. Hunter; (N. 2321–2324) fed and unfed os and *L* raised at Refugio and Utopia in 1912–13 and presented by Mr F. C. Bishopp. **California**: (N. 1954) small ♀s from Claremont (N. 2772) 12 ♀ from *Lepus auduboni,* San Francisco, 30. IV. 1909, coll. M. B. Mitzmain.

CANADA: (N. 1144) ♂ ♀ from *Lepus americanus,* Aweme, Manitoba, 13. V. 1910, coll. N. Criddle and (N. 1196) adults, from *Lepus dalli,* Peardonville, British Colombia, 17. VI. 1910, collected by Dr S. Hadwen, who (1912, p. 98) also found the tick at Mt Lehman and at Nelson, B.C.

CENTRAL AND SOUTH AMERICA: **Panama**: (N. 1907) ♀ s, with their progeny of eggs and larvae, the ♀ s having been taken from *Dasyprocta* sp., at Mataichan, Canal Zone, IX. 1911, by Dr S. T. Darling. **Brazil**: (N. 1894) ♂ ♀ from *Lepus braziliensis,* Manguinhos, VII. 1907, presented by Dr H. de B. Aragão (*H. leporis* var. *proxima* Aragão, of which we have also seen the type): [Neumann, 1901, p. 262, records a ♀ from Brazil, collected by Delalande (Paris Mus.), and Rohr, 1909, pp. 100–110 states it occurs on *wild rabbits* and *Dasyprocta agouti*]. **Paraguay**: (Berlin Mus. 113, 132) ♀ o collected at San Bernardino by K. Fiebrig. **Argentine**: [Lahille, 1905, p. 45, states that the species attacks *man,* and that S. Venturi has found it on *Penelope obscura* (a bird) in the Province of Santa Fe, Colonia Mocovi, in September; his determination is uncertain, as he merely quotes Neumann's description].

[1] Hunter and Hooker, 1907, p. 53; Hooker, 1909, p. 423.
[2] Hunter and Bishopp, 1911, p. 228.

5. HAEMAPHYSALIS MONTGOMERYI Nuttall, 1912.

Figs. 330, 331.

Lit. and Icon.: Nuttall, 1912, pp. 57–59, Figs. 7, 8 (reproduced).

Male (Fig. 330): *Scutum* 1·9 × 1·3 to 2·5 × 1·6 mm.[1], long-oval; cervical grooves normal; lateral grooves including the first festoon

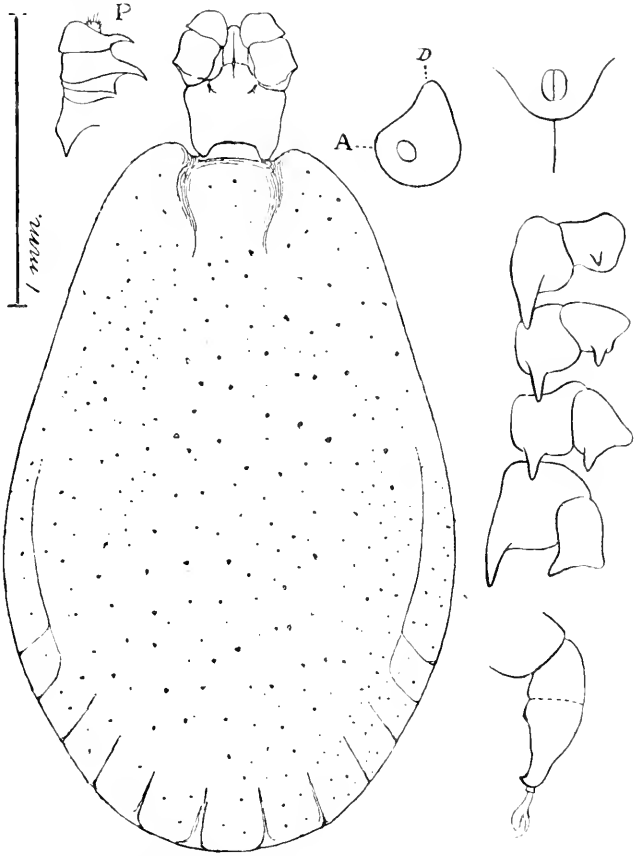


Fig. 330. *Haemaphysalis montgomeryi* ♂. Dorsum, right palp (*P*) in profile, spiracle, anal grooves, coxae with trochanters, tarsus IV. (G. H. F. N. and F. M. H. del.) Nuttall, 1912, Fig. 7.

[1] Five ♂ gave the following measurements in mm.:

Scutums	Capitulums
2·5 × 1·6	0·4
2·3 × 1·4	0·5
2·3 × 1·4	0·5
2·0 × 1·4	0·5
1·9 × 1·3	0·4

and attaining half the body-length; festoons longer than broad. *Capitulum*: 0·4 to 0·5 mm. long, base with lateral borders almost straight, converging behind; cornua pointed, continuous with the crescentic dorsal ridge; ventral ridge sharp, with trenchant lateral angles; palps with article 2 protruding slightly, about a third longer than article 3; articles 2 and 3, viewed laterally (*P* in Fig. 330), bear sharp protruding recurved spines ventrally; hypostome 5 | 5 or 6 | 6, armed nearly to the base with 12 distinct teeth per external file, besides finer denticles and a large corona. *Venter*: hairy, genital orifice between coxae II; spiracle large with well-marked postero-dorsal elongation. *Legs* relatively strong; coxae I–IV with a long, pointed, retrograde spur, longest on coxa I; trochanters with pointed spurs; tarsi short, tapering from near the pseudoarticulation, bearing a small distal spur, and, in some specimens, a slight median protuberance ventrally; pads almost as long as the claws.

Female (Fig. 331): *Scutum* 0·9 × 1·1 mm.[1], cordiform, with slight lateral angles, broadly rounded behind; cervical grooves well-marked, extending slightly beyond half the length; punctations poorly marked,

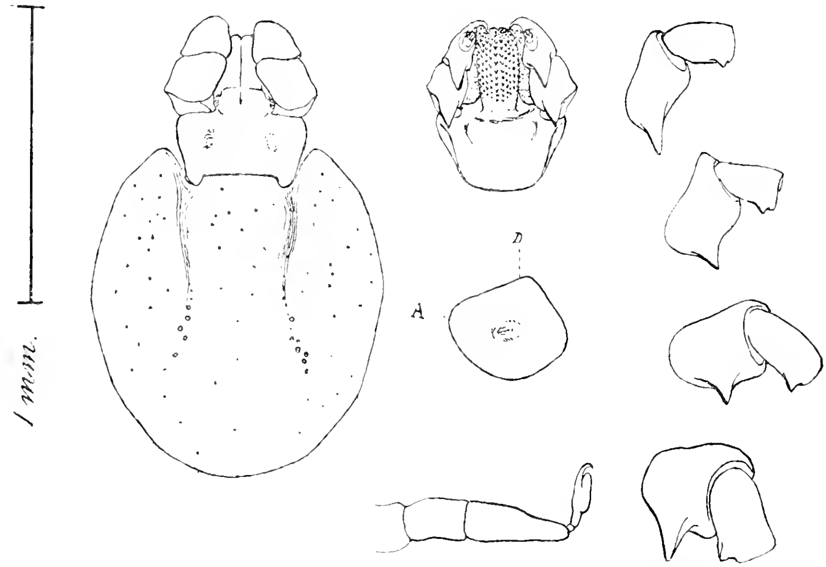


Fig. 331. *Haemaphysalis montgomeryi* ♀. Capitulum and scutum, capitulum in ventral aspect, coxae with trochanters, spiracle and tarsus IV. (F. M. H. del.) Nuttall, 1912, Fig. 8.

[1] All of the ♀ were but partly gorged; they measured roundly 4 mm. in length.

uniformly distributed. *Capitulum* 0·5 mm. long, resembling that of ♂, but broader, shorter, with cornua less pronounced; porose areas small, oval, far apart, converging in front, placed anteriorly. *Venter*: vulva between coxae II; spiracle with dorsal and posterior margins flattened. *Legs* resembling those of the ♂, but the spurs on coxae and trochanters less pronounced; tarsi tapering gradually, unarmed.

Described from 9 ♂ and 2 ♀ taken from the ears of *ponies*, at Muktesar, United Provinces, India, 30. v. and 1 7. vi. 1905, also on a *bull's* ear at Bhulumaya: 3 ♂ found on a *dog*, Muktesar, 3. viii. 1905; 2 ♀ found on the ear of a *bull*, at Berinag, U.P., 9. ix. 1905; all of these specimens (N. 760, 761, 762) were collected by Dr R. E. Montgomery, after whom the species is named. We have since received: (N. 1407) ♂ from a *dog*, Balaghat, Central Provinces, India, 1908, coll. S. H. Gaiger; (N. 2251) ♀ from *sheep*, Gilgit, Kashmir, v. 1913, coll. Dr M. Abdullah; (N. 2923) ♂ from *dog*, Kashmir, 1912, coll. J. E. M. Mellor; and specimens have been sent to us for determination by the Indian Museum: ♂ and ♀, collected at Almora[1], Kumaon (5500 ft. elevation), vi. 1911, by C. Paiva.

Types in Cambridge: we have presented co-types to the Berlin Museum and to the Neumann collection, Toulouse.

6. HAEMAPHYSALIS KINNEARI Warburton, 1913.

Fig. 332.

Lit. and Icon.: Warburton, vii. 1913, pp. 127, 128, Fig. 6 (reproduced).

Male: Unknown.

Female (Fig. 332): *Scutum* sub-circular, slightly broader than long, 0·8 × 0·9 mm., with numerous medium or rather large punctations, most numerous on the lateral fields; cervical grooves, beginning as shallow depressions, deepening into oval pits at some distance from the anterior border, then broad and shallow to within a short distance of the postero-lateral borders. *Capitulum* base twice as broad as long, rectangular, with blunt cornua; porose areas apparently nearly circular, but ill-defined and not easily distinguished; palps long and, in general facies, much like those of *H. montgomeryi*, having the lateral salience slight and very obtuse; instead, however, of being smoothly rounded

[1] Almora is distant about 14 miles from Muktesar where the types were found.

as in that species, their dorsal surface presents corrugations, article 3 has an irregular posterior border, and the internal contour of article 2 presents a strong rounded protuberance anteriorly: moreover, article 2 bears no ventral retrograde spur, though one is present under article 3; hypostome 4 | 4. *Venter*: spiracle rather large, oval, with blunt dorsal process; anal grooves ogival. *Legs*: coxae with very slight armature of the normal type; tarsus IV rather long (especially the proximal pseudo-segment), somewhat tapering; no trochantal spurs.

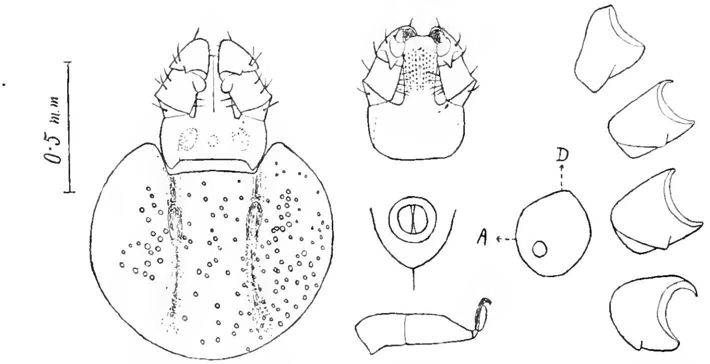


Fig. 332. *H. kinneari* ♀. Capitulum and scutum, ventral aspect of capitulum, anus with anal grooves, tarsus IV, spiracle and coxae. (N. C. del.) Warburton, 1913, Fig. 6.

Described from (N. 1997) 1 ♀ taken from a *tiger* at Kadra, Kanara, **India** (Bombay Nat. Hist. Mammal Survey), XI. 1911, by Mr N. B. Kinnear, after whom the species is named. The specimen was found in company with *H. bispinosa* and *Amblyomma prolongatum*.

Type in Cambridge.

A large species, recalling *H. montgomeryi* in general appearance but easily distinguishable from that species by the rounded scutum, the absence of a ventral spur on the second palpal article and the absence of trochantal spurs.

7. HAEMAPHYSALIS ABORENSIS Warburton, 1913.

Fig. 333.

Lit. and Icon.: Warburton, VII. 1913, pp. 122, 123, Fig. 1 (reproduced).

Male: Unknown.

Female (Fig. 333): *Scutum* broader than long, 1·5 × 1·8 mm., broad-oval, pale yellow; punctations numerous and fairly large, distributed laterally and posteriorly, inconspicuous in the median field; cervical grooves far apart, extending to the posterior border. *Capitulum*: base much broader than long, cornua short and blunt; porose areas ill-defined, ovate, the interval greater than their diameter; palps with very slight and obtuse lateral salience on article 2, of which the internal border is nearly straight and much longer than the external border; the dorsal surface of articles 2 and 3 smooth, rounded and destitute of spines; a short, blunt spur under article 3; hypostome spatulate, well-covered

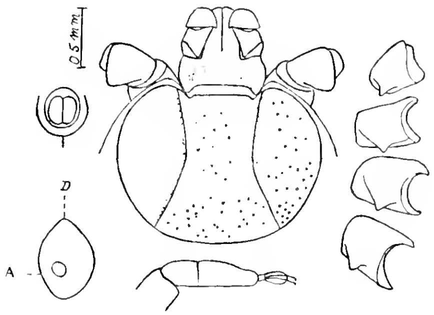


Fig. 333. *H. aborensis* ♀. Capitulum and scutum, anus with anal grooves, spiracle, tarsus IV and coxae. (N. C. del.) Warburton, 1913, Fig. 1.

on its anterior $\frac{2}{3}$ by 4|4 sub-equal teeth. *Venter*: spiracle large, transversely oval, with slight blunt dorsal projection; anal grooves nearly semi-circular, with hardly any visible median post-anal groove. *Legs*: very long and strong; coxa I with a short, blunt internal spur; coxae II–IV with slight spur in the middle of the posterior border; tarsus IV long and tapering, pad short.

Described from 1 ♀ found on grass at Yambung, **India**, 13–17. I. 1912, by S. W. Kemp (Abor Expedition); the species is remarkable because of its size.

Type in the Indian Museum, Calcutta (No. 1251/17).

8. HAEMAPHYSALIS FORMOSENSIS Neumann, 1913.

Figs. 334, 335.

Lit. and Icon.: Neumann, 1913, pp. 135–137, Figs. 1, 2 (♂ capitulum in ventral aspect with coxa I, ♀ capitulum in dorsal aspect with scutum and trochanter I, not reproduced).

Male (Fig. 334): Body broadly oval, livid brownish-yellow, legs lighter. *Scutum* about 2·4 × 1·9 mm.[1]; punctations numerous, but

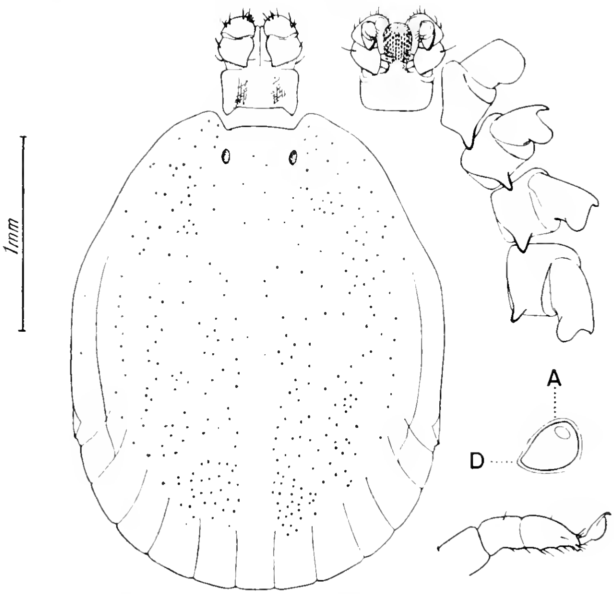


Fig. 334. *H. formosensis* ♂. Dorsum, capitulum in ventral aspect, coxae with trochanters, spiracle and tarsus IV. (N. 2730 Co-type.) Original, N. C. del.

very shallow and inconspicuous; cervical grooves slight oval pits; lateral grooves long and rather noticeably straight, including one festoon; festoons long. *Capitulum*: base rectangular (in some specimens rather broader posteriorly), cornua strong and blunt; palps

[1] The scutums of the 5 ♂ co-types in our collection (N. 2715, 2730) measured respectively:

2·5 × 1·9 mm.
2·4 × 1·85 ,,
2·35 × 1·85 ,,
2·3 × 1·9 ,,
2·1 × 1·75 ,,

short, very slightly salient laterally, with rounded contours and without dorsal spines; article 2 rather longer than article 3; a small but distinct retrograde spur under article 3; article 2 ending in a point which, however, does not project; hypostome short, broad in front, corona rather small, dentition 6|6, the median teeth very small, the three external files much larger, about 8 teeth per file. *Venter*: spiracle pear-shaped, the pointed end dorsal. *Legs*: coxae I–IV with rather strongly-developed spurs; coxa I has its posterior end truncated, and the spur proceeds from its postero-external angle; small trochantal spurs, progressively diminishing, and almost absent on trochanter IV[1]; tarsus IV stout, with pseudo-segments of almost equal length, tapering moderately, with a small terminal ventral spur; pad moderate.

Female (Fig. 335): *Scutum* about 1·1 × 1·3 mm., sub-circular, but rather broader than long, with numerous fine shallow punctations;

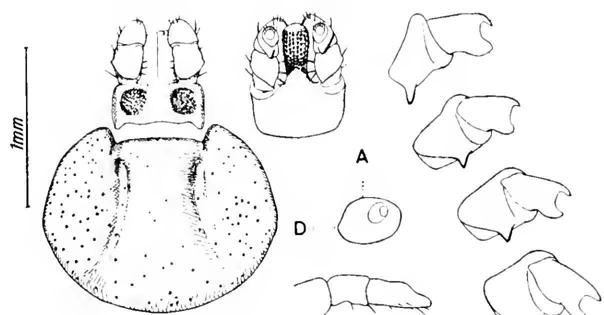


Fig. 335. *H. formosensis* ♀. Capitulum in dorsal and ventral aspects, scutum, coxae with trochanters, spiracle and tarsus IV. (Deutsches Entomol. Mus., Type.) Original, N. C. del.

cervical grooves beginning as small pits behind the anterior border and visible as shallow grooves almost to the posterior border. *Capitulum*: base rectangular, twice as broad as long, with slight blunt cornua; porose areas large, far apart, oval, converging anteriorly; palps with hardly any lateral salience, longer than in the ♂, but with the same characteristics; hypostome 4|4, with a trace of 5|5 at its posterior end. *Venter*: spiracle transversely oval, with faint dorsal protuberance. *Legs*: coxae as in the ♂; trochantal spurs absent; tarsus IV more slender than in the ♂, unarmed.

[1] The slight spur on trochanter I, is omitted in the figure.

Neumann founded this species on 20 ♂ and 2 ♀ found on the *dog* at Kosempo, **Formosa,** IV. 1912. We here redescribe the species from 5 ♂ and 1 ♀ belonging to the type material: 1 ♀ (type) lent and 4 ♂ (co-types) presented by the Deutsches Entomologisches Museum, and 1 ♂ (co-type) presented by Professor L. G. Neumann. Our description and figures differ somewhat from the author's. We have found (N. 2958) a ♀ from **Burma** (in a tube together with a ♀ *H. hystricis* probably from *Hystrix bengalensis* or *Ursus torquatus*) in the L. Fea collection at the Museo Civico di Storia Naturale, Genoa.

Types (D.E.M. No. 14 ♂ ♀) in the Deutsches Entomologisches Museum, Berlin-Dahlem; co-types (♂ ♀) in the Toulouse and (N. 2715, 2730; 5 ♂s) Cambridge collections.

9. HAEMAPHYSALIS JAPONICA Warburton, 1908.

Figs. 336, 337.

Lit., Icon. and Synon.:

Haemaphysalis flava Neumann, 1897, p. 333, *pro parte*; Neumann, 1905, p. 237, *pro parte* (see discussion under *H. flava* Neumann, p. 408).

Haemaphysalis japonnica Warburton, 1908, pp. 512, 513, Figs. 3, 4 (reproduced). Blanchard, 1909, p. 152, wrongly gives *H. japonica* as a synonym of *H. flava* Nn.

Haemaphysalis flava flava Neumann, 1911 *a*, p. 12.

Male (Figs. 336, 337): *Scutum* 2·5 × 1·8 mm., oval, rather broad, not much narrowed in front, glossy yellow, with numerous rather shallow punctations, absent in places; cervical grooves, oval pits; lateral grooves fairly long, markedly concave internally, including distinctly one and faintly two festoons; festoons rather short, almost square, punctate. *Venter* glossy, punctate, genital orifice large, between coxae II; anal grooves ogival: spiracle short comma-shaped. *Capitulum* base broad, punctate, with short blunt cornua; palps with article 2 moderately salient, the lateral contours of articles 2 and 3 unbroken; no dorsal spines; ventrally article 2 is much corrugated and forms a retrograde angle; a short spine under article 3; hypostome spatulate with very large corona, dentition 5 | 5, small pointed sub-equal teeth. *Legs*: strong; coxae large, especially coxa IV, all with a short spur, sharp on coxa I, conical on coxae II–IV; tarsus IV fairly long, considerably more slender than the preceding article.

Female: unknown.

Our description is based on numerous specimens found in a tube labelled "No. 173, *H. flava*" in the British Museum, the specimens having been wrongly determined by Neumann. The ticks were found on *Nemorhaedus crispus* at Hondo, **Japan**, by the Duke of Bedford's

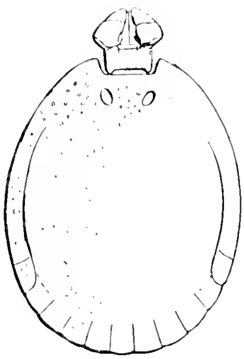


Fig. 336.

Fig. 337.

Fig. 336. *H. japonica* ♂, dorsum. Warburton, 1908, Fig. 3.
Fig. 337. *H. japonica* ♂, venter and spiracle. Warburton, 1908, Fig. 4.
(Sketches, C. W. del.)

collector. We have since received (N. 1374) 24 ♂ taken from a *roe-buck* at Kansu, **China**, the specimens were purchased by us from Mr T. V. Sherrin, taxidermist.

Types in the British Museum and co-types (N. 1247, 2 ♂) in Cambridge.

Haemaphysalis japonica var. douglasi Nuttall and Warburton, 1915, n. var.

This variety differs from the type as follows:

Male: Distinctly smaller. *Scutum* 2·1 × 1·5 mm., narrower in front, and with straighter sides and lateral grooves. *Palps* with ventral spine on article 3 distinctly longer and sharper.

Female: unknown.

Described from 4 ♂ taken from *roe-deer*, at Ten-an-fu, Shiensi, Northern **China**, 19. v. 1909, by Captain H. E. M. Douglas.

Types in the British Museum and co-types (N. 1248 2 ♂) in Cambridge.

10. HAEMAPHYSALIS PAPUANA Thorell, 1882.

Figs. 338–341.

Lit. and Icon.: Thorell, 1882, pp. 62-66, Pl. VI, Figs. 40–45 (♂ dorsum and venter, ends of digits, foot; ♀ dorsum; good figures). Canestrini, G., 1884, p. 705 (repr. p. 13) Pl. VI, Fig. 4 (figures the capitulum of a specimen he determined as *H. papuana* from Queensland; his determination is probably wrong, if not the figure is inaccurate). Neumann, 1897, pp. 336, 337. Rainbow, 1906, p. 165 (lists the tick as occurring in Australia on Canestrini's authority cited above q.v.). Warburton, 1908, pp. 514–516, Fig. 6 (reproduced). Blanchard, 1909, p. 154 (species listed only). Neumann, 1911 *a*, p. 108.

Male (Fig. 338): *Scutum* about 2·2 × 1·6 mm.[1], yellow, flat, broadest towards the posterior end, coarsely pitted except along certain ridge-

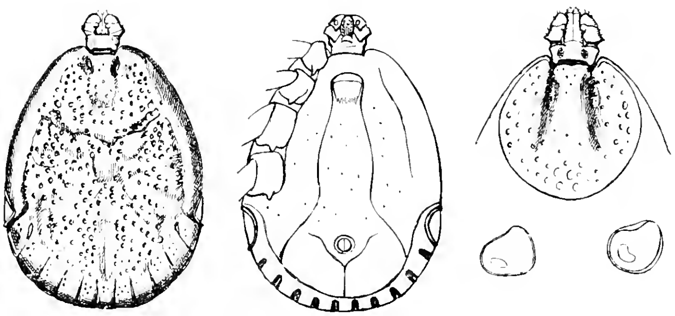


Fig. 338. *H. papuana* ♂, dorsum and venter; ♀ capitulum and scutum; ♂ and ♀ spiracles. Specimen from Borneo. Warburton, 1908, Fig. 4. E. Wilson del.

like tracts where punctations are absent; festoons about as broad as long, the intervals often dark and broadening distally; cervical

[1] The following measurements, in mm., relate to 20 ♂ from various sources:

N.		Scutums	N.		Scutums
309	from Borneo	2·5 × 1·7	295	from Borneo	2·2 × 1·6
1563	,, ,,	2·45 × 1·8	1563	,, ,,	2·15 × 1·55
496	,, Java	2·4 × 1·65	1563	,, ,,	2·15 × 1·52
1563	,, Borneo	2·4 × 1·76	220	,, ,,	2·14 × 1·5
496	,, Java	2·34 × 1·6	2116	,, Malaya	2·1 × 1·6
220	,, Borneo	2·25 × 1·6	1563	,, Borneo	2·1 × 1·6
1563	,, ,,	2·3 × 1·7	1563	,, ,,	2·1 × 1·57
1563	,, ,,	2·27 × 1·6	309	,, ,,	2·05 × 1·65
220	,, ,,	2·24 × 1·7	1563	,, ,,	2·04 × 1·54
309	,, ,,	2·2 × 1·65	1563	,, ,,	1·97 × 1·43

The size of the ♂ given by Thorell (about 3 × 2 mm.) is apparently only roughly approximate and doubtless includes the capitulum.

grooves consist of oval pits with slight shallow continuation; lateral grooves very short and ill-defined, beginning about midway along the body-length and ending behind the spiracles. *Capitulum*: base rectangular, with slightly convex sides, broad blunt cornua, coarsely punctate dorsally; palps only slightly salient, the external angle of article 2 fairly sharp, its inner dorsal border has an inward projection distally; no distinct dorsal spines, but the posterior border of article 3 is sharply angular in the middle; article 2 is sharply angular ventrally; a short, retrograde ventral spine on article 3; hypostome 4|4. *Venter*: yellow-brown, darker than the scutum, glabrous; finely punctate; sexual orifice broad, between coxae II; sexual grooves far apart, nearly parallel; festoons well-marked ventrally, with dark intervals; spiracles yellow, ovoid, with fairly pronounced dorsal process. *Legs*: a short sharp spur on coxa I, a very slight spur near the middle of the posterior border of coxae II and III, a very short spur at the inner angle of coxa IV; trochanters slightly spurred; tarsi relatively short, somewhat humped; pad medium.

Atypical ♂ from Malaya (Fig. 339). We include under *H. papuana*

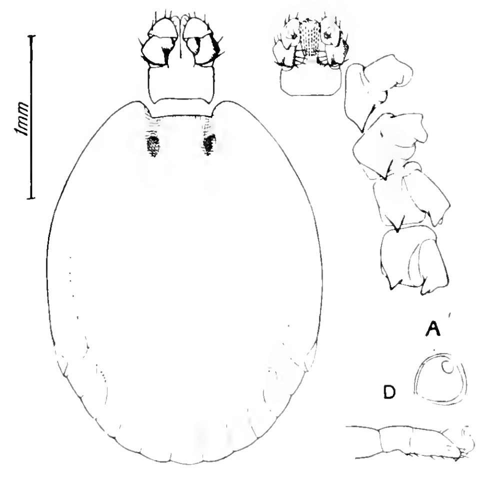


Fig. 339. *H. papuana* ♂ (N. 2116, atypical form from Malaya). Dorsum, ventral aspect of capitulum with coxae and trochanters, spiracle and tarsus IV. Original, N. C. del.

a specimen (N. 2116) from Malaya which only differs from the typical form in that the characteristic coarse punctations are absent: the scutum is smooth, irregularly undulating, with very faint shallow punctations.

Female (Fig. 338): *Scutum* nearly circular, about 1 × 1 mm.[1], bright yellow, coarsely pitted; cervical grooves shallow, concave externally. *Capitulum*: base broader and shorter than in the ♂, with very slight cornua; sides somewhat convex; porose areas large, oval, far apart, converging anteriorly; palps longer and narrower than in the ♂; article 2 with sharper external angle, its inner dorsal contour like that of the ♂. *Venter*: spiracle ovoid, with blunt dorsal protuberance, yellowish. *Legs*: coxae as in the ♂; tarsus IV tapering gradually, the distal pseudo-segment rather long.

Nymph (Fig. 340): *Scutum* deeply emarginate, oval, about as long as broad, but appearing longer (0·45 × 0·45 mm.), of uneven surface

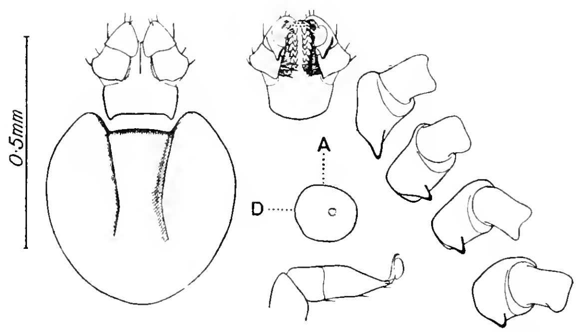


Fig. 340. *H. papuana*. Nymph. Capitulum in dorsal and ventral aspects, scutum, coxae with trochanters, spiracle and tarsus IV. Specimen (N. 220) from Borneo. Original, N. C. del.

and more punctate than is usual with nymphs of this genus. Cervical grooves well-marked, nearly parallel for half the scutal length. *Capitulum*: base rectangular with slight cornua; palps slightly salient laterally, fairly long; article 2 about equal in length to article 3; no dorsal spines, but the inner angle of article 3 slightly recurved; a slight retrograde spur under article 3; hypostome rather narrow, 2|2. *Venter*: spiracle circular. *Legs*: coxae normal; tarsus IV short and tapering rapidly; pad fairly long.

[1] The following measurements, in mm., relate to 8 ♀ from various places in Borneo:

N.	Scutums	N.	Scutums
309	1·15 × 1·2	1563	0·95 × 1·07
220	1·05 × 1·15	1563	0·95 × 1·05
295	1·0 × 1·0	220	0·9 × 1·05
220	0·97 × 1·0	1563	0·9 × 1·03

Larva (Fig. 341): *Scutum* cordate, broader than long (about 2·3 × 3·3 mm.). *Capitulum*: like that of the o, with obscure division between palpal articles 2 and 3. *Legs*: as in the o, but the spurs on coxae II and III practically absent. When replete, the larva attains 1·35 × 1·1 mm.

Thorell's excellent figures of the ♂ and ♀ leave no doubt as to the identity of this species, and show clearly various characteristics not mentioned in his description, such as the ridge-like tracts, referred to in our description, the short indefinite lateral grooves, and the inward dorsal projection of article 2 of the palps.

Our description is based on specimens collected in **Borneo** by Dr A. R. Wellington: (N. 220, 295) 2 ♂ 2 ♀ 3 o from *dog*, Sarawak,

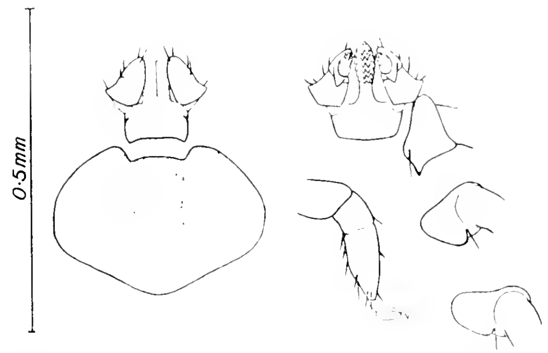


Fig. 341. *H. papuana*. Larva. Capitulum in dorsal and ventral aspects, scutum, coxae, tarsus III. Specimen (N. 1563) from Borneo. Original, N. C. del.

I. 1907, and (N. 309) 3 ♂ 1 ♀ from *pig*, Sarawak, VII. 1907. We have also received (N. 1563) 30 ♂ 1 ♀ 1 o and 1 *L* from *Ursus malayanus*, collected II. 1912 at Kuching, Sarawak, by J. C. Moulton. We possess specimens from **Java**: (N. 496 *b* ♂) from *Felis pardus*, collected by Dr J. C. Koningsberger in 1908 and (N. 3117 *a* ♂) from *wild pig*, Tjibaroesa near Buitenzorg, 1914, Dr de Blieck coll.; we have determined adults found in **Sumatra** on a *tiger* (Schüffner 3*a*) 1912. The atypical form (N. 2116 ♂) we have figured, was found on a pariah *dog*, near Kota Baru, Kelantan, **Federated Malay States**, 17. III. 1913, by Dr J. D. Gimlette.

Thorell's types (1 ♂ 1 ♀) were found on a mammal at Ramoi, **New Guinea**; they were collected by L. M. D. Albertis. We do not know where these types are deposited. Our types of the o and *L* are in Cambridge.

11. HAEMAPHYSALIS FLAVA Neumann, 1897.

Figs 342, 343.

Lit., Synon. and Icon.:

Haemaphysalis flava Neumann, 1897, pp. 333–336, Fig. 3 (digit; not reproduced); Neumann, 1901, p. 260 (*pro parte*).

Haemaphysalis flava var. *armata* Neumann, 1905, pp. 237, 238.

Haemaphysalis flava Neumann in Dönitz, 1905, pp. 129, 130.

Haemaphysalis flava Neumann 1897, in Warburton, 1908, pp. 510–512, Figs. 1 and 2 (♂ and ♀ described; figures reproduced); Blanchard, 1909, p. 151 (only a few lines).

Haemaphysalis flava armata Nn. in Neumann 1911 *a*, p. 112 (raised to a sub-species of his *H. flava* of which it constitutes the type !).

Nothing can exceed the confusion which has arisen with regard to this species. Neumann's original description (1897) was fairly definite[1], but he subsequently (1905) came to the conclusion that two varieties were in existence, and these he interchanged, making the last found form the type, and the original type the variety. Dönitz (1905) pointed out that this was inadmissible, and we entirely agree with him. Moreover, Neumann, in identifying specimens, confounded yet other species with *H. flava,* for in a tube (No. 137 in the Brit. Mus.) labelled by him *H. flava,* we found three distinct species[2]. Dönitz (1905), moreover, found two species[3] among alleged *H. flava* which Neumann sent him. After reviewing the situation, Warburton (1908) reinstated what appeared to be the original *H. flava* and removed two other forms from it under the names of *H. japonica* and *H. campanulata.*

Male (Fig. 342): Colour dull yellow. *Scutum* 2·1 × 1·4 to 2·8 × 1·9 mm.[4], broadest at about the level of the spiracles; punctations numerous, of medium size, regularly distributed; cervical grooves short, faint, converging, then separating; lateral grooves short, beginning about at half the body length and ending just behind the spiracles; festoons long, curved. *Capitulum*: base rectangular, twice as broad as long, with strong sharp cornua; palps with article 2 fairly salient, but not sharply angular externally; lateral contour of articles 2 and 3 continuous; no dorsal spines; ventral border of article 2 having a

[1] Neumann here specifically mentions the yellow colour and the long-spurred coxa IV of the ♂. Dönitz (1905, p. 130) lays stress on the characteristic colour. We would note that the name "*armata*," chosen by Neumann, refers to the long sharp spur on coxa IV.

[2] Including *H. japonica* Warburton 1908, *H. campanulata* Warburton 1908.

[3] *H. neumanni* Dönitz 1905 (= *H. bispinosa* Nn. 1897) and *H. flava* Nn.

[4] The second measurement is from (N. 763) specimens from India.

somewhat prominent retrograde angle; a distinct retrograde spine, directed inwards at the ventro-lateral angle of article 3; hypostome 4 | 4 on its distal half, then 5 | 5, the additional teeth being median. *Venter*: yellow, spiracles white, ovoid, with slight blunt dorsal protrusion. *Legs*: a fairly long blunt spur on coxa I; shorter blunt spurs on coxae II and III; a long sharp spur (longer than the width of the article) at the inner angle of coxa IV; tarsus IV rather short, about thrice as long as broad, tapering gradually.

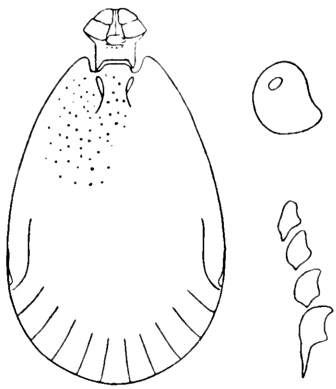


Fig. 342.

Fig. 343.

Fig. 342. *H. flava* ♂. Dorsum, spiracle and coxae. (Sketch by C. W.) Warburton, 1908, Fig. 1.

Fig. 343. *H. flava* ♀. Capitulum and scutum, coxae, spiracle and tarsus IV. (Sketch by C. W.) Warburton, 1908, Fig. 2.

Female (Fig. 343): All yellow when unfed, the scutum a bright yellow when the body is dark and distended. *Scutum* as broad as long, about 1 × 1 mm.[1], broadest at the posterior third, bright yellow, with numerous fairly large punctations; cervical grooves long, concave externally, beginning somewhat behind the anterior border as fairly deep depressions and continuing faintly to the postero-lateral margin; no lateral grooves. *Capitulum*: base comparatively broader than in the ♂, and with short blunt cornua, porose areas large, oval, converging anteriorly, their interval equal to their long diameter, a few irregular punctations in the middle of the interval; palps more salient and more sharply angular outwards, otherwise like those of the ♂; hypostome 4 | 4 or 5 | 5. *Venter*: spiracles white, rounded, with blunt

[1] The scutums of two other females measured in mm.: (N. 893) from Japan, 0·85 × 1; (N. 763) from India, 1·2 × 1·2.

dorsal protuberance. *Legs*: coxa I with weaker spur than in the ♂, a slight sharp spur at the middle of the posterior border of coxae II and III, a short blunt spur at the internal angle of coxa IV; tarsus IV slightly longer than in the ♂, tapering gradually. When replete the ♀ may attain a length of 8·5 mm.

Our description is based on (N. 893) 1 ♂ 1 ♀ from **Japan**, kindly presented by the late Prof. W. Dönitz. The specimens were found on a *dog* at Ise, and on *cattle* or on a *horse* at Hiroshima. Neumann (1905 p. 238; 1911 *a*, p. 112) states that his *armata* (i.e. his original *flava* were found in Japan upon a *horse* and on vegetation. We have received and determined specimens from **India**: (N. 763) ♂ ♀ from *dog*, Madras, collected v. 1906 by Mr V. I. Phadke; (Montgomery coll.) adults from *Sus cristatus*, Muktesar, VIII. 1905; (Indian Mus. coll.) ♂ from *sheep*, on hillside below Phagu (7000 ft.), Simla Hills, Western Himalayas.

Types in Toulouse.

12. HAEMAPHYSALIS TURTURIS Nuttall and Warburton, 1915, n. sp.

Fig. 344.

Male (Fig. 344): *Scutum* 2 × 1·5 mm., ovate, broader posteriorly, covered by very numerous small shallow punctations also on the festoons; cervical grooves shallow, comma-shaped, beginning at some distance behind the anterior border; lateral grooves almost absent, represented only by short shallow depressions dorsal to the spiracle. *Capitulum*: base rectangular, not greatly broader than long, cornua strong; palps short, only slightly salient laterally, with broken lateral contour; articles 2 and 3 of about equal length; a very slight retrograde point at the middle of the posterior dorsal border of article 3; the posterior ventral border of article 2 ends in a sharp point, and there is a strong retrograde spine under article 3; hypostome 4 | 4, small equal teeth, about 7 per file, corona large. *Venter*: spiracle ovoid, with distinct dorsal process. *Legs* fairly long and strong; coxa I with spur well-developed, a slight spur, progressively diminishing, on coxae II–IV; trochanters with distinct retrograde ventral spurs, largest on trochanter I; tarsus IV fairly long and strong, tapering rather rapidly.

Female: unknown.

Described from a single ♂ found on a *dove* (*Turtur suratensis*)[1], **Ceylon,** 2. III. 1906. H. Schoede coll.

The specimen is of a uniform pale yellow colour. In size and general facies it greatly resembles *H. hystricis* Supino, but appears to be separated from this species by the presence of trochantal spurs,

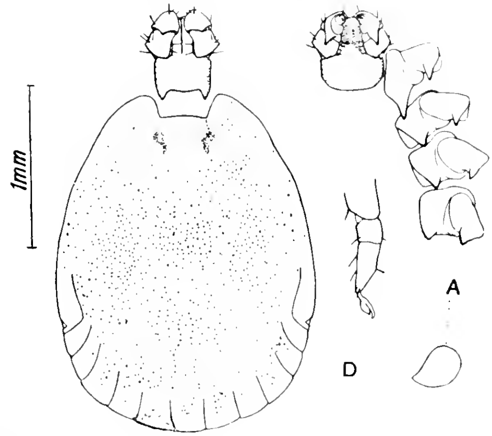


Fig. 344. *H. turturis* ♂. Dorsum, capitulum in ventral aspect, coxae with trochanters, spiracle and tarsus IV. Drawn from the type. Original, N. C. del.

which are perfectly distinct, though not very strongly developed. The dorsal spine on the third article of the palp of *H. hystricis* is represented in the present species by a very small retrograde cusp.

Type (No. 167) in the Zoological Museum, Berlin.

13. HAEMAPHYSALIS ACICULIFER Warburton, 1913.

Figs. 345, 346.

Lit. and Icon.: Warburton, VII. 1913, pp. 125, 126, Figs. 4, 5 (reproduced).

Male (Fig. 345): *Scutum* about 1·9 × 1·2 mm., oval, widest in the middle, glossy, with very fine, shallow, unequal punctations; cervical grooves short, fairly distinct: lateral grooves distinct, rather short, concave internally, including one festoon; festoons fairly long and rather broad. *Capitulum*: base rectangular, with strong cornua; palps short; article 2 short, but slightly salient laterally, prominent, but without ventral spine; article 3 slightly salient laterally, breaking the

[1] The original label refers to the host as "Kowadall's Taube" which no doubt stands for "Kawada," the Mahrati name for this species.

external contour, without dorsal spine but slightly protuberant where a spine might be expected, recurved at its postero-internal margin; the whole posterior border of the palp is characteristic; hypostome short, dentition 4|4, teeth small. *Venter*: spiracle rather broad, with very slight, blunt, dorsal process; anal grooves slightly ogival. *Legs*:

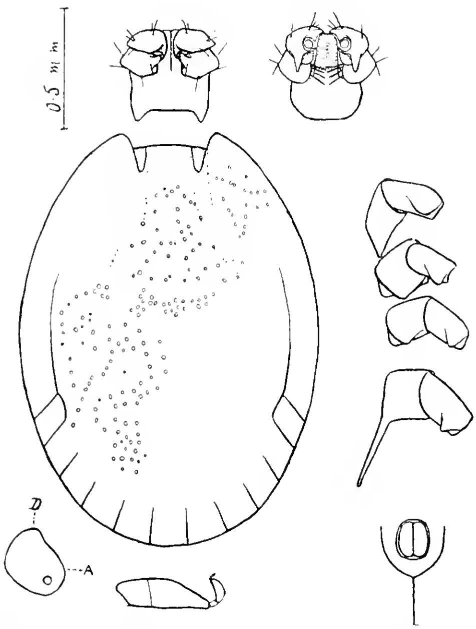


Fig. 345. *H. aciculifer* ♂. Capitulum in dorsal and ventral aspects, scutum, coxae and trochanters, spiracle, tarsus IV and anus with anal grooves. (N. C. del.) Warburton, 1913, Fig. 4.

coxa I with strong internal spur and a slight hint of an external spur; coxae II and III with slight protuberance in the middle of the posterior border; coxa IV with long, needle-like, internal spine (hence *aciculifer*) longer than the article itself, and narrow from its origin; slight, progressively diminishing trochantal spurs; tarsus IV tapering rather abruptly; pads rather long.

Female (Fig. 346): *Scutum* cordiform, as long or slightly longer than broad (0·9 × 0·9 or 0·8 × 0·7 mm.), widest at the anterior third; punctations small and inconspicuous; cervical grooves well marked, slightly converging, visible for about two-thirds the scutal length; emargination deep. *Capitulum*: base much broader than long, cornua strong; porose areas oval and far apart; palps as in the ♂, especially as regards their internal contour, but the dorsal protuberance on article 3 is more marked and pointed, almost amounting to a spine; hypostome 4 | 4. *Venter*: spiracle sub-circular; anal grooves slightly ogival. *Legs*: coxa I with fairly sharp internal spur; coxae II–IV with slight protuberance near the middle of the posterior border, strongest on coxa IV; tarsi and trochanters as in the ♂.

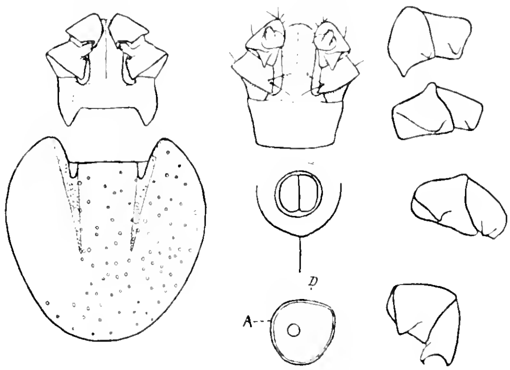


Fig. 346. *H. aciculifer* ♀. Capitulum in dorsal and ventral aspects, scutum, anus with anal grooves, spiracle, coxae and trochanters. (N. C. del.) Warburton, 1913, Fig. 5.

Described from (E. 463 *a*) 1 ♂ and 1 ♀ found on *Cobus thomasi* (antelope) on the N.E. shore of Lake Edward, **Uganda,** x. 1911, by S. A. Neave. We have since received (N. 2625) 1 ♀ from a *reedbuck*, Wandara, **Gold Coast,** West Africa, 16. v. 1913, coll. J. J. Simpson.

Types in London (Imperial Bureau of Entomology).

14. HAEMAPHYSALIS KOCHI Aragão, 1908.

Fig. 347.

Lit. and Icon.: Aragão, 1908, reprint, pp. 3–6; Rohr, 1909, pp. 142–144, 200 (merely quotes Aragão); Blanchard, 1909, p. 152 (merely listed); Aragão, 1911, pp. 178–181, Pl. XII, Figs. 16, 17, 17 *a* (♂ venter, capitulum in dorsal and ventral aspects)

Male (Fig. 347): *Scutum* 1·77 × 1·12 mm., regularly oval, broadest at the posterior third, earthy yellow; cervical grooves short comma-shaped, the concavity outward, deep anteriorly; lateral grooves very short, beginning with a shallow depression opposite leg IV and including one festoon; festoons distinct, longer than broad; punctations fine and discrete on scutum and festoons. *Capitulum* short (0·46 mm.); base broader than long (0·12 × 0·28 mm.) with very strong cornua; palps without dorsal spines, articles 2 and 3 nearly equal in length, lateral salience of article 2 slight, a strong hook-like spine under article 3; hypostome spatulate, dentition 4|4, 7 to 8 teeth per file. *Venter* pale yellow, finely punctate, bearing a few short hairs; anal grooves **V**-shaped; spiracle ovate, narrowing dorsally. *Legs* long, hairy, yellow; coxa I with rather strong internal spine, a blunt tuberosity, decreasing progressively in size, near the middle of the posterior border of coxae II–IV; the trochanters bear slight, progressively decreasing spurs; tarsi tapering; pads as long as the claws.

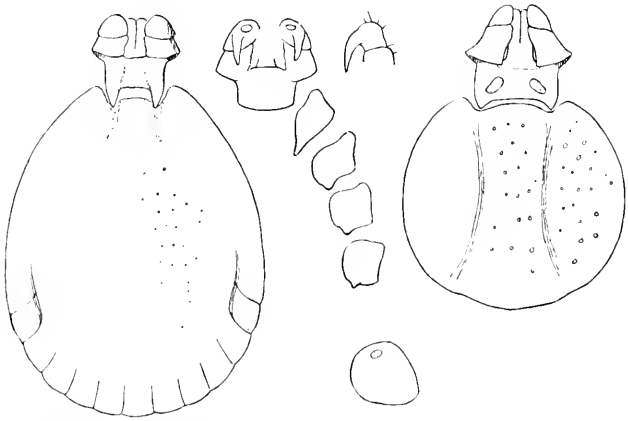


Fig. 347. *H. kochi* ♂. Dorsum, coxae and ventral aspect of capitulum; lateral aspect of palp, spiracle. ♀ capitulum and scutum. Sketched from the types. Original, C. W. del.

Female (Fig. 347): Body, when unfed, regularly oval, 2·79 × 1·66 mm. *Scutum* nearly circular, 1·02 × 1·16 mm.; cervical grooves attaining the posterior border, but deepest at the anterior half; punctations fine and evenly distributed. *Capitulum*: base rectangular, 0·1 × 0·56 mm., cornua much less marked than in the ♂; porose areas small, oval, far apart, converging anteriorly, their posterior ends encroaching on the lateral ridge; palps with article 2 much longer than article 3, and more salient laterally than in the ♂; hypostome spatulate, dentition 5|5, 9 to 10 small teeth per file. *Legs* as in the ♂, but the coxal spines are shorter and the trochantal spurs are reduced to minute tubercles.

Description based on 1 ♂ and 2 ♀ taken from *Cervus campestris*, at Baurú, East of S. Paulo, **Brazil**, by Dr Castro Goyanna, 15. XI. 1907, and 1 ♂ taken from *Cervus rufus* at Jacutinga, S. Paulo, in the collection of Dr A. Lutz, IV. 1907 (dry specimens).

The species is apparently allied to *H. flava*. Through the courtesy of Dr H. de Beaurepaire Aragão of Rio de Janeiro, we have been able to examine and redescribe the types and to figure their salient features.

Types in Rio de Janeiro.

15. HAEMAPHYSALIS BIRMANIAE Supino, 1897.

Fig. 348.

Lit. and Icon.:

H. birmaniae Supino, 1897, III, fasc. 1; IV, p. 251, Pl. XIII, Figs. 17, 18 Supino only figures the ♂ and ♀ tarsi which do not serve to distinguish the species; his description of both sexes is so meagre as to be useless.

H. birmaniae Supino, in Neumann, 1897, p. 336.

Not identical with *H. semermis* Neumann, 1901, p. 263, as stated by Neumann, 1902, p. 128, when he condemned his own species after examining Supino's types (the latter were found by Neumann to include specimens of *Amblyomma* besides *H. birmaniae*). *H. semermis* Nn. = *H. hystricis* Supino q.v. Neumann, 1911 *a*, p. 109, gives the following confusing synonymy:

H. birmaniae Supino + *H. hystricis* Supino in Supino, 1897, ser. 2, v. 3, p. 236; *H. punctata* (part.) Can. and Fanz. + *H. bispinosa* Nn. in Neumann, 1897, pp. 327, 341; *H. semermis* Neumann, 1901.

It will be seen that we regard the species *H. birmaniae* Supino, *H. hystricis* Supino, and *H. bispinosa* Nn. as valid. *H. punctata* Can. and Fanz. = *H. cinnabarina* var. *punctata* (C. & F.), and cannot be confused with any of the foregoing; whilst *H. semermis* Nn. = *H. hystricis* Supino. Because of this confusion we do not record data from other authors who may have supposed they were dealing with *H. birmaniae* Supino.

Male (Fig. 348): *Scutum* rather broadly oval, about 2 × 1·4 mm.[1]; punctations very numerous and fine, but so shallow that the general effect is a smooth surface; cervical grooves only represented by small oval pits behind the anterior border; lateral grooves obsolete. *Capitulum*: base with strong blunt cornua and with slightly rounded lateral margins; palps only very slightly salient laterally and without dorsal spur; article 2 rather longer than article 3; a moderate retrograde spur under article 3; hypostome well covered with 4 | 4 to 5 | 5 small, subequal teeth, about 8 per file. *Spiracle* pear-shaped, or sub-circular,

[1] Supino's measurement. The scutums of the 4 ♂ types examined by us measure respectively:

1·9 × 1·35 mm.
1·9 × 1·3 ,,
1·8 × 1·3 ,,
1·7 × 1·2 ,,

with a slight dorsal process. *Legs*: coxae, especially coxae III and IV, short and broad (antero-posteriorly); coxal armature normal; well-marked, but rather blunt trochantal spurs; tarsus IV tapering rather rapidly; pad long.

Female: unknown.

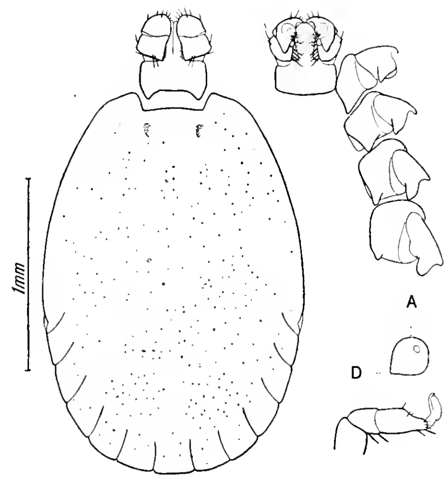


Fig. 348. *H. birmaniae* ♂. Dorsum, capitulum in ventral aspect, coxae with trochanters, spiracle and tarsus IV. Drawn from the type. Original, N. C. del.

Closely allied to *H. hystricis*, but without the dorsal spur on article 3 of the palps, and to *H. formosensis*, from which it is distinguished by the absence of the lateral groove and its different dentition.

Our description is based on 4 ♂ (labelled types) found on *Cervulus muntjac* and *Atherura macrura*, at Carin-Gheen and Yado-Carin-Asciuii-Chebà, **Burma**, by L. Fea in 1885–89, types (Nos. 27, 44) in the Museo Civico di Storia Naturale, Genoa; co-types (N. 2962, 2970) in Cambridge.

16. HAEMAPHYSALIS SILACEA Robinson, 1911.

Fig. 349.

Lit. and Icon.: Robinson, 1911, pp. 478–480, Fig. 1 *a-f* (♀ reproduced).

Male: unknown.

Female (Fig. 349): *Body* 2·4 × 1·7 mm. (unfed), ovate, narrowing anteriorly; colour earthy yellowish-brown; dorsum punctate, almost glabrous; marginal groove commencing some distance behind the scutum and terminating at the antepenultimate festoon; postero-median and accessory grooves represented by broad shallow depressions;

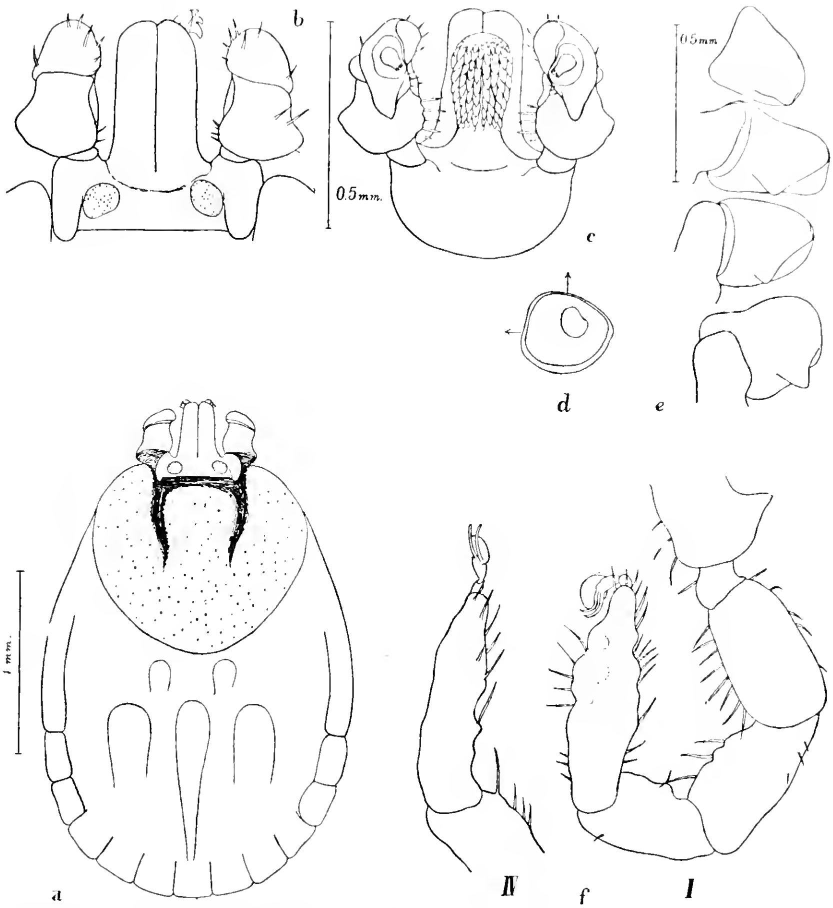


Fig. 349. *Haemaphysalis silacea* ♀ : (*a*) dorsum (capitulum foreshortened); (*b*) capitulum, dorsal aspect; (*c*) capitulum, ventral aspect; (*d*) spiracle (the arrows indicate the anterior and lateral margins, respectively); (*e*) coxae I–IV; (*f*) tarsi I and IV. *f*—same magnification as *b* and *c*, *d*—same magnification as *e*. (L. E. R. del.) Robinson, 1911, Fig. 1.

festoons well-defined. *Scutum* 1·04 × 1·17 mm., broadly ovate, almost circular; colour somewhat darker than the general body colour; deeply emarginate; scapulae rounded; punctations fine, fairly numerous and regularly distributed; cervical grooves of moderate depth, slightly convergent posteriorly. *Capitulum* (0·44 mm. long) very short and broad; base rectangular, about three times as broad as long; cornua short, with rounded extremities; porose areas well separated, the interval as great as or exceeding the double diameter: palps hemicylindro-conical, with moderate lateral protrusion; articles 2 and 3 with postero-ventral, -lateral and -dorsal margins slightly salient; article 3 with a retrograde process on the ventral surface only; hypostome dentition 4 | 4. *Venter* scattered with pale hairs; genital orifice opposite interspace between coxae II and III; genital grooves widely separated and divergent; spiracles sub-circular. *Legs*: coxa I with a small wide triangular spur; coxae II and III with an oblique salient ridge; coxa IV with a wide triangular spur, larger than that on coxa I; tarsi tapering gradually, unarmed; tarsus IV more than three times as long as broad.

Described by Robinson from 4 ♀ found by Mr R. J. Davys on *oxen* allowed to run on "starvation camp" from which stock had been excluded for two years at Gonubie Park, East London, Cape Colony, **South Africa.**

Types in Cambridge 4 ♀ (N. 1629, 2944).

17. HAEMAPHYSALIS PARMATA Neumann, 1905.

Figs. 350–353.

Lit.: Neumann, 1905, pp. 228–230; described but not figured. Dönitz, 1907, p. 71; quotes Neumann. Blanchard, 1909, p. 154; description abstracted from Neumann. Galli-Valerio, 1909, p. 539; listed as occurring (?) in Sumatra. Ziemann, 1905, pp. 116–117; 1912, p. 58; listed as occurring in W. Africa. Neumann, 1911 *a*, pp. 109, 110; abstract of author's earlier description. None of the foregoing authors figure the species.

Male (Fig. 350): *Scutum* rather broadly oval, 1·8 × 1·1 mm., strongly and uniformly punctate with moderate-sized deep punctations; cervical grooves short; lateral grooves very short, including one festoon; festoons short and broad, punctate like the rest of the scutum. *Capitulum*: base much broader than long, with strong sharp cornua; palps short and broad, a strong retrograde spur dorsally on article 3, directed somewhat outwardly; ventral retrograde spurs under articles 2 and 3; hypostome broad, dentition 4 | 4. *Venter*: spiracle rather large, sub-oval, with slight dorsal process. *Legs*: coxae rather short and broad, with normal armature very feeble, but with a slight external spur on coxa I and indications of trochantal spurs (not shown in figure); tarsus IV fairly long and tapering; pad medium.

Female (Fig. 351): *Scutum* circular, 0·7 × 0·9 mm. in the specimen we figure; cervical grooves broad, parallel, far apart, visible for rather

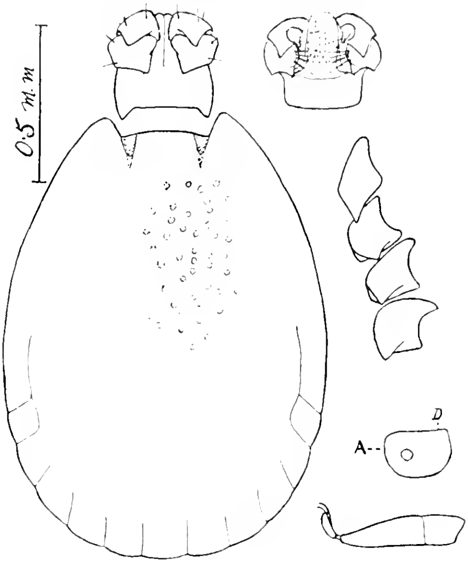


Fig. 350. *H. parmata* ♂. Dorsum, capitulum in ventral aspect, coxae, spiracle and tarsus IV. Specimen (N. 504) from West Africa. Original, N. C. del.

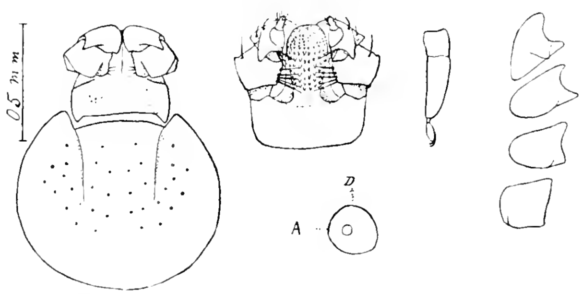


Fig. 351. *H. parmata* ♀. Scutum, capitulum in dorsal and ventral aspects, coxae, spiracle and tarsus IV. Specimen found with the ♂ depicted in Fig. 350. Original, N. C. del.

more than half the scutal length. *Capitulum*: base short and very broad, with moderate cornua; porose areas ill-defined, far apart; palps and hypostome as in ♂. *Venter*: spiracle sub-circular, sometimes with a slight dorsal protuberance. *Legs* as in the ♂.

Nymph (Fig. 352): *Scutum* broad-oval, with deep emargination in which the short, broad, basis capituli is deeply set; cervical grooves forming conspicuous broad depressions, widely separated, extending to more than half the scutal length. *Capitulum*: palps as in the ♀, except that the dorsal spur on article 3 is absent; hypostome 2 | 2. *Venter*: spiracle very small, sub-circular. *Legs* as in the ♀, but relatively thicker.

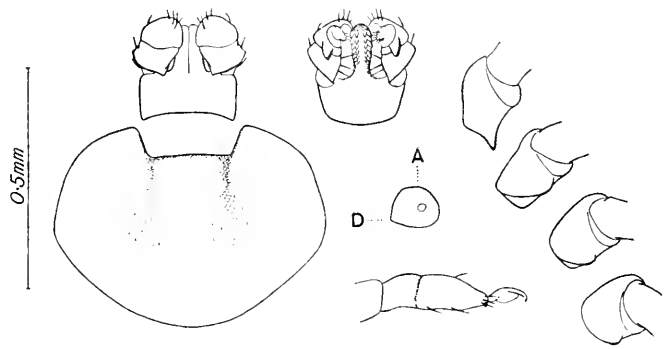


Fig. 352. *H. parmata* nymph. Scutum, capitulum in dorsal and ventral aspects, coxae, spiracle and tarsus IV. Specimen (N. 2354) from Congo Free State. Original, N.C. del.

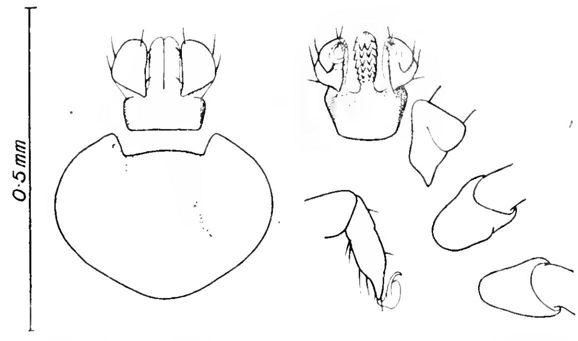


Fig. 353. *H. parmata* larva. Scutum, capitulum in dorsal and ventral aspect, coxae and tarsus III. Specimen (N. 2354) from Congo Free State. Original, N. C. del.

Larva (Fig. 353): *Scutum* essentially like that of the o. *Capitulum*: base with cornua obsolete; palps with rounded lateral contour, most salient laterally in the middle of their length, otherwise approximating to those of the o. *Legs*: coxae almost destitute of armature except for a fairly marked internal spur on coxa I; tarsus IV tapering to a point.

This species is closely allied to *H. hystricis* Supino.

Our description is based especially upon the examination of (N. 1899) adults from Sierra Leone and of co-types (N. 2887, 2888 ♂ ♀) from Cameroon; the immature stages (N. 2354), now first described, came from the Congo Free State.

Geographical Distribution and Hosts.

We have received or examined and determined the following specimens from Africa:

Uganda: (N. 884 *c*) 2 ♀ from *bushbuck*, III. 1909, and (N. 877) 1 ♀ from *cattle* which came from Bukedi to Mpumu, Chagwe, IX. 1909, both lots having been sent us by Sir David Bruce. J. H. Ashworth's collection contains 1 ♀ from a *bushbuck* shot at Toro. **British East Africa**: (E. 307 *b*) 1 ♀ from Jackson's *hartebeeste*, Upper Nzoià River, North Kavirondo, collected VI. 1911, by S. A. Neave. **Congo Free State**: (Liverpool N. 45 *a*) 1 ♀ from *antelope*, Kasongo, collected I. 1905, by Drs Dutton and Todd; (N. 2354) ♂ os and larvae from *antelope*, Kimaka, 15. VI. 1913, and (N. 2906) a large ♂ from *buffalo*, Beni, 31. VI. 1913, collected by F. Harker. **Gold Coast**: (N. 504) 2 ♂ 1 ♀ 2 o, collected in 1908 at Prahsu by Dr W. Graham. **Sierra Leone**: (E. 584 = N. 1899) ♂s ♀s os from harnessed *antelope*, Port Lokko, V. 1912, and (E. 106 *a*) a ♀ from Cross River, Obubura, VI. 1912, both collected by Dr J. J. Simpson. J. H. Ashworth's collections contain 1 ♀ from *cattle*, Securella, 19. II. 1913, collected by Dr J. Y. Wood. **Cameroon**: Prof. Neumann has presented us with co-types (N. 2887 ♂) from *Bos taurus*, Njanga, 1904, and (N. 2888 ♀) from *Capra hircus*, Mbula, 1904, collected by Dr Ziemann, who also found the adults on *sheep* and *pig* in this region. [Ziemann (1905, pp. 116–117), whose specimens were determined by Neumann, records that the tick occurs on *cattle* at Lagos (Coastal Region), on *pigs* in Cameroon, on *cattle* and *goats* in Duala (Coastal Region), on *cattle, goats* and *pigs* in and about the Bakossi Mountains and on *cattle* in the Cameroon Mountains. Ziemann, I. 1912, p. 58, states that he found specimens on *cattle, goats* and *dogs* in the Cameroon Coastal Region. We learn by correspondence that he also found the tick on "pigs" i.e. *Potamochoerus porcus* L., at Akonolinga, 6. VII. 1910; he informs us that the latter were determined either by Neumann or Dönitz.]

[Galli-Valerio, 1909, p. 539, states that Dr Narbel found *H. parmata* on a *monkey* in Sumatra, 1909, but the determination appears to us doubtful, as the species has not hitherto been found outside Africa.]

The types are in Toulouse, the co-types in Cambridge.

18. HAEMAPHYSALIS HYSTRICIS Supino, 1897.

Figs. 354–357.

Lit., Synon, and Icon.:

Haemaphysalis hystricis Supino, 1897, III, fasc. 1, pp. 251, 252; fasc. 2, Pl. XIII, Figs. 19, 20. The author only figures the tarsi, these being of no use for classification: his description is valueless.

Haemaphysalis hystricis Supino in Neumann, 1897, pp. 342, 343.

"*Haemaphysalis bispinosa* Neumann, 1897" in Neumann, 1901, pp. 261–263. Description of ♂ with notes on ♀.

Haemaphysalis hystricis Supino, 1897, in Warburton, 1908, pp. 518, 519, Fig. 11 (♀ reproduced). Describes the ♀.

Not *Haemaphysalis bispinosa* Neumann, 1897, pp. 341, 342, Figs. 7, 8, as stated by Neumann, 1902 *a*, p. 128, when he wrongly degraded his species, regarding it as identical with *H. hystricis* Supino. See our description of *H. bispinosa.*

Not *Haemaphysalis birmaniae* Supino as stated in Neumann, 1911 *a*. Neumann here describes *H. bispinosa.*

Male (Figs. 354, 355): *Scutum* ovate, narrow in front, broad posteriorly, 3 × 2·2 to 2·54 × 2 mm.[1], broadest just in front of the spiracles. Numerous minute very inconspicuous punctations; cervical grooves small deep pits, behind the anterior border, followed by shallow divergent depressions; *no lateral grooves*; festoons only slightly longer than broad. *Capitulum*: base rectangular, twice as broad as long; cornua strong and rather sharp; palps very slightly salient laterally; articles 2 and 3 nearly equal in length; the lateral salience of article 2 about its middle and forming an obtuse angle; a fairly strong dorsal retrograde spine on the middle of the posterior border of article 3; strong ventral retrograde spine on article 3; hypostome rather broad anteriorly, well covered with 4 | 4 to 5 | 5 strong teeth of uniform size, about 8 per file. *Venter*: spiracle short comma-shaped, with bluntly rounded dorsal process. *Legs*: coxae normal; trochanter I with the dorsal retrograde spur rather sharp, and with a small sharp ventral retrograde spur; tarsus IV sloping rather rapidly, with small spur.

[1] The scutums of 9 ♂ measured as follows in mm.:

N. 2956	3·0 × 2·2	N. 1060	2·7 × 2·0
N. 1060	2·9 × 2·1	N. 576	2·6 × 2·0
N. 679	2·8 × 2·0	N. 1060	2·6 × 1·9
,, ,,	2·76 × 2·0	,, ,,	2·54 × 2·0
,, 1060	2·75 × 2·05		

Lots N. 679 and 1060 are from Malaya, N. 576 from Assam, N. 2956 (co-type) from Burma.

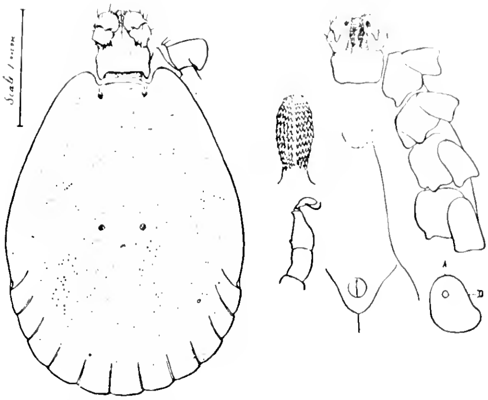


Fig. 354. *H. hystricis* ♂. Dorsum, part of venter, hypostome (highly magnified), spiracle and tarsus IV. Specimen (N. 679) from Federated Malay States. Original, G. H. F. N. del.

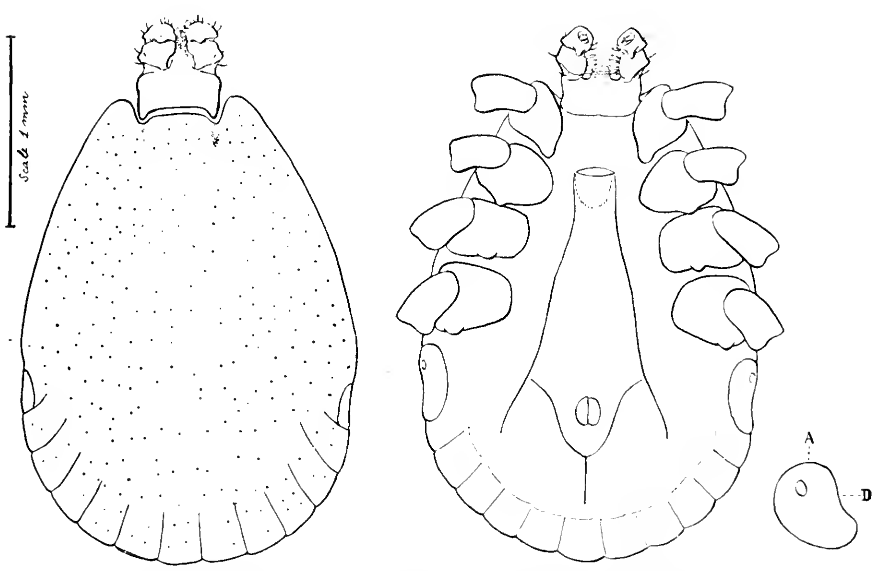


Fig. 355. *H. hystricis* ♂. Dorsum, venter and spiracle. Drawn from the type of *H. semermis* Nn. in the Paris Museum. Original, G. H. F. N. del.

Female (Figs. 356, 357): *Scutum* 1·4 × 1·1 to 0·8 × 0·8 mm.[1], usually sub-circular, with fairly numerous moderate punctations, more conspicuous in the lateral fields; cervical grooves forming pits at some distance from the anterior border, followed by fairly well-marked sub-parallel

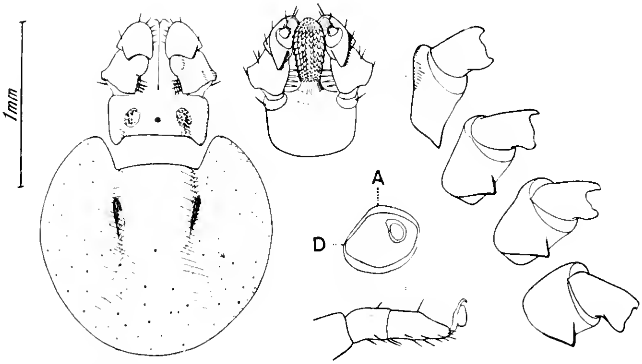


Fig. 356. *H. hystricis* ♀. Scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. Specimen (N. 576) from Assam. Original, G. H. F. N. del.

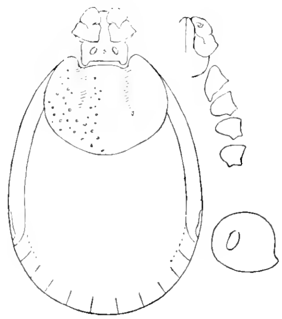


Fig. 357. *H. hystricis* ♀. Dorsum, etc. (not drawn to scale). Sketched by C. W. from a specimen lent by Prof. Neumann. Warburton, 1908, Fig. 11.

depressions not reaching the posterior border. *Capitulum* with the characteristics of that of the ♂; porose areas oval, far apart, a depression in the middle of the interval; palps with article 2 longer than 3,

[1] The scutums of 6 ♀ measured as follows in mm.:

N. 2956	1·4 × 1·1	N. 572	1·1 × 1·3
N. 572	1·2 × 1·35	N. 1070	0·95 × 1·1
N. 576	1·2 × 1·2	N. 576	0·8 × 0·8

Lots N. 2956 (co-types) from Burma, N. 572 and N. 576 from Assam, N. 1070 from Malaya.

the lateral salience more pronounced and more acute than in the ♂; palpal spurs as in the ♂; hypostome 4|4, about 10 teeth per file. *Venter*: spiracle pear-shaped, the narrow end dorsal. *Legs* as in the ♂. Fully gorged specimens may attain 11 × 8·5 mm.

Our description is based on the examination of the types and co-types, some of the latter (N. 2956, 2957 ♂ ♀) having been presented to us by the Genoa Museum.

Geographical Distribution.

We have received or examined and determined specimens from the following countries[1]:

Burma: Supino's specimens, ♂ ♀ (Genoa Mus. Nos. 20, 21, 51), of which we possess co-types (N. 2956, 2957), were found on *Hystrix bengalensis* and *Ursus torquatus* at Yado-Carin-Ascinii-Chebà and at Carin-Chebà (900 m. elevation), by L. Fea in 1887–1889; (Indian Mus. 1798 b/17) 1 ♂ found at Arakan Yomas, Chaung, Upper Myinudaung Reserve, Hedzada District, Lower Burma, 2. I. 1912, by C. G. Rogers; (Indian Mus.) 1 ♀ found on *Geoemyda spinosa*. **Assam**: (N. 572) 3 ♀ from *Canis familiaris*, Lhassia, and (N. 576) 1 ♂ 3 ♀ from the same host, Lushai Mountains, both lots having been collected in 1907 by R. A. Lorrain (presented by the Hon. N. C. Rothschild). We have determined specimens from the Indian Museum (N. 1253/17) collected at Sadiya in N.E. Assam, XII. 1911, and also at Sibsagar, hosts not recorded. **China**: (D.E.M. No. 13 = N. 2905, N. 2977) ♀s from *hedgehog*, Tsingtau, Prof. Hoffmann coll. **Federated Malay States**: (N. 1060 *b*) ♂s from *tiger*, Pahang, 1910, collected by Dr A. T. Stanton who also found this tick on a *wild boar*; (N. 2106) ♂s ♀s from *tiger*, Kuantan, Pahang, I. 1913, collected by Dr Oscar Pou; Messrs J. H. Ashworth and H. C. Pratt have also sent us (N. 1070 *a*) 1 ♀ from Kelantan, and (N. 679) 2 ♂ from an unrecorded place. Mr C. Strickland has sent us (N. 2953) 2 ♀ from *Ursus malayanus*, IV. 1913, and (N. 2952) ♂ ♀ from *dog*, XI. 1913, both collected at Ulu Gombak, Selangor; (N. 2951) 1 ♀ from *dog*, Port Dickinson, North Sembilan, II. 1912. **Sumatra**: (N. 1274) 1 ♂ from *dog*, V. 1911, presented by the late Prof. W. Dönitz. **Borneo**: (N. 954) 2 ♀ from a *dog*, Upper Sarawak, XI. 1909, collected by Mr J. C. Moulton. **Ceylon**: (Indian Mus. No. 847/17) 1 ♀ from Kandy. **Celebes**: (N. 72)

[1] Owing to the confusion in the synonymy, we confine ourselves to mentioning only such specimens as we have ourselves examined.

1 ♀ from *Sus celebensis*, presented by Hon. N. C. Rothschild. **Formosa**: (Berlin Mus. No. 174) ♂ ♀ from *wild boar*, Taihorin, VI. 1911, collected by H. Sauter.

19. HAEMAPHYSALIS BISPINOSA Neumann, 1897.

Figs. 358–362.

Lit., Syn. and Icon.:

Haemaphysalis bispinosa Neumann, 1897, pp. 341–342, Figs. 7, 8 (♀ palp in dorsal aspect, tarsus IV, reproduced). Blanchard, 1909, p. 148; merely listed.

Not *Haemaphysalis bispinosa* Nn. in Neumann, 1901, pp. 261–262.

Not *Haemaphysalis hystricis* Supino, as stated in Neumann, 1902 *a*, p. 128.

Haemaphysalis bispinosa in Warburton, VI. 1907, p. 11, Fig. 9 (poor) incomplete description; 1908, pp. 517–518, Figs. 9–10 (♂ dorsum, part of venter, spiracle; ♀ scutum and capitulum, spiracle and tarsus IV; sketchy, not reproduced).

Haemaphysalis neumanni Dönitz, 1905, pp. 127–129, 134, Figs. 4–6 (reproduced). We have co-types.

Not *Haemaphysalis birmaniae* Supino, as stated in Neumann, 1911 *a*, p. 109.

Haemaphysalis neumanni Dönitz, in Neumann, 1911 *a*, p. 109.

? *Haemaphysalis neumanni* Dönitz, in Galli-Valerio, 1909, p. 539, found on *Canis aureus*, Ceylon, 1907, Dr Narbel coll.; Yakimoff and Kohl-Yakimoff, 1911, p. 418. (They record 6 ♀ from *cattle* coming from China, Primorsk Government, E. Siberia.)

Haemaphysalis bispinosa in Patton and Cragg, 1913, p. 648 (raised on *mongoose*), Pl. LXXIII, Fig. 11; ♀ capitulum in ventral aspect; Pl. LXXXI, Figs. 5, 6, ♂ dorsum and (?) ♀ venter (legend confused).

There has been a great deal of confusion about this species: Neumann (1897) founded the species *bispinosa* on a single ♀ from Ramnad, India, the description being fortunately accompanied by figures (Fig. 361 *a* and *b* here reproduced). In 1901 he described the ♂ and ♀ of what was evidently another species under the name of "*bispinosa*"; these ticks came from Japan and China. The second description agrees with that of *H. hystricis* Supino, 1897. In 1902, Neumann, after examining Supino's types, regarded *bispinosa* as identical with "*hystricis*," and (wrongly) gave the latter name priority. He had evidently been led astray by his second description of the purported "*bispinosa*" and the fact, which he mentions, that Supino's types (♂ ♀) are devoid of capitulums.

Dönitz (1905), like ourselves, perceived the confusion which had arisen, and to clear up matters selected one of the forms described as '*bispinosa*" by Neumann as the type of a separate species, which he named *neumanni*. The form Dönitz selected is, we find, identical with *H. bispinosa* Neumann, 1897, and therefore falls into synonymy (see Fig. 359 from Dönitz). Warburton (1908) restored and redescribed *H. bispinosa*.

Male (Figs. 358, 359): *Scutum* 1·45 × 1 to 2·3 × 1·65 mm.[1], yellow or brown (in well chitinised specimens), long oval, broadest in the middle,

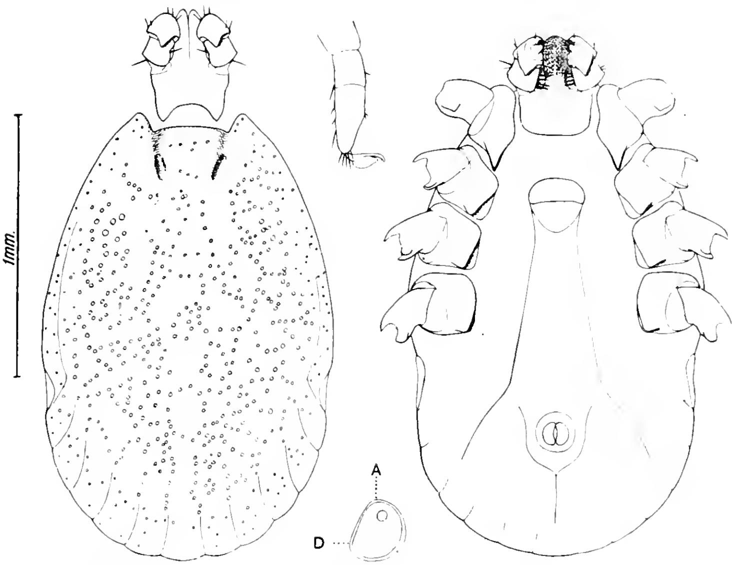


Fig. 358. *H. bispinosa* ♂. Dorsum, venter, tarsus IV, spiracle. Specimen (N. 1826 from Madras). Original. N. C. del.

glabrous, uniformly punctate with medium inconspicuous punctations; cervical grooves very faint, lateral grooves long, well-marked, ending behind spiracles; festoons very long. *Venter*: spiracles white, sub-oval, broadest posteriorly, almost without dorsal protuberance. *Capitulum*: base fairly long, broadly rectangular, with straight sides and stout cornua; palps only slightly salient, articles 2 and 3 about equal in size and

[1] The following measurements show the variation in the size of the ♂ scutum in mm.:

N. 1826, from India	1·8 × 1·1	chosen for range of size from amongst 83 ♂ contained in the lot.		
	1·8 × 1·05			
	1·7 × 1·1			
	1·65 × 1·15			
N. 1373, from China	1·7 × 1·1		N. 129, from Japan	2·3 × 1·65
	1·45 × 1·0			2·05 × 1·5

equally angular externally; no spines on article 2, a short, sharp retrograde spine at the middle of the dorsal border and at the middle of

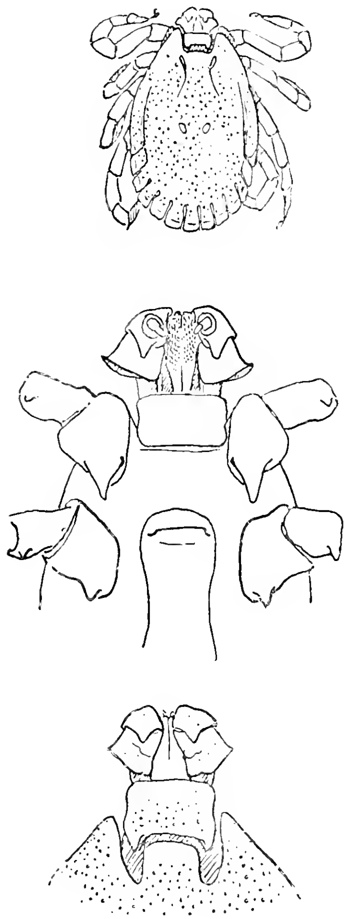


Fig. 359. *H. bispinosa* ♂: (A) dorsum, × 12 (the original figure showed eyes which are absent, they have now been erased; vide Dönitz, 1906, p. 143); (B) part of venter and—(C) capitulum more highly magnified. Dönitz, 1905, Pl. Figs. 4–6, illustrating *H. neumanni* Dö., 1905 (from horse, Japan), which we find = *H. bispinosa* Nn.

the ventral border of article 3; hypostome 4 | 4 to 6 | 6, with equal teeth. *Legs*: a moderate sharp spur on coxa I; a very slight protuberance on coxae II–IV.

Female (Figs. 360, 361): *Scutum* yellow or brown, nearly circular, 0·8 × 0·8 to 1·25 × 1·2 mm.[1], with unbroken contour; cervical grooves beginning rather behind the anterior margin as fairly deep furrows which converge and then curve outward, almost reaching the postero-lateral border; numerous regularly distributed punctations of medium size. *Venter*: spiracles white, nearly circular, practically without dorsal protuberance. *Capitulum*: base broader than in the ♂, the sides

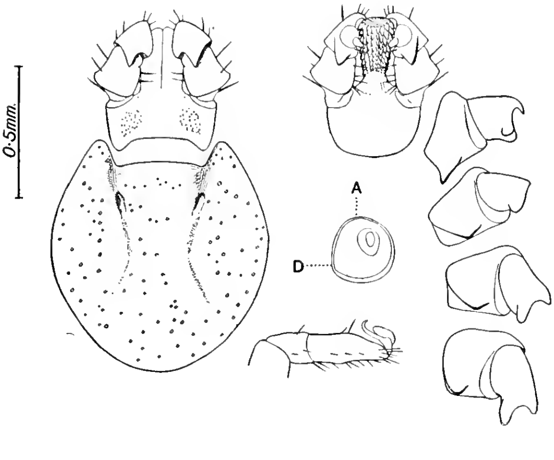


Fig. 360.

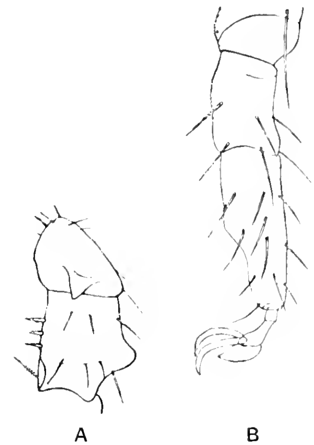


Fig. 361.

Fig. 360. *H. bispinosa* ♀. Capitulum in dorsal and ventral aspects, scutum, coxae with trochanters, spiracle and tarsus IV. (N. 1826, same origin as ♂ in Fig. 358.) Original, N. C. del.

Fig. 361. *H. bispinosa* ♀: (*a*) right palp in dorsal aspect, × 65; (*b*) tarsus IV, × 75. Neumann, 1897, Figs. 7, 8, illustrating his original description of the species (clearly drawn from balsam-mounted specimen).

straight, the cornua short and blunt; porose areas fairly large, far apart, oval, not very clearly defined; palps as in the ♂; hypostome 4 | 4 to 6 | 6, with teeth of equal size. *Legs*: coxae as in ♂; tarsus IV long (at least four times as long as broad), tapering gradually.

[1] The scutums of 12 ♀ measured as follows in mm.:

N. 1826, from India	0·95 × 0·9	N. 129, from Japan	1·0 × 1·1
	0·85 × 0·9	N. 1852, from Australia	1·25 × 1·2
	0·85 × 0·8		1·15 × 1·15
	0·8 × 0·8		1·1 × 1·25
	0·8 × 0·85		1·1 × 1·2
	0·7 × 0·7		1·1 × 1·2

Nymph (Fig. 362): Body elongate. *Scutum* sub-circular, about 0·2 × 0·2 mm.[1], a few faint punctations generally visible in the posterior region; cervical grooves well-marked, not very concave externally, not quite reaching the posterior border. *Capitulum*: like that of the ♀, but without an erect dorsal spine on article 3; its inner edge is, however, recurved (as in the ♀ of *H. bispinosa* var. *intermedia*); hypostome 3|3. *Venter*: spiracle nearly circular. *Legs*: coxal armature normal; tarsus IV fairly long and sharply pointed; pad short.

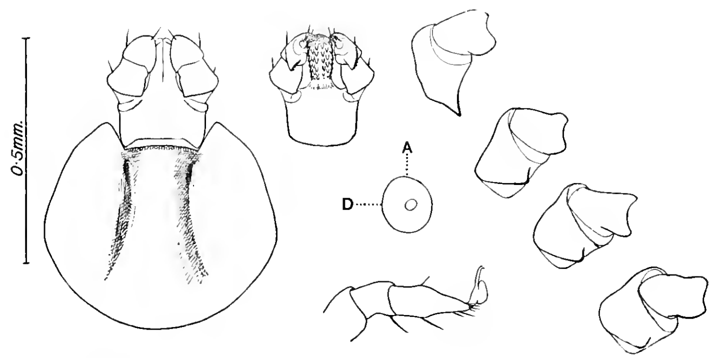


Fig. 362. *H. bispinosa* nymph. Capitulum in dorsal and ventral aspects, scutum, coxae with trochanters, spiracle, tarsus IV. (N. 1826, same origin as ♂ in Fig. 358.) Original, N. C. del.

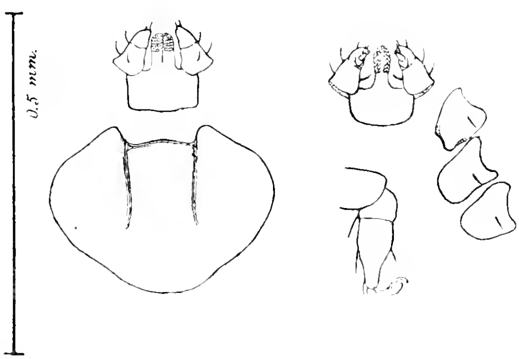


Fig. 362 *a*. *H. bispinosa* larva. Capitulum in dorsal and ventral aspects, scutum, coxae and tarsus III. Drawn from (N. 2745) specimens raised in Cambridge, the progeny of a ♀ from Madras. Original, G. H. F. N. del.

[1] The scutums of 5 nymphs measured as follows in mm.:

N. 169, from India	0·21 × 0·23	N. 169, from India	0·18 × 0·24
	0·21 × 0·23		0·18 × 0·2
	0·2 × 0·21		

Larva (Fig. 362 *a*) unfed, measures about 0·53 × 0·44 mm. *Scutum* broader than long, about 0·25 × 0·33 mm., with undulating postero-lateral borders; cervical grooves distinct, parallel. *Capitulum* with base rectangular, posterior border almost straight, no cornua; palps with article 2 protruding more than in the o; hypostome 2 | 2. *Legs*: coxa I with blunt tuberosity postero-internally, coxae II and III unarmed; tarsus IV short, tapering to a point.

Description based on numerous specimens from India and Ceylon, where it appears to be common.

Geographical Distribution and Hosts.

India: The tick is widely distributed, occurring apparently throughout India. We possess, or have examined, specimens collected as follows: **Punjab**: at Kasauli (Liverpool 149 *a*). **United Provinces**: Mr Abdal Ghani collected specimens from *goats*, at Haldwani, VI. 1905 (Liverpool coll.); Mr R. Hodgart collected adults from *Felis tigris*, at Motisal, Garthwal District, III. 1910 (Indian Mus.). **Nepal**: (Ind. Mus. 1082/17) ♂, from *Felis tigris*, Neapalganj, near the Frontier, II. 1911; (Ind. Mus.) ♀, from *Felis tigris*, Burdwar, Nepal Terai. **Bengal**: (Ind. Mus. cc/367 c.) ♂, found at Singla, Darjiling District, IV. 1913, collected by Lord Carmichael; (Ind. Mus.) ♂ ♀, from *dog*, at Bhogaon, Purneah District; (Ind. Mus. 917/17), found at Katihar, Purneah District, by C. Paiva; (Ind. Mus. 999–17) from *buffalo*, Purneah District, L. R. Paiva, XI. 1910; (London Sch. Trop. Med.) from *dog*, Calcutta, collected by C. R. M. Green; (Ind. Mus. 1079/17 = N. 1804), ♂ from *dog*, Calcutta, II. 1911; (N. B. Kinnear) ♀ from *Canis aureus*, Andheri, near Calcutta, XII. 1908; (Ind. Mus. 2140/17 = N. 2864) adults from *Viverricula malaccensis* (Gmel.), Satpara, Puri District, Orissa, 17. VIII. 1914, Dr N. Annandale coll. **Eastern Bengal and Assam**: (N. 890), from the Chin Hills, just east of Chittagong, 1909, H. M. Lefroy coll.; (N. 892), from *Canis familiaris*, Southaia Mts.; (N. 582 and 583), from *Equus caballus* and *Talpa* sp., Lushai Mts., collected VI. 1907 by R. A. Lorrain; these three lots were presented by the Hon. N. C. Rothschild; (Ind. Mus. 1202/17, 1244/17) ♂ ♀, from N.E. Assam, XI. 1911, found on *grass* and on *floor* at Sadiya respectively. **Madras Presidency**: Beginning in the north: (Ind. Mus.), ♂, from *dog*, Berhampur, I. 1910; (Ind. Mus.) ♀, from *grass* at Lake Chilka, collected III. 1910 by Dr A. Annandale; (N. 1826), ♂ ♀ o, from a *cow*, Madras collected in 1912 by Mr J. F. Valladares; (N. 167 and

168) were collected by Colonel C. E. Nuthall, A.V.C., XI. 1906, from *cattle*, at the slaughter-house and from a *goat* at Madras; (N. 1906), ♀, from *cattle*, collected VII. 1906, at Bellary by Mr F. M. Howlett; (N. 343) ♂ ♀, from Coimbatore, collected in 1906 by Colonel C. E. Nuthall, A.V.C.; (N. 1958) ♂ ♀, from *sheep*, at Agricultural Farm, Coimbatore, collected in 1912 by Mr T. Bainbrigge Fletcher; (N. 2745) ♀, from *calves*, Guindy, III. 1914, Captain W. S. Patton coll. **Travancore**: (Ind. Mus.) ♀, from *Macacus sinicus*, at Maddathory, western base of Western Ghats; (N. 1253 *a*) ♂ ♀, from *dog*, place not stated, collected III. 1911, by Mr E. R. Howlett; (Ind. Mus. TM/3, TM/6) ♀s, from *bullock*, collected XII. 1911, at Nagercoil; (N. 3072 = Ind. Mus. 2173/17) ♂ ♀ from *Hemitragus hylocrius*, Parambikulam, Cochin State, IX. 1914, F. H. Gravely coll. **Mysore**: (N. 1071 *b*), ♂ ♀, from *cow*, Bangalore, collected I. 1910, by Mr W. H. Marshall. **Bombay Presidency**: (N. 863), from *calves*, and (N. 869) from *foxhounds*, at Belgaum, collected in 1909, by Captain F. H. C. Hutchinson, I.M.S.; (Ind. Mus. 1117/17) ♂, found at Caunter, Panwell, II. 1911; (N. 2529 *b*), ♂ ♀, from *bullocks*, collected X. 1913, at Poona by Major Eassie and presented by Colonel E. R. C. Butler; (Mr Howlett's coll.) adults from *lion*, shot 11. III. 1909, in Gaur Forest, Kathiawar; (N. 2002) ♀, from *Felis tigris*, Kadra, Kanara, XI. 1910, N. B. Kinnear coll. **Ceylon**: Dr Aldo Castellani, in 1906, sent us four lots (N. 150), from *dogs*, Nugegoda; (N. 148) from *polecat*, Kollupitiya; (N. 151) from *Mouse-deer*, Cinnamon Gardens; (N. 152) from *pig*, Government Model Farm, near Colombo. Colonel B. Skinner, R.A.M.C., in 1906, sent us three lots; (N. 186 *a*) from *country cat*, Borlesgama; (N. 187) from *dog*; (N. 188) from *black monkey*, Raygam Koili. Mr E. E. Green sent us two lots (N. 510) ♀s, from *dog*; (N. 515 *b*) ♀s, from *cattle*, Matara, VII. 1906. We have a specimen (N. 891) ♀, from *cattle*, presented by Mr E. G. Wheler in 1906. We have determined (E. 876 *a* = N. 2901, E. 771) adults and nymphs found on the *goat*, at Hakgala, 23. VII. 1913 and 27. III. 1914, and (E. 768) on *cattle*, at Peradeniya, 31. V. 1913, by A. Rutherford.

Burma: (N. 1384 *a*) from *goat*, Rangoon, collected IX. 1911, by Dr H. H. Marshall. **Andaman Islands**: (Ind. Mus. 1118/17) ♂, from *dog*, at Ross, collected III. 1911, by O. Paiva. **Federated Malay States**: Dr W. M. Scott has sent us (N. 2459) ♂s ♀s, found on *fowls*, III. 1913, at Singapore. **China**: We have received through Mr T. V. Sherrin (N. 1372) 1 ♀, from *Nemorhaedus cinereus*, Jehang, and (N. 1373) 6 ♂ 5 ♀, from *Cervulus* sp., Fen Tuang Shan, An-Wei; we have, moreover, determined numerous specimens (Berlin Mus. No. 179) from Chinese roebuck (*Hydropotes inermis*), Herr Lemm coll., and (D.E.M. 3, 4, 10; N. 2905, 2976) from *dog* and other (?) hosts, collected at Tsingtau, 7. VIII. 1914, by Prof. Hoffmann.

Japan: The late Professor W. Dönitz presented us with co-types (N. 129) of his *H. neumanni*, ♂ and ♀, found on the *horse*. Dr M. Miyajima has sent us (N. 2911 *a*) 1 ♀ from *cattle*, Tokio, 16. X. 1911, found with *Boophilus*; (N. 2907 *a*) ♀s from *horse*, Aomori, North-Central Japan, 15. VII. 1912, found with *Dermacentor*; (N. 2908) adults and larvae, from *horse*, Daisen, N.W. of Central Japan, 2. VIII. 1912, found with *Ixodes ricinus*; (N. 2909) ♀s from *horse*, Takanabe, Kiushiu, 5. VI.–12. X. 1912. **Borneo**: (N. 307 *b*), from *wild red-deer*, Kuching, Sarawak, collected VII. 1907, by Dr A. R. Wellington. **Australia**: We are indebted to Dr J. Burton Cleland for (N. 1851) ♀, from *horse*, Ballina, N.S. Wales, X. 1911; (N. 1852) ♀, from *calf*, Bonville. **British East Africa**: Dr J. G. Parham, IV. 1912, collected specimens (N. 1787 *b*, 1781 *d*), ♂s and ♀s respectively, from *bullocks* at Bet-el-Ras and Chuckwani; (N. 1783 *a*) ♀, from a *goat* at Mahonda; (N. 1790 *b*) ♀, from a *bull* at Kikwaguni; he also found a ♀ on a *bullock* at Bububu. (N. 2846 = E. 870) ♂, from imported Indian (Bombay) *cattle*, Zanzibar, 2. IX. 1913, Dr W. M. Aders coll. We have also determined specimens collected by Mr Last in Zanzibar, X. 1905, which are in the collection at Liverpool (Liverpool coll. Nos. 74 and 87) ♀s and nymphs from *cattle*, and ♂s, ♀s from *goat*, and specimens (♂ ♀ Berlin Mus. No. 71) labelled merely "Zanzibar." From the foregoing records it would appear that *H. bispinosa* has recently been imported into Africa as it has not previously been reported from this continent.

Haemaphysalis bispinosa var. intermedia Warburton and Nuttall, 1909.

Figs. 363, 364.

Lit. and Icon.: Warburton and Nuttall, 1909, pp. 69–70, Fig. 16 (reproduced).

Differs from the type in little else than the structure of the palps[1]. In the ♀ (Fig. 364) the third article, instead of bearing a somewhat

[1] The scutums of 4 ♂ and 4 ♀ measured as follows in mm.:

♂	♀
1·8 × 1·15	0·9 × 0·9 (3 specimens)
1·75 × 1·15	0·8 × 0·8
1·7 × 1·2	
1·6 × 1·05	

erect dorsal retrograde spine at the *middle* of its posterior border, has its internal angle produced to a retrograde point, hardly raised above the dorsal surface of the palp. In the ♂ (Fig. 363) the point may be altogether absent, the postero-internal angle of article 3 being bluntly rounded. The spiracle is, as a rule, somewhat narrower and more transverse than in the type.

This variety was described from specimens marked * (♀ types) in the subjoined list relating to the geographical distribution; it was named *intermedia* because it seemed to connect the group with a dorsal spur on article 3 of the palp with another group, destitute of such a spur, of which *H. campanulata* is the type.

Types in Cambridge (N. 1686 ♂; N. 34 *d* and *h*; N. 327, N. 515 *a* ♀). We presented co-type N. 34 *h* ♀ to the collection of the London School of Tropical Medicine.

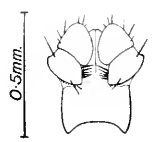


Fig. 363.

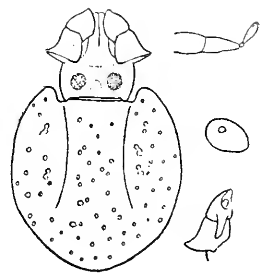


Fig. 364.

Fig. 363. *H. bispinosa* var. *intermedia* ♂. (N. 1686) capitulum of type. Original, N. C. del.

Fig. 364. *H. bispinosa* var. *intermedia* ♀. Capitulum and scutum, tarsus IV, spiracle and ventral aspect of right palp. Warburton and Nuttall, 1909, Fig. 16. Sketch by C. W.

Although widely distributed in **India**, this variety has not reached us from the same places as *H. bispinosa*, and it does not appear to be as common. We have received the following specimens: (*N. 327), from a *cat*, Agra, collected in 1907 by Dr E. H. Hankin; (*N. 1686, ♂ types), from *Lepus ruficaudatus*, collected, III. 1911, at Shamghar by Mr N. B. Kinnear.

The following were collected in Cutch by Mr N. B. Kinnear:—(N. 1680), 3 ♂ 1 ♀, from *Canis pallipes*, at Charwa, 1911; (N. 1682), ♂s, from *Felis caracal*, at Bhuj, VIII. 1911; (Kinnear No. 289 *b*), ♂, from *Felis caracal*, at Dhonsa, 1911; (Kinnear, No. 348), from

Erinaceus micropus, at Bhuj, VII. 1911; (Kinnear No. 241 *a*), ♂ ♀, from *Felis ornata*, at Bhuj, 1911: (Kinnear No. 264 *a*), ♂s, from *Felis affinis*, at Nohaman, 1911. Major O. A. Smith collected on 9. VIII. 1912 numerous ♂ ♀ in Chota Nagpur (Indian Mus. 1524/17 = N. 2056, N. 2077), from a *wolf*, four miles west of Koderma Station. Mr N. B. Kinnear collected three lots in Kandeish, at Ghodasgaon, v. 1911, namely (N. 1665), ♂, from *Hyaena hyaena*: (N. 1666) ♂s, from *Felis affinis*; (Kinnear, No. 402), ♀, from *Millardia meltada*[1]; also one lot at Pili, Sipna Valley, Berars; (N. 1672) ♂ ♀, from *Cyon dukhunensis*. Colonel C. E. Nuthall, A.V.C., sent us several lots (*N. 34 *d*, *h*) collected in 1906 in the Bangalore, Mysore, Secunderabad and Hyderabad Districts, the hosts not having been recorded. One lot (N. 3071 = Ind. Mus. 2172/17) ♂ ♀ was found on *Sus cristatus*, near Barhi, Hazaribagh Distr., Chota Nagpur, 21. VII. 1914, by Major O. A. Smith.

One lot has reached us from **Ceylon** (*N. 515 *a*), from *cattle*, at Matara, collected, VII. 1906, by Mr E. E. Green.

20. HAEMAPHYSALIS PARVA Neumann, 1908.

Figs. 365, 366.

Lit. and Icon.: Neumann, VII. 1908, pp. 89–91, Fig. 10 (reproduced). Blanchard, 1909, p. 154, and Galli-Valerio, 1909, p. 539 (listed only).

Male (Figs. 365, 366): Very small, body measuring 1·1 × 0·8 to 1·4 × 1·0 mm. *Scutum* a rather broad oval, broadest posteriorly, the posterior border being rather flat or truncate; strongly punctate, the punctations deep and often confluent; cervical grooves shallow; lateral grooves medium, including no festoons; festoons fairly long, well-marked. *Capitulum*: base rectangular, relatively rather long, cornua strong; hypostome short, with dentition 4|4; palps with articles 2 and 3 of about equal length, article 2 not very salient laterally, without spines; article 3 with strong ventral retrograde spine and a dorsal tooth not very erect and somewhat internal. *Venter*: spiracle subcircular. *Legs*: a strong spine on coxa I, a slight internal spur on coxae II–IV; tarsi medium, not humped; pad long: the hairs along the ventral surface of the legs are longer and more conspicuous than in *H. bispinosa*.

[1] Family *Muridae*.

Female: Body oval, red-brown or yellowish. *Scutum* oval 0·7 × 0·65 mm., with punctations as in the ♂, a little lighter than the rest of the body; cervical grooves well marked, spiracle as in

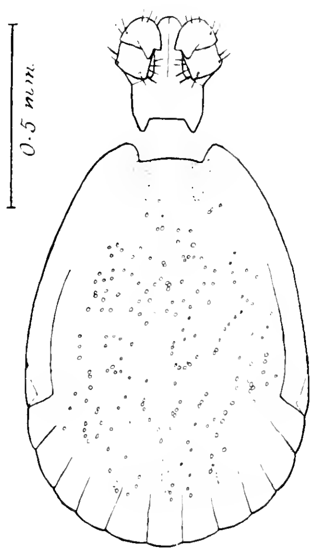


Fig. 365. *H. parva* ♂. Dorsum. Drawn from co-type No. 1038 in Galli-Valerio coll. Original, N. C. del.

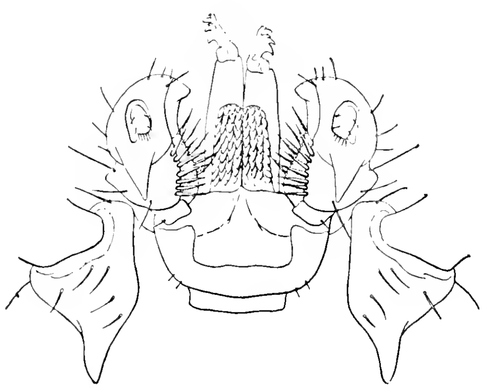


Fig. 366. *H. parva* ♂. Capitulum in ventral aspect with coxae I. Neumann VII. 1908, Fig. 10.

the ♂. *Dorsum* conspicuously hairy. *Capitulum* 0·33 mm. long; base more than twice as broad as long; cornua strong; porose areas small, indistinct, far apart; hypostome 4|4; palps as in the ♂. *Legs* medium, as in the ♂.

Nymph and **Larva**: These only differ from the corresponding stages of *H. bispinosa* (see pp. 430, 431) in having stronger cornua and more hairy dorsum and legs.

The species was originally described from 16 ♂ 8 ♀ 3 O and 7 L, from *Canis aureus*, **Ceylon**, 1907, collected by Dr Marbel. The types and co-types are in Toulouse, in Prof. Galli-Valerio's collection at Lausanne and in Cambridge (N. 2889 ♂ ♀), the last having been presented to us by Prof. Neumann.

Prof. Galli-Valerio has kindly allowed us to examine all of his specimens of *H. parva* (Nos. 1037, 1038), which are co-types if not types. No. 1037 contained 2 ♂ *H. parva* and 2 ♀s which differed much from each other and do not belong to the ♂s; one was *H. hystricis* ♀, and the other was indistinguishable from *H. bispinosa* ♀. No. 1038 contained 10 ♂, 1 ♀, 2 O and 4 L; all of which agree fairly well together and are doubtless the various stages of the tick named *H. parva* by Neumann.

When the dorsal spur on article 3 of the palps is added to Neumann's description, the likeness to *H. bispinosa* is very close, and it is not without hesitation that we regard it as specifically distinct. Besides the difference in size, the ♂s have a different facies, *H. parva* ♂ being short and broad, truncated posteriorly, and more deeply punctate than *H. bispinosa*. The ♀s, Os and L have stronger cornua and are distinctly more hairy.

We have determined the following as *H. parva*: (Ind. Mus. 2141/17, 2143/17 = N. 2865 and 2931 *a*) ♂s ♀s from *Felis viverrina* Bennett and *Lepus ruficaudatus* Geoff., Satpara, Puri District, Orissa, **India**, 16. III. 1914, coll. Dr N. Annandale; (Berlin Mus. = N. 2822) ♂ ♀, origin unknown, collected by Schoede; (N. 3073 = Ind. Mus. 2176/17) ♂s ♀s from *Lepus* sp., Satpara, Lake Chilka, Orissa, IX. 1914, Chilka Survey coll.; (N. 2388 b) ♂s ♀s from *panther*, no locality stated presented by R. Hancock; this lot contained some large specimens.

21. HAEMAPHYSALIS CUSPIDATA Warburton, 1910.

Figs. 367–370.

Lit. and Icon.: Warburton, XII. 1910, pp. 401–402, Figs. 6, 7, ♂ and ♀ (reproduced).

Male (Fig. 367). *Scutum*: 1·8 × 1·1 mm., fairly glossy, with numerous very small, shallow, discrete punctations; cervical grooves deep under the cornua, then faint and gently diverging; lateral grooves medium, faint, including one festoon; festoons long, curved, with distinct broad intervals widening distally. *Capitulum*: base rectangular, broader than long, with straight sides and very long cornua, longer than the base (hence *cuspidata*); palps of medium length; article 2 fairly salient laterally, unarmed, article 3 with long dorsal retrograde spine reaching to the posterior border of article 2, and almost equally long ventral spine, article 4 unusually long; hypostome 4 | 4. *Venter*:

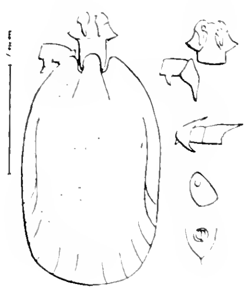


Fig. 367.

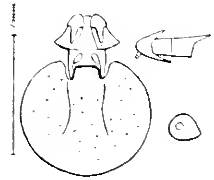


Fig. 368.

Figs. 367 and 368. *H. cuspidata*. (Fig. 367) ♂ dorsum, capitulum in ventral aspect, coxa and trochanter I, palp in profile, spiracle, anal grooves. (Fig. 368) ♀ capitulum and scutum, palp in profile, spiracle. (Sketches by C. W.) Warburton, 1910, Figs. 6, 7.

genital orifice between coxae II; anal grooves ogival; spiracle subtriangular, with narrow rounded anterior border and nearly straight posterior border. *Legs*: coxa I with long narrow spur, coxae II–IV unarmed, trochanter I with a strong rather sharp retrograde spur both dorsally and ventrally: otherwise as in *H. aculeata* (p. 440).

Female (Fig. 368): Body dark-brown, very punctate. *Scutum*: yellowish, nearly circular, 0·96 × 1·3 mm., numerous medium-sized punctations; cervical grooves rather long and slightly converging till they reach the middle of the scutum. *Capitulum*: base about twice as broad as long, with long cornua, but not so long as in the ♂;

porose areas rather large, oval, converging in front, separated by more than their diameter; palps with the same characteristics as those in the ♂, but the ventral spur on article 3 longer than the dorsal; hypostome 4 | 4. *Venter*: spiracle nearly circular, but rather pointed dorso-laterally; vulva between coxae II and III. *Legs*: as in the ♂.

Nymph: (Fig. 369): *Scutum*: 0·42 × 0·48 mm. *Capitulum*: without dorsal spur on article 3 of the palp; otherwise like the ♀ in such structures as are present. The long cornua give it a very characteristic appearance.

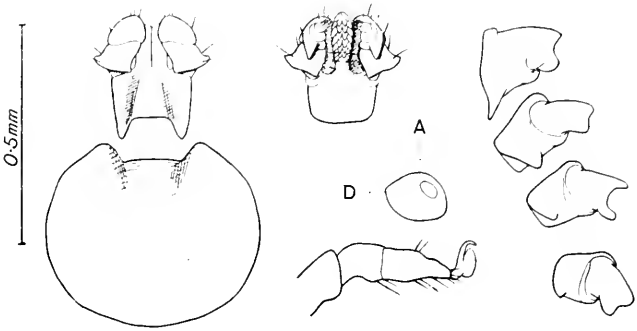


Fig. 369. *H. cuspidata*. Nymph. Scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. (N. 2692 type.) Original, N. C. del.

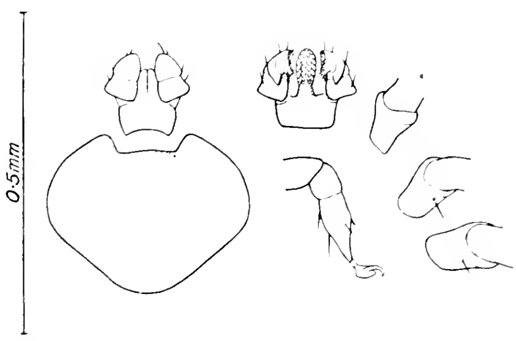


Fig. 370. *H. cuspidata* Larva. Scutum, capitulum in dorsal and ventral aspects, coxae and tarsus III. (N. 2692 type.) Original, N. C. del.

Larva (Fig. 370): *Scutum*: 0·25 × 0·31 mm., cordate, emargination deep; cervical grooves well marked for half the scutal length, parallel. *Capitulum*: base sub-rectangular, with cornua only slightly developed: palps as in the nymph, but less salient laterally. *Legs*: coxae practically unarmed; tarsus III tapering finely; pad short. There is little to indicate the connection of the larva with the adult.

Described from (N. 1108) 30 ♂, found (in company with *H. aculeata*) on *Tragulus memmina* (the "Mouse Deer"), at Colombo, **Ceylon**, 3. VIII. 1909, by Mr C. C. Dobell; and (N. 2692) 2 ♀, 7 os and 4 larvae, found on *Paradoxurus niger* (Palm civet) at Colombo, Ceylon, 16. II. 1910, Dr A. Willey coll. We have since received (N. 2766) 3 ♂ 1 ♀, found on *Herpestes mungo*, Peradeniya, Ceylon, II. 1912, J. S. Fryer coll.

This species much resembles *H. aculeata* in most respects, but it is easily distinguished by the capitulum.

Types in Cambridge (N. 1108, ♂s; N. 2792, 1 ♀ 7 o 4 L). We have presented co-types (N. 1108 ♂) to the Zoological Museum, Berlin, and to the Neumann collection, Toulouse.

22. HAEMAPHYSALIS ACULEATA Lavarra, 1905.

Figs. 371, 372.

Lit., Icon. and Synon.:

H. aculeata Lavarra, 1905, pp. 255–258, no figure (♂).
H. longipalpis Warburton, 1910, pp. 399–400, Figs. 4, 5 (♂ and ♀ reproduced).
H. aculeata Lavarra, in Neumann, 1911 *a*, p. 110; no figure.

Male (Fig. 371). *Scutum* 2 × 1·3 mm.[1], glossy, with numerous very small punctations, many of them confluent; cervical grooves deep to receive the cornua, barely visible behind them; lateral grooves rather short and faint, including one festoon; festoons long, with well-marked curved intervals. *Capitulum*: base sub-rectangular, with rounded sides, broader than long, with cornua of almost equal length; palps very long, three times as long as broad: article 2 very slightly protuberant laterally, unarmed; article 3 with a long, strong retrograde spine dorsally and ventrally; hypostome small, with numerous very small sharp teeth, apparently 6 | 6, considerably shorter than the palps. *Venter*: genital aperture between coxae II; spiracles sub-rectangular, more rounded anteriorly; anal grooves rather ogival. *Legs*: coxae I with a rather long blunt spur; coxae II–IV unarmed; trochanter I has a distal retrograde spur both dorsally and ventrally,

[1] The scutum of (N. 2731 co-type) the ♂ presented by Lavarra measures 1·7 × 1·2 mm. but the specimen appears somewhat shrivelled.

the former blunt, the latter shorter and more pointed; tarsus IV roundly tapering; pads large.

Female (Fig. 372). *Scutum* nearly circular, 1·2 × 1·2 mm.; cervical grooves deep pits behind the cornua, followed, at a short interval, by broad, shallow, nearly parallel depressions extending slightly beyond the middle of the scutum; numerous very small punctations. *Capitulum*: base rectangular, twice as broad as long, porose areas much longer than broad, very far apart; cornua short and blunt; palps very

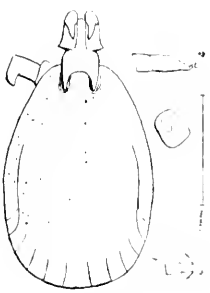


Fig. 371.

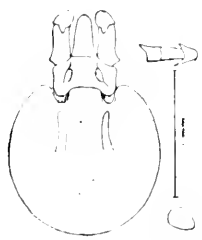


Fig. 372.

Haemaphysalis aculeata.

Fig. 371 ♂. Dorsum, tarsus IV, spiracle, palp in profile.

Fig. 372 ♀. Capitulum and scutum, palp in profile, spiracle. Warburton, 1910, Figs. 4, 5 (sketches; scutums to scale).

long, four times as long as broad, nearly cylindrical, armed as in the ♂, but with the dorsal retrograde spur of article 3 shorter; hypostome 5/5, well covered with small teeth; spatulate. *Venter*: spiracle smaller than in the ♂ and more pointed dorso-laterally. *Legs*: as in the ♂.

Described from 10 ♂ and 1 ♀ taken by Mr C. C. Dobell from *Tragulus memmina* (the Mouse Deer), at Colombo, **Ceylon**, 3 VIII. 1909, and named *H. longipalpis* by Warburton (1910). The ♂ was described before as *H. aculeata* by Lavarra (1905); the latter name has, therefore, priority. Lavarra's specimens (16 ♂) were found on *Tragulus memmina* Bodd. in the **East Indies**, the host, which died in a menagerie, having been purchased by the Zoological Museum, Rome. A specimen kindly presented to us by the author (N. 2731, co-type) agreed fully with the foregoing description of the ♂.

This remarkable species, though undoubtedly a *Haemaphysalis*, has the abnormal character of palps much longer than broad. It belongs to the *H. bispinosa* group.

Types and co-types (♂) in Lavarra's collection, Rome, in Toulouse and Cambridge. The types of *H. longipalpis* Warb. (N. 1107, ♂ ♀) are in Cambridge.

23. HAEMAPHYSALIS CALCARATA Neumann, 1902.

Figs. 373–377.

Lit. and Icon.: Neumann, 1902, pp. 113–115, Figs. 2, 3 (♂ reproduced). Description of ♂ and o, the latter not figured. Neumann, 1910, pp. 173–174, Figs. 11, 12. Description of ♀. The figures represent the ♀ capitulum and scutum, ventral aspect of palp, digit; not reproduced (see our text). Neumann, 1911 *a*, pp. 113–114; account condensed from Neumann, 1902, ♀ not described, species not figured. Blanchard, 1909, p. 148, Fig. 178; species merely listed, the figure taken from Neumann.

Male (Figs. 373–375): Body about 1·7 × 1·1 mm. in average specimens[1]. *Scutum*: punctations very fine, discrete, inconspicuous; cervical grooves short, deep, converging; lateral grooves medium, well-marked, including one festoon; festoons relatively broad, hardly longer than broad.

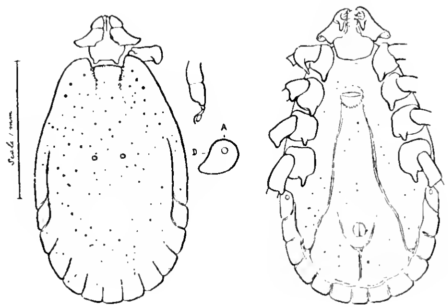


Fig. 373.

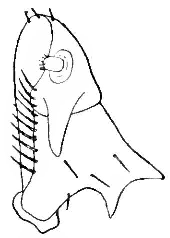


Fig. 374.

Fig. 373. *H. calcarata* ♂. Dorsum and venter, spiracle and tarsus IV. (Drawn from the type in Neumann's collection, No. 1292.) Original, G. H. F. N. del.

Fig. 374. *H. calcarata* ♂, left palp, ventral aspect. Neumann, 1902, Fig. 2.

Capitulum: base trapezoid, broadest in front, with straight or somewhat rounded sides converging behind, cornua slight; palps with article 2 very salient laterally, the salience hollowed to receive coxa I, and produced on the ventral side to a sharp retrograde spur; article 3 broader than long, with a long sharp ventral retrograde spur; no

[1] This is the size of the ♂ type we illustrate in Fig. 373; our 4 ♂s from Somaliland measured 1·95 × 1·1; 1·8 × 1·1; 1·75 × 1·1; and 1·65 × 1 mm. respectively.

dorsal spurs on the palps; hypostome 4 | 4. *Venter*: spiracle sub-triangular or somewhat comma-shaped, rather small. *Legs*: coxae with strong internal spurs, strongest on coxa I; trochanter I with long sharp ventral (as well as dorsal) retrograde spur; a similar but less-marked spur on trochanters II and III, nearly obsolete on trochanter IV; tarsi short and very stout almost to the tip, where they taper very abruptly; pad moderate.

Female (Fig. 376). *Scutum*: 0·95 × 0·85 mm.[1], appearing distinctly longer than broad, narrowing posteriorly; punctations rather few, indistinct, of moderate size. *Capitulum* with base of similar shape to that of ♂ though relatively broader; porose areas oval, well separated,

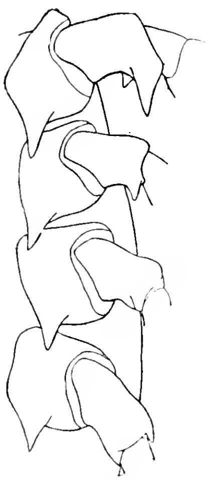


Fig. 375.

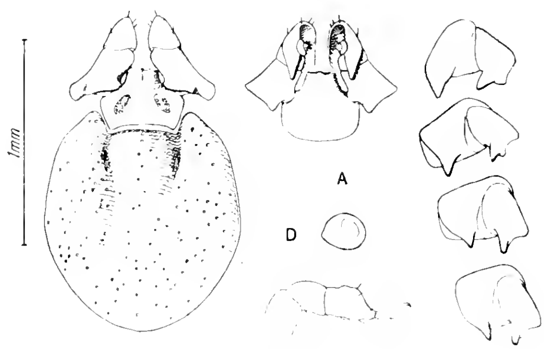


Fig. 376.

Fig. 375. *H. calcarata* ♂. Coxae with trochanters. Neumann, 1902, Fig. 3.

Fig. 376. *H. calcarata* ♀. Scutum, capitulum in dorsal and ventral aspects, coxae and trochanters, spiracle and tarsus IV. (N. 1224.) Original, N. C. del.

converging anteriorly; palps as in the ♂ but relatively longer and with the ventral spur on article 2 less marked. *Venter*: spiracle sub-circular, small. *Legs* as in the ♂, with the same coxal and trochantal armature less marked, and with similar thick abruptly-tapering tarsi.

Nymph (Fig. 377): *Scutum* sub-circular, shagreened but without definite punctations; cervical grooves well-marked and converging at first, then broad and shallow. *Capitulum* with base broadening anteriorly, cornua slight; palps with article 2 sharply salient laterally,

[1] Measured on our specimen from Somaliland.

with its posterior border almost straight dorsally, but with a ventral retrograde spur directed outward; lateral contour of articles 2 and 3 continuous and concave outwardly; article 2 twice as long as article 3; hypostome 2 | 2. *Legs* with a sharp internal spur on all the coxae.

Through the courtesy of Professor Neumann we have been able to study and figure one of his type specimens (♂), the species having been founded by him on 5 ♂ and 1 o from *Spermosciurus* sp., Sichi Baz, **Abyssinia**, collected by Hilgert (received in 1901 from Erlanger).

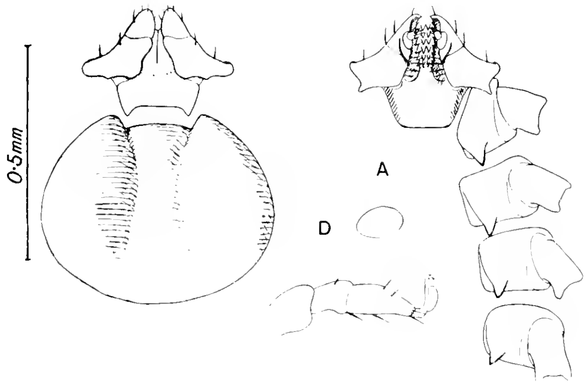


Fig. 377. *H. calcarata* Nymph. Capitulum and scutum, capitulum in ventral aspect, with coxae and trochanters, spiracle and tarsus IV. (N. 1224.) Original, N. C. del.

Neumann, 1910, p. 173, records 2 ♂ and 8 ♀ from a *squirrel*, Rosérès, Upper Blue Nile, **Egyptian Soudan**, 1906, coll. C. Alluaud (Paris Mus.). The female as described and figured by Neumann (1910) does not agree so closely with the male as do our specimens; we do not, therefore, reproduce his figures.

Our description of the adults and nymph is based on specimens (N. 1203, 1224), 4 ♂ 2 ♀ and 1 o, from *Xerus rutilus*, Biacobaba, **Somaliland**, IV. 1901, presented by Dr E. Brumpt, and the study of a type ♂.

Types in Neumann collection, Toulouse. Co-type (N. 2882) ♂ in Cambridge.

Haemaphysalis calcarata var. houyi Nuttall and Warburton, 1915, n. var.

Male: Resembles the type but for its somewhat sturdier build and the fact that the trochantal spurs are short and blunt, the palps being somewhat shorter and more massive.

Female: Resembles the type except for the reduced trochantal spurs.

Nymph: Possesses a scutum rather longer than in the type. Trochantal spurs absent.

Described from 7 ♂ 1 ♀ and 2 o from Bate, New Cameroon, collected by Dr Houy. The variety is closely allied to a small form of *H. leachi* found in Abyssinia by Dr Brumpt but it is distinguished therefrom by its humped tarsi.

Types in the Berlin Museum (No. 279), co-types in Cambridge (N. 2996).

24. HAEMAPHYSALIS CALVUS Nuttall and Warburton, 1915 n. sp.

Figs. 378, 379.

Male (Fig. 378). *Scutum* about 2·4 × 1·7 mm.[1], broadly oval, widest at about the fourth coxae, glossy, with very numerous minute

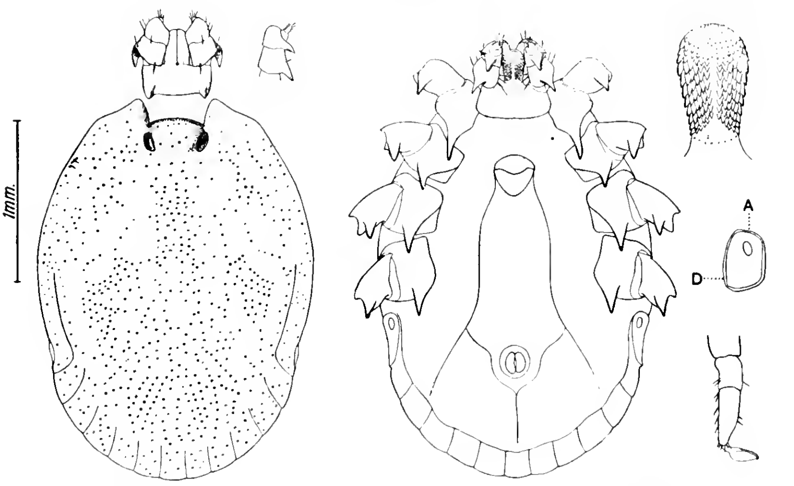


Fig. 378. *H. calvus* ♂. Dorsum and venter, right palp in profile, hypostome (highly magnified), spiracle and tarsus IV. (N. 2120 type.) Original, N. C. del.

shallow punctations, often confluent and tending to a linear arrangement; cervical grooves short deep depressions close behind the anterior border; lateral grooves short, beginning far back and ending very

[1] The scutums of our 3 ♂ specimens measure respectively:
2·6 × 1·85 mm. 2·3 × 1·7 mm.
2·45 × 1·8 ,,

indefinitely; festoons rather longer than broad. *Capitulum*: base rectangular, twice as broad as long, finely punctate, with moderate cornua; palps short, article 2 only slightly salient laterally, the salience about the middle of the article, considerably longer than article 3 in its ventral aspect; no dorsal spines, but long sharp ventral retrograde spines on articles 2 and 3, those on article 2 so divergent as to be visible dorsally; hypostome short and broad, with 6|6 small sub-equal teeth, about 8–10 per file, and large corona. *Venter*: anal grooves ogival; spiracle sub-rectangular, rather broader posteriorly. *Legs*: strong sharp spines on all the coxae, longest on coxa I; well-marked sharp trochantal spurs, progressively diminishing, and shortest on coxa IV; tarsus IV long, tapering gradually; pad long.

Female (Fig. 379). *Scutum* broader than long, 0·9 × 1·1 mm., broadest near the posterior end, glossy, with numerous moderate punctations; cervical grooves well-marked, sub-parallel. *Capitulum*: base twice as broad as long, cornua slight, porose areas large, sub-circular, far apart, but indefinite in contour except where defined

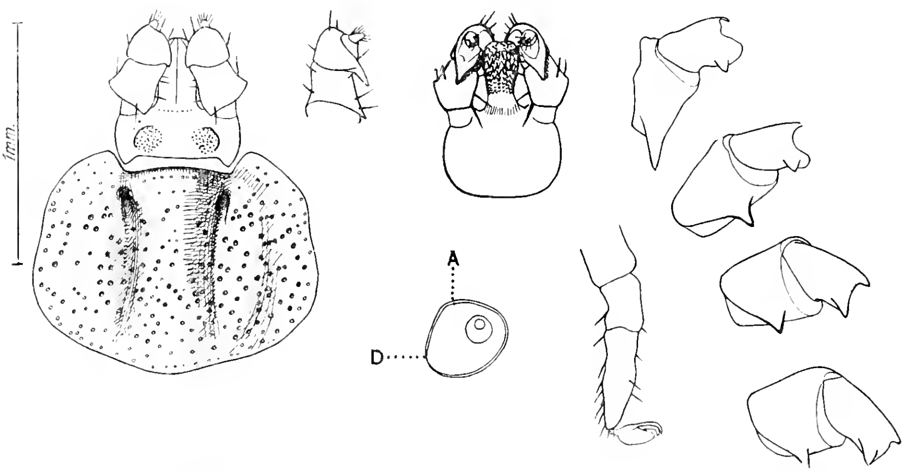


Fig. 379. *H. calvus* ♀. Scutum, capitulum in dorsal and ventral aspects, right palp in profile, coxae with trochanters, spiracle and tarsus IV. (N. 2120 type.) Original, N. C. del.

by the lateral ridge; palps of the same character as in the ♂, but rather longer and entirely without the divergent ventral spurs on article 2; hypostome short and broad, 4|4. *Venter*: anal groove semi-circular; spiracle sub-circular. *Legs* as in the ♂, with shorter spurs.

Described from 3 ♂ and 1 ♀ (N. 2120 *a*), taken from *buffalo*, Sekong River, Sandakan, **British North Borneo**, 19. IV. 1913, Dr H. F. Conyngham coll.

A large species allied to *H. montgomeryi* Nuttall, 1912, but differing therefrom as follows: basis capituli and scutum broad, fourth coxal spur less developed, venter not hairy, ventral spur of article 2 of ♂ palp more divergent, etc.

Types in Cambridge.

25. HAEMAPHYSALIS SPINIGERA Neumann, 1897.

Figs. 380–383.

Lit. and Icon.: Neumann, 1897, pp. 352–354, Fig. 18 (♂ palp, digit and coxae, herein reproduced); Neumann, 1901, p. 264; Neumann, 1911 *a*, p. 113, Figs. 59, 60 (condensed from his earlier description; omits the figure of the digit); Blanchard, 1909, p. 157, Fig. 195 (four-line description with figure; both taken from Neumann).

Male (Figs. 380, 381). *Scutum* oval, about 2·5 × 1·5 mm., broader posteriorly, finely punctate all over; cervical grooves shallow, parallel;

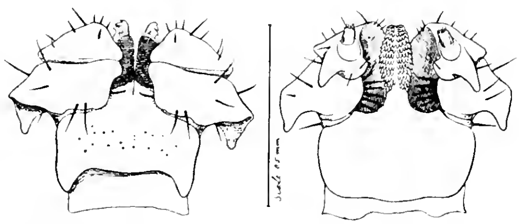


Fig. 380. *H. spinigera* ♂. Capitulum in dorsal and ventral aspects. Drawn from a balsam-mounted type specimen taken from a bear. Only the surface structures are shown. Original, G. H. F. N. del.

lateral grooves short, very concave internally, including no festoon; festoons long. *Capitulum*: base rectangular, finely punctate dorsally, cornua strong; palps short, article 2 fairly salient laterally, with a retrograde spine at the ventro-lateral angle; article 3 much broader than long, with a short stout ventral tooth; hypostome 5 5, 9 or 10 teeth per file. *Venter*: spiracle oval, with slight dorsal process. *Legs*: relatively stout; coxa I with a long internal spur; short spurs at the middle of the posterior border of coxae II and III, a very long internal spur on coxa IV; tarsi tapering, pad long.

Fig. 381. *H. spinigera* ♂ : (1) left digit, × 320 ; (2) left palp in ventral aspect, × 65 ; (3) coxae, × 45. Drawings from the type. Neumann, 1897, Fig. 18.

Female (Figs. 382, 383). *Scutum* sub-circular, 1·2 × 1·1 mm., with very fine punctations irregularly distributed; cervical grooves faint,

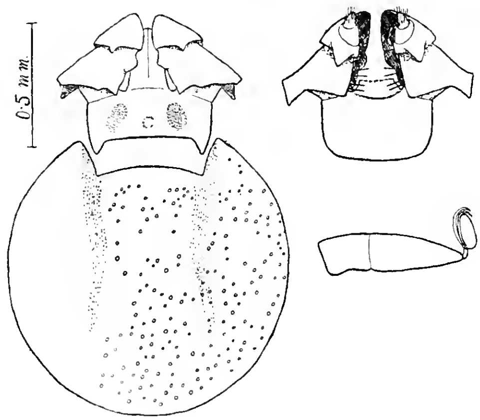


Fig. 382.

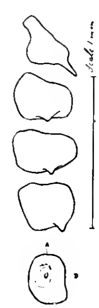


Fig. 383.

H. spinigera, ♀.

Fig. 382. Capitulum and scutum, capitulum in ventral aspect, tarsus IV. Drawn from one of our specimens (N. 1998). Original, N. C. del.

Fig. 383. Coxae of right side and spiracle. Drawn from a type specimen mounted in balsam. The tick was found on an Indian bullock. Original, G. H. F. N. del.

sub-parallel. *Capitulum*: base rectangular, much broader than long; porose areas oval, far apart, a small median pit in the interval; cornua fairly strong; palps relatively longer than in the ♂, but with the same characteristics; hypostome 4 | 4. *Venter*: spiracle sub-rectangular, dorsal process almost absent. *Legs*: coxa I with a fairly strong internal spine; a very small spur on coxae II–IV; tarsi tapering, pad long.

Our description is based on specimens (N. 1998, ♂ ♀) found on *Felis tigris*, at Kadra, Kanara, **India**, XI. 1910, by N. B. Kinnear, and on others (N. 2388 5 ♂ 2 ♀ 1 o) found on a *panther* and received in 1913 from R. Hancock. Neumann's types were (*a*) specimens from S. Mahratta, India, mounted as microscopic preparations[1], namely, 2 ♂ found on *Felis tigris* and a *bear* respectively, and 1 ♀ (now in Toulouse) found on an *Indian bullock*, (*b*) 2 ♂ 4 ♀ from **Ceylon**, collected by Deschamps (Paris Mus.). Neumann has since (1901, p. 264) recorded 3 ♀ from **Judea**, collected by Roux (Paris Mus.).

Haemaphysalis spinigera var. novae-guineae (S. Hirst 1914) Nuttall and Warburton, 1915.

Figs. 384–386.

Lit., Synon. and Icon.:

Haemaphysalis novae-guineae Hirst, VI. 1914, pp. 328–330, Fig. 16; ♂ palp in ventral aspect and coxae with trochanters; ♀ capitulum and scutum (not reproduced).

Both sexes are more glossy and less punctate than the type species.

Male (Fig. 384) differs from the type chiefly in the palps and the coxal armature. *Scutum*: ranges in size from 2·45 × 1·6 down to 1·66 × 1·05 mm.[2]. *Capitulum*: the external contour of articles 2 and

[1] These specimens were kindly lent us by Prof. Neumann for purposes of study and they were used in connection with our figs. 380 and 383. The specimens bear the labels of the firm of E. Wheeler, London and formerly belonged to the Blanchard collection.

[2] The scutums of 12 ♂ and 14 ♀ varied as follows in their measurements in mm.:

12 ♂		14 ♀	
2·45 × 1·6	Type from New Guinea.	1·1 × 0·9	Type from New Guinea.
2·25 × 1·53	,, ,, ,,	0·95 × 1·1	Specimens from Queensland.
2·2 × 1·5	,, ,, ,,	0·93 × 1·0	,, ,, ,,
1·93 × 1·22	Specimens from Queensland.	0·9 × 1·0	,, ,, ,,
1·9 × 1·2	,, ,, ,,	0·9 × 0·96	,, ,, ,,
1·85 × 1·2	,, ,, ,,	0·9 × 0·9	,, ,, ,,
1·81 × 1·24	,, ,, ,,	0·87 × 0·9	,, ,, ,,
1·8 × 1·18	,, ,, ,,	0·87 × 0·9	,, ,, ,,

(*Footnote continued overleaf*)

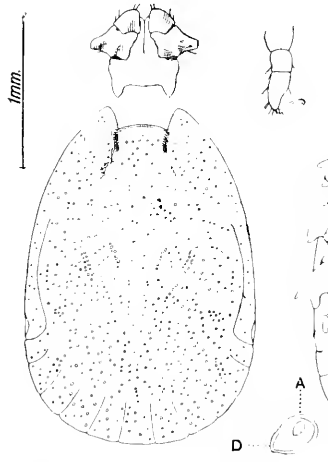


Fig. 384. *H. spinigera* var. *novae-guineae* ♂. Dorsum and venter, spiracle and tarsus IV. (N. 2673.) Original, N. C. del.

3 of the palps is almost unbroken; the lateral salience of article 2 is longer and more retrograde in direction; there is a slight but distinct dorsal spine in the middle of the posterior border of article 2. *Legs*: the spurs on coxae I–III are very short and blunt; whereas in the type there is a long spur on coxa I and well-marked spurs, longer than broad, on coxae II and III. The long needle-like spur on coxa IV is present in both forms.

Female (Fig. 385). *Scutum*: ranges in size from 1·1 × 0·9 to 0·78 × 0·91 mm.[1] *Capitulum* like that of the ♂, and presenting similar differences from that of the type. *Legs*: spur on coxa I slight.

Nymph (Fig. 386). *Scutum* about 0·52 × 0·54 mm.[2], sub-circular, with a few faint punctations and well-marked sub-parallel cervical grooves. *Capitulum* with the characteristics of the ♀ less pronounced;

1·7 × 1·14	Specimens from Queensland.	0·85 × 0·95	Specimens from Queensland.
1·7 × 1·08	,, ,, ,,	0·85 × 0·92	,, ,, ,,
1·68 × 1·15	,, ,, ,,	0·84 × 0·95	,, ,, ,,
1·66 × 1·05	,, ,, ,,	0·8 × 0·95	,, ,, ,,
		0·8 × 0·9	,, ,, ,,
		0·78 × 0·91	,, ,, ,,

[1] See note 2, p. 449.

[2] The scutums of 5 nymphs measured as follows in mm.:

0·54 × 0·54	0·48 × 0·53
0·52 × 0·54	0·44 × 0·53
0·51 × 0·55	

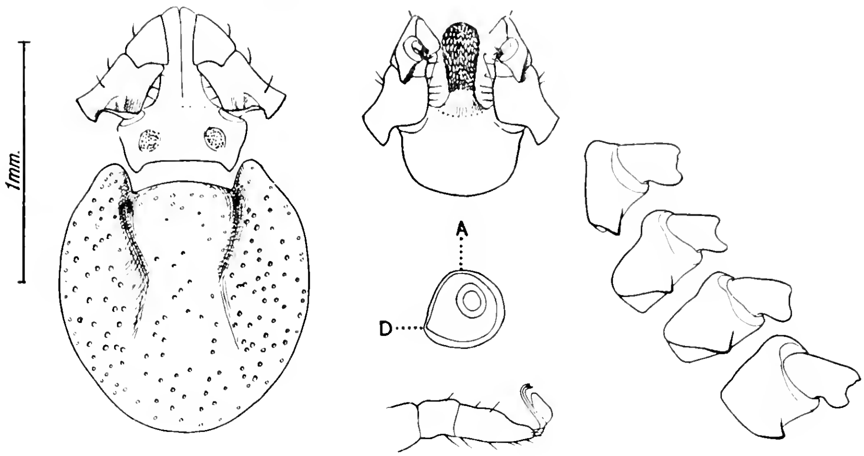


Fig. 385. *H. spinigera* var. *novae-guineae* ♀. Scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. (N. 2673.) Original, N. C. del.

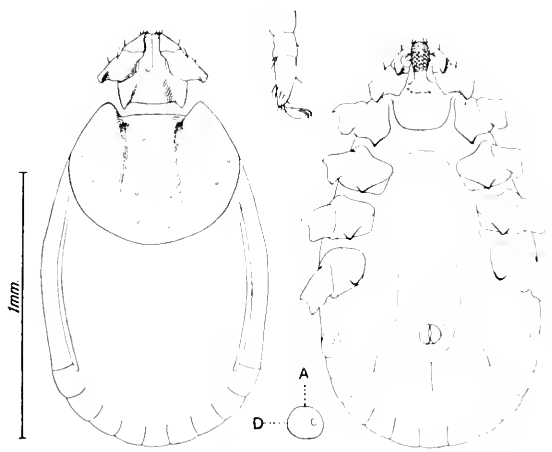


Fig. 386. *H. spinigera* var. *novae-guineae*, nymph. Dorsum and venter, spiracle and tarsus IV. (N. 2673.) Original, N. C. del.

cornua distinct: hypostome 4 | 4. Spiracle circular. *Legs* as in the ♀.

Described from 3 ♂, 1 ♀ and os (N. 2673), from *bandicoot*, Manus, Admiralty Islands, German **New Guinea**, 20. IX. 1913, A. F. Eichhorn coll. We have since determined (Sweet No. 463 = N. 2832) 9 ♂ and 13 ♀ from *kangaroo*, Northern Territory, Queensland, **Australia**: and

(N. 3011 = Berlin Mus. No. 185) many ♂ ♀ o and L from *Perameles dorevanus,* Astrolabe Bay, German New Guinea. After this description was written and the figures completed, we were able to examine specimens of *H. novae-guineae* Hirst (♂ ♀) through the courtesy of the author. We regard Hirst's species as but a variety of *H. spinigera*; his description was based on numerous specimens taken from *Kangaroo, Perameles,* and *Hydromys* sp., at Sattelberg, Huon Gulf, German New Guinea, 1911, by Prof. F. Forster.

Types (♂ ♀) in the British Museum; co-types (N. 2903, ♂ ♀, from *Hydromis*), and our types (N. 2673) of the o are in Cambridge.

26. HAEMAPHYSALIS CONCINNA Koch, 1844.

Figs. 387–393.

Lit., Synon. and Icon.:

Haemaphysalis concinna C. L. Koch, 1844, pp. 237–238; 1847, p. 125, Pl. XXVII, Figs. 99, 100, ♂ and ♀, coloured, fairly good but for the capitulum of the ♂. Origin undetermined.

Haemaphysalis concinna C. L. Koch, in Neumann, 1897, pp. 338–341, Figs. 4–6 (reproduced). Neumann is wrong in giving *Ixodes nigrolineatus* Packard and *I. cookei* Packard in his synonymy of *H. concinna* (see *Ticks*, Part II, pp. 280 *et seq.*); Salmon and Stiles, 1901, Figs. 219–221 (reproduced from Neumann). Blanchard, 1909, p. 148, quotes Neumann.

Ixodes chelifer Mégnin, 1880, p. 132; all the author says of this tick is that it is distinct from *Ixodes ricinus* "the palp, of which the third article is extended inward in a curved point, simulating, with its mate, a pair of pincers." He collected the ♂ only. Canestrini, 1890, p. 526, and Berlese, 1891, fasc. LVIII, No. 10, wrongly give *I. chelifer* Mégnin as a synonym of *H. punctata* (=*cinnabarina* var. *punctata*).

"*Haemaphysalis hirudo* L. Koch," in Neumann, 1897, p. 341; see Note, p. 456, and our list of Condemned Species.

? *Haemaphysalis concinna* var. *kochi* Neumann, 1905, p. 239; see Note, p. 456.

Haemaphysalis concinna Koch, from ? *Ovis aries*, Brunswick, chosen as the type of the genus *Haemaphysalis* by Neumann, 1901, p. 340.

Haemaphysalis concinna concinna Koch, a sub-species in Neumann, 1911 *a*, p. 110, Fig. 53 (reproduced from Neumann, 1897, Fig. 4).

Haemaphysalis concinna kochi Neumann, a sub-species in Neumann, 1911*a*, p. 111. (See Note, p. 456.)

Haemaphysalis concinna Koch, in Bonnet, 1908, pp. 259–260, poor description, condensed from Neumann, 1897; Fig. 28, of ♀ capitulum, is original, but bad. Banks, 1908, p. 32, says the record of the presence of *concinna* in the United States is "due to wrong synonymy" (refers to Neumann, 1897, q.v. supra). Blanchard, 1909, pp. 148–150, Figs. 180–184, taken from Neumann, 1897, 1901, 1905; Fig. 183, taken from Bonnet, 1908; description contains errors. Patton and Cragg, 1913, p. 630, description taken from Neumann, 1911 *a*, p. 110; Pl. LXXXI, Figs. 1, 2, original, of ♀ in ventral and dorsal aspects. (For *Haemaphysalis longicornis* Neumann, 1901, *Haemaphysalis concinna* var. *longicornis* (Neumann) Neumann, 1905, otherwise *H. concinna concinna* (Neumann) Neumann, 1911, refer to list of doubtful and condemned species.)

Male (Figs. 387–390): *Scutum* oval, 2·3 × 1·9 to 3 × 1·84 mm.[1], glossy, with many fine but inconspicuous punctations; lateral grooves

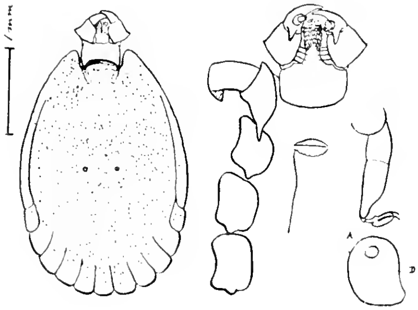


Fig. 387.

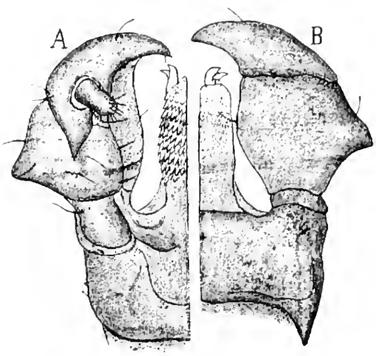


Fig. 388.

Fig. 387. *H. concinna* ♂. Dorsum; part of venter, tarsus IV and spiracle (more highly magnified than dorsum). Specimen (N. 1075) from France. Original, G. H. F. N. del.

Fig. 388. *H. concinna* ♂. Capitulum (A) ventral and (B) dorsal aspect, ×65. Neumann, 1897, Fig. 4. (Drawn evidently from balsam-mounted specimen.)

well-marked, including one festoon; cervical grooves short and faint; festoons long, the intervals well-marked. *Capitulum*: base with strong sharp cornua; palps longer than broad, article 2 moderately salient laterally, article 3 elongate and curved inwards at the tip, *giving the palps when closed a chelate appearance*; a fairly strong retrograde spine

[1] The scutums of 20 ♂ captured on deer in France by Brumpt measured as follows in mm. (One of the types in Berlin measures 2·7 × 1·8 mm.):

3 × 1·84	2·7 × 1·73
2·95 × 1·85	2·66 × 1·7
2·9 × 1·85	2·65 × 1·6
2·9 × 1·8	2·6 × 1·8
2·85 × 1·84	2·6 × 1·78
2·82 × 1·77	2·58 × 1·7
2·8 × 1·84	2·53 × 1·72
2·75 × 1·75	2·46 × 1·57
2·72 × 1·8	2·4 × 1·54
2·7 × 1·8	2·3 × 1·9

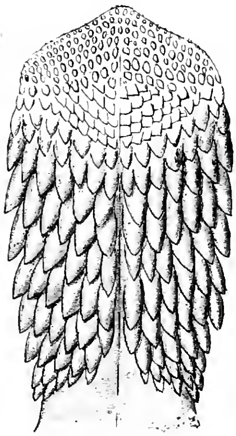


Fig. 389.

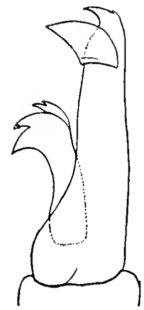


Fig. 390.

Fig. 389. *H. concinna* ♂, hypostome, × 210. Neumann, 1897, Fig. 6.
Fig. 390. *H. concinna* ♂, left digit in dorsal aspect, × 230. Neumann, 1897, Fig. 5.

ventrally on article 3; hypostome markedly shorter than the palps, corona large, dentition 6 | 6, teeth strong and uniform. *Venter*: spiracle large, white, sub-oval, with slight dorsal process. *Legs*: coxa I with fairly long pointed spur; coxae II–IV with slight spurs; tarsus IV tapering rather rapidly; pad medium.

Female (Fig. 391): *Scutum* sub-circular, about $1{\cdot}2 \times 1{\cdot}4$ mm. (varies)[1], glossy; cervical grooves distinct for about two-thirds the length of the scutum, concave externally, the interval rather broad; punctations very fine and inconspicuous. *Capitulum*: base broader than in the ♂ and with less pointed cornua; porose areas ill-defined, sub-circular, far apart; palps with article 2 rather prominent at postero-internal dorsal margin; article 3 much broader than in ♂, the palps not being chelate when closed; no dorsal spines but a moderate blunt spur ventrally on article 3; hypostome with dentition 5 | 5 or 6 | 6. *Venter*: spiracle large, sub-circular. *Legs*: coxae as in ♂; tarsus IV longer, tapering gradually.

[1] The type ♀, seen and drawn by G. H. F. N., has the scutum distinctly longer than broad; but in Neumann's description it is given as circular, and it is very nearly so in a specimen kindly given us by Neumann, which we figure; the scutum may, however, be slightly broader than long.

The scutums of 5 ♀, captured on deer in France by Brumpt, measured as follows in mm.:

1·3 × 1·33	1·2 × 1·18
1·24 × 1·45	1·13 × 1·4
1·2 × 1·45	

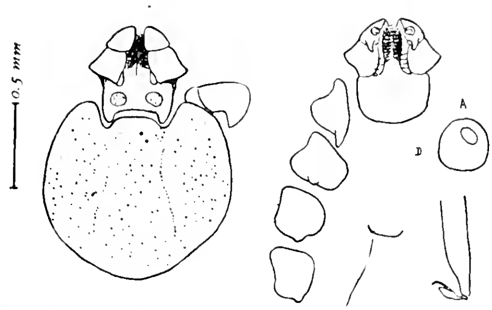


Fig. 391. *H. concinna* ♀, capitulum and scutum, ventral aspect of capitulum with coxae, spiracle and tarsus IV. Same origin as the ♂ in Fig. 387. G. H. F. N. del.

Nymph (Fig. 392): Body (when gorged) may attain 3·4 × 2·3 mm. *Scutum* nearly circular, about 0·5 × 0·6 mm.[1], shagreened, with a few

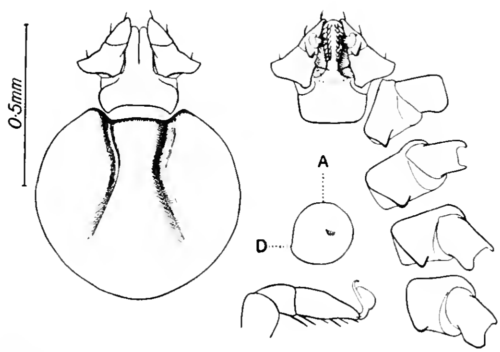


Fig. 392. *H. concinna* nymph, capitulum in dorsal and ventral aspects, scutum, coxae with trochanters, spiracle and tarsus IV. (N. 2763, specimen raised by E. Brumpt.) Original, N. C. del.

scattered punctations; cervical grooves well marked for two-thirds of the scutal length. *Capitulum*: base with slight blunt cornua; palps with article 2 more salient laterally than in the ♀; hypostome 2|2.

[1] The scutums of 5 o, captured on deer in France by Brumpt, measured as follows in mm.:

0·54 × 0·6	0·5 × 0·6
0·5 × 0·68	0·5 × 0·54
0·5 × 0·64	

The body length of 7 fully gorged nymphs, found on deer and hedgehog in France by Brumpt, measured as follows in mm.:

3·4 × 2·3	3·15 × 2·1
3·3 × 2·1	3·0 × 2·1
3·25 × 2·1	3·0 × 2·05
3·2 × 2·0	

Venter: spiracle sub-circular. *Legs*: coxal spurs distinct; tarsus IV tapering gradually.

Larva (Fig. 393): Body (unfed) 0·67 × 0·56 mm. *Scutum* broader than long, about 0·28 × 0·34 mm.[1], shagreened, but without punctations; cervical grooves generally fairly distinct for half the scutal length. *Capitulum*: like that of the nymph, except that the cornua are almost obsolete and the distinction between articles 2 and 3 of the palps obscure. *Legs*: a slight indication of a spur on coxa I; coxae II and III unarmed; tarsus III tapering to rather sharp point.

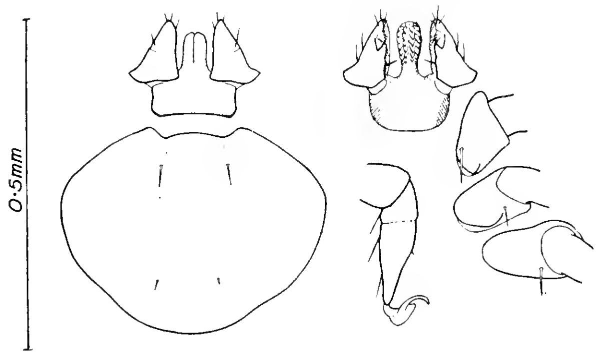


Fig. 393. *H. concinna* larva, capitulum in dorsal and ventral aspects, scutum, coxae with trochanters, spiracle and tarsus III. (N. 2763, specimen raised by E. Brumpt.) Original, N. C. del.

Our description is based on numerous specimens from France and an examination of the types.

Types (♂ ♀) in the Zoological Museum, Berlin; origin unknown. The types of the immature stages (N. 2763, o, L, figured) are in Cambridge.

NOTE

Haemaphysalis concinna var. kochi Neumann, 1905.

We fail to recognize this variety as valid for the following reasons:

Neumann, 1897, p. 341, described the specimens concerned under the name of " *H. hirudo* Koch," a species which he subsequently recognized as purely nominal in view of the types not being available. (We include *H. hirudo* in our list of

[1] The scutums of five larvae (N. 2778) measured as follows in mm.:

0·28 × 0·36	0·26 × 0·37
0·28 × 0·35	0·25 × 0·34
0·28 × 0·34	

condemned species q.v.) Neumann, 1905, p. 239, renamed the specimens *H. concinna* var. *kochi*. The specimens were (*a*) 6 ♀ from the Amur River, Eastern Siberia, coll. Dickman, 28, vi. 1899 (Hamburg Mus.); (*b*) 3 ♀ from Japan, coll. Hilgendorf (Berlin Mus.); (*c*) 2 ♀ from *dog*, Saga, Japan, coll. Yamaguchi; (*d*) 2 ♀ from Saigon, Cochin China, coll. Harmand (Paris Mus.).

Through the courtesy of the Museum authorities in Hamburg, Berlin and Paris, we have been able to study the types of (*a*), (*b*) and (*d*), ten specimens having been received from Hamburg[1], and one each from Berlin and Paris. The specimens conform to *H. concinna* ♀, but we do not find the suggested varietal characters at all constant in these specimens—and in themselves they are exceedingly slight. Moreover, it appears to us very unsafe to attribute the females to *concinna* at all in the absence of males, more especially when the specimens are extra-European. The ♀ of *H. concinna* has no very salient characteristics, and though the ticks in question bear a strong general resemblance to our European specimens they are also like other species, e.g. *H. papuana*. If the corresponding ♂s should turn out to possess cheliform palps the attribution to *H. concinna* would be justified, but if this be not the case we do not think that the similarity of the ♀s would be sufficient ground to maintain this form as a variety of that species.

Geographical Distribution.

There is no trustworthy evidence of *H. concinna* having been found outside Europe, for no ♂ has been recorded as accompanying the supposed ♀s from other parts of the world. The tick occurs in **Germany**: there is a ♀ in the Berlin Museum, collected in Brunswick, and a ♂ of German origin. Neumann records 4 ♂s from *deer* in **Poland**. The bulk of the specimens collected comes from **France**; thus, in the north, Mégnin (1880, p. 132) collected only ♂s in the Forest of Fontainebleau. We are indebted to Dr E. Brumpt, of Paris, for the opportunity of examining many specimens of fed and unfed adults, nymphs and larvae found by him on sixteen occasions on *deer* at Fontainebleau (S. et M.), Chantilly and Compiègne (Dépt. Oise), and the Dépt. Indre; and twice (♂ and L) on *hedgehogs* at Chantilly; on nine occasions *H. concinna* was found with *H. inermis* on *deer*, and once with *H. cinnabarina* var. *punctata*[2]. Dr Brumpt raised *H. concinna* successfully upon the *dog* and *hedgehog* in the laboratory, thus giving us an opportunity of publishing the first description of the immature stages. He has kindly allowed us to retain some of his specimens (N. 1529, 2754, 2755, 2760, 2761, 2778). Neumann (1897) who has presented us with a ♂ and ♀ (N. 1075), also records *concinna* from

[1] We are much indebted to the Hamburg Museum for the gift of two of these specimens (N. 1987).

[2] See Table of Brumpt's observations under Biology, p. 544.

Southern France; a ♂ from St Jean-de-Luz, near the Spanish border, a ♀ from Belesta, Ariège; 33 ♂, 22 ♀ (Simon coll.) and 1 ♀ from *sheep* (R. Blanchard coll.) being from undetermined places.

Biology: see p. 542.

27. HAEMAPHYSALIS SIMPLEX Neumann, 1897.

Figs. 394–397.

Lit. and Icon.: Neumann, 1897, pp. 345, 346, Figs. 10–12 (drawn from balsam-mounted specimens; reproduced by us); Dönitz, 1907, p. 70 (quotes Neumann); Blanchard, 1909, p. 157 (species listed); Neumann, 1911 *a*, p. 111, Figs. 55, 56 (taken from author's earlier paper).

Male (Figs. 394–397): *Scutum* cinnamon yellow, elongate, 1·8 × 1·0 mm., ovate, very convex, glossy, with very minute shallow punctations, distributed all over, also on the festoons; cervical grooves shallow, sub-parallel; lateral grooves practically absent; festoons, especially the anterior festoon, broad, involving an unusual proportion of the body periphery. *Capitulum* small; base with very slight bluntly rounded cornua; palps with article 2 strongly salient laterally; articles 2 and 3 of equal length, without dorsal spurs; a small sharp ventral spur under article 3; hypostome spatulate, dentition 4 | 4, about 8 files of uniform fairly strong teeth. *Venter*: spiracle large, with a slight dorsal process; a large proportion (nearly half of the body) lies posterior to coxa IV. *Legs* short and thick; coxae I very small, with slight blunt spur; coxae III and IV very broad (antero-posteriorly), with short blunt spurs[1]; the dorsal spur on trochanter I almost obsolete; the other trochanters unarmed; tarsi short, thick, humped, without ventral spur; pad almost as long as the claws.

Female: unknown.

Nymph: body 0·5 mm. long, corresponding in form and colour to the ♂. *Scutum* rounded, extending almost to half the body-length. *Capitulum*: hypostome 3 | 3, with 6 or 7 stout teeth per file. Palps and *Legs* as in the ♂.

Our description of the ♂ is based on a co-type kindly presented by Prof. Neumann from his type material which originally consisted

[1] Neumann's figure, here reproduced as Fig. 396, does not agree with his text, which reads "Coxae contiguous, without spurs; a simple, almost obsolete tuberosity at the postero-internal angle."

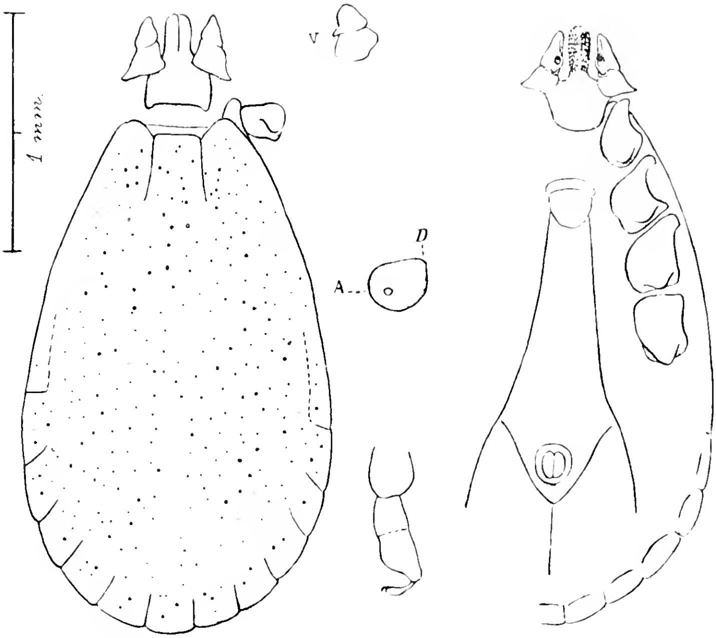


Fig. 394. *H. simplex* ♂, dorsum, venter, left palp in profile (*v* = ventral spur), spiracle and tarsus IV. Drawn from British Museum specimen. Original, G. H. F. N. del.

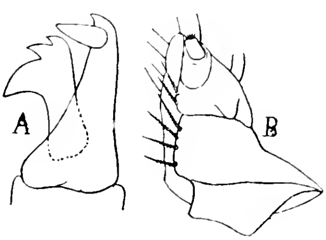


Fig. 395.

Fig. 396.

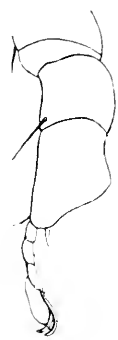


Fig. 397.

Fig. 395. *H. simplex* ♂, (*A*) left digit, × 425; (*B*) left palp in ventral aspect, × 110. (The spur on palpal article 2 is misplaced.) Neumann, 1897, Fig. 10.

Fig. 396. *H. simplex* ♂, coxae and trochanters, × 45. Neumann, 1897, Fig. 11.

Fig. 397. *H. simplex* ♂, tarsus IV, × 60. Neumann, 1897, Fig. 12.

of 13 ♂ and 1 o found on *Erinaceus* sp. in **Madagascar**, 1894, by Sikora, together with *H. elongata* ♀. The description of the o is taken from Neumann. We reproduce the author's figures of parts of the ♂. Our figure is drawn from a ♂ found on *Ericulus setosus* in Madagascar (Cohen coll., 1862, Brit. Mus.; determined by Neumann in 1905).

Types in Toulouse, co-type ♂ in Cambridge (N. 2891).

28. HAEMAPHYSALIS LEACHI (Audouin 1827) Neumann, 1897.

Plates XII and XIII. Text-Figs. 398–410.

Lit., Syn. and Icon.: *Ixodes leachii* Audouin in Savigny, 1826, Pl. IX, Fig. 9; an excellent figure of ♂ dorsum, that is considering the date when it was drawn. Audouin, 1827, p. 428.

Rhipistoma leachi Koch, 1844, p. 239.

Rhipistoma ellipticum Koch, 1844, p. 239.

Rhipicephalus ellipticus Koch, 1847, p. 135, Pl. LXX, Fig. 111.

Rhipidostoma leachii (Audouin) in Karsch, 1878, p. 337.

Opisthodon canestrinii Supino, 1897 *a*, 1897 *b*, p. 252, Pl. XIII, Fig. 21. The author only describes and figures the ♂ tarsus. Neumann, 1902, p. 128, states he examined the types and concluded they were ♂ *leachi*. Neumann, 1911 *a*, p. 115, nevertheless lists *canestrinii* as a doubtful species but probably *leachi*. We have examined the types and can state positively that *canestrinii*=*leachi*. The types of *H. canestrinii* are in the Genoa Museum, co-types in Cambridge.

Opisthodon gestroi Supino, 1897 *b*, p. 252, Pl. XIII, Fig. 23. The author only describes and figures the ♀ tarsus. Neumann, 1902, p. 128, examined the types in Genoa and stated they were allied to *H. leachi*. Neumann, 1911 *a*, p. 116, gives it as a doubtful species of *Haemaphysalis*. We have examined the types; there is no doubt about their being=*H. leachi*.

Opisthodon asiaticus Supino, 1897 *a*; 1897 *b*, p. 252, Pl. XIII, Fig. 22; the author only figures the ♂ tarsus, his description is useless. We have examined the types at Genoa and regard them as=*H. leachi*. Neumann, 1897, p. 357; renamed *Haemaphysalis asiatica* (Supino). Neumann, 1902 *a*, p. 123; types stated to be lost.

Haemaphysalis leachi (Audouin) Neumann, 1897, pp. 347–350, Figs. 13–15 (reproduced by us); 1901, p. 263, refers to distribution and hosts. Froggatt, 1900, p. 542 (cited by Rainbow, 1906, p. 165). Lounsbury, XI. 1901, pp. 1–12, first experiments on the transmission of canine piroplasmosis by this tick.—**1902.** Lounsbury, pp. 4–9, Pl. I, Figs. 1–11; second series of experiments on tick-transmission of canine piroplasmosis; important; the figs. illustrate all stages. Lounsbury, pp. 5–7; biology.—**1904.** Lounsbury, pp. 27–29; biology. Lounsbury, pp. 22–43; experimental tick-transmission of canine piroplasmosis; important. Nuttall, pp. 226 *et seq.*, Pls. XII, XIII (photomicrographs of all stages); treats of biology of tick and relation to canine piroplasmosis.—**1906.** Buy, pp. 140–142; specific description taken from Neumann. Rainbow, p. 165; species listed for Australia on Neumann's authority.—**1907.** Dönitz, pp. 68, 69, Pl. III, Fig. 20 *a*, Pl. V, Fig. 32 (♂ in dorsal aspect, ♀ capitulum and scutum); we cite this author in our text. Newstead, Dutton, and Todd, p. 99; listed from Congo Free State; cited in our text. Neumann (*a*) p. 24; species listed from E. Africa (see our text).—**1908.** C. W. Howard, pp. 160–162, Pl. XVI, Figs. *a–m*; gives a good description of all the stages together with figures of the capitulums (in dorsal and ventral aspects) of the ♂ ♀ and o, digits of the ♂ ♀ and o, ♂ ♀ scutums, ♂ coxae (the latter and the ♂ capitulum being taken from Neumann, 1897, Figs. 14, 15, whose synonymy is followed); refer to our text regarding the author's records as to hosts and distribution. Meuleman, repr. pp. 12 *et seq.*; nothing original. Nuttall (VIII), p. 394; unfed adults survive 7 months. Nuttall (IX) pp. 514, 522, 523; biology of tick, a carrier of canine piroplasmosis.—**1909.** Blanchard, pp. 152, 153, Figs. 188, 191 (taken from Neumann); contains two erroneous statements: that this tick conveys canine piroplasmosis in Italy (the tick does not occur in Italy) and that it is the suspected carrier of "*Babesia parva*" in Japan (there is no evidence whatever for this statement, and East Coast Fever, caused by the parasite named, does not occur in Japan). Manteufel, p. 16; nothing original; C. W. Howard, p. 162; short statement regarding hosts and distribution.—**1911.** Lounsbury, pp. 5, 6; biology. Nuttall (X), p. 180; type of parasitism shown graphically. Ziemann, p. 58; occurrence in Cameroon.—**1913.** Nuttall (IV), pp. 93–99; biology. Nuttall (X), pp. 309, 310, Figs. 7–10, also pp. 308, 309, Figs. 5–8 (published in two journals, figures herein reproduced). Patton and Cragg, Pl. LXXIII, Fig. 12, ♀ capitulum in ventral aspect; Pl. LXXXI, Figs. 3, 4, ♂ venter, ♀ dorsum, sketchy; p. 647, cite Nuttall and Lounsbury.—**1915.** Nuttall, p. 252, Fig. 3, malformation in a ♂.

Haemaphysalis canestrinii (Supino) Neumann, 1897, p. 357 ... ...
Haemaphysalis asiatica (Supino) Neumann, 1897, p. 357 ... ...
Haemaphysalis gestroi (Supino) Neumann, 1897, pp. 357, 358 ... ...
} See further under *Opisthodon* above.

Haemaphysalis leachi var. *australis* Neumann, 1905, p. 238; 1911, p. 115.

Haemaphysalis koningsbergeri Warburton and Nuttall, 1909, p. 65, Figs. 11, 12 (reproduced).

Haemaphysalis leachi var. *indica* Warburton, 1910, p. 402 (not figured).

Haemaphysalis leachi australis Neumann in Neumann, 1911 *a*, p. 115; the author here raises his variety to a sub-species.

Haemaphysalis leachi leachi (Audouin) in Neumann, 1911 *a*, p. 114, Figs. 62, 63; condensed description with figures as in Neumann, 1897.

Male (Text-figs. 398–402; Pl. XII, Figs. 4, 5; Pl. XIII, Fig. 2). Very variable in size (see Fig. 399). *Scutum*, in average specimens

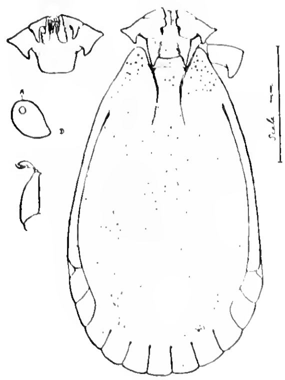


Fig. 398.

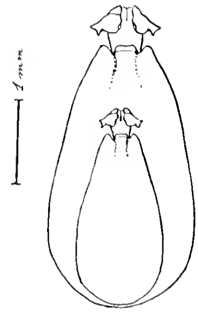


Fig. 399.

Fig. 398. *H. leachi* ♂, dorsum, capitulum in ventral aspect, spiracle and tarsus IV. (N. 532 *c*, G. H. F. N. del.) Nuttall x. 1913 *a*, Fig. 7.

Fig. 399. *H. leachi* ♂s, contours of two ♂s collected from one host and showing the variation in size. (N. 310, G. H. F. N.) Original.

about 2·6 × 1·3 mm.[1], long and narrow, widest at the level of the spiracles, convex, with very many minute punctations; cervical grooves fairly well marked, the interval between them narrow; lateral grooves

[1] The scutums of 25 ♂ from various sources measured in mm.:

N. 2264 from Sierra Leone	3·4 × 1·8 3·05 × 1·7 2·9 × 1·6		Three ♂ picked out of a lot of 17 typical specimens, the largest, smallest, and an average specimen being selected.
N. 310 from Congo Free State	3·3 × 1·8 3·1 × 1·8 2·85 × 1·6 2·7 × 1·25 2·55 × 1·15 2·55 × 1·25 2·5 × 1·2	2·45 × 1·25 2·45 × 1·25 2·4 × 1·2 2·4 × 1·15 2·3 × 1·3 2·05 × 1·1	All comprised in one lot of typical specimens.
(Berlin 22 *b*) from G. E. Africa	2·9 × 1·4 2·36 × 1·1 2·5 × 1·3		Typical Specimens.
N. 496 *c* from Java N. 951 *a* from Borneo N. 1060 *c* from Pahang	2·4 × 1·3 2·4 × 1·5 2·45 × 1·5		Three specimens of *H. koningsbergeri* type.
Ind. Mus. 5994/10 from Bengal	1·5 × 0·8		*H. leachi* var. *indica* type.
N. 1225 Abyssinia	1·4 × 0·8 1·35 × 0·9		A small form.

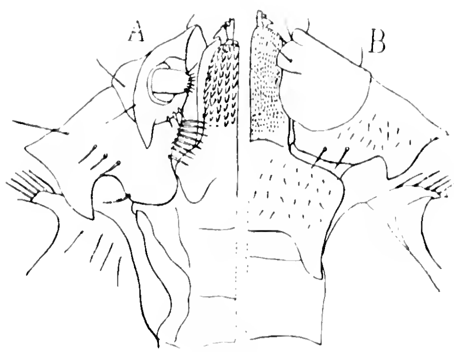


Fig. 400.

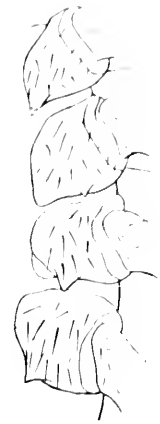


Fig. 401.

Fig. 400. *H. leachi* ♂, capitulum (*A*) in ventral, (*B*) in dorsal aspect, ×55. Neumann, 1897, Fig. 14.

Fig. 401. *H. leachi* ♂, coxae I–IV, ×30. Neumann, 1897, Fig. 15.

Fig. 402.

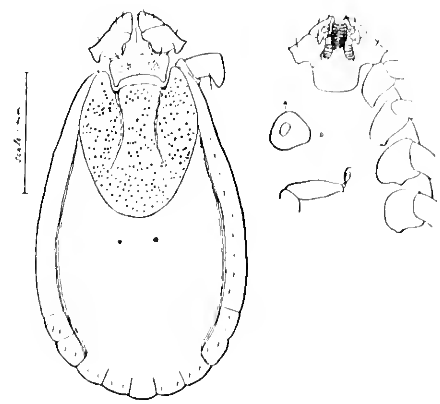


Fig. 403.

Fig. 402. *H. leachi*, ♀ and ♂ digits of right side in ventral aspect, ×260. Neumann, 1897, Fig. 13.

Fig. 403. *H. leachi* ♀, dorsum, ventral aspect of capitulum with coxae, spiracle and tarsus IV. (N. 532 *c* G. H. F. N. del.) Nuttall, x. 1913 *a*, Fig. 8.

long, near the lateral border, including one or two festoons; the latter as broad as long. *Capitulum* remarkable for the very obtuse angle at which the palps meet anteriorly; base broadest in front, the lateral borders nearly straight and converging posteriorly; cornua strong;

palps broadly conical, article 2 very salient laterally, with a dorsal and a ventral triangular retrograde spur from each lateral salience; article 3 very small, with no dorsal spine but a strong ventral retrograde spur; the lateral contours of articles 2 and 3 continuous and typically rectilinear, forming a very obtuse angle in front; hypostome 5 | 5 or 4 | 4, stout teeth, 10–12 per file. *Venter*: anal grooves ogival; spiracle oval with slight, blunt, dorsal process. *Legs*: coxa I bluntly pointed posteriorly; dorsal spur on trochanter I strong and pointed; coxae II–IV with a slight spur at the internal angle; all the coxae broad antero-posteriorly; tarsi rather stout with small, terminal spur; pad fairly long.

Female (Text-figs. 403, 402; Pl. XII, Figs. 1, 4; Pl. XIII, Fig. 1). *Scutum* long-oval, somewhat narrowing behind, about 1·2 × 0·8 mm. in average specimens[1], minutely punctate all over; cervical grooves rather long and near together. *Capitulum*: base rectangular, broader than in the ♂, cornua strong; porose areas oval, far apart; palps resembling those of ♂ but relatively longer and meeting at a less obtuse angle; hypostome 5 | 5, at times 6 | 6, rarely 4 | 4. *Venter*: spiracle subcircular, somewhat narrowing dorsally. *Legs*: coxae very slightly armed, bearing only minute spurs situate as in the ♂; tarsi rather stout, tapering gradually; pad short. When gorged may attain 12 × 9 mm.[2]

Nymph (Text-fig. 404; Pl. XII, Figs. 3, 4): *Body*, unfed, about

[1] The following measurements, in mm., relate to ♀ s from various sources:

	Scutums		Bodies (unfed)
N. 2264 from Sierra Leone (10 ♀)	1·5 × 1·2	N. 2264 (6 ♀)	3·35 × 2·1
	1·5 × 1·15		3·3 × 2·0
	1·5 × 1·05		3·2 × 2·05
	1·5 × 1·05		3·2 × 2·0
	1·45 × 1·1		3·2 × 1·95
	1·45 × 1·1		3·0 × 2·1
	1·4 × 1·2		
	1·4 × 1·0		
	1·35 × 1·1		
	1·25 × 1·1		
N. 310 from Congo Free State	1·35 × 0·9		
	1·3 × 0·95		
	1·15 × 0·75		
N. 1223 from Abyssinia	0·8 × 0·7	N. 1223	1·8 × 1·2
N. 496*c* from Java	1·2 × 0·9	(*H. koningsbergeri* type).	
(Ind. Mus. 5994/10) from Bengal	0·8 × 0·6	(*H. leachi* var. *indica* type).	

[2] The largest of about 80 ♀ raised in Cambridge (N. 1737).

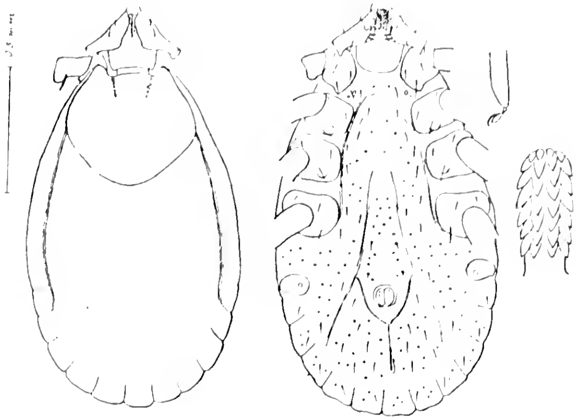


Fig. 404. *H. leachi* nymph, dorsum, venter, tarsus IV, hypostome [highly magnified]. (N. 1048. G. H. F. N. del.) Nuttall x. 1913 *a*, Fig. 9.

1·5 × 1 mm.[1]; may attain 3·4 × 2·0 mm. when replete[2]. *Scutum* pentagonal, with rounded angles, about as wide as long (0·5 × 0·5 mm.); cervical grooves short and straight. *Capitulum* like that of the ♀ with the characters less pronounced, the cornua being very small and the palpal processes slight; hypostome 2 | 2, 6–7 teeth per file. *Venter*: spiracle small, transverse, bluntly comma-shaped. *Legs* as in the ♀.

Larva (Text-figs. 405–407: Pl. XII, Fig. 2): *Body*, unfed,

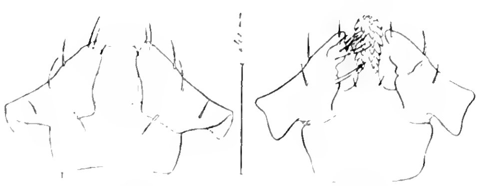


Fig. 405.

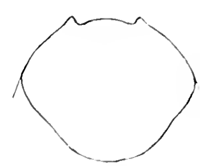


Fig. 406.

Figs. 405, 406. *H. leachi* larva. Capitulum in dorsal and ventral aspects, highly magnified. Scutum, drawn to the same scale as Fig. 407. All figures of the larva drawn from one specimen. (G. H. F. N. del.) Original.

[1] The largest of a lot experimentally raised.

[2] The following measurements in mm., relate to ♀s raised in Cambridge:

	Scutums	Bodies (unfed)
N. 1737 from B. E. Africa (5 ♀)	0·5 × 0·51	1·4 × 0·82
	0·5 × 0·5	1·4 × 0·85
	0·46 × 0·46	1·2 × 0·8
	0·46 × 0·5	1·2 × 0·77
	0·43 × 0·44	1·18 × 0·7

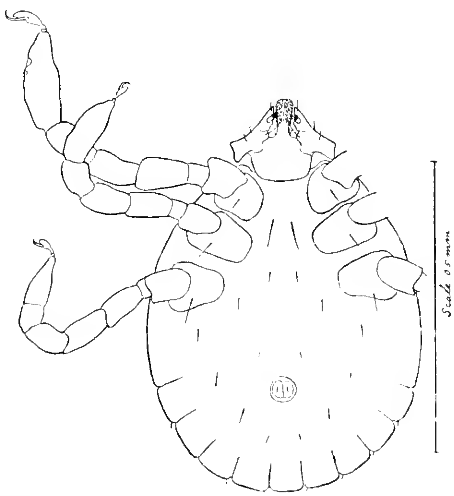


Fig. 407. *H. leachi* larva. Ventral aspect. Specimen raised in Cambridge. Nuttall, x. 1913 *a*, Fig. 10.

0·5 × 0·4 mm.[1], attaining, when gorged, about 1·5 × 0·9 mm. *Scutum* broader than long, with rounded posterior angle and rather sinuous postero-lateral borders; cervical grooves faint, converging behind. *Capitulum* like that of the ♀. *Legs*: coxae unarmed; tarsi tapering to a point.

It is unusual to find so close a resemblance between the capitula of the immature and adult stages as is presented by *H. leachi*, and the nymphs and larvae can generally be identified by this character alone. On the other hand the adult tick is subject to considerable variation both in size and facies.

Our description is mainly based on numerous specimens from Africa some of which have been raised in the laboratory in Cambridge.

See further in the Section on Biology, p. 536.

[1] Measurements of larvae in mm.:

	Scutums	Bodies (unfed)
N. 1049	0·28 × 0·32	0·54 × 0·48
	0·24 × 0·32	0·49 × 0·39
	0·24 × 0·32	
	0·23 × 0·31	
	0·23 × 0·29	

Varieties of Haemaphysalis leachi.

Two varieties of *H. leachi* have been established: var. *australis* Neumann, 1905, and var. *indica* Warburton, 1910.

Neumann regarded *H. leachi* as an essentially African species, the dentition of the hypostome in the ♂ being 5 | 5 and in the ♀ either 4 | 4 or 5 | 5. When, therefore, he received ♂ examples from Australia and Sumatra with dentition 4 | 4 he considered this difference, in conjunction with the habitat, as of varietal importance, hence his var. *australis*. Dönitz (1907, p. 68) has however pointed out that African *leachi*, both ♂ and ♀, vary in respect to their dentition which in one and the same lot may range from 4 | 4 to 5 | 5. We have observed the dentition in African *leachi* to vary between 4 | 4 and 6 | 6 as the result of examining a large material, and it is clear from the many specimens that have reached us from abroad that the species is much more widely distributed than was at first believed. It seems, therefore, impossible to maintain Neumann's variety *australis*.

Warburton (1910) also underrated the range of variation to which *leachi* is subject, not only in dentition, but also in other characteristics. In a *typical leachi* the palps meet at a very obtuse angle, their lateral contour is nearly a straight line, and article 2 has dorsal and ventral retrograde processes on the lateral salience; moreover, the scutum in both sexes is long and narrow. Warburton described a variety *indica* (Fig. 408; from India) with dentition 4 | 4, other characteristics much softened and the dorsal retrograde process absent; it appeared necessary to establish the variety in view of the difference in facies. True examples of *leachi* (African type) have more recently been received from India, and though there are indications that the species is undergoing some change in that country, tending to have *shorter and broader scuta* and less obtuse and spinous palps, intermediate forms occur and a clearly marked variety is doubtfully present.

Similar considerations have led us to degrade *H. koningsbergeri* (Figs. 409, 410) to a synonym of *H. leachi*.

There remain three established species, *H. spinulosa*, *H. numidiana*, and *H. obtusa*, which we think it best to retain for the present, but which may eventually have to be merged in *H. leachi*. They are very closely allied to *H. leachi* and would appear to be recently derived therefrom, but a wider knowledge of them is necessary to determine how far their peculiarities are constant. It is interesting to note that they correspond in size to the two extremes of the range of authentic

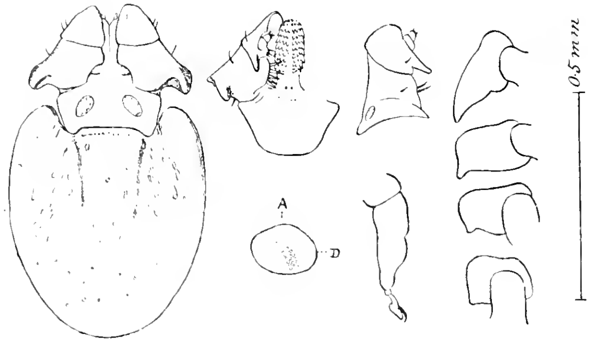


Fig. 408 *H. leachi* ♀ (var. *indica*, Warburton). Capitulum (0·8 mm. long) in dorsal and ventral aspects, scutum, palp in profile, coxae, spiracle and tarsus IV. Specimen (N. 942 *b*) from Madras. Original, G. H. F. N. del.

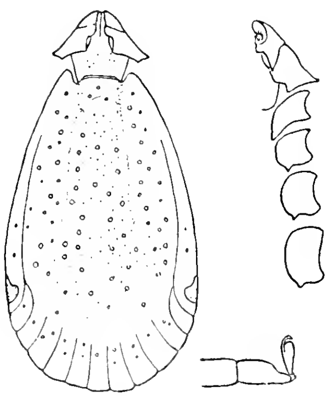


Fig. 409.

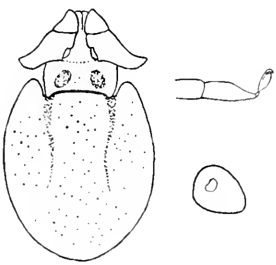


Fig. 410.

Fig. 409. *H. leachi* (*koningsbergeri*) ♂, dorsum, palp and coxae, tarsus IV. Sketch C. W. del. Warburton and Nuttall, 1909, Fig. 11. Drawn from the type.

Fig. 410. *H. leachi* (*koningsbergeri*) ♀, capitulum and scutum, tarsus IV, spiracle. Sketch C. W. del. Warburton and Nuttall, 1909, Fig. 12. Drawn from the type.

H. leachi, *H. numidiana* being a large species, while *H. obtusa* is very small ; see their descriptions on pp. 478, 477.

Geographical Distribution and Hosts.

The species is widely distributed, occurring on a variety of hosts, mainly in Africa, but it is also encountered in Asia and Australia. The types, now lost, came from Egypt (Savigny, 1826). The following records relate to specimens (usually ♂ ♀) we have examined or determined [records by other authors are enclosed in square brackets]:

AFRICA: Egypt and Soudan: (N. 539) ♂ from *Erinaceus albiventris*, Gebel Auli, White Nile, Egyptian Soudan, collected v. 1900 by Messrs S. and T. Witherby; (from information received from Mr H. H. King, the species occurs on *hedgehog* and *dog* at Taufikia, Upper White Nile Province, at Khartoum, and at Roseires, Blue Nile Province); the species was first described from Egypt by Audouin (1827, p. 428). **Abyssinia**: (N. 2318 *a*) from *dog*, Diré Daoua, Ethiopia, collected 28. v. 1913 by M. Pellerin; (N. 2819, received from Berlin Mus.) ♂ ♀ from *Herpestes* sp., 5. III. 1913, and (Berlin Mus. 676/1913) from *hare*, 7. III. 1913, both collected in Erithrea by Dr Klatt; (Brumpt coll.) ♂s ♀s from *Canis mesomelas*, *Hyaena crocuta*, *Procavia brucei*, (N. 1223) *P. abyssinica*, all collected v. 1901 at Harrar by Dr E. Brumpt (the last two lots were small specimens). [Pavesi, 1884, p. 92, states that Antinori found the tick on *Felis pardus* in the Mahal-Uonz Mts., Eastern Ethiopia.] **British East Africa**: (E. 599) ♀ from *dog*, Gwasinyras Post, Northern Frontier, collected in 1912 by J. O. W. Hope: (E. 258) ♂ ♀ from *Canis adustus*, Northern slopes of Mt Kenia (7700 feet elevation); (E. 266, 267 = N. 3065) ♀ os from *Tachyoryctes audax* Thos. (mole rat), near Embu, East of Mt Kenia, 2. II. 1911, collected by S. A. Neave. Several lots were received from Nairobi: (N. 102 *c*) ♂ from Dr P. H. Ross; (E. 291 = N. 1422) ♂ ♀ from *dog*, collected IV. 1911 by T. J. Anderson; (N. 1737) ♀ and *L* from *jackal*, collected III. 1912 by R. E. Montgomery. (N. 48 *b*) from *dog*, collected XI. 1904 by Dr P. H. Ross at Makindu; (E. 711) from *dogs*, Massai Preserve, 1913, and (E. 712) from *cheetah*, Mara River, Boma, 30. VI. 1913, collected by Captain A. O. Luckman; (E. 184) ♂ ♀ from terrier *dog*, Usoga, VIII. 1910, collected by Dr Hailstone; (N. 2403 *c*) ♂ from *lion*, near Kadjiado River, Magady Railway, VIII. 1913, collected by Dr L. Nicholls; (E.) ♂ from *dog*, Meko, and (E.) ♀ from *sheep*, Ibesha, collected, II. 1910 by J. J. Simpson; (E. 294 *b*) ♀ from *cattle*, Kokolo, IV. 1911, collected by C. C. Gowdey; (E. 587) ♂ collected at Mombassa, I. 1912, by R. P. Thomas; (E. 839, 844 = N. 2836, E. 847, 849 *a*) ♂s ♀s from *dogs*, Mau, Narok, Massai Reserve, 15–20, I. 1914, and (E. 781 *b*) from Olorogoti, XII. 1913, collected by Captain A. O. Luckman. (Probably from British East Africa are: (N. 2377 *a*) os from *rhinoceros*, 1912, and (N. 2388 *c*) ♂s ♀s from *panther*, no date, received 1913 from R. Hancock; also (Armstrong coll.) from *cat*,

I. 1911, at Aburi.) **Uganda**: We have determined two lots for the London School of Tropical Medicine, collected from *dog* and *ferret* by Dr H. Bayon (no further data); (N. 885 *b*) o from *goat*, (N. 876 and 695) from *dog*, Mpumu, Chagwe, collected in 1909 by Sir David Bruce; (E. 300) from *dog*, Lango, VI., coll. Dr McConnell; (E. 480 *b*) ♀ from grass, Upper Kafu River, Unzoro, XII. 1911, coll. S. A. Neave; (E. 692 = N. 3153) from *lion*, Busuju, 12. XII. 1912, coll. C. C. Gowdey; (N. 873 *c*) from Buyago District, South Buddu, Lake Shore, VIII. 1909, (N. 775 *c*) from *cattle*, Masaka, in Buddu, VI. 1909, coll. Sir David Bruce; (E. 472 *a*) from grass, same locality, IX. 1911, coll. S. A. Neave; (N. 874 *b*) from Kumi, Bukedi, VIII. 1909, coll. E. G. Morris; (N. 682) from *dog*, Bussu-Bussoga, 1909, coll. Dr H. Bayon; (N. 532 *c*) from Entebbe, 1909, coll. R. P. Richés; (E. 289 *a* and 556) from *dog*, Entebbe, IX. 1910, coll. C. C. Gowdey; (Liverpool 191) from *lion*, Kamsala, 21. XII. 1912, coll. Capt. G. J. Keane; (N. 507) from Sesse Islands, Victoria Nyanza, 1908, coll. Dr H. Bayon; we have recently identified 8 lots presented by Dr Bayon to the Genoa Museum in 1909, the specimens having been found on *cattle* and *Bos indicus* at Bujata, Sesse Islands, and on unrecorded hosts at Entebbe, Kyetume and Bussu-Bussoga. **German East Africa**: (E. 164 *d*) from *cattle*, Ruhaha River, Uhehe District, XI. 1910, coll. S. A. Neave; (N. 2581 *b*) from *jackals*, Kilimabindi, Ngogo, 14. VII. 1913, coll. Dr W. Bartels, received from Dr Kudicke of Daressalam; (N. 575) from *Hyaena crocuta*, Darie, coll. Erlanger-Hilgert Expedition, presented by Hon. N. C. Rothschild (we cannot trace Darie on the map and assume it lies in this country). We have identified several lots of adults for the Berlin Museum (their Nos. 22 *b*, 48, 54, 65, 1417/08 = N. 2795) as follows: from *Genetta* sp., Maliwe, 6. VI. 1908, and from spotted *Hyaena*, Rukwasteppe, 31. VIII. 1908, both collected by Capt. Fromm; from *Anomalurus orientalis* (a squirrel), Amani, X. 1907, Prof. Vosseler coll.; R. Regner collected specimens at Daressalam, Tangani and in the Hinterland; two lots (Nos. 221, 222) labelled Ssongea, 23. II. 1905 and Longra, 17. II. 1909, are probably from this region. [Neumann, 1907 *a*, p. 24, records ♂s ♀s from *Genetta suahelica* Mtsch., and ♂s from *Herpestes caffer* (Sjöstedt Exped.); os from *Felis leo* L., Massimani and ♀ from *leopard*, Donje-Erok (Schillings coll.)] **Portuguese East Africa**: (N. 2425) from *dog*, Magude, 11. VIII. 1913, coll. Dr J. B. Botelho; (E. 618 *a*) from Cala, Zambesi River, coll. Dr H. Swale, received 1912; [Karsch records the tick from Mozambique, according to Neumann]. **Rhodesia**: (North): (N. 2169 *b*) from *dog*, Broken Hill, II.–III. 1913, coll. E. A. Copeman; (N. 1971) from *dog*, Serenje, coll. Dr A. Brown; from N.W. Rhodesia: (N. 754 *H. leachi* var. *indica*) from *Helogale varia* Thos., Msofu River, Alala Plateau, 7. XI. 1905, coll. S. A. Neave: from Southern Rhodesia: (N. 577) from *Itonyx capensis*, Bulawayo, IV. 1907, coll. E. C. Chubb, presented by Hon. N. C. Rothschild; from North Eastern Rhodesia: (E. 137) from *dog*, Fort Jameson, VI. 1910, coll. S. A. Neave; (E. 178 *a*) from *man*, i.e. the collector's person and from natives, Upper Luangwa Valley, VIII. 1910, coll. S. A. Neave; (Liverpool 185) from *lion*, Mpamadzi River, IX. 1911, coll. Dr A. Kinghorn. **Nyasaland**: collected by Dr J. B. Davey at Karonga were (N. 1617) from terrier *dog*, IV. 1909; (N. 742) os from *civet cat*, I. 1909; (Liverpool 72 *a* = N. 728 *a*) from *leopard*, Kambwi near Karonga, IV. 1909; (Liverpool 71 = N. 733) from native *dog*, Nyika Plateau, II. 1909; (E. 135 *b*) from *dog*, Valley of S. Rukuru River, VI. 1910. Collected by S. A. Neave were (E. 130) from *dog*, N.W. shore of Lake Nyasa, VII. 1910. The following were collected in unrecorded places in North Nyasaland: (E.) coll. Dr J. B. Davey; (Liverpool 107) from terrier *dog*, III.–IV. 1909, coll. J. B. Davey; (E. 689) from *dog*, 9. VIII. 1909, coll. J. G. Morgan. (N. 749) from native *dog*, Chirua River, Central Angoniland, V. 1909, coll. E. H. A. Pask; (E. 135) from *dog*, Bua River, Central Angoniland, VI. 1910, coll. S. A. Neave; (N. 2366) from *Hyrax* sp., Monkey Bay, 23. V. 1913, coll. Dr W. C. Wigan; (N. 2244) ♂s ♀s o from *dog*, Mpondas, Fort Johnston, I. 1913, coll. Dr W. C. Wigan. The following were collected at Zomba: (E. 250 = N. 1327) from grass, II. 1911, coll. A. M. D. Turnbull; (E. 76) from *dog*, III. 1910; (E. 248, 249 *a*) from domestic *cat*, X. and XII. 1910, coll. A. M. D. Turnbull; (E. 196, 219, 220) from domestic *cat*, *civet cat*, and collector's bed, II. 1911, XI. and XII. 1910 respectively, coll. Dr H. S. Stannus; (E. 73 *a*) from *dog*, on Mlanje Road, V. 1910; (E. 252) from *cattle*, X. 1910, coll. A. M. D. Turnbull. Dr Stannus also found specimens on a *lion*, near Zomba, II. 1910. Dr J. G. Morgan collected (E. 690 *a*, 619 *a*) from *dogs*, at Sichenya River, Mlanje, XII. 1912 and I. 1913. Received from Blantyre were: (E. 70) from *dog*, IV. 1910; two lots collected by Dr J. E. S. Old, namely (E. 81 *c*) found on the ground, IV. 1910, and (E. 214 *a*) from an unrecorded host, VI. 1910. Collected by S. A. Neave, on the Mwanza River, Shire Valley, were (E. 717 *a*, 729, 732) from *dogs*, IV. and VII. 1913; (E. 731) from *dogs*, Lower Ruo Valley, VII. 1913. From Chiromo: (E. 67 *b*) from *dog*, IV. 1910; from the Lower Shire Valley (E. 65, 71 *a*) from *dogs*, IV. 1910; one lot was collected at

Port Herald by Dr J. E. S. Old: (E. 727) from *lion*, 12. vi. 1913. The remaining specimens which we have examined from Nyasaland are from places we could not trace on the map or from places unrecorded by the collectors, namely: (E. 5 *c*) from terrier *dog*, after journey from Florence Bay (W. shore of Lake Nyasa) to Cheranya, Akamanga Country, v. 1909; (E. 148) from *dog*, xi. 1910, coll. Dr J. E. S. Old; (E. 216) from *cat*, i. 1911, coll. Dr H. S. Stannus; (N. 727 = Liverpool 57) from native *dog*, Chizizi, near Howe River, ii. 1909, coll. Dr J. B. Davey. Since the above was written we have received (E. 851 *b*, 852 *b*, 853 *b*, 854 = N. 2841) from *dogs*, S.W. shore of Lake Chilwa, i. 1914, coll. S. A. Neave.

Transvaal: [Neumann, 1901, p. 263, records the tick from the Transvaal, without mentioning either hosts or localities.] C. W. Howard, 1908, pp. 162, 166–168, states that he has found the tick in nearly every part of the Transvaal, upon almost all carnivora, where it is rarely found on *cattle* and other animals "even when most abundant"; he lists it as occurring on *cat*, *Felis pardus*, *F. leo*, *F. nigripes*, *Viverra civetta*, *Genetta* sp., *Cynictis penicillata*, *jackal* and *Erinaceus* sp., this author also records the tick as occurring in Orange River Colony. **Natal**: [C. W. Howard, 1910, p. 162, found Os on *Avicanthus pumillis* (field rat) and on *tortoise* at Pretoria; Galli-Valerio, 1909, p. 539, records the tick from *man*, Durban, 1908, coll. Miss Fontaine]. **Cape Colony**: [Lounsbury, 1901, p. 4 *et seq.*, found it in the western part of the Colony upon *dogs*, the localities mentioned are Wynberg, Rondebosch, Claremont, Stellenbosch, places where dogs are particularly liable to acquire piroplasmosis through the agency of this tick; "cases among Cape Town dogs can usually be traced to walks up the Kloof or along the mountain sides; the ticks appear to be almost confined to the grass veld districts. It is the common dog tick of South Africa"; Neumann, 1901, p. 263 records it from Kafraria and Port Elizabeth]. Specimens have reached us as follows: (N. 121) from *dog*, Grahamstown, vi. 1906, coll. T. Bowhill; (N. 894–896, and several other lots besides) in all stages from *dog*, Capetown, 1906, sent alive by C. P. Lounsbury; (N. 578) from *Suricata tetradactyla*, Deelfontein, iv. 1902, coll. C. J. B. Grant, presented by Hon. N. C. Rothschild. From correspondence, we learn that the mortality among dogs, due to piroplasmosis, used to be excessive at Port Elizabeth until the introduction of our trypanblue treatment. **Portuguese Congo**: (N. 1949 *a*) from *dog*, San Salvador, xi. 1912, and (N. 1950, 2652 and E. 740) from *dog*, Kibokolo do Zombo, iv. 1911, both lots collected by Dr M. Gamble; [Neumann, 1901, records it from Landana]. **Congo Free State**: (N. 310) from *lion*, Katanga District, 1907, coll. Dr A. Yale Massey; (N. 2012) from *dog*, Bongandanga, Upper Congo, 1912, coll. W. D. Armstrong, received from Dr J. H. Ashworth of Edinburgh; (Liverpool 118 = N. 1621) from *leopard*, Tshumburi, no date, coll. Mrs Billington; (Liverpool 103) found at Lake Leopold II, Kutu, II. 1904, coll. Dr S. Lorisets; (N. 2475) from *leopard*, Kimaka, 4. VIII. 1913, coll. F. Harker; (N. 2399) from *dog*, place not stated, 1913, coll. Dr A. Yale Massey; (N. 2771) from *dog*, Kibondo, 1914, coll. F. Harker. [Newstead, Dutton and Todd, 1907, p. 99, record the tick from Tshumburi, these being doubtless the same specimens we examined as reported above.] **French Congo**: [Neumann, 1897, records the tick from Sette-Camma, collected by Hupferden (Hamburg Mus.)]. **Cameroon**: we have determined a number of specimens from this region as follows: (Berlin Mus. 107) ♀s collected by Dr Waibel; (D. E. M. 24, 27) ♀ collected by Conradt; the following from South Cameroon: (Berlin Mus. 99, 106) ♂ ♀ from *cat*, also from an unrecorded host, at Iaunde, Abong, Mbang in the Dume Region, collected by Sommerfeld. **New Cameroon**: (Berlin Mus. 277) ♀ from Pama Quelle, V. 1913, Dr Houy coll.; [Neumann, 1901, p. 263, states the species occurs in Cameroon; Ziemann, 1911, p. 58, found it on *dogs* at Dschang, in 1910]. **Southern Nigeria**: (E. 40 *a*) from *sheep*, Ilesha, II. 1910; (E. 149) from *dog*, Onitsha, VIII. 1910; (E. 38 *a*) from *dog*, Meko, II. 1910, coll. J. J. Simpson; (N. 195 *a*) from *dog*, Ilesha, N.E. District of Lagos Province, 1907, coll. W. H. Best; (E. 764) from *dog*, Okigwi, 29. X. 1913, coll. Dr H. R. M. Ferguson; (E. 297) from *pig*, Bende, VI. 1911, coll. Dr P. H. Macdonald. **Northern Nigeria**: (E. 147) from *dog*, Zungeru, VIII. 1910, and (E. 195 *b*) from *dog*, Teigna, near Zungeru, VIII. 1910, coll. J. J. Simpson; (N. 2198) from *civet cat*, Baro, 2. X. 1910, coll. Dr J. M. Dalziel, received from Dr J. H. Ashworth whose collection also contains specimens from Abinsi, 23. XII. 1912 taken by the same collector. **Togoland**: [Neumann, 1901, states that there are specimens from this region at the Berlin and Hamburg Museums]. **Gold Coast**: (E. 663 *a*) from *cattle*, Jatto's Zonga, 5. II. 1913; (E. 670 *a*) from *horse*, Prang, 9. II. 1913; (E. 673 *a*) from *horse*, Makongo, 15. II. 1913; all three lots collected by J. J. Simpson. (E. 762) from *dog*, 1913, coll. A. E. Evans; (Liverpool 75) from Kumasi, collected by Sir Rubert Boyce; (Liverpool 67, 99 *a*) from *cattle* and *dog*, coll. Dr McConnell; (E. 423) from *dog*, Addah, V. 1911, coll. Dr H. T. Palmer; (N. 3085 *a*) from *hedgehog*, Accra, 20. x. 1914, coll. Dr J. W. S. Macfie. **Sierra Leone**: (E. 565, 575, 577) from *dogs*, Port Lokko, v. 1912, coll. J. J. Simpson; (E. 581 *a*) from *dog*, Kaballa, v. 1912, coll. J. J. Simpson; (N. 2266) gorged ♀ from *leopard*, v. 1910 and (N. 2663) adults from *dogs*, 20. x. 1913, both from Kaballa, coll. Dr J. Y. Wood; (E. 564, 569) from *dogs* and (E. 568) from *cattle*, Laminaia, iv. 1912, coll. J. J. Simpson; (E. 563) from *cattle* and (E. 572) from *dog*, Mussaia, iv. 1912, coll. J. J. Simpson; (N. 2261 *c*) from *cattle* and (N. 2264) from *goats*, Koinadugu, iii.–iv. 1913, coll. Dr J. Y. Wood. Dr J. J. Simpson moreover collected the following: (E. 619) from grass, Mongheri, 16. ix. 1912; (E. 621) from *Dryoscopus turetii*, Newton, 20. x. 1912; (E. 622) from *dog*, York, 23. x. 1912; (E. 570) from *dog*, Komakoni, iv. 1912; (E. 571) from *dog*, Konta, iii. 1912; (E. 574 = N. 1811) from *dog*, Botkana, v. 1912; (E. 582) from *dog*, Hangha, vii. 1912; (E. 557) from *dog*, Simimaia, iv. 1912; (E. 561) from *cattle*, Bafodea, iv. 1912; (E. 585) from *dog*, Yiraia, vi. 1912; (E. 586, 587) from ? Panguma and Freetown, vii. 1912; (E. 484) from *dog*, Dani Railway, vii. 1912; (E. 604 *a* = N. 1923) from *bush-cat*, Komatendu, viii. 1912; (E. 588) from *dog*, Firiwa, vi. 1912. We have also received the following specimens collected by Dr J. Y. Wood: (N. 2257 *a*) from *goat*, Kagbo, 19. v. 1913; (N. 2258) from *cattle*, Kapankuna, 24. v. 1913; (N. 2269) from *dog*, Kasuntana, 20. v. 1913; (N. 2482 *b*) from *sheep*, Kasukura, 8. ix. 1913; (N. 2486) from *dog*, Fulamanca, 28. vii. 1913; (N. 2488 *b*) from *cattle*, Mananeolu, 2. viii. 1913; (N. 2490) from *dog*, Gahnia, 25. vii. 1913; (N. 2492) from *dog*, Gaenikora, 19. vii. 1913; (N. 2654) from *dog*, Mussaiya, 17. xi. 1913; (N. 2658) from *dog*, Tilia, 13. xi. 1913; (N. 2659 *a*) from *cattle*, Boulakarafia, 11. x. 1913; (N. 2496 *a*) from *dogs*, Yiben, 11. ix. 1913; (N. 2499 *b*) from *cattle*, Kakonta, 6. ix. 1913; (N. 2502 *a*) from *dogs*, Kasukura, 9. ix. 1913; (N. 2328) from *dogs*, Dunkiawallia, 28. vi. 1913. **Gambia**: (E. 238 *a*) from *dog*, Alijamadu, iv. 1911, coll. J. J. Simpson. We have recently received numerous specimens, ♂ ♀, collected by Dr J. Y. Wood in the Koinadugu District: (N. 3035 *a*, 3041 *b*, 3043 *a*, 3047 *a*) from *dogs* at Falaba, 16. viii. 1914; Ninkintumania, 18. vii. 1914; Yeria, 21. vii. 1912; Kombile, 21. viii. 1912; (N. 3038) from *Felis serval*, Kaballa, 17. ix. 1914; (N. 3048 *e*, 3053 *c*), from *cattle*, Dunkiawallia, 17. vii. 1914, and Boalakarafia, 22. viii. 1914; (N. 3054 *e*) from *sheep*, Ninkintumania, 11. vii. 1914. **Algeria**: [Neumann, 1897, records *leachi* from the *nightingale*, at Oran, and from grass at Sebdou].

ASIA: **Transcaucasia**: (N. 786) from *bear*, Surnabad, VIII. 1903, coll. Dr E. Dschunkowsky. **Burma**: Supino's types and co-types of the following supposed species (= *H. leachi*) were collected by L. Fea in Burma during 1885–1889: *Opisthodon canestrinii* (Genoa Mus. 23, 43 = N. 2960) ♂s found, according to Fea, on *Felis bengalensis*, *Centrococcyx intermedius*, *Nicoria trijuga* and *Testudo elongata* at Bhamo; *O. asiaticus* (Genoa Mus. 24) ♂ found at Meteleo; *O. gestroi* (Genoa Mus. 22, 42 = N. 2959) ♀s found on *Viverra zibetha* and *Felis nebulosa* at Yado and Caro-Chebà; all of these ticks proved to be but *H. leachi* upon examination; we are much indebted to Prof. Gestro for lending us Supino's ticks for purposes of study and for allowing us to retain some of them. **India**: (Ind. Mus.) from *Felis tigris*, Burdwar, Nepal Terai; (Ind. Mus. 5994/10, 5995/10 = N. 1085) numerous specimens of all stages from *Canis aureus*, Museum Compound, Calcutta; (Ind. Mus. 1797/17) very small adults and o from jackal or wolf, Jogidih, Hazaribagh District, Chota Nagpur, 12. III. 1913, coll. Major O. A. Smith. Specimens corresponding to those described as *H. leachi* var. *indica* Warburton, reached us as follows: Collected by Mr N. B. Kinnear: in Cutch (K. 253) from *Herpestes mungo*, Nokania, VII. 1911; (K. 289 *a*) from *Felis caracal*, Dhonsa, 1911; in Kandeish (N. 1661) from *Herpestes mungo*, III. 1911; (N. 1663) from *Felis affinis*, Fardapur, IV. 1911; (K. 54, 56, 65) from *Herpestes mungo*, *Canis indicus* and *Felis affinis* respectively, Fardapur, III. and IV. 1911; (K. 9) from *Herpestes mungo*, Parola, III. 1911. Specimens (K. 402 *a*) were taken from *Millardia meltada* (Muridae), at Ghodasgaon, and (K. 220) from *Cyon dukhunensis*, at Pili, Sipna Valley, Berar, in 1911. (N. 2003) adults and nymphs from *Canis indicus*, Alibagh, Bombay, 25. I. 1912. We are indebted to Captain W. S. Patton for (N. 942 *b*) specimens from *Herpestes mungo*, Madras, received in 1909. **Sumatra**: (Schüffner 4 *a*) from *tiger*, 1912; [Neumann, 1905, p. 238, records his *H. leachi* var. *australis* (♂s) from *Felis tigris* in Sumatra]. Our *H. koningsbergeri* types (N. 496 *c*) were collected by Dr J. C. Koningsberger from *Felis pardus* in **Java** in 1908, and we have since received various specimens of this form from **Borneo**: (N. 954 *a*) ♂ ♀ from *dog*, Upper Sarawak, XI. 1909, coll. J. C. Moulton; **Federated Malay States**: (N. 1060 *c*) ♂ from *tiger*, Pahang, 1910, coll. Dr A. T. Stanton; we have moreover examined and determined specimens collected by Dr Stanton from *Paradoxurus*, *Viverra* and *Felis chaus* (London School of Tropical Medicine coll.); we have more recently received the *koningsbergeri* form of *leachi* collected by C. Strickland (N. 2954) ♂ ♀ from *Ursus malayanus*, Ulu Gombak, Selangor, IV. 1913, and (N. 2732) ♂ from *Felis pardus*, Kampong Batu, Negri Sembilan, 10. III. 1914.

AUSTRALIA: New South Wales: [Neumann, 1905, p. 238, records his var. *australis* from the *horse*, the specimens having been received from the Dept. of Agriculture, N.S.W.].

29. HAEMAPHYSALIS SPINULOSA Neumann, 1906.

Figs. 411, 412.

Lit. and Icon.: Neumann, 1906, pp. 212, 213, Figs. 13, 14 (reproduced); Dönitz, 1907, p. 70 (quotes Neumann); Blanchard, 1909, p. 157, Figs. 196, 197 (species only listed, figures taken from Neumann); Neumann, 1911 *a*, p. 115 (condensed from his earlier description).

Male: Unknown.

Female (Figs. 411, 412): *Scutum* circular, 0·8 × 0·8 mm., with fine scattered punctations; cervical grooves narrow, shallow, almost attaining the posterior border. *Capitulum*: base rectangular, twice as broad as long, cornua faintly indicated by the sharp postero-lateral angles; porose areas small, oval, far apart; hypostome 4|4, with 8 or 9 teeth per file; palps short, article 2 pointed at the postero-lateral angle, four hairs on the internal ventral border, a short blunt prominence at the postero-ventral and postero-dorsal borders, the dorsal prominence nearer the external angle, article 3 longer ventrally where it bears a short retrograde spine. *Venter*: vulva between coxae II; spiracle small, transversely oval. *Legs*: coxae all bear at their internal angle a

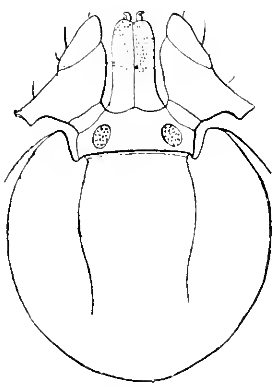


Fig. 411.

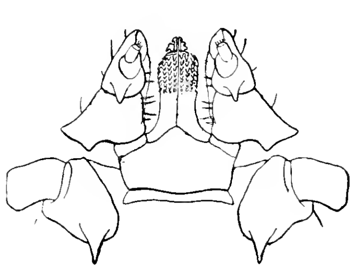


Fig. 412.

Fig. 411. *H. spinulosa* ♀, capitulum and scutum. Neumann, 1906, Fig. 13.

Fig. 412. *H. spinulosa* ♀, capitulum in ventral aspect, coxae I. Neumann, 1906, Fig. 14.

pointed spur slightly longer than broad; *trochanters unarmed*; tarsi long, narrow, not humped; pad almost as long as the claws.

Description based on 2 ♀ from **Uganda**, collected by E. Degen.

Types in the British Museum.

The species is allied to or a varietal form of *H. leachi*.

30. HAEMAPHYSALIS OBTUSA Dönitz, 1910.

Fig. 413.

Lit. and Icon.: Dönitz, 1910, p. 492, Pl. XVII, Figs. 11, 12 (here reproduced).

Male (Fig. 413): Very small, colour brownish-grey. *Scutum* 1·5 × 0·9[1], punctations few and fine, cervical grooves short, lateral grooves absent; festoons much longer than broad. *Capitulum*: base broadest in front, the antero-lateral margins broadly rounded; cornua slight. The palps form a very obtuse cone (hence *obtusa*), thrice as broad as long; article 2 much longer than 3, broad basally, a very slight spur under article 3. Hypostome 2 | 2. *Legs*: coxae unarmed; tarsus IV not humped, but narrowing abruptly.

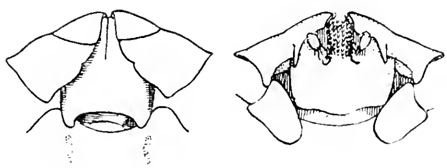


Fig. 413. *H. obtusa* ♂. Capitulum in dorsal and ventral aspects, with front of scutum and coxae I. Redrawn from Dönitz, 1910, Pl. XVII, Figs. 11 and 12.

Female: unknown.

Described originally from numerous ♂s from the **Island of Réunion**. *H. obtusa* is a very small species of the general facies of *H. leachi*, but distinguished from it by the different conformation of article 2 of the palps, the dentition of the hypostome and by the absence of lateral grooves and coxal armature. We are inclined to regard it as a doubtful species (see discussion p. 467).

Types in the Berlin Museum, co-type (N. 2816) in Cambridge.

[1] The measurement cited is that of Dönitz. The scutums of 3 ♂ sent to us for study from Berlin measured as follows in mm.:

1·46 × 0·87 1·43 × 0·82 1·36 × 0·74

31. HAEMAPHYSALIS NUMIDIANA Neumann, 1905.

Figs. 414, 415.

Lit.: Neumann, 1897, p. 349 (included under *H. leachi*); 1905, p. 230; Dönitz, 1907, p. 70 (quotes Neumann); Blanchard, 1909, p. 154 (merely listed from Neumann); Neumann, 1911 *a*, p. 112. The species has not hitherto been figured.

H. numidiana, which we regard as a somewhat doubtful species (see p. 467), is very large compared with the average *H. leachi*, the ♂ measuring 3·5 × 2·0 mm. In the case of an exceptionally large *H. leachi* all our experience would lead us to expect that salient characteristics would be emphasized, that the spines on the palps for instance, would be more pronounced than usual. Instead of this being the case, article 2 of the palps in *H. numidiana* is almost spineless. The general facies is much like that of *H. leachi*, the body being elongate, the lateral grooves and punctations being similar, it differs, however, from *H. leachi* in that the basis capituli is rectangular, whereas in typical *H. leachi* it is trapezoidal; the palps meet in front at a less obtuse angle than they do in *H. leachi*; for further details the reader is referred to the figures (Figs. 414, 415).

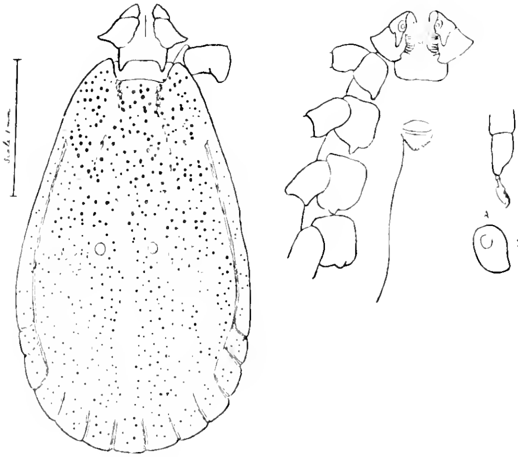


Fig. 414.

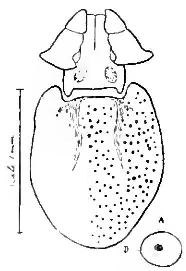


Fig. 415.

Fig. 414. *H. numidiana* ♂, dorsum, part of venter, tarsus IV and spiracle. The finely stippled areas indicate depressions in the scutum. Drawn from the type. Original, G. H. F. N. del.

Fig. 415. *H. numidiana* ♀, capitulum and scutum, spiracle. Drawn from the type. Original, G. H. F. N. del.

Through the courtesy of Professor Neumann, we have been able to examine a ♂ and ♀ from his collection (No. 999) and he has presented us with a co-type (N. 2890 ♂). The types, 3 ♂ 1 ♀, were taken from a *hedgehog*, at Tebessa, **Algeria**, in 1894 by Fayet. Neumann, 1897, p. 349, originally included the species under *H. leachi*.

Types in Toulouse (2 ♂ 1 ♀), co-type in Cambridge (1 ♂).

32. HAEMAPHYSALIS WELLINGTONI Nuttall and Warburton, 1907.

Figs. 416–420.

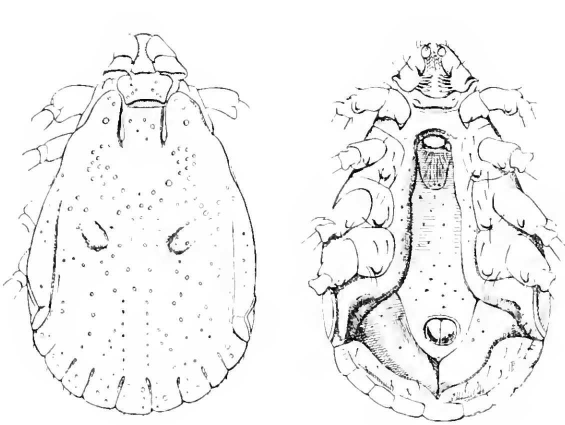
Lit. and Icon.: Nuttall and Warburton, XII. 1907, pp. 397–398, Figs. 9–11 (reproduced). Blanchard, 1909, p. 157 (species only listed).

Male (Fig. 416): *Scutum* 1·42 × 1·1 to 1·3 × 1 mm.[1], oval, narrow in front, dark brown, glossy, with many medium-sized punctations, especially posteriorly on the pseudoscutum; a non-punctate depression on either side of the centre; cervical grooves deep, straight, parallel; lateral grooves short, including first festoon. *Venter*: brown; spiracles white, bluntly piriform. *Capitulum* proportionately large (0·3 mm. *l.*), base finely punctate, cornua slight; palps: article 2 projecting strongly laterally; article 3 with dorsal and ventral retrograde processes at inner angle; the outer borders of articles 2 and 3 form an unbroken line; hypostome broad, dentition 4 | 4, about 11 teeth per file. *Legs*: coxae strong, with a single short spur on each, strongest on coxa I.

Female (Figs. 417, 418): *Body* (unfed), 1·5 × 1·1 mm., brown, punctate, marginal grooves well marked. *Scutum* oval, about 0·9 × 0·7 mm.[1], sides nearly parallel, many rather large punctations, some confluent; cervical grooves long, nearly parallel, middle field broad. *Venter*: brown; spiracles white, rounded. *Capitulum*: proportionately

[1] The scutums of 10 ♂ and 9 ♀ specimens measured as follows in mm.:

♂		♀	
1·42 × 1·1	(N. 2089)	0·9 × 0·91	(N. 2234)
1·42 × 1·05	,,	0·9 × 0·8	,,
1·4 × 1·06	,,	0·9 × 0·79	,,
1·38 × 1·07	,,	0·9 × 0·7	(N. 221)
1·38 × 1·05	,,	0·86 × 0·71	,,
1·37 × 1·08	,,	0·84 × 0·79	(N. 2234)
1·37 × 0·96	(N. 2232)	0·83 × 0·87	,,
1·36 × 1·05	,,	0·8 × 0·75	,,
1·33 × 0·93	(N. 221)	0·76 × 0·8	,,
1·3 × 1·0	,,		



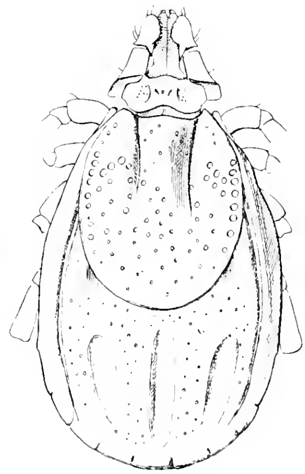
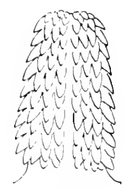


Fig. 416. Fig. 417.

Fig. 416. *H. wellingtoni* ♂, dorsum and venter.

Fig. 417. *H. wellingtoni* ♀, dorsum. Nuttall and Warburton XII. 1907, Fig. 9, *A*, *B* and *C*. G. H. F. N. and E. W. del.



H.

D.

Fig. 418. *H. wellingtoni* ♀. *H.* hypostome, 250 μ l. *D.* digit 100 μ l. Nuttall and Warburton, XII. 1907, Figs. 10, 11. G. H. F. N. del.

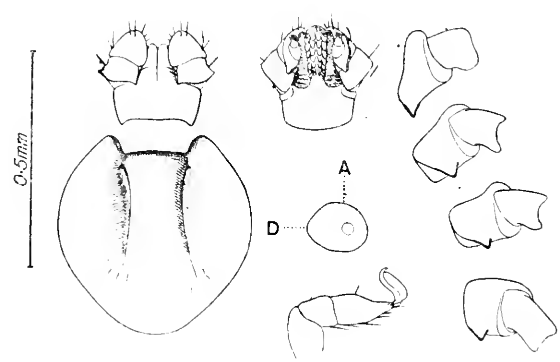


Fig. 419. *H. wellingtoni* nymph. Capitulum in dorsal and ventral aspects, scutum, coxae with trochanters, spiracle and tarsus IV. (N. 1057 from Selangor.) Original, N. C. del.

very large (0·6 mm. *l.*), with characteristics of ♂ (hypostome, Fig. 418); porose areas large, oval, far apart. *Legs*: paler than body, coxae as in ♂.

Nymph (Fig. 419): *Scutum* 0·45 × 0·44 mm., about as broad as long, deeply emarginate, with distinct sub-parallel cervical grooves fading away towards the narrow posterior border. *Capitulum*: base broad, cornua short, lateral salience of article 2 of palps slight; hypostome 2 | 2, with 6 teeth per file. *Venter*: spiracle transversely ovoid. *Legs*: coxae recalling those of the adult, tarsus IV short and tapering; pad long.

Larva (Fig. 420): *Scutum* 0·25 × 0·33 mm., broader than long, slightly emarginate, scapulae broadly rounded; cervical grooves sub-parallel, poorly defined. *Capitulum*: base with concave posterior margin, without cornua, lateral salience of article 2 of palps slight; hypostome as in the nymph. *Legs*: coxa I as in the nymph, coxae II and III with protruding flange; tarsi as in the nymph.

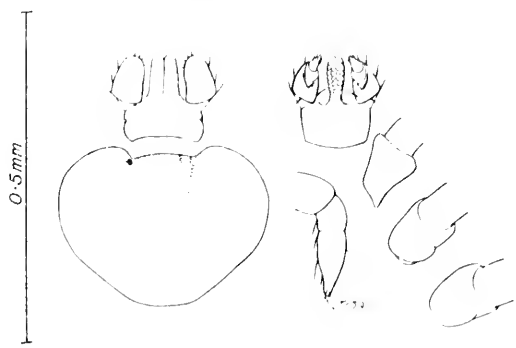


Fig. 420. *H. wellingtoni* larva. Capitulum in dorsal and ventral aspects, scutum, coxae, tarsus III. (N. 1057 from Selangor.) Original, N. C. del.

Our description is based on (N. 221) 2 ♂, 11 ♀ and 2 o taken from *domestic fowl* at Sarawak, **Borneo**, collected by Dr A. R. Wellington I. 1907. We have since received the following consignments: (N. 294), 8 ♂, 3 ♀, 10 o (data as under N. 221), collected V. 1907. **Sumatra**: (N. 495 *c*), 4 ♀, from *Bos indicus* or *bubalis*, collected in 1908 at Palembang by Dr J. C. Koningsberger; (Schüffner's coll., 4 *b*) a ♂ found on a *goose*.

Federated Malay States: (N. 1014), 1 ♀, from *domestic fowl*, Kuala Lumpur, 1910, and (N. 1057) 2 ♂, 2 o, 25 larvae from *domestic fowl*, Selangor, collected III. 1910, by Dr A. T. Stanton. **Siam**: Dr R. Stokoe has sent us (N. 2232), 6 ♂, 1 ♀ and 3 o from *domestic fowl*;

(N. 2233), 6 ♀, from *buffalo*; and (N. 2234) 7 ♀ from *dog*; the three lots having been collected, IV. 1913, at Lakhon, Lampang. Dr A. F. Kerr has sent us (N. 2089) 7 ♂ from *turkey*, collected 10. XII. 1912, at Chiengmai, by Mrs Harris. We determined 1 ♀ from the **Andaman Islands** which is in the Indian Museum, Calcutta (no data or number).

Types in Cambridge (N. 221, ♂ ♀; N. 1057, o *L*). We have presented specimens, since compared with the types (N. 294 ♂ ♀ o), to the British Museum and (♂ ♀) to the Zoological Museum, Berlin.

33. HAEMAPHYSALIS DOENITZI Warburton and Nuttall, 1909.

Figs. 421–422.

Lit. and Icon.: Warburton and Nuttall, 1909, pp. 64, 65, Figs. 9, 10 (reproduced).

Male (Fig. 421): *Scutum* about 1·3 × 0·9 mm.[1], long-oval, narrower in front, glossy yellow-brown, finely punctate; cervical grooves nearly straight, converging posteriorly; lateral grooves long, curved, deep, including two festoons; festoons long, the dividing lines curved.

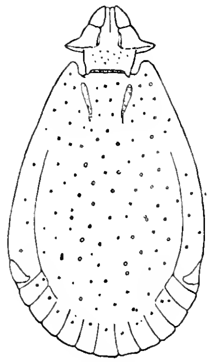


Fig. 421.

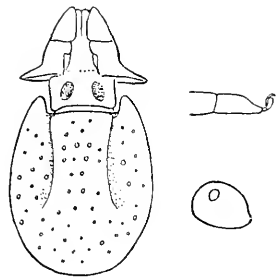


Fig. 422.

Fig. 421. *H. doenitzi* ♂. Dorsum. (Sketch by C. W.) Warburton and Nuttall, 1909, Fig. 9.

Fig. 422. *H. doenitzi* ♀. Capitulum and scutum, spiracle and tarsus IV. (Sketch by C. W.) Warburton and Nuttall, 1909, Fig. 10.

[1] The scutums of our other specimens measure as follows in mm.:

♂	♀
1·4 × 0·8	0·78 × 0·68
1·25 × 0·8	0·75 × 0·7

Capitulum 0·3 mm. long, base trapezoidal, broader in front, punctate, with short pointed cornua; hypostome 4 | 4 or 5 | 5 with very small teeth; palps long, articles 2 and 3 of about equal length, article 2 strongly salient at the base, article 3 without dorsal process but with a very small ventral spine. *Venter*: spiracle ovate, bluntly pointed dorsally; anal grooves rather ogival. *Legs*: coxae normal; tarsus IV of medium length, tapering rather abruptly.

Female (Fig. 422): *Scutum* oval, about 0·8 × 0·6 mm.[1], deeply emarginate, uniformly punctate with rather large punctations; cervical grooves sub-parallel, hardly visible for more than half the actual length. *Capitulum* 0·4 mm. long, base rectangular, with very slight cornua; porose areas long-oval, far apart; palps as in the ♂, but longer; hypostome narrow, rather spatulate, 4 | 4, very small teeth. *Dorsum* strongly and coarsely punctate. *Venter*: spiracle sub-circular, with blunt dorsal process; anal grooves ogival. *Legs*: coxae and tarsus IV as in the ♂.

Described from (N. 635) 4 ♂ and 3 ♀ from *water-hen*, St John's Island, **Singapore**, 1909, collected by Dr A. R. Wellington, and named in honour of the late Geheimrath W. Dönitz of Berlin.

Types in Cambridge, a co-type ♂ was presented to the Berlin Museum.

A very small species closely allied to *H. hoodi*.

34. HAEMAPHYSALIS HOODI Warburton and Nuttall, 1909.

Figs. 423–426.

Lit., Icon. and Syn.: *Haemaphysalis hoodi* Warburton and Nuttall, 1909 (June), pp. 62–63, Figs. 7, 8 (reproduced).
Haemaphysalis africana C. W. Howard, 1909 (August), reprint 4 pp., Pl. XXXIV, Figs. 1–10 capitulums of ♂, ♀, o and larva; ♂ dorsum and venter; ♀ scutum; digits of ♂, ♀ and o (not reproduced).

Male (Fig. 423): *Scutum* 1·8 × 1·3 to 1·4 × 1·05 mm.[2], oval, rather

[1] See note 1, p. 482.

[2] The scutums of 4 ♂ and 7 ♀ measured respectively in mm.:

♂	♀
1·8 × 1·3	1·0 × 0·9
1·7 × 1·2	0·95 × 0·8
1·7 × 1·1	0·9 × 0·9 (2 specimens)
1·4 × 1·05	0·85 × 0·85 ,,
	0·75 × 0·75

broad, narrowing in front, with many fairly large punctations; cervical grooves moderate, deep anteriorly, concave externally; lateral grooves well-marked, of medium length, including one festoon. *Capitulum* rather short (0·3 mm. *l.*); base rectangular, punctate, with sharp cornua; palps with article 2 very salient laterally at right angles to the axis, article 2 slightly longer than article 3, article 3 with a very small ventral process directed inwards; hypostome well covered with equal teeth, 4|4, about 10 teeth per file. *Venter*: spiracle sub-rectangular, with blunt dorsal process. *Legs*: coxa I with blunt internal spur; coxa II with a slight conical spur near the internal angle; coxa III almost unarmed, a blunt spur at the inner angle of coxa IV; tarsus IV of medium length, abruptly narrowing at its tip.

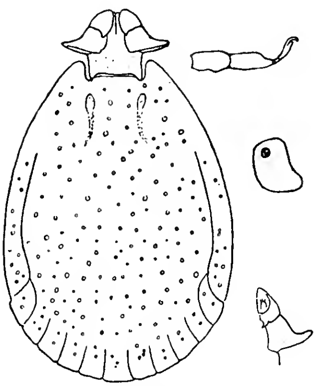


Fig. 423.

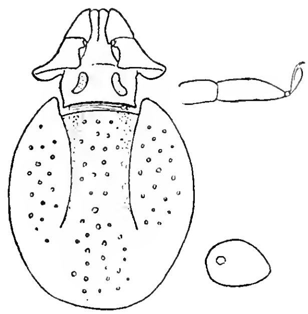


Fig. 424.

Fig. 423. *H. hoodi* ♂. Dorsum, tarsus IV, spiracle, palp in ventral aspect. (Sketch by C. W.) Warburton and Nuttall, 1909, Fig. 7.

Fig. 424. *H. hoodi* ♀. Capitulum and scutum, tarsus IV, spiracle. (Sketch by C. W.) Warburton and Nuttall, 1909, Fig. 8.

Female (Fig. 424): *Body* (unfed) yellow with darker border, well-marked off by deep marginal grooves, which are nearly parallel; festoons square. When gorged, the scutum generally shows yellow on the dark body. *Scutum* oval $1 \times 0·9$ to $0·75 \times 0·75$ mm.[1], truncated posteriorly; cervical grooves sub-parallel, extending about two-thirds its length; punctations fairly large and uniformly distributed. *Capitulum*: 0·4 mm. long; base sub-rectangular, with posterior border somewhat concave and cornua almost obsolete; porose areas reniform and situated anteriorly; well separated; hypostome 4|4, like that of ♂; palps

[1] See note 2, p. 483.

longer than in ♂, especially article 2, which is not so abruptly salient laterally. *Venter*: spiracle rather large, ovate, the pointed end dorsal; anal grooves semi-circular. *Legs*: like those of the ♂, but tarsus IV is longer and tapers less abruptly.

Nymph (Fig. 425): *Scutum* 0·6 × 0·6 mm., sub-circular, the postero-lateral borders slightly concave; cervical grooves long, sub-parallel. *Capitulum* resembling that of ♀: base much broader than long, with well-marked cornua; palps with article 2 very salient laterally; hypostome dentition 2 | 2, 5 to 6 teeth per file. *Legs*: coxae I–IV with very slight spurs; tarsus IV stout.

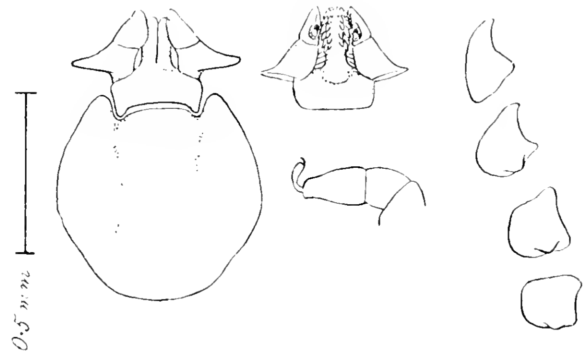


Fig. 425. *H. hoodi* o. Capitulum and scutum, capitulum in ventral aspect, coxae and tarsus IV. (N. 1364.) Original, G. H. F. N. del.

Larva (Fig. 426): *Scutum* 0·25 × 0·3 mm., broader than long, cervical grooves long and parallel. *Capitulum*: base with slight cornua; palps conical, article 2 moderately prominent laterally; hypostome dentition 2 | 2, 4 to 5 teeth per file. *Legs*: coxa I with slight blunt spur, coxae II and III unarmed; tarsi tapering.

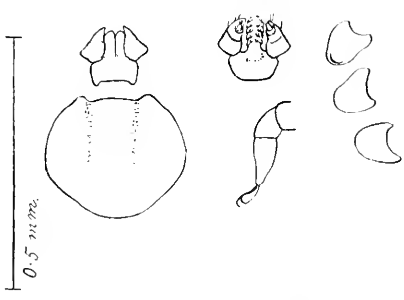


Fig. 426. *H. hoodi* larva. Capitulum and scutum, capitulum in ventral aspect, coxae and tarsus III. (N. 1364.) Original, G. H. F. N. del.

Our description of the adults is based on numerous specimens (N. 424, ♂s ♀s 1 o) occurring on *fowls*, v. 1908, at Bathurst, Gambia, **West Africa**, presented by Dr P. Hood. The nymph and larva are now described and figured from specimens (N. 1364) found with ♂s and ♀s on the neck of a bird (*Centropus burchelli*), shot 3. vi. 1908, at Manhica, in the northern district of Lourenço Marques, Province of Mozambique, Portuguese **East Africa**. We are indebted to Mr C. W. Howard, formerly Entomologist for the Province, for the gift of these specimens; he described all the stages of this tick under the name of *Haemaphysalis africana* in August, 1909. Our description was published in June, 1909, under the name of *Haemaphysalis hoodi*, which consequently has priority.

We have also received the following specimens: (N. 1093 and E. 12) ♂s ♀s, from the ears of *partridges*, Nyungwi Stream, N. Nyasaland, British Central Africa, collected by Dr J. B. Davey, xi. 1909; (N. 1546 = E. 422), ♂s ♀s, from *Numida meleagris* (guinea-fowl), Addah, Gold Coast, West Africa, collected by Dr H. T. Palmer, x. 1911; (E. 606), 1 ♂, from cuckoo (*Centropus senegalensis*), Freetown, Sierra Leone, West Africa, collected by Major H. Kelsall, v. 1912; (E. 473), 1 ♂, from a bird (*Gymnoschizorhis leopoldi* Shelley), S. E. Ankole, British East Africa, collected by S. A. Neave, x. 1911.

Types in Cambridge (N. 424, adults and o; N. 1364, o and *L*); co-types (♂ ♀ from our collection) at Toulouse.

Haemaphysalis hoodi var. orientalis Nuttall and Warburton, 1915, n. var.

Male: Differs from the type as follows: *Body* more parallel-sided, narrowing less in front. *Scutum*[1] more coarsely punctate; emargination slight; scapulae blunt; cervical grooves deep and converging at first, then shallow and diverging; lateral grooves longer than in the type; festoons short. *Capitulum*: smaller than in the type, the base particularly small, without cornua, narrowing posteriorly; palps shorter;

[1] The scutums of the type lot measure in mm. respectively:

5 ♂	3 ♀
1·74 × 1·1	0·93 × 0·76
1·7 × 1·2	0·92 × 0·8
1·7 × 1·2	0·9 × 0·8
1·7 × 1·1	
1·65 × 1·0	

hypostome 4 | 4, 6 teeth per file. *Venter*: spiracle transversely elongate, pointed dorsally. *Legs*: coxa I bluntly pointed, coxae II–IV unarmed; trochanter I with blunter spur.

Female: Differs from the type as follows: *Scutum*[1] more pointed posteriorly, more coarsely punctate: cervical grooves shorter, deep, straight and parallel. *Capitulum*: hypostome short, 4 | 4, about 7 teeth per file. *Venter*: spiracle very small. *Legs*: coxae practically unarmed.

Described from 6 ♂ and 3 ♀ taken from *Procavia manningi* Wroughton, S.W. Shore of Lake Nyasa, **British Central Africa**, III. 1910, S. A. Neave coll.

Types in Imperial Bureau of Entomology coll., London (Nos. 66 *a* and 69); co-types in Cambridge (N. 2847 and N. 2848, 1 ♂ 2 ♀).

35. HAEMAPHYSALIS BANCROFTI Nuttall and Warburton, 1915. n. sp.

Figs. 427–430.

Male (Fig. 427): *Scutum*: oval, rather narrowed in front, 2 × 1·25 to 1·3 × 0·85 mm.[2], rather coarsely, but not deeply, punctate; cervical grooves well-marked but short, the interval between them rather wide; lateral grooves fairly long, including one festoon; festoons longer than broad. *Capitulum*: base broader than long, broader anteriorly than posteriorly; cornua small but distinct and sharp; palps strongly salient laterally at the base of article 2, article 2 longer than article 3, their lateral contour an almost unbroken curve; no dorsal spines; a

[1] See note 1, p. 486.

[2] The scutums of 9 ♂ and 11 ♀ measured as follows in mm.:

9 ♂		11 ♀	
2 × 1·25	(N. 2115)	0·83 × 0·83	(N. 2114)
1·8 × 1·2	(N. 2691)	0·83 × 0·8	(N. 2100, type)
1·8 × 1·15	(N. 2100)	0·8 × 0·9	(N. 2691)
1·75 × 1·15	(N. 2691)	0·8 × 0·83	,,
1·6 × 1·1	(N. 2100, type)	0·8 × 0·8	(N. 2689)
1·55 × 1·0	(N. 2691)	0·76 × 0·86	(N. 2100)
1·5 × 1·0	,,	0·76 × 0·83	,,
1·35 × 1·0	,,	0·75 × 0·9	(N. 2691)
1·3 × 0·85	,,	0·74 × 0·9	(N. 2689)
		0·67 × 0·7	(N. 2100)
		0·62 × 0·8	,,

moderate retrograde spur under article 3; the lateral salience of article 2 is somewhat arched to accommodate coxa I, and its posterior border is curvilinear both dorsally and ventrally; hypostome dentition 4|4, with 6 to 7 teeth per file, without median interval. *Venter*: spiracle of medium size, ovate, the narrow end postero-dorsal. *Legs*: coxae

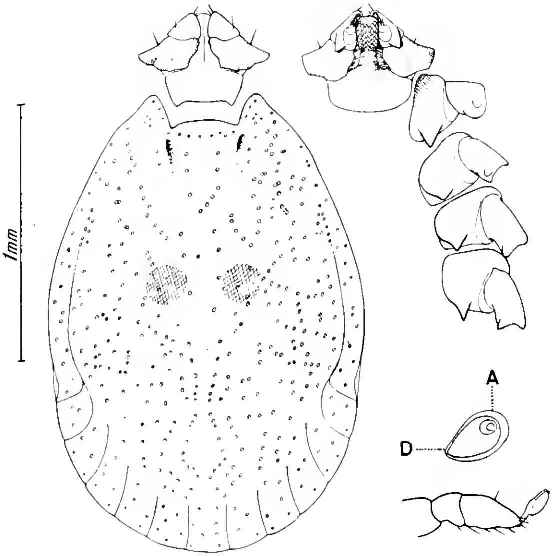


Fig. 427. *H. bancrofti* ♂, dorsum, capitulum in ventral aspect, coxae with trochanters, spiracle and tarsus IV. (N. 2100 type.) Original, N. C. del.

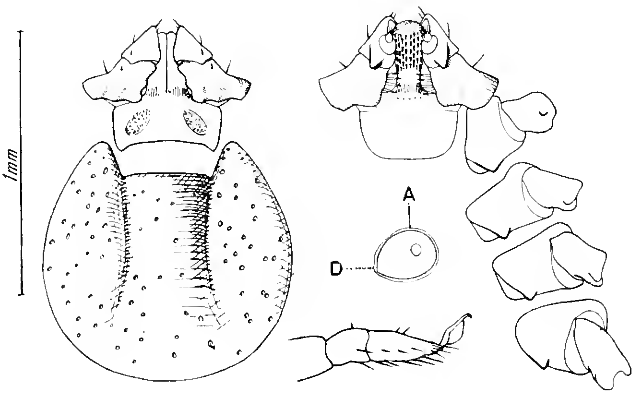


Fig. 428. *H. bancrofti* ♀, scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. (N. 2100 type.) Original, N. C. del.

with normal armature; extremely small indications of spurs on the trochanters; tarsus IV short and blunt.

Female (Fig. 428): *Scutum* sub-circular, 0·83 × 0·83 to 0·62 × 0·8 mm., coarsely punctate, the punctations less numerous in the median area, and often confluent at the sides; emargination deep; cervical

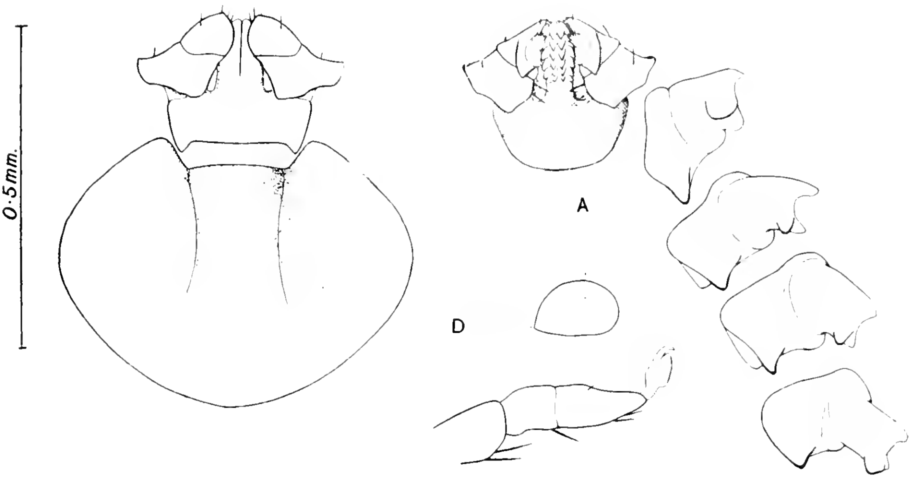


Fig. 429. *H. bancrofti* nymph. Scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. (N. 2114 co-type.) Original, N. C. del.

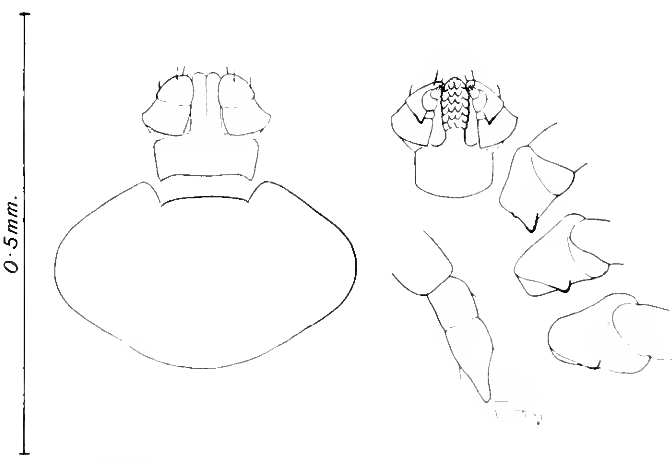


Fig. 430. *H. bancrofti* larva. Scutum, capitulum in dorsal and ventral aspects, coxae, tarsus III. (N. 2689 co-type.) Original, N. C. del.

grooves long, deep and sub-parallel, the interval rather broad. *Capitulum* greatly resembles that of the ♂; porose areas much longer than broad, converging strongly in front; hypostome dentition 4 | 4. *Venter*: spiracle oval, hardly pointed dorsally. *Legs*: as in the ♂.

Nymph (Fig. 429): *Scutum*: broader than long, about $0{\cdot}2 \times 0{\cdot}25$ mm.[1], cordate; cervical grooves long, sub-parallel, well-marked. *Capitulum*: much like that of the ♂, except that the dentition is 2 | 2. *Legs*: like those of the adult, with trochantal spurs more distinct.

Larva (Fig. 430): *Scutum*: much broader than long, about $0{\cdot}37 \times 0{\cdot}58$ to $0{\cdot}32 \times 0{\cdot}56$ mm.[1], rather deeply emarginate; cervical grooves well-marked and visible for the whole length of the scutum. *Capitulum*: base twice as broad as long, with distinct, rather sharp, somewhat outwardly directed cornua; palps only slightly salient laterally, article 2 about equal in length to article 3, no dorsal spines, but a short retrograde spur under article 3; hypostome dentition 2 | 2. *Legs*: coxal armature normal; no trochantal spurs; tarsus III tapering rapidly to a rather sharp point; pad half as long as the claws.

Described from specimens derived from Queensland, **Australia**: (N. 2100), 2 ♂ and 5 ♀ from *Macropus dorsalis*, Burnett District, III. 1913; (N. 2114), 1 ♀ and 1 o, found crawling on collector's trousers, at Brigaton Scrub, Burnett; (N. 2115), 1 ♂, from *Macropus giganteus*, Burnett District, III. 1913; (N. 2689), 2 ♀, with eggs and larvae, the ♀s taken from *Macropus dorsalis*, Eidsvold, XII. 1913; (N. 2691), 6 ♂, 3 ♀ and 2 o, host (?) found at Eidsvold. All collected by Dr T. L. Bancroft, of Eidsvold, after whom the species is named. Mr L. Harrison has recently presented us with (N. 3090) ♂ o from *Bettongia penicillata*, Queensland.

Types in Cambridge: (N. 2100, ♂ ♀; N. 2691, o; N. 2689, larvae).

[1] The scutums of 3 nymphs (N. 2114, N. 2691) and 12 larvae (N. 2689) measured as follows in mm.:

o	L
0·2 × 0·26	0·36 × 0·5
0·2 × 0·25	0·36 × 0·52
0·18 × 0·22	0·35 × 0·54
	0·35 × 0·51
L	0·34 × 0·52
0·37 × 0·58	0·33 × 0·52
0·36 × 0·58	0·33 × 0·51
0·36 × 0·56	0·32 × 0·56
0·36 × 0·54	

36. HAEMAPHYSALIS CAMPANULATA Warburton, 1908.

Figs. 431–432.

Lit., Icon. and Syn. : *H. campanulata* Warburton, 1908, pp. 513 514, Figs. 5, 6 (reproduced).

H. campanulata Warburton, 1908, wrongly stated to = *H. flava* Neumann, 1897, in Blanchard, 1909, p. 148.

See discussion under *H. flava*, p. 408.

Male (Fig. 431): *Body* oval, slightly convex, colour yellow, lighter ventrally. *Scutum* about 2 × 1·4 mm.[1], with numerous fine punctations; cervical grooves deep, sub-parallel, slightly convex externally: lateral grooves beginning about the anterior third of the body and ending behind the spiracles; festoons long and narrow, well-marked, the

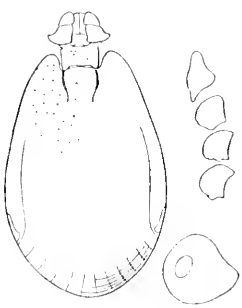


Fig. 431.

Fig. 432.

Fig. 431. *H. campanulata* ♂. Dorsum, coxae and spiracle. Sketch, Warburton, 1908 Fig. 5.

Fig. 432. *H. campanulata* ♀. Capitulum and scutum, tarsus IV, and spiracle. Sketch, Warburton, 1908, Fig. 6.

[1] The scutums of 11 ♂ and 5 ♀ measured as follows in mm. :

♂		♀	
2·1 × 1·5	(N. 579)	1·25 × 1·1	(N. 579)
2·0 × 1·4	(2 N. 897)	1·15 × 1·05	,,
2·0 × 1·4	(N. 1251 *b*)	1·1 × 1·0	(N. 897)
1·95 × 1·35	(N. 579)	1·1 × 0·95	,,
1·95 × 1·3	(N. 897)	1·0 × 1·15	(N. 579)
1·9 × 1·35	,,		
1·9 × 1·3	,,		
1·85 × 1·4	,,		
1·8 × 1·25	,,		
1·6 × 1·15	,,		
1·55 × 1·1	(N. 1251 *b*)		

intervals sometimes dark. *Venter*: sexual orifice broad, between coxae II; spiracles almost trapezoid, with blunt rounded dorsal protuberance. *Capitulum*: base rectangular, dorsally barely twice as broad as long, punctate all over, and with short blunt cornua; the rest of the capitulum notably bell-like in shape (hence *campanulata*) owing to the forwardly curved lateral projections of article 2 of the palps; hypostome 4 | 4, files of broad teeth, about 8 teeth per file, the outermost teeth the stoutest; palps without any dorsal spines, but the ventral border of article 2 projects strongly backwards, and article 3 has a well-marked ventral retrograde spine. *Legs*: coxae each with a short blunt spur; tarsi IV very short and thick, ending in a somewhat abrupt slope, the false articulation about the middle of the article.

Female (Fig. 432): *Body* yellow, somewhat parallel-sided, sometimes attaining 7 × 4 mm. when distended; marginal grooves including two festoons. *Scutum*: 1·25 × 1·1 to 1·1 × 1 mm.[1], glossy-brown or yellow, cordiform, finely punctate; cervical grooves well-marked, far apart, at first convex outwardly, then turning outward. *Venter*: yellow; spiracles like those of the ♂, but with dorsal protuberance even less marked. *Capitulum*: base broader and shorter than in the ♂, with less distinct cornua; porose areas oval, their axes converging forward, far apart, the interval twice their diameter, a narrow longitudinal pit midway between them; the rest of the capitulum like that of the ♂, but even more markedly bell-shaped; hypostome 4 | 4, with teeth narrower than in the ♂. *Legs*: coxae as in the ♂, tarsus IV short, somewhat humped.

Description based on numerous specimens (N. 897) taken from Chinese *dogs* in Mongolia by Major M. L. Hearn, and received by us from Colonel B. Skinner, R.A.M.C., in 1906. They agreed in every respect with specimens kindly lent by Professor Neumann (3. III. 1908) as *H. flava*, and with others so named by him in the British Museum.

We have also received: (N. 524 *a*), 1 ♀, collected with other ticks, from *cattle* and *horses*, at Wei-Hai-Wei, **China**, by Dr W. M. Muat, X. 1908 and (Berlin Mus. No. 166) ♀s from Chengtu, China, collected by Consul Weiss; (N. 579), 2 ♂ 2 ♀, from a *dog*, Yokohama, **Japan**, collected by A. Owston, IV. 1902, and presented to us by Hon. N. C. Rothschild; Dr Miyajima has sent us adults (N. 2917, 2921) found on house *rat*, 11. IX. 1912, and on *dog*, 18. VI. 1914, at Tokio. We include here (N. 2886) 1 ♀ from *dog*, Tokio, 1894, Janson coll.

[1] See note 1, p. 491.

(a purported co-type of *H. flava* Nn.) presented to us by Prof. Neumann. (N. 1251 *b*), 2 ♂, from *deer*, Satharangapara, Travancore, **S. India**, collected by E. R. Howlett, I. 1911.

Types in Cambridge (N. 897); we have presented co-types (♂ ♀) to the British Museum and London School of Tropical Medicine, also (♂) to the Museums in Paris, Berlin, Toulouse (Neumann coll.), and Washington, D.C. (U.S. Dept. Agric.).

37. HAEMAPHYSALIS HOWLETTI Warburton, 1913.

Figs. 433, 434.

Lit. and Icon.: Warburton, VII. 1913, pp. 123, 124, Figs. 2, 3 (reproduced).

Male (Fig. 433): Of the general appearance of *H. campanulata* Warburton, 1908, from which it differs, however, as follows: it is smaller; the *scutum*, 1·75 × 1·2 mm., more densely and deeply punctate, less rounded posteriorly; *spiracle* sub-rectangular, with very slight blunt, dorsal process; *hypostome* 5 | 5 to 6 | 6, very small sharp teeth; tarsus IV longer and more tapering.

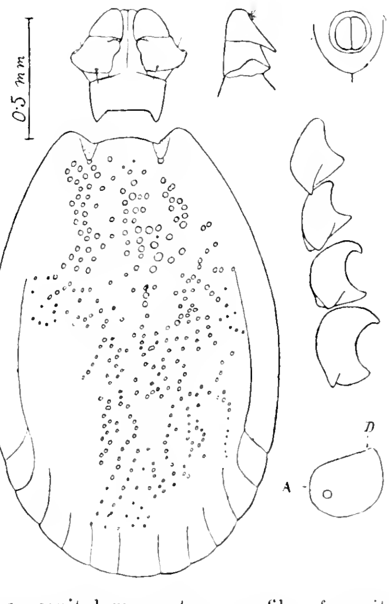


Fig. 433. *H. howletti* ♂, capitulum, scutum, profile of capitulum, anus with anal grooves, coxae and spiracle. (N. C. del.) Warburton, 1913, Fig. 2.

Female (Fig. 434): *Scutum* longer than broad, 1·0 × 0·85 mm., long-oval, of nearly uniform width throughout, strongly and deeply punctate, the punctations more or less confluent on the lateral fields; cervical grooves beginning as pits at some distance from the anterior border, and continuing as shallow depressions for about $\frac{2}{3}$ the scutal length. *Capitulum*: much like that of *H. campanulata*; porose areas oval and far apart, with a median depression between them; hypostome 5 | 5, very small teeth confined to distal portion. *Dorsum* closely and deeply punctate all over. *Legs*: tarsi tapering.

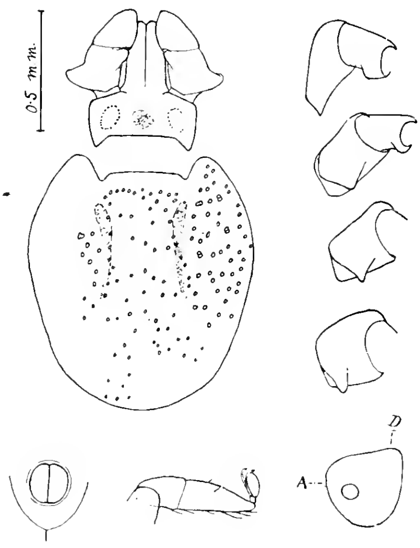


Fig. 434. *H. howletti* ♀, capitulum, scutum, coxae and trochanters, anus with anal grooves, tarsus IV and spiracle. N. C. del. Warburton, 1913, Fig. 3.

Described from (N. 1979) 1 ♂ and 1 ♀ from hill *pony*, Rawalpindi, Punjab, **India**, 1912, collected by F. M. Howlett after whom the species is named.

Types in Cambridge.

This species is closely allied to *H. campanulata*. It is, however, smaller, much more punctate and its hypostome is very different, that of *campanulata* being well covered with 4 | 4 large teeth. The different shape of the ♀ scutum and the tapering tarsi in both sexes will also serve to distinguish it from that species.

38. HAEMAPHYSALIS VIDUA Warburton and Nuttall, 1909.

Fig. 435.

Lit. and Icon.: Warburton and Nuttall, 1909, pp. 66 67, Fig. 13 (reproduced).

Male (Fig. 435): *Scutum*: 1·8 × 1·1 mm., yellow, oval, broadest in the middle, with very numerous shallow punctations; cervical grooves deep oval pits with shallow divergent posterior continuations; no lateral grooves. *Capitulum*: short; base rectangular, comparatively long, with short blunt cornua; hypostome with large corona followed by 4 | 4 rather scale-like teeth, few in number, about 30 in all; palps with

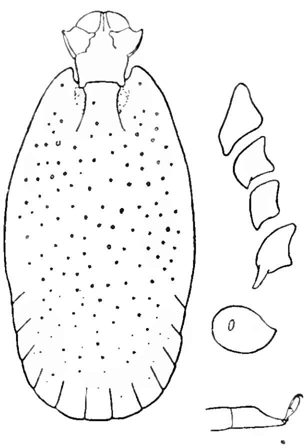


Fig. 435. *H. vidua* ♂, dorsum, coxae, spiracle, tarsus IV. Sketch by C. W. Warburton and Nuttall, 1909, Fig. 13.

articles 2 and 3 about equal in length, and with article 2 salient near its distal end, and forming a sinuous contour with article 3; a ventral retrograde spur from the outer border of article 3. *Venter*: spiracle oval, with slight dorsal prominence; anal grooves ogival. *Legs*: not very strong, coxae with a moderate spur at each postero-internal angle, strongest on coxa IV; tarsi thick and abruptly tapering, almost humped.

Female: unknown.

Described from 1 ♂ taken (in company with *H. leachi*) from *Paradoxurus* sp., in the **Federated Malay States**, by Dr A. T. Stanton, III. 1909.

Type in Cambridge.

39. HAEMAPHYSALIS HUMEROSA Warburton and Nuttall, 1909.

Figs. 436, 437.

Lit. and Icon.: Warburton and Nuttall, 1909, pp. 60, 61, Figs. 4, 5 (reproduced).

Male (Fig. 436): Livid yellow-brown, very long and narrow. *Scutum*: 1·95 × 0·9 to 2·37 × 1·04 mm.[1], glossy, with very uneven surface due to more or less confluent punctations and ridges; cervical

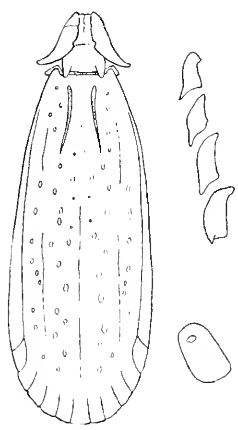


Fig. 436.

Fig. 437.

Fig. 436. *H. humerosa* ♂, dorsum, coxae, spiracle. Sketch by C. W. Warburton and Nuttall, 1909, Fig. 4.

Fig. 437. *H. humerosa* ♀, capitulum and scutum. Sketch by C. W. Warburton and Nuttall, 1909, Fig. 5.

[1] The scutums of 16 ♂ gave the following measurements in mm.:

2·37 × 1·04	2·1 × 1·0
2·3 × 0·97	2·1 × 0·84
2·2 × 0·95	2·03 × 0·98
2·2 × 0·95	2·0 × 0·92
2·16 × 1·0	2·0 × 0·9
2·16 × 0·94	2·0 × 0·87
2·15 × 0·9	1·97 × 0·96
2·14 × 0·94	1·85 × 0·87

grooves long and nearly straight, slightly diverging posteriorly: lateral grooves long and very near the border, including one festoon; festoons moderately long, the intervals curved. *Capitulum* 0·3 mm. long, base rather long, with long sharp cornua proceeding from the dorsal surface. Hypostome with very small teeth, 5|5. Palps long, especially article 2, which is about four times as long as article 3; its sharp external angle being much posterior to its insertion; no dorsal spur; a very small sharp spur under article 3. *Venter*: genital aperture between coxae II, covered by an elongate shield; spiracle large, broader posteriorly, without definite dorsal process. *Legs*: coxae very broad (antero-posteriorly) and progressively increasing in size, all more or less pointed at the internal angle, the spur on coxa IV dark and conical; coxa I protrudes beyond the scapular angle and rises to the level of the dorsal surface, giving a characteristic appearance (hence *humerosa*).

Female (Fig. 437): Of the same colour as the ♂. *Scutum* oval, 0·8 × 0·6 to 1·0 × 0·66[1] mm., cervical grooves only slightly concave and attaining the posterior border. *Capitulum* 0·4 mm. long, like that of the ♂, but with article 2 rather less salient, and only about thrice as long as article 3; hypostome 5|5, very small teeth; basis capituli ridged laterally and anteriorly, the sub-circular porose areas are very faintly indicated at the sides of the flat median area. *Legs* like those of the ♂; tarsus IV medium, rather thick, tapering.

Nymph: Strongly resembles the ♀, having the same elongated body and the same type of *capitulum*, which is, however, shorter in comparison to its breadth. The *scutum* about as long as broad, 0·4 × 0·4 mm.[2]; punctations few and scattered; cervical grooves are deep broad furrows not quite attaining the posterior border. *Legs* as in the ♀ but with shorter sharply pointed tarsi IV.

Described from (N. 669) 3 ♂ 1 ♀ and 1 o taken from *Perameles macrura*, Barrow Island, **N.W. Australia**, and presented by the Hon. N. C. Rothschild. The measurements appended in the footnotes relate to specimens brought from Australia by Mr L. Harrison: 2 ♂ 3 ♀ 5 o from *Perameles macrura*, Stapleton, Northern Territory, 31. XI. 1913,

[1] The scutums of 5 ♀ gave the following measurements in mm.:

1·0 × 0·66	0·95 × 0·66
0·97 × 0·7	0·9 × 0·6
0·97 × 0·65	

[2] The scutums of 5 nymphs gave the following measurements in mm.:

0·4 × 0·4 (3 specimens)	0·38 × 0·39
0·4 × 0·36	

G. F. Hill coll.; and 14 ♂ 2 ♀ 1 o taken from *Perameles nasuta*, Sydney, New South Wales, III. 1913, L. Harrison coll. Mr Harrison has kindly presented us with some of his specimens (N. 3024, 3025); some of these ♀s and os are fairly replete and their bodies appear remarkably long and slender.

Types in Cambridge.

40. HAEMAPHYSALIS ELONGATA Neumann, 1897.

Figs. 438–440.

Lit. and Icon.: Neumann, 1897, pp. 354–356, Fig. 19 (reproduced); Dönitz, 1907 *a*, p. 73 (quotes Neumann); Blanchard, 1909, p. 150, Figs. 186, 187 (taken from Neumann); Neumann, 1911 *a*, p. 113, Fig. 61 (condensed from Neumann, 1897, with the same figure as before).

Male (Figs. 438, 439): Remarkable because of the backward protrusion of the body when replete; the ventral festoons are folded backward dorsally as shown in Fig. 438; in a fully distended specimen, the body may project 0·6 mm. *Scutum*: long and narrow, about 2 × 1 mm.[1]; cervical grooves broad, shallow, sub-parallel; lateral grooves well-marked behind a pseudo-scutum and including either one or two festoons; pseudo-scutum chiefly indicated by its more uniform texture compared to that of the rest of the scutum, which is diversified by raised longitudinal ridges, a median ridge or carina being rather conspicuous; punctations irregular, shallow, confluent, not numerous. *Capitulum*: base much broader than long, rectangular, with well-marked sharp cornua; palps long, especially article 2, which is thrice as long (dorsally) as article 3, its posterior border being produced backward and hollowed to receive coxa I; a slight retrograde spine under article 3; hypostome 3 | 3, teeth small and uniform. *Venter*: anal grooves ogival; spiracle oval, slightly pointed dorso-laterally. *Legs*: all the coxae bear a sharp internal spur; in some specimens these spurs increase progressively from I to IV, in others the spur on coxa I is longest[2]; a sharp ventral spur on all the trochanters; tarsus IV rather stout and narrowing rather abruptly; pads long.

[1] The scutums of our 5 ♂ measure respectively: 2·15 × 1, 2·1 × 1·2, 2 × 1·1, 1·9 × 1·2, 1·8 × 1 mm.

[2] Compare our Figure 438 with that of Neumann (Fig. 439, here reproduced).

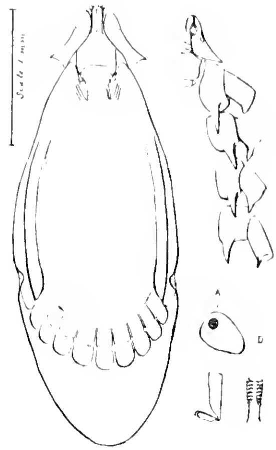


Fig. 438. *H. elongata* ♂ (N. 670, gorged), dorsum showing protrusion of abdomen beyond the scutum, coxae and trochanters with part of capitulum, spiracle, tarsus IV and hypostome. Original, G. H. F. N. del.

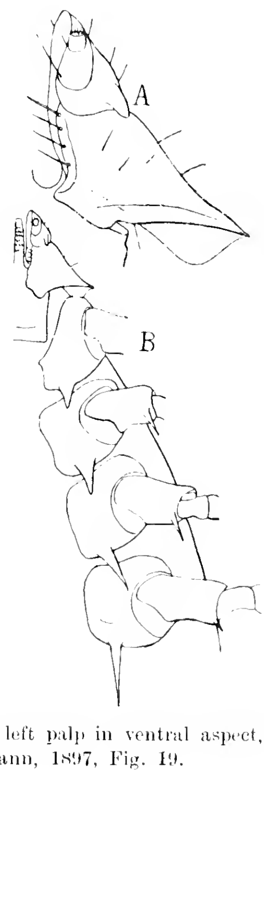


Fig. 439. *H. elongata* ♂, (*A*) left palp in ventral aspect, ×100; (*B*) coxae I–IV with trochanters, ×40. Neumann, 1897, Fig. 19.

Female (Fig. 440): When unfed, the body measures 2 × 1·2 mm. *Scutum*: 1 × 0·8 mm.[1]; cervical grooves long and shallow; faint, raised longitudinal ridges in the lateral fields; punctations faint, irregular, shallow, confluent. The posterior portion of the dorsum bears two rather conspicuous depressions. *Capitulum*: base broader than in the ♂; porose areas elongate, wide apart; palps as in the ♂, except that the posterior border of article 2 is more rounded dorsally; hypostome 3 | 3, 7 to 8 teeth per file. *Venter*: anal grooves as in the ♂; spiracle sub-circular, not pointed postero-laterally. *Legs*: coxal and trochantal armature as in the ♂.

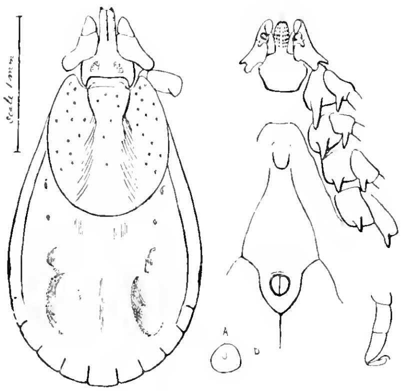


Fig. 440. *H. elongata* ♀ (N. 670, unfed), dorsum, part of venter, spiracle and tarsus IV. Original, G. H. F. N. del.

Our description is based on (N. 670) 5 ♂ and 2 ♀ from *Centetes ecaudatus*, **Madagascar**, presented by Hon. N. C. Rothschild. Neumann founded the species on 4 ♂ and 1 ♀ found on *Centetes madagascariensis* at Zura, 2 ♂ from *Centetes ecaudatus* and 2 ♀ from *Erinaceus* sp., collected by Sikora in Madagascar.

Types in Toulouse, co-types in Cambridge (N. 2884, 2885, 1 ♂, from Zura, 1 ♀, taken from *Erinaceus*, presented by the author).

41. HAEMAPHYSALIS CORNIGERA Neumann, 1897.

Figs. 441–445.

Lit., Icon. and Synon.:

Haemaphysalis cornigera Neumann, 1897, pp. 350–352, Figs. 16, 17 (left palp and coxae; figures reproduced); Neumann, 1911 *a*, pp. 112, 113, Figs. 57, 58

[1] The scutum of our second ♀ measures 0·95 × 0·85 mm.

(the same account as the foregoing, but condensed); Blanchard, 1909, p. 150, Fig. 185 (species merely listed; figures taken from Neumann).

Haemaphysalis spiniceps Warburton and Nuttall, v. 1909, p. 68, Fig. 15 (♂ reproduced). Through a typographical error the measurements of the ♂ are wrongly given.

Haemaphysalis proxima Warburton and Nuttall, v. 1909, p. 61, Fig. 6 (♀ not reproduced).

Male (Figs. 441–444): *Scutum* long-oval, 3 × 2 mm., broadest near the middle, glossy yellow-brown, darker at the sides and on the pseudo-scutum, with large deep punctations anteriorly, some of them confluent and indicating by their distribution a pseudo-scutum; puncta-

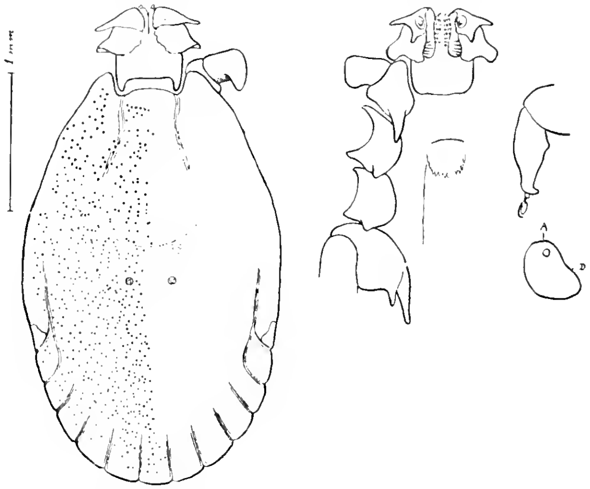


Fig. 441. *H. cornigera* ♂, dorsum, part of venter, spiracle and tarsus IV. Specimen from Borneo, co-type (N. 2883). Original, G. H. F. N. del.

tions very small and numerous on the hinder portion; cervical grooves well-marked, broad, nearly parallel; lateral grooves almost obsolete, only recognisable in the neighbourhood of the spiracles; festoons medium, punctate, the intervals dark and mostly straight. *Capitulum*: 0·6 mm. long; base broadly rectangular, slightly punctate, with convex sides and strong cornua; hypostome long, parallel-sided, well-covered with 5|5 small teeth; palps of remarkable form; article 2 strongly salient at about the middle of its length and with five spatulate hairs on its inner margin; *article 3 with a strong, sharp lateral spine* and with a similar ventral retrograde spine directed downwards and outwards. *Venter*: spiracle very large and short comma-shaped; anal grooves slightly ogival. *Legs*: strong: coxa I prominent in front and with a strong spur; a conical spur about the middle of the posterior border of coxae II and III; *two long spurs on coxa IV*, the inner the longer; tarsi tapering, pad long.

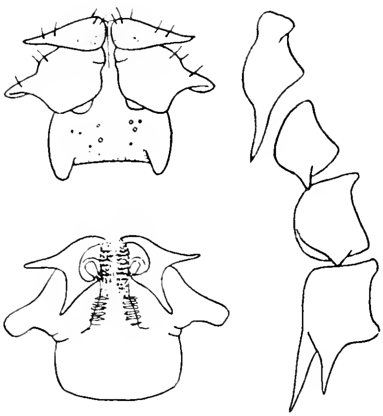


Fig. 442. *H. cornigera* ♂, capitulum in dorsal and ventral aspects, coxae. Specimen from Federated Malay States. (N. 1647. Type of *H. spiniceps* Warb. and Nutt.) Sketch by C. W. Warburton and Nuttall, 1909, Fig. 15.

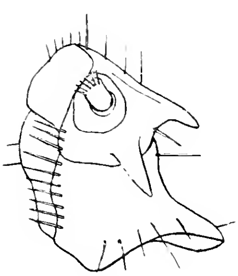


Fig. 443.

Fig. 444.

Fig. 443. *H. cornigera* ♂, left palp in ventral aspect, ×70. Neumann, 1897, Fig. 16.
Fig. 444. *H. cornigera* ♂, coxae I–IV, ×35. Neumann, 1897, Fig. 17.

Female (Fig. 445): *Scutum* cordate, 1·3 × 1·2 mm., glossy, uniformly punctate all over with moderate sized punctations; cervical grooves shallow. *Capitulum*: base rectangular, much broader than long; porose areas oval, ill-defined, far apart, usually with a small depression in the interval; cornua strong. *Palps*: the absence of the lateral spine on article 3 prevents any great resemblance to those of the ♂, but the lateral contour of article 2 is somewhat similar, and it is not continuous with that of article 3 which is slightly salient laterally, a strong retrograde spine under article 3: hypostome well covered with 4 | 4 strong equal teeth, 10 or 12 per file. *Venter*: anal grooves semi-circular; spiracle large, oval, with hardly any dorsal process. *Legs*: a strong internal spine on coxa I; a small spur at the middle of the posterior border of coxae II and III and at the internal angle of coxa IV; tarsi long, tapering gradually; pad as long as the claws.

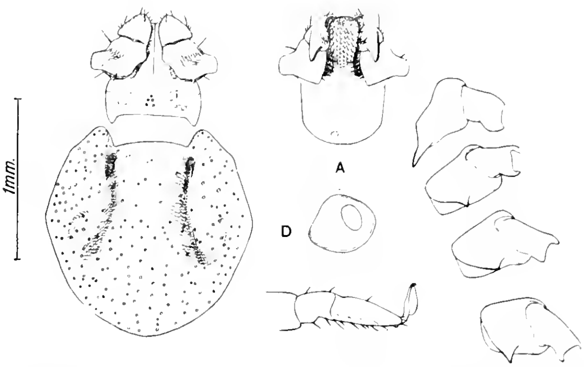


Fig. 445. *H. cornigera* ♀, scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle, tarsus IV. Drawn from specimens from British N. Borneo (N. 2119 *b*), the tarsus drawn from (N. 2118). Original, N. C. del.

Our description of the ♂ is from a specimen (N. 1647) collected in the **Federated Malay States** by Mr H. C. Pratt, which was described by us as *H. spiniceps* (Warburton and Nuttall, 1909, p. 68, Fig. XV, here reproduced). We are indebted to Dr Oscar Pou for (N. 2104) 5 ♂, from a tiger or wild pig, and (N. 2105) a ♀ from a *wild pig*, shot in the jungle at Kuantan, F. M. S., I. 1913. We have also received numerous specimens from **British North Borneo**: (N. 2118) from which we describe the ♀, taken with many ♂s from the *Sambur deer*, Bode River, Sandakan Bay, IV. 1913; (N. 2119 *b*) ♂ ♀ from a *water buffalo*, Labuk River, 10. XII. 1912; (N. 2120), 2 ♀, from *buffalo*, Sekong River, IV. 1913; the three lots were collected by Dr H. F. Conyngham. We have determined (Berlin Mus. No. 172) 1 ♀ from Darvel Bay, Dr Pagel coll. A ♀ (N. 1251 *a*) has reached us from **India**; it was found on *deer*, at Satharangapara, Travancore, I. 1911, by E. R. Howlett. Neumann (1897) described both sexes from specimens (2 ♂) found on *Cervus* sp. in Borneo, R. Blanchard coll., 1894; (2 ♂ 1 ♀) from **Singapore**, Simon coll.; (1 ♂) from *Bos bubalis*, **Sumatra**[1], Oudemans coll.; (1 ♂) from **Judea**, in the Paris Museum.

The types and co-types are in Toulouse (♂ ♀), Paris Museum (♂), and Cambridge, Prof. Neumann having presented us with a co-type (N. 2883) ♂ from *Cervus* sp., Borneo.

The lateral spine on article 3 of the palp, and the double internal spine on coxa IV, are such striking characteristics as to make the ♂ of this species easily distinguishable. Unfortunately both these characteristics are absent in the ♀, which resembles the ♂ in little except in the lateral contour of article 2 of the palp and the break between it and article 3, and the unusually large size of the spiracle.

Haemaphysalis cornigera var. anomala Warburton, 1913.

Fig. 446.

Lit. and Icon.: Warburton, VII. 1913, p. 128, Fig. 7 (reproduced).

Male (Fig. 446): Closely resembles the type except in the following respects: *the 3rd article of the palps not projecting laterally* (hence *anomala*); basis capituli somewhat narrower compared with its length; spiracle more pointed dorso-laterally.

Female: unknown.

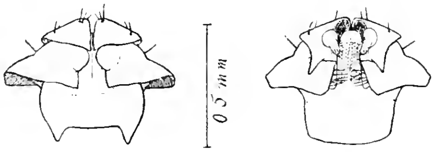


Fig. 446. *H. cornigera* var. *anomala* ♂, dorsal and ventral aspects of capitulum. N. C. del. Warburton, 1913, Fig. 7.

[1] A ♀ (N. 540), described by us as *H. proxima* N. and W., 1909, p. 61, is now referred to this species; the specimen was taken by Dr J. C. Koningsberger, from *Bos bubalis*, in 1909 in Sumatra.

The most remarkable characteristics of *H. cornigera*—the presence of two divergent spines under article 3 of the palps, and of a double spine on coxa IV—are repeated in this variety.

Described from a single ♂ taken from a *wolf*, four miles west of Koderma Station, Chota Nagpur, **India**, VIII. 1912, by Major O. A. Smith. In its company were specimens of *H. bispinosa* var. *intermedia*, *H. leachi* and *Rhipicephalus haemaphysaloides*.

Type in the Indian Museum, Calcutta (No. 1524/17 *a*).

42. HAEMAPHYSALIS DENTIPALPIS Warburton and Nuttall, 1909.

Fig. 447.

Lit. and Icon.: Warburton and Nuttall, 1909, pp. 67–68, Fig. 14 (reproduced).

Male (Fig. 447): *Body* long-oval, 2·7 × 1·3 mm., broadest towards the hind end; colour, dull brownish-yellow, the front legs, the capitulum and the anterior part of the scutum darker. *Scutum*: showing conspicuous pseudo-scutum, with numerous large, deep punctations; very fine punctations on the anterior portion; cervical grooves deep and convergent, then faint and divergent and visible almost to the posterior border of the pseudo-scutum; lateral grooves short, beginning faintly

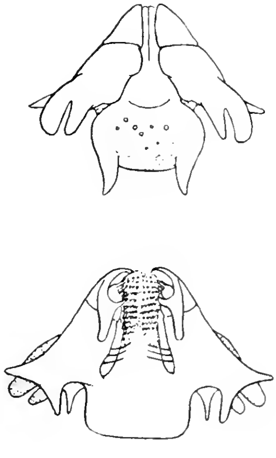


Fig. 447. *H. dentipalpis* ♂, capitulum in dorsal and ventral aspects. Sketch by C. W. Warburton and Nuttall, 1909, Fig. 14.

at about half the body-length, and including two festoons: festoons rather short and broad, with straight intervals. *Capitulum*: 0·6 mm. long; base broader anteriorly, with convex sides and rather concave anterior border; cornua strong, rather curved; hypostome long, parallel-sided, well covered with 7 | 7 very small equal teeth; palps long, conical, their dorsal surface concave; article 2 much longer than 3 and with five retrograde projections, two dorsal and three ventral, best understood by reference to the figures; three simple hairs on the internal margin of article 2; a strong retrograde spine under article 3. *Venter*: spiracle very large, pear-shaped, with the narrower end dorsal; anal grooves ogival. *Legs*: long, hairy, coxae like those of *H. leachi* (p. 468, Fig. 409), with a short conical spur at each postero-internal angle; tarsi rather thick, tapering abruptly.

Female: unknown.

Described from 4 ♂ taken (in company with *H. leachi*) from *Felis chaus*, by Dr A. T. Stanton in the **Federated Malay States.**

Types in the London School of Tropical Medicine collection and (N. 693 *a*, 2 ♂) at Cambridge.

GEOGRAPHICAL DISTRIBUTION AND HOSTS OF THE GENUS.

Of the species and varieties we recognize, 3 occur in Europe, 15 in Africa, 32 in Asia, 4 in Australasia and 3 in America. *H. bispinosa* has almost to a certainty been recently imported into East Africa and possibly into New South Wales with Indian cattle; *H. leachi* may well have reached Australia (again New South Wales) from India. If we regard these species as not indigenous to the continents mentioned, the number of indigenous species would be as follows: Europe (3), Africa (14), Asia (32), Australia (2), America (3).

This is in marked contrast to what we observe in the genus *Ixodes*. If we add some species described by Bishopp (1911, pp. 197 *et seq.*), Nuttall (1913, pp. 131–136), and Lahille (1913, p. 2) to those listed in Part II of this work, varieties being excluded, we find the species of *Ixodes* which we recognize as valid to-day distributed as follows: Europe (10), Africa (13), Asia (10), Australia (10), America (25). It is clear therefore that Asia is richest in species of *Haemaphysalis* and that America possesses the greatest number of *Ixodes*.

There are three species of *Haemaphysalis* which show a particularly wide distribution: (1) *H. cinnabarina* occurs in North and South America; its var. *punctata* is found in Europe, Northern Africa, Asia Minor and Transcaucasia; (2) *H. bispinosa* occurs in Asia [British East Africa and New South Wales]; (3) *H. leachi* occurs practically throughout Africa, in different parts of Asia [and in New South Wales]. The continents where these species are perhaps not indigenous are enclosed in [ ] brackets.

Regarded from the point of view of the *hosts* which they infest, we find but one species of *Haemaphysalis* which, as far as our knowledge goes, would appear to be restricted to birds, i.e. *H. hoodi*.

This is again in marked contrast to what we have observed in *Ixodes* where certain species have been repeatedly found only on birds (*I. brunneus*, *I. caledonicus*, *I. neumanni*, *I. putus*, *I. signatus*, *I. unicavatus*), on *Ornithorhynchus* (*I. ornithorhynchi*) and bats (*I. vespertilionis*). In this sense, the genus *Ixodes* appears more specialized than *Haemaphysalis*.

In the list which follows, the scientific names of the hosts are given as far as possible from the data at hand.

	Countries where the species occur	Hosts
EUROPE		
cinnabarina var. *punctata*	Great Britain, France, Holland, Denmark, Germany, Russia, Italy, Spain, Hungary, Croatia, Dalmatia, Roumania, Greece, Cyprus, Cyclades, Crete	Mammals: *Ovis aries*, *Bos taurus*, *Capra hircus*, *Cervus dama*, *Equus caballus*, *Lepus europaeus*, *Erinaceus europaeus*. Bat, *Plecotus auritus* Birds: *Turdus viscivorus*, partridge, *Numenius arcuatus* Reptiles: *Vipera aspis*, *Lacerta* spp. (o. & L.)
concinna	Germany, France, Poland	*Ovis aries*, *Cervus* sp., *Erinaceus europaeus*
inermis	Caucasia, France	*Cervus* sp.
AFRICA		
aciculifer	Uganda, Gold Coast	Antelope, reed-buck
bispinosa	British East Africa	*Bos taurus*, bullock, *Capra hircus*
calcarata	Abyssinia, Egypt, Soudan, Somaliland	*Spermosciurus* sp., *Sciurus* sp., *Xerus rutilus*
calcarata var. *houy*	New Cameroon	unknown
cinnabarina var. *punctata*	Algeria, Egypt, Canary Islands	Mammals: *Ovis aries*, *Capra hircus*, *Bos taurus* Reptiles: *Lacerta* sp.
elongata	Madagascar	*Centetes ecaudatus*, *C. madagascariensis*, *Erinaceus* sp.
hoodi	West: Gambia, Gold Coast, Sierra Leone East: Portuguese East Africa, Nyasaland	Birds: *Centropus burchelli*, *C. senegalensis*, *Gymnoschizorchis leopoldi*, *Gallus domesticus*, *Numida meleagris*, partridge
hoodi var. *orientalis*	Nyasaland	*Procavia manningi*
leachi	Practically everywhere in Africa (refer to text pp. 469–474)	Mammals: Man (rarely) Carnivora (chiefly): *Canis familiaris*, *C. adustus*, *C. mesomelas*, *Felis leo*, *F. pardus*, *F. nigripes* *F. serval*, *F. domesticus*, *Gueparda jubata*, bushcat, *Viverra civetta*, *Genetta* sp., *G. suahelica*, *Herpestes* sp., *H. caffer*, *Cynictis penicillata*, *Suricata tetradactyla*, *Helogale varia* Thos., *Hyaena* sp., *H. crocuta*, *Mustela* sp. *Ovis aries*, *Capra hircus*, *Bos taurus*, *Bos indicus*, *Equus caballus*, Rhinoceros, *Procavia brucei*, *P. abyssinica*, *Tachyoryctes audax*

	Countries where the species occur	Hosts
AFRICA (*cont.*)		(mole-rat), *Aricanthus pumillis* (o s.), *Anomalurus orientalis* (squirrel), *Lepus* sp., *Erinaceus albiventris*, *Erinaceus* sp. Birds: *Dryoscopus turatii* and nightingale Reptiles: *Itongx capensis*, *Testudo* sp. (o s.)
numidiana	Algeria	*Erinaceus* sp.
obtusa	Island of Réunion	unknown
parmata	Uganda, British East Africa, Congo Free State, Gold Coast, Sierra Leone, Cameroon	*Potamochoerus porcus*, *Ovis aries*, *Capra hircus*, *Bos taurus*, antelope, bushbuck, hartebeeste, *Canis familiaris*
silacea	Cape Colony	*Bos taurus*
simplex	Madagascar	*Ericulus setosus*, *Erinaceus* sp.
spinulosa	Uganda	unknown
ASIA		
aborensis	India (Abor Country)	unknown
aculeata	Ceylon, India	*Tragulus memmina*
birmaniae	Burma	*Cervulus muntjac*, *Atherura macrura*
bispinosa	India (widely distributed), Burma, Assam, Ceylon, Andaman Islands, Malaya, China, Japan, Borneo	Mammals: *Canis familiaris*, jackal, *Felis tigris*, *F. domesticus*, *Viverricula malaccensis*, *Bos bubalis*, *B. taurus*, *Hemitragus hylocrius*, *Nemorhaedus cinereus*, *Ovis aries*, *Capra hircus*, *Equus caballus*, *Sus scrofa*, *Cervulus* sp., *Cervus* sp., mouse deer, *Hydropotes inermis*, *Macacus* sp., *Talpa* sp. Birds: *Gallus domesticus*
bispinosa var. *intermedia*	India (widely distributed), Ceylon	Mammals: *Felis caracal*, *F. ornata*, *F. domesticus*, *F. affinis*, *Canis pallipes*, *C. vulpes*, *Cyon* (*Cuon*) *dukhunensis*, *Hyaena hyaena*, *Bos taurus*, *Sus cristatus*, *Erinaceus micropus*, *Lepus ruficaudatus*, *Millardia meltada*
calvus	British North Borneo	*Bos bubalis*
campanulata	India, China, Japan	*Bos taurus*, *Equus caballus*, *Cervus* sp., *Canis familiaris*, *Mus* sp.
cinnabarina var. *punctata*	Asia Minor, Transcaucasia (? Japan, doubtful, see text p. 387)	*Bos taurus*, *Ovis aries*, *Capra hircus*, *Equus caballus*, *Canis vulpes*, *Ursus* sp., *Lepus* sp.

	Countries where the species occur	Hosts
ASIA (*cont.*)		
cornigera	India, Federated Malay States, Singapore, Borneo, Sumatra, Judea	*Cervus aristotelis*, *Bos bubalis*, *Felis tigris*, wild pig
cornigera var. *anomala*	India	*Canis lupus*
cuspidata	Ceylon	*Tragulus memmina*, *Paradoxurus niger*, *Herpestes mungo*
dentipalpis	Federated Malay States	*Felis chaus*
doenitzi	Singapore	water-hen
flava	Japan, India	*Canis familiaris*, *Sus cristatus*, *Bos taurus*, *Ovis aries*, *Equus caballus*
formosensis	Formosa, Burma	*Canis familiaris*, *Hystrix bengalensis* or *Ursus torquatus*
howletti	India	*Equus caballus*
hystricis	Burma, Assam, Ceylon, China, Federated Malay States, Sumatra, Borneo, Formosa	Mammals: *Hystrix bengalensis*, *Erinaceus* sp., *Ursus torquatus*, *U. malayanus*, *Felis tigris*, *Canis familiaris*, *Sus scrofa*, *S. celebensis* Reptiles: *Geoemyda spinosa*
inermis	Transcaucasia (? Japan)	*Bos taurus*, *Naemorhaedus crispus*, *Canis* sp. (fox)
inermis var. *aponommoides*	India, Japan	*Bibos* sp. (Himalayan zebu), *Equus caballus*
japonica	Japan, China	*Naemorhaedus crispus*, roebuck
japonica var. *douglasi*	China	roebuck
kinneari	India	*Felis tigris*
leachi	Transcaucasia, India, Sumatra, Java, Borneo, Federated Malay States	Mammals (chiefly Carnivora): *Ursus* sp., *U. malayanus*, *Felis affinis*, *F. bengalensis*, *F. chaus*, *F. nebulosa*, *F. tigris*, *F. caracal*, *F. pardus*, *Viverra zibetha*, *Viverra* sp., *Canis aureus*, *C. indicus*, *C. familiaris*, *Cyon* (*Cuon*) *dukhunensis*, *Paradoxurus* sp., *Herpestes mungo*, *Centrococcyx intermedius*, *Millardia meltada* Reptiles (Testudiniae): *Nicoria trijuga*, *Testudo elongata*
montgomeryi	India	*Equus caballus*, *Bos taurus*, *Ovis aries*, *Canis familiaris*

	Countries where the species occur	Hosts
ASIA (*cont.*)		
papuana	New Guinea, Borneo, Java, Sumatra, Federated Malay States	*Canis familiaris*, *Ursus malayanus*, *Felis tigris*, *F. pardus*, *Sus* sp.
parva	Ceylon, India	*Felis viverrina*, *F. pardus*, *Lepus ruficaudatus*, *Lepus* sp.
spinigera	India, Ceylon, Judea	*Felis tigris*, *F. pardus*, *Ursus* sp., bullock
spinigera var. *novae-guineae*	German New Guinea, Queensland	Kangeroo sp., *Perameles* sp., *Hydromys* sp.
turturis	Ceylon	*Turtur suratensis*
vidua	Federated Malay States	*Paradoxurus* sp.
warburtoni	China, Western Siberia, Formosa	*Nemorhaedus* (Serow goat), *Bos taurus*
wellingtoni	Borneo, Sumatra, Federated Malay States, Siam, Andaman Islands	Mammals: *Canis familiaris*, *Bos bubalis*, but oftener from Birds: fowl, goose, turkey
AUSTRALASIA		
bancrofti	Queensland	*Macropus dorsalis*, *M. giganteus*, *Bettongia penicillata*
bispinosa	New South Wales	*Equus caballus*, *Bos taurus*
humerosa	Australia	*Perameles macrura*, *P. nasuta*
leachi	New South Wales	*Equus caballus*
AMERICA		
cinnabarina	United States, Canada	Birds (chiefly): *Chordeilis popetue*, turkey, meadow lark, jackdaw, red-winged blackbird, marsh-hawk, quail, ruffed grouse (in the United States) Mammals: *Bos taurus*, Man (in Canada)
kochi	Brazil	*Cervus campestris*, *C. rufus*
leporis-palustris	United States, Canada, Mexico, Panama, Brazil, Paraguay, Argentina	Mammals (chiefly Leporidae): *Lepus americanus*, *L. auduboni*, *L. bairdi*, *L. braziliensis*, *L. dalli*, *L. palustris*, *Dasyprocta agouti*, *Equus caballus*, *Felis domesticus*, pine squirrel Birds: robin, quail, meadow lark, chaparal cock, Brewer's blackbird, thrush, jackdaw, blue jay, magpie, *Penelope obscura* (in the United States)

LIST OF

CONDEMNED AND DOUBTFUL SPECIES OF HAEMAPHYSALIS

INCLUDING THEIR SYNONYMY AND LITERATURE

The species are ordered according to the genera to which they have at various times been referred. The list of good species will be found on p. 548. See also further particulars under the Synonymy of *Haemaphysalis* on p. 349.

Haemaphysalis Koch, 1844.

africana C. W. Howard, VIII. 1909, repr. Pl. XXXIV = *H. hoodi* Warburton and Nuttall, VI. 1909, p. 62.

ambigua Neumann, 1901, p. 262 ; 1906, p. 217 ; 1911 *a*, p. 109 ; Bonnet, 1908, p. 260, Fig. 30 ; Blanchard. 1909, p. 148, Fig. 178 (from Bonnet) = *H. inermis* Birula, 1895, p. 360.

asiatica (Supino, 1897) Neumann, 1897, p. 357 = *H. leachi* (Audouin, 1827). See further under *Opisthodon asiaticus*. Listed as a valid species by Blanchard, 1909, p. 148, and as a doubtful species by Neumann, 1911 *a*, p. 115.

"*birmaniae* Supino, 1897" in Neumann, 1911 *a*, p. 109 = *H. bispinosa* Neumann, 1897.

"*bispinosa* Neumann" in Neumann, 1901, p. 261 = *H. hystricis* Supino, 1897.

canestrinii (Supino, 1897) Neumann, 1897, p. 357 = *H. leachi* (Audouin, 1827) Neumann, 1897 ; Blanchard, 1909, p. 148, lists it as a valid species ; Neumann, 1911 *a*, p. 115, lists it as a doubtful species.

chordeilis (Packard, 1869) = *H. cinnabarina* Koch, 1844.

"*chordeilis* Banks, 1908" in Blanchard, 1909, p. 148 = *H. cinnabarina* Koch, 1844.

"*chordeilis* Packard" in Hunter and Bishopp, 1911, p. 229 (and subsequent American authors) = *H. cinnabarina* Koch, 1844.

"*cinnaberina*" Koch, 1847, p. 123 = *H. cinnabarina* Koch, 1844, p. 237.

"*coccinea*" mentioned casually by Bonnet, 1906 *c*, p. 544, doubtless meant for *H. concinna* Koch, 1844.

"*concinna concinna* Koch" in Neumann, 1911 *a*, p. 110, a sub-species = *H. concinna* Koch, 1844.

concinna kochi (Neumann) Neumann, 1911 *a*, p. 111, a sub-species = *H. concinna* Koch, 1844, and other (doubtful) species.

concinna var. *kochi* Neumann, 1905, p. 239 = *H. concinna* Koch, 1844, and other (doubtful) species.

concinna longicornis (Neumann) Neumann, 1911 *a*, p. 111, a sub-species ; described as *H. longicornis* Neumann, 1901, p. 261, Fig. 2 (reproduced) from 2 ♀ found on cattle, at Kempsey, N. S. Wales, mounted as microscopic specimens ; degraded to a variety of *H. concinna* Koch, 1844 (*H. concinna* var.

longicornis (Neumann)) by Neumann, 1905, p. 237, and finally raised by that author to a sub-species. It is in our opinion impossible to determine the species to which the tick belongs on the evidence of mounted specimens, at any rate without other confirmatory evidence. *H. concinna* ♀ is scarcely to be identified in the absence of the characteristic ♂, and a purported ♀, coming from a remote country whence the ♂ has not been derived, is open to grave suspicion. We reproduce Neumann's figure for what it is worth.

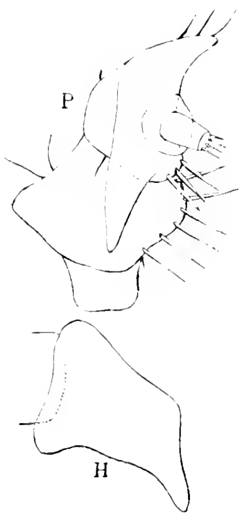


Fig. 448. *H. longicornis* Neumann, 1901, Fig. 2. ♀ (*P*) palp in ventral aspect, (*H*) coxa I.

H. longicornis Neumann is listed by Rainbow, 1906, p. 165, as an Australian species on Neumann's authority. Blanchard, 1909, p. 148, Fig. 184, who reproduces Neumann's figure, includes this tick in the synonymy of *H. concinna* Koch. We prefer to regard it as a doubtful species.

concinna var. *longicornis* (Neumann) Neumann, 1905, p. 237; *vide supra*.

crassa Warburton, 1908, p. 516; listed as a valid species by Blanchard, 1909, p. 150 = *H. cinnabarina* var. *punctata* (Can. and Fan.).

cuscobia (Canestrini, 1897) Neumann, 1897, p. 356 = merely a nominal species. See further under *Opisthodon cuscobius*. Listed as a valid species by Blanchard, 1909, p. 150, and as a doubtful species by Neumann, 1911 *a*, p. 115.

erinacei Pavesi, 1884, p. 484; merely a nominal species, the description being insufficient. We quote from the original all that might serve for its identification: *Male*: 3 × 2 mm., finely punctate, cervical grooves divergent, lateral grooves present, sexual orifice facing coxae II, coxae unarmed. *Female*: scutum 1 mm. long, broadening and rounded behind, anterior borders parallel.—Found by Marquis Doria on *Erinaceus algirus* at Gebel Resas, Tunisia, in 1881. Pavesi considers the tick allied to *H.*

concinna; it may be identical with this species as Neumann states (1897, p. 331). Neumann, 1909, p. 151, and 1911 *a*, p. 116, lists the species as doubtful.

flava as listed by Neumann since 1897, p. 333 = a confusion of species which may have included *H. flava* Nn., *H. campanulata* Warburton, and *H. japonica* Warburton, q.v.

flava armata (Neumann) Neumann, 1911 *a*, p. 112, a sub-species = *H. flava* Neumann, 1897, p. 333.

flava var. *armata* Neumann, 1905, p. 237 = *H. flava* Neumann, 1897, p. 333.

flava flava (Neumann) Neumann, 1911 *a*, p. 112, a sub-species = *H. japonica* Warburton, 1908.

gestroi (Supino, 1897) Neumann, 1897, p. 357 = *H. leachi* (Audouin, 1827). Neumann, 1902, p. 128, regarded the species as allied to *H. leachi*; Blanchard, 1909, p. 151, lists it as valid; Neumann, 1911 *a*, p. 115, lists it as a doubtful species.

hirudo L. Koch, 1877 *a*, p. 786, not figured. Undeterminable from the author's description; he may have been dealing with a *Haemaphysalis*; a ♀ from Japan. Neumann, 1897, p. 341, at first referred specimens of his own to Koch's species because they also came from Japan, but afterwards renamed them *H. concinna* var. *kochi* Neumann, 1905, p. 239, realizing that in the absence of the type, the species *hirudo* was purely nominal. We fully agree with Neumann with regard to the foregoing but do not recognize his var. *kochi* as valid (see text p. 456). *H. hirudo* is listed as a doubtful species by Blanchard, 1909, p. 151, and by Neumann, 1911 *a*, p. 116.

"*hystricis* Supino" in Neumann, 1902 *a*, p. 128, and 1911 *a*, p. 109 = *H. bispinosa* Neumann, 1897, p. 341.

japonnica Warburton, 1908, p. 512. Name misspelt; should read *H. japonica*.

lagotis (Gervais) of Neumann, 1901, p. 265 = merely a nominal species, for *Ixodes lagotis* Gervais, 1849, whilst it may have been a *Haemaphysalis*, was too poorly described to make this certain. Listed as a nominal species of *Haemaphysalis* by Blanchard, 1909, p. 152, and as a doubtful species by Neumann, 1911 *a*, p. 116.

leachi australis (Neumann) Neumann, 1911 *a*, p. 115, a sub-species = *H. leachi* (Audouin, 1827).

leachi var. *australis* Neumann, 1905, p. 238 = *H. leachi* (Audouin, 1827).

leachi leachi Neumann, 1911*a*, p. 114, a sub-species = *H. leachi* (Audouin, 1827).

"*leporis* Packard" in Rohr, 1909, pp. 144–146 (quotes Neumann's description) = *H. leporis-palustris* (Packard, 1869).

"*leporis* (Packard)" in Neumann, 1897, p. 343; 1901, p. 262 and 1911 *a*, p. 111 = *H. leporis-palustris* (Packard, 1869).

leporis var. *proxima* Aragão, 1911, p. 167, Pl. XI, Figs. 4, 5 (♂) = *H. leporis-palustris* (Packard, 1869).

"*leporis-palustris* Packard" in Hunter and Bishopp, 1911, p. 228 = *H. leporis-palustris* (Packard, 1869).

longicornis Neumann, 1901, p. 261; a doubtful species, see discussion above under *H. concinna longicornis* (Neumann).

longipalpis Warburton, XII. 1910, p. 399 = *H. aculeata* Lavarra, 1905, p. 255.

marmorata Berlese, 1887, Fasc. 47, No. 4, Pl. 11 (♂) = *Dermacentor reticulatus* (Fabricius, 1794).

micropla Canestrini, 1887, p. 104, Pl. IX, Figs. 3, 5; also in Berlese, 1888 = *Rhipicephalus microplus* (Canestrini) Canestrini, 1890, p. 493 = *Boophilus annulatus* var. *microplus* according to Neumann, 1901, p. 280.

neumanni Dönitz, 1905, pp. 127–129, Figs. 4–6 = *H. bispinosa* Neumann, 1897, p. 341.

neumanni Dönitz in Blanchard, 1909, p. 154 (merely listed); in Neumann, 1911*a*, p. 109; ? in Yakimoff and Kohl-Yakimoff, 1911, p. 418 = *H. bispinosa* Neumann, 1897, p. 341.

"*peregrina* Cambridge," listed as a doubtful species by Neumann, 1911 *a*, p. 116. See under *peregrinus*.

"*peregrinus* Cambridge" in Neumann, 1897, p. 327; see below.

peregrinus O. Pickard-Cambridge, 1889, p. 406, 2 figures. Description and figures useless; purely a nominal species. The author informed us that the types are lost. Included by Neumann, 1897, p. 327, in the synonymy of *H. punctata* (= *cinnabarina* var. *punctata*) without sufficient reason.

proxima Warburton and Nuttall, v. 1909, pp. 61, 62, Fig. 6 = *H. cornigera* Neumann, 1897, ♀.

"*proxima* Aragão" in Rohr, 1909, p. 146, Pl. I, Fig. 1 (♀), Pl. II, Figs. 12–14; Hooker, Bishopp and Wood, 1912, p. 89 (merely cite Rohr) = *H. leporis-palustris* (Packard, 1869).

punctata Canestrini and Fanzago, 1877, p. 188; repr. p. 120 (and other authors since) = *H. cinnabarina* var. *punctata* (Can. and Fan.) Nutt. and Warb.

punctata Can. and Fan. in Hadwen, 1912, p. 98 = *H. cinnabarina* Koch, 1844.

punctata cinnaberina (Koch, 1844) in Neumann, 1911 *a*, p. 108, a sub-species = *H. cinnabarina* var. *punctata* (Canestrini and Fanzago, 1877).

punctata var. *cinnaberina* (Koch) in Neumann, 1905, p. 237 = *H. cinnabarina* var. *punctata* (Can. and Fan.).

punctata punctata Canestrini and Fanzago, 1877, in Neumann, 1911 *a*, p. 107, a sub-species = *H. cinnabarina* var. *punctata* (Can. and Fan.).

rhinolophi Canestrini and Fanzago, 1877, p. 189, repr. p. 121; Canestrini, 1890, p. 526 = *H. cinnabarina* Koch, 1844. Listed as a valid species by Blanchard, 1909, p. 157, and as a doubtful species by Neumann, 1911 *a*, p. 116.

rosea Koch, 1844, p. 237; 1847, p. 121, Pl. XXVI, Figs. 95, 96 (♀) = probably *Boophilus annulatus* (Say, 1821) judging from the original description and figures. Neumann, 1897, p. 408, and 1901, p. 276, also refers *rosea* to that species. In the absence of the type the synonymy must remain in doubt.

"*rostralis* Dugès" in Banks, 1908, p. 54 (listed) = partly *H. leporis-palustris* (Packard, 1869) ♀. Refer to the synonymy of the latter species in our text p. 387 and under *Gonixodes*, p. 516.

sanguinolenta Koch, 1844, p. 237; 1847, p. 124, Pl. XXVII, Fig. 48 = *H. cinnabarina* Koch, 1844. Type (♀) examined by Nuttall in 1911. Listed as a valid species by Blanchard, 1909, p. 157, and as a doubtful species by Neumann, 1911 *a*, p. 116. Rohr, 1909, p. 146, merely copies from

Neumann (1897, p. 332) and calls the purported species "*sanguinolenta* Kock" (*sic*).

semermis Neumann, 1901, p. 263 (♂) = *H. hystricis* Supino, 1897. Nuttall examined the type.

spiniceps Warburton and Nuttall, 1909, p. 68 (♂) = *H. cornigera* Neumann, 1897, p. 350.

"*sulcata* Koch" in Canestrini and Fanzago, 1877, p. 189; reprint, p. 120; also in Berlese, 1889. Listed as a doubtful species by Neumann, 1911 *a*, p. 117. See further under the synonymy of *H. cinnabarina* var. *punctata* (Canestrini and Fanzago, 1877).

Gonixodes Dugès, 1888.

rostralis Dugès, 1888, p. 129, Fig. 2 (supposed ♂) = *H. leporis-palustris* (Packard, 1869) ♀ in Neumann, 1897, p. 343, whose attribution is probably correct, judging from Dugès' figure 2; Figs. 1 and 3 (the supposed larva and nymph) belong to another genus. See further under synonymy of *H. leporis-palustris*. Type: *G. rostralis*.

Herpetobia Canestrini, 1890.

sulcata Canestrini, 1890, pp. 486, 493, 527, Pl. XLI, Fig. 6 (adult, nymph, and larva) = "*Haemaphysalis sulcata* Koch" in Canestrini and Fanzago, 1877, p. 189 = probably *H. punctata* Can. and Fan., 1877 as Neumann, 1897, pp. 327, 329, supposes = *H. cinnabarina* var. *punctata* (Can. and Fan.). Type: *Herpetobia sulcata*.

Ixodes Latreille, 1795.

chelifer Mégnin, 1880, p. 132 (♂) = *H. concinna* Koch, 1844. Wrongly included by Canestrini, 1890, p. 526, in his synonymy of *H. punctata* (= *H. cinnabarina* var. *punctata* (Can. and Fan.)), as first pointed out by Neumann, 1897, p. 338.

chordeilis Packard, 1869, p. 67 = *H. cinnabarina* Koch, 1844; not *H. leporis* (Packard) as stated by Neumann, 1897, p. 343.

lagotis Gervais, 1849, p. 49 = merely a nominal species, the description being valueless but for the statement that the second palpal article is "dilatato a modo de espina." Stated to occur in the ears of *Lagostomus viscaccia*. See above under *Haemaphysalis lagotis* (Gervais) Neumann, 1901. Lahille, 1905, p. 44, notes in this connection that *L. viscaccia* of the Pampas does not live in Chili, and that Gervais' record probably refers to *L. peruanum* (Meyen) which occurs in the Sierras and in Argentina. Lahille has failed to find any ticks as yet upon *L. viscaccia* in the Pampas.

leachii Audouin, 1827, p. 428 = *H. leachi* (Audouin, 1827) Neumann, 1897, p. 347.

leporis-palustris Packard, 1869, p. 67 = *H. leporis-palustris* (Packard, 1869).

testudinarius Murray, 1877, p. 192, which Murray regards as = *Ixodes marginatus* Leach, is referred to the synonymy of *H. punctata* (= *cinnabarina* var. *punctata* Can. and Fan.) by Neumann, 1901, p. 260. This author bases his conclusion on a wretched figure of Murray's which in our opinion affords no evidence regarding the nature of the supposed species.

Opisthodon Canestrini, 1897.

asiaticus Supino, 1897 *a*; 1897 *b*, p. 252, Pl. XIII, Fig. 22 = *H. leachi* (Audouin, 1827). See further under synonymy of *H. leachi*.

canestrinii Supino, 1897 *a*; 1897 *b*, p. 252, Pl. XIII, Fig. 21 = *H. leachi* (Audouin, 1827). See further under synonymy of *H. leachi*.

cuscobius Canestrini, 1897, p. 468 = *H. cuscobia* (Canestrini) Neumann, 1897, p. 356. Described by Canestrini from one ♂ of which he gives the following characters: Size 2·0 × 1·1 mm., hypostome 5 | 5, tarsi 3 and 4 with two spurs; found by L. Biró on *Cuscus* sp., at Friedrich-Wilhelmshafen, New Guinea. This, the *type* of the author's genus *Opisthodon*, has been lost. The species is purely nominal.

gestroi Supino, 1897, p. 252, Pl. XIII, Fig. 23 = *H. leachi* (Audouin, 1827). See further under synonymy of *H. leachi*.

Prosopodon Canestrini, 1897.

cuscobius (Canestrini) Canestrini, 1897, p. 417 (footnote) = *H. cuscobia* (Canestrini) in Blanchard, 1909, p. 150. See above under *Opisthodon* the generic name which the author found was preoccupied and for which he substituted *Prosopodon*.

Rhipicephalus Koch, 1844.

ellipticus Koch, 1847, p. 135, Pl. XXX, Fig. 111. Species based on one ♀ from the Cape of Good Hope. Judging from the description and figure, we may safely conclude that the tick was *H. leachi* (Audouin, 1827); we agree in this with Neumann. See also under *Rhipistoma*.

expositicius L. Koch, 1877 *b*, p. 196 = most probably *H. cinnabarina* var. *punctata* (Can. and Fan.), judging from the description.

Rhipistoma Koch, 1844 (misspelt "*Rhipidostoma*" by Karsch, 1878, and Dugès, 1888, and "*Rhiphistoma*" by Osborn, 1896).

ellipticum Koch, 1844, p. 239 = *Rhipicephalus ellipticus* Koch, 1847, p. 135 (see above) = *H. leachi* (Audouin, 1827).

leachii in Koch, 1844, p. 239 (cites Savigny), and in Karsch, 1878, p. 337 = *H. leachi* (Audouin, 1827). The type of the genus *Rhipistoma*.

leporis in Osborn, 1896, p. 261 = *H. leporis-palustris* (Packard, 1869).

NOTES ON THE BIOLOGY OF HAEMAPHYSALIS

By G. H. F. NUTTALL.

Referring to the list of 50 species and varieties enumerated in the table at the end of this fasciculus, the table serving likewise as an index, the reader will find that the various stages of each species and variety known to science give the following figures: The

♂	♀	o	*L*	are known in	14	species and varieties.
♂	♀	o		,, ,, ,,	4	,, ,, ,,
♂	♀			,, ,, ,,	18	,, ,, ,,
♂		o		,, ,, ,,	1	,, ,, ,,
♂	only			,, ,, ,,	8	,, ,, ,,
♀	,,			,, ,, ,,	5	,, ,, ,,

It follows that these species and varieties are known by 45 ♂, 41 ♀, 19 o, and 14 *L*.

By referring to Part II, p. 295, it will be seen that 51 species and varieties of *Ixodes* are known by 21 ♂, 48 ♀, 22 o and 14 *L*. These figures show that a marked difference exists between the two genera. The number of ♂s of *Haemaphysalis* which are known is slightly greater than that of the ♀s, this being evidently due to the habit of the ♂s to remain upon the host which the ♀s have abandoned; this habit is also indicated by certain field observations on *H. cinnabarina* var. *punctata*, *H. concinna* and *H. inermis*, where ♂s only have been at times found upon the host. In *Ixodes* on the other hand, some ♂s do not attack the host (see Part II, pp. 334–345), and this accounts for the preponderance of ♀s that are known to science, although the ♂s of some species frequently occur in copula upon the host and abandon the latter together with the ♀.

Reference to pp. 507–511, where we have listed the *hosts* upon which *Haemaphysalis* occur, seems to show that the members of this genus are less specialized in respect to hosts than are *Ixodes*.

The life-history, in *Haemaphysalis*, appears to agree in the main with that outlined for *Ixodes* (see Part II, p. 295) but it is impossible to generalize since we only know the life-history of six species and varieties of *Haemaphysalis*, and in *H. inermis* we have a species whose life-history, in the present state of our knowledge, is unique amongst the Ixodoidea.

In the following pages an account is given of all that is known regarding the biology of six species:

of which numbers 1 and 4 have been proved to be the carriers of pathogenic Protozoa.

Haemaphysalis cinnabarina var. punctata[1].

The only authors who have occupied themselves with the biology of this species are the writer (1908) and Stockman (1911, pp. 23–32); a detailed study of the external anatomy has been published by Nuttall, Cooper and Robinson (1908). The hosts upon which the tick is found are given on pp. 508, 509. The species was first raised by me on hedgehogs, this animal having been found to serve as a host in nature. The rabbit and sheep were also used as hosts. The tick occurs most commonly on sheep, and between 1902 and 1905 we received large numbers from Kent, especially from the districts surrounding Lydd and Canterbury. We have also received specimens found on goats and ferrets, but we have no record of its occurrence on cattle in England. It is interesting therefore that McFadyean and Stockman were able to transmit British redwater, due to *Piroplasma divergens*, to cattle by means of this tick, although it can but play an unimportant part in transmitting the disease in Europe, *Ixodes ricinus* being certainly the chief vector.

Stockman raised *H. cinnabarina* var. *punctata* upon the scrotum and ears, using cattle and sheep as hosts, the usual method of placing bags about the scrotum and ears being employed to recover the ticks as they dropped from the host. None of Stockman's ticks were incubated during metamorphosis; they were maintained in corked bottles and glass dishes in an unheated outhouse, moulds being avoided by keeping the ticks somewhat drier than under natural conditions. The results of his raising experiments are fully referred to and incorporated in the following pages, the author's name being given in all cases where he is

[1] Reprinted (with slight modifications and certain additions duly indicated) from Nuttall, IV. 1913, pp. 99–105.

cited. Stockman's records were somewhat confused and it was not always easy to extract the desired information from them.

Seasonal occurrence on hosts. The specimens which have reached us have been adults collected in April. According to Stockman, in Kent and Devon, engorged females are found on sheep in April–June, in October and occasionally at other times of the year; engorged nymphs were found in May and August. Judging from observations at the Alperton laboratory on material collected at various times in the field, the ticks not being incubated during metamorphosis, Stockman concludes that larvae which feed and moult up to May, nymphs which feed and moult up to July, and adult females which feed and oviposit up to August, are all derived from eggs hatched the previous year. The larvae which hatch out, feed, and moult from July onwards, the nymphs which feed and moult from August onwards, and the adults which feed from October onwards are presumably all derived from eggs of the same year. All eggs laid in February, May and June hatched in July and August. Stockman believes that in nature the different stages emerge and feed as follows: the larvae do so chiefly in July and August, the nymphs in August–October, the females in October–November, but all stages may hibernate (fed or unfed) and appear on hosts in the spring. The females oviposit mainly in the spring. Starting with eggs laid in the spring, the ticks, according to Stockman, probably pass the next winter as gorged nymphs, and feed as adults in April–May of the following year, the cycle presumably lasting about 290 days.

Further observations made in the field appear to me required before definite conclusions can be arrived at; until such observations are made Stockman's hypothesis, based almost purely on laboratory experience, can scarcely be accepted.

The time H. cinnabarina var. punctata remains upon the host. (Nuttall.)

No. of Lot	Host	Date when put on host	Host maintained at a temp. of	Number of gorged ticks collected on succeeding days	Remarks
Larvae.					
1	Hedgehog	12. VI. 1905	17° C.	18 on day 3	—
				333 ,, 4	
				120 ,, 5–6	
				10 ,, 7	

No. of Lot	Host	Date when put on host	Host maintained at a temp. of	Number of gorged ticks collected on succeeding days	Remarks
Larvae.					
2	Hedgehog	15. VI. 1905	17° C.	10 on day 4	—
				151 ,, 5	
				707 ,, 6	
				330 ,, 7	
				78 ,, 8	
				61 ,, 9–10	
3	,,	8. VIII. 1905	16° C.	36 ,, 4	—
				477 ,, 5–6	
				142 ,, 7	
				66 ,, 8–9	
				40 ,, 10	
				15 ,, 11	
4	,,	17. XI. 1905	10° C.	10 ,, 21	—
5	,,	28. XI. 1905	12° C.	21 ,, 13	—
				30 ,, 15	
				18 ,, 16	
6	,,	19. XII. 1905	12° C.	2 ,, 7	—
				7 ,, 8–13	
				5 ,, 14–19	
7	Rabbit	2. VI. 1905	17° C.	3 ,, 13	—
				5 ,, 14	
				4 ,, 15	
8	,,	6. VI. 1905	17° C.	116 ,, 7	—
				119 ,, 8	—
				30 ,, 9	—
9[1]	Sheep	27. VI. 1914	17° C.	60 ,, 6	—
				90 ,, 7	
				33 ,, 8	
				5 ,, 9	
Nymphs.					
1	Hedgehog	29. VII. 1905	20° C.	152 by day 12	—
2	,,	3. XII. 1905	12° C.	33 ,, 25–27	—
3	,,	19. XII. 1905	12° C.	4 on day 13	(34 lost).
				1 ,, 14	
				1 ,, 20	
4	,,	22. I. 1906	8° C.	1 ,, 32	(22 lost).
				1 ,, 33	
5	,,	17. III. 1906	11° C.	7 ,, 11	(5 lost).
				11 ,, 12	
				1 ,, 13	
				4 ,, 14–17	
				8 ,, 18–20	
				11 ,, 21–29	

[1] Added to previously published record.

No. of Lot	Host	Date when put on host	Host maintained at a temp. of	Number of gorged ticks collected on succeeding days	Remarks
Nymphs.					
6	Hedgehog	11. IV. 1906	12° C.	7 on day 9	(33 lost).
7	,,	14. V. 1906	13° C.	3 ,, 7	(13 lost).
				10 ,, 8	
				4 ,, 9	
Adults (♀).					
1	Hedgehog	9–11. IX. 1905	12° C.	1 ,, 14	Put on with males, none lost.
				1 ,, 17	
				3 ,, 18	

Conclusions from the foregoing protocol regarding the time *H. cinnabarina* var. *punctata* remains upon the host:

Larvae placed upon a hedgehog in June–August, the host being maintained at 16–17° C., remain 3–11 days upon the host, the majority dropping off gorged after 4–7 days. In November–December, the temperature being 10–12° C., they remain upon the host 7–21 days, the majority dropping off gorged after 13–21 days. When placed on rabbits and sheep in June, at 17° C. they drop off gorged after 6–15 days.

Nymphs, placed on hedgehogs at 20° C., all dropped off by day 12; at 11–13° C. they dropped off after 7–29 days; at 8° C. after 32–33 days.

Adults (♀) remained upon the hedgehog at 12° C. for 14–18 days.

Note:—Stockman (1911), who raised *H. cinnabarina* var. *punctata* on cattle and sheep, records that,

	Remain on host	Average period
Larvae	4—12 days	5— 9 days
Nymphs	4—17	4—13
Adults	6—30	9—22

The time required by H. cinnabarina var. punctata for metamorphosis.

In the protocols dealing with this section I include those of Stockman with my own:

Egg to Larva.

Observer	No.	Date when first eggs were laid	Date when first larvae appeared	Time required for metamorphosis (days)	Temperature	Remarks
Nuttall	1	4. IV. 1905	25. VI. 1905	82	14° C.	——
Stockman	16/3	20. V. 1907	2. VIII. 1907	74	—	——
,,	—	—	—	38	—	The shortest time observed.

Larva to Nymph.

Observer	No.	Date when larvae gorged on host	Date when nymphs emerged	Time required for metamorphosis (days)	Temperature	Remarks
Nuttall	1	26. XII. 1905	8. V. 1906	159	10° C.	Host: hedgehog.
,,	2	1. I. 1906	2. VI. 1906	153	10° C.	,, ,,
Stockman	53	30. VII. 1907	15. III. 1908	197		Hibernation at outside temperature.
,,	32	30. VIII. 1907	29. IV. 1908	242		
,,	33	30. VIII. 1907	30. IV. 1908	243		
,,	—	—	—	14	—	The shortest time observed; the average time stated to be 16–29 days.

Nymph to Adult.

Observer	No.	Date when nymphs gorged on host	Date when adults emerged	Time required for metamorphosis (days)	Temperature	Remarks
Nuttall	1	10. VIII. 1905	28. VIII. 1905	18	At room temp., then at 30° C. during last 3 days	Host: hedgehog.
,,	2	8. XII. 1905	13. I. 1906	36	—	Host: dog.
,,	3	1. I. 1906	17. IV. 1906	107	9° C.	Host: hedgehog.
,,	4	28. III. 1906	14. IV. 1906	17–26	At room temp., then at 30° C. during last 14 days	,, ,,
Stockman	26	27. IX. 1907	23. VII. 1908	229	—	Hibernation at outside temp., a number survived winter but died without moulting.
,,	27	30. III. 1908	15. IV. 1908	15	—	——
,,	—	—	—	7	—	The shortest time observed.

Longevity of unfed H. cinnabarina var. punctata.

The following protocols include Stockman's observations as well as my own, the latter being but few:

Larvae.

Observer	No.	Date when emerged from eggs	Date to which larvae survived	Longevity unfed (days)	Remarks
Stockman	16/3	2. VIII. 1907	1. VI. 1908	303	This being the maximum period in 1 out of 9 lots.

Nymphs.

Observer	No.	Date of emergence	Date to which nymphs survived	Longevity unfed (days)	Remarks
Nuttall	1	3. VI. 1906	25. IX. 1906	114	At 16° C. Most of the lot were dead.
,,	2	12. VII. 1914	12. IX. 1914	62	At ca. 16° C.; all in 90 days[1].
Stockman	30	20. X. 1907	11. III. 1908	142	Hibernated at outside temperature.
,,	27	29. IX. 1907	30. III. 1908	182	Ditto, and after starving 182 days raised to adults.
,,	53	16. X. 1907	1. V. 1908	197	Hibernated at outside temperature.
,,	32	12. X. 1907	30. IV. 1908	200	
,,	21	12. IX. 1907	3. IV. 1908	203	
,,	29	20. IX. 1907	30. V. 1908	252	

[1] Record since added.

Adults.

Observer	No.	Date of emergence	Date to which adults survived	Longevity unfed (days)	Remarks
Nuttall	1	13. I. 1906	—	255	At 12° C. Lived longer, death not noted.
,,	2	18. IV. 1906	—	160	,, ,, ,,
Stockman	16/4	6. IX. 1906	18. IV. 1907	224	At outside temp., feeble when state recorded.

Oviposition.

The manner in which the female *H. cinnabarina* var. *punctata* lays her eggs was illustrated by me in the Harben Lectures 1908, p. 398, but I kept no records of the time it takes for the tick to oviposit and did not count the number of eggs laid by single females. Judging from memory a female would lay 3000–5000. When the opportunity arises I shall have enumerations made. Apart from this the only other observations recorded are those of Stockman which are likewise incomplete. He states that the shortest and longest times which elapsed before oviposition commenced were 10 and 211 days respectively, the female usually ovipositing 24–29 days after abandoning the host. Some gorged females (Lot 27) survived 216 days without ovipositing. He gives no temperature records in his protocols; the only records with dates are the following:

Stockman No.	Female dropped from host	Eggs first laid on	Oviposition commenced after
16/3	12. XI. 1906	20. V. 1907	189 days
16/4	12. X. 1906	15. II. 1907	124 ,,

Stockman does not state how long oviposition lasts, but he says that the process may be interrupted with the onset of cold weather and resumed when the weather is warm.

The following description of the process of oviposition in *H. cinnabarina* var. *punctata* is quoted from Nuttall (VII. 1908, p. 398): "In the accompanying figure (Fig. 450) I have illustrated the successive stages I have observed in the process of oviposition in *Haemaphysalis*. Prior to oviposition the capitulum is retracted so that it lies in a depression beneath the scutum, the vulva approaching the capitulum. When about to oviposit, a remarkable organ (which I named 'Gené's organ,' after its discoverer) is protruded between the scutum and capitulum. The organ appears in the form of two vesicles containing hyaline secretion, the vesicles being protruded and retracted rhythmically whilst being completely extruded. When Gené's organ

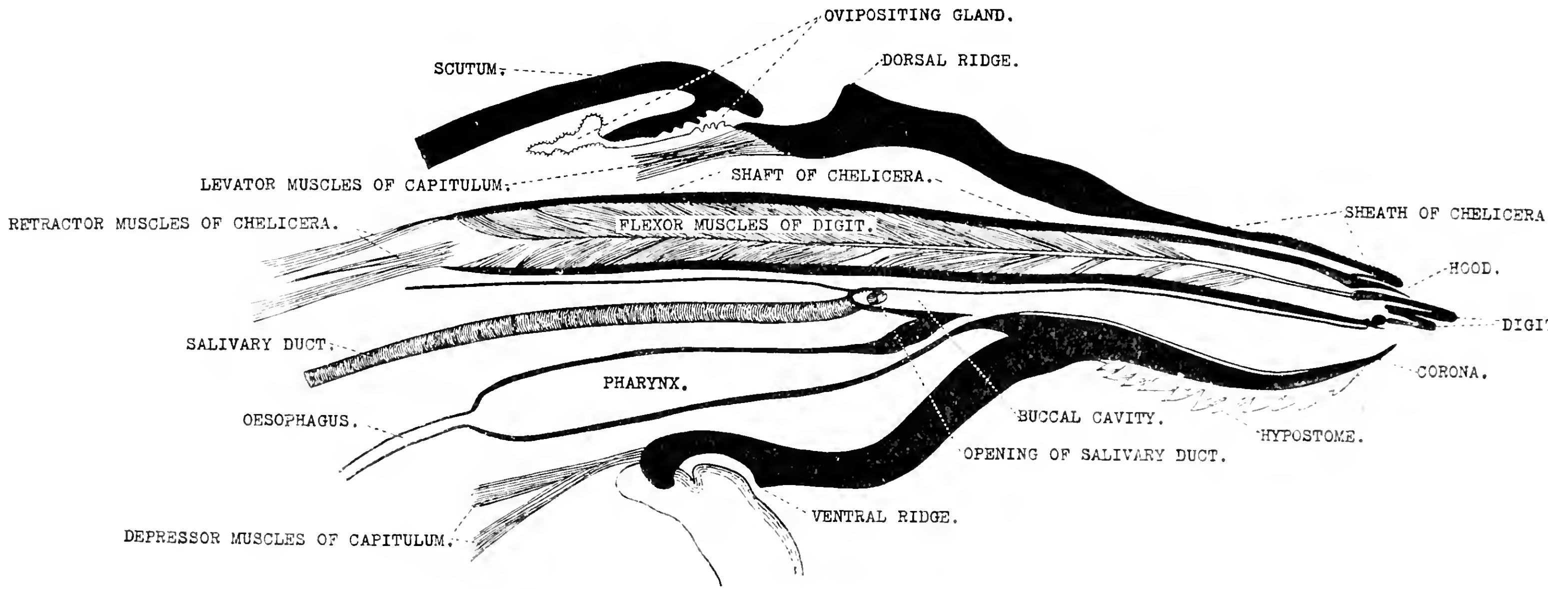


Fig. 449. *Haemaphysalis cinnabarina* var. *punctata* ♀. Median longitudinal section through the capitulum showing the relations between the internal and external parts. Slightly schematized. The "ovipositing gland" of the figure is Gené's organ. Nuttall, Cooper and Robinson, 1908, Fig. 6. G. H. F. N. and L. E. R. del.

appears, the capitulum is depressed (Fig. 450 at 2) and the vulva is arched upwards. The capitulum next disappears in the depth of the pit, and the ovipositor protrudes from the vulva through being evaginated (3). The two halves or vesicles of Gené's organ grow in size and show two glove-finger-like processes (4–8). The ovipositor grows in length, forcing apart the vesicles (5), and the egg appears (6) and is protruded (7), after which the ovipositor is quickly retracted (8), the egg being left between the vesicles and the capitulum reappearing beneath. Next (9), the vesicles begin to collapse and disappear (10), leaving the egg resting upon the back of the capitulum, which presently is tossed backward (11), so as to 'shovel' the egg upward and backward upon the scutum. The capitulum is then slowly depressed (12), and Gené's organ reappears prior to the laying of another egg. It takes two to four minutes to lay an egg, the intervals between ovipositions varying somewhat in length. This process is repeated for each egg, and entails a good deal of labour."

In Fig. 449 the position of Gené's organ ("ovipositing gland") is shown in a schematized longitudinal section through the capitulum of the female.

Summary.

Haemaphysalis cinnabarina var. *punctata* seeks a host three times, feeding thereon in the larval, nymphal and adult stages. It readily attaches itself to the host 4–12 days after each ecdysis and is easily reared under experimental conditions upon hedgehogs, rabbits, sheep, cattle and ferrets. The larvae usually remain upon the host 4–7 days, although they may remain attached anywhere from 3 to 19 days. The nymphs usually remain attached for about a week, but this period of attachment may range from 4 to 33 days. Adult females remain attached for 6 to 22 days, the longer stay upon the host is doubtless due to their waiting to be fertilized. Males and females both behave like those of *H. leachi*, *q.v.* My observations suggest that when a hedgehog (hibernating host) is maintained a ta low temperature, the larvae and nymphs remain somewhat longer upon the host than in warm weather. The time required for metamorphosis is governed by temperature, being much prolonged by cold. The larvae may hatch from the egg after 38 days (Stockman's shortest time) to 82 days (at 14 C., Nuttall); the nymphs may emerge after 14 days (Stockman's minimum) to 159 days (at 10 C., Nuttall) or after as long a period as 243 days (Stockman's maximum); the adults emerge after 7 to 229

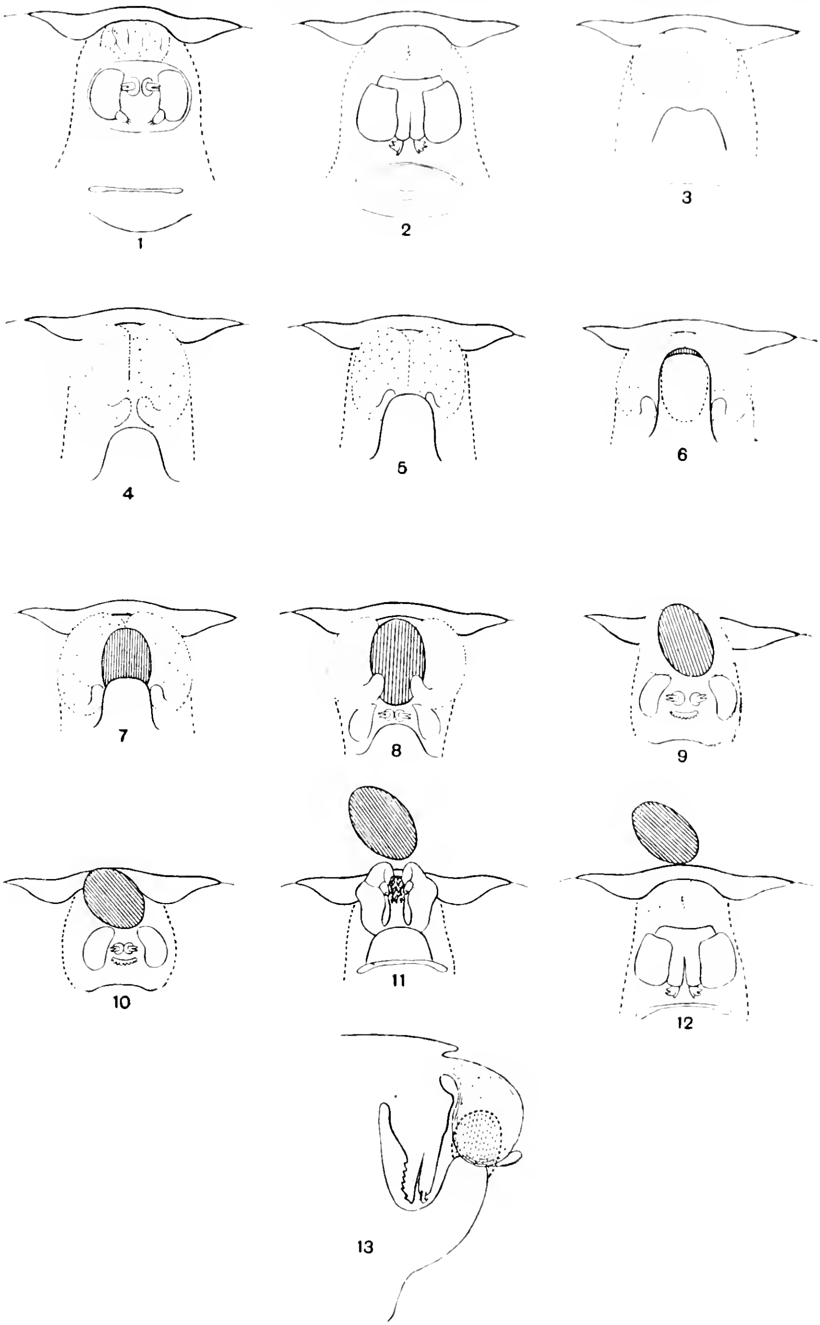


Fig. 450. Illustrating the mechanism of oviposition observed in *H. cinnabarina* var. *punctata*. For description see text. (13) is a schematic sketch. Drawn from living specimens so as to show the different stages of the process in sequence. (Nuttall, 1908, p. 399.)

days (Stockman's minimum and maximum); my observations show a range of 17 days (at 30° C.) to 107 days (at 9° C.). The longevity of the unfed tick is very marked; the records of Stockman and the writer show that larvae may survive for 303 days, nymphs for 252 days, adults 255 days; all stages are therefore able to hibernate readily in this condition. The time which elapses between the dropping of the gorged female from the host and the commencement of oviposition is markedly influenced by temperature, ranging accordingly from 10 to 211 days (Stockman). Data are lacking as to the duration of oviposition and the number of eggs laid by single females.

In nature, the tick will probably be able to complete its life cycle in a year but it may well run into two years in our climate. Taking average figures from the data recorded above, the cycle may be completed in 125 days, but the developmental period may of course be much prolonged:

	Time required in days
From the time egg is laid to emergence of larva ...	38
Larva hardens	7
Larva stays on host	6
Metamorphosis: Larva to Nymph	14
Nymph hardens	7
Nymph stays on host	7
Metamorphosis: Nymph to Adult	15
Adult hardens	7
Adult (♀) stays on host	14
Gorged ♀ after dropping off host, begins to lay after ...	10
	125 days

Haemaphysalis cinnabarina.

This tick requires three hosts upon which to feed as a larva, nymph and adult. The first to raise the tick were Hooker, Bishopp and Wood (1912, p. 98), who state that the *larvae* feed 5–12 days on rabbits or guinea-pigs; they twice failed to feed on fowls. Metamorphosis from larva to nymph takes 14 days at 79° F. or 76 days at 54° F. Some unfed *nymphs* lived up to 55–75 days. Nymphs, placed on cattle, fed for 5–8 days, and then underwent metamorphosis to adults in 26 days at 68° F., or in 186 days at 60° F. (average temperature). *Adults* survived unfed for 100–305 days. A female (probably unfertilized) remained for 19 days upon an ox; she then dropped off replete and survived for 172 days, but did not oviposit.

The following observations were made by me in Cambridge with the progeny of 2 ♀ (N. 2452) taken from *cattle* in Winnipeg, Canada, and for which I am indebted to Mr J. R. N. Harrison. The ticks were raised on rabbits in experimental cages at room temperature (about 15° C.) in the laboratory. The ticks were kept in an incubator at 30° C. during metamorphosis.

The recently emerged larvae were placed on a rabbit on 27. XI. 1913:

No. of gorged larvae collected on successive days		
7	on day	5
270	,,	6
560	,,	7
306	,,	8
160	,,	9
98	,,	10
51	,,	11
15	,,	12
12	,,	13

The first nymphs emerged on 11. XII. 1913, i.e., metamorphosis from larva to nymph lasted 10–11 days at 30° C. (86° F.). On 6. I. 1914 the nymphs (100) were placed on a rabbit:

No. of gorged nymphs collected on successive days		
3	on day	8
1	,,	9
3	,,	11
5	,,	12
1	,,	13
2	,,	14
3	,,	15
2	,,	17

The first adults emerged on 10. II. 1914, i.e., metamorphosis from nymph to adult lasted 28 days at 30° C.

My results accord with those of the American authors, but the nymphs remained longer upon the host.

Longevity of unfed ticks.

Larvae which emerged 7. XI. 1913, died after 43 days. *Nymphs* which emerged 11. XII. 1913, died after 34 days (at room temperature).

Haemaphysalis leporis-palustris.

The life-history of this species has been studied experimentally by Hunter and Hooker (1907, pp. 53–54), Hooker (1908, pp. 47–48), Rohr (1909, pp. 100–110), Hunter and Bishopp (1911, pp. 228–229), Hooker, Bishopp and Wood (1912, pp. 90–96), and Hadwen (1912, pp. 97–98). Rohr's observations were made in Brazil, his "*Haemaphysalis proxima*" having been found on wild rabbits and agouti; Hadwen studied the species in Canada, specimens having been collected in Manitoba and British Columbia from *Lepus americanus*; the remaining authors' investigations were carried out in Dallas, Texas. In the following pages I have sought to arrange the data supplied by these authors so as to present them in a uniform manner. A summary will be found at the end of the section.

Time the tick remains upon the host.

Larvae: drop off gorged beginning on the 5th day according to Hooker (in October in Texas; host not stated). Rohr found that they remain 6–11 days on the rabbit, he records an experiment in Brazil, as follows:

6th day	10	larvae dropped off gorged
7 ,,	139	,, ,, ,,
8 ,,	151	,, ,, ,,
9 ,,	60	,, ,, ,,
10 ,,	24	,, ,, ,,
11 ,,	5	,, ,, ,,
12 ,,	0	no more collected
Total	389	

Hooker, Bishopp and Wood give two experiments on rabbits and on cattle:

	Rabbit I	Rabbit II	Cattle	
4th day	0	5	0	larvae dropped off gorged
5 ,,	25	77	19	,, ,, ,,
6 ,,	27	71	75	,, ,, ,,
7 ,,	33	29	27	,, ,, ,,
8 ,,	7	5	11	,, ,, ,,
9 ,,	5	1	2	,, ,, ,,
10 ,,	1	4	0	,, ,, ,,
Totals	98	192	134	

Hadwen placed larvae on a tame rabbit (in Canada 12. IV. 1912) with the following results:

6th	day	10	larvae dropped off gorged
7	,,	44	,, ,, ,,
8	,,	17	,, ,, ,,
9–10	,,	36	,, ,, ,,
Total		107	

Nymphs: drop off gorged on the 6th day (from rabbit?) according to Hooker. Rohr states that they remain 6–11 days on rabbits and he records an experiment as follows:

6th	day	3	nymphs dropped off gorged
7	,,	12	,, ,, ,,
8	,,	48	,, ,, ,,
9	,,	11	,, ,, ,,
10	,,	5	,, ,, ,,
11	,,	3	,, ,, ,,
12	,,	0	no more collected

Hooker, Bishopp and Wood state that the nymphs remain 4–8 days on the host, mostly 5–6 days; they carried out 4 experiments. Hadwen placed 32 nymphs on a tame rabbit and 4 dropped off gorged after 6–7 days.

Adults: according to Rohr, the ♀ remains 19–25 days on the rabbit before it drops off gorged, whereas the ♂ remains on the host long after the ♀ has left. Dead ♂s are commonly found attached to the host's skin. Hooker, Bishopp and Wood had difficulties in studying the adults; they only record the behaviour of 2 ♀ which dropped off gorged on the 19th and 21st day respectively.

Time required for metamorphosis.

Egg to Larva: reckoned from the time the eggs are laid, according to Rohr, the larvae emerge after

47–61 days at ca. 21–22° C. (15 observations)
22–29 ,, ,, 30° C. (3 ,,)
none hatched out at 35° C.

Hooker, Bishopp and Wood record that larvae emerge after

22	days	at ca.	32° C.	(out of doors in VI.–VII. 1909)
23	,,	,,	28° C.	(in laboratory in VI.–VII.)
34	,,	,,	28° C.	(,, ,, V.–VI.)
24	,,	,,	25° C.	(,, ,, IX. 1907)
24	,,	,,	25° C.	(,, ,, IX. 1907)
34	,,	,,	25° C.	(,, ,, V.–VI. 1910)

Hadwen found that the larvae emerged 47 days after the eggs were laid in May 1910; in 45 days after the eggs were laid in July 1911. Hunter and Hooker (1907) state that metamorphosis lasted 24–31 days in May–September.

Larva to Nymph: reckoned from the time the larvae drop off gorged from the host, Rohr found that the nymphs emerged after

15–22	days at ca.	20–21° C.	(5 observations)
8–12	,, ,,	26–27° C.	(5 ,,)
7–9	,, ,,	30° C.	(3 ,,)

the ticks died without moulting at 35° C.

Hooker, Bishopp and Wood record that the nymphs emerged after

18	days at ca.	20° C.	(in March)
134	,, ,,	16·5° C.	(in November)

Hooker gives 18 days as the time required for metamorphosis in October.

Nymph to Adult: reckoned from the time the gorged nymphs abandon the host, Rohr found that the adults emerge after

19–26	days at ca.	20–22° C.
10–17	,, ,,	27° C.

Hooker, Bishopp and Wood record that the adults emerge after

14	days at ca.	28° C.	(June 1908)
89	,, ,,	15° C.	(,,)
124	,,	was the longest period observed	

These authors noted no difference between the ♂ and ♀ in respect to the time required for metamorphosis. Hadwen records that from 12 gorged nymphs there emerged 2 adults after 53 days, and 1 adult after 58 days, in July–September, 1911.

Longevity of unfed ticks.

Larvae: Hooker, Bishopp and Wood found that larvae which emerged early in the summer, died in about 60 days; others which emerged in June, 1906, survived up to 258 days.

Nymphs: these survived, in three experiments, for 78, 246 and 307 days respectively, the ticks being kept in the laboratory. Specimens taken from a rabbit survived for 342 days.

Adults: a ♂ lived for 403 days, a ♀ for 588 days, both having emerged in May.

Oviposition.

According to Rohr, the gorged and fecundated females begin to oviposit after

2– 5 days, and oviposition lasts 14–21 days at ca. 21° C.
13–15 ,, ,, ,, 31–57 ,, ,, 15° C.
The female dies without ovipositing when maintained at 0° C.

Hooker, Bishopp and Wood state that females begin to oviposit 3–15 days after they abandon the host, i.e. after

3 days at ca. 32° C. (June 1910)
15 ,, ,, 20° C. (March 1910)
8 days in the spring and summer being the average for 25 ♀s observed

According to Hadwen the female begins to oviposit after

18 days (1 ♀ in May 1910)
8 ,, (1 ♀ ,, ,, 1911)
6 ,, (1 ♀ ,, July 1911)

The number of eggs laid per female varies as follows:

Hunter and Hooker record that a ♀ laid 1112 eggs; they give such small numbers of eggs as having been laid by three other females that I conclude they must have been disturbed or that they were imperfectly gorged specimens.

Rohr's observations are given in detail. The largest number of eggs laid by one of five females was 2389; about 1820 would represent the average number. The most replete females lay the most eggs. The number of eggs laid per day, varied from 2 to 287; larger numbers per day were laid when the females were maintained at a higher temperature. We select two examples out of five tabulated by Rohr as showing the number of eggs laid by two females on successive days. The first tick began to oviposit on the 5th day and died within 24 hours after oviposition had ceased as indicated by the +.

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	—	—	—	—	46	75	79	112	158	178	148	176	172	187	118	82	134	76	49	27	19	2	+	—	—
	—	—	52	298	148	105	46	171	236	161	209	92	225	135	99	159	132	58	84	44	23	22	10	—	+

Totals 1830 and 2389 respectively.

The female usually dies 0–4 days after oviposition has ceased (at 21° C.), but she may survive 2–28 days at a lower temperature (15° C.).

Hooker, Bishopp and Wood record that 8 females laid 59–2240 eggs apiece, averaging 1517; they also note that the most gorged females lay the most eggs. One female oviposited for 20 days, the maximum number of eggs laid per day being 303. Females survive 0–5 days after oviposition has ceased.

Weights and measurements.

Rohr gives a number of data which I have compressed in tabular form as follows:

	Weight in mgr.	Average of	Size in mm.	Average of
Egg	0·07	1000	0·58 × 0·49	10
Larva: unfed	0·055	200	0·72 × 0·52	
,, replete	0·35	—	1·25 × 0·93	
Nymph: unfed	0·2	20	1·22 × 0·85	
,, replete	2·0	—	2·16 × 1·47	
Male: unfed	0·67	10	1·86 × 1·28	
,, fed	0·70	—	2·0 × 1·28	
Female: unfed	1·10	10	3·87 × 1·37	
,, replete	349·0	—	10 × 7·5 × 6·0	

The foregoing measurements are of the length × breadth × thickness; in the case of the gorged female only the largest size and weight attained is given.

A female which weighed 334·5 mgr. laid 1853 eggs, and, after oviposition had ceased, she weighed 78 mgr. Hooker, Bishopp and Wood note that a female which laid 2240 eggs measured 11·3 × 7·5 × 5·3 mm.

Insect enemies.

Ixodiphagus texanus L. O. Howard (1907, p. 375) was first discovered in engorged nymphs of *H. leporis-palustris* taken from wild rabbits in March and May, 1907, in Jackson County, Texas, by J. D. Mitchell.

Summary and Remarks.

H. leporis-palustris requires three hosts upon which to feed in the larval, nymphal and adult stages respectively, as was first shown by Hunter and Hooker (1907), who state that it attacks wild rabbits in such numbers in Montana, U.S.A., that the animals may be weakened and thus rendered easy to capture. The larvae remain upon the host for 4–11 days, the majority taking 7–8 days to gorge; nymphs remain attached for 4–11, the majority gorging in 6–8 days. The males persist upon the host which the females have abandoned; they may die whilst attached to the skin. Rohr states that copulation must take place at night upon the host as he has never succeeded in observing the process by day. The female remains attached to the host 17–25 days. The time required for metamorphosis is influenced by temperature: Larvae emerge from the egg after 22–29 days at 30° C., or after 47–61 days at ca. 22° C.; nymphs emerge after 7–9 days at 30° C., or after 134 days at 16·5° C.; adults emerge after 10–17 days at 27° C. or after 89 days at

15° C., in one case they only emerged after 124 days. Longevity of unfed ticks: larvae survived 258 days, nymphs up to 342 days, a male and female lived up to 403 and 588 days respectively. Oviposition commences 2–18 days after the female has abandoned the host, the process lasting 14–57 days according to the surrounding temperature; oviposition does not occur at 0° C. The female dies 0–28 days after she has ceased laying her quota of eggs. The normal number of eggs appears to be 1800–2400, laid at the maximum rate of about 300 in 24 hours.

Hooker states, from personal observation, that large numbers of larvae and lesser numbers of nymphs, when replete, abandon the host during the daytime. He regards this as a remarkable adaptation of the tick to the habits of their usual hosts, the hare and rabbit. These remain during the daytime in their resting places or "forms" and roam at night. The gorged ticks, dropping from the host in the forms, undergo metamorphosis in a situation which favours their finding a host when they emerge and are ready to feed. The observation is certainly suggestive and it would be interesting to learn if other species of ticks behave in a similar manner. The ticks usually attach themselves about the ears and heads of rabbits.

Laboratory experiments by the authors quoted above (p. 530), indicate that *H. leporis-palustris* may, under favourable conditions, complete its life-cycle once or twice in a year. This supposition is strengthened by the statement of Hooker, Bishopp and Wood that all stages occur at all seasons upon their hosts in nature in the United States.

Judging from the foregoing data the life-cycle may be completed in 87 to 405 days, as follows:

	Time required in days: Minimum	Time required in days: Maximum
From the time the egg is laid to the emergence of the larva	22 (at 30° C.)	61 (at 22° C.)
Larva hardens	7	7
Larva stays on host	4	11
Metamorphosis: Larva to Nymph	7 (at 30° C.)	134 (at 16·5° C.)
Nymph hardens	7	7
Nymph stays on the host	4	11
Metamorphosis: Nymph to Adult	10 (at 27° C.)	124 (at ?° C.)
Adult hardens	7	7
Adult (♀) stays on host	17	25
Gorged ♀, having dropped from the host, begins to lay eggs after	2 (at 21° C.)	18 (at ?° C.)
Totals	87 to	405 days

Haemaphysalis leachi[1].

Mr Charles P. Lounsbury, Union Entomologist, South Africa, was the first to raise this tick experimentally and to demonstrate that it transmits canine piroplasmosis in Africa. The protocols of his experiments (1901, pp. 5–6; 1902, pp. 5–7; 1904, pp. 27–29) give the main points in the life-history of the species. From his brief statements regarding the tick, the following data are abstracted:

H. leachi is a three-host tick. The larvae and nymphs may drop off gorged from the host as early as 48 hours after being put on. The female remains upon the host for 9 days (minimum) to 12–15 days. The time required for metamorphosis from egg to larva is 30–46 days in summer and 80–110 days in winter; the nymph emerges from the larval skin in 10–12 days in summer; the adult emerges from the nymphal skin in 18–20 days in summer and 70–105 days in winter. A female laid 4200 eggs. The males remain upon the host for many weeks, they release their hold upon the skin of the host and seek the females. By using an incubator he hastened the process of metamorphosis so that he was able to raise three generations in a year. The tick abandons the dying host.

The following records relate (*a*) to ticks received in 1902–1906 from Mr Lounsbury, Cape Colony, S. Africa (they were used for infection of dogs with *Piroplasma canis*), and (*b*) to ticks received 23. III. 1912 from Mr R. E. Montgomery, Nairobi, B. E. Africa. The last named were the progeny (larval stage) of two replete females collected beneath a box in which a jackal had been kept. The first and second generations raised in the laboratory are numbered respectively 1737 I and 1737 II.

The time H. leachi remains upon the host.

Host	No. of Lot	Date when put on host	Host maintained at a temperature of	Number of gorged ticks collected on succeeding days	Remarks
Larvae.					
Hedgehog	10	10. x. 1905	10° C.	126 on day 4	—
				250 ,, 5	
,,	11	18. x. 1905	9° C.	104 ,, 5	—
				6 ,, 6	
,,	12	28. x. 1905	9° C.	6 ,, 6	—

[1] Reprinted, with slight changes and additions, from Nuttall, IV. 1913, pp. 93–99.

Host	No. of Lot	Date when put on host	Host maintained at a temperature of	Number of gorged ticks collected on succeeding days	Remarks
Larvae.					
Hedgehog	...	16. XI. 1906		19 on day 4	—
				17 ,, 5	
				6 ,, 6	
				7 ,, 7	
				4 ,, 8	
				8 ,, 9 10	
				3 ,, 11	
Jackal	1737 "I"	24. III. 1912	18° C.	1 ,, 3	—
				61 ,, 4	
				500 ,, 5	
				350 ,, 6	
				36 ,, 7	
Dog	1737 "II"	22. XI. 1912	20° C.	44 ,, 3	Larvae put on host 88 days (at 17° C.) after ecdysis. Progeny of 1737 I, ♀ 11.
				375 ,, 3	
				36 ,, 5	
Nymphs.					
Hedgehog	10	25. IV. 1906	10° C.	20 ,, 5	50 put on, 20 recovered.
,,	11	14. V. 1906	11° C.	3 ,, 3	30 put on, 17 recovered.
				12 ,, 5	
				2 ,, 7	
,,	13	4. VI. 1906	16° C.	4 ,, 5	20 put on, 4 recovered.
Jackal	1737 "I"	11. V. 1912	23° C.	13 by day 7	13 nymphs put on host 15 days after ecdysis; all recovered.
,,	,,	19. V. 1912	23° C.	24 on day 4	Nymphs put on host 23 days after ecdysis.
				81 ,, 5	
				48 ,, 6	
				19 ,, 7	
				6 ,, 9	
				3 ,, 11	
,,	,,	27. V. 1912	22° C.	12 ,, 3	Nymphs put on host 31 days after ecdysis.
				51 ,, 4	
				5 ,, 5	
				3 ,, 7	
				7 ,, 9	
Adults. (Female.)					
Dog	1	29. V. 1902	Room temp.	— ,, 12–15	—
,,	2	4. VI. ,,	,,	— ,, 11–12	—
,,	3	18. I. 1904	,,	— ,, 11	—
,,	4	26. I. ,,	,,	— ,, 14	—
,,	5	21. X. ,,	10° C.	— ,, 12 13	—
,,	6	22. X. ,,	10° C.	— ,, 14	—

	No. of Lot	Date when put on host	Host maintained at a temperature of	Number of gorged ticks collected on succeeding days	Remarks
Adults.	(Female.)				
Jackal	1737 "I"	3. VII. 1912	20° C.	2 on day 10	Adults (7 ♂, 7 ♀) put on host 32 days after ecdysis; 6 ♀'s recovered.
				1 ,, 12	
				2 ,, 14	
				1 ,, 16	
..	1737 "I"	15. VII. 1912	20° C.	5 ,, 8	Adults (about 100 ♂ and ♀) put on host 44 days after ecdysis; 48 ♀'s recovered.
				5 ,, 9	
				18 ,, 10	
				10 ,, 11	
				7 ,, 12	
				1 ,, 13	
				1 ,, 14	
				1 ,, 16	

The time required by H. leachi for metamorphosis.

The time required for metamorphosis is reckoned as follows:—(1) *Egg to Larva:* from the date on which the female began ovipositing to the day on which the first larvae emerged from the egg-shells; (2) *Larva to Nymph:* from the date on which the larvae dropped off gorged to the day on which the first nymphs emerged; (3) *Nymph to Adult:* from the date on which the nymphs dropped off gorged to the day on which the first adults emerged.

Egg to Larva.

Lot	Eggs laid on	Larvae emerged after	Eggs maintained at
1	15. XII. 1903	63 days	—
2	14. III. 1904	80	12° C.
3	2. V. 1904	58	13° C.
1737 I	16. VII.–1 VIII. 1912	26–37	20° C. *

* See table relating to the progeny of 39 ♀'s, etc. p. 540.

Larva to Nymph.

Lot	Host	Date on which gorged larvae dropped off host	Nymphs emerged after	Ticks maintained throughout at
1*a*	Ferret	13. VII. 1904	30 days	17° C.
1*b*	Rabbit	10. ,,	33	,,
1*c*	Hedgehog	11. ,,	32	,,
1*d*	Kid	20. VI. 1904	44	,,
2	Dog	2. IX. 1904	35	11° C.
3	Hedgehog	23–24. X. 1905	39	10° C.
1737 I	Jackal	27–30. III. 1912	31	24–26° C.

Nymph to Adult.

Lot	Host	Date	Adults emerged after	Temperature
1	Rabbit	25. VII. 1904	42 days	14° C.
2	Hedgehog	30. IV. 1906	70	14° C.
1737 I	Jackal	23. V. 1912	15–16	24–26° C.

Longevity of unfed H. leachi.

The longevity of the unfed tick is reckoned from the date of its emergence from the egg in the case of the larva, from the larval skin in the case of the nymph, from the nymphal skin in the case of the adult.

Larvae.

Lot	Date of emergence		Remarks
1	12. VIII. 1904	Still lively after 56 days at 13° C.	In jar on earth.
2	29. VI. 1904	Dead after 44 days at 17° C.	,, ,,
1737 I	12. VIII. 1912	Of the progeny of 32 ♀'s isolated in separate corked tubes at room-temperature in semi-darkness, 8 lots were found dead after 322, 355, 360, 360, 362, 376, 376 and 400 days respectively; about 25 % of the larvae, composing each of the remaining 24 lots, survived for 354–378 days when they were used for raising experiments*.	

* Note added since the publication of the paper from which this is extracted.

Nymphs.

1737 I	7. XII. 1912	Lively after 61 days at 12° C.	Then raised to adults.

Adults. Received VII. 1903 from Cape Colony, survived ca. 210 days at room temperature, and when placed on a dog produced infection with piroplasmosis.

Observations relating to oviposition, etc.

Lot No.	Date when gorged females dropped from host	Oviposition began after	Ticks maintained at temperature of
1	X. 1903	60 days	Cool room.
2	I.–III. 1904	47	,,
3	3. III. ,,	24	,,
4	24. V. ,,	18	16° C.
5–8	IV.–V. ,,	14	16–21° C.
1737 I	VII.–VIII. 1912	3–5	23° C.*

* This holds for 33 out of 35 ♀'s, the two remaining oviposited on days 9 and 12 respectively.

Summary.

Haemaphysalis leachi requires three hosts upon which to feed during its larval, nymphal and adult stages. It readily attaches itself to the host at each stage in about a week after ecdysis. It is easily reared under experimental conditions upon a number of different hosts (jackal, dog, ferret, hedgehog, goat, rabbit), and it appears to be immaterial upon which of these hosts it feeds. The larva and nymph remain attached to the host for 3–7 days (2–3 days, Lounsbury), occasionally longer; the females remain attached longer, i.e. 8–16 days. The males

Record relating to 39 H. leachi ♀'s (*Lot* 1737 I) *and their progeny.*

No. of Tick	Days tick stayed on host	Day when gorged ♀ began to oviposit, reckoned from when it dropped off host	Number of days oviposition lasted	Days ♀ survived after oviposition ceased	No. of eggs each ♀ laid	Day larvae started to emerge, reckoned from day oviposition began
1	10	3	25	2	—	27
2	10	4	26	5	—	26
3	12	4	29	5	2982	29
4	14	5	29	6	3626	28
5	14	3	31	8	4575	30
6	16	4	28	13	3362	28
7	8	4	32	5	3660	30
8	8	5	26	8	3043	29
9	8	4	21	5	—	28
10	8	9	27	8	2400	32
11	8	4	21	0	—	30
12	9	4	26	7	4803	33
13	9	3	34	15	3815	32
14	9	4	17	1	—	30
15	9	5	24	9	3595	33
16	9	5	31	12	—	32
17	10	4	22	13	—	30
18	10	3	30	31	3763	30
19	10	3	24	5	—	29
20	10	3	29	7	4817	29
21	10	3	31	15	—	29
22	10	4	32	6	—	29
23	10	4	29	3	3811	29
24	10	4	29	2	—	30
25	10	3	30	3	—	30
26	10	4	29	3	3395	32
27	10	—	—	—	—	—
28	10	3	30	15	—	30
29	10	5	30	6	—	30
30	10	—	—	—	—	—
31	10	5	28	6	—	29
32	11	—	—	—	—	—
33	12	—	—	—	—	—
34	10	3	30	6	—	30
35	10	3	26	3	—	31
36	10	12	—	—	*	—
37	13	3	28	2	—	30
38	14	3	28	0	—	34
39	16	5	37	10	—	37
		16. VII.– 1. VIII. 12 at 22·5° C.	10. VIII.– 11. IX. 12 at 20° C.	at 20° C.		12. VIII.– 11. IX. 12 at 20° C.

* Laid a few unfertilized eggs.

may remain upon the host for many weeks (according to Lounsbury). The temperature of the air within the limits observed (9–23° C.) appears to exert little or no influence upon the time the tick remains upon the host, the warmth emanating from the latter being doubtless sufficient to keep the ticks active. The time required for metamorphosis[1] is influenced by temperature, thus the larvae hatch after 26–37 days at 20° C., in 58 to 80 days at 12–13° C.; the nymphs emerge, as a rule, after 30 to 40 days; adults emerge after 15–16 days at 24–26° C. whereas they may only emerge after 42–70 days at 14° C. The longevity of the unfed tick is considerable when the conditions are favourable; in small corked bottles some larvae were still active after 399 days, the nymphs after 61 days and the adults after about 210 days when maintained at room temperature in semi-darkness and all stages fed upon their hosts after these periods. When males and females are simultaneously placed upon the host they scatter, but the sexes are found attached in close proximity to each other after 2–3 days. Copulation must take place upon the host, though it has never been actually observed. (Lounsbury has seen males, which he had marked, detach themselves and reattach themselves close to females; a male may mate with more than one female.) I find that the males do not seek the females as do *Ixodes* when the sexes have been removed from the host. The time which elapses before oviposition commences, after the replete female a andons the host, is markedly influenced by temperature; thus, when females were placed at 23° C. they began to lay after 3–5 days, at 16–21° C. after 14–18 days, at lower temperatures after 24, 47 to 60 days. Whereas an occasional female dies as soon as oviposition has ended, others may survive for a few days or, in exceptional cases, for a month The female lays from 2400 to 4800 eggs. *H. leachi* begins to abandon its host on the approach of death in a manner that neither Lounsbury nor myself has observed in other ticks.

In nature, this tick may doubtless run twice through its life cycle in a year. By the use of an incubator, as first shown by Lounsbury, this author succeeded in raising three generations in a year. Taking average figures from my protocols of ticks raised under favourable conditions, the cycle may be completed in 123 days, as follows:

[1] See reference to Lounsbury's observations on p. 536.

	Time required, in days	
From the time egg is laid to emergence of larva	30	(Eggs to 20° C.)
Larva hardens	7	
Larva stays on host	5	
Metamorphosis: Larva to Nymph ...	31	(Larvae at 17° C.)
Nymph hardens	7	
Nymph stays on host	5	
Metamorphosis: Nymph to Adult ...	15	(Nymphs at 24° C.)
Adult hardens	7	
Adult ♀ stays on host	12	
Gorged ♀ drops from host and waits before laying	4	
	123 days	

Relation of H. leachi to disease.

H. leachi occurs all over Africa, and wherever it occurs it is the carrier of a very fatal disease in dogs known as canine piroplasmosis or malignant jaundice. The relation of the tick to this disease and the pathology, parasitology and treatment of the malady, are fully treated in the following papers, the titles of which will be found in Bibliographies I and II of this work:

Nuttall, 1904, pp. 219–257; 1905, pp. 12–32; IX. 1908, pp. 513–526. Nuttall and Graham Smith, VII. 1905, pp. 237–249; 1906, pp. 536–651; 1907, pp. 232–272; X. 1908, pp. 243–260; IX. 1909, pp. 211–214, 215–228. Nuttall and Hadwen, VII. 1909, pp. 156–191; IX. 1909, pp. 229–235. Nuttall, X. 1913, pp. 302–320. Many of these papers are illustrated.

Haemaphysalis concinna.

The only observations on the biology of this species are by Brumpt in France, who has kindly supplied me with his MS. notes thereon.

Brumpt has found the adults only upon deer, attached in the cervical region, especially along the mane, occasionally at the base of the ears, and rarely elsewhere. When placed experimentally upon dogs, they attached themselves anywhere. The sexes are found attached close together upon deer. Nymphs and larvae were found by Brumpt on deer and hedgehog and it is probable that they occur on other mammals; they attach themselves anywhere upon the hosts mentioned.

Time the tick remains upon the host.

The *Larvae*, a few days after emergence, attach themselves quickly to a variety of hosts (deer, hedgehog, dog, guinea-pig, rat, mouse) and gorge themselves with blood or lymph in 3–10 days; nearly all of them abandon the host in 3–5 days.

The *Nymphs*, a few days after emerging, attach themselves to the same hosts as do the larvae and feed to repletion in 3–12 days, mostly abandoning the host in 4–5 days.

The *Adults*, after fasting for weeks or months, attach themselves to the host whereon they copulate, probably after 4 days, for the sexes are then found attached close together with their venters juxtaposed. The fertilized female becomes replete in 8–10 days; she is then slate-coloured and weighs on an average, when fully gorged, 0·35 g. Unfertilized females may stay for several weeks upon the host remaining about a third gorged.

Time required for metamorphosis.

Egg to Larva: the larvae emerge some weeks after the eggs are laid and they are capable of living for a long time unfed.

Larva to Nymph: nymphs emerge 17 days after they abandon the host as gorged larvae when maintained at 25–30° C. From 64 gorged larvae found upon a hedgehog, 64 nymphs emerged.

Nymph to Adult: adults emerge after 22 days at 25° C. From 4 gorged nymphs found on a stag at Chantilly there emerged 4 ♂ after 2 months: from 15 gorged nymphs found on a hedgehog there emerged 15 adults. Certain incompletely gorged nymphs undergo metamorphosis to adults very slowly and they often die before it is completed. *H. concinna* differs in this respect from certain species of ticks, for instance *Amblyomma cayennense* (as seen by Aragão, 1912, p. 96), *Rhipicephalus appendiculatus* and *R. sanguineus* (Nuttall, 1913, p. 195; Cunliffe, 1914, p. 372), *Dermacentor reticulatus* (as seen by Brumpt), wherein imperfectly gorged nymphs were found to give rise to small adults.

Oviposition.

At a temperature of 18° C., oviposition occurs in about the second week. The eggs are larger than those of *Ixodes ricinus*, they are dark salmon coloured. Each female usually lays upwards of 1000 eggs.

Table showing the prevalence of Haemaphysalis on Deer in France as observed by Dr E. Brumpt.

Number of deer examined	Date	Locality *	*H. concinna*	*H. inermis*	*H. cinnabarina* var. *punctata*
	1911				
1	3. XI.	Fontainebleau	. . . .	♂ – ♀ 14	. . . .
1	7. XII.	,,	. . . .	♂ – ♀ f. numerous	. . . .
1	16. XII.	,,	. . . .	♂ – ♀ 52	. . . .
	1912				
1	24. I.	?	. . . .	♂ 1 . . .	. . . .
1	13. II.	Indre	♂ 1 . ⊙ 2 L 1	♂ 3 ♀ 3 . .	♂ 1 . . .
1	20. II.	Fontainebleau	♂ 5 . ⊙ 3 .	♂ 4 ♀ 7 . .	. . . .
1	27. II.	Vienne	♂ 18 ♀ 14 ⊙ 3 .	♂ 2 ♀ 2 . .	. . . .
1	28. II.	Indre	♂ – ♀ many	♂ – ♀ many .	. . . .
1	18. III.	Compiègne	♂ 3 . . .	. . . .	. . . .
1	4. III.	Fontainebleau	♂ – ♀ few ⊙ 1 L 3	♂ – ♀ few . .	. . . .
1	30. III.	Indre	♂ 37 ♀ 34 ⊙ 15 L 2	♂ 2 ♀ 15 . .	. . . .
1	13. IV.	Fontainebleau	♂ – ♀ – ⊙ – L f. numerous	♂ – ♀ f. numerous	. . . .
1	17. IV.	,,	♂ – ♀ – ⊙ – L f. numerous	♂ – ♀ f. numerous	. . . .
1	24. IV.	,,	♂ 150 ♀ 30 ⊙ 40 L 10	♂ 1	
1	31. IX.	Chantilly	. . . .	. . . .	. . . .
1	3. X.	,,	. . ⊙ 1 L 2	. . . .	. . . .
1	8. X.	,,	♂ – ♀ f. num. ⊙ 1 L 2	. . . .	. . . .
1	14. X.	,,	. . . .	. . . .	. . . .
1	21. X.	,,	. . ⊙ 1 .	. . . .	. . . .
1	21. X.	,,	♂ 1 . ⊙ 1 .	. . . .	. . . .
1	24. X.	,,	. . . .	. . . .	. . . .
6	18–19 XI. and XII.	,,	. . . .	. . . .	. . . .
	1913				
1	28. IV.	,,	♂ – ♀ – ⊙ – L many	. . . .	. . . .
1	30. IV.	,,	♂ 30 ♀ few . .	. . . .	. . . .
Total 29					

Note: the signs ♂, ♀, ⊙, L denote male, female, nymph and larva respectively. The abbreviation "f. num." or "f. numerous" stands for "fairly numerous."

* Fontainebleau (Dépt. Seine-et-Marne); Dépt. Indre; Dépt. Vienne; Compiègne (Dépt. Oise); Chantilly (Dépt. Oise).

Season.

From the above table relating to Brumpt's observations on the seasonal occurrence of *H. concinna* (and *H. inermis*) in France, it will be seen that all stages were encountered on *deer* in February–April and October, none were found in January and September, 1912, and none were encountered in November–December of 1912 and 1913. All stages were most numerous in March and April, usually few or none being encountered later. Observations for the 4 months May–August are lacking. In one instance (April, 1912) the number of ♂s greatly exceeded that of the ♀s encountered on one host.

On two *hedgehogs*, examined at Chantilly (27. VI. 1911 and 6. VI. 1912), he found immature stages only: 15 nymphs and 64 larvae, and 19 nymphs and 174 larvae respectively.

Insect parasites of H. concinna.

Brumpt has several times found the nymphs of *H. concinna* at Chantilly and Fontainebleau to be infested with *Ixodiphagus caucurtei* du Buysson (see p. 547). Under experimental conditions, the nymphs were readily attacked by the chalcidid but only about 2–4 per cent. became parasitized.

Haemaphysalis inermis.

The biology of this species has been studied by Dr E. Brumpt of Paris who has kindly placed his notes at my disposal thus enabling me to compile the following account of the life-history of *H. inermis.*

Brumpt finds that the adults, which are very active, occur commonly on deer in France during the months November to April inclusive. They quickly abandon the host and readily reattach themselves to the hedgehog or dog in the laboratory. The ticks occur in all situations upon the host but they attach themselves by preference, as does *I. ricinus,* in places where the skin is thin. On deer, they occur in the axillary and inguinal regions and occasionally upon the ears.

H. inermis requires three hosts upon which to feed in the larval, nymphal and adult stages respectively. Both sexes occur upon the host on whom copulation takes place. Brumpt has never found the sexes attached at the same spot on the host as is usually seen in *H. concinna.*

Time the tick remains upon the host (Laboratory experiments).

The *Larvae,* when a week old, attach themselves immediately in any situation upon the host, be it either a mammal (hedgehog, mouse, rat) or reptile (lizard); they *gorge very rapidly,* some being replete in

$1\frac{1}{2}$ hours; the majority, however, engorge in 2–3 hours, whilst some feed for 20 hours. Their bodies appear bright red at first owing to the blood ingested, but after some days they assume a bluish hue.

The *Nymphs* are often ready to feed a few days after emergence; they *gorge rapidly*; some are replete within 1 hour, the majority gorge within 2 hours, whilst others remain longer upon the host, but in no case do they remain attached longer than 24 hours upon a mammal. They suck blood for longer periods when attached to cold-blooded animals (lizards) at room-temperature.

The *Females* may remain attached to the host for weeks whilst awaiting the male, during which time they appear but partially fed. In the presence of the male, i.e. when the female is fecundated, she usually grows replete and abandons the host in about 8 days.

Time required for metamorphosis.

Egg to Larva: the larvae emerge 7–8 weeks after the eggs are laid when the latter are kept at 18° C.

Larva to Nymph: the nymphs emerge after 17 days at 25° C., the time being reckoned from when they dropped off the host as gorged larvae.

Nymph to Adult: an exceptionally long time is required for metamorphosis at this stage. When the nymphs have fully gorged themselves they moult after 6 months at 15–25° C., some may, however, require 10 months, and incompletely fed specimens are found to be still active after 16 months.

Observations relating to oviposition.

Oviposition usually begins on the 5–6th week (at 18° C.) after the replete and fecundated female has abandoned the host. The eggs are large, dark salmon-coloured, and only number about 200 per female.

Season.

From the table on p. 544, which contains Brumpt's observations on *H. inermis* and *H. concinna*, we learn that the adults of *H. inermis* occur on deer in France during the six months November to April inclusive. Observations for the four months May–August are lacking. The ticks were not found in September–October.

Remarks upon the exceptional behaviour of H. inermis.

H. inermis offers an exception to all the ticks whose life-histories we know in that it gorges with remarkable rapidity both in the larval and nymphal stages. It is the rule in Ixodid ticks for all stages to remain attached to the host for several days. In Argasidae we do not know of a species where the larvae feed as rapidly as does the larva of *H. inermis* although the nymphs, *O. megnini* excepted, are rapid feeders (see pp. 81–104, 325–345 of this work). Whilst this habit of rapid feeding may favour the survival of the species, the long time required for the process of oviposition and for metamorphosis from egg to larva and from nymph to adult must exert a contrary effect. This phenomenon observed in *H. inermis* by Brumpt is very interesting and worthy of attention.

Insect parasites of H. inermis.

A chalcidid called *Ixodiphagus caucurtei* du Buysson, 1912 (p. 246) was discovered by Brumpt in the nymphs of *Ixodes ricinus* in France and raised by him to the seventh generation in the laboratory. This insect attacks the nymphs of *H. inermis.* Whereas scarcely 1 % of these nymphs become infested, all of the nymphs of *I. ricinus, Dermacentor venustus, D. reticulatus* and *Rhipicephalus sanguineus* in which the parent *I. caucurtei* deposits her offspring, die and yield imagines of *Ixodiphagus.*

INDEX TO VALID SPECIES OF HAEMAPHYSALIS

Together with a list of collections in which the types are to be found.

N.B. The reader should also refer to the list of condemned and doubtful species on p. 512.

Name of Species, authors and date	Collections which include the types and co-types	Stages of each species which are known	Page
**aborensis* Warburton, 1913	Calcutta, 1 ♀	♀	398
**aciculifer* Warburton, 1913	London (*b*), 1 ♂, 1 ♀	♂ ♀	411
aculeata Lavarra, 1904	Rome, 15 ♂; Cambridge, 1 ♂, 1 ♀	♂ ♀	440
bancrofti Nuttall and Warburton, 1915	Cambridge, 9 ♂, 11 ♀, 3 o, 1 L	♂ ♀ o L	487
birmaniae Supino, 1897	Genoa and Cambridge, 4 ♂	♂	415
bispinosa Neumann, 1897	Toulouse, 1 ♀; Cambridge, ♂ o	♂ ♀ o L	426
bispinosa var. *intermedia* Warburton and Nuttall, 1909	Cambridge, ♂ ♀; London (*c*), ♀	♂ ♀	433
calcarata Neumann, 1902	Paris (*a*), Toulouse, Cambridge, 5 ♂, 8 ♀, 1 o	♂ ♀ o	442
calcarata var. *houyi* Nuttall and Warburton, 1915	Berlin (*a*); Cambridge, 7 ♂, 1 ♀, 2 o	♂ ♀ o	444
calvus Nuttall and Warburton, 1915	Cambridge, 3 ♂, 1 ♀	♂ ♀	445
campanulata Warburton, 1908	Cambridge, London (*a*, *c*), Paris (*a*), Berlin (*a*), Toulouse, Washington (*d*)	♂ ♀	491
cinnabarina Koch, 1844	Berlin (*a*), 1 ♀	♂ ♀ o L	372, 528
cinnabarina var. *punctata* (Canestrini and Fanzago, 1877)	? lost, ♂ ♀	♂ ♀ o L	378, 519
concinna Koch, 1844	Berlin (*a*), 1 ♂, 1 ♀	♂ ♀ o L	452, 542
cornigera Neumann, 1897	Toulouse, ♂ ♀; Paris, ♂; Cambridge, ♂	♂ ♀	500
**cornigera* var. *anomala* Warburton, 1913	Calcutta, 1 ♂	♂	504
cuspidata Warburton, 1910	Cambridge, Berlin (*a*), Toulouse, 30 ♂, 2 ♀, 7 o, 4 L	♂ ♀ o L	438
dentipalpis Warburton and Nuttall, 1909	Cambridge, London (*c*), 4 ♂	♂	505
doenitzi Warburton and Nuttall, 1909	Cambridge, Berlin (*a*), 4 ♂, 3 ♀	♂ ♀	482
elongata Neumann, 1897	Toulouse, Cambridge, 6 ♂, 3 ♀	♂ ♀	498
flava Neumann, 1897	Toulouse, ♂ ♀	♂ ♀	408

* = species not represented in our collection in Cambridge

* = species not represented in our collection in Cambridge.

The types of the following have not been accessible: *papuana* ♂ ♀, *leporis-palustris* ♀, *leachi* ♂, *inermis* ♀, *cinnabarina* var. *punctata* ♂ ♀. If we except these, all of our specimens, that are not either types or co-types, have been carefully compared with the types.

Note. In the second column of the foregoing list the whereabouts of the collections is but briefly indicated; places not referred to in the following list will be found recorded on p. 348 of Part II:

Berlin (*a*)	signifies	Entomologische Abteilung, Zoologisches Museum, Berlin.
,, (*b*)	,,	Deutsches Entomologisches Museum, Berlin-Dahlem.
Genoa	,,	Museo Civico di Storia Naturale, Genoa.
London (*a*)	,,	British Museum (Natural History), London.
,, (*b*)	,,	Imperial Bureau of Entomology, London.
,, (*c*)	,,	London School of Tropical Medicine, London, E.
Petrograd	,,	Collection of Prof. A. Birula, Imperial Academy of Science, Petrograd.

Rio de Janeiro (*a*) signifies Collection of H. de B. Aragão, Rio de Janeiro, Brazil.
,, (*b*) ,, ,, ,, Dr A. Lutz, ,, ,, ,,
Rome signifies R. Museo Zoologico Universitario, Rome.

PARASITOLOGY

Edited by George H. F. Nuttall, F.R.S., Quick Professor of Biology in the University of Cambridge, assisted by Edward Hindle, Ph.D.

When the *Journal of Hygiene* was founded it was announced that papers on Parasitology "in relation to hygiene and preventive medicine" would be published in its pages. It had however been felt for some time that the Journal was becoming unduly burdened with papers dealing with the anatomy of mosquitoes, fleas, protozoa and other parasites—of great importance in themselves—but having only an indirect relation to hygiene and preventive medicine.

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