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TICKS

A MONOGRAPH OF THE

IXODOIDEA

PART III

CAMBRIDGE UNIVERSITY PRESS
C. F. CLAY, MANAGER
London: FETTER LANE, E.C.
Edinburgh: 100 PRINCES STREET



London: H. K. LEWIS AND CO., 136, GOWER STREET, W.C.
London: WILLIAM WESLEY AND SON, 28, ESSEX STREET, STRAND
New York: G. P. PUTNAM'S SONS
Bombay, Calcutta and Madras: MACMILLAN AND CO., LTD.
Toronto: J. M. DENT AND SONS, LTD.
Tokyo: THE MARUZEN-KABUSHIKI-KAISHA

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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

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., of the Cooper Laboratory for Economic Research, Watford

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
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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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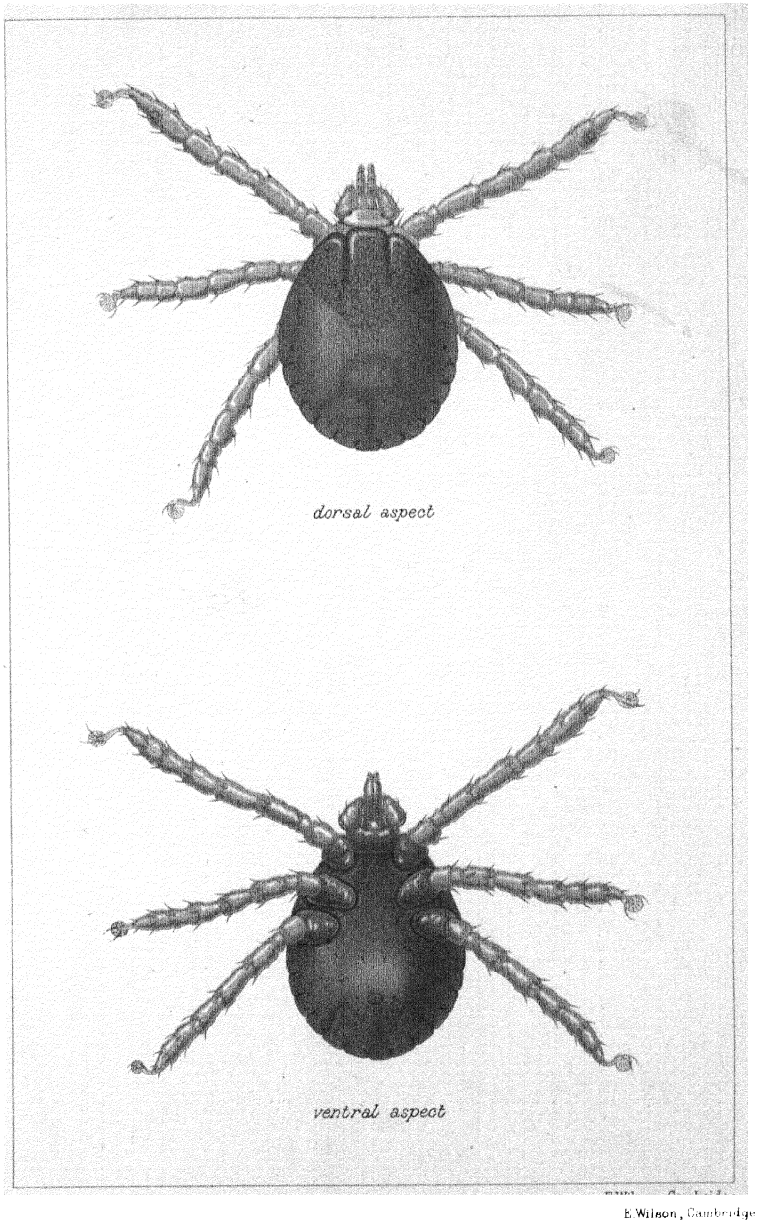
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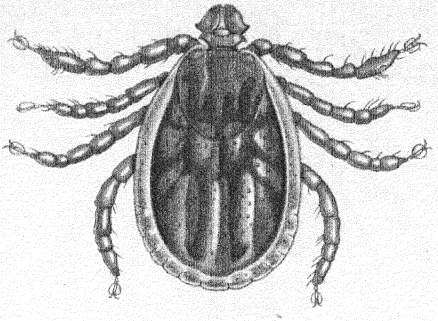
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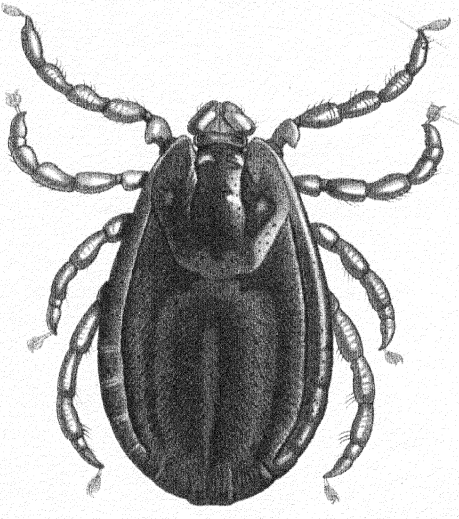


E. Wilson, Cambridge

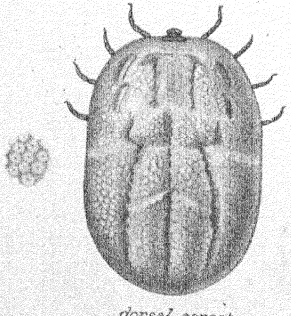
HAEMAPHYSALIS PUNCTATA Can & Fan.
THE LARVA



Nymph

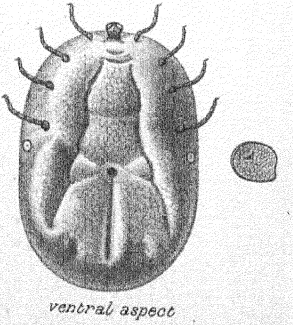


Female *(unfed)*



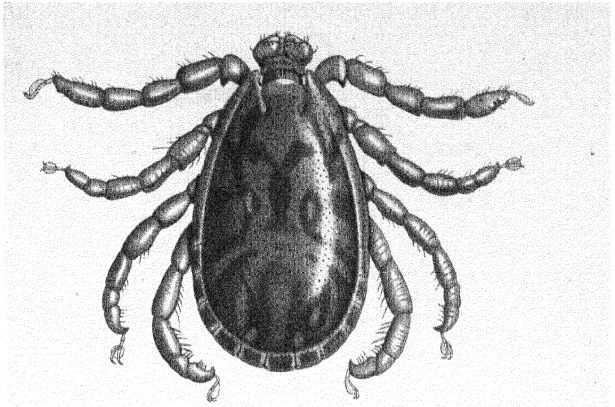
dorsal aspect

Female *(replete)*

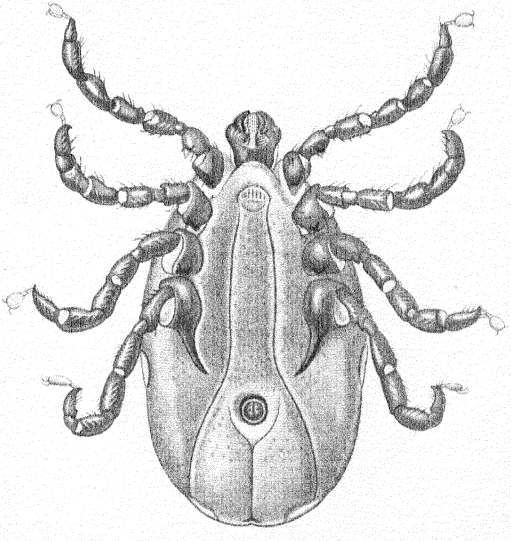


ventral aspect

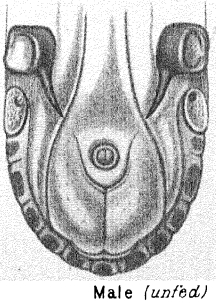
HAEMAPHYSALIS



Male



Male *(replete)*



Male *(unfed)*

E. Wilson, Cambridge

PUNCTATA Can. & Fan.

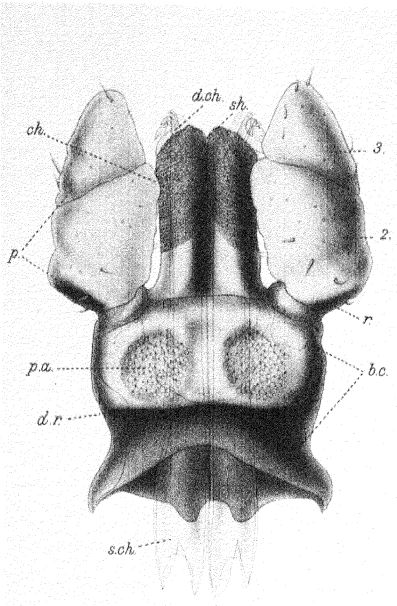


Fig.1.

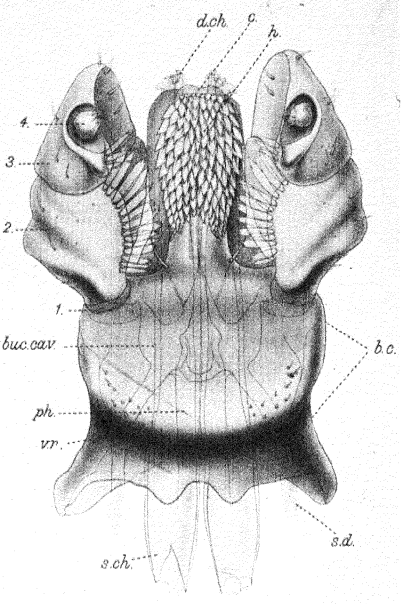
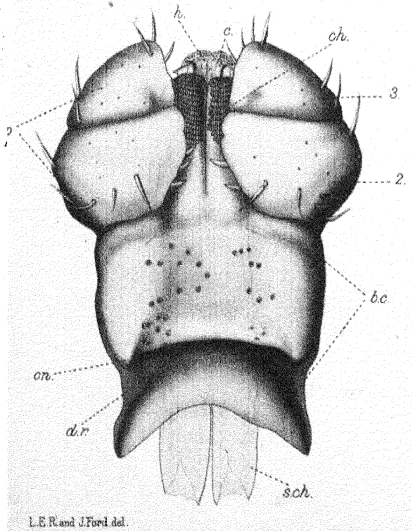


Fig.2.



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Fig.3.

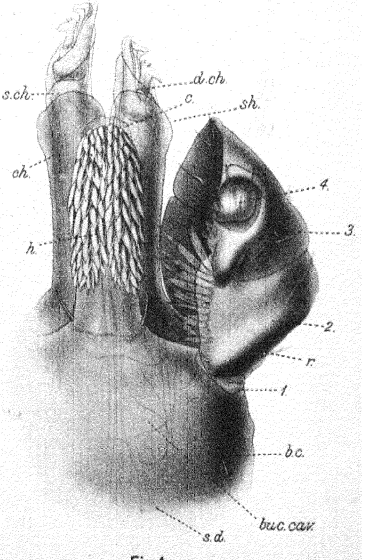


Fig.4.

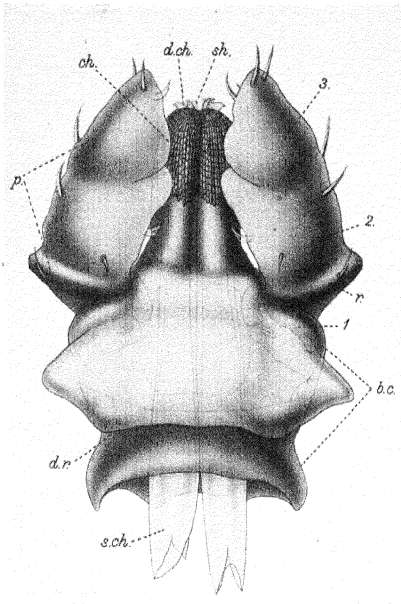


Fig.5.

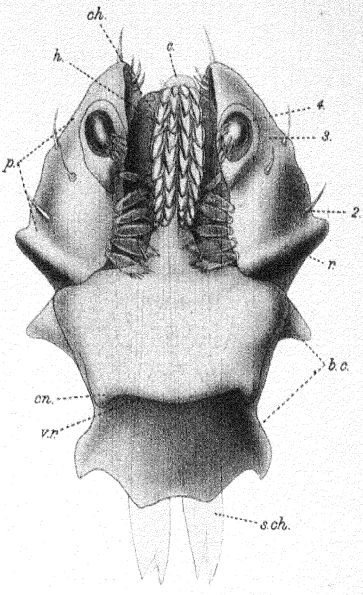


Fig.6.

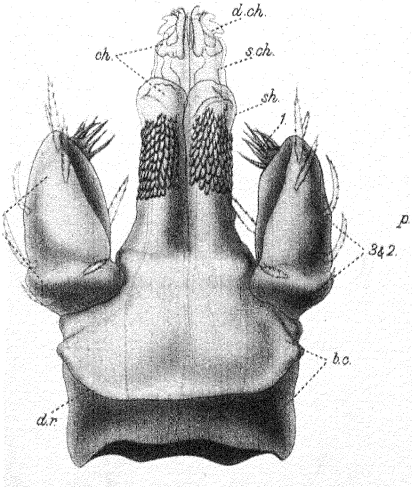


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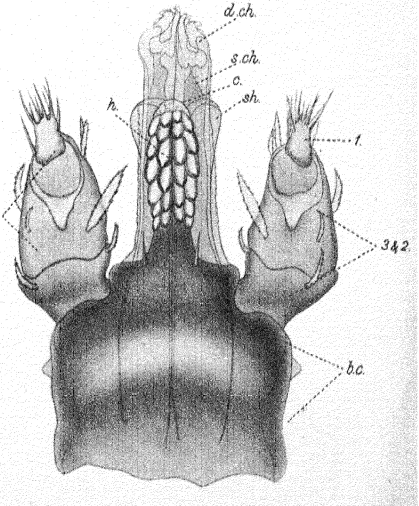


Fig.8.

Morgan & Kidd Richmond Collotype.

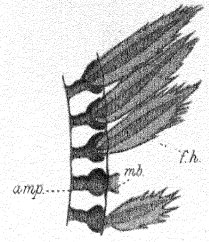


Fig.1.

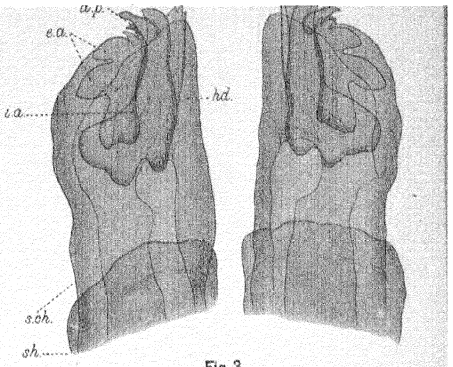


Fig.3.

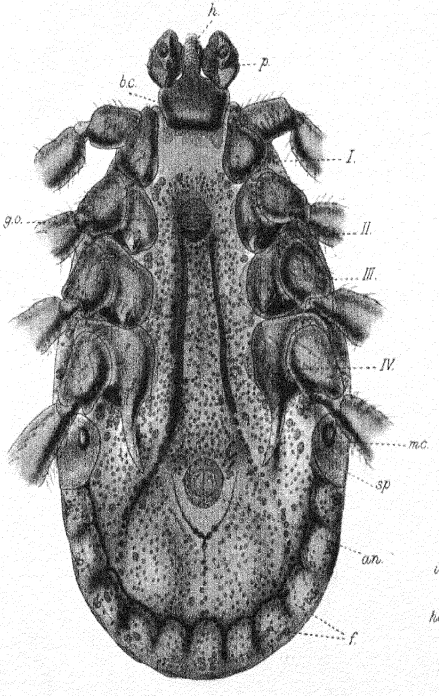


Fig.2.

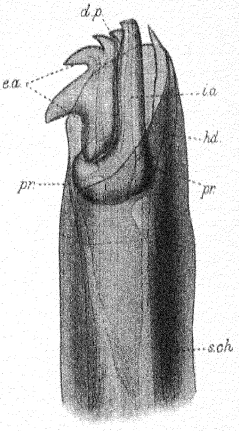


Fig.4.

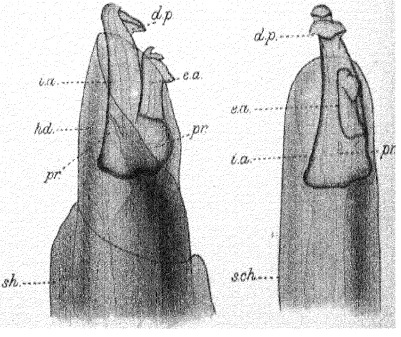


Fig.5.

L.E.R. and J.Ford.del.

Morgan & Kidd Richmond. Collotype

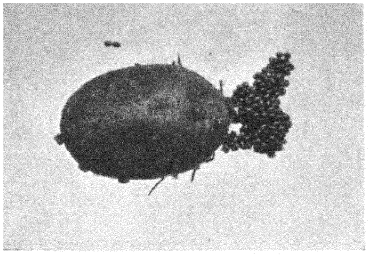


Fig. 1

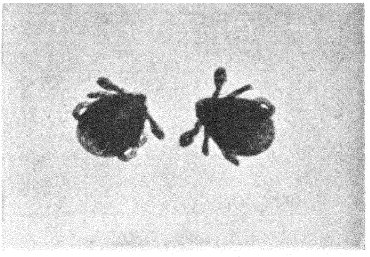


Fig. 2

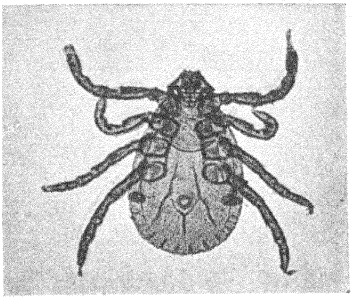


Fig. 3

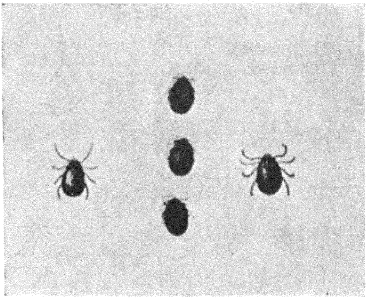


Fig. 4

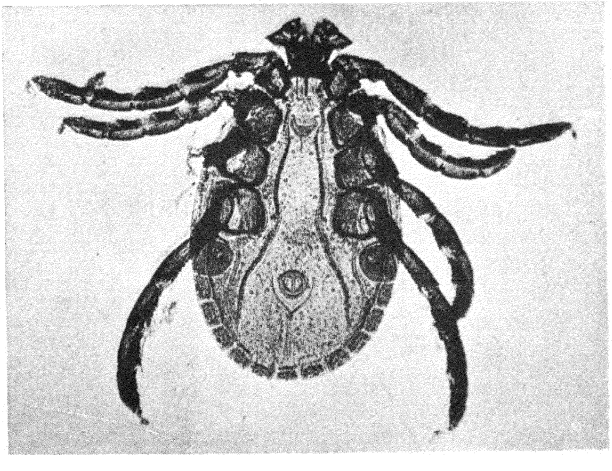


Fig. 5

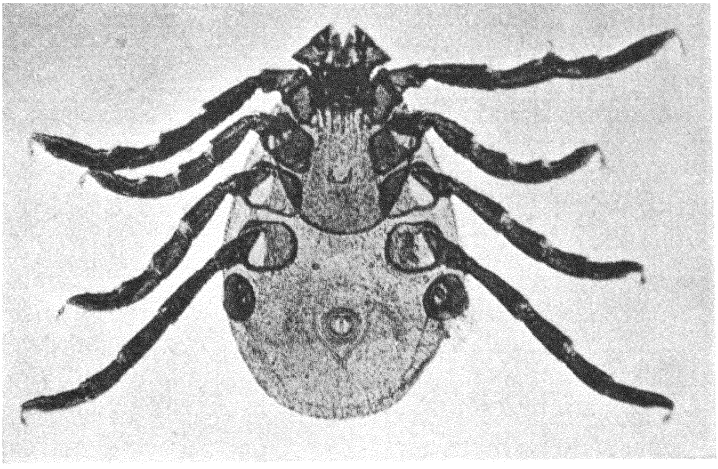


Fig. 1

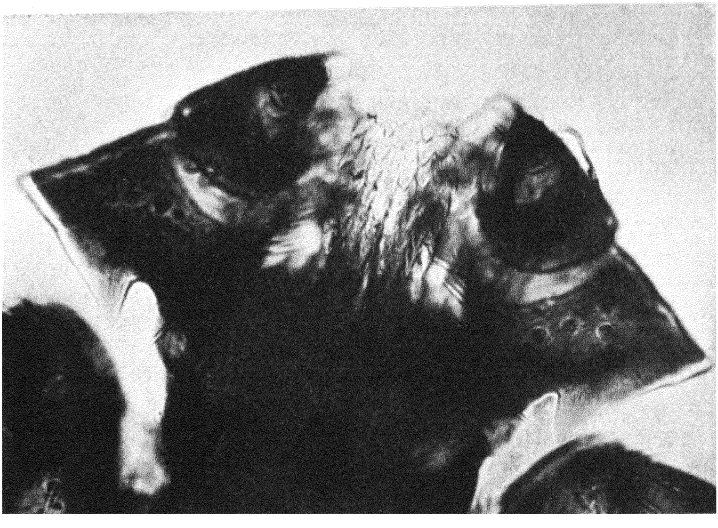


Fig. 2

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

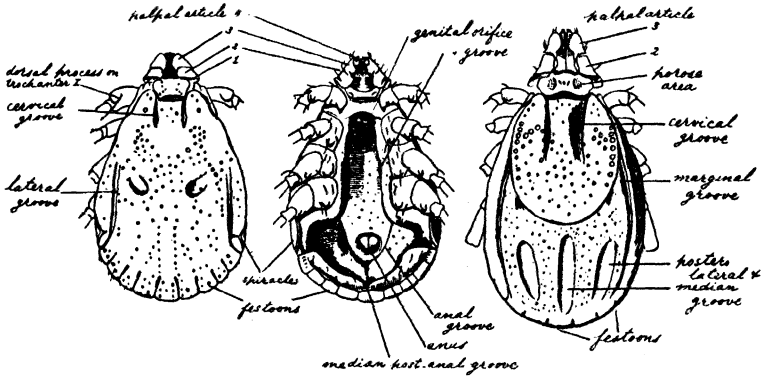


Fig. 308. *Haemaphysalis wellingtoni* ♂ in dorsal and ventral aspects, ♀ in dorsal aspect. (Reprinted from Part II, Fig. 120.) To show the generic characters and nomenclature of parts.

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, 40
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, 36
	„ 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	*cinnaburina*	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 o.

			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* (o and *L* ; see Figs. 319, 320), as well as in its var. *punctata* (o 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

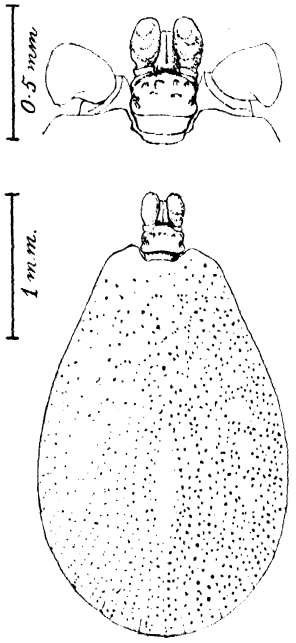


Fig. 309. *H. inermis* ♂ (N. 739 *d*). Dorsum, and more highly magnified detail of capitulum and legs. Specimen found on fox at Surnabad, Transcaucasia, 1903, by Dr E. Dschunkowsky. Original, N.C. del.

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 ♂.

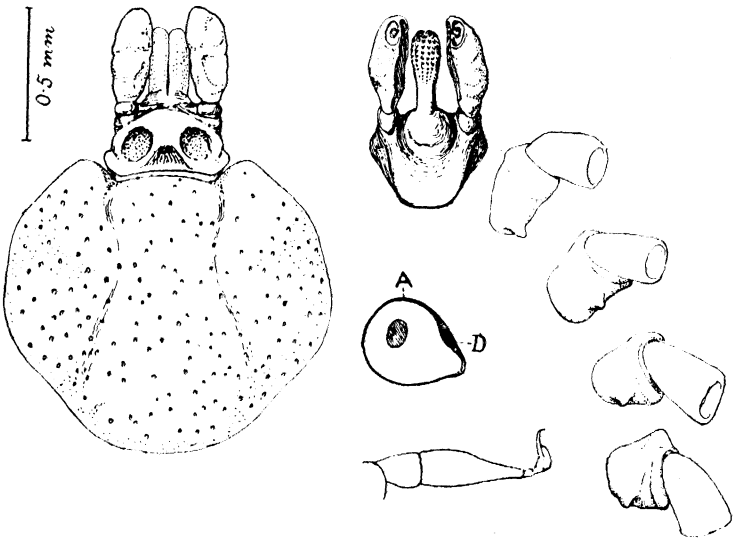


Fig. 310. *H. inermis* ♀ (N. 788). Scutum and capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. Same origin as ♂ in Fig. 309. Original, N. C. del.

[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*	
1·18 × 0·9	0·96 × 1·33	
1.13 × 1·10	0·95 × 1·12*	2·32 × 1·8
1·12 × 0·96	0·94 × 1·16	2·5 × 1·85
1·1 × 1·1	0·93 × 0·95	2·57 × 1·8
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

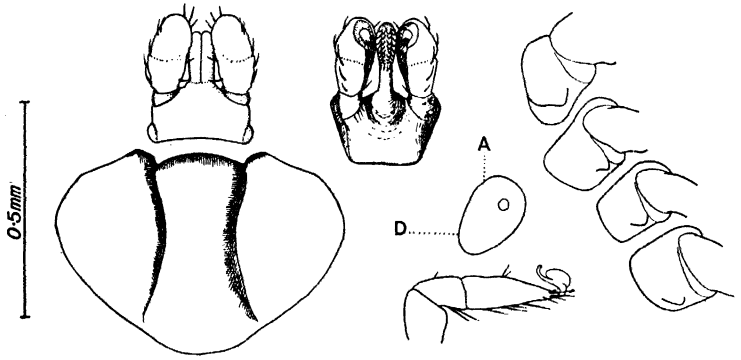


Fig. 311. *H. inermis* o (N. 2762). Scutum, capitulum in dorsal and ventral aspects, coxae, spiracle and tarsus IV. Specimen from France, received from Dr Brumpt, 1911. Original, N. C. del.

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 o, 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

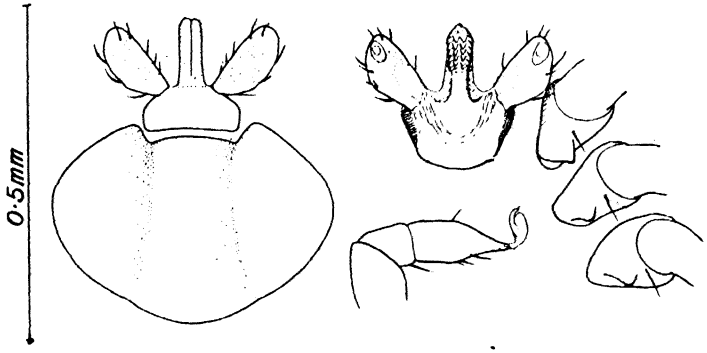


Fig. 312. *H. inermis* larva (N. 2757 *a*). Scutum, capitulum in dorsal and ventral aspects, coxae and tarsus III. Specimen raised by Dr Brumpt. Original, N. C. del.

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

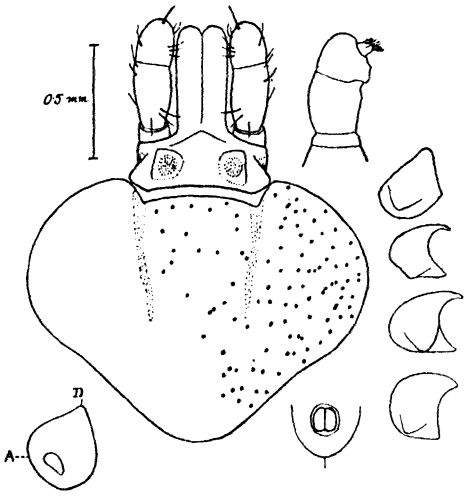


Fig. 313. *H. inermis* var. *aponommoides* ♀. Capitulum and scutum, profile of right palp, coxae, spiracle and anus with anal grooves. (N. C. del.) Warburton, 1913, Fig. 8.

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 ⅔ the body-length; posteriorly a median groove and two lateral depressions, two longitudinal grooves anterior to the latter extending forward to ½ 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 ⅓ 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,

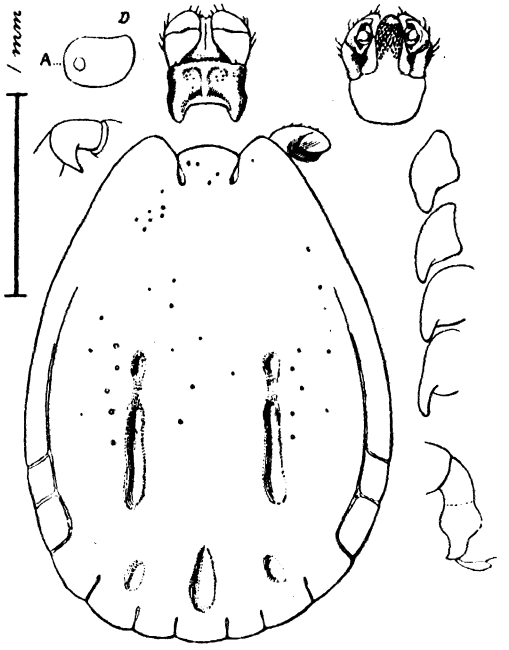


Fig. 314. *Haemaphysalis warburtoni*, ♂. Capitulum in dorsal and ventral aspects, scutum, spiracle, trochanter I seen from in front (and, attached to body, from above), coxae, tarsus IV. (G. H. F. N. and E. W. del.) Nuttall, 1912, Fig. 5.

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

1·6 × 1·2 to 1·2 × 1·6 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

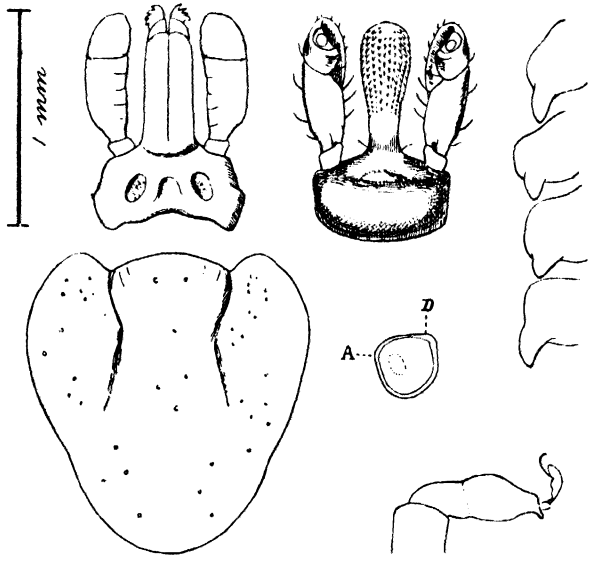


Fig. 315. *Haemaphysalis warburtoni* ♀. Capitulum in dorsal and ventral aspects, scutum, coxae, spiracle and tarsus IV. (G. H. F. N. and E. W. del.) Nuttall, 1912, Fig. 6.

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,

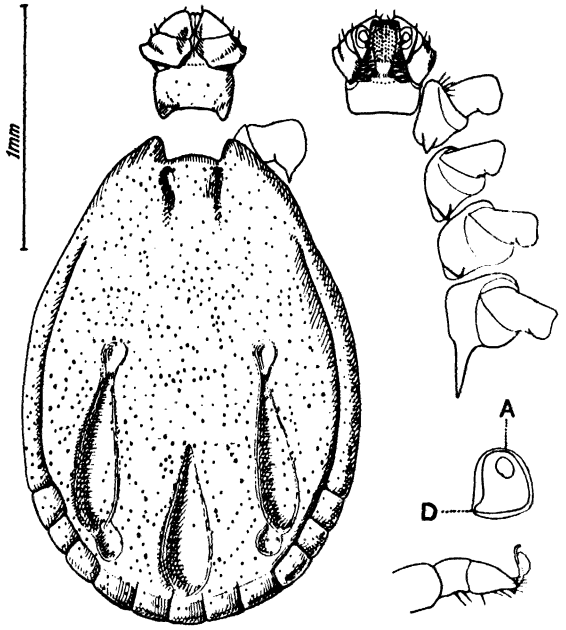


Fig. 316. *H. cinnabarina* ♂. Dorsum, ventral aspect of capitulum, coxae with trochanters, spiracle and tarsus IV. (Specimen, N. 2452, raised in Cambridge, parents from cattle, Winnipeg, Canada.) Original, N. C. and E. W. del.

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

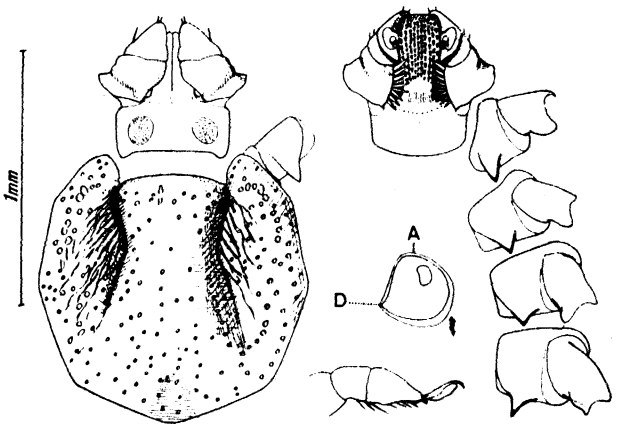


Fig. 317. *H. cinnabarina* ♀. Scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. (Same source as ♂ in Fig. 316.) Original, N.C. del.

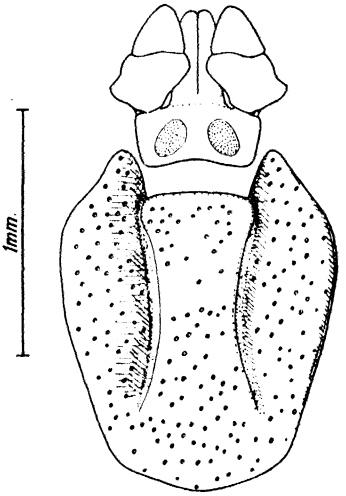


Fig. 318. *H. cinnabarina* ♀. Scutum and capitulum in dorsal aspect (N. 2833, received from Mr F. C. Bishopp, Victoria, Texas). Original, N. C. del.

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

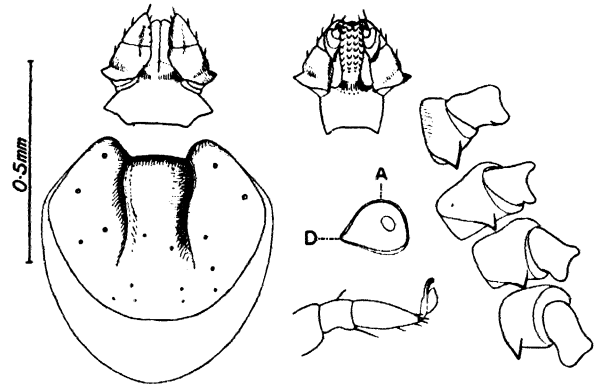


Fig. 319. *H. cinnabarina*, nymph. Capitulum in dorsal and ventral aspects, scutum (variations in shape indicated by second contour), coxae with trochanters, spiracle, tarsus IV. (Same source as ♂ in Fig. 316.) Original, N. C. del.

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

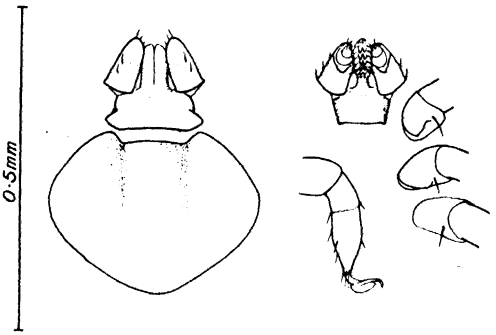


Fig. 320. *H. cinnabarina*, larva. Capitulum in dorsal and ventral aspects, scutum, coxae, tarsus III. (Same source as ♂ in Fig. 316.) Original, N. C. del.

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

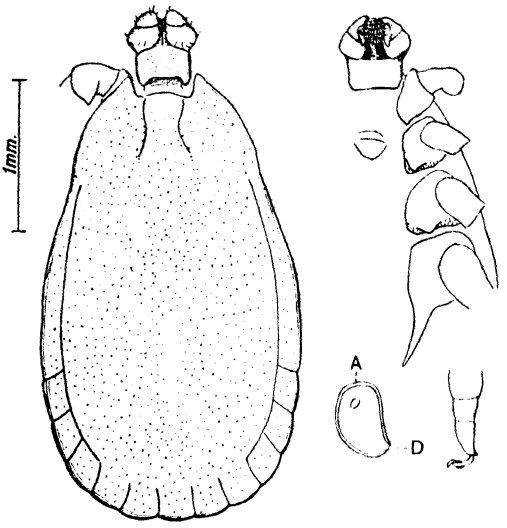


Fig. 321. *H. cinnabarina* var. *punctata* ♂. Dorsum, part of venter, spiracle and tarsus IV. Specimen (N. 2708) from Germany. Original, G. H. F. N. del.

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.

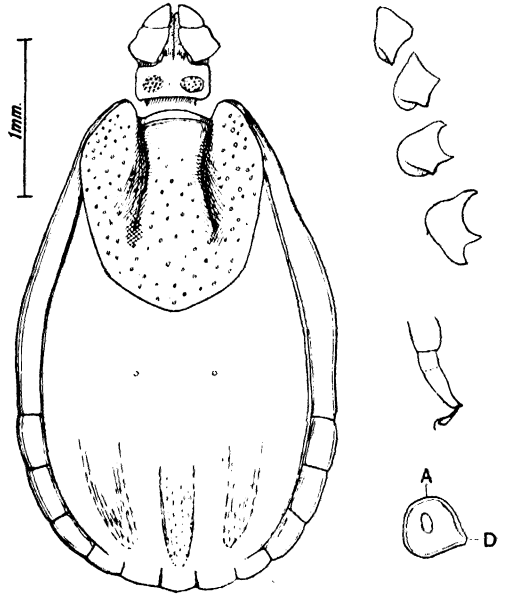


Fig. 322.

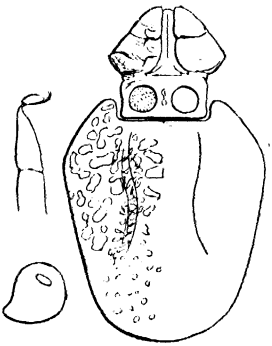


Fig. 323.

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

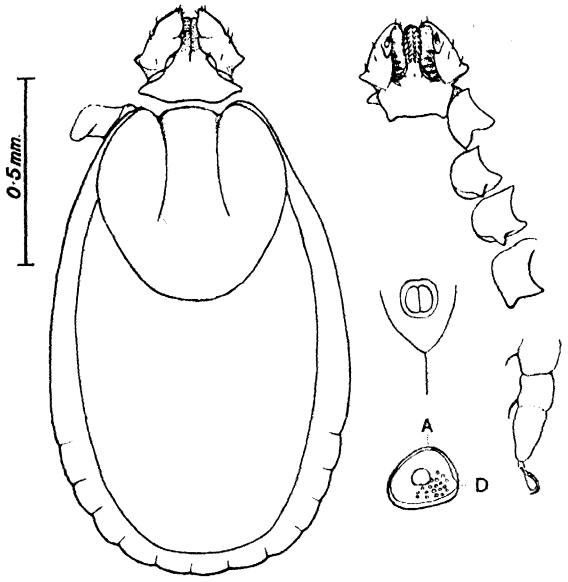


Fig. 324. *H. cinnabarina* var. *punctata* ○. Dorsum, ventral aspect of capitulum, coxae, anus and anal grooves, spiracle and tarsus IV. Specimen (N. 814) raised in Cambridge. Original, G. H. F. N. del.

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 ♂ 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

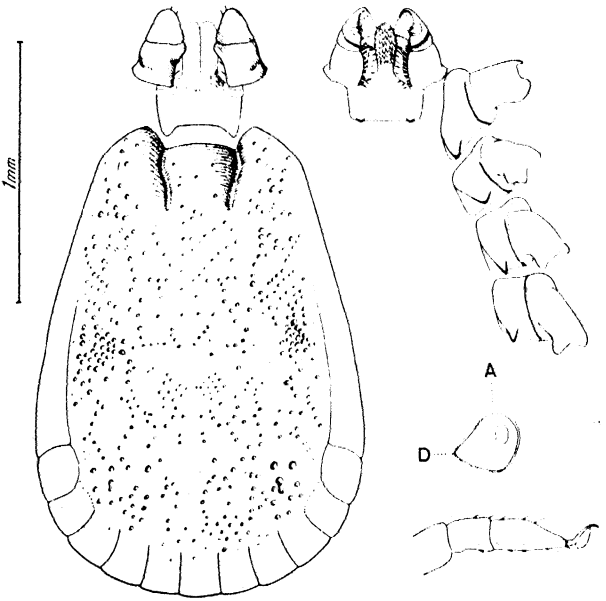


Fig. 325. *H. leporis-palustris* ♂. Dorsum, capitulum in ventral aspect, coxae with trochanters, spiracle and tarsus IV. Drawn from (N. 719) a specimen from Texas. Original, N. C. del.

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

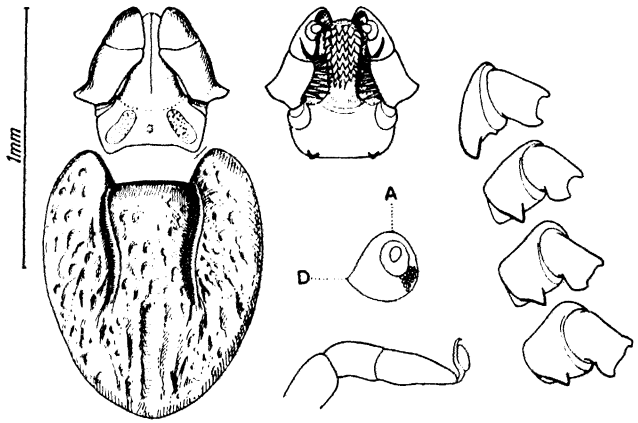


Fig. 326. *H. leporis-palustris* ♀. Scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. Drawn from (N. 719) a specimen found with the ♂ in the foregoing Fig. Original, N. C. and E. W. del.

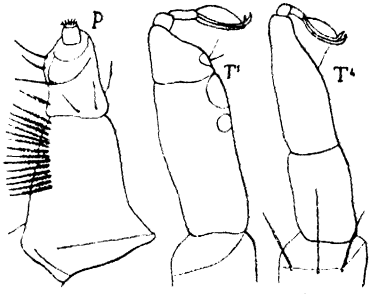


Fig. 327. *H. leporis-palustris* ♀. (*P*) Palp of left side in ventral aspect, (T^1 and T^4) tarsi I and IV. ×80. Neumann, 1897, Fig. 9. (Reprinted from original block.)

[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].

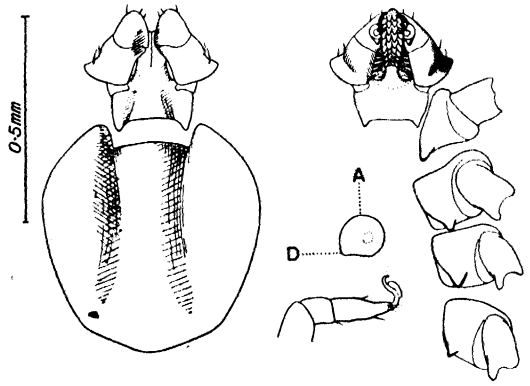


Fig. 328. *H. leporis-palustris* o. Scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. Drawn from (N. 2324) Texan specimen. Original, N. C. del.

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.

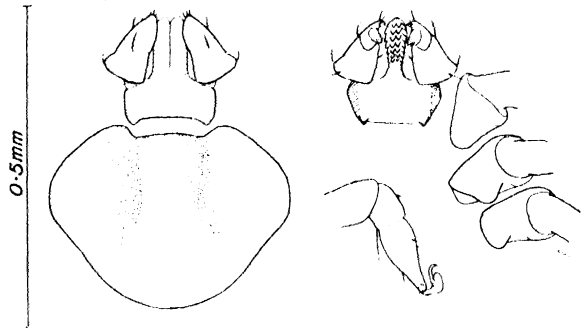


Fig. 329. *H. leporis-palustris*, larva. Scutum, capitulum in dorsal and ventral aspects, coxae and tarsus III. Drawn from (N. 2321) Texan specimen. Original, N. C. del.

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 ○s 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

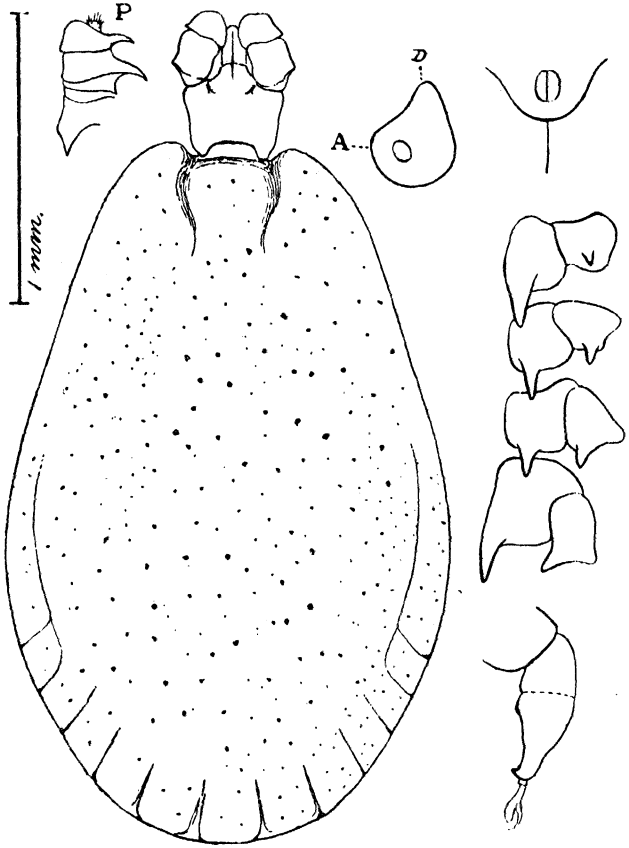


Fig. 330. *Haemaphysalis montgomeryi* ♂. Dorsum, right palp (*P*) in profile, spiracle, anal grooves, coxae with trochanters, tarsus IV. (G. H. F. N. and F. M. H. del.) Nuttall, 1912, Fig. 7.

[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,

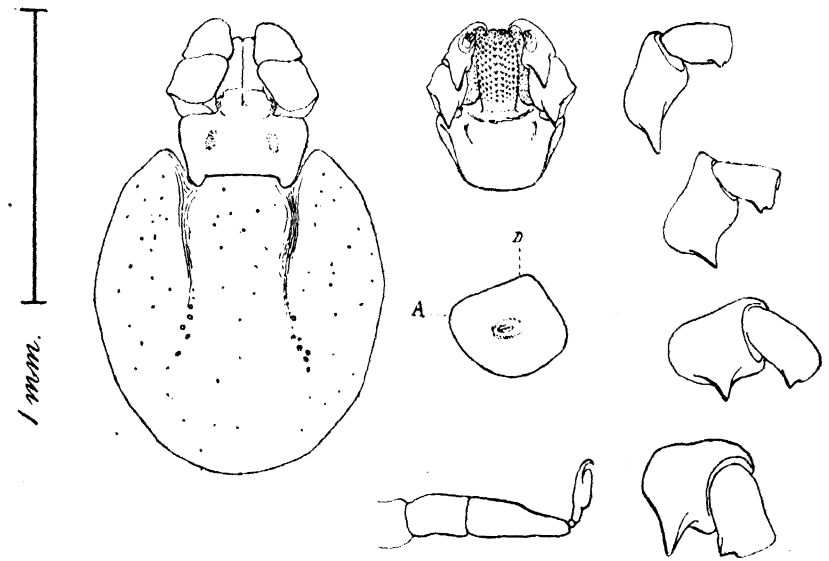


Fig. 331. *Haemaphysalis montgomeryi* ♀. Capitulum and scutum, capitulum in ventral aspect, coxae with trochanters, spiracle and tarsus IV. (F. M. H. del.) Nuttall, 1912, Fig. 8.

[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.

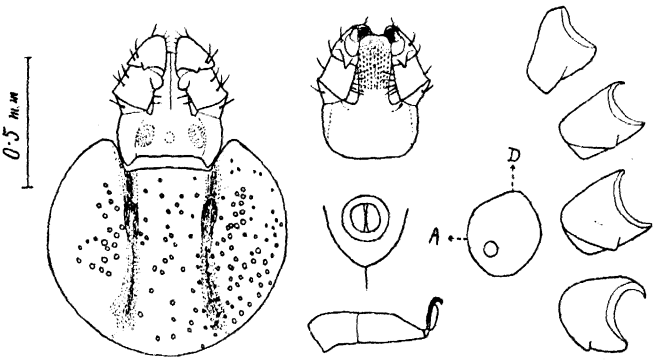


Fig. 332. *H. kinneari* ♀. Capitulum and scutum, ventral aspect of capitulum, anus with anal grooves, tarsus IV, spiracle and coxae. (N. C. del.) Warburton, 1913, Fig. 6.

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

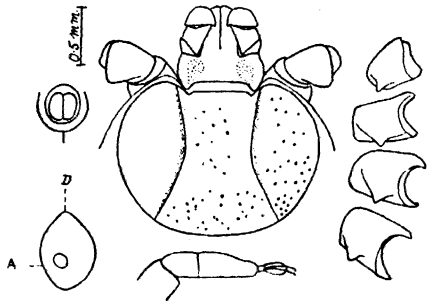


Fig. 333. *H. aborensis* ♀. Capitulum and scutum, anus with anal grooves, spiracle, tarsus IV and coxae. (N. C. del.) Warburton, 1913, Fig. 1.

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

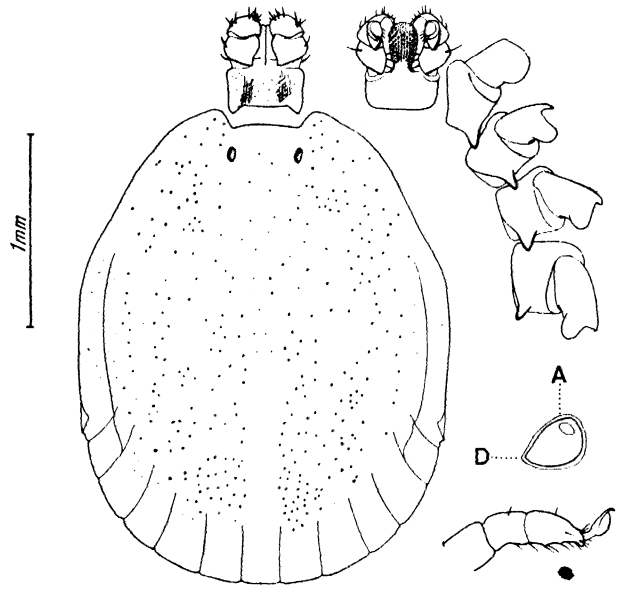


Fig. 334. *H. formosensis* ♂. Dorsum, capitulum in ventral aspect, coxae with trochanters, spiracle and tarsus IV. (N. 2730 Co-type.) Original, N. C. del.

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;

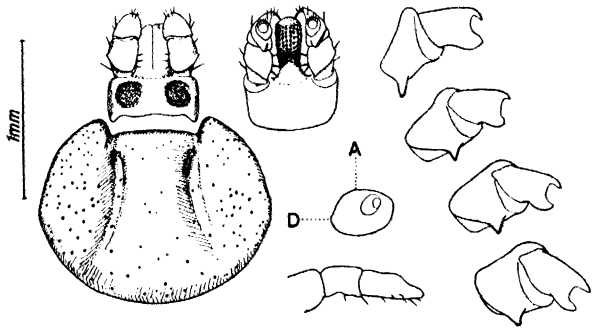


Fig. 335. *H. formosensis* ♀. Capitulum in dorsal and ventral aspects, scutum, coxae with trochanters, spiracle and tarsus IV. (Deutsches Entomol. Mus., Type.) Original, N. C. del.

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

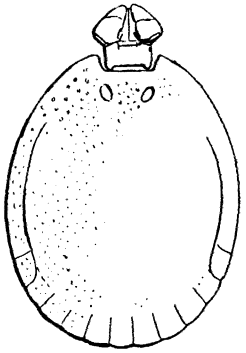


Fig. 336.

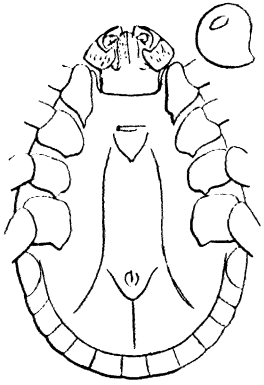


Fig. 337.

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-

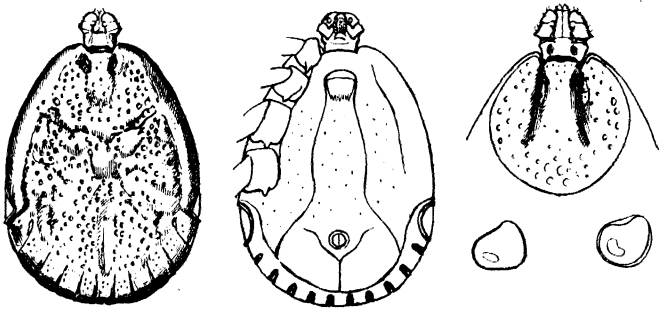


Fig. 338. *H. papuana* ♂, dorsum and venter; ♀ capitulum and scutum; ♂ and ♀ spiracles. Specimen from Borneo. Warburton, 1908, Fig. 4. E. Wilson del.

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*

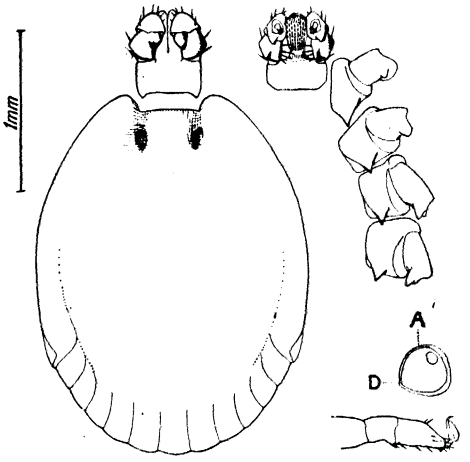


Fig. 339. *H. papuana* ♂ (N. 2116, atypical form from Malaya). Dorsum, ventral aspect of capitulum with coxae and trochanters, spiracle and tarsus IV. Original, N. C. del.

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

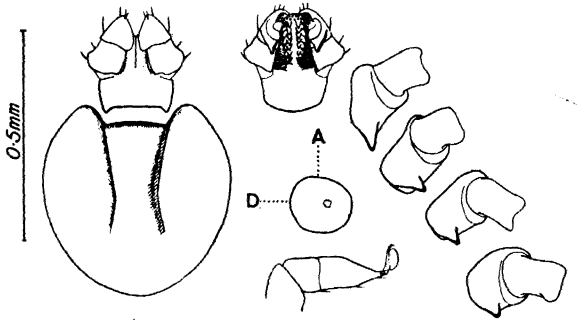


Fig. 340. *H. papuana*. Nymph. Capitulum in dorsal and ventral aspects, scutum, coxae with trochanters, spiracle and tarsus IV. Specimen (N. 220) from Borneo. Original, N. C. del.

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,

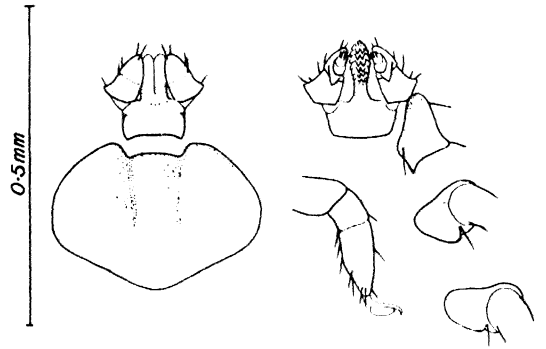


Fig. 341. *H. papuana*. Larva. Capitulum in dorsal and ventral aspects, scutum, coxae, tarsus III. Specimen (N. 1563) from Borneo. Original, N. C. del.

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.

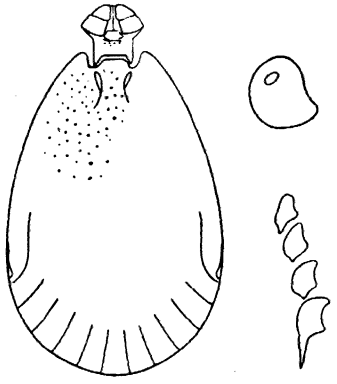


Fig. 342.

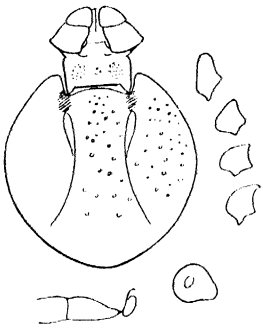


Fig. 343.

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,

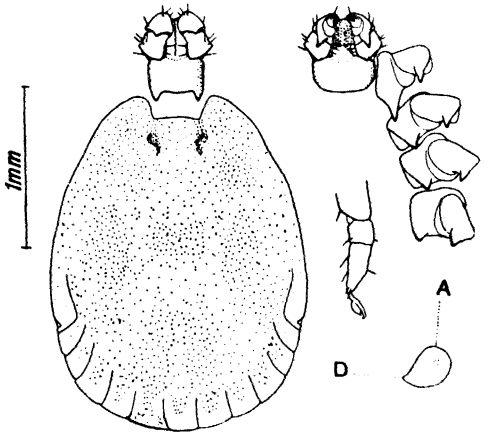


Fig. 344. *H. turturis* ♂. Dorsum, capitulum in ventral aspect, coxae with trochanters, spiracle and tarsus IV. Drawn from the type. Original, N. C. del.

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*:

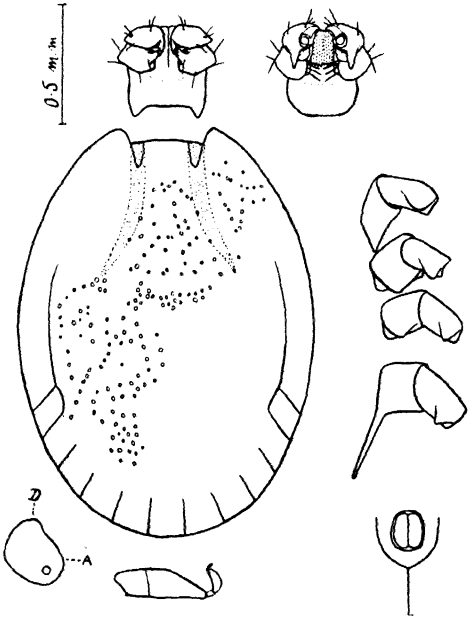


Fig. 345. *H. aciculifer* ♂. Capitulum in dorsal and ventral aspects, scutum, coxae and trochanters, spiracle, tarsus IV and anus with anal grooves. (N. C. del.) Warburton, 1913, Fig. 4.

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 ♂.

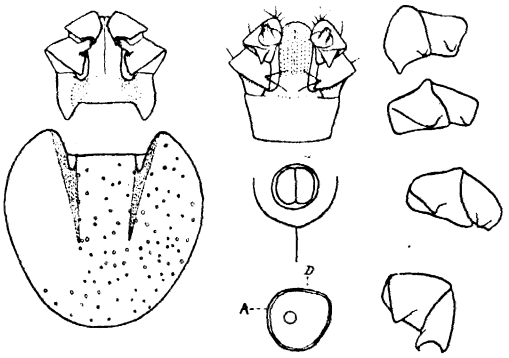


Fig. 346. *H. aciculifer* ♀. Capitulum in dorsal and ventral aspects, scutum, anus with anal grooves, spiracle, coxae and trochanters. (N. C. del.) Warburton, 1913, Fig. 5.

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.

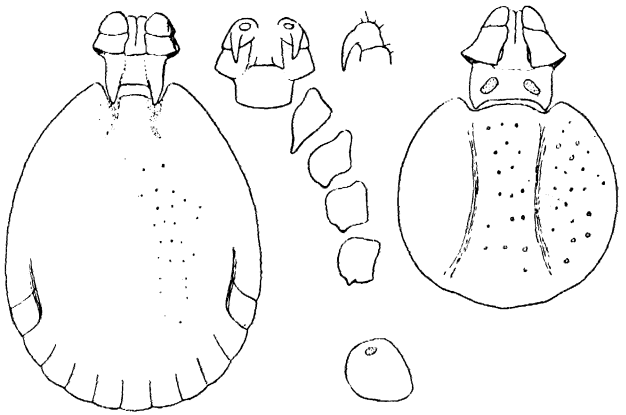


Fig. 347. *H. kochi* ♂. Dorsum, coxae and ventral aspect of capitulum; lateral aspect of palp, spiracle. ♀ capitulum and scutum. Sketched from the types. Original, C. W. del.

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.

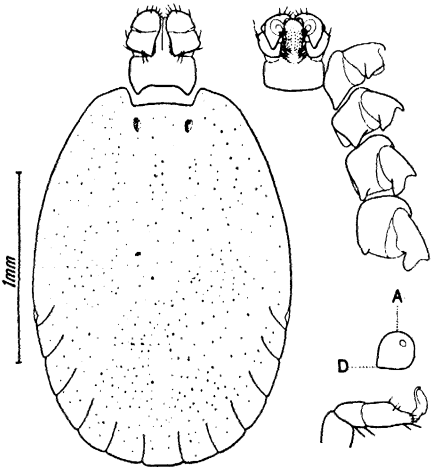


Fig. 348. *H. birmaniae* ♂. Dorsum, capitulum in ventral aspect, coxae with trochanters, spiracle and tarsus IV. Drawn from the type. Original, N. C. del.

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;

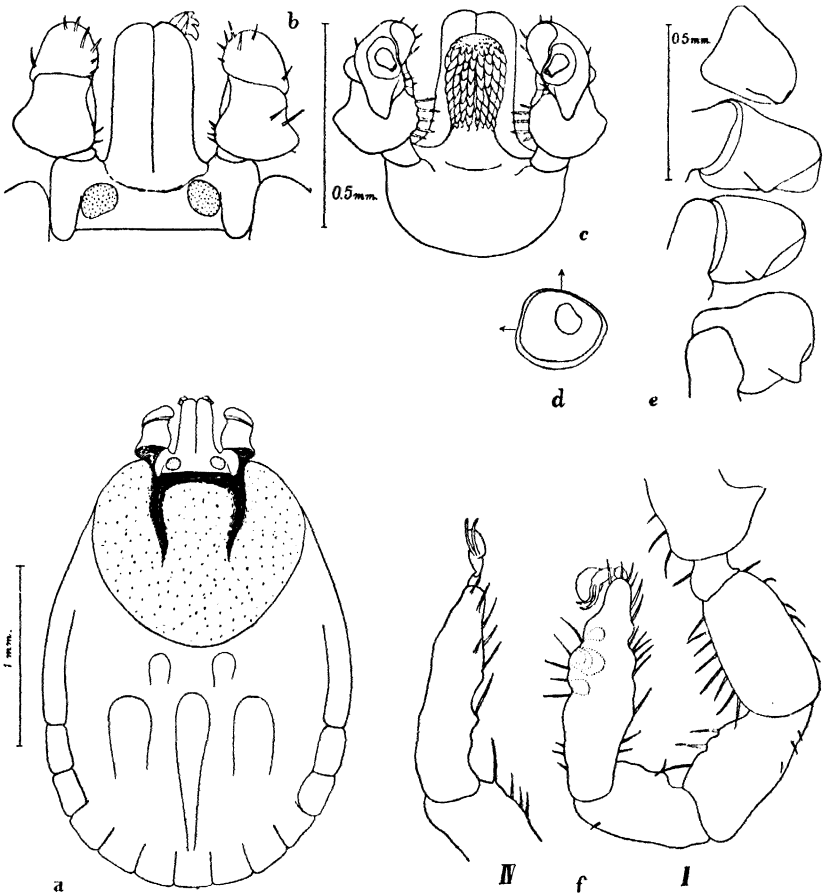


Fig. 349. *Haemaphysalis silacea* ♀ : (*a*) dorsum (capitulum foreshortened); (*b*) capitulum, dorsal aspect; (*c*) capitulum, ventral aspect; (*d*) spiracle (the arrows indicate the anterior and lateral margins, respectively); (*e*) coxae I–IV; (*f*) tarsi I and IV. *f*—same magnification as *b* and *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

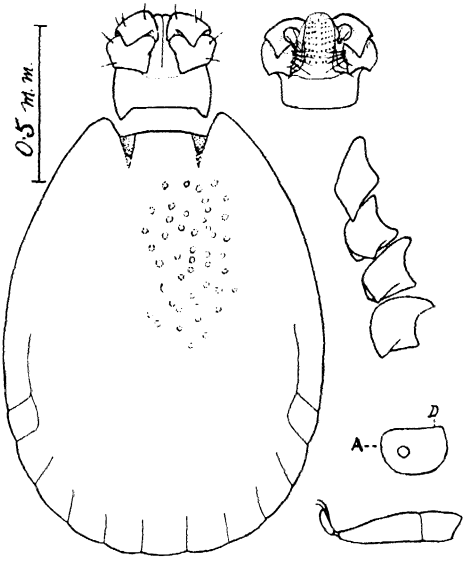


Fig. 350. *H. parmata* ♂. Dorsum, capitulum in ventral aspect, coxae, spiracle and tarsus IV. Specimen (N. 504) from West Africa. Original, N.C. del.

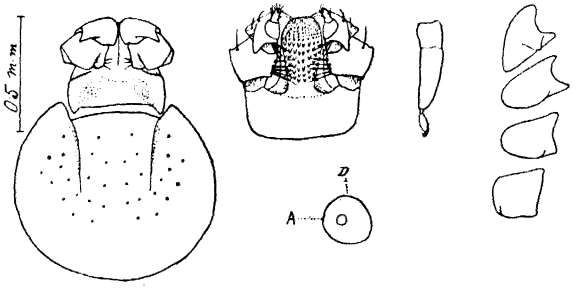


Fig. 351. *H. parmata* ♀. Scutum, capitulum in dorsal and ventral aspects, coxae, spiracle and tarsus IV. Specimen found with the ♂ depicted in Fig. 350. Original, N.C. del.

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.

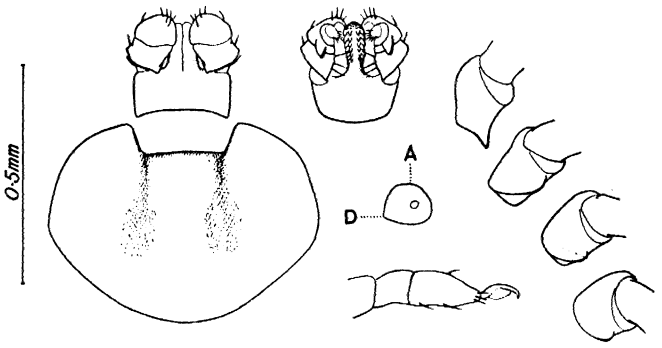


Fig. 352. *H. parmata* nymph. Scutum, capitulum in dorsal and ventral aspects, coxae, spiracle and tarsus IV. Specimen (N. 2354) from Congo Free State. Original, N. C. del.

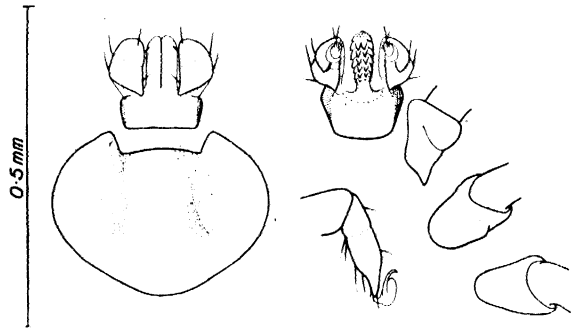


Fig. 353. *H. parmata* larva. Scutum, capitulum in dorsal and ventral aspect, coxae and tarsus III. Specimen (N. 2354) from Congo Free State. Original, N. C. del.

Larva (Fig. 353): *Scutum* essentially like that of the ♂. *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 ♂. *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 Nzoia 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) ♂ ♀s 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 ♀, collected in 1908 at Prahsu by Dr W. Graham. **Sierra Leone:** (E. 584 = N. 1899) ♂s ♀s ♀s 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.

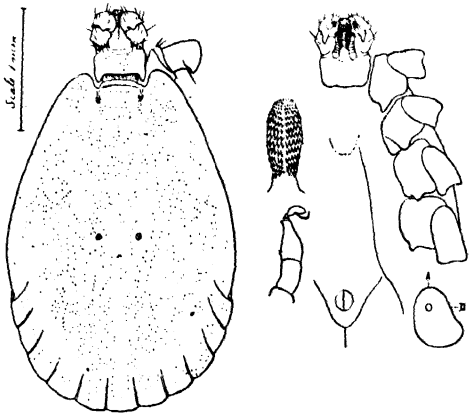


Fig. 354. *H. hystricis* ♂. Dorsum, part of venter, hypostome (highly magnified), spiracle and tarsus IV. Specimen (N. 679) from Federated Malay States. Original, G. H. F. N. del.

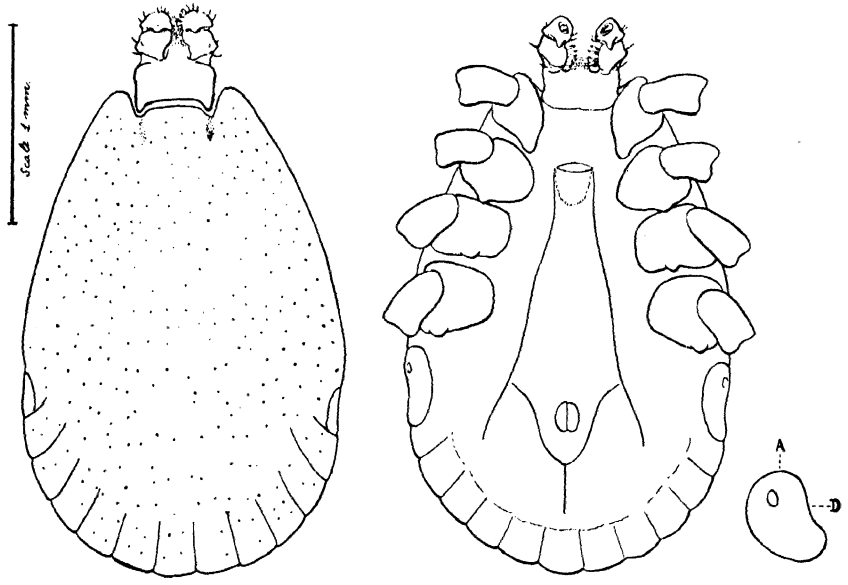


Fig. 355. *H. hystricis* ♂. Dorsum, venter and spiracle. Drawn from the type of *H. semermis* Nn. in the Paris Museum. Original, G. H. F. N. del.

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

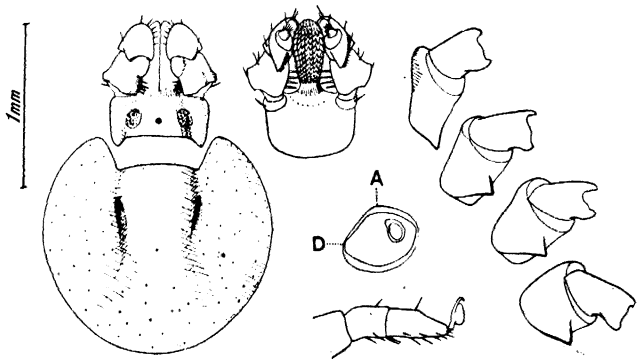


Fig. 356. *H. hystricis* ♀. Scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. Specimen (N. 576) from Assam. Original, G. H. F. N. del.

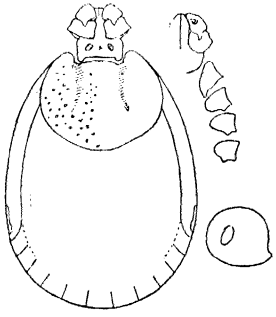


Fig. 357. *H. hystricis* ♀. Dorsum, etc. (not drawn to scale). Sketched by C. W. from a specimen lent by Prof. Neumann. Warburton, 1908, Fig. 11.

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-Asciuii-Chebà and at Carin-Chebà (900 m. elevation), by L. Fea in 1887–1889; (Indian Mus. 1798 b/17) 1 ♂ found at Arakan Yomas, Chauung, 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,

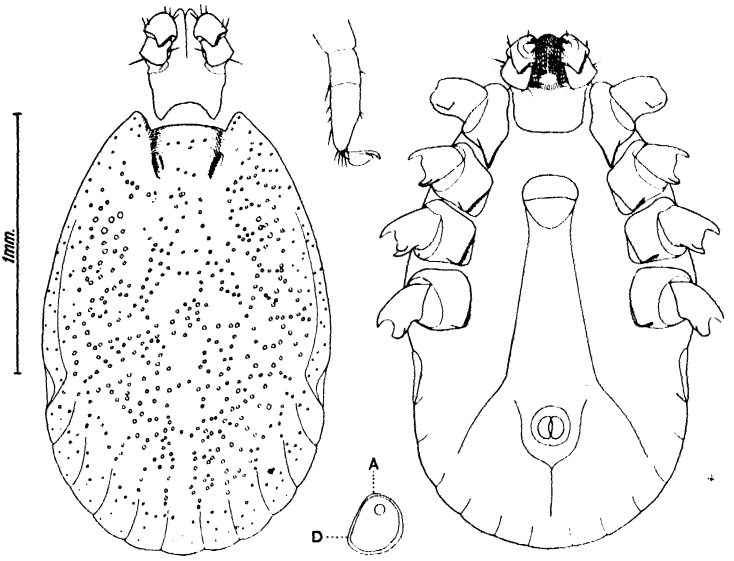


Fig. 358. *H. bispinosa* ♂. Dorsum, venter, tarsus IV, spiracle. Specimen (N. 1826 from Madras). Original, N. C. del.

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

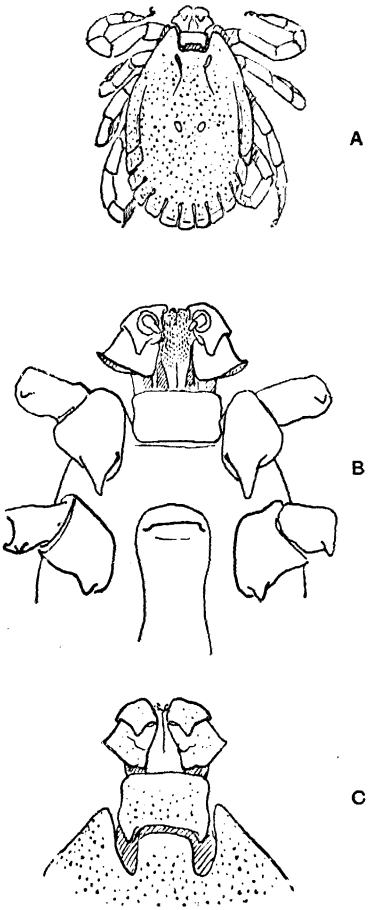


Fig. 359. *H. bispinosa* ♂: (A) dorsum, × 12 (the original figure showed eyes which are absent, they have now been erased; vide Dönitz, 1906, p. 143); (B) part of venter and—(C) capitulum more highly magnified. Dönitz, 1905, Pl. Figs. 4–6, illustrating *H. neumanni* Dö., 1905 (from horse, Japan), which 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

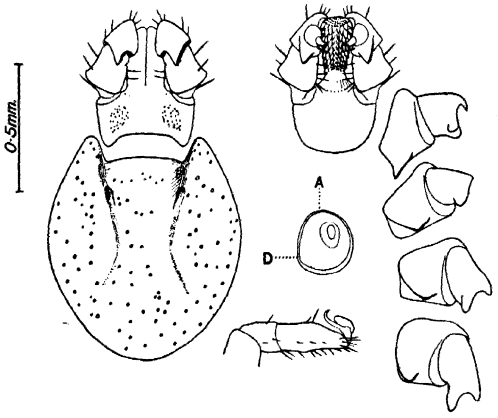


Fig. 360.

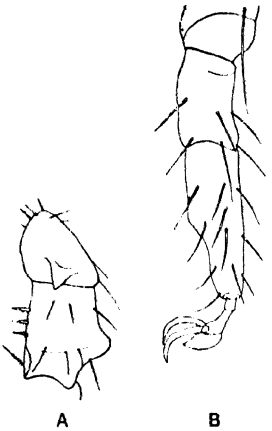


Fig. 361.

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.

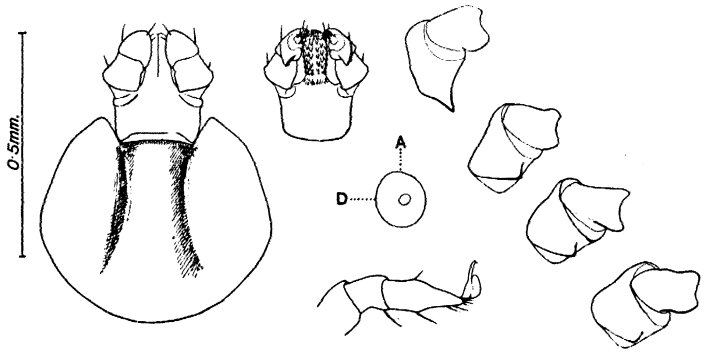


Fig. 362. *H. bispinosa* nymph. Capitulum in dorsal and ventral aspects, scutum, coxae with trochanters, spiracle, tarsus IV. (N. 1826, same origin as ♂ in Fig. 358.) Original, N. C. del.

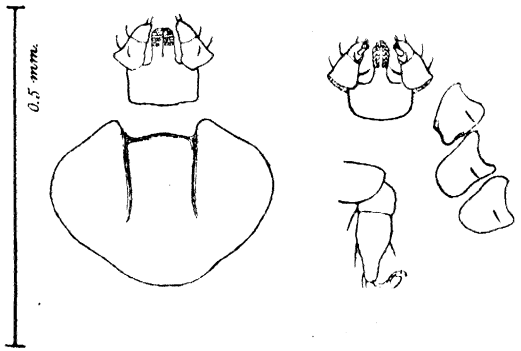


Fig. 362*a*. *H. bispinosa* larva. Capitulum in dorsal and ventral aspects, scutum, coxae and tarsus III. Drawn from (N. 2745) specimens raised in Cambridge, the progeny of a ♀ from Madras. Original, G. H. F. N. del.

[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 ♀; 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), ♂ ♀ ♀, 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.

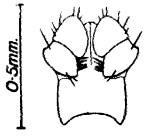


Fig. 363.

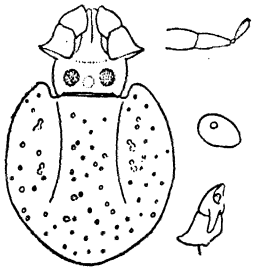


Fig. 364.

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

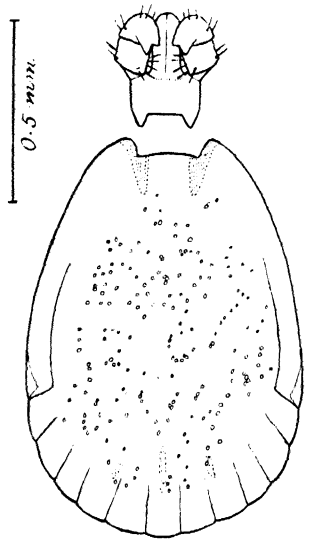


Fig. 365. *H. parva* ♂. Dorsum. Drawn from co-type No. 1038 in Galli-Valerio coll. Original, N. C. del.

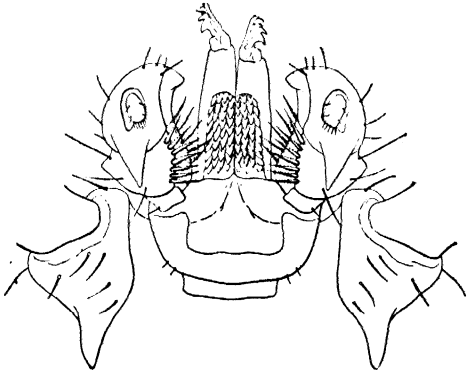


Fig. 366. *H. parva* ♂. Capitulum in ventral aspect with coxae I. Neumann VII. 1908, Fig. 10.

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, o s 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*:

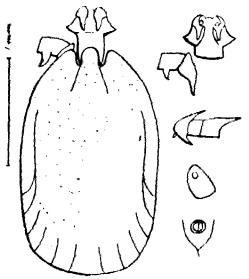


Fig. 367.

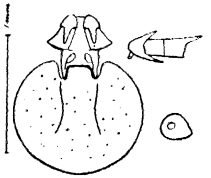


Fig. 368.

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.

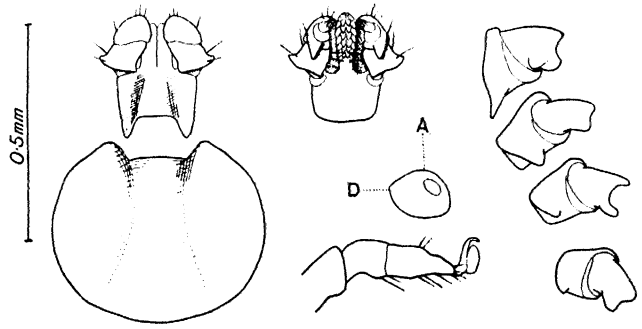


Fig. 369. *H. cuspidata*. Nymph. Scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. (N. 2692 type.) Original, N. C. del.

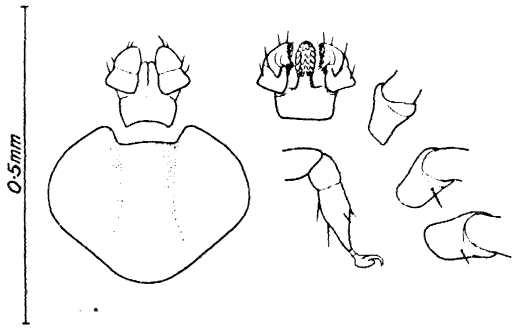


Fig. 370. *H. cuspidata* Larva. Scutum, capitulum in dorsal and ventral aspects, coxae and tarsus III. (N. 2692 type.) Original, N. C. del.

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

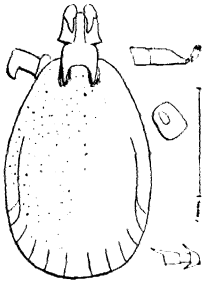


Fig. 371.

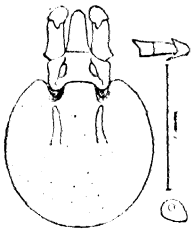


Fig. 372.

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.

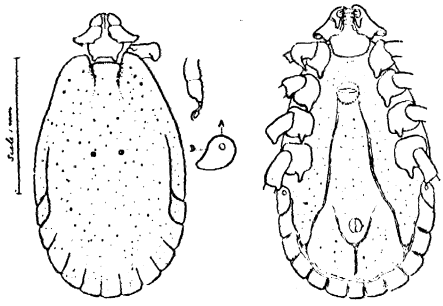


Fig. 373.

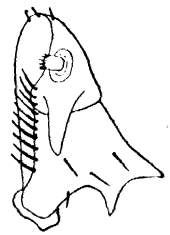


Fig. 374.

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,

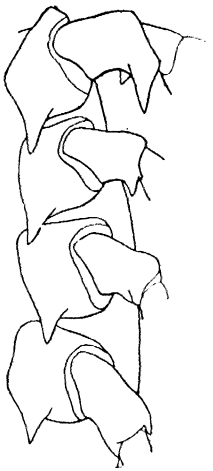


Fig. 375.

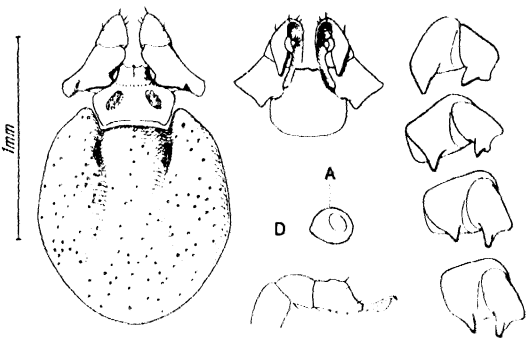


Fig. 376.

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 ♀ from *Spermosciurus* sp., Sichi Baz, **Abyssinia**, collected by Hilgert (received in 1901 from Erlanger).

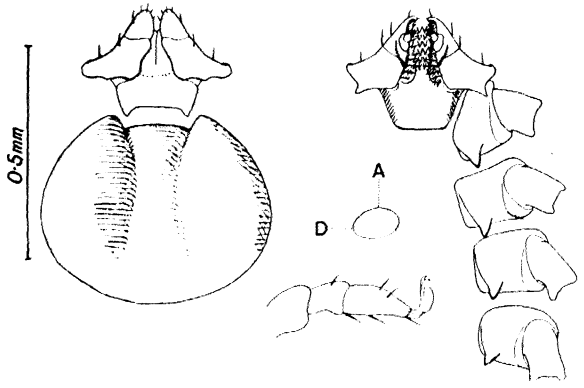


Fig. 377. *H. calcarata* Nymph. Capitulum and scutum, capitulum in ventral aspect, with coxae and trochanters, spiracle and tarsus IV. (N. 1224.) Original, N. C. del.

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 ♀, 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

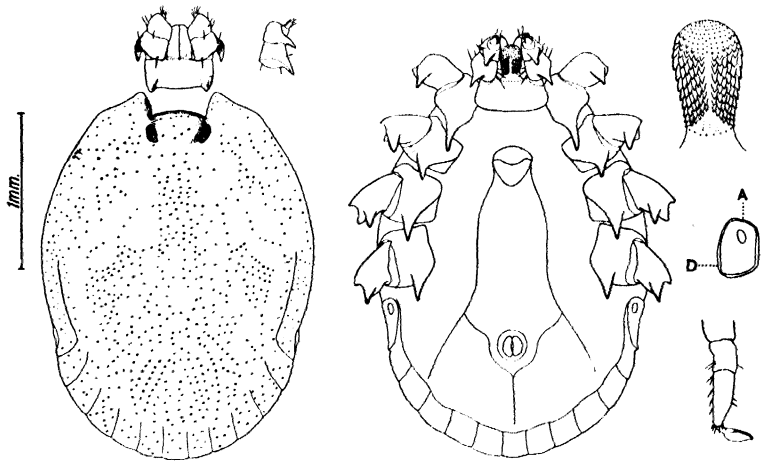


Fig. 378. *H. calvus* ♂. Dorsum and venter, right palp in profile, hypostome (highly magnified), spiracle and tarsus IV. (N. 2120 type.) Original, N. C. del.

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

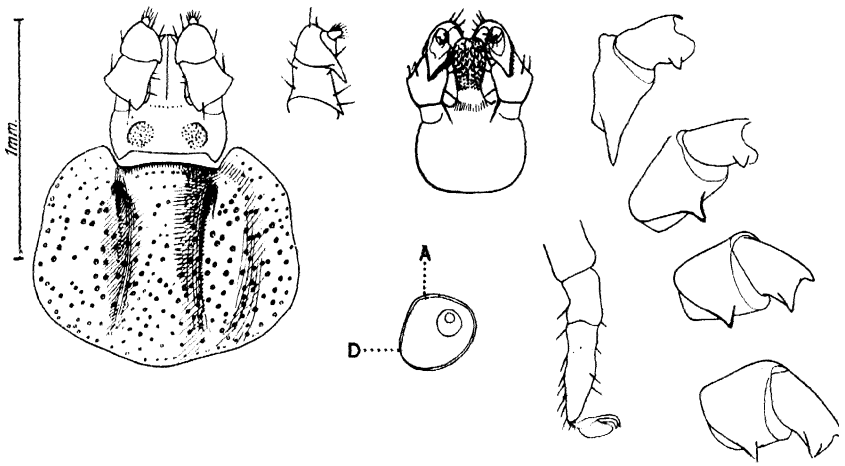


Fig. 379. *H. calvus* ♀. Scutum, capitulum in dorsal and ventral aspects, right palp in profile, coxae with trochanters, spiracle and tarsus IV. (N. 2120 type.) Original, N. C. del.

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;

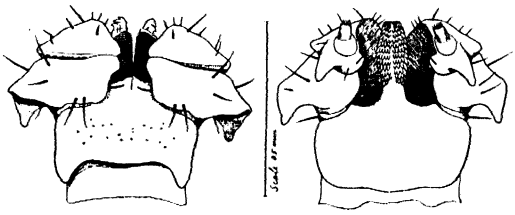


Fig. 380. *H. spinigera* ♂. Capitulum in dorsal and ventral aspects. Drawn from a balsam-mounted type specimen taken from a bear. Only the surface structures are shown. Original, G. H. F. N. del.

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.

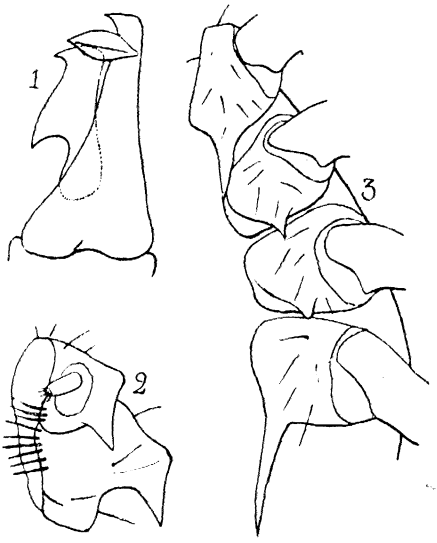


Fig. 381. *H. spinigera* ♂: (1) left digit, × 320; (2) left palp in ventral aspect, × 65; (3) coxae, × 45. Drawings from the type. Neumann, 1897, Fig. 18.

Female (Figs. 382, 383). *Scutum* sub-circular, 1·2 × 1·1 mm., with very fine punctations irregularly distributed; cervical grooves faint,

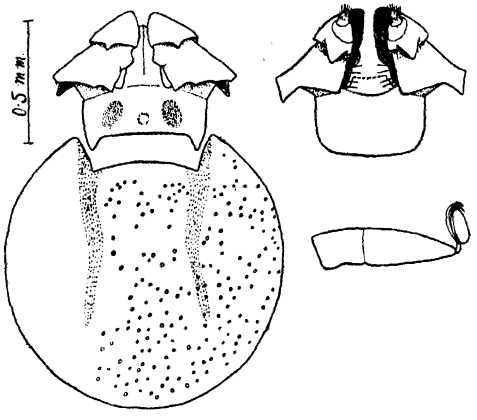


Fig. 382.

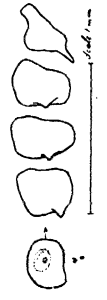


Fig. 383.

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*)

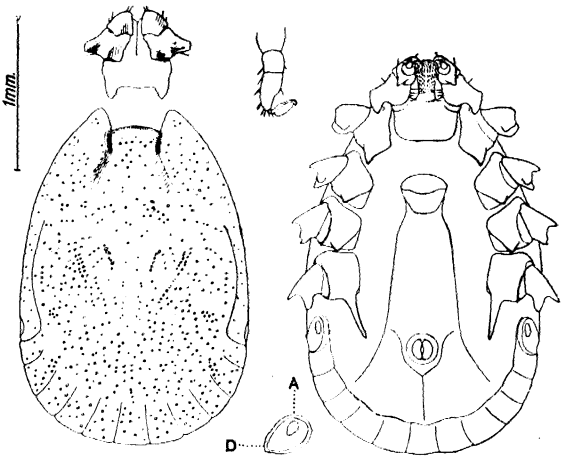


Fig. 384. *H. spinigera* var. *novae-guineae* ♂. Dorsum and venter, spiracle and tarsus IV. (N. 2673.) Original, N. C. del.

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	

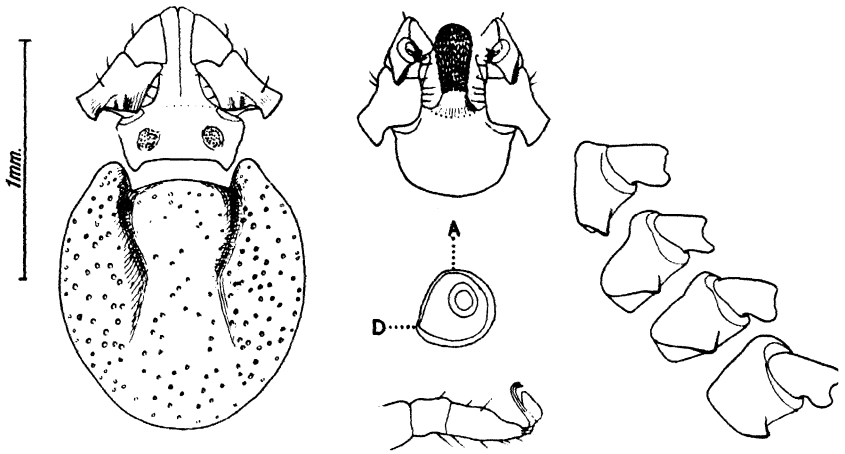


Fig. 385. *H. spinigera* var. *novae-guineae* ♀. Scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. (N. 2673.) Original, N. C. del.

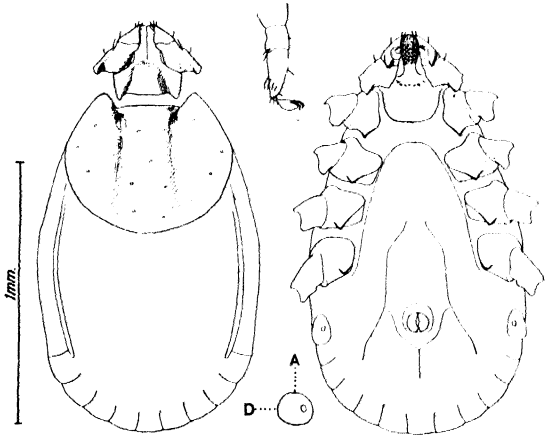


Fig. 386. *H. spinigera* var. *novae-guineae*, nymph. Dorsum and venter, spiracle and tarsus IV. (N. 2673.) Original, N. C. del.

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; descrip-

tion 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

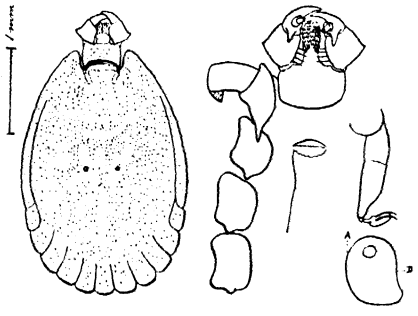


Fig. 387.

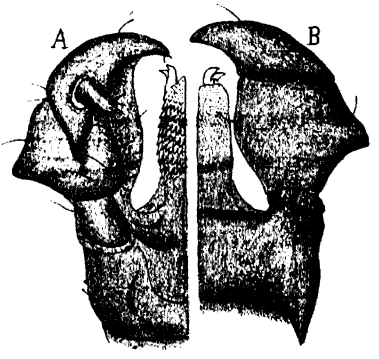


Fig. 388.

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

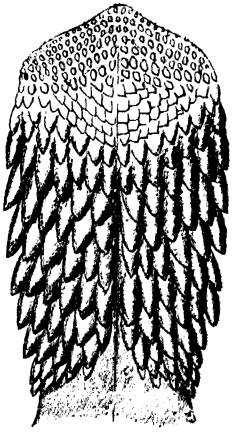


Fig. 389.



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 1·2 × 1·4 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	

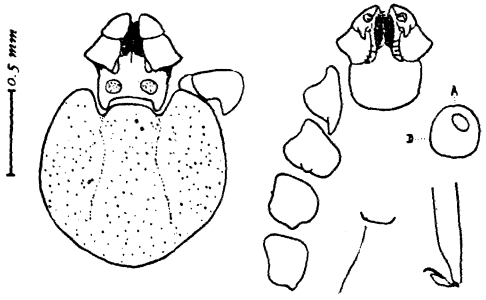


Fig. 391. *H. concinna* ♀, capitulum and scutum, ventral aspect of capitulum with coxae, spiracle and tarsus IV. Same origin as the ♂ in Fig. 387. G. H. F. N. del.

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

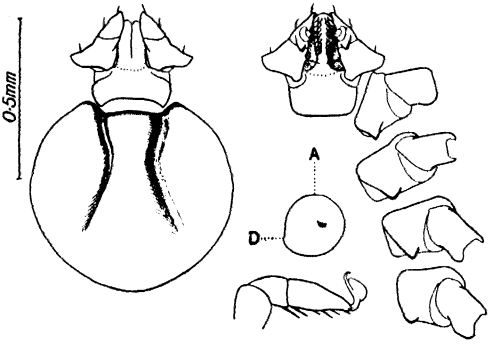


Fig. 392. *H. concinna* nymph, capitulum in dorsal and ventral aspects, scutum, coxae with trochanters, spiracle and tarsus IV. (N. 2763, specimen raised by E. Brumpt.) Original, N. C. del.

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.

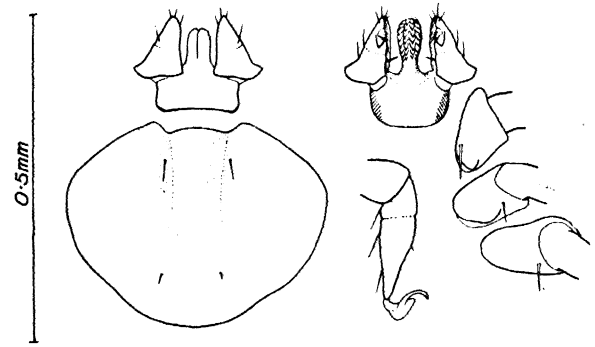


Fig. 393. *H. concinna* larva, capitulum in dorsal and ventral aspects, scutum, coxae with trochanters, spiracle and tarsus III. (N. 2763, specimen raised by E. Brumpt.) Original, N.C. del.

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 (O 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."

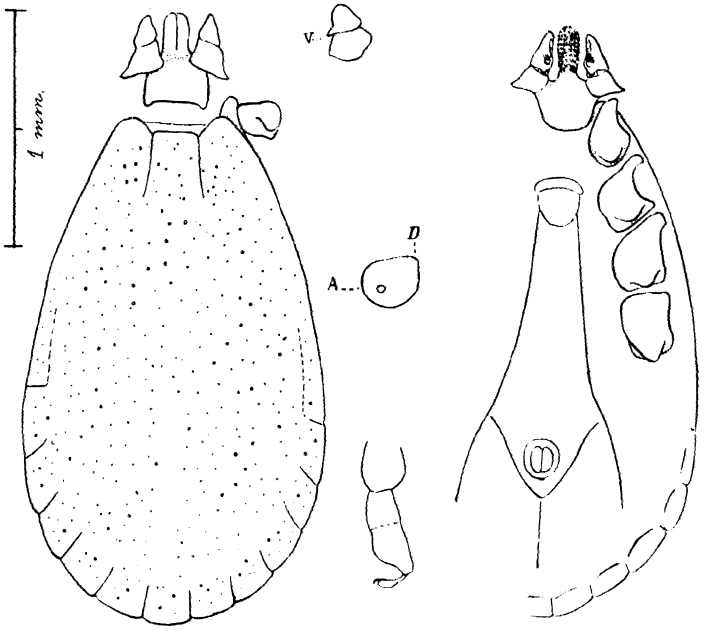


Fig. 394. *H. simplex* ♂, dorsum, venter, left palp in profile (*v* = ventral spur), spiracle and tarsus IV. Drawn from British Museum specimen. Original, G. H. F. N. del.

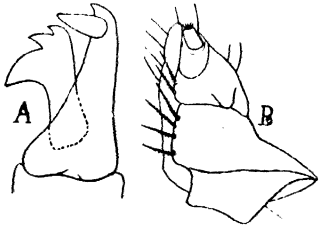


Fig. 395.

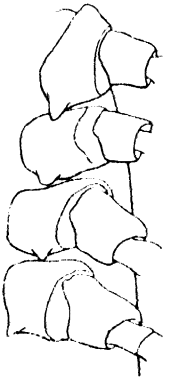


Fig. 396.



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 ♀ found on *Erinaceus* sp. in **Madagascar**, 1894, by Sikora, together with *H. elongata* ♀. The description of the ♀ 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; experi-

mental 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

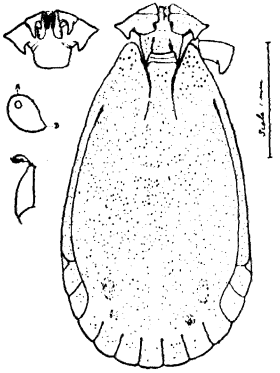


Fig. 398.

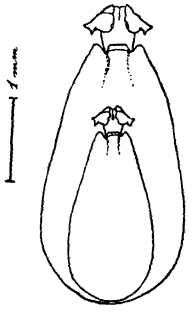


Fig. 399.

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. 954 *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.

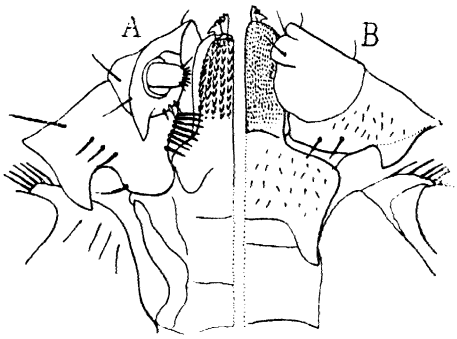


Fig. 400.

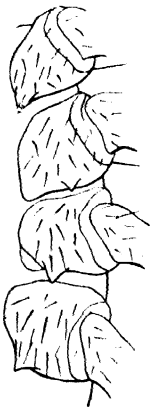


Fig. 401.

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.

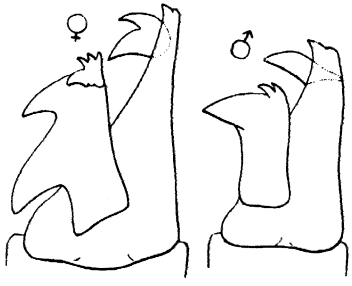


Fig. 402.

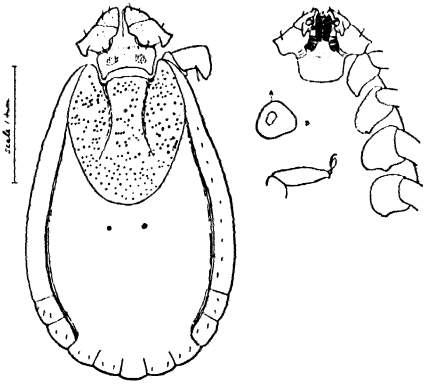


Fig. 403.

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 sub-circular, 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).

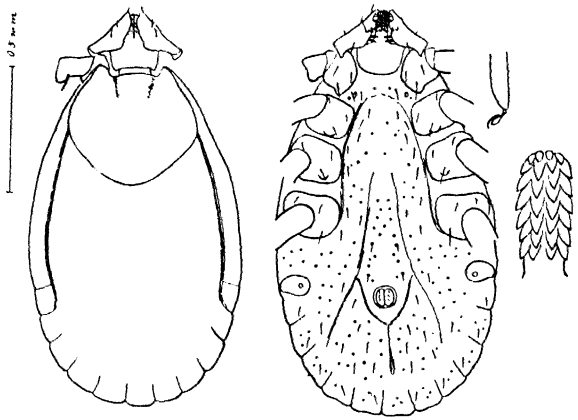


Fig. 404. *H. leachi* nymph, dorsum, venter, tarsus IV, hypostome [highly magnified]. (N. 1048. G. H. F. N. del.) Nuttall x. 1913 *a*, Fig. 9.

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,

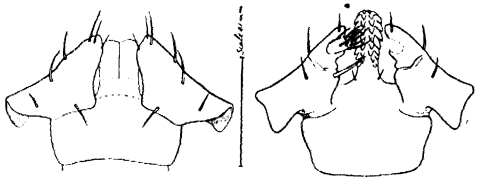


Fig. 405.

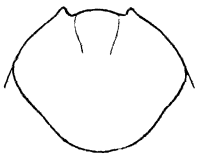


Fig. 406.

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 o s raised in Cambridge:

	Scutums	Bodies (unfed)
N. 1737 from B. E. Africa (5 o)	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

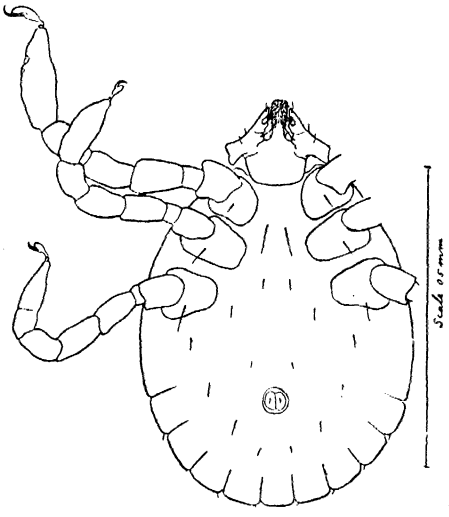


Fig. 407. *H. leachi* larva. Ventral aspect. Specimen raised in Cambridge. Nuttall, x. 1913 *a*, Fig. 10.

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

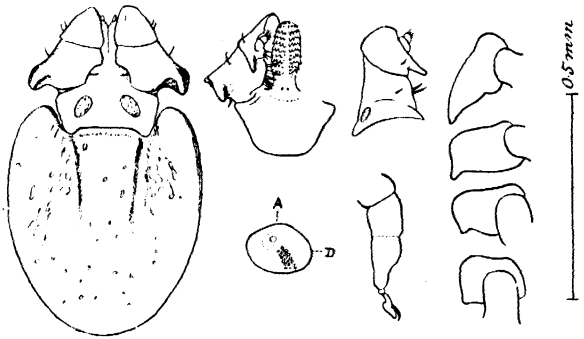


Fig. 408 *H. leachi* ♀ (var. *indica*, Warburton). Capitulum (0·8 mm. long) in dorsal and ventral aspects, scutum, palp in profile, coxae, spiracle and tarsus IV. Specimen (N. 942 *b*) from Madras. Original, G. H. F. N. del.

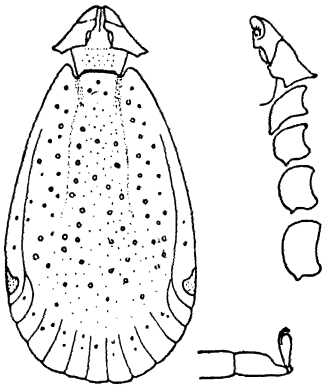


Fig. 409.

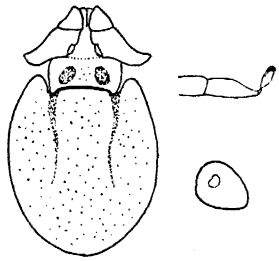


Fig. 410.

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

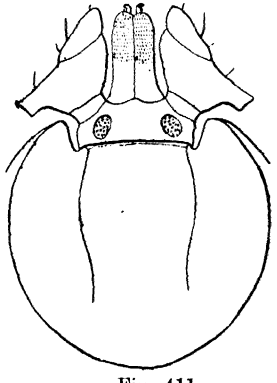


Fig. 411.

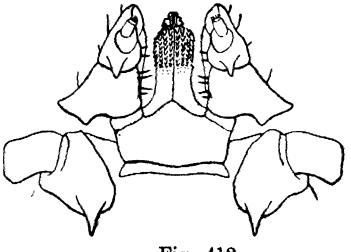


Fig. 412.

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.

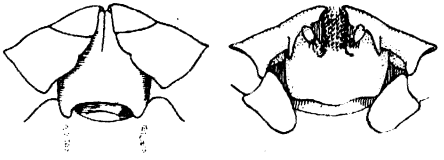


Fig. 413. *H. obtusa* ♂. Capitulum in dorsal and ventral aspects, with front of scutum and coxae I. Redrawn from Dönitz, 1910, Pl. XVII, Figs. 11 and 12.

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).

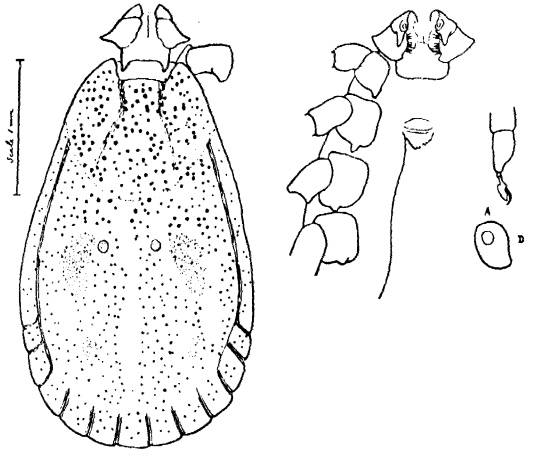


Fig. 414.

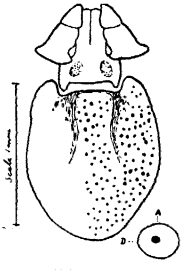


Fig. 415.

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.

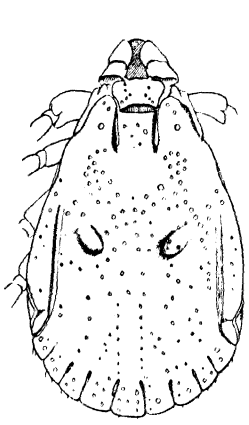
Lit. and Icon.: Nuttall and Warburton, XII. 1907, pp. 397–398, Figs. 9–11 (reproduced). Blanchard, 1909, p. 157 (species only listed).

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	,,		



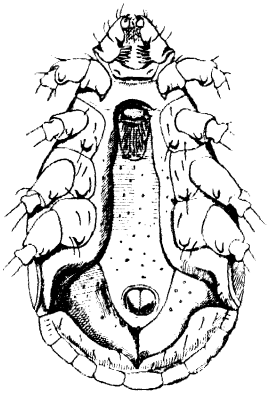


Fig. 416.

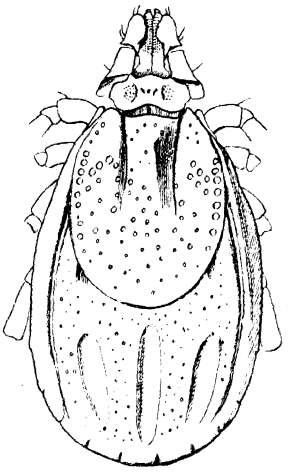
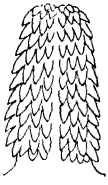


Fig. 417.

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.

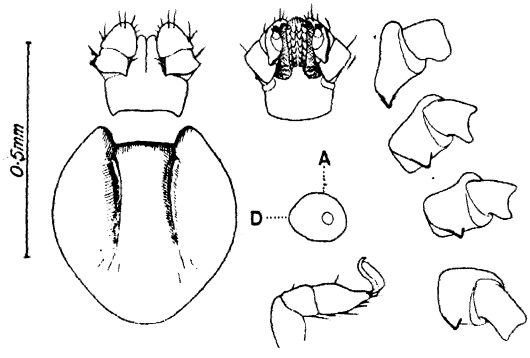


Fig. 419. *H. wellingtoni* nymph. Capitulum in dorsal and ventral aspects, scutum, coxae with trochanters, spiracle and tarsus IV. (N. 1057 from Selangor.) Original, N. C. del.

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.

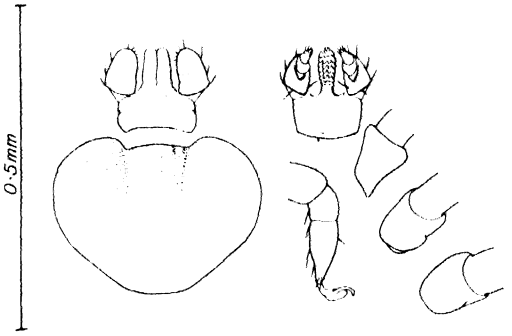


Fig. 420. *H. wellingtoni* larva. Capitulum in dorsal and ventral aspects, scutum, coxae, tarsus III. (N. 1057 from Selangor.) Original, N. C. del.

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.

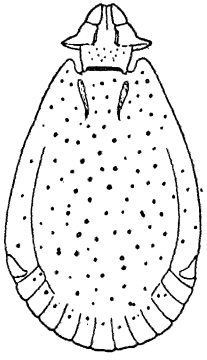


Fig. 421.

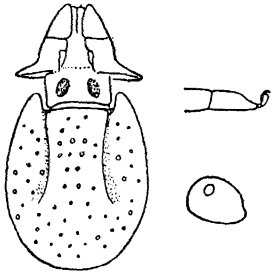


Fig. 422.

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.

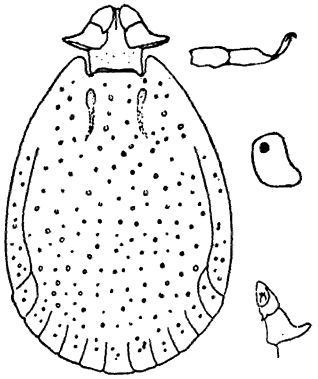


Fig. 423.

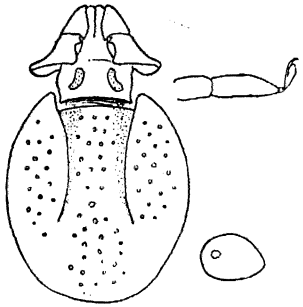


Fig. 424.

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 × 0·9 to 0·75 × 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.

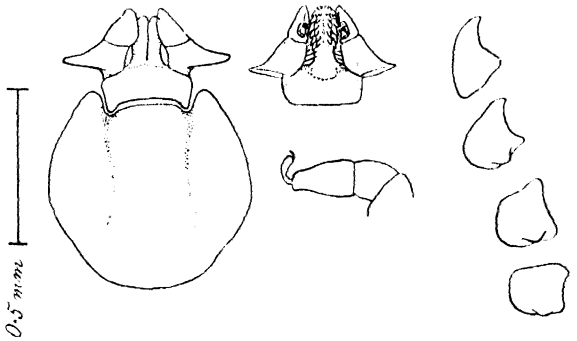


Fig. 425. *H. hoodi* o. Capitulum and scutum, capitulum in ventral aspect, coxae and tarsus IV. (N. 1364.) Original, G. H. F. N. del.

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.

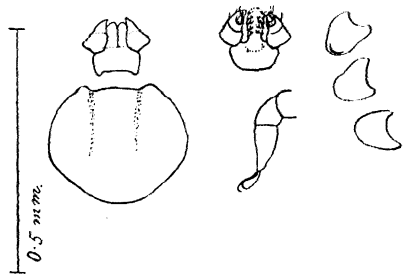


Fig. 426. *H. hoodi* larva. Capitulum and scutum, capitulum in ventral aspect, coxae and tarsus III. (N. 1364.) Original, G. H. F. N. del.

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

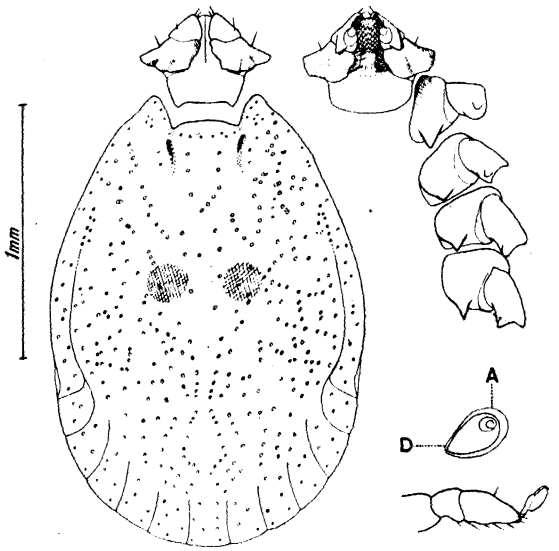


Fig. 427. *H. bancrofti* ♂, dorsum, capitulum in ventral aspect, coxae with trochanters, spiracle and tarsus IV. (N. 2100 type.) Original, N. C. del.

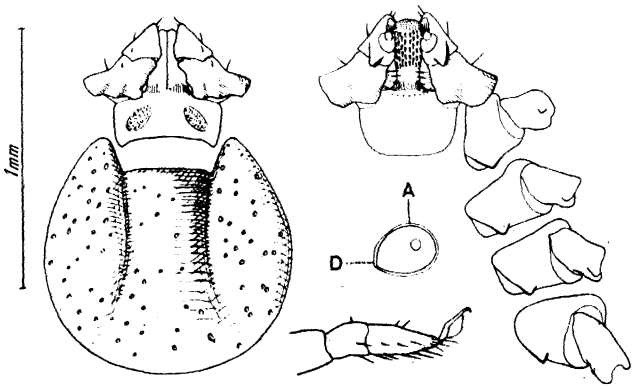


Fig. 428. *H. bancrofti* ♀, scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. (N. 2100 type.) Original, N. C. del.

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

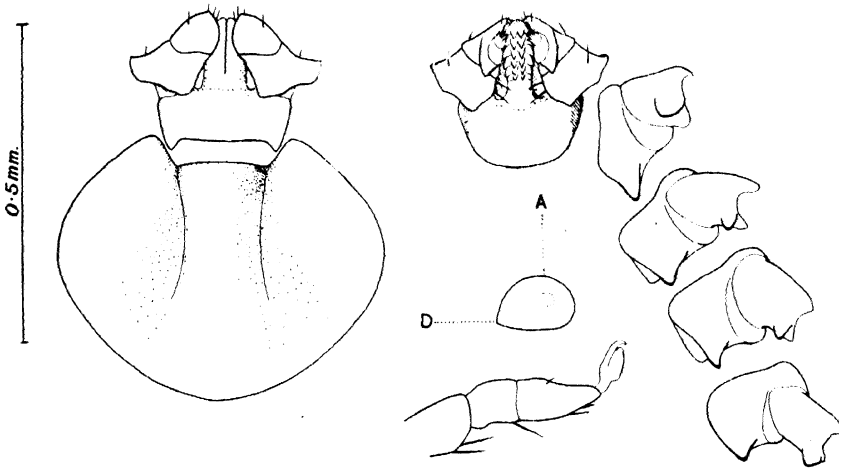


Fig. 429. *H. bancrofti* nymph. Scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle and tarsus IV. (N. 2114 co-type.) Original, N. C. del.

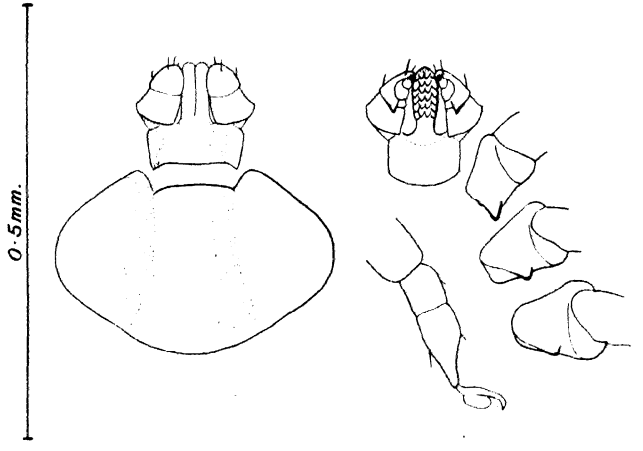


Fig. 430. *H. bancrofti* larva. Scutum, capitulum in dorsal and ventral aspects, coxae, tarsus III. (N. 2689 co-type.) Original, N. C. del.

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 0·2 × 0·25 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 0·37 × 0·58 to 0·32 × 0·56 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
L	0·35 × 0·51
	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

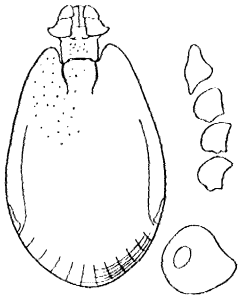


Fig. 431.

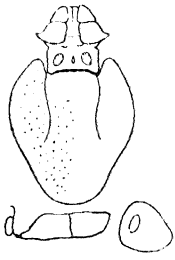


Fig. 432.

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.

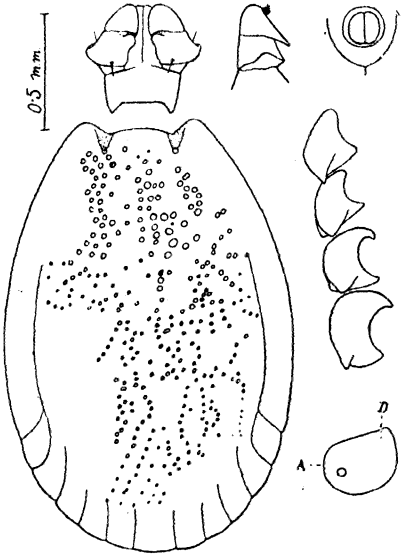


Fig. 433. *H. howletti* ♂, capitulum, scutum, profile of capitulum, anus with anal grooves, coxae and spiracle. (N. C. del.) Warburton, 1913, Fig. 2.

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.

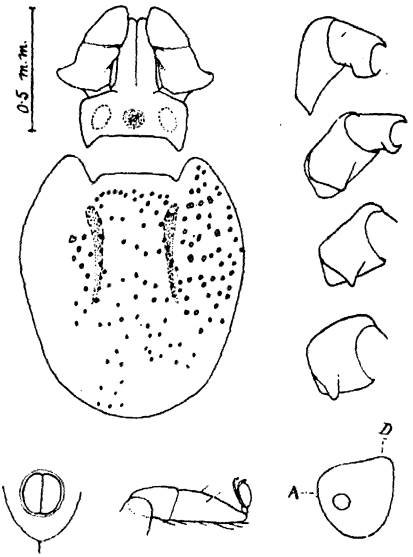


Fig. 434. *H. howletti* ♀, capitulum, scutum, coxae and trochanters, anus with anal grooves, tarsus IV and spiracle. N. C. del. Warburton, 1913, Fig. 3.

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

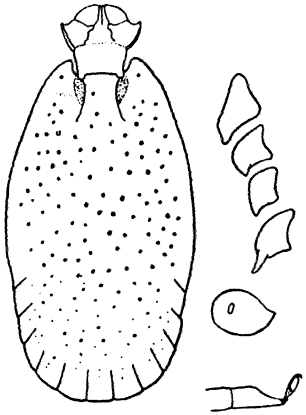


Fig. 435. *H. vidua* ♂, dorsum, coxae, spiracle, tarsus IV. Sketch by C. W. Warburton and Nuttall, 1909, Fig. 13.

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

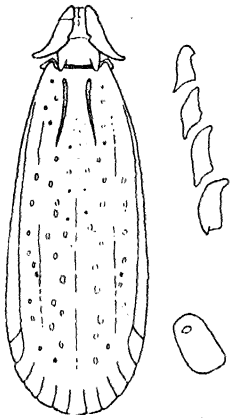


Fig. 436.

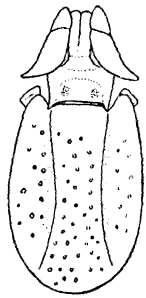


Fig. 437.

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	

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 ♀ 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 ♀s 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).

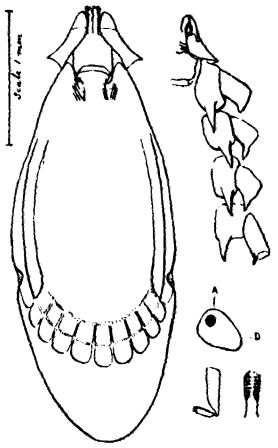


Fig. 438. *H. elongata* ♂ (N. 670, gorged), dorsum showing protrusion of abdomen beyond the scutum, coxae and trochanters with part of capitulum, spiracle, tarsus IV and hypostome. Original, G. H. F. N. del.

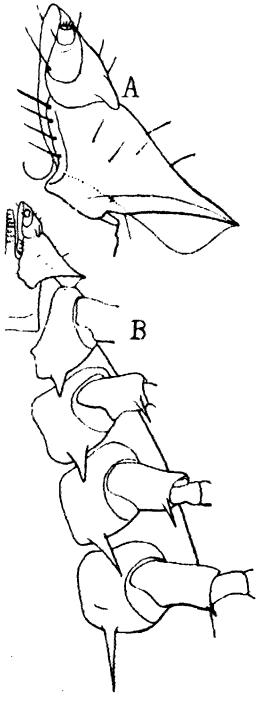


Fig. 439. *H. elongata* ♂, (*A*) left palp in ventral aspect, ×100; (*B*) coxae I–IV with trochanters, ×40. Neumann, 1897, Fig. 19.

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 ♂.

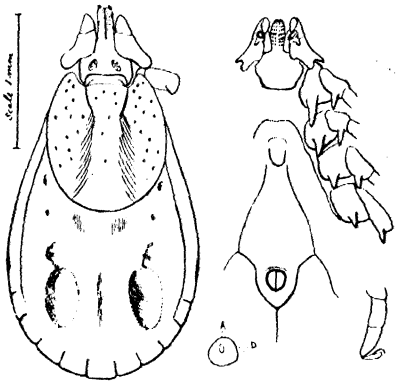


Fig. 440. *H. elongata* ♀ (N. 670, unfed), dorsum, part of venter, spiracle and tarsus IV. Original, G. H. F. N. del.

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-

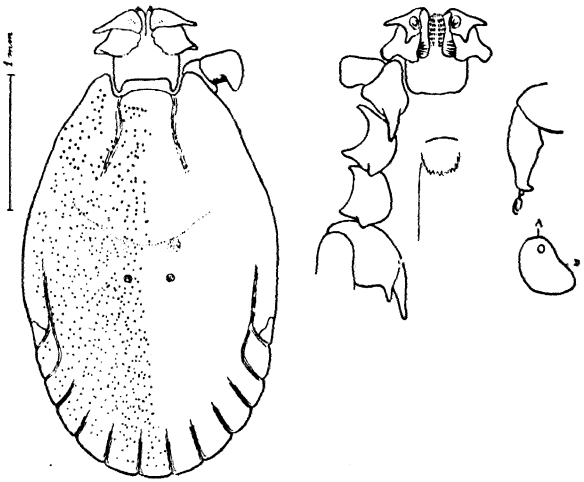


Fig. 441. *H. cornigera* ♂, dorsum, part of venter, spiracle and tarsus IV. Specimen from Borneo, co-type (N. 2883). Original, G. H. F. N. del.

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.

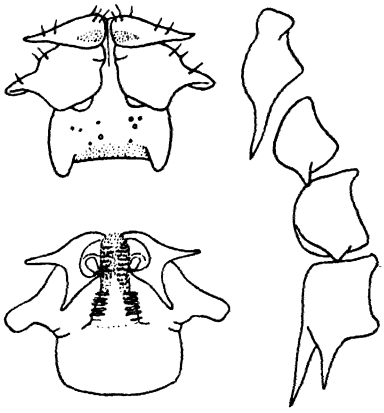


Fig. 442. *H. cornigera* ♂, capitulum in dorsal and ventral aspects, coxae. Specimen from Federated Malay States. (N. 1647. Type of *H. spiniceps* Warb. and Nutt.) Sketch by C. W. Warburton and Nuttall, 1909, Fig. 15.

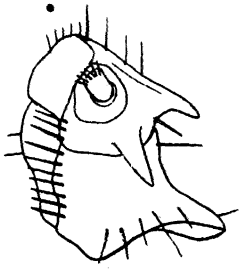


Fig. 443.



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.

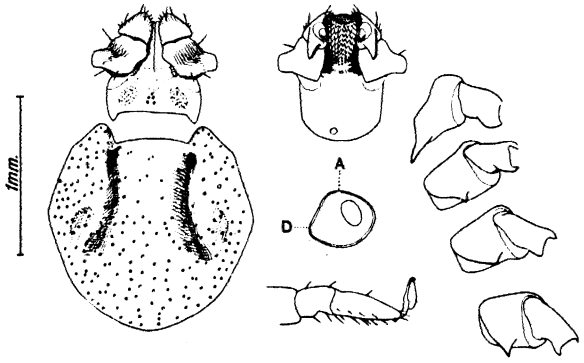


Fig. 445. *H. cornigera* ♀, scutum, capitulum in dorsal and ventral aspects, coxae with trochanters, spiracle, tarsus IV. Drawn from specimens from British N. Borneo (N. 2119 *b*), the tarsus drawn from (N. 2118). Original, N. C. del.

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.

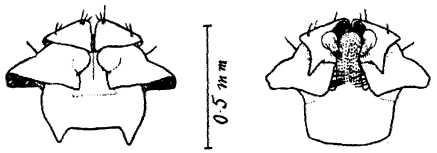


Fig. 446. *H. cornigera* var. *anomala* ♂, dorsal and ventral aspects of capitulum. N. C. del. Warburton, 1913, Fig. 7.

[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

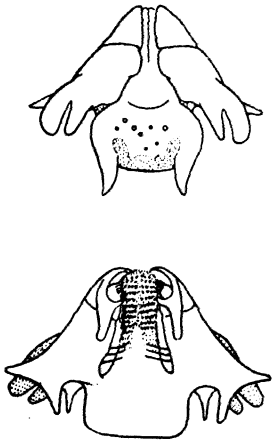


Fig. 447. *H. dentipalpis* ♂, capitulum in dorsal and ventral aspects. Sketch by C. W. Warburton and Nuttall, 1909, Fig. 14.

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), *Avicanthus pumillis* (os.), *Anomalurus orientalis* (squirrel), *Lepus* sp., *Erinaceus albiventris*, *Erinaceus* sp. Birds: *Dryoscopus turatii* and nightingale Reptiles: *Itonyx capensis*, *Testudo* sp. (os.)
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.

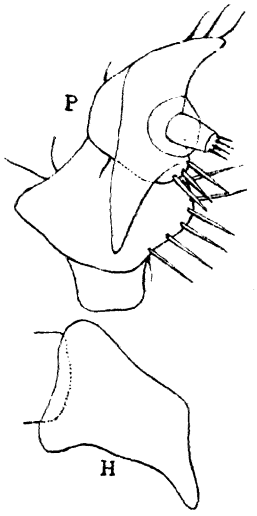


Fig. 448. *H. longicornis* Neumann, 1901, Fig. 2. ♀ (*P*) palp in ventral aspect, (*H*) coxa I.

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. II (♂) = *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:

		PAGE
1.	*H. cinnabarina* var. *punctata* . . .	519
2.	*H. cinnabarina*	528
3.	*H. leporis-palustris*	530
4.	*H. leachi*	536
5.	*H. concinna*	542
6.	*H. inermis*	545

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	
				4 ,, 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
				1 ,, 17	males, none
				3 ,, 18	lost.

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

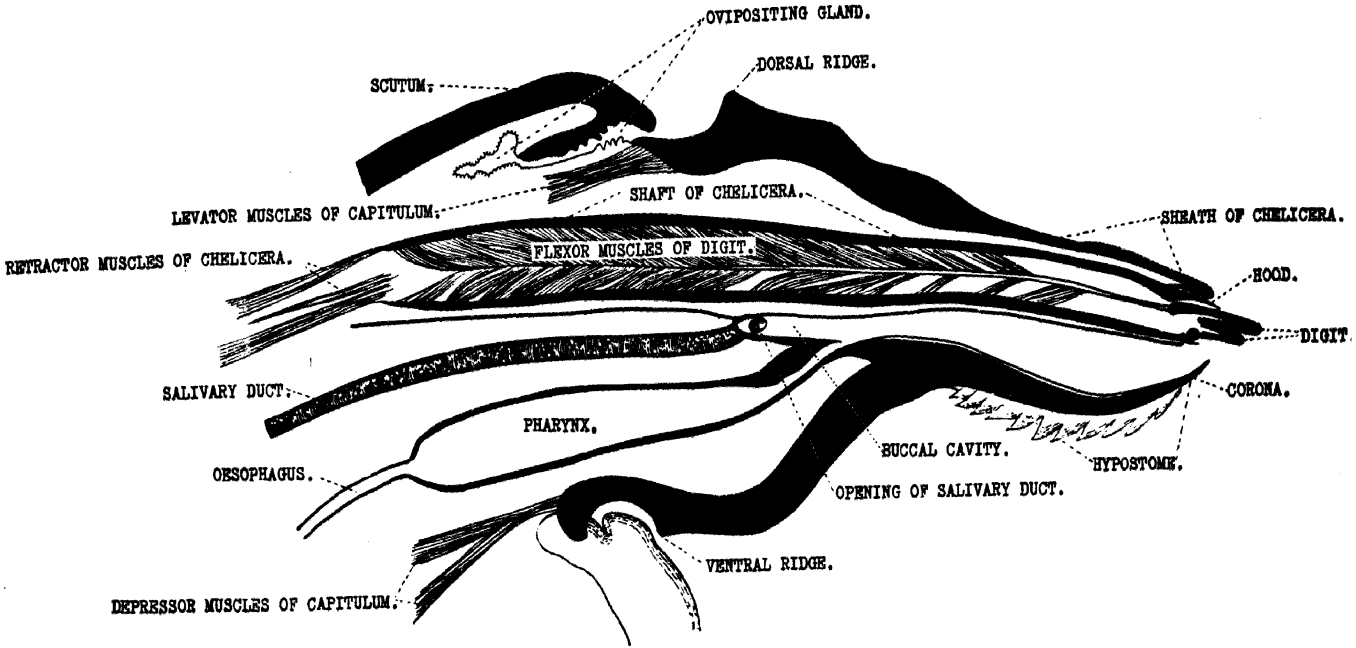


Fig. 449. *Haemaphysalis cinnabarina* var. *punctata* ♀. Median longitudinal section through the capitulum showing the relations between the internal and external parts. Slightly schematized. The "ovipositing gland" of the figure is Gené's organ. Nuttall, Cooper and Robinson, 1908, Fig. 6. G. H. F. N. 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 mininum) 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

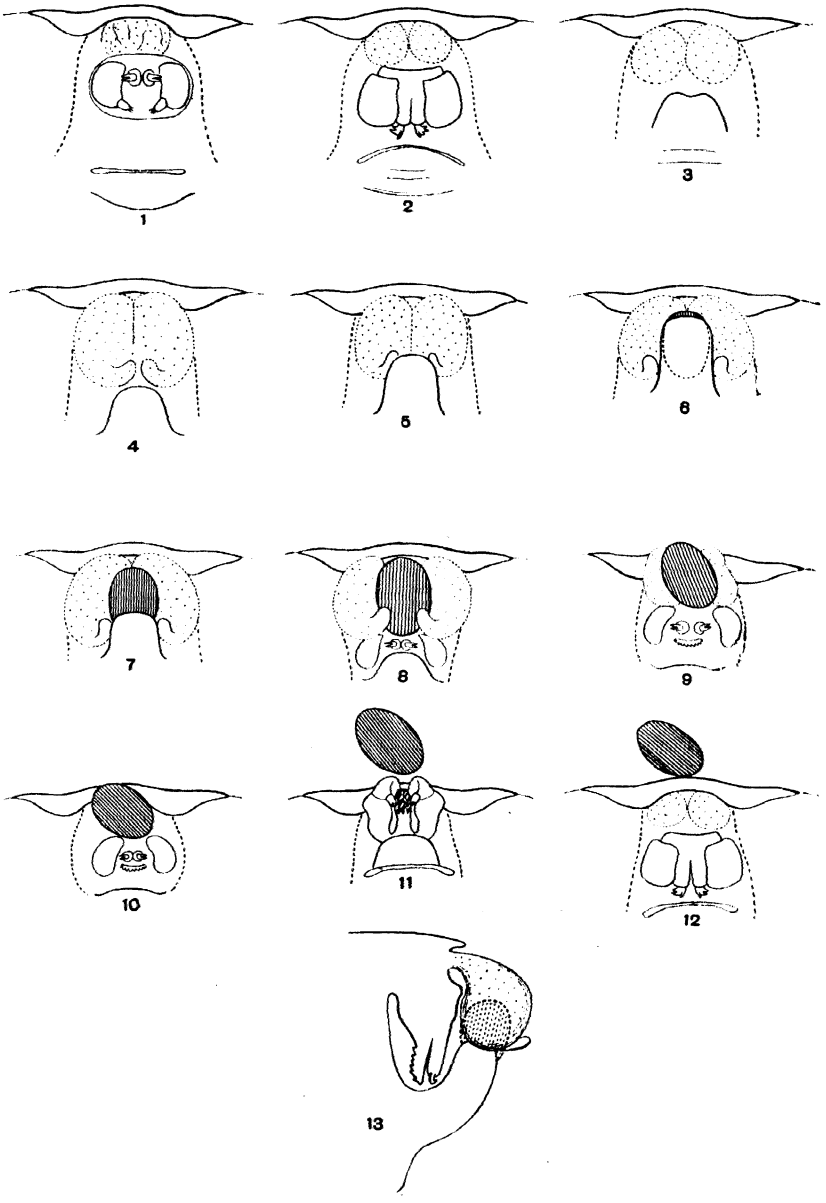


Fig: 450. Illustrating the mechanism of oviposition observed in *H. cinnabarina* var. *punctata*. For description see text. (13) is a schematic sketch. Drawn from living specimens so as to show the different stages of the process in sequence. (Nuttall, 1908, p. 399.)

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
4	,, 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	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	—
				64 ,, 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	29. 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.

			Adults emerged after	
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 adandons 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

1½ 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 ♁, 1 L	♂ ♀ ♁ L	487
birmaniae Supino, 1897	Genoa and Cambridge, 4 ♂	♂	415
bispinosa Neumann, 1897	Toulouse, 1 ♀; Cambridge, ♂ ♁	♂ ♀ ♁ L	426
bispinosa var. *intermedia* Warburton and Nuttall, 1909	Cambridge, ♂ ♀; London (*c*), ♀	♂ ♀	433
calcarata Neumann, 1902	Paris (*a*), Toulouse, Cambridge, 5 ♂, 8 ♀, 1 ♁	♂ ♀ ♁	442
calcarata var. *houyi* Nuttall and Warburton, 1915	Berlin (*a*); Cambridge, 7 ♂, 1 ♀, 2 ♁	♂ ♀ ♁	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 ♀	♂ ♀ ♁ L	372, 528
cinnabarina var. *punctata* (Canestrini and Fanzago, 1877)	?lost, ♂ ♀	♂ ♀ ♁ L	378, 519
concinna Koch, 1844	Berlin (*a*), 1 ♂, 1 ♀	♂ ♀ ♁ 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 ♁, 4 L	♂ ♀ ♁ 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

Name of Species, authors and date	Collections which include the types and co-types	Stages of each species which are known	Page
formosensis Neumann 1913	Berlin (*b*), Toulouse, Cambridge, 20 ♂, 1 ♀	♂ ♀	400
hoodi Warburton and Nuttall, 1909	Cambridge, Toulouse, ♂ s, ♀ s, 2 o, 1 L	♂ ♀ o L	483
hoodi var. *orientalis* Nuttall and Warburton, 1915	London (*b*), Cambridge, 6 ♂, 3 ♀	♂ ♀	486
howletti Warburton, 1913	Cambridge, 1 ♂, 1 ♀	♂ ♀	493
humerosa Warburton and Nuttall, 1909	Cambridge, 3 ♂, 1 ♀, 1 o	♂ ♀ o	496
hystricis Supino, 1897	Genoa, Cambridge, ♂ ♀	♂ ♀	422
inermis Birula, 1895	Petrograd, 1 ♀; Cambridge, ♂ o L	♂ ♀ o L	362, 545
inermis var. *aponommoides* Warburton, 1913	Cambridge, Berlin, Toulouse, 23 ♀	♀	367
japonica Warburton, 1908	London (*a*), 2 ♂	♂	402
japonica var. *douglasi* Nuttall and Warburton, 1915	London (*a*), Cambridge, 4 ♂	♂	403
kinneari Warburton, 1913	Cambridge, 1 ♀	♀	397
kochi Aragão, 1908	Rio de Janeiro (*a*, *b*), 2 ♂, 2 ♀	♂ ♀	413
leachi (Audouin, 1827)	♂ lost?	♂ ♀ o L	460, 536
leporis-palustris (Packard, 1869)	♀ lost?	♂ ♀ o L	387, 530
montgomeryi Nuttall, 1912	Cambridge, Berlin (*a*), Toulouse, 12 ♂, 4 ♀	♂ ♀	395
numidiana Neumann, 1905	Toulouse, Cambridge, 3 ♂, 1 ♀	♂ ♀	478
obtusa Dönitz, 1910	Berlin, Cambridge, many ♂	♂	477
papuana Thorell, 1882	? ♂ ♀; Cambridge, o L	♂ ♀ o L	404
parmata Neumann, 1905	Toulouse, ♂ ♀ o L; Cambridge, ♂ ♀	♂ ♀ o L	418
parva Neumann, 1908	Lausanne, Toulouse, Cambridge	♂ ♀ o L	435
silacia Robinson, 1911	Cambridge, 4 ♀	♀	416
simplex Neumann, 1897	Toulouse, 12 ♂, 1 o; Cambridge, 1 ♂	♂ o	458
spinigera Neumann, 1897	Toulouse, Paris, 4 ♂, 5 ♀	♂ ♀	447
spinigera var. *novae-guineae* (Hirst, 1914)	London (*a*), ♂ ♀; Cambridge, ♂ ♀ o	♂ ♀ o	449
**spinulosa* Neumann, 1906	London (*a*), 2 ♀	♀	476
**turturis* Nuttall and Warburton, 1915	Berlin (*b*), 1 ♂	♂	410
vidua Warburton and Nuttall, 1909	Cambridge, 1 ♂	♂	495
warburtoni Nuttall, 1912	Cambridge, Toulouse, 5 ♂, 9 ♀	♂ ♀	369
wellingtoni Nuttall and Warburton, 1907	Cambridge, 1 ♂, 2 ♀, o L	♂ ♀ o L	479

* = 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.