

BRITISH TICKS.

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THE Ixodidae have received so little consideration at the hands of British naturalists that there does not exist amongst our literature any classification of the family having pretension to accuracy or completeness. This may be sufficient to account for the fact that in 1900 when inviting correspondence through the columns of *Science-Gossip*¹, I did not receive any reply from a fellow-countryman who had made a serious attempt to study the British ticks, though I have been favoured with much kindly assistance from correspondents who had turned their attention to foreign species.

There seems no doubt that the best classification of the genera, giving descriptions of the known species, is that contained in a very carefully compiled series of articles in the *Mémoires de la Société Zoologique de France* for the years 1896-97-99 and 1902². These articles were written by M. G. Neumann, Professeur à l'École vétérinaire de Toulouse, and are entitled "Révision de la famille des Ixodidés." Some of these papers are out of print, and may not fall readily into the hands of an English reader.

The diagram (fig. 2) of the various parts of a tick may assist readers in following the descriptions in this paper.

Ticks pass through four stages in their existence: the egg, the larva, the pupa or nymph, and the adult. In the larval, pupal, and adult female stages of the sub-family Ixodinae the body is enclosed by a highly distensible cuticle. The body is partly covered by a hard scutellum, or shield, on the back, and is provided with a false head, or capitulum.

¹ Vols. VII. and VIII., New Series.

² Vols. IX., X., XII. and XIV.



Fig. 1.
Female ticks ovipositing.

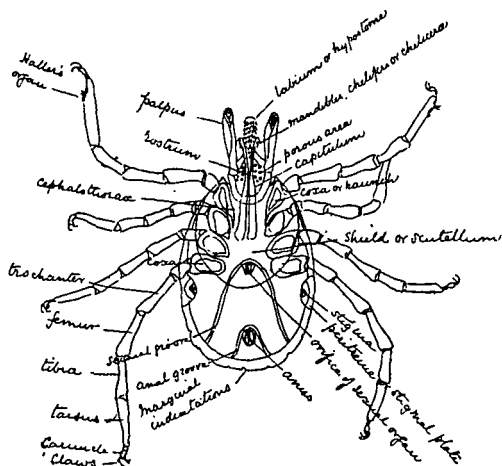


Fig. 2.
Diagram.

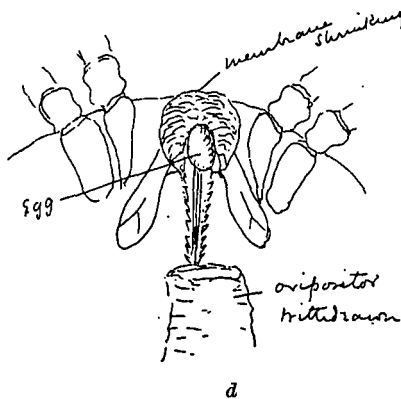
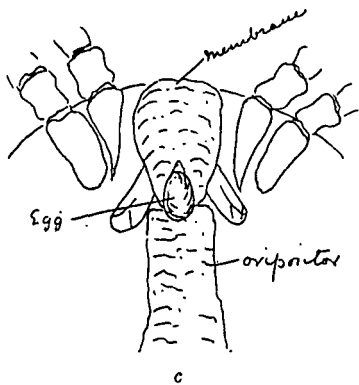
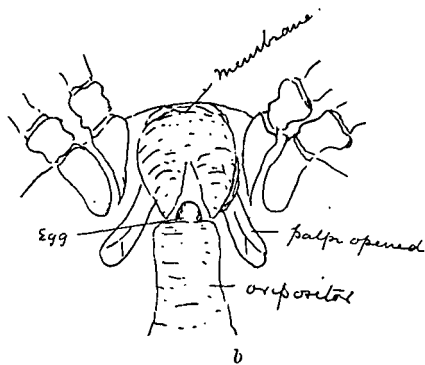
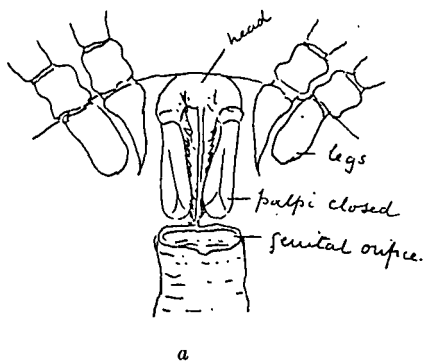


Fig. 3.
Method of oviposition.

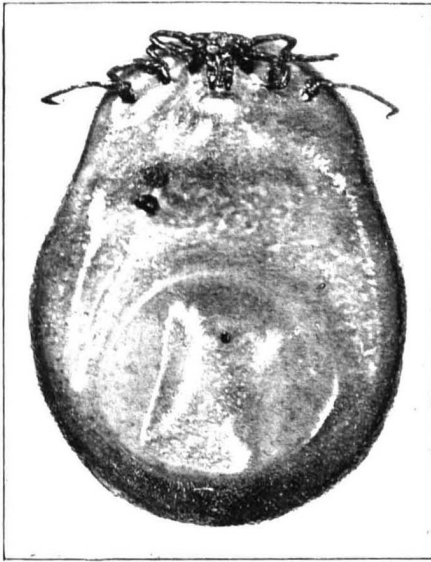


Fig. 4.
Ixodes ricinus, ♀. ×6.
Fully distended and about to lay eggs.



Fig. 5.
Ixodes ricinus, ♀. ×2.
Ovipositing.



Fig. 6.
Argas reflexus, ♀. ×10.

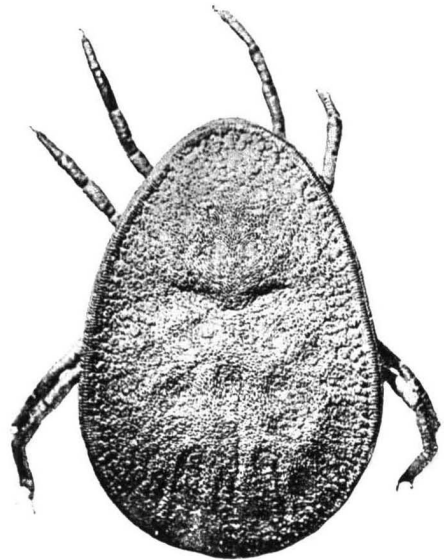


Fig. 7.
Argas reflexus, ♂. ×10.

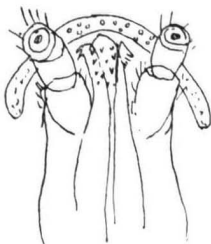


Fig. 9.
Argas vespertilionis. Rostrum enlarged.

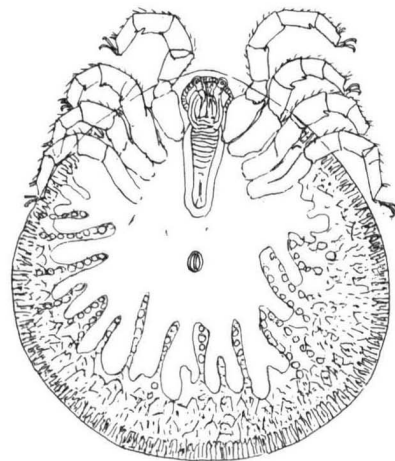


Fig. 8.
Argas vespertilionis. ×13.

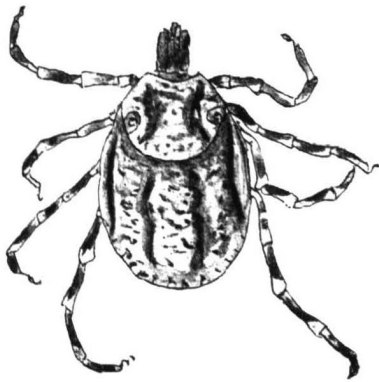


Fig. 10.
Hyalomma, shewing eyes on margin of shield.

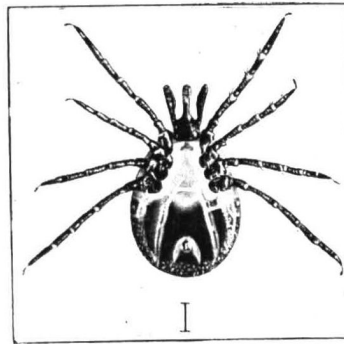


Fig. 11.
Ixodes ricinus, ♀. ×9.

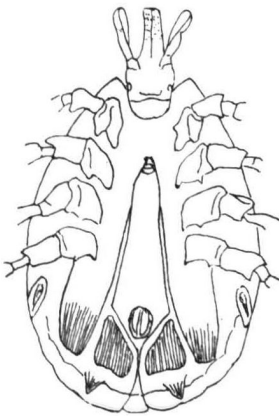


Fig. 12.
Hyalomma, shewing anal groove and plates.



Fig. 13.
Ixodes ricinus, ♂.
Rostrum, coxa and tarsus of fore-leg.



Fig. 14.
Ixodes ricinus, ♀. Coxa, caruncle and tarsus of fore-leg.



Fig. 15.
Eschatocephalus. Rostrum of male.

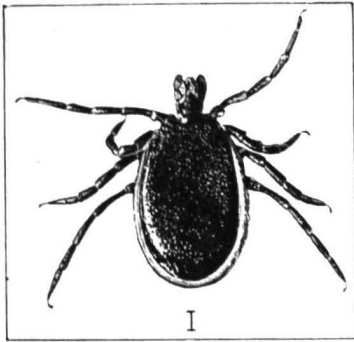


Fig. 16.
Ixodes ricinus, ♂. ×12.

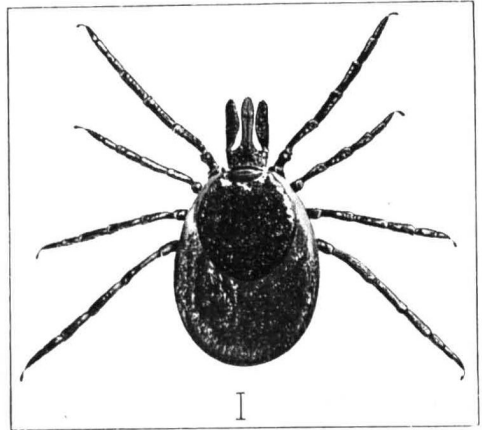


Fig. 17.
Ixodes ricinus, ♀. ×12.

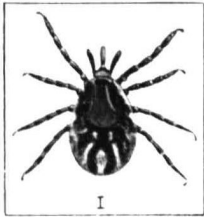


Fig. 18.
Ixodes ricinus, nymph. ×12.



Fig. 19.
Ixodes ricinus, larva. ×12.

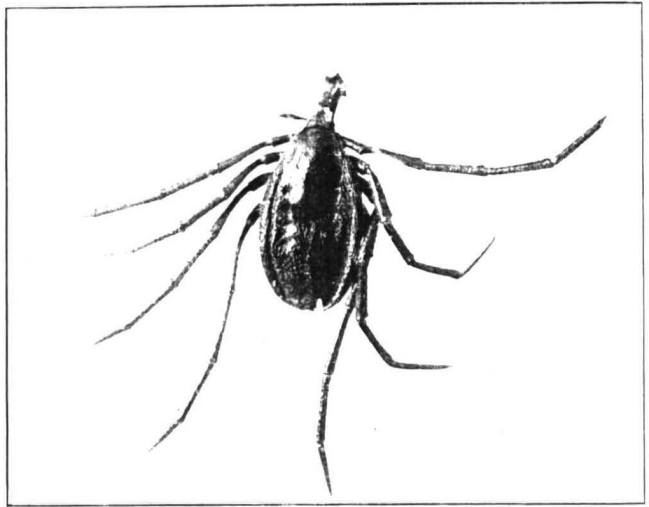


Fig. 19 a.
Eschatocephalus vespertilionis, ♀. ×7.



Fig. 20.
Ixodes hexagonus, ♀. ×6.

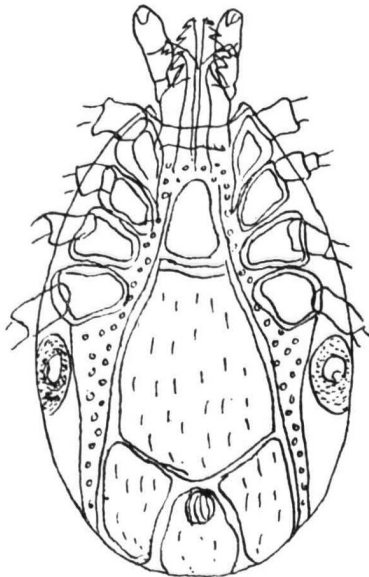


Fig. 21.
Ixodes ricinus, ♂. ×28.

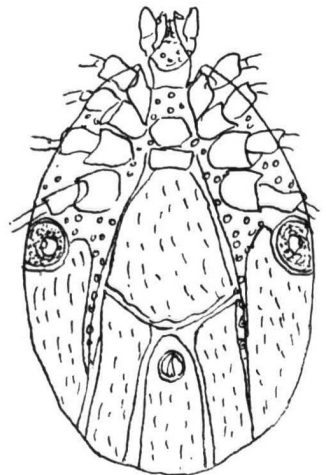


Fig. 22.
Ixodes hexagonus, ♂. ×24.

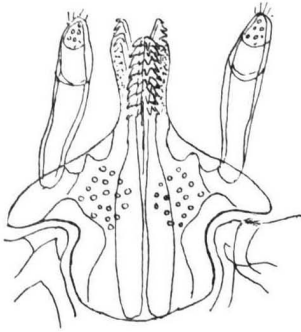


Fig. 23.
Ixodes tenuirostris, ♀.



Fig. 24.
Ixodes tenuirostris, ♂. × 24.

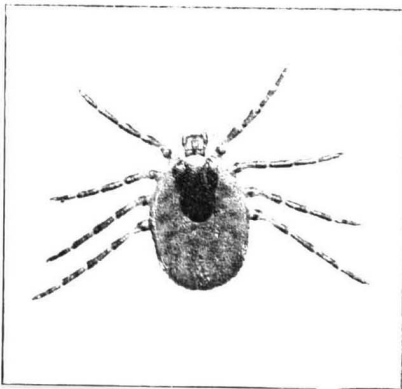


Fig. 25.
Ceratixodes putus, ♀. × 7.



Fig. 26.
Ceratixodes putus, ♂. × 7.



Fig. 27.
Rostrum of *Rhipicephalus*.



Fig. 28.
Dermacentor reticulatus, ♂. × 10.

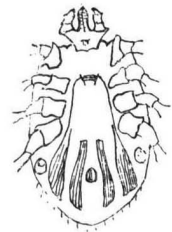


Fig. 29.
Rhipicephalus, shewing
anal shields of male.

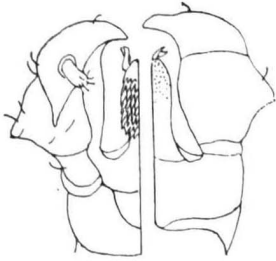


Fig. 30.
Haemaphysalis, palpi of male.



Fig. 31.

Haemaphysalis punctata. ×7.



Fig. 32.



Fig. 33.
Dermacentor reticulatus, ♀. ×10.



Fig. 34.
Dermacentor reticulatus, ♂. ×10.

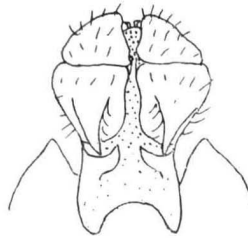


Fig. 35.
Dermacentor reticulatus,
palpi of male.

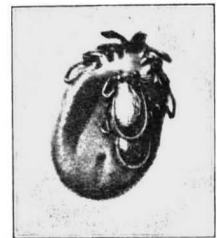


Fig. 36.
Ixodes ricinus. ×3.
in coitu.



Fig. 37.
Spermatozoon of
Ixodes ricinus.

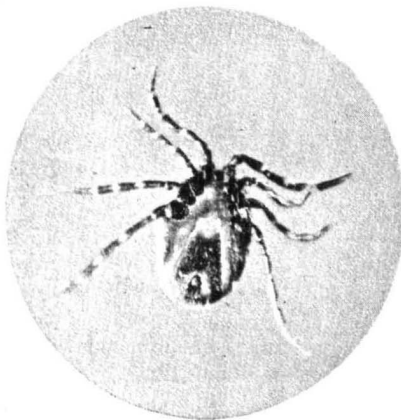


Fig. 38.
Ixodes ricinus, headless female. ×6.

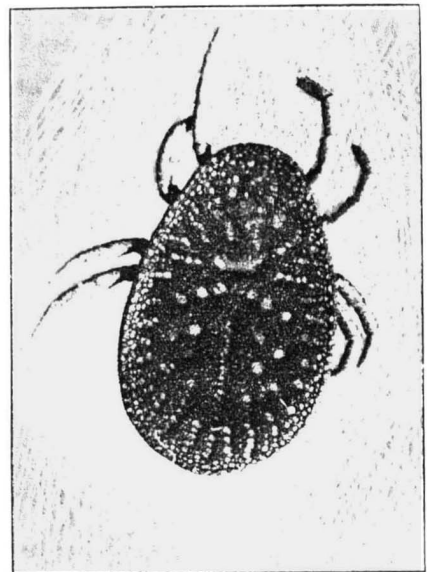


Fig. 39.
Argas persicus ♂. ×9.

The latter carries the palpi, and the mouth organs, consisting of a hard chitinous labium or hypostome provided with a tube for the suction of blood, and armed with rows of barbs for clinging on to the flesh of the host. On each side are situated the mandibles, also called chelifers, or chelicerae. They are retractile, and doubtless serve to cut a slot in the skin to make a passage for the insertion of the labium, and afterwards to force it into the flesh of the host. For these purposes the chelifers are furnished with a series of teeth or hooks. Collectively these organs constitute the rostrum.

The adult male is similar, but he has a shield that, with the exception in many cases of a narrow margin, covers the whole of the body. The latter is incapable of being much distended by the suction of the host's blood. In the sub-family Argasinae these shields are altogether absent and distension after feeding does not take place to anything like the same extent as with the Ixodinae. In the larval stage ticks have but six legs, but in all other stages eight legs.

In adults the sexual organ is situated far forward between the haunches of the legs; behind it is the anus, usually surrounded in part by a groove, and on each side, near the fourth pair of legs, is placed a stigmal plate or peritreme for respiration, in the centre of which is the stigma. The plates are absent in the larval state. There is reason for believing that the sexual organ of the male may be either immature or obsolete in certain, if not all the species of Ixodidae, and that in such cases the sexual functions are performed by the mouth organs, all of which are inserted with the exception of the palpi¹. The sexual orifice is absent in the larval and pupal stages. The tarsus, or last joint, of the first pair of legs is furnished with a peculiar organ (see figs. 2, 13 and 14), known as "Haller's organ," which is probably one of touch, hearing, or smell; but its function is not understood. The second pair of legs are the shortest, and the fourth pair the longest.

The life-history of a tick is sharply divided between a free and a parasitical existence. In the first state it lives absolutely without food of any sort for prolonged periods, and passes its time either in a semi-torpid condition, or else is actively occupied in searching for a host on which to establish itself. A headless female of *Ixodes ricinus*², lacking all the mouth organs by which feeding would be possible, survived under my observation for over a year in captivity, and was eventually lost.

¹ See Appendix, p. 425.

² Mentioned by me in "Louping-ill and the Grass-tick" in the *Royal Agricultural Journal* of December, 1899 (Vol. x., Part iv.). See Appendix, p. 427.

Argas persicus is similarly stated to have lived without food for three and a-half years in captivity¹. At such times all growth is suspended, and the tick is debarred from making any advance towards metamorphosis from one stage of its existence to another.

In the parasitical states life is supported by sucking the blood of the host until the body of the tick has, unless it is an adult male, become enormously distended, and it is in this condition that these pests are generally noticed owing to their increased size. When replete, whether as larvae or nymphs, most species fall to the ground, and there remain while development is proceeding inside the distended cuticle. After a time the skin is split open, and the creature emerges with its rostrum, shield, legs and other external parts, increased in size and fully developed. The body is proportionately diminished, so that the animal's entire length is about the same as before; but the new body, being formed of a similarly distensible cuticle, is again ready for repletion so soon as another host is attacked. Adult females when distended also fall to the ground, and remain there for oviposition.

Some species never leave the host they have first found, but pass all their metamorphoses upon it. In this respect the habits of different Ixodidae vary considerably. *Ixodes ricinus* seeks a fresh host after each moult, but as yet little is known of the habits of any other British species. Mr Lounsbury, Government Entomologist at the Cape of Good Hope, informs me that the "red tick," *Rhipicephalus evertsi*, passes the first moult on, and the second moult off, the host. *R. decoloratus*, the "blue tick," never leaves the host that it has once found, after being hatched out of the egg, until, if a female, it is ready in its turn for oviposition. *Argas persicus* attacks by night, like the bed bug, a practice which may enable it to escape destruction from the beaks of the fowls or pigeons which are its usual prey, as at such times they would be asleep, or at least in a drowsy condition. Mr Lounsbury says "it has the peculiarity of undergoing an additional moult, and, what is more, when adult, alternates egg-laying with feeding, the interval being about the same as between the moults." Referring to the South African "bont-tick," *Amblyomma hebraeum*, Mr Lounsbury writes: "Females do not appear to complete their engorgement until they have mated." If this be so with *I. ricinus*, and perhaps other species, it may account for the numerous dead and half-distended specimens that may generally be found on sheep in the North of England.

¹ Referred to by C. Fuller in his *Bovine-tick Fever*, 1896, p. 8.

The length of life depends mainly on the climatic conditions, and whereas Messrs Dixon and Spreull state that *Rhipicephalus decoloratus*, the Texas cattle-tick, is only sixty days in passing the whole period of its existence, it is probable that our British species average about a year and a half, varying largely according to circumstances.

The damage done to stockowners by these pests in other countries is enormous. Mr Cooper Curtice says¹: "Cattle-ticks cause the quarantine of eighty-one counties in North Carolina. The cattle traffic in thirteen States and the Indian Territory is seriously interfered with on account of the ticks."

Mr P. R. Gordon, Chief Inspector of Stock for the Government of Queensland, states in his Annual Report for 1898 that previous to that year no less than £44,000 had been spent in that colony in connexion with the investigations and experiments made in combating "tick," or "Texas fever." The searching character of these investigations has probably proved the salvation of stock-raising in Australia, as they resulted in the discovery by Mr C. J. Pound, Director of the Stock Institute, that inoculation by the blood of immune beasts would produce immunity in previously susceptible stock.

From Cape Colony Mr Lounsbury writes in his Report for 1899: "Heartwater," another tick-inoculated disease, "seems to have gained fresh impetus of late years, and is spreading by leaps and bounds into the Midlands." "The market value of these properties is depreciated by the infection from 30 per cent. to 60 per cent., I am reliably informed." This disease attacks sheep and goats, and is carried by a tick named *Amblyomma hebraeum*.

The following diseases are now known to be tick-conveyed, the tick acting as an intermediary host²:

Human Tick Fever	Man	<i>Ornithodoros moubata</i> (? <i>savignyi</i>)
Texas Fever or Redwater	Cattle	{ <i>Rhipicephalus annulatus</i> " <i>decoloratus</i> " <i>evertsi</i>
Heartwater	Sheep, goats, etc.	<i>Amblyomma hebraeum</i>
Malignant Jaundice	Dogs	<i>Haemaphysalis leachi</i>
Piroplasmosis	Sheep	<i>Rhipicephalus bursa</i>
Piroplasmosis	Cattle in Europe	<i>Ixodes ricinus</i> (?)

¹ "Regulations for the Control of Contagious Diseases of Live Stock, etc.," May 1st, 1900, North Carolina Department of Agriculture.

² See Nuttall (1904-5) *Journal of Hygiene*, Vol. iv. pp. 219-257; Vol. v. p. 237, *et seq.* *Trans. Epidemiol. Soc.* London, Vol. xxiv. pp. 12-32. This author is preparing an exhaustive treatise on Ticks.

The ravages caused in Scotland and the Borders by the disease known as "Louping-ill" have been commonly attributed to the direct agency of the Grass-tick, *Ixodes ricinus*, but recent investigations negative this conclusion, except as to its being an accidental carrier of the specific bacillus¹.

That ticks may be the carriers of the germs of other animal diseases in this country is very probable.

As the study of ticks is of so much economic importance, a few hints as to the methods of collecting and preserving them may not be out of place. The object in view is usually identification of species, or investigation of the life-history of the parasite. For the former purpose the large distended females, which are generally those first noticed on the host, are of comparatively little use. The great distension of body obliterates some material characteristics and obscures others. Where these large females are observed careful search should be made for the much smaller undistended specimens, by which identification is facilitated.

Ticks of a uniform brownish colour may generally be preserved without damage in spirits of wine, but those having variety of colour should be immersed in 3 per cent. formalin. For examination and future reference I find it convenient to mount them dry in cells as microscopic objects. This keeps them clean and free from dust. Those that have been soaked in formalin must be very thoroughly washed and dried. Even then they will be found to deposit an oily dew on the slide and cover-glass. This can only be removed by remounting, which may have to be done more than once. Treated in this manner they have so far retained their colours excellently. They may also be mounted in Canada balsam as transparent objects, but so mounted they are far harder to identify, and I have found difficulty in clearing the body of its contents when preparing them in this manner after they have been much distended. Ticks may be almost instantly killed by the use of chloroform.

For the purpose of studying their life-history ticks may be kept alive for long periods in tightly corked glass bottles, but many species require to be supplied with a little very slightly damped sand and fresh moss. Provided there is enough moisture to keep the moss alive, and no more, lest the ticks become mouldy, they will survive many months. Air does not seem necessary to them. If collected when fully distended

¹ The results of the investigations of the Louping-ill and Braxy Committee of the Board of Agriculture, which are here referred to, will shortly be published in a Blue Book.

in any immature stage they will undergo metamorphosis, or when adult the females will lay eggs, in confinement.

The process of egg-laying by ticks is most remarkable, and was fully described by Mr R. T. Lewis in the *Royal Microscopical Journal* of 1892. When oviposition is about to take place, the head is depressed till it rests close against the under side of the body (fig. 4). In this attitude the end of the rostrum actually touches the genital orifice, the palpi being at the same time widely opened out. From between the head and the shield a white, perfectly transparent, delicate, gelatinous membrane is brought down over the head, which it temporarily conceals. This is attained by inflation with a transparent fluid. The end of this membrane terminates in two points, covered with a glutinous secretion. At the same time a semi-transparent ovipositor is pushed forward from the genital orifice. As the ovipositor, within which is the egg, projects, this organ turns inside out, and leaves the egg protruded at the end, lying between the two conical points of the membrane. The ovipositor and membrane are then both withdrawn from each other, leaving the egg adhering to the glutinous surface of the latter. Owing to the withdrawal of its fluid contents the membrane collapses, and, dragging the egg forward with it, deposits it on the top of the head. Neither the legs, palpi, nor the organs of the mouth take any part in the oviposition. After the collapse of the membrane the palpi are closed, and the head is raised, by which latter action each egg is pushed further forward to the front edge of the shield, forming in time an adherent mass of eggs, which are deposited in front of the tick (figs. 1 and 5). The rough sketches shown on fig. 3, *a*, *b*, *c*, and *d*, will help to explain the process. The time occupied by a female *Ixodes ricinus* in depositing one egg was three minutes, with a further similar interval between the laying of two eggs. As the number of eggs laid is about 2,050¹, and the process continues at intervals for several days, it may easily be observed under the microscope.

It is scarcely necessary to emphasise the importance of keeping notes of the date and place where specimens are found, together with any circumstances attending their capture, especially the prevalence of disease amongst hosts infested by them.

It must be remembered that not only do individuals of all species vary much in size when fasting, but in the Ixodinae the variation is

¹ Some foreign ticks, such as *Amblyomma hebraeum*, are said to lay as many as 17,000 eggs. Fig. 1 is from a remarkable photograph by Mr C. J. Pound of female *Rhipicephali* (a foreign species) ovipositing.

immensely increased when distension takes place on a host. Full consideration must be given to this fact when referring to the measurements given below. The colours of distended individuals also depend entirely on the quantity of blood consumed. When the distension is complete the colour is usually a blue-black in all stages.

It is with the object of popularising the systematic study of British ticks that I venture to print the following *résumé* of M. Neumann's classification, giving copies of such of his figures as may assist in explaining the letterpress¹. The descriptions which are in great part taken from those of M. Neumann, are confined to the more salient characteristics, and may probably suffice for identifying the sub-family and genus to which a specimen may belong. To these are added remarks on the number of known species in each genus, a description of those which have been identified in this country, a list of synonyms, and other points of interest². Most of the characteristics referred to are such as may be examined readily without having recourse to any more powerful magnifier than a pocket lens.

I am indebted to the Editor of the *Royal Agricultural Society's Journal* for kindly lending me the blocks of figs. 11, 16, 17, 18, and 19, and the Editor of the *Highland Agricultural Society* for that of fig. 38, all of which were reproduced from my photographs.

CLASSIFICATION.

The family of the Ixodidae are broadly divided into two sub-families —I. Argasinae; II. Ixodinae.

I.—THE ARGASINAE.

The Argasinae are plainly distinguishable from the Ixodinae by the absence of either dorsal or ventral shields in either sex, also by the situation of the rostrum, this being placed beneath the cephalothorax, which covers it as with a hood, except in the larval state, when it is often terminal. In the pupal state it often partially projects. The palpi are plain, cylindrical, and the joints differ little from each other. Legs nearly equal in length. Colour varying from earthy yellow, or red, to dark brown. Sexual orifice situated between the two first pairs

¹ The illustrations copied are figs. 12, 15, 27, 29, 30, and 35.

² My remarks are based upon a series of notes contributed to *Science-Gossip* in 1900 and 1901.

of legs. In general dimensions the male is smaller than the female. Distension, after feeding, moderate.

The genera of the Argasinae are (a) *Argas*; (b) *Ornithodoros*.

GENUS *ARGAS* Latreille, 1796.

Synonym *Rhynchoprion* Hermann, 1804.

Body flat, general contour round or oval: narrower in front than behind, and larger behind the haunches of the fourth pair of legs. The sides of the body thin, or slightly thickened like a cushion. Tegument of body finely shagreened, except in certain spots which are covered with thin, roundish discs, more or less numerous and variously situated: the most important always forming a radiating series, of which the central one is longest both on the back and beneath. Eyes absent.

Of this genus M. Neumann describes eleven species, some of which are doubtful. Of these *Argas reflexus* and *A. vespertilionis* have both been found in England.

Argas reflexus Fabricius.

Synonyms: *Acarus reflexus* Fabricius, 1794; *Acarus marginatus* Fabricius, 1794; *Argas reflexus* Latreille, 1796; *Rhynchoprion columbae* Herm. 1804.

Adults: length, female from 7 mm. fasting, to 8 mm. when distended, (fig. 6); male, 6 mm. (fig. 7). The thin tegument of the female allows the brown or dark violet tint of the digestive organs to be seen, the margin always remaining yellowish (*marginatus*) and a little raised (*reflexus*) when fasting. The male is uniformly brown. The tarsi of all the legs have a prominent dorsal knob at the extremity. The hypostome is rounded at the end, and often a little dilated in the middle. Dorsal surface of the body finely shagreened. The discs are larger towards the centre and smaller and more numerous within the margin. The latter is finely and evenly folded, or wrinkled all round the body. Two of these, which are large, oval, and divergent in front, are situated near the middle line, about one-fourth of the distance from the front. They are surrounded by an interrupted circle of smaller ones. Posteriorly are others radiating from the centre, with one long middle line of this series, which almost reaches to the centre. On the ventral face is a similar well-defined radiating series. The male closely resembles the female, but the former is more narrow in front¹.

The nymph resembles the male, but is without the sexual organ.

¹ Compare fig. 7 with that of *A. persicus*, fig. 39.

The larva is round, 2 mm. in length, and has the rostrum terminal. The three pairs of legs are relatively long.

In this country this species has been found in Canterbury Cathedral, but is common abroad¹. It is parasitical on fowls and pigeons, which it only attacks by night, hiding itself in the daytime.

Argas vespertilionis Latreille.

Synonyms.—*Carios vespertilionis* Latreille, 1796. *Caris vespertilionis* Latreille, 1804. *Argas fischeri* Audouin, 1827. *Argas pipistrellae* Audouin, 1832. *Caris vespertilionis* Gervais, 1844. *Caris elliptica* Kolenati, 1857. *Caris longimana* Kolenati, 1857. *Caris decussata* Kolenati, 1857. *Caris inermis* Kolenati, 1857. *Argas fischeri* George, 1876. *Argas pipistrellae* Westwood, 1877.

Adult. Length, 3·70 mm. by 3·78 mm. wide. Body nearly round.

Dorsal surface surrounded by a margin formed of somewhat regular folds, and shagreened within. A deep transverse integumental fold behind the anus, which is situated about the centre of the body. Rostrum covered by the hood. Hypostome with four rows of teeth, and about six in each row. Palpi claviform. Legs thick, cylindrical; tarsi truncate; coxae in contact with each other (figs. 8 and 9).

Nymph. Rostrum partly exposed. Length, fasting, 1·40 mm. by 1·10 mm. Neumann gives the measurements of the nymph as 2·40 by 2·10 mm.

Larva. Similar, but rostrum fully exposed. Length, partly distended, 1·10 mm.

The above descriptions are taken from two mounted specimens kindly lent to me by Mr H. E. Freeman, being some of the original individuals found at Blyborough in 1877 when removing the church roof, and described in *Science-Gossip*². It is parasitical on bats.

GENUS *ORNITHODOROS*.

Body with thick sides, often densely covered with small, round, shining granules in various patterns, some deep furrows beneath. Eyes sometimes present (?).

The larva of one species, *Ornithodoros moubata* (? *savignyi*), has been shown to pass the whole of that stage of its existence in the egg, and to hatch out as a nymph³.

¹ *Science-Gossip* (Old Series), Vol. x., 1874.

² *Science-Gossip* (O.S.) Vol. XIII., p. 104, and in the *Quekett Microsc. Journal*, Vol. IV., p. 223. Also (N.S.) 1901, where the illustration is called the nymph, in error, as is shown by the context.

³ *The Nature of Human Tick Fever*, by Dr J. L. Todd, 1905.

No indigenous British species, but the following has been imported :

Ornithodoros megnini Dugés.

Synonyms: *Argas megnini* Dugés. *Rhynchoprion spinosum* Marx.

Nymph. Length, 3 mm. to 4 mm. fasting, to 9 mm. when replete.

Body brown, diamond-shaped, and with the rostrum exposed before repletion. Rostrum beneath body, and the latter squarer after distension. Palpi filiform. Legs far apart, and coxae almost entirely concealed beneath the skin. Surface of anterior half of body covered with small brown spines, replaced by whitish hairs posteriorly, which are specially numerous in the hinder margin. The stigmata are placed above, instead of behind, the fourth pair of legs. These differ entirely from the stigmal plates and peritremes usually present, and consist of cone-like projections pointing backwards. The top is truncate, and perforated by an orifice. Through this is a jointed organ, somewhat resembling the terminal joints of the palpi, which partially fills the orifice, and is furnished with three hairs at the end. It can be projected and withdrawn with rapidity. Its use is unknown. This peculiar feature, which, according to Neumann, is absent in the adult, may suffice to cause this species to be relegated to a separate genus.

The female is stated by Neumann to differ greatly from the nymph, which latter attains dimensions at least as large as the mature adult. It is in this state that it acquires most of the reserves of blood, which the female utilises to form its eggs.

Two specimens in the nymphal state were taken from the ear of an American visitor to Cambridge by Dr J. Christian Simpson¹. They were supposed to have entered the ear when the American was camping out in Arizona. This species is well known in the States as infesting the ears of children and animals².

II.—IXODINAE.

The Ixodinae have the rostrum terminal, and never concealed under the body. Palpi four-jointed, of which the fourth is very short, and is situated in a hollow at the end of the third. Legs somewhat unequal in length. They are six-jointed, with two false joints, giving the appearance of having eight joints; one being on the femur and the other on the tarsus of each leg; but the latter is absent on the front pair.

¹ See his description with illustrations in the *Lancet*, April 27, 1901.

² See *New York Ent. Soc. Journ.* for 1893, pp. 49 to 52.

The cuticle of the body is very distensible in all stages, except in the case of adult males, and covered more or less, according to the state of distension at the time, by a dorsal shield, or scutellum. This shield seldom or never covers so much as one-half of the body, and as distension takes place it is proportionately less. In the case of males, which do not distend, the body is entirely covered, or with the exception of only a narrow margin. Stigmata are encircled by peritremes situated behind the haunches of the fourth pair of legs. The sexual orifice is situated beneath, between the haunches of the first three pairs of legs. In both sexes the orifice is half encircled by a groove, opening outwards behind (see fig. 11). There is considerable difference between the sexes, the males being usually the smaller. There are often eleven indentations on the posterior margin. The dorsal base of the rostrum of the female has two symmetrical hollows, with numerous punctuations, which are not found in the males, nymphs, or larvae; their purpose is doubtful.

The Ixodinae are chiefly parasitical on mammals, but also attack birds and reptiles. They rarely confine themselves to one species of host.

The genera of the sub-family of Ixodinae are:—

Ixodae, comprising *Ixodes*, *Eschatocephalus*, *Aponomma*, *Hyalomma*, *Amblyomma*.

Rhipicephalae, comprising *Rhipicephalus*, *Haemaphysalis*, *Derma-centor*.

IXODAE.

The Ixodae are distinguished from the Rhipicephalae by the length of the rostrum, which reaches nearly to the end of the palpi, sometimes further. The palpi are longer than broad. The presence or absence of eyes divides the genus into two groups:—*Amblyomma* and *Hyalomma* have eyes, which are placed on the marginal edge of the shield (fig. 10). *Ixodes*, *Eschatocephalus* and *Aponomma* have no eyes.

The form of the anal groove gives another division. In *Ixodes* and *Eschatocephalus* this groove contours the anus in front and opens behind (fig. 11). In *Ceratiixodes* this groove is present in the male, absent in the female. In *Aponomma*, *Amblyomma*, and *Hyalomma* it contours the anus behind and is open to the front (fig. 12).

There is close affinity between *Ixodes* and *Eschatocephalus*; in fact, there is no fundamental characteristic to separate the females of the two genera; the great length of the legs, a deflected direction of the

rostrum, and the habit of living in holes and caverns, alone give presumption for placing a female specimen in *Eschatocephalus* rather than *Ixodes*. The males, however, differ entirely in the form of their palpi, which, flat and caniculated on the inner margin in *Ixodes* (fig. 13), are boldly claviform in *Eschatocephalus* and *Ceratiixodes* (fig. 15).

The affinity between *Aponomma*, *Amblyomma*, and *Hyalomma* is greater still. The absence of eyes, as in *Aponomma*, appears a character easily distinguishable; but in some of the *Amblyomma* to find the eyes requires extreme attention, as they are neither prominent nor distinct in colour. In such cases they are probably immature or obsolete.

There is no definite distinction between the females of *Amblyomma* and *Hyalomma*, but it is otherwise with the males, which in *Hyalomma* are provided with ad-anal shields (fig. 12). These are wanting in *Amblyomma*.

(A) ANAL GROOVE ENCIRCLING ANUS IN FRONT.

(a') *IXODES* Latreille, 1795.

Synonyms: *Acarus* Linn., 1758; *Cynorhaestes* Hermann, 1804; *Crotonus* Dumeril, 1822.

Eyes absent. Palpi long. An ad-anal groove open or closed behind, encircles the anus in front; another long groove similarly encircles the sexual organ in front and widens behind (fig. 11). No terminal spine to the tarsi. Underside of the male covered with shields or plates. Dorsal shield of male covering the whole body with the exception of a margin. No indentations on the posterior margin. The distended female has three dorsal longitudinal grooves behind. Peritremes and stigmata circular.

Professor Neumann describes over sixty species of this genus.

Ixodes ricinus Latreille, 1804¹.

Synonyms: *Reduvius* Charleton, 1668; *Ricinus caninus* Ray, 1710; *Acarus ricinoides* De Geer, 1778; *A. ricinus* Linnaeus, 1788; *Cyno-*

¹ In the original article in *Science-Gossip* (Vol. VIII., p. 39) the name of *Ixodes reduvius* Leach, was adopted, following Neumann's classification. He now points out in his fourth Mémoire that this is an error, as Leach was describing a different parasite. The name *reduvius* should be therefore deleted, and *Ixodes ricinus* Latreille, substituted. This species is locally known as the "Grass-tick" in the North of England, and is one of the commonest British species.

rhaestes reduvius Hermann, 1804; *C. ricinus* Hermann, 1804; *Ixodes megathyreus* Leach, 1815; *I. bipunctatus* Risso, 1826; *Cynorhaestes hermanni* Risso, 1826; *Crotonus ricinus* Dumeril, 1829; *Ixodes trabeatus* Audouin, 1832; *I. plumbeus* Dugés, 1834; *I. reduvius* Hahn, 1834; *I. fuscus* Koch, 1835 (?); *I. lacertae* Koch, 1835 (?); *I. pustularum* Lucas, 1866; *I. fodiens* Murray, 1877; *Ixodes rufus* Koch; *Ixodes sulcatus* Koch; *Ixodes scuiri* Koch.

FEMALE (fig. 17). Length from about 3 mm. when fasting, to 10 mm. long by 6·50 mm. wide when fully distended. Basal joint of first pair of legs with a long spine. Legs, shield, rostrum, etc., dark brown to nearly black. Colour of body deep orange-red, showing four faint dark intestinal lines behind the shield; lighter underneath; light grey in front both above and below. Pubescent, opaque, and margined. When distending, light red to reddish-grey, or even pure white; fully distended, olive green, or dark red to black, with irregular yellow streaks on the back and sides when about to lay eggs. Sexual orifice opposite fourth pair of legs. MALE (fig. 16). Length about 2·35 mm. to 2·80 mm. Coxae of first pair of legs with shorter spine. Body dark brown to almost black, with brownish-white margin. Apparent sexual orifice opposite third pair of legs. Rostrum much shorter than that of female (figs. 13 and 14). Shield oval. Anal shield small, about one-third the length of the large ventral shield (fig. 21)¹.

NYMPH (fig. 18). Length, about 1·50 mm. fasting to 3·00 mm. when replete. Body olive-white, with four distinct brown posterior intestinal marks, also similar anterior ones; leaving a paler centre to the shield shaped like an arrow-head. When distending, opaque white to blue-black, and finally black.

LARVA. Length, 0·80 mm. fasting to 1·43 mm. distended. Body transparent, with olive-green intestinal marks; same colours as nymph when distending (fig. 19).

It is parasitical on numerous hosts, of which the favourite appear to be sheep, goats, cattle, and deer; but it is found on hedgehogs, moles, bats, etc., even on birds and lizards.

Ixodes hexagonus Leach, 1815.

Var. *longispinosus* Neumann.

Synonyms: *I. autumnalis* Leach, 1815; *I. erinacei* Audouin, 1832; *I. reduvius* Audouin, 1832; *I. crenulatus* Koch; *I. vulpis* Pagenstecher, 1861; *I. erinaceus* Murray, 1877; *I. ricinus* Mégnin, 1880.

¹ Compare figs. 21 and 22.

FEMALE (fig. 20). Length, 3·00 fasting to 11 mm. when fully replete. Coxae of first pair of legs with a moderate spine. Shield heart-shaped, punctate; body finely hirsute. Palpi short and broad. Labium shorter, and tarsi of all legs more truncate than in *I. ricinus*. Body when slightly distended drab, waxy, and semi-transparent. Rostrum, shield, legs, &c., light testaceous. MALE. Length, 2·50 to 3 mm. Red-brown, legs lighter. Shield punctate, leaving a narrow margin round the body. Genital orifice opposite the interval between the second and third pair of legs. Body elliptical, almost as large in front as behind. Spine on coxae of first pair of legs longer than in the female, but shorter than that of the male *I. ricinus*. Anal shield nearly as long as the ventral shield between the apparent sexual orifice and the anus¹ (fig. 22).

PUPA. Fasting 1·76 mm. Body light bluish-grey, margined, transparent, with four posterior large intestinal marks joined together behind the shield, and smaller ones extending to the front and sides; visible through the shield. Uniform brownish-white when distended. Shield, legs, rostrum, etc., pale testaceous.

LARVA. 0·88 mm. fasting to 1·76 mm. distended. Body light, translucent, becoming dark on repletion. Shield, legs, etc., very pale testaceous. Body with very similar intestinal marks to *I. ricinus*.

This species is common, and is parasitical on various hosts, more especially on stoats, ferrets, hedgehogs, etc. It is also found on sheep, cattle, and other animals. The males are rare, and, unlike *I. ricinus*, are not generally found accompanying the female on the host. It seems possible from this fact, that this species is essentially a "kennel" tick, frequenting naturally those animals only that return nightly to a kennel, hole, or burrow, at which time sexual intercourse may take place, and that when found on other animals its presence may be considered accidental, and that in such cases propagation of the species is unlikely to occur. The point seems worthy of investigation.

Ixodes hexagonus Leach, var. *inchoatus* Neumann, described as *I. plumbeus* in *Science-Gossip* of 1899. The length of the female is only about 2·86 mm. fasting to 6·56 mm. when replete. Colour of body fasting light brownish-grey, with eight large dark triangular intestinal marks, terminating within the margin, two other small ones being nearly concealed by the shield. Margin distinct, grey. Head, shield, legs, etc., same colour as *I. hexagonus*. Coxae of first pair of legs differ, having

¹ Compare figs. 21 and 22.

no distinct spine, but sometimes a tubercle. The second and third pairs have also small tubercles. Labium shorter, with only eight barbs, as against about ten on the outer margin in *I. hexagonus*. MALE. Length, 2.52 mm. Body elliptical, deeply punctate above and below. Margin round shield wider than in *I. ricinus*. Apparent genital orifice as in *I. hexagonus*. Small spine or tubercle on coxae of front pair of legs. Anal shield long as in *I. hexagonus*. This description is taken from a solitary capture found in the North Tyne Valley in copula, intercourse being by the mouth organs, as with *I. ricinus*.

PUPA and LARVA. Similar to *I. hexagonus*, but smaller and lighter, the larva, being 0.74 mm. fasting. This tick is very abundant on the shepherds' dogs on the Border, but in no case was found on sheep. The male was not found present with the females on the host.

Ixodes tenuirostris Neumann.

The following description is taken from one of two females found on a vole at Painswick, in Gloucestershire, in 1893, kindly sent me by Mr C. J. Watkins, who also gave me photographs of a nymph and larva, evidently of the same species, from the collection of the Hon. C. Rothschild. Both the females have been mounted in balsam. The one is in my possession; the other is in the British Museum. I found two females of this species on a field vole, at Alnwick, on August 18th, 1901.

FEMALE. Length partly distended 3.78 mm. Coxae of all legs without spines or tubercles. Palpi long and narrow, second joint twice the length of the third joint. Capitulum prolonged laterally to a prominent point on each side (fig. 23), from near the ends of which spring the palpi, which are thus set widely apart at the base. Coxae of fore-legs developed to fit into the angle thus produced. Shield oval, with two posterior marginal indentations. Sexual orifice between the third pair of legs. Tarsi of fore-legs cylindrical, truncate, and with very slight indentations. Body finely and shield coarsely and sparsely punctate.

MALE (fig. 24). Length 1.83 mm. Light brown, margin lighter, nearly white. Capitulum slightly distended laterally. Palpi wide apart at the base, though in less degree than in the female. Coxae of all legs without spines or tubercles. Apparent sexual orifice opposite the space between the second and third pairs of legs. Ventral shield large. Tarsi short and truncate. Labium and palpi very short and wide.

The male was described for the first time by me in *Science-Gossip* for December, 1901. I was indebted to Mr Pocock, of the British Museum, for kindly lending me a specimen preserved in spirits, recently taken from a long-tailed vole (*Arvicola pratensis*) near Swansea. The species occurs on the short-tailed vole (*A. agrestis*), and doubtfully on the water vole.

As it has now been taken in Gloucestershire, Northumberland, and in South Wales, it must be widely distributed, and will probably prove to be by no means uncommon. This species is the most minute of the British ticks. It resembles *I. hexagonus* in general appearance, but is much smaller, and can be at once recognised by the greater width between the palpi at their base than at their extremities, which touch, and thus give the idea of grasping, the labium. All the above specimens were taken from voles. I also found a fasting nymph on a dead shrew mouse at Alnwick in July, 1902. Length 1.10 mm. Very transparent. Light testaceous mottled with brown. Shield coarsely and body finely striated above. A few strong white hairs above and below. The lateral projections of capitulum marked.

(B) ANAL GROOVE ABSENT IN FEMALE, BUT ENCIRCLING ANUS IN FRONT IN MALE.

(a²) *CERATIXODES*.

Synonyms: *Ixodes* Cambridge, 1879. *Hyalomma* Cambridge, 1879. *Ceratixodes* Neumann, 1902.

Palpi long, convex inside and with a conical prolongation in the male, slightly canaliculated and swollen at the end in the female. No eyes. Anal groove absent in the female, but present in the male. One anal and two ad-anal shields in the male. Peritremes circular in both sexes.

Ceratixodes putus Cambridge.

Synonyms: *Ixodes putus* Cambridge, 1879; *Hyalomma puta* Cambridge, 1879, female. *Ixodes borealis* Kramer and Neumann, 1883, female. *Ixodes fimbriatus* Kramer and Neumann, 1883, male.

FEMALE (fig. 25). Length fasting 3.30 mm. to 10 mm. when replete. Body oval, rounded at both ends, light grey, with numerous white hairs above and below. Shield yellowish-grey mottled, with lateral triangular margins rich brown; subtriangular in shape, and twice as wide in front

as behind, where it is rounded. Cervical grooves converging in front, then diverging and a little concave within, enclosing a raised portion: punctuations large and fairly regular. Sexual orifice opposite the second pair of legs. Sexual grooves widely separated behind. Anal grooves absent. Peritremes round. Legs and palpi light green, mottled with dark green and orange. False articulations near the middle of the tarsi of the three hinder pairs of legs. Labium orange, with two rows of teeth on each side.

MALE (fig. 26). Length 3·70 mm. Body greenish-yellow, mottled with black when alive, margins light grey. After death, body dark reddish-brown. Flat, square, and covered with both large and small punctuations. The margin divided behind into five short wide segments or festoons, on each of which is a fringe of strong white bristles. Ventral side finely punctuated, showing the same five segments which are separated from each other by the sexual and anal grooves respectively. Apparent sexual orifice opposite the space between the first and second pair of legs. Sexual grooves widely diverging behind, anal grooves parallel. Peritremes small and round. Palpi much longer than labium, third joint being as long as the first and second together, and pointed. Legs and palpi yellowish-green mottled with darker green. Labium bright orange, very short. Three front pairs of legs thick, the third being thicker than the second, and the second than the first. The fourth pair much attenuated.

NYMPH. Length 1·59 mm. to 3·50 mm. when fully distended. Colour (in spirits) brownish-yellow. Body nearly round. When fully distended nearly black, and legs dark testaceous. Shield shaped like that of the female.

This species had not been reported in England till 1901, when I received three distended nymphs found on a guillemot from Mr S. F. Harmer, F.R.S., University Museum of Zoology, Cambridge. Mr Pocock afterwards obtained a number of distended females from a dead puffin at Morthoe in North Devon. Since then a considerable number of males and females, both fasting and distended, have been taken by Mr Hewett of York, on cliffs frequented in the nesting season by guillemots, and other sea birds, at Bempton and Buckton on the Yorkshire coast. These were under small stones on the narrow ledges of cliff facing the sea, and in some cases were in copula. I have myself found a few on the Pinnacle rocks on the Farne Islands. I have also received a specimen from the Hebrides. It is widely distributed, having been found as far north as Alaska, and as far south as Cape Horn. The

male is certainly the most remarkable in appearance of the British ticks.

(a³) *ESCHATOCEPHALUS* Frauenfeld, 1853.

Synonyms: *Haemalastor* Koch, 1844; *Sarconyssus* Kolenati, 1857.

Rostrum long; palpi claviform (fig. 15) in the male, flat and canaliculated in the female. Ad-anal groove contouring anus in front and open behind. Peritremes circular. Irregular chitinous thickenings both above and below in the male. Very fine striae or parallel grooves on the female. Legs generally very long.

Seven species of this genus are described. They are mostly parasitical on bats, and inhabit holes and caverns.

One species, *E. vespertilionis*, widely distributed on the Continent, has just (January, 1906) been received by me from Mr Newstead of the Liverpool University, having been collected by him at Cefn in Wales.

Eschatocephalus vespertilionis (C. L. Koch).

Synonyms. Male. *Eschatocephalus gracilipes* Frauenfeld, 1853; *Ixodes troglodytes* Schmidt, 1853; *Sarconyssus kochi* Kolenati, 1860; *Eschatocephalus frauenfeldi* L. Koch, 1872; *Eschatocephalus seidlitzii* L. Koch, 1872; *Ixodes longipes* Lucas, 1872; *Ixodes siculifer* Megnin, 1880. Female. *Ixodes vespertilionis* C. L. Koch, 1844; *Ixodes flavipes* C. L. Koch, 1844; *Haemalastor gracilipes* Frauenfeld, 1854; *Sarconyssus flavipes* Kolenati, 1857; *S. hispidulus* Kolenati, 1857; *S. brevipes* Kolenati, 1857; *S. kochi* Kolenati, 1857; *S. flavidus* Kolenati, 1857.

FEMALE (fig. 19 a)¹. Body oval. Length 4 to 6 mm. when fasting, to 6 or 8 mm. when replete. Colour when fasting from a light to an earthy yellow. A thick marginal dorsal pad or swelling extends, when fasting, half-way up the shield and terminates at the sides. Body thickly covered with whitish hairs except on the shield, which is light brown, elongated, lance-shaped and wider in the middle. Beneath, the sexual orifice is situated opposite the haunches of the third pair of legs. Rostrum often carried perpendicularly. Hypostome lance-shaped, and very pointed, with a wide base, covered with long, sharp teeth arranged in 4 or 5 rows on each side. Porous spaces well developed. Palpi very similar to those of the female of *I. ricinus*. Legs long.

MALE. Body, flat oval, dark red-brown in colour. Length 4 mm. On the back a narrow marginal pad or swelling, pointed in front, enlarged behind, extending almost to the stigmata. Tegument orua-

¹ The hypostome of the specimen figured is concealed by a piece of bat's flesh adhering to it.

mented with patterns or shields, which vary considerably in different individuals, some being altogether without them, whilst in others they are well developed. Genital orifice situated opposite the spaces between the second and third pair of legs. The grooves underneath resemble those of *I. hexagonus*, but are more parallel. Rostrum generally carried perpendicularly. Palpi club-shaped (fig. 15), wide apart at the base. Legs very thin and long, longer than in the male. The fourth pair the longest.

NYPH. Oval body, length 1 to 2 mm. Yellowish or reddish in colour. A few short bristles. Rostrum similar to that of larva, but more developed.

LARVA. Body oval. Length 0.2 mm. Yellowish when fasting, blood-red when distended. Rostrum not inflected, otherwise almost resembling that of the female, but the hypostome has only 2 rows of teeth on each side.

The specimens sent me by Mr Newstead consist of two partly distended nymphs and one fasting female, all taken feeding on the Lesser Horseshoe Bat (*Rhinolophus hipposideros*) from a cave at Cefn, North Wales, on April 4th, 1896, but these were not examined until now¹. This is the first time this species has been reported in this country, though the probability of its occurrence was mentioned by me in my notes to *Science-Gossip* in 1901.

The above descriptions are extracted from those of Neumann.

(C) ANAL GROOVE ENCIRCLING ANUS BEHIND.

(b¹) *APONOMMA* Neumann, 1899.

No eyes. Base of rostrum generally pentagonal; palpi long. Body of male either wider or nearly as wide as long; beneath naked. Dorsal shield covering the whole body, and generally with green metallic marks. The shield of the female shorter and scarcely any longer than wide, ordinarily marked with three green metallic spots in a triangle.

This genus is exotic, and it is almost exclusively parasitical on snakes and saurians. Twelve species are described; but none are British.

(b²) *AMBLYOMMA* Koch, 1844.

Synonym: *Ixodes* Latreille, 1795.

Eyes usually flat and but little apparent; sometimes brilliant; placed on the outer edge of the shield. Rostrum long. Anal groove

¹ Two other females found at the same place on Dec. 2nd, 1905, by Mr Oldham of Knutsford are deposited at the British Museum.

open in front, joining the sexual grooves. Dorsal shield often marked with coloured designs. No ad-anal shields on the male. Peritremes generally triangular, with rounded angles. Eleven marginal posterior indentations nearly always present, especially in the male.

Professor Neumann describes no less than 86 species of *Amblyomma*, mainly from tropical and sub-tropical climates. One species, *A. hebraeum*, known at the Cape as the "bont" or variegated tick, is the carrier of "heartwater" in sheep, which Mr Lounsbury says "is gradually rendering the splendid veldt of the infected districts useless for sheep farming." Not any British species.

(b^s) *HYALOMMA* Koch, 1844.

Eyes generally round and brilliant (fig. 10), sometimes flat and little noticeable. Rostrum long. Anal groove open in front, joining the sexual groove with another extending from the anus to the posterior margin (fig. 12). Body elongated oval. Colour brown, more or less dark. The male has two pairs of ventral shields, two of which are ad-anal and large, with two others outside, added to which are often two accessory ones, or lamellae, behind the ad-anal shields (fig. 12).

Only three species are described by Professor Neumann, one of which—*H. aegyptium* Linn.—is known at the Cape as the "bont-legged tick," where it attacks small stock and ostriches, as well as cattle and horses, and is considered second only to the "bont tick" as a pest to farmers. It is known probably all over Africa and the greater part of Asia. No less than thirty synonyms are given for this species, showing the great confusion there has been in the nomenclature of ticks. No British indigenous species is known, but one, *H. syriacum*, has been taken on imported tortoises.

Hyalomma syriacum Koch.

Synonym: *Hyalomma affine* Neumann, 1899.

FEMALE. Length, fasting, 6 mm., when distended up to 13 mm.; shield oval, and but little longer than wide, each anterior angle prolonged to nearly half way up the palpi; punctuated sparsely but deeply; eyes small; body reddish-brown. Two very minute dorsal spiracles behind the shield. Coxae of front legs divided with two blunt spines or tubercles; the other haunches with two small tubercles at the outer edge of each. Tarsi short and thick, and suddenly attenuated at the end, which in the three posterior pairs is furnished with a small hook.

MALE. Length, 6 mm.; shield, reddish-brown, bare, anterior angles projecting little; grooves at the neck short and deep, none at the sides; punctuations sparse, equal, and large; underside reddish-brown, sometimes yellow; anus a little behind the orifice of the stigmata; anal shields wide and short; peritremes short and comma-shaped (fig. 12).

Mr Pocock mentions this tick as having been found at Feltham in Surrey, and another was sent me by Mr F. Noad Clarke. The latter was a distended female, which he had exhibited at the South London Entomological Society in June, 1899. Others taken from tortoises imported from abroad have been received by me.

RHIPICEPHALAE.

Synonym: *Conipalpi* Canestrini.

The Rhipicephalae are characterised by their palpi, which are short and more or less conical or subtriangular—not, or but slightly, longer than broad (fig. 27). The upper face of the base of the rostrum is triangular and elongated transversely in *Haemaphysalis* and *Dermacentor*, whereas in *Rhipicephalus* it is hexagonal, and in consequence is provided with salient lateral angles. The underside of the male is unprovided with shields in *Haemaphysalis* and *Dermacentor*, whereas *Rhipicephalus* has two to four symmetrically disposed at the sides of the anus (fig. 29). The absence of ventral shields is almost always compensated for in *Dermacentor* by the great development of the haunches of the fourth pair of legs (fig. 28). *Haemaphysalis* is distinguished, independently of the absence of ventral shields in the male, by the absence of eyes, and by the form of the second joint of the palpi, which in both sexes makes a lateral projection more or less marked (fig. 30).

(c) *HAEMAPHYSALIS* Koch, 1844.

Synonyms: *Rhipistoma* Koch, 1844; *Gonixodes* Dugés, 1888; *Opistodon* Canestrini, 1897.

No eyes; base of rostrum in a rectangle, twice as wide as long. Palpi conical, second joint having a strong conical lateral projection (fig. 30). Peritreme round, or shaped like an abbreviated comma. No shields on ventral face of male. Coxae of first pair of legs not bifid, those of the fourth pair of normal size in the male. Colour uniform brownish.

Of this genus twenty-two species are described from Asia, Africa, Europe, and America, one of which, *H. punctata*, is British.

Haemaphysalis punctata Canestrini and Fanzago, 1877-8.

Synonyms: *Haemaphysalis sulcata* Canestrini and Fanzago, 1877-8; *Rhipicephalus expositicius* Koch, 1877; *Haemaphysalis peregrinus* Cambridge, 1889; *Herpetobia sulcata* Canestrini, 1890.

FEMALE (fig. 31), fasting, 3.44 in length to 12 mm. when replete. Dorsal shield deeply indented in front to encompass the base of the rostrum. Colour reddish-brown, when replete of a leaden grey, which turns to a deep red-brown in alcohol. Rostrum, shield, and legs always brownish. The body above and below punctuated finely and regularly all over. Sexual orifice opposite the coxae of the second pair of legs in both sexes. Shield coarsely and regularly punctate. Peritremes whitish and nearly round. Labium furnished with numerous very small teeth, arranged in five rows on each side. Palpi a little longer than the labium, the first joint short and narrow, the second and third much widened on the dorsal face. Legs comparatively short, coxae with a wide, short, blunt spine; tarsi short and terminated with a spur, which is small on the first pair.

MALE (fig. 32). Length, 3.10 mm. Body rather narrow, reddish-brown or yellowish. Dorsal shield covering nearly the whole body; cervical grooves deep, short and wide in front; numerous punctuations over its whole surface. Eleven indentations on posterior margin of body; peritremes lighter in colour, large, and somewhat comma-shaped. The three anterior pairs of legs with a short spine on the haunches; the fourth with a very long one directed backwards, and being at least as long as the haunch.

NYMPH. Length, 2.50 mm. to 3.00 mm. Body oval, varying from light yellow to dark red-brown. Dorsal shield rounded, with a few punctuations, otherwise like that of the female. Ventral face like the female, but the sexual orifice nearly obsolete. No spur on the tarsi.

LARVA. Body short, oval. Length, 1.20 mm.

This species is somewhat widely distributed, but is not common anywhere. The specimens taken are never very numerous. It is found on sheep, especially behind the ears; on goats, cattle, horses, etc. British specimens were sent to me by Mr Pocock, taken from a hedgehog at Dungeness, consisting of a male and distended female. I have received others taken from sheep in England, but locality not stated.

(d) *RHIPICEPHALUS* Koch, 1844.

Synonyms: *Acarus* Linn., 1758; *Ixodes* Latreille, 1795; *Phauloixodes* Berlese, 1889; *Boophilus* Curtice, 1890.

Eyes distinct. Base of rostrum wider than long, hexagonal on the dorsal side, forming a prominent angle at each side. Palpi short, wide (fig. 27). Coxae of the first pair of legs with two spines, usually strong. Peritremes of female in form of a short comma, generally long in the male. The male has one or two pairs of ventral shields; one pair placed on each side of the anus, triangular, sometimes rectangular, large; a second pair, if present, smaller and placed outside.

M. Neumann describes twenty-three species of this genus, most of which are African. It is to some of these that is to be attributed the immense damage to cattle already referred to, which is caused by carrying the microbes of the disease known as "tick fever," "Texas fever," etc., from diseased to healthy animals.

In the Cape Colony *R. decoloratus*, called the "blue tick," and *R. evertsi*, called the "red tick," are best known as such; in the Southern States of North America a closely allied species, *R. annulatus*, is the chief cause of the disease, which in Australia is represented by a slightly different form named *R. australis* by Mr Fuller. No British species is known; but one, *R. sanguineus*, is so widely distributed that there is every possibility of its occurring in England. It is found not only in France and the south of Europe, but in Asia, Africa, America, and Australia.

(d²) *DERMACENTOR* Koch, 1844.

Synonyms: *Ixodes* Latreille, 1795; *Pseudixodes* Haller, 1882.

Eyes present. Base of rostrum wider than long, rectangular on the dorsal face. Palpi short and thick. Peritremes shaped like a short comma. The ventral side of the male has, like the female, no shields. Haunches of the first pair of legs bidentated in both sexes; those of the fourth in the male greatly enlarged (fig. 28). Dorsal shield generally ornamented with various designs.

Seventeen species of this genus are described. One only is British.

Dermacentor reticulatus Fabricius.

Synonyms: *Acarus reticulatus* Fabricius, 1794; *Ixodes reticulatus* Latreille, 1804; *Cynorhaestes pictus* Hermann, 1804; *I. marmoratus*

Risso, 1826; *Ixodes pictus* Gervais, 1844; *Dermacentor reticulatus* Koch, 1844-47; *D. albicollis* Koch, 1844-47; *D. pardalinus* Koch, 1844-47; *D. ferrugineus* Koch, 1844-47; *Ixodes holsatus* Kolenati, 1857; *Pseudixodes holsatus* Haller, 1882; *Haemaphysalis marmorata* Berlese, 1887; *Acarus marginatus* Sulzer; *Crotonus variegatus* Dumeril, 1829.

FEMALE (fig. 33). When fasting, 3.86 mm. long by 2 mm. wide. Body depressed, larger behind. Colour reddish-brown. Shield very large, extending to the level of the third pair of legs, punctuated with a few large and many small punctuations. Colour milky-white, variegated with reddish-brown. Sexual orifice is opposite the coxae of the second pair of legs. Sexual grooves near together in front, rapidly diverging behind the haunches of the fourth pair, and terminating between the second and third festoons on the posterior margin of the body. Peritreme comma-shaped, short, and rounded. Coxae of front legs deeply bifid, the others with a moderate spine. A strong claw at the end of the tarsi of the three posterior pairs of legs, very small in the front pair. Length when replete up to 16 mm. Colour light brown. When depositing eggs, mottled with dark brown above and beneath. Legs brown.

MALE. Very like female (fig. 34). Shield reddish-brown, variegated with milky-white pattern; in front this takes nearly the appearance of the shield of the female, margined by a white border behind. Coxae of the fourth pair of legs three times the size of the third. Palpi having on the second joint a sharp spine pointing backwards (fig. 35), which is less pronounced in the female. Length 4.20 mm.

I am not aware that the nymph or larva have been described.

This species varies very much in individuals, both in shape and colouring. It occurs in England occasionally on sheep. Specimens have been sent to me by Mr Pocock which were found on sheep at Revelstoke in Devonshire. It is widely distributed in Europe and Asia. It also attacks cattle, deer, goats, roe-deer, and even man. Mrs Richardson stated that in March, 1902, this species was so numerous in her garden at Stoke House, Revelstoke, as to be a nuisance to those gathering flowers. It is most probably an imported species that has become acclimatized, in which case, as it is hardy and active, it is likely to become widespread and troublesome.

TABULAR SYNOPSIS.

The following is a short tabular synopsis of the foregoing classification of the Ixodidae:

- I. Rostrum concealed beneath the fore-part of the body, except in the immature states; no dorsal or ventral shields,—

ARGASINAE.

- (a) Body flat with thin edges, finely shagreened and punctuated, narrower in front. No eyes *Argas*
 (b) Body with thick sides, often densely covered with small, round, shining granules in various patterns. Eyes sometimes present¹. *Ornithodoros*
- II. Rostrum terminal. Body more or less covered with a dorsal shield. Considerable difference generally between the sexes. Dorsal base of the rostrum of female with two symmetrical hollows finely punctuated, which are absent in males, nymphs, and larvae.

IXODINAE.

- (A) Rostrum and palpi longer than broad (fig. 11).
 (a) Anal groove contouring anus in front (fig. 11). No eyes.
 (a¹) Palpi caniculated in both sexes *Ixodes*
 (a²) Palpi claviform, not caniculated in the male. Anal groove absent in the female *Ceratixodes*
 (a³) Palpi claviform, not caniculated in the male (fig. 15). Legs very long. Anal groove present in both sexes *Eschatocephalus*
 (b) Anal groove contouring anus behind (fig. 12).
 (b¹) No eyes. Ad-anal shields *Aponomma*
 (b²) Eyes present (fig. 10). Males have no ad-anal shields. *Amblyomma*
 (b³) Eyes present. Males have ad-anal shields (fig. 12) *Hyalomma*
- (B) Labium and palpi short and more or less conical; not, or very little, longer than broad.

RHIPICEPHALAE.

- (c) No eyes nor ventral shields in the male. Rostrum rectangular; second joint of palpi with lateral projection (fig. 31) *Haemaphysalis*
 (d) Eyes present.
 (d¹) Rostrum with salient angles. Either two or four shields at the side of the anus of the male (fig. 29) *Rhipicephalus*
 (d²) Rostrum rectangular. No ad-anal shields, but usually a great development of the coxae of the fourth pair of legs in the male (fig. 30) *Dermacentor*

¹ This is denied by Dr Marx in *Proceedings of Entomological Soc.*, Washington, Vol. II., No. 2, 1892.

APPENDIX.

PAIRING OF SEXES.

THERE are considerable doubts as to the method of sexual intercourse in the different genera of the *Ixodidae*. Dr Marx writes "that the orifice of the oviduct in the matured female and that of the sexual organs of the male are situated very close to the insertion of the capitulum¹."

Dr Cooper Curtice writing of the cattle tick (*Rhipicephalus annulatus*) says, "The external genitals which appear in the adults are very similar in each sex, and occur between the bases of the second pair of legs²"; and again, "The male places himself in copulation, belly to belly with the female, attaches to the host by his beak, and winds his legs around those of the female, thus bringing their external genitals in contact³."

Others have held the same view, and as recently as last November Dr Todd referring to *Ornithodoros moubata* (?) says, "In coitus the male lays hold of the posterior margin of the female, and turning on his back, crawls forward beneath the female, until the genital pores are in opposition. Pairs are often formed and remain for hours *in coitu*⁴." One writer goes so far as to assert that the tail-like projection in *Rhipicephalus annulatus* is a penis!

It is certain, notwithstanding, that in the case of several of the species of *Ixodidae*, insertion of the mouth organs of the male into the orifice of the female takes place at the time of sexual intercourse. In proof of this I have found spermatozoa in the females of *I. ricinus* immediately after pairing effected in this manner (fig. 36)⁵. A similar manner of pairing has been observed by me in the case of *I. hexagonus*, and with *Ceratixodes putus*, which last observation has been confirmed by Mr Hewett of York. This method of intercourse seems to have been noticed by earlier observers. C. L. Koch in his *Uebersicht der Arachnidensystems*, part IV. page 10 (1847), says, literally translated, "I have

¹ *Proceedings of Ent. Soc.*, Washington, Vol. II., No. 3, p. 273, 1892.

² "About Cattle-ticks," by Cooper Curtice, M.D., *Journal of Comparative Medicine*, Jan., 1892.

³ *Agricultural Gazette*, N. S. Wales, July, 1896.

⁴ *The Nature of Human Tick Fever in the Congo Free State*, Nov., 1905. Liverpool School of Tropical Medicine, Memoir xvii.

⁵ In this illustration two males are shown, one *in coitu*, the other waiting.

already in the preliminary treatise of which I have made mention alluded to the fact that, according to the observations of the celebrated naturalist De Geer, large ticks have been found that have a small tick attached to their ventral surface with its proboscis sunk into an aperture in the body of the larger. This condition, in which ticks are frequently found, is nothing but coition." Unfortunately no particular species of ticks are mentioned. Mr Lounsbury of the Department of Agriculture, Cape Colony, confirms these observations with regard to *Ixodes pilosus*, *Amblyomma hebraeum*, known in Cape Colony as the "bont tick," *Rhipicephalus evertsi*, the "red tick," *R. decoloratus*, the "blue tick," *Ornithodoros savignyi*, and *Argas persicus*. He also kindly sent me in 1902 spermatozoa taken from the females, after copulation, of *R. evertsi*, *R. decoloratus*, and *A. hebraeum*.

Since these have been noted in such widely different species and by such a careful observer, it seems more than probable that the habit is universal amongst the *Ixodidae*.

Mr R. T. Lewis¹ drew attention to two organs at the base of the hypostome, which if examined immediately after forcibly separating the male from the female, "presented the appearance of flexible semi-transparent tubular papillæ, which conveyed the impression to my mind that here possibly were the organs by means of which actual impregnation took place."

Dr Nuttall, however, to whom I am indebted for most valuable assistance, is of opinion that the insertion of the rostrum by the male is merely for the purpose of holding on to the female, and that the external male sexual organ is not obsolete. He considers that the spermatozoa must be remitted therefrom and be in some way passed forward to the vulva, possibly by a mechanism analogous to the ovipositor of the female.

Ticks of different species vary in their habits when pairing. The males of *I. ricinus* are only to be found *in coitu* with distended females on the host. At the same time virgin males and females may be collected separately, but never in intercourse, from rushes or coarse herbage.

Immediately on being confined together in a bottle which is warmed in the pocket, pairing takes place, and usually continues for some hours. I found that if prematurely separated no sperms had passed from the male to the female.

¹ *Quckett Microscopical Society Journal*, October, 1900,

The male of *R. decoloratus* also seeks the female and remains *in coitu* several days¹. (Lounsbury.)

The habits of *A. hebraeum* are quite different. The male first establishes himself on the host, and after he has been affixed several days he becomes a source of attraction to the females. These latter will surround him and fight amongst themselves to secure him. A male remained attached to a host almost a full year. (Lounsbury.)

SPERMATOOZA.

The spermatozoa of *Ixodes ricinus* are shaped as shown in Fig. 37. I have failed to observe any movement in them. They are usually, but not always, accompanied by a very fine worm-like body about half the length of the spermatozoon. This takes a darker stain with haematoxylin than the larger body, from which it becomes easily separated by pressure. This darker body Dr Nuttall considers to be undoubtedly nuclear. Mr Lounsbury writing in 1902 said, "The sperms vary in shape in the different species. There is no doubt about their being sperms. They do not occur in the males of *hebraeum* or *decoloratus* until these have been feeding some days and are ready for females. Of this I am positive from the examination of much material. The prettiest feature is finding them in the females. By carefully removing the whole dorsal skin, and washing out the contents of the digestive tract of fully engorged females, the forming ovaries are easily placed, and between them in the shape of a rotund, dense, white body is the receptaculum containing the sperms. It has a tube leading to the oviduct. When this is cut the sac may be removed entire and burst under the microscope when the myriads of sperms fly out. The sac is quite visible to the naked eye. I have seen several in *decoloratus* and *hebraeum*. Of course there is only one sac in a female. By carefully opening *hebraeum* males, I have found what I take to be the testes. At least I can get out a pair of bodies which swarm with sperms."

HEADLESS FEMALE.

The remarkable vitality of the headless female of *Ixodes ricinus*, referred to on page 401, is worthy of further notice. A reproduction of a photograph of the creature (fig. 38) is given for comparison with that of an ordinary female of the same species, shown by fig. 11, with the

¹ *Cape Agricultural Journal*, Nov. 24, 1898.

mouth organs complete. That such a deformed individual could survive at all seems wonderful. It will be seen that beyond a slight prominence, no vestige of any capitulum or mouth organs was present. This individual proved beyond all question the power of a tick to live many months without food of any sort.

Argas persicus Fischer de Waldheim, 1823.

As this species has often been mistaken for *Argas reflexus*, a figure (39) of the male is here given for comparison with that of the male of *reflexus* (fig. 7). The chief and characteristic differences are the wrinkled margin of *A. reflexus* as compared with the discs on that of *A. persicus*, and the prominent knobs on the tarsi of the former species, shown clearly in fig. 6 of the female. These differences are similar in both sexes.

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