

South African Ticks.

PART I.

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It is 25 years ago since Nuttall and Warburton published Part I of their Monograph of the Ixodoidea, and Howard his paper on South African ticks in the Annals of the Transvaal Museum. As both these works are now out of date, the former has never been completed, and the latter is now out of print, it was considered advisable, in view of the importance of ticks, to prepare the present work. Owing to the cost of publishing this work it will appear in about four parts in the Onderstepoort Journal of Veterinary Science and Animal Industry. Sufficient reprints will be printed so that the work, when complete, can be published in book form. Part I deals mainly with the species of Argasidae. A complete list of references will be given in the final part. A number of them will be found in "A Synoptic Check-list and Host-list of the Ectoparasites found in South African Mammalia, Aves and Reptilia. Second Edition", published in Ann. Rep. Dir. Vet. Serv. and Anim. Indust., Un. S. Afr., 1932, XVIII, pp. 515-517. Only a list of works referring to the transmission of diseases by species of Argasidae will be found at the end of this paper.

It is hardly necessary to emphasize the importance of ticks as it is well known that they play an important rôle in the transmission of a number of diseases to man and domestic animals. Apart from this they also do a considerable amount of harm to animals when numerous by sucking blood and setting up irritation, which cause their hosts to lose their appetites and fall off in condition, and may even cause the death of their host without transmitting a disease. Theiler (1911) recorded a case in which a horse, badly infected with blue ticks (*Boophilus decoloratus* Koch) died from acute anaemia as a result of the tick infestation. No less than 14 lb. of blue ticks were collected from this animal in three days, and this amount only represented about half the number of ticks which had gorged on this animal.



Fig. 1. Horse badly infected with *Boophilus decoloratus* (Koch). Engorged female ticks plainly visible. [Photo T. Meyer.]

The spinose ear tick (*Argas megnini* Dugès), which was introduced into this country from America, has often been known to kill sheep, goats and calves by the irritation set up when feeding in the ears (it being usually only found in the ears of its host).

The bites of some species of *Hyalomma* and *Amblyomma* sometimes cause sores which may lead to sloughing.



Fig. 2. Neck of same horse.

[Photo T. Meyer.]

As our knowledge concerning the hosts of various species of ticks is by no means complete, and as certain species may feed only on certain kinds of animals in their immature stages, and on other animals in their adult stages, it is important that we should be able to identify all the stages of a species of tick, especially as it is frequently inconvenient, if not impossible, to breed the larvae and nymphs collected from animals or birds shot in the veld to their adult stages. The only ticks in which I have up to the present been unsuccessful in detecting specific characters have been the larvae of *Amblyomma*.

EXTERNAL ANATOMY.

The body is usually oval in shape and flattened dorso-ventrally in unfed specimens, becoming swollen after feeding, except in the males of *Ixodidae*. The *capitulum* (rostrum or false head) is situated in front in the *Ixodidae* and lies in a *camerostome* or hollow on the venter in the *Argasidae*. It consists of the following parts:—

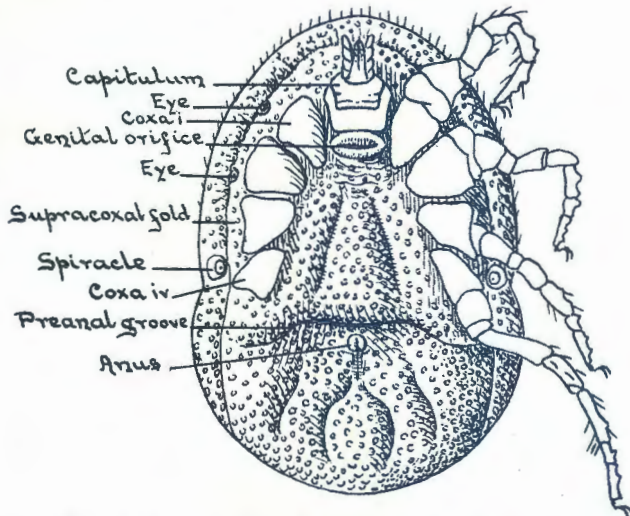


Fig. 3. *Argas savignyi* Aud., venter of female.

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The *basis capituli* which is the basal portion articulated with the body. In the *Ixodidae* a *dorsal ridge* with backward projecting edge is often present. It may have protruding angles termed *cornua*. A *ventral ridge* may likewise be present, also a protruding retrograde process at the lateral angles of the ventral ridge termed the *auricula*. The females of *Ixodidae* have a pair of depressions on the dorsum known as *porose areas*, the space between them being called the *interval*.

The *hypostome*, which arises from the *basis capituli*, projects forward in front and bears backward-projecting teeth (except in the adults of *A. megnini*), which are usually arranged in longitudinal

files. The number of files varies in different species, and 3/3 indicates that there are three files on each half of the hypostome. The hypostome may be rounded, pointed or emarginated at its apex, and if a number of minute teeth are present at its tip, it is described as having a *corona*.

The *chelicerae* or mandibles are paired organs lying above the hypostome. Situated at the extremity of each chelicera is a *digit* or cutting organ consisting of an *internal article* which has a *dorsal process* projecting outwards near the apex, and an *external article* articulating with the internal article on its inner side.

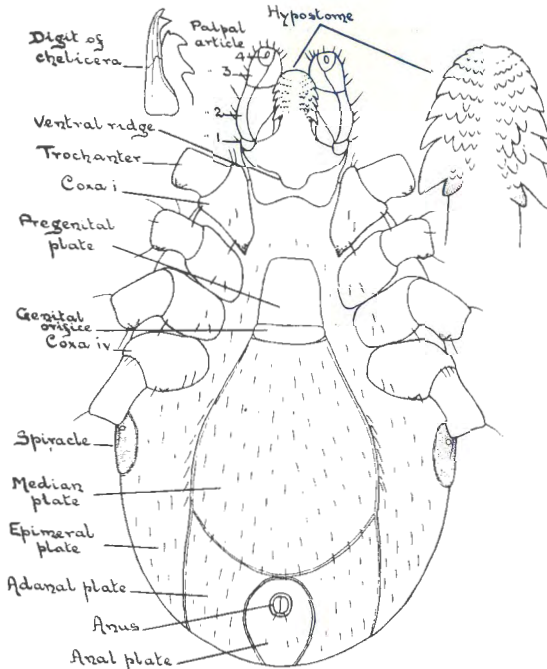


Fig. 4. *Ixodes pilosus* Koch, venter of male.

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The *palpi* are situated one on each side of the hypostome. In the Argasidae they are always four segmented, flexible, and have the fourth segment terminal. In the Ixodidae they are usually four-segmented, but some of the segments may be fused, especially the second and third segments. The first three segments are usually grooved on their inner margins. In all species, except *N. namaqua*, the segments are rigid, and the fourth segment is very small and lies in a cup-like hollow on the venter of the third segment.

Body.—In the Ixodidae there is a chitinous shield or *scutum* on the dorsum. In the adult males it often covers the whole of the upper surface, but may, as in all *Ixodes*, be surrounded by a raised fold of the body, termed the *marginal fold*. In all the other stages the scutum forms a small oval or round plate behind the capitulum. Some males possess a ridge or punctations on the scutum outlining in shape and position the female scutum, this being termed the *pseudoscutum*.

In a number of species the scutum is of a uniform colour, but many have well-marked colour designs and spots on the scutum, when it is spoken of as *ornate*. Small circular depressions, termed *punctations*, are usually present on the surface. The antero-lateral angles of the scutum may be prolonged into well-marked shoulders, the *scapulae*. Extending backwards from the inner angles of the scapulae are the *cervical grooves*, and running along the sides of the scutum are the

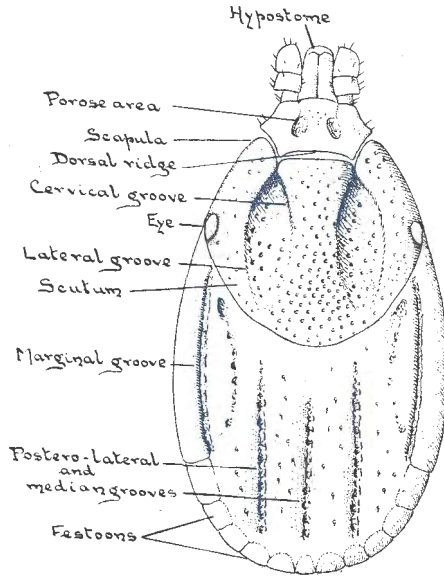


Fig. 5. *Rhipicephalus appendiculatus* Neu., dorsum of female.

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lateral grooves, which in the male may extend backwards and include one or more festoons. The female also has *marginal grooves* running along the sides of the body, these corresponding to the lateral grooves in the male. Depressions, often ill-defined, known as the *median* and *postero-lateral depressions, furrows* or *grooves*, may be present towards the posterior margins in the males and females of certain species. Two small spots, termed the *foveae*, may also often be seen near the middle of the scutum in the males, and posterior to the scutum in the females. Uniform rectangular areas, known as *festoons*, are frequently present on the posterior margins of Ixodidae. They are visible both dorsally and ventrally, but more distinct in unfed than gorged females. They sometimes have chitinous plates on their ventral surfaces.

Venter.—Situated on the under surface of the body is the *genital orifice*, termed the *vulva* in the female, which lies in the median line behind the basis capituli. It will be seen to be a transverse slit, and is wider in the females of Argasidae than in the males. Arising in front of the orifice, which it covers, is a chitinous flap called the *apron*. Extending from the sides of the genital orifice are two well-marked grooves, the *genital grooves*, which run backwards between the coxae and then laterally towards the posterior margin of the body.

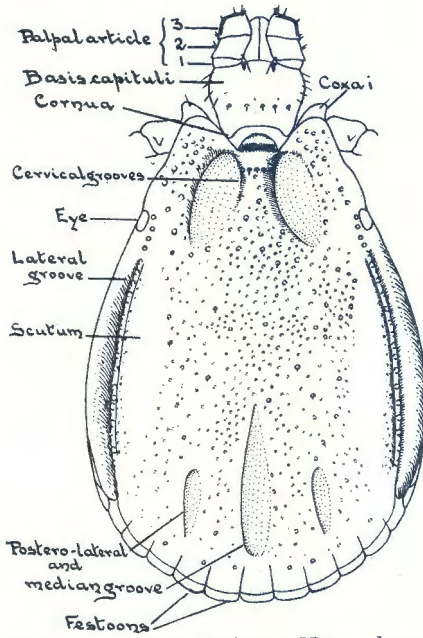


Fig. 6. *Rhipicephalus appendiculatus* Neu., dorsum of male.
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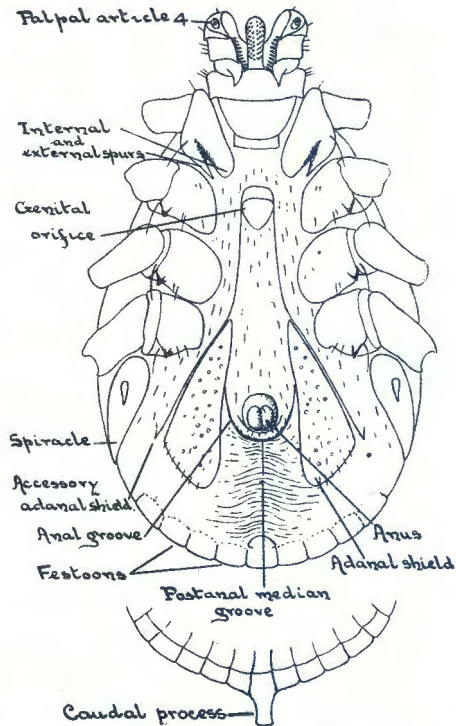


Fig. 7. *Rhipicephalus appendiculatus* Neu., venter of male.
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The *anus* lies in the median line posterior to the hind coxae, and behind this is a median longitudinal groove, the postanal groove. In the Ixodidae there is usually an *anal groove* present, which either curves round the anus in front or behind. In the males of *Ixodes* there are several flat chitinous plates present; these include one *pregenital*, one *median*, one *anal*, two *adanal* and two *epimeral plates* (see Fig. 4). The males of *Rhipicephalus*, *Boophilus* and *Hyalomma* possess a pair of salient chitinous structures, known as the *adanal shields*, situated one on each side of the anus, and external to these a pair of *accessory adanal shields* are frequently present (see Fig. 7). In the Argasidae there is a well-developed fold, the *supra-coxal* fold, extending on each side from the lateral margins of the camerostome along the outer margins of the coxae, and on the inner margins of the coxae a pair of *coxal folds* are frequently present. The camerostome may project forwards in front of the capitulum, forming a *hood*.

Spiracles.—In the Ixodidae the spiracles are situated ventrolaterally, one on each side behind coxae iv. Only in one species, *N. namaqua*, has it not been possible to demonstrate their presence. They are circular, oval or comma-shaped, and may have a marginal frame of chitin, which is always incomplete postero-ventrally in the comma-shaped forms. Situated at or near the centre of each spiracle is a round or elongate structure termed the *macula*. The spiracles of *Haemaphysalis cinnabarina punctata* Can. and Fan., have been studied by Nuttall, Cooper and Robinson (*Parasit.*, 1908, I, iv, pp. 347-351, pl. 22, 23). In the Argasidae they are smaller and situated more anteriorly, usually between legs iii and iv.

Eyes may be either absent or present. If present, there are two pairs in the Argasidae and one pair in the Ixodidae. In the former they are situated on the supra-coxal folds, the first pair in a line with coxae i and the second pair between coxae iii and iv; and in the latter they are situated on the lateral margins of the scutum.

Legs.—The legs are six-jointed, the first joint being the coxa, which is immovable, followed by the *trochanter*, *femur*, *tibia*, *protarsus* and *tarsus*, and in addition to these false articulations may be present. At the end of the tarsus there is a stalk to which are attached two well-developed *claws*. On the ventral surface of the claws there is a disc-like expansion, the *pulvillum*, which is well-developed in the Ixodidae, but absent or rudimentary in the Argasidae. Situated on the dorsum of the first pair of tarsi is a sense organ known as *Haller's organ*; it consists of several cup-shaped pores containing sensory setae and dermal cells. It has been described by Nuttall, Cooper and Robinson (*Parasit.*, 1908, I, iii, pp. 238-242, t.f. 1, pl. 18). In the Argasidae the tarsi frequently have *dorsal protuberances*, and in the Ixodidae they either taper or are humped, and are often armed with one or two *ventral spurs*.

INTERNAL ANATOMY.

The internal anatomy of *Argas persicus* (Oken) has been fully described by Robinson and Davidson (1913-14: *Parasit.*, VI, 1, pp. 20-48, t.f. 1-2, pl. 1-6; *ibid.*, VI, iii, pp. 217-256, t.f. 1-8, pl. 14-17; *ibid.*, VI, iv, pp. 383-424, t.f. 1-8, pl. 25-28). Patton and Cragg, *A Textbook of Medical Entomology*, 1913, pp. 651-674, pl. 83-86) have also described the internal anatomy of *A. persicus* and other species.

CLASSIFICATION.

Ticks belong to the order ACARINA, which also includes the mites. They are usually much larger than mites, except their larvae, and can be distinguished from them by possessing the following combined characters:—

- (i) A pair of spiracles situated laterally, either behind the posterior pair of legs or between the third and fourth pairs. Only in one species, *Nuttalliella namaqua*, has it not been possible to detect spiracles.
- (ii) The tracheae opening through a chitinous plate.
- (iii) Having a movable false head, or capitulum, of a special structure.
- (iv) The hypostome is large and provided with backward-projecting teeth. Only in the adults of *A. megnini* is the hypostome unarmed, and in the female of *N. namaqua* the teeth are very rudimentary.
- (v) Possessing a sense organ, known as Haller's organ, on tarsus i.

The ticks are included in the superfamily IXODOIDEA, which is sub-divided into two families as follows:—

Family ARGASIDAE.—Integument of body more or less leathery, without a hard shield (scutum). Sexual dimorphism slight, the males only being distinguishable from the females by the shape of the sexual opening. Head situated on the anterior portion of the ventral surface, and not projecting beyond the anterior margin of the body, except in the larvae, and also sometimes in the nymphs of *A. megnini*. Eyes usually absent; when present, four in number and situated laterally on the supra-coxal folds. Pulvillus absent or rudimentary.

Family IXODIDAE.—Scutum present on the dorsal surface of the body, forming a small round or oval plate behind the capitulum in the females, nymphs and larvae, and covering or practically covering the entire upper surface in the males. Head situated on the anterior margin, and always plainly visible when viewed from above. Eyes absent or present; when present, two in number and situated on the lateral margin of the scutum. Pulvillus always present.

In addition to the above, there are other characters by which these two families can usually be distinguished, but they do not hold good for *Nuttalliella namaqua* Bedford, which is included in the family Ixodidae. This species is particularly interesting as it appears to be the missing link in the evolutionary chain between the Argasidae and Ixodidae, and seems to indicate that the Ixodidae may have originated in Africa. It resembles the Argasidae in possessing a leathery integument, and has a scutum as in the Ixodidae, but instead of being highly chitinous as in that family, it more closely resembles the rest of the integument of the body. The joints of the palpi are very flexible as in the Argasidae, not ridged as in the Ixodidae; the fourth segment is terminal as in the Argasidae, whereas in the Ixodidae it is situated ventrally at the distal end of the third segment, and is reduced, forming a tactile papilla; the second segment is grooved. The Argasidae possess ungrooved palpi, whereas in the Ixodidae the second and third segments are grooved on their inner margins, except in the male of the exotic species, *Ixodes putus* (Pickard-Cambridge), which is parasitic upon birds.

In the Ixodidae the spiracles are generally large and situated well behind coxae iv, whereas in the Argasidae they are small and situated more anteriorly. In *N. namaqua* these organs could not be located, although they should exist. Apart from external characters, the species of Argasidae also differ from those of the Ixodidae in their biology.

THE LIFE CYCLES OF TICKS.

All ticks are blood-sucking parasites of mammals, birds, reptiles and amphibia, but no species has been recorded from the last named hosts in Africa. Some species are only parasitic on hosts that are closely related to each other, whereas others are found on a number of different hosts that are in no way related to one another. Moreover, the immature stages of one or two species, such as *I. rubicundus* and *H. aegyptium*, are rarely, if ever, found on the same hosts as the adults.

ARGASIDAE.—The females feed several times, and after each meal crawl to some sheltered spot where they lay a small batch of eggs. The total number of eggs laid rarely exceeds a thousand. The egg stage usually lasts about one to three weeks, and a few days after hatching the young larvae crawl about in search of a host, except those of *A. moubata* and *A. savignyi*, which are unable to feed, and on getting on to a suitable host immediately commence to suck blood. They remain feeding on their host for a few days, and then drop off and seek shelter, where they moult into nymphs a few days later. Both the nymphs and adults live most of their time in sheltered places and only seek a host at intervals to feed. They invariably only feed at night, and are rapid feeders, taking from 30 minutes or less to an hour or two to feed. In *A. persicus* and *A. respertilonis* there are two nymphal stages, and in *A. moubata* and *A. savignyi* the male nymphs undergo 3 to 5 ecdyses and the female nymphs from 3 or 4 to 6 or 7 ecdyses before moulting into adults. Pairing takes

place off the host, either before or after feeding. The life cycle of *A. megnini* is unique in that the adults do not feed; also, the larvae after feeding moult into nymphs on their hosts, and the nymphs remain attached to their hosts for one to twelve weeks or longer.

IXODIDÆ.—The females remain on their hosts until they are fully gorged. They then drop off and hide in grass or under stones, and in a few days commence to lay eggs. Laying continues until the bodies of the females are flat and empty, then they die. The number of eggs laid by a single female varies according to the species. *B. decoloratus* lays from 1,000 to 2,500; *R. appendiculatus* from 3,000 to 5,700; *H. aegyptium* from 10,000 to 15,500 and *A. hebraeum* up to 18,500. The egg stage lasts about 3 to 6 weeks or longer, the period depending upon the species and climatic conditions. The larvae are ready to feed a few days after escaping from the eggs, and then crawl up the stems of grasses or other plants where they frequently accumulate in masses, and wait for a host to pass by. Should they be so unfortunate as to not meet with a host, which many, in fact the majority, that hatch in the course of a year undoubtedly do, they must, of course, eventually die of starvation. On the other hand, should a suitable host pass within their reach they promptly cling to it by means of their legs, and having selected a suitable spot, insert their mouth-parts into the flesh and commence to feed. From now on various species differ in their habits, and may be classified into three groups as follows:—

One-host Ticks.—Ticks which moult from the larval stage into the nymphal stage, and from the nymphal stage into the adult stage on the same host. To this group belongs the species of *Boophilus* and *Margaropus winthemi*.

Two-host Ticks.—The larvae of these ticks moult into nymphs on their hosts, but the nymphs drop off after feeding. After remaining on the ground for about three weeks they moult into adults, which crawl up vegetation and wait for another host. To this group belongs *Rhipicephalus evertsi* and *Hyalomma aegyptium*. The later is also sometimes a three-host tick.

Three-host Ticks.—The larvae of these ticks, having found a suitable host and gorged, drop off and, after remaining on the ground for some time, moult into nymphs which, in turn, have to find another host. Having done so, they gorge and then drop off, and, after a lapse of time, moult into adults, which again have to seek another host. To this group belongs the majority of Ixodidae.

Adults belonging to all the above groups usually pair on their hosts, and the males remain on their hosts much longer than the females, and never, except in exceptional circumstances perhaps, drop off their host to find another one, or get on to another animal that may happen to come in contact with its host. The males of a few exotic species, chiefly *Ixodes*, are known not to feed. These, after emerging from the nymphal stage, lie in wait for the females to drop off gorged from their host in its burrow or nest. It is possible that the males of the three following South African species do not feed: *Ixodes daveyi* Nutt., *I. nairobiensis* Nutt., and *I. simplex* Neu.

MODE OF FEEDING.

The method of feeding is similar in all ticks. A tick penetrates the tissue of its host by means of its paired chelicerae, which can be moved backwards or forwards. Situated at the extremity of each chelicera is a digit or cutting organ, which is provided with backward-projecting teeth and can be moved laterally by means of two tendons. When a wound has been made the hypostome is inserted into it. This is provided with backward-projecting teeth which serve to anchor the tick to its host. When the chelicerae and hypostome have penetrated sufficiently and the digits have cut the smaller blood vessels, the tick proceeds to imbibe blood, this being sucked in by means of a pumping organ, the pharynx, which is situated in the capitulum. Entering the pharynx the blood passes through the oesophagus into the intestinal caeca, and then the tick proceeds to swell. At first the blood is imbibed slowly, the maximum increase in the engorgement of ticks belonging to the Ixodidae usually taking place during the last twenty-four hours before they abandon their hosts.

Whilst feeding, not only is saliva injected by the tick from its salivary glands into the wound, but a considerable quantity of secretion may be expelled from large pores situated between the first and second pairs of coxae. Both the secretions from the salivary and coxal glands have been shown by Nuttall to contain an anticoagulin, which obviously prevents the blood from coagulating and promotes its flow. There is reason to suppose that the secretions may at times exert a toxic action. During feeding ticks also frequently void excreta.

Family ARGASIDAE Canestrini.

This family has in the past comprised two genera, *Argas* and *Ornithodoros*, the former only distinguishable from the latter in having the margin of the body differing in structure from the rest of the integument. Recently, in 1932, I sank *Ornithodoros* as a synonym of *Argas*, and pointed out that in 1908 Nuttall, Warburton, Cooper and Robinson stated that they were by no means sure that the family *Argasidae* contained more than one genus, *Argas*, and that since then one or two species have been described which support their view. I also drew attention to the fact that in *Ornithodoros* the integument varies in different species, and in some, such as *O. perengueyi*, it more closely resembles the integument of certain species of *Argas* than of other species of *Ornithodoros*, such as *moubata*, etc. My chief reason, however, for sinking *Ornithodoros* is because in *O. megnini* and several other species included in the genus *Ornithodoros*, the whole of the integument differs from that of *O. savignyi*, the type of genus, and if the whole of the integument is of no generic significance, then it is unreasonable to consider a portion of the integument (the margin) as being of generic importance, especially as the differences in the latter are no greater than the differences in the former. Moreover, in *O. megnini* the integument of the nymph differs considerably from that of the adults. To place all the species in two genera is, therefore, as far as I can see, entirely out of the question. Either the species must be included in a single genus, *Argas*, or else several genera will have to be established. After going

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carefully into the matter, and taking not only the external anatomy but also the biology of the ticks into consideration, I have come to the conclusion that the former procedure is the only reasonable one to adopt, at any rate at the present time.

Genus ARGAS Latreille.

Argas Latreille, 1796, *Précis Caract. Ins.*, p. 178.

Carios Latreille, 1796, *ibid.*, p. 177.

Rhynchoprion Hermann, 1804, *Mém. aptérol.*, XII, p. 69.

Ornithodoros Koch, 1844, *Arch. f. Naturg.*, X, 1, p. 219.

Ornithodoros Karsch, 1878, *Zeitschr. f. ges. Naturwiss.* (3) III, p. 321.

Alectorobius Pocock, 1907, *Allbutt's Syst. Med.*, V, ii, (2), p. 189.

Otobius Banks, 1912, *Proc. Ent. Soc. Wash.*, XIV, p. 99.

Argas Nutt., Warb., Cooper and Robinson, 1908, *Ticks: Mon. Irod.*, i, p. 39.

Ornithodoros Nutt., Warb., Cooper and Robinson, 1908, *ibid.*, i, p. 39.

Genotype: *Argas reflexus* (Fabricius).

This genus is widely distributed and comprises about thirty-two species, of which ten have been recorded from South Africa.

Key to the South African Adults and Nymphs.

1. Integument not mammillated; eyes absent 2
 Integument mammillated or granular, usually without discs;
 eyes present or absent 7
2. Body of adults and 2nd stage nymph wider than long with
 anterior margin pointed; of 1st stage nymph circular
 A. vesperlitionis (Ltr.) p. 61
 Body of adults and nymphs oblong 3
3. Integument of adults with numerous small pits, of nymph
 with numerous small spines in front and setae behind;
 margins similar to rest of body ... *A. megnini* Dugès, p. 77
 Integument without spines or small pits, but symmetrically
 arranged discs (largish depressions) present 4
4. Anterior margin of body rounded 5
 Anterior margin of body sub-conical 6
5. Margin of body formed of quadrangular plates
 A. persicus (Oken) p. 65
 Margin of body formed of a series of irregular wrinkles
 A. transgaripepinus White, p. 69
6. Integument with numerous striae, the arrangement of the
 striae on the margins differing from those on the rest of
 the body; venter and posterior margin of dorsum wrinkled;
 a few indistinct discs on dorsum ... *A. striatus* Bedf., p. 70
 Integument finely wrinkled or corrugated, the margins being
 similar to the rest of the body; discs larger and more
 numerous *A. perengueyi* (Bedf. and Hewitt), p. 72
7. Body broad and rounded in front; discs absent 8
 Body narrower, sub-conical in front, discs present; eyes
 absent *A. talaje capensis* (Neu.), p. 74
8. Body with hemispherical granulations⁽¹⁾ 9
 Body with flat contiguous granulations; eyes present.
 A. pavimentosus (Neu.), p. 87

(¹) In fully distended adults of *A. moubata* the granulations may be flat.

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Argas vespertilionis (Latr.) Nutt., Warb., Cooper and Robinson, 1908, *Ticks: Mon. Ixod.*, i, p. 34, t.f. 48-57, pl. 1, f. 4, 5.

Argas vespertilionis (Latr.) Howard, 1908, *Ann. Tvl. Mus.*, I, ii, p. 79, pl. 1, figs. h-p: pl. 2, figs. p-w.

Argas vespertilionis (Latr.) Dönitz, 1910, *Die Zecken Südafr.*, p. 411.

Argas vespertilionis (Latr.) Patton and Cragg, 1913, *A Textb. of Med. Ent.*, pp. 582, 584, pl. 74, f. 5.

Argas vespertilionis (Ltr.) Neumann, 1911, *Das Tierreich: Ixod.*, p. 120, f. 66.

Argas vespertilionis (Latr.) Bedford, 1932, *Rep. Dir. Vet. Serv. and Anim. Indust., Un. S. Afr.*, XVIII, p. 282.

Adults (Figs. 8-9).—*Body* broader than long, pointed in front, measuring (excluding hood) 6·8×7·2 mm. to 7·2×8·7 mm.; the males being about as large as the females. The dorsum is irregularly convex in the middle, and the lateral margin reflexed. Colour reddish-brown except on the margin which is yellowish-brown. The hood projects forwards in front and is visible dorsally.



Fig. 8. *Argas vespertilionis* (Latr.), dorsum of ♀.
[Photo T. Meyer.]

Integument with fine granulations and numerous small discs arranged more or less in lines extending from the lateral margins towards the centre. *Venter*: genital opening between coxae i; spiracles small, situated laterally to coxae iv. A short distance behind the anus there is a pair of organs, each consisting of a narrow, deep, transverse cleft lying in a small area free from granulations; the area above the cleft is finely striate at right angles to the cleft, whilst that behind is finely punctate. *Eyes* absent. *Capitulum* lying in the hood; the base is much longer than broad, and the appendages are extremely small. *Hypostome* narrow, indented at the apex with small marginal teeth. *Palpi* with the first segment much larger than the others, which are very small and narrow. *Legs* long and slender, yellow.

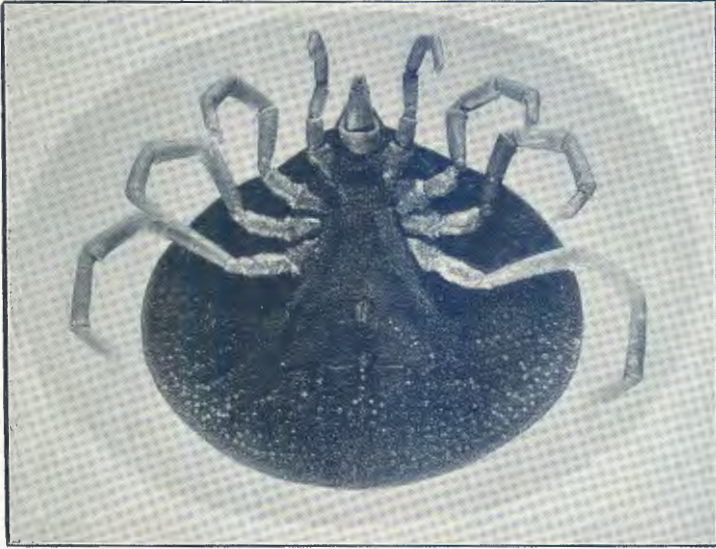


Fig. 9. *Argas vespertilionis* (Latr.), venter of ♀.

[Photo T. Meyer.]

Nymphs (Fig. 10).—There are two nymphal stages, the *second stage* differing from the adults in having either no sexual orifice or only a rudimentary orifice, and the hypostome dentition is 2/2 with 5 or 6 teeth per file. We have specimens measuring 5 × 5.6 mm. and 2.9 × 3.1 mm.

In the *first nymphal stage* the body is almost circular, being usually slightly longer than broad, measuring 2.4 × 2.1 mm. The hood is absent, but the hypostome and palpi are partly visible dorsally. Integument finely creased in zig-zags and margin with irregular folds; both dorsally and ventrally there are numerous small depressions. Organs posterior to the anus present as in the adults.

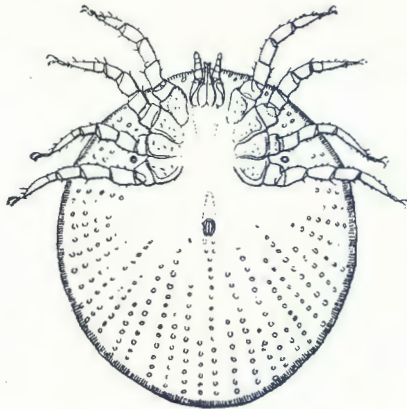


Fig. 10. *Argas vespertilionis* (Latr.), venter of nymph (After Neumann).

SOUTH AFRICAN TICKS.

Larva (Fig. 11).—Body of partly and fully fed specimens short oval, 1.3 × 1 mm. to 2 × 1.5 mm. On the dorsum there are three pairs of setae on the anterior portion, twenty on the margin, and about ten radiating furrows on the posterior half; between the intestinal caeca are radiating series of discs. Integument with fine transverse parallel striae, except anterior to the middle of the dorsum, where there is an oval plate. *Capitulum* almost entirely visible dorsally. *Hypostome* long, narrow and pointed; dentition 4/4 in front, 2/2 behind. *Palpi* slender, with segment 1 short, segments 2 and 3 long, sub-equal, segment 4 short. *Legs* pale and slender, sub-equal; tarsi with a distinct pulvillum.

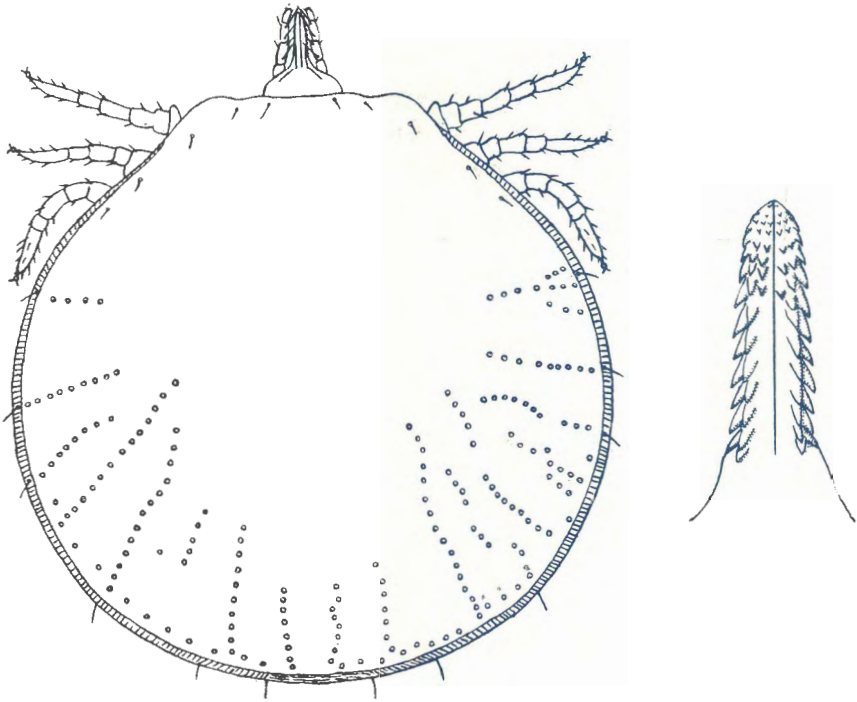


Fig. 11. *Argas respertilonis* (Latr.), engorged larva and hypostome.
G. A. H. B. del.

Hosts and Distribution.—Recorded taken off various species of bats in South Africa, Egypt, Sudan (King), Tunis, England, France and India (Patton and Cragg). Howard (1908) recorded it from *Miniopterus natalensis* (= *M. schreibersi*), Pretoria. Larvae have been taken off *Eptesicus capensis* at Onderstepoort and at Driefontein, S. Rhodesia. It has occasionally been known to attack human beings living in Pretoria in houses frequented by bats, and a specimen has been received taken off a cat at Vryburg, C.P. A nymph was found on a sheep at Onderstepoort. It was kept in a shed which was no doubt visited at night by bats. Latreille's type was taken off *Vesperugo noctula*.

Life-cycle.—The life history has been studied by Patton (Patton and Cragg, 1913). The eggs, which are laid in the resting places of bats, take from 10 to 12 days to hatch. The larvae remain attached to the wing of their host for 10 days and about 24 hours before leaving their host become flat. They moult into first stage nymphs about 5 days after dropping off. The first nymphal stage lasts about 11 days, the ticks taking about 25 minutes to gorge. The second nymphal stage lasts about 17 days, the ticks taking about 50 minutes to feed to repletion. The females can be fertilised immediately after the last ecdysis, and, if fed 22 days later, will commence laying eggs 28 days after moulting.

Transmitter of Disease.—In Tunis the tick has been demonstrated to transmit a spirillum, *Treponema respertilionis*, to bats.

2. *Argas persicus* (Oken).

“ The Fowl Tick ”.

Rhynchoprion persicum Oken, 1818, *Isis*, p. 1567, pl. 19, f. 1-4.

Argas mauritanus, Guéin-Méneville, 1829, *Iconogr. du règne animal de G. Curier. Arach.*, pl. 6, f. 3.

Argas miniatus C. L. Koch, 1844, *Arch. f. Naturg.*, X, i, p. 219.

Argas americanus Packard, 1872, *U.S. Geolog. Surv. of the territory, etc.*, p. 740, f. 68.

Argas sanchezi A. Dugés, 1891, *La Nature* (2), 1, p. 20.

Argas chinche Goudet, referred to by Neumann, 1901, p. 344, to *A. miniatus*.

Argas radiatus, Railliet, 1893, *Traité de zool. méd., etc., agric.*, fasc. 1, p. 718.

Argas miniatus firmatus Neumann, 1896, *Mém. Soc. Zool. de France*, IX, p. 12.

Argas miniatus (Koch) Salmon and Stiles, 1900, *Ann. Rep. Bur. Anim. Indust. U.S. Dept. Agric.*, XVII, p. 402, t.f. 56-58, 71-81, pl. 78; also Reprint, 1902.

Argas persicus (Oken) Lounsbury, 1903, *Agric. Journ.*, Capetown, XXIII, p. 261, 3 pls.; also Reprint.

Argas persicus (Oken) Nutt., Warb., Cooper and Robins., 1908, *Ticks: Mon. Inod.*, i, pp. 8, 81, t.f. 1-26, pl. 1, f. 3.

Argas persicus (Oken) Howard, 1908, *Ann. Trl. Mus.*, I, ii, p. 76, pl. 1, figs. f-i, pl. 2, figs. c-n.

Argas persicus (Oken) Dönitz, 1910, *Die Zecken Südafr.*, p. 409.

Argas persicus (Oken) Neumann, 1911, *Das Tierreich. Inod.*, p. 121.

Argas persicus (Oken) Patton and Cragg, 1913, *A Textbook of Med. Ent.*, pp. 581, 583, pl. 74, f. 1, 2; pl. 75, f. 1; pl. 83, f. 1-3; pl. 84, f. 3; pl. 86, f. 1-3, 5-6.

Argas persicus (Oken) Robinson and Davidson, 1913-1914, *Parasit.*, VI, i, pp. 20-48, t.f. 1-2, pl. 1-6; *ibid.*, VI, iii, pp. 217-256, t.f. 1-8, pl. 14-17; *ibid.*, VI, iv, pp. 383-424, t.f. 1-8, pl. 25-28.

Argas persicus (Oken) Bedford, 1932, *Rep. Dir. Vet. Serv. and Anim. Indust., Un. S. Afr.*, XVIII, p. 281, f. 6.

SOUTH AFRICAN TICKS.

ADULTS (Figs. 12-14).—Females measure from 7×5 mm. to 12·5×8·5 mm., and males from 4·25×2·5 to 8×5 mm. *Body* yellowish-brown to slate coloured; oval in shape, being widest towards the posterior end. *Integument* with numerous oval or round discs, arranged more or less symmetrically. *Venter*: genital opening between coxae i and ii; spiracles small, crescentic; eyes absent. *Capitulum* with four long setae directed forwards on the base, two post-hypostomal, one near the articulation of each palp. Palpi about twice as long as the hypostome. *Hypostome* with several fine denticles on each side distally, followed by stout teeth 2/2, the teeth increasing to 3/3, 4/4, 5/5 basally, but decreasing in size. *Legs* sub-equal and similar, pale yellow. Coxa i separated from coxa ii in female; coxae ii, iii and iv contiguous.

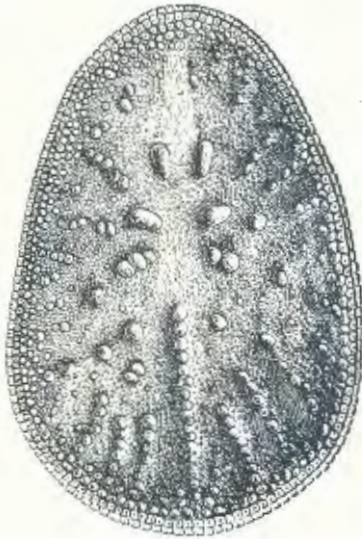


Fig. 12.

Fig. 12. *Argas persicus* (Oken), dorsum of ♀.

U. G. Walker del.

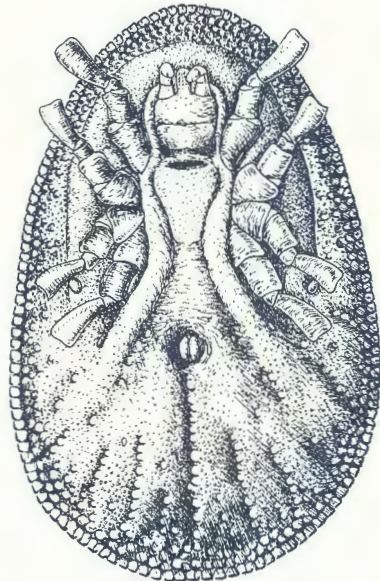


Fig. 13.

Fig. 13. *Argas persicus* (Oken), venter of ♀.

C. G. Walker del.

NYMPHS.—There are two nymphal stages. The second-stage nymph only differs from the adults in having no sexual orifice, and the discs are not quite as numerous. When full-fed it measures 5·5 to 7 mm. The first-stage nymph differs from the second-stage nymph when fed in having slightly fewer discs, and in unfed specimens the discs are absent.

LARVA (Fig. 15).—The unfed larva measures 0·67×0·65 mm. to 0·73×0·71 mm. It is pale in colour, almost spherical in shape, with the capitulum inserted ventrally, but projecting well in front of the body. Integument finely striated, except in the middle of the dorsum where there is a semi-circular plate. Setae more numerous on the body than in other known larvae. *Legs* long, the tarsi with a distinct pulvillum. After feeding they become dark and visibly swollen.

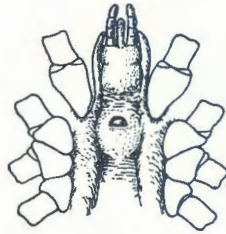


Fig. 14. *Argas persicus* (Oken).

C. G. Walker del.

ANATOMY.—Both the external and internal anatomy of *A. persicus* have been studied by Robinson, L. E., and Davidson, J. (1913, 1914), and also by Patton and Cragg (1913).

REGENERATION.—Regeneration in *A. persicus* has been studied by Hindle and Cunliffe (*Parasit.*, 1914, VI, iv, pp. 353-371, t.f. 1-4) and Nuttall (*Parasit.*, 1920, XII, i, pp. 7-26, t.f. 1-4).

HOSTS.—It is mainly parasitic on fowls but also attacks ducks, geese, turkeys, pigeons, canaries and ostriches. Howard (1908) also recorded it from secretary bird (*Sagittarius serpentarius*), and specimens have also been taken off wild guinea-fowl (*Numida papillosa transvaalensis*) at Pienaars River, Tvl. It has frequently been reported to attack man in Persia, but rarely does so in South Africa.

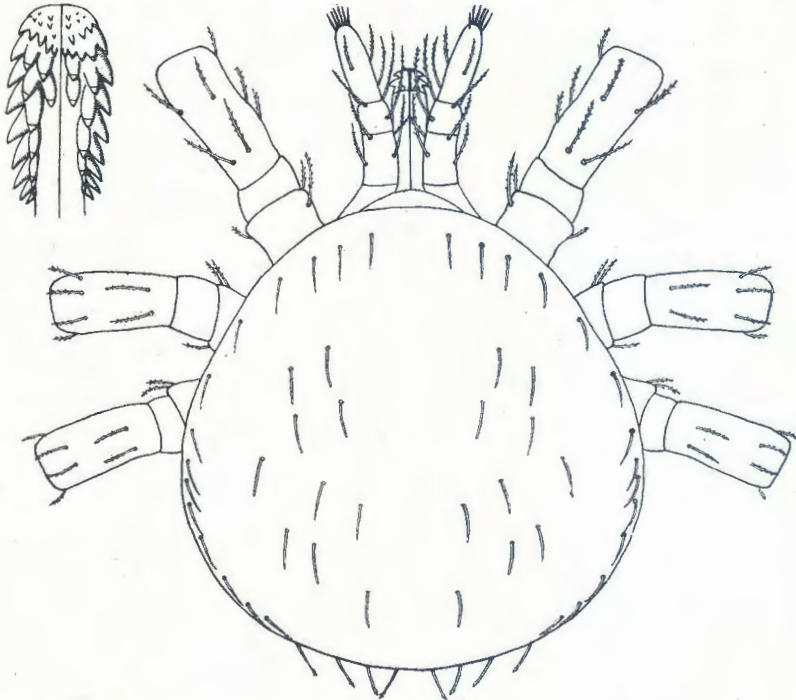


Fig. 15. *Argas persicus* (Oken), unfed larva and hypostome
G. A. H. B. del.

GEOGRAPHICAL DISTRIBUTION.—It is very common throughout South Africa, and is the most serious pest the poultry-keeper has to contend with. It has also been recorded from Southern Rhodesia, Mozambique, Belgian Congo, Egypt, Sudan, Algeria, Mauritius, Russia, Turkestan, Persia (type locality), India, China, the southern part of North America, South America and Australia.

LIFE CYCLE.—The life cycle has been studied by Lounsbury (1903) in the Cape, Nuttall (1908) at Cambridge, and other workers.

The *eggs* are usually laid in batches of about 20 to 100 in the cracks and crevices of walls of fowl-houses, etc., or under the bark of trees. Fuller (1896) and Brown (1902), however, have observed oviposition taking place occasionally on fowls in Australia. The eggs usually take about three weeks to hatch, the time varying according to the temperature. The *larvae* crawl about in search of a host as soon as their chitin has hardened, and on getting on to a suitable host, they immediately attach themselves to its skin and commence to suck blood, continuing to feed for 5 to 10 days, according to the temperature. They then drop off and seek shelter, moulting into nymphs about 8 days later in summer.

The *nymphs* and *adults*, unlike the larvae, only feed on their hosts at intervals, hiding in the crevices of woodwork, etc., after feeding. They invariably suck blood at night, but have been known to feed during the day when protected from strong light. They are rapid feeders, usually only taking from 30 minutes or less to two hours to gorge themselves. The first nymphal stage lasts about two to three weeks, and then they moult into the second nymphal stage, and again, after about five weeks, into adults. The females feed more plentifully than the males; usually about once a month during the summer. About a week after each meal they lay a batch of eggs. Lounsbury found that the complete life-cycle from egg to egg stage occupied about ten months in the Cape. The larvae are only able to live for seven or eight weeks without food, but nymphs have been known to live for a year without having had a meal, and the adults for two to three years.

The sensory perceptions of *persicus* have been studied by Hindle and Merriman (*Parasit.*, 1913, V, pp. 203-216, f. 1-2).

TRANSMITTERS OF DISEASE.—The fowl tick is the chief transmitting agent of the fowl spirochaete, *Treponema anserinum* Sakharoff (= *T. gallinarum* Marchoux and Salimbeni), which is usually fatal to birds, as was first demonstrated by Marchoux and Salimbeni in Brazil in 1903. It also produces fatal results in geese, ducks, guinea-fowls, turkeys, canaries, turtle-doves, and other birds. The disease usually breaks out four to five days after the ticks bite the birds. The ticks become infected by sucking the blood of infected birds, and when infection has taken place and the ticks remain at a favourable temperature (30-35° C), the organisms multiply within the bodies of the ticks. Should, however, the ticks be kept at a low temperature (15 to 18° C.) the organisms seem to disappear, but reappear when the ticks are again maintained at a suitable temperature. Once the ticks have become infected they are able, whenever the temperature is suitable,

to transmit the disease to healthy fowls for six months or even longer. The infection may pass through the egg to the next generation, and, as Hindle (1912) has demonstrated, this generation may, without re-infection, hand it on to the next.

Since coccoid bodies may be found within the lumen of the gut, sexual organs, malpighian tubes and in the excreta of infected ticks, but soon disappear from the salivary glands, it would appear that the disease is transmitted in the same way that *T. duttoni* is transmitted by *A. moubata*, namely: In the act of feeding, the tick may void excrement and exude a few drops of secretion from the coxal glands situated in the first intercoxal space, which dilutes the excrement and facilitates its getting into the wound caused by the mouth-parts of the tick.

The disease is fairly common in the Union, and prevalent in Rhodesia. It also occurs in other parts of Africa, S.E. Europe, Asia, S. America and Australia. The fowl tick also does a considerable amount of harm to birds, especially when very numerous, by sucking blood and the irritating effects it produces, which result in lowering the vitality of infected birds. Birds kept in badly infected houses and runs cease to feed normally, rapidly fall off in condition, and may eventually die of anaemia and general debility.

Aegyptianella pullorum Carpano in Fowls.—Bedford and Coles (1933) demonstrated that *A. persicus* is a transmitting agent of this disease. The disease was transmitted to nine healthy chickens by single adult ticks which had previously fed on infected birds. Moreover, it was shown that the ticks retain their infection after feeding on healthy birds, as one adult tick transmitted the disease to two healthy chickens. The shortest interval between feeding on an infected bird and healthy chicken was 26 days. The incubation period in chickens after an infected tick has bitten varies from 12 to 15 days or more.

The tick has also been reported to cause prolonged illness and even death to man in Persia. It frequently became so numerous in houses in that country as to necessitate the removal of entire villages to new sites. It has also been recorded from houses in Egypt.

3. *Argas transgariëpinus* White.

Argas transgariëpinus White, in Methuen, 1846, Life in South Afr., p. 318, pl. 2, f. 4.

Argas kochi Neumann, 1901, *Mém. Soc. zool. France*, XIV, p. 254.

Argas transgariëpinus (White) Neumann, 1906, *Arch. de Parasit.*, X (2), p. 218.

Argas transgariëpinus (White) Nutt., Warb., Cooper and Robins., 1908, *Ticks: Mon. Ixod.*, i, p. 29, f. 36-37.

Argas transgariëpinus (White) Howard, 1908, *Ann. Trvl. Mus.*, I, ii, p. 81.

Argas transgariëpinus (White) Bedford, 1932, *Rep. Dir. Vet. Serv. and Anim. Indust., Un. S. Afr.*, XVIII, p. 282.

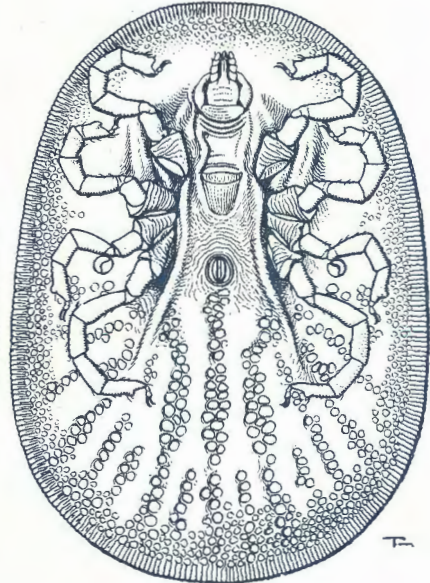
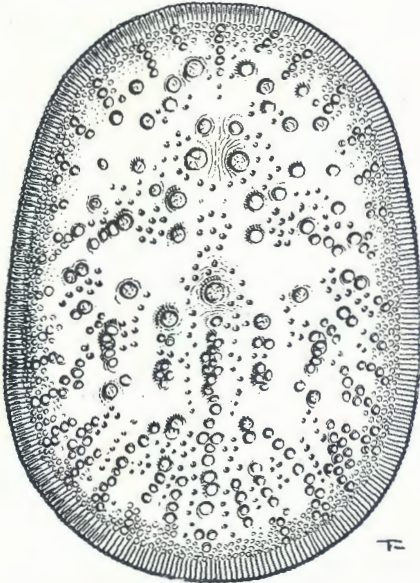


Fig. 16.

Fig. 17.

Fig. 16. *Argas transgaripepinus* White, dorsum of ♀.

Fig. 17. *Argas transgaripepinus* White, venter of ♀.

(Drawn from type in British Museum.)

A. J. E. Terzi del.

Following description after Nuttall and Warburton:—

ADULTS. (Figs. 16, 17).—Body short, oval and almost as broad in front as behind. Margin striate like that of *reflexus*, but relatively broad (3 mm.). Spiracles scarcely as long as the width of the anus. Sexual orifice of the male very small, facing the posterior extremity of coxa i. Capitulum very small (0.8 mm.) and very posterior, far from coxae i, lying in a clearly marked camerostome. Hypostome narrow, palps short. Coxa i far from coxa ii, and the space between the coxae on the two sides very broad—equal to one-third the width of the venter. Tarsi i much humped distally, the protuberances on the other tarsi slight. Females measure from 8.5 × 6 mm. to 10 × 7 mm.

The types of *A. transgaripepinus*—three females in the British Museum, differ from *A. kochi*, based on a single ♂ from Basutoland in the Paris Museum, in having the tarsal protuberance almost as well marked on tarsi ii, iii, and iv as on tarsi i.

4. *Argas striatus* Bedford.

Argas striatus Bedford, 1932, *Rep. Dir. Vet. Serv. and Anim. Indust., Un. S. Afr.*, XVIII, p. 221, f. 1-2; *ibid.*, p. 282.

FEMALE.—*Body* long and narrow, 6 × 3.5 mm., the anterior margin tapering to a rounded point, the sides parallel, and the posterior margin rounded. Margin with a few short, pale setae, transversally striated and raised higher than the rest of the integument in unfed specimens; brown in colour and paler than the rest of the body which is dark brown. Dorsum striated, the enclosed areas between the striae small and irregular in shape; on the anterior and median

portions of the body they are flat and smooth, and behind raised, making the surface appear wrinkled; in the middle a semi-circular row of four shallow discs and a median one beneath them; grooves present as shown in figure. *Venter* wrinkled, without discs; genital orifice situated between coxae i; median post-anal groove long and very shallow; a deep groove extends on each side from coxae iv almost to the posterior margin, the inner margin being raised higher than the rest of the integument. *Hypostome* with minute teeth anteriorly, followed by dentition 2/2. *Legs* yellowish; coxa i separated from coxa ii; coxae ii, iii and iv contiguous; tarsi without protuberances.

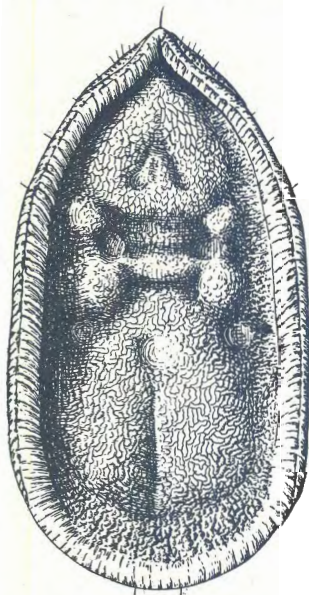


Fig. 18. *Argas striatus* Bedford, cloacum of ♀.

C. G. Walker del.

The description is based upon three unfed females found in the nest of a sociable weaver, *Philetairus socius* (Lath.), at Kenhardt, C.P. They were sent by Dr. R. F. Lawrence. The holotype and one paratype in the South African Museum, Capetown, and the other paratype in the Onderstepoort collection.

This species is apparently closely related to *A. aequalis* (Neumann), which was described from a single late-state nymph collected in Tanganyika Territory. The host is unknown. As Neumann did not figure the species, and his description is somewhat short, it is difficult to compare it with the specimens described above, but in *aequalis* the integument is folded, with very fine granulations.

As sociable weavers occupy the same nests year after year it is possible that *A. striatus* may be a temporary feeder, remaining in the nests and hibernating during the periods the nests are not occupied by the birds. The South African cliff swallow (*Petrochelidon spilodera*) is another bird which uses the same nest year after year, and *A. perengueyi* (Bedford and Hewitt), which is parasitic on this species, hibernates in the nest during the winter months.

5. *Argas perengueyi* (Berford and Hewitt).

“ The Swallow Tick ”.

Ornithodoros perengueyi Bedf. and Hewitt, 1925, *S. Afr. Journal. Nat. Hist.*, V, i, p. 259, pl. 19, f. 1-3.

Argas perengueyi (Bedf. and Hewitt) Bedford, 1932, *Rep. Dir. Vet. Serv. and Anim. Indust., Un. S. Afr.*, XVIII, p. 281.

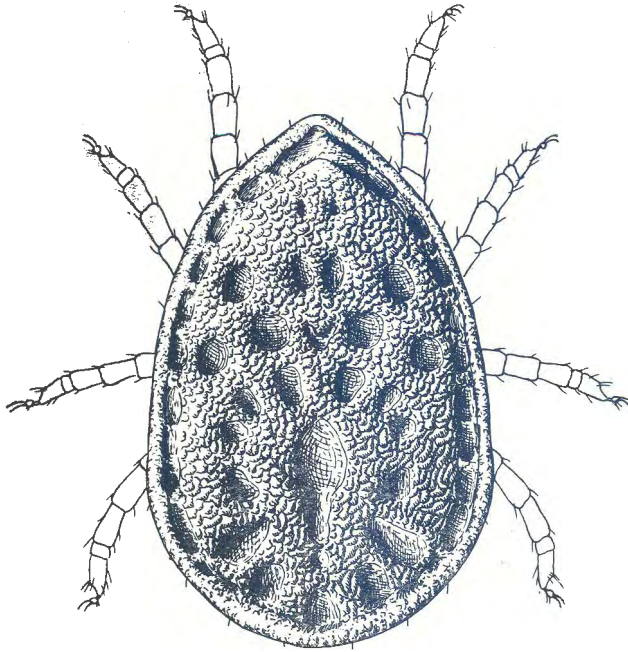


Fig. 19. *Argas perengueyi* (Bedford and Hewitt), dorsum of ♀.
C. G. Walker del.

ADULTS. (Figs. 19-21).—Body of female 4·1 to 6·5 mm. long, 2·6 to 4 mm. broad; of male 3·5 to 4·5 mm. long, 2·1 to 3 mm. broad; conical anteriorly, rounded posteriorly with sides almost straight and parallel; brown or slate-coloured, with pale yellowish lateral margins. *Integument* very finely and closely wrinkled or corrugated. *Dorsum* with symmetrically arranged depressed areas and lateral grooves; sparsely clothed with minute pale setae. The lateral grooves are frequently more or less broken and discontinuous, and sometimes indistinct. *Venter* clothed with minute pale setae as on the dorsum, and with three depressions on each side of the median postanal groove; transverse pre-anal and post-anal grooves absent; supra-coxal folds well developed. Genital orifice situated between coxae i. *Spiracles* small, circular. *Eyes* absent. *Capitulum* lying in a deep camerostome; base slightly broader than long, with a pair of long admedian setae directed backwards. *Hypostome* (fig. 21) with asymmetrically arranged teeth. *Palpi* broad, the second segment being the largest, the third shorter and broader than the fourth. *Legs* pale yellow; coxae i larger than the others, separated from coxae ii; coxae ii, iii, and iv contiguous; tarsi i with two protuberances; tarsi ii to iv with only one protuberance.

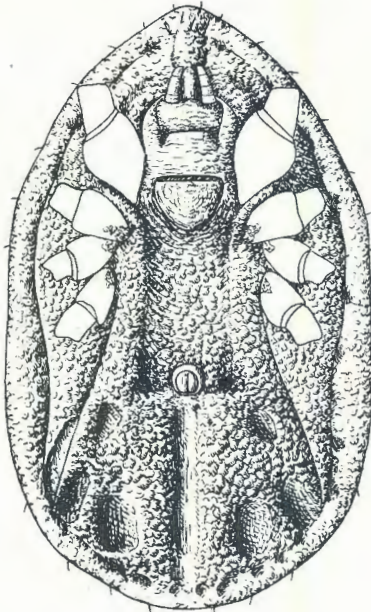


Fig. 20.

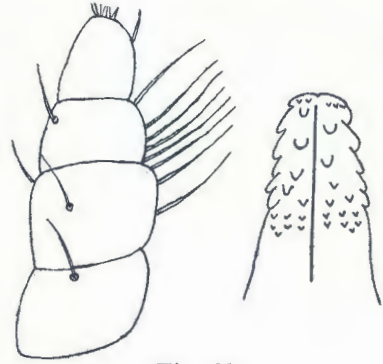


Fig. 21.

Fig. 20. *Argas perengueyi* (Bedford and Hewitt), venter of ♀.

C. G. Walker del.

Fig. 21. *Argas perengueyi* (Bedford and Hewitt), left palpus and hypostome

G. A. H. B. del.

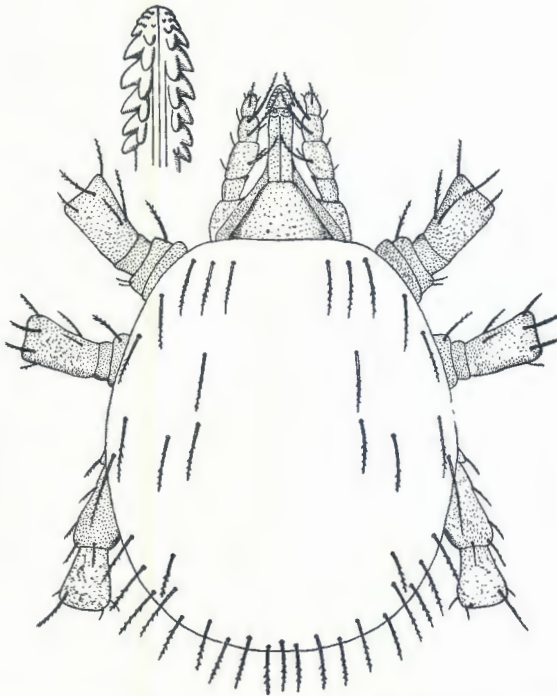


Fig. 22. *Argas perengueyi* (Bedford and Hewitt), unfed larva and hypostome
G. A. H. B. del.

NYMPHS.—It is not known how many nymphal stages there are. They resemble the adults except for the absence of the sexual orifice. Body from 3×2 mm. to 3.9×2.5 mm.

LARVA (Fig. 22).—The unfed larva measures 0.64×0.54 mm. It is pale in colour, and has the capitulum terminal. *Body* with numerous setae. *Palpi* of medium length, the second segment the largest, the fourth segment small. *Hypostome* of medium length; dentition 2/2. *Tarsi* with a distinct pulvillum.

HOSTS AND DISTRIBUTION.—Described from adults and one nymph taken at Nqamakwe, C.P. They were collected by the Rev. L. S. Byrde, who reported on them as infesting a native church. I have since taken adults and immature forms in the nests of *Petrochelidon spilodera* (South African cliff swallow) at Onderstepoort. The birds return to the same nesting sites year after year, and the ticks may be found in the nests throughout the winter months. Specimens have also been fed on fowls.

Transmitters of Disease.—Bedford and Coles (1933) failed to transmit *Aegyptianella pullorum* Carpano to fowls by feeding two or three adults of *A. perengueyi* on healthy chickens after they had fed on infected birds.

6. **Argas talaje capensis** (Neumann).

“ The Penguin Tick ”.

Ornithodoros talaje var. *capensis* Neumann, 1901, *Mem. Soc. zool. France*, XIV, p. 258.

Ornithodoros talaje var. *capensis* (Neu.) Nutt., Warb., Cooper and Robins., 1908, *Ticks: Mon. Ixod.* i, p. 61, t.f. 58, 89, pl. 3; f. 1-2.

Ornithodoros talaje var. *capensis* (Neu.) Howard, 1908, *Ann. Trvl. Mus.*, I, ii, p. 88, pl. 1, figs. r, s; pl. 3, figs. a-e.

Ornithodoros talaje Dönitz, *Die Zecken Südafr.*, 1910, p. 416, pl. 16A, f. 6, 7 nec Guérin-Méneville, 1849.

Argas talaje capensis (Neu.) Bedford, 1932, *Rep. Dir. Vet. Serv. and Anim. Indust., Un. S. Afr.*, XVIII, p. 280.

This variety closely resembles the type which occurs in native houses in South America.

ADULTS (Figs. 24; 25).—*Body* of female 5 to 6 mm. long, 3 to 3.5 mm. broad; of male 3.5 to 5 mm. long, 2 to 3 mm. broad; conical anteriorly, rounded posteriorly with sides usually almost parallel; dirty yellow changing to yellowish or reddish-brown when gorged. *Integument* with numerous large, sub-equal mammillae, and a number of large discs on the dorsum. When unfed there is a lateral groove on each side on the inner margin of the dorsal surface, which is thick and raised, and other depressions are also present on the dorsum, but these disappear in replete specimens. *Venter*: genital

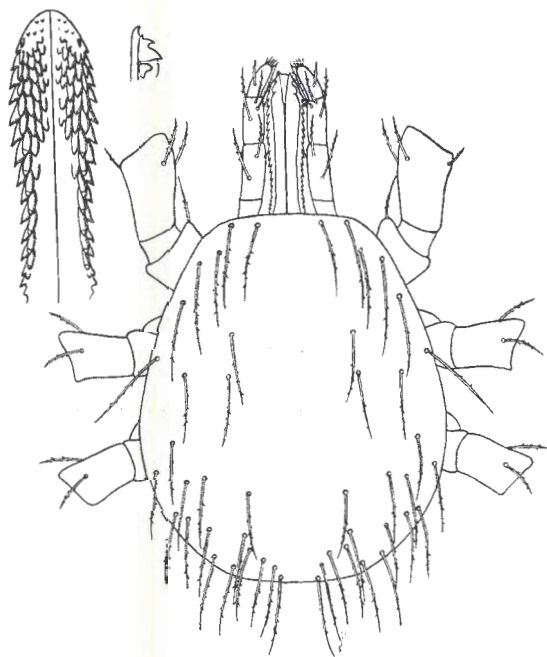


Fig. 23. *Argas talaje cypensis* (Neu.), unfed larva, hypostome and digit. G. A. H. B. del.

opening opposite posterior margin of coxae i; coxal folds well-developed, extending between coxae i and ii; pre-anal and post-anal grooves present, the latter with transverse striae. *Spiracles* conical, situated on the dorsal surface of the supra-coxal folds. *Eyes* absent. *Capitulum* lying in a deep camerostome, with prominent lateral flexible flap-like borders which protect the capitulum; base finely wrinkled transversely. *Hypostome* indented at apex, dentition 2/2, except at the tip where there are a number of small teeth. *Palpi* with segment i the longest, slightly longer than segment ii; segment iii shorter than segment iv; numerous setae present on all segments. *Legs* pale brown, long and slender with numerous fine setae; coxae contiguous decreasing in size from pair i to iv, covered with small granulations; tarsi tapering without marked protuberances.

NYMPHS.—It is not known how many nymphal stages there are. They are yellowish-brown in colour and resemble the adults except for the absence of the sexual orifice. Body 1.73 × 1.0 mm. to 2.42 × 1.43 mm.

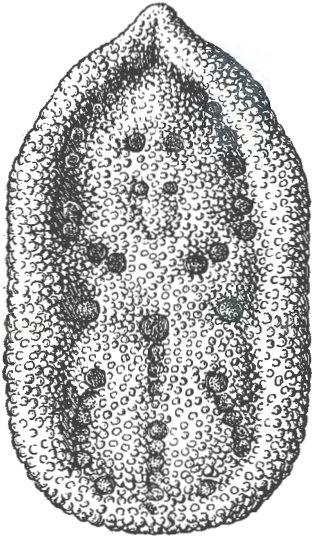


Fig. 24.

Fig. 24. *Argas talaje capensis* (Neu.), dorsum of ♀.
C. G. Walker del.

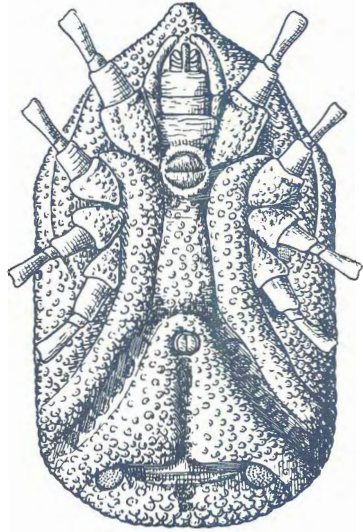


Fig. 25.

Fig. 25. *Argas talaje capensis* (Neu.), venter of ♀.
C. G. Walker del.

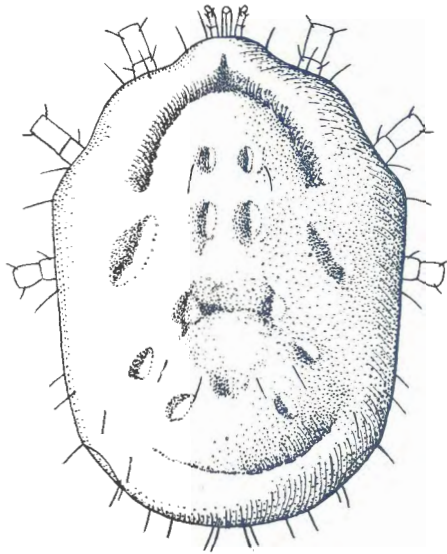


Fig. 26. *Argas talaje capensis* (Neu.), dorsum of engorged larva.
C. G. Walker del.

LARVA (Figs. 23, 26).—The unfed larva measures 0.47×0.38 mm. It is pale in colour, and has the capitulum inserted ventrally, the base being hardly if at all visible from above. *Body* with numerous setae, resembling that of *A. perengueyi* in shape; plate on dorsum absent. *Palpi* elongated, first segment long, only the apical portion is shown in the figure; fourth segment short. *Hypostome* very long, dentition 5/5 in front, then one row of 3/3 followed by 2/2. *Tarsi* with a distinct pulvillum.

HOSTS AND DISTRIBUTION.—This species is common in the nests of the jackass penguin (*Spheniscus demersus*) on the islands off the western coast of the Cape Province, and specimens have been taken in the nests of the same birds on St. Croix Island off Port Elizabeth (coll. J. Hewitt). It readily attacks both man and fowls when opportunities offer. Nuttall, Warburton, Cooper and Robinson (1908) have recorded specimens collected by the Challenger Expedition in 1876 at St. Paul's Rocks from birds' nests. Neumann (1907) recorded specimens found on the ground at Cargados Carajos (Siren Island), and Howard (1908) states that it has been reported from Tristan de Cunha.

LIFE-CYCLE.—The life-cycle is not known.

7. *Argas megnini* Dugès.

“The Spinose Ear Tick”.

Argas megnini Dugès, 1883, *Natureza*, V, p. 195.

“*Argas americana* Packard,” Townsend, 1893, *Journ. New York Ent. Soc.*, 1, (2), p. 50.

Rhynchoprium spinosum Marx, 1895, *Proc. Ent. Soc. Wash.*, June 24, p. 199, pl. 2, f. 1, li.

Ornithodoros megnini (Dugès) Neumann, 1896, *Mém. Soc. zool. France*, 1X (1), p. 42, f. 36a-b.

Ornithodoros megnini (Dugès) Salmon and Stiles, 1900, *Ann. Rep. Bur. Anim. Indust., U.S. Dept. Agric.*, XVII, p. 408, t.f. 94-108, pl. 79; also Reprint, 1902.

Ornithodoros megnini (Dugès) Nutt., Warb., Cooper and Robins., 1908, *Ticks: Mon. Lond.*, i, pp. 71, 103, f. 102-112.

Ornithodoros megnini (Dugès) Bedford, 1912, *Rep. Dir. Vet. Res., Un. S. Afr.*, II, p. 343, pl. 37.

Ornithodoros megnini (Dugès) Bedford, 1925, *Journ. Dept. Agric., Un. S. Afr.*, X, pp. 147-153, f. 1-2, also Reprint No. 7, 1925.

Argas megnini (Dugès) Bedford, 1932, *Rep. Dir. Vet. Serr. and Anim. Indust., Un. S. Afr.*, XVIII, p. 280.

ADULTS. (Figs. 27, 28).—Females 5 to 10 mm. long, 3 to 5 mm. broad; males slightly smaller. *Body* brown to slate-coloured, yellowish between the post-anal grooves, fiddle-shaped, wider in front than behind, and constricted near legs iv. *Integument* very finely granulated with small circular shallow pits, a short, pale seta arising from each; symmetrical depressions on both dorsum and venter as shown in the figures; between the post-anal grooves there are numerous short spines. Reticulate fossettes occupy the depressions, others scattered here and there. *Spiracles* circular. *Eyes* absent. *Capitulum* very small. *Hypostome* unarmed, broad at the base, rounded distally. *Legs* pale yellow.

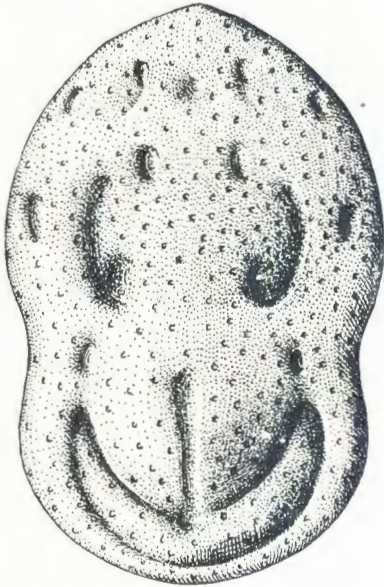


Fig. 27.

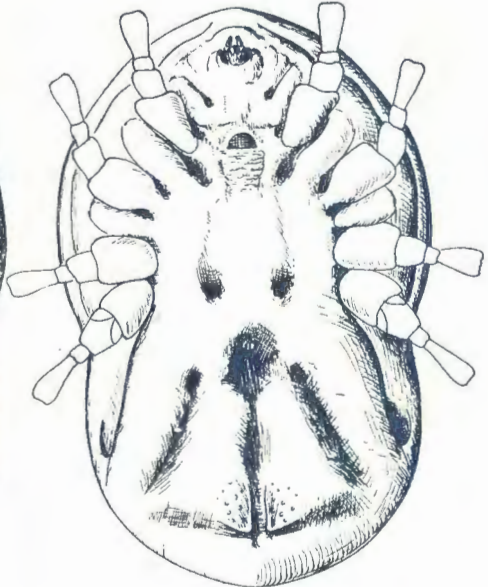


Fig. 28.

Fig. 27. *Argas megnini* Dugès, dorsum of ♀.

C. G. Walker del.

Fig. 28. *Argas megnini* Dugès, venter of ♀.

C. G. Walker del.

NYMPH (Fig. 29).—May be distinguished by the integument being beset with numerous backward-projecting spines in front and short setae behind; pits absent; spiracles situated on salient tubercles which project laterally between legs iii and iv.

Body 3-9 mm. long, 2-6 mm. broad; pale when unengorged, reddish when slightly gorged, turning to slate when partly, and yellowish-brown when fully gorged; lozenge-shaped, abruptly constricted at legs iv. *Capitulum* subterminal in unfed nymphs, but usually projecting well beyond margin of body in later stage nymphs. *Hypostome* lanceolate, dentition 4/4, with 7 to 9 teeth per file. *Legs* slightly longer and stronger than in the adults.

LARVA (Figs. 30, 31).—The unfed larva measures 0.53×0.48 mm. It is pale in colour, oval in shape with the capitulum terminal. The integument is finely striated except in the centre of the dorsum. On the anterior half of the dorsum there are 10 setae, and four shorter ones on the posterior margin. On the venter there are four pairs of setae between the legs and one pair behind the anus. *Hypostome* elongated, with dentition 2/2. When gorged the larva is inactive, this being the "pupa-like stage". It is usually pale in colour, but may be reddish: oval in shape, with the anterior margin pointed. The legs are very small for the size of the tick, and are difficult to see without the aid of a lens.

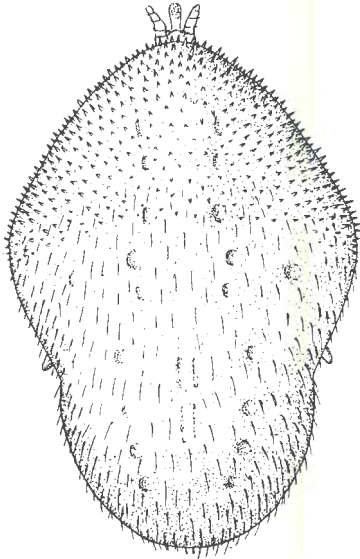


Fig. 29.

Fig. 29. *Argas megnini* Dugès, dorsum of partly fed nymph.

C. G. Walker del.

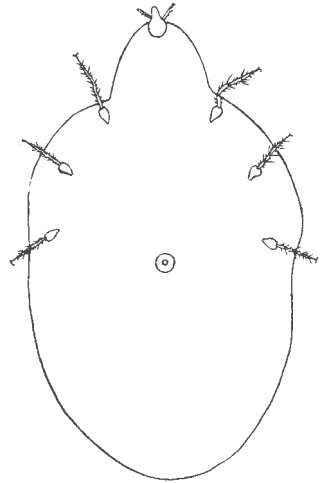


Fig. 30.

Fig. 30. *Argas megnini* Dugès, venter of gorged larva.

G. A. H. B. del.

Hosts.—The larvae and nymphs are usually only found in the ears of their hosts. Storey (1920), however, observed on one occasion two almost fully gorged nymphs attached to the bodies of sheep. They are chiefly parasitic on cattle, sheep and goats, but also attack man, horses, donkeys, mules, dogs, cats and ostriches. The adults are non-parasitic.

GEOGRAPHICAL DISTRIBUTION.—This is an American tick which has established itself throughout the arid districts of the Cape Province and Orange Free State. It also occurs in parts of Natal, and in the Transvaal as far north as the Pretoria District. It appears to have been observed by Manley in the Cape Colony as far back as 1898, and was found by Theiler at Vryburg in 1912.

LIFE-CYCLE.—The *larvae* on hatching crawl on to a host and attach themselves to the tender skin inside the ears, usually below the hair-line, and sometimes as far as the eardrum. Here they usually engorge in from 5 to 10 days, when they become quiescent and are unable to move until they have cast their skins and become nymphs. The *nymphs*, in turn, also attach themselves to the skin lining of the ears. The length of time they remain feeding in the ears of their hosts varies considerably. The shortest period in which they can gorge appears to be about a week, but they have been observed at Onderstepoort to remain attached for three months, and according to

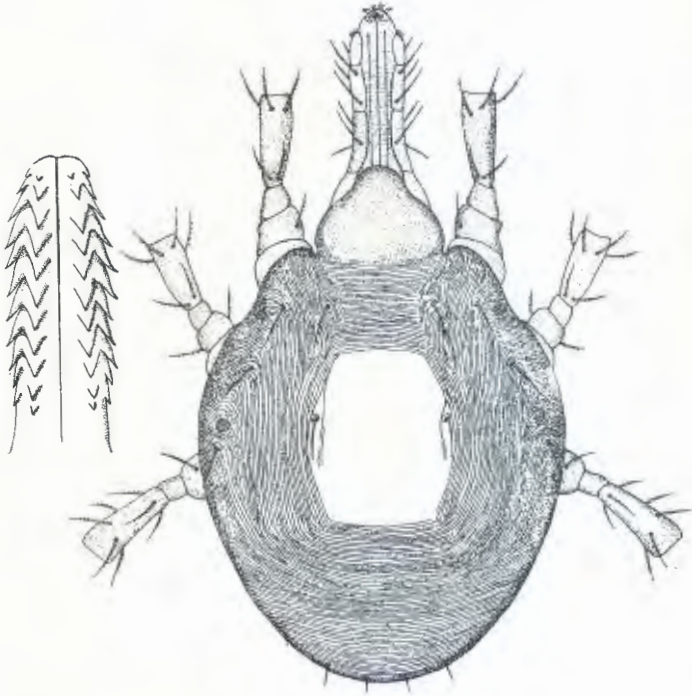


Fig. 31. *Argas megnini* Dugès, dorsum of unfed larva and hypostome.
G. A. H. B. del.

American observers may remain in the ears for seven months. However, Storey (1920), who made observations in the Aliwal North District, C.P., states that they generally leave their hosts within thirty-six days. When full grown the nymphs drop to the ground and crawl about in search of a sheltered spot where they can moult into *adults* and the females lay their eggs. The sites usually chosen by the ticks are the cracks and crevices in the walls of kraals and stables, usually close to the ground. As a rule, therefore, the ticks are only a serious pest on farms where animals are kraaled or stabled. Other sites selected by the ticks are cracks and crevices of posts, vertical rather than horizontal, and adults have also been found under the bark of trees at Onderstepoort.

Under favourable circumstances a female may live up to eleven months awaiting a male, and according to one American observer even as long as eighteen months. After mating has taken place, however, egg-laying commences in about a week and may continue steadily for as long as six months, the eggs being deposited at intervals in small batches. When egg-laying is completed the females die. The *eggs* hatch in twenty-two to fifty-six days. As a rule the *larvae* do not survive longer than a month without food, but under exceptionally favourable circumstances they may be kept alive for four months.

The *adults* are unable to penetrate the skin of animals owing to the fact that their mouth-parts are only partially developed. It is not necessary for them to nourish themselves since enough food is stored up in the nymphal stage to last for adult life and egg-laying. They are, therefore, never found on animals.

TRANSMITTER OF DISEASE.—This tick is not known to transmit disease, but the ticks do a considerable amount of harm to their hosts when numerous by puncturing the tender skin of the ears and sucking blood, at the same time injecting an irritating fluid. The wounds thus caused often ulcerate, and the constant irritation and possible toxic effects of the ticks cause nervous and digestive disturbances, which result in lowering the vitality of the infested animals. The animals cease to feed normally and rapidly fall off in condition. Calves, sheep, and goats not infrequently succumb if sufficiently badly infected. It is not uncommon to find the ear-canals completely filled with a mingled mass of ticks, particles of earwax, and other matter.

Mrs. V., Mooi River, Natal, writes: "I have found three of the ticks in my ears. They caused intense earache, and general disturbances in the head and throat . . . the lining membrane of my ears seems to have been eaten away, causing supperation and blood. They must have been present some time without my realising that they were there and thinking that I had a severe attack of earache". One specimen was sent which proved to be a partly engorged nymph.

8. *Argas moubata* Murray.

"THE TAMPAN TICK."

Argas moubata, Murray, 1877, *Econ. Ent.*, *Apt.*, p. 182.

Ornithodoros savignyi var. *caecus* Neumann, 1901, *Mém. Soc. Zool. France*, XIV, p. 256.

Ornithodoros moubata (Murray) Dönitz, 1906, *Sitz.-Ber. Ges. naturf. Freunde*, p. 144.

Ornithodoros moubata (Murray), Nutt., Warb., Cooper and Robins., 1908, *Ticks: Mon. Ixod.*, i, pp. 46, 96, f. 58, 66-80.

Ornithodoros savignyi var. *caecus* (Neu.) Howard, 1908, *Ann. Tvl. Mus.*, I, ii, p. 86, pl. 1, figs. a-e; pl. 3, figs. g-h.

Ornithodoros moubata (Murray) Dönitz, 1910, *Die Zecken Südafri.*, p. 415.

Ornithodoros moubata (Murray) Neu., 1911, *Das Tierreich, Ixod.*, p. 123.

Ornithodoros moubata (Murray) Patton and Cragg, 1913, *A Textbook of Med. Ent.*, p. 588, pl. 74, f. 6.

Argas moubata (Murray) Bedford, 1932, *Rep. Dir. Vet. Serv. and Anim. Indust., Un. S. Afr.*, XVIII, p. 280.

ADULTS. (Fig. 32).—Body oval, broadly rounded in front and behind and slightly constricted on a level with coxae iii and iv, usually measuring from 4×2.6 mm. to 12×10 mm., but we have one gorged female 15.5×12 mm. Colour usually brown with occasional dull ochreous patches, darker in gorged and preserved specimens. *Integument* mammillated, except along shallow grooves which disappear in gorged specimens, but remain recognisable by the absence of mammillae; short, pale setae present between the mammillae, more numerous in front. *Venter* with well-developed coxal folds and pre-anal groove, and three pairs of long furrows behind, also a short median depression. *Spiracles* crescentic, situated above the supra-coxal folds. *Eyes* absent. *Capitulum* free. *Palpi* with the first two segments equal in length, the third the shortest. *Hypostome* dentition 3/3 in front, the teeth smaller and more numerous posteriorly. *Legs* yellowish, well-developed, the fourth pair the longest. Coxae contiguous and diminishing from i to iv. Tarsi and pretarsi humped.

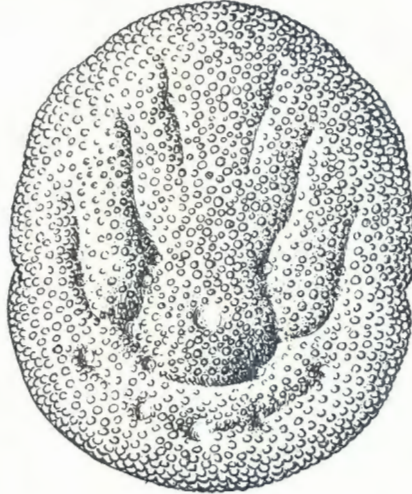


Fig. 32. *Argas moubata* Murray, dorsum of ♀.
C. G. Walker del.

NYMPHS.—The male nymphs undergo 3 to 5 and the female nymphs 3 to 7 ecdyses before moulting into adults. They resemble the adults, except for the absence of the sexual orifice, and the hypostome dentition, the teeth increasing, as Cunliffe has shown, each time the tick undergoes ecdysis. The first stage nymph measures 1.38×1.12 mm. when unfed, and from 1.5×1.2 mm. to 1.78×1.41 mm. after feeding. Full grown nymphs may attain the size of small adults.

LARVA. (Figs. 33, 34).—Body brown, sub-circular, measuring from 1.26×1.06 mm. to 1.34×1.13 mm. When developed the mammillae on the nymphal integument can be plainly seen. Hypostome dentition 1/1 (two files).

HOSTS.—It is chiefly parasitic on man, but also attacks domestic animals, rabbits, rats, mice and fowls. Adults and nymphs have also been taken off 44 tortoises (*Testudo oculifera* and *T. verreauxii*), Niekerk's Hope, Kimberley, C.P. (coll. J. H. Power).

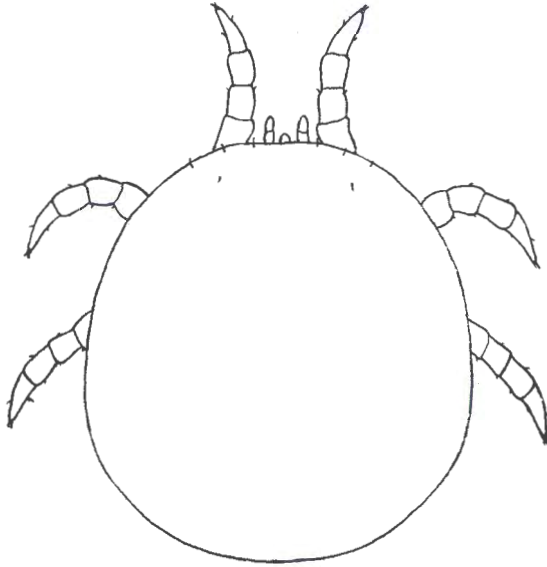


Fig. 33. *Argas moubata* Murray, dorsum of larva.
G. A. H. B. del.

GEOGRAPHICAL DISTRIBUTION.—The ticks are mainly found in native huts and in sand in desert-like localities. In the Transvaal specimens have been found at Lydenburg (Neumann), Acorn Hoek and Onderstepoort. In the Cape Province at Vryburg and other localities. It has also been recorded from Koffiefontein in the Orange Free State (Neumann), Natal (Howard), Bechuanaland, South-west Africa, Angola, Northern and Southern Rhodesia, Belgian Congo, French Congo, Cameroons, Kenya Colony, Uganda, Nyasaland, Tanganyika Territory, Zanzibar, Sudan (King), Abyssinia and Somaliland.

LIFE-CYCLE.—The life-history has been studied by Dutton and Todd (1905), Rodhain (1919), Cunliffe (1921) and Jobling (1924), and the process of copulation by Nuttall and Merriman (1911). The females lay their eggs in batches of from 28 or less to 340 after each feed, the greatest number being laid after the first and second meals, and the total number of eggs laid by a single female varies from about 44 to 1,217. The egg stage lasts 8 to 25 days, and the larvae on hatching are unable to feed. It has frequently been stated that they remain within the egg-shell, and differ from those of *A. savignyi* in this respect. However, both Jobling and myself have noticed that the larvae frequently free themselves from the egg-shell, and then become motionless and moult into nymphs 3 to 13 days later. After

SOUTH AFRICAN TICKS.

laying a batch of eggs, which takes on an average 7 days to accomplish, the female usually remains on them a few days longer until many have developed into their larvae or nymphs, and Jobling has noted that from 5 to 10 of the latter may usually be seen clinging to the ventral surface of the female, and may be transported by their parent some distance.

The male nymphs undergo 3 to 5 (usually 3) and the female nymphs 3 to 7 (usually 4) ecdyses before moulting into adults. Like the adults, they usually only attack their hosts at night and are ready to feed from 1 to 5 days after moulting, except the first stage nymphs, which require from 3 to 12 days. They feed but once between each ecdysis, taking from 13 to 87 minutes to gorge, those of the first stage and the stage preceding the adult usually taking the longest time to feed. The time they take to moult between each stage depends upon the preceding meal and not upon the preceding ecdysis. The shortest period a nymphal stage may last varies from about 5 to 9 days at 30° C. and from 9 to 13 days at 22° C.

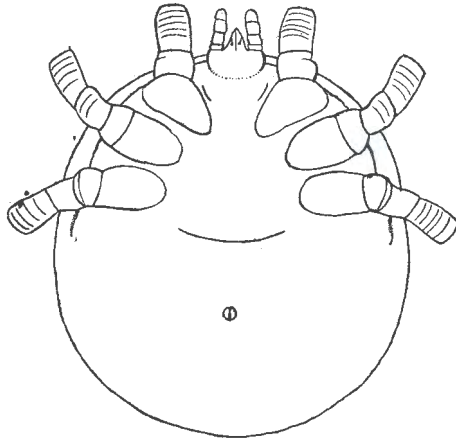


Fig. 34. *Argas moubata* Murray, venter of larva.

G. A. H. B. del.

The ratio of males to females is practically equal. Thus from one batch of 163 eggs, 72 males and 67 females were hatched (Jobling). The males are capable of fertilising the females before feeding and a single male may fertilise ten females, three before and seven after feeding (Jobling). In the males the interval between the last ecdysis and feeding is much longer than in the case of nymphs and females, the interval being from 1 to 5 days in the latter. The females can be fertilised immediately after the last ecdysis, also after they have laid several batches of eggs. Jobling also observed a female that was fertilised four or more times in succession. The females usually commence egg-laying about 8 days after feeding and fertilisation. They take from 21 to 92 minutes to feed. Cunliffe observed the minimum periods required for a tick to undergo metamorphosis from egg to adult are as follows:—

Moults	4	5	6		5	6	7
At 22° C.	♂ 64	87	104	♀	84	103	
At 30° C.	36	46	57		45	55	72

LONGEVITY.—Cunliffe kept a female performing normal functions alive for 862 days. The following were the longest periods he kept unfed ticks alive without food: A female for 105 days, a male for 244 days and a first stage nymph for 418 days.

TRANSMITTERS OF DISEASE.

RELAPSING FEVER OF TROPICAL AFRICA.—Although Livingstone, in 1857, suggested that tampans were responsible for the transmission of this disease in man, it was not until 1905 that Dutton and Todd in the Congo, and later Robert Koch, in Tanganyika Territory, experimentally proved that *A. moubata* transmitted *Treponema duttoni* (Novy and Knapp). The former authors not only found spirochaetes in the blood of monkeys on which they had fed ticks collected from native huts, but also made the important discovery that the offspring of infected ticks were capable of infecting animals on which they fed. Möllers (1907) has since shown that infected ticks do not lose the infection after feeding on six clean animals in succession. Furthermore, that the infection may be carried through to the third generation, even though the parents of these ticks had never fed on an infected animal.

Schuberg and Manteufel (1910) discovered that certain individuals of *A. moubata* may acquire an active immunity against infection with *T. duttoni*, and also *T. recurrentis*, and Hindle (1911a) found that about 30 per cent. of *A. moubata* from Uganda were immune to infection with *T. duttoni*.

Leichman (1909, 1910) studied the life-cycle of *T. duttoni* in the tick, and brought forward considerable evidence to show that at ordinary temperatures the salivary glands of the tick are not infected. This was confirmed by Hindle (1911a), who found that when ticks are kept at about 21° C. they harbour the parasites in the gut + contents, sexual organs, malpighian tubes and excrement, but not in the salivary glands and coxal fluid. When infected ticks were kept at a temperature of 35° C. for two or three days, the spirochaetes appeared in all the organs, and also in the coelomic fluid. The infection that may follow the bite of an infected tick would appear, therefore, to result from the entrance of the infective material, excreted by the tick whilst feeding, into the open wound caused by the tick's mouth-parts.

The incubation period in man after an infected tick has bitten is usually 5 to 11 days, but may last 19 days.

The disease has been reported to occur along the east of Africa from Abyssinia in the north to Zululand in the south; also from Angola, Congo Free State and Northern Rhodesia. The relapsing fever reported from Zululand (Hindle, 1911b) is probably the same disease, especially as *A. moubata* occurs in this country.

Neumann (1909) demonstrated that *T. duttoni* could occasionally be transmitted from rat to rat by means of the rat louse, *Polyplax* (= *Haematopinus*) *spinulosa* (Burm.).

OTHER RELAPSING FEVERS.—Manteufel (1909) showed that *A. moubata* could transmit *Treponema recurrentis* (Lebert), and Neumann (1909) transmitted *T. recurrentis*, *T. nocyi* (Schellack) and also *T. duttoni* by means of this tick. Brumpt (1908b), however, failed to transmit both the Algerian and American relapsing fevers with this species.

FOWL SPIROCHAETOSIS.—Fülleborn and Mayer (1908) and Brumpt (1908b) demonstrated that *A. moubata* could transmit *Treponema anserinum* Sakharoff (= *T. gallinarum* Marchoux and Salimbeni) to fowls.

ÆGYPTIANELLA PULLORUM CARPANO IN FOWLS.—Bedford and Coles (1933) failed to transmit the disease by feeding four adults of *A. moubata* on healthy chickens after they had fed on infected birds, and likewise failed by feeding nymphs, whose mother had previously fed on an infected fowl, on a healthy chicken.

DIPETALONEMA PERSTANS IN MAN.—Both Christy (1903) and Feldmann (1905) considered that *A. moubata* is capable of transmitting *Dipetalonema* (= *Filaria*) *perstans* (Manson) to man and Wellman (1907) observed a certain degree of development of *D. perstans* embryos in *moubata* raised from the egg. It is not known, however, to occur in the Union.

9. *Argas savignyi* Audouin.

“The Eyed Tampan Tick”.

Argas savignyi Audouin, 1827, *Des Égypte*, ed. 2, XXII, p. 426, pl. 9, f. 5.

Ornithodoros savignyi (Aud.) C. L. Koch, 1844, *Arch. Naturg.*, X, i, p. 219.

?*Ornithodoros morbillosus* Gerstaecker, 1873, *Decken's Reis, O.-Afr.*, III, ii, p. 464.

Argas schinzi Berlese, 1889, *Atti Soc. Veneto-Trent.*, X, p. 289, pl. 7, f. 5, 6.

Ornithodoros savignyi (Aud.), Nutt., Warb., Cooper and Robins., 1908, *Ticks: Mon. Lwod.*, i, p. 42, t.f. 58, 59-65, 70, 71 and pl. 2.

Ornithodoros savignyi (Aud.) Howard, 1908, *Ann. Trvl. Mus.*, I, ii, p. 83.

Ornithodoros savignyi (Aud.) Neumann, 1911, *Das Tierreich, Lwod.*, p. 123, f. 68, 69.

Ornithodoros savignyi (Aud.) Patton and Cragg, 1913, *A Textb. of Med. Ent.*, p. 586, pl. 72, f. 4, 5; pl. 75, f. 2, 3; pl. 83, f. 4-5; pl. 85, f. 7, 9.

Argas savignyi (Aud.) Bedford, 1932, *Rep. Dir. Vet. Serv. and Anim. Indust., Un. S. Afr.*, XVIII, p. 282, f. 7.

The adults (Fig. 3) and nymphs differ from those of *A. moubata* in possessing eyes, there being one pair on each side on the supra-coxal folds.

HOSTS.—It is chiefly parasitic on man, and Lounsbury (1899) has recorded it from dog, horse, cattle, goat, pig and fowls. Patton and Cragg (1913) state that it feeds on camels, and is common along the camel caravan tracks in the Aden Hinterland. It also feeds on sheep (Howard, 1908) and rabbits.

GEOGRAPHICAL DISTRIBUTION.—This species is mainly found in loose soil in the shade of trees and rocks in desert-like localities; probably also in native huts. It is widely distributed in Africa and also occurs in parts of Asia. Lounsbury has recorded it from the Cape Province, Bechuanaland, Transvaal, Rhodesia and Portuguese East Africa. Two adults were found by the Verney-Lang Expedition to the Kalahari on sandy ground at Damara Pan, 1930. It has also been recorded from South-west Africa, Tanganyika Territory, Egypt (type locality), Sudan (King), Somaliland, Abyssinia, Nubia, Aden, Arabia and India.

LIFE-CYCLE.—The life history, which is similar to that of *A. moubata*, has been studied by Patton and Cragg (1913) and Cunliffe (1922). The females lay their eggs in batches of from 4 to 174 after each feed, and the total number of eggs laid by a single female varies from 100 to 417. The egg-stage lasts 7 to 28 days at 30° C., and the larvae on hatching are unable to feed. They usually free themselves from the egg-shell, but a small number may remain within the shells; they moult into nymphs after remaining motionless for 4 to 9 days. The male nymphs undergo 3 to 5 (usually 4) and the female nymphs 4 to 6 (usually 5) ecdyses before moulting into adults. Like the adults they usually only attack their hosts at night, and, as a rule, they feed but once between each ecdysis, taking from 10 to 74 minutes to gorge. The time they take to moult between each stage depends, as in the case with *A. moubata*, upon the preceding meal and not upon the preceding ecdysis. The shortest period a nymph stage may last varies from 8 to 15 days at 30° C. (Cunliffe). According to this observer the minimum periods required for a tick to undergo metamorphosis from egg to adult are as follows:—

Moults... ..	4	5	6	♀	5	6	7
At 30° C.	♂ 60	73	89	♀	73	88	103

LONGEVITY.—Cunliffe kept a female performing normal functions alive at 30° C. for 420 days, and three females under similar conditions at 22° C. had an average life of 775 days.

TRANSMITTER OF DISEASE.—Brumpt (1908b) proved by experiments on animals that this species can transmit a spirochaete derived from cases of human relapsing fever occurring in Abyssinia.

10. *Argas pavimentosus* (Neumann).

Ornithodoros pavimentosus Neumann, 1901, *Mém. Soc. Zool. France*, XIV, p. 257.

Ornithodoros pavimentosus (Neu.) Dönitz, 1906, *Sitz.-Ber. Ges. naturf. Freunde*, p. 145, f. 2, 3.

Ornithodoros pavimentosus (Neu.) Nutt., Warb., Cooper and Robins., 1908, *Ticks; Mon. Lood.*, i, p. 62, f. 90-92.

Ornithodoros savignyi var. *pavimentosus* (Neu.) Howard, 1908, *Ann. Trl. Mus.*, I, ii, p. 87, pl. 3, figs. f, h.

Ornithodoros pavimentosus (Neu.) Dönitz, 1910, *Die Zecken Südafr.*, p. 413, pl. 16A, f. 8, 9.

Argas pavimentosus (Neu.) Bedford, 1932, *Rep. Dir. Vet Serv. and Anim. Indust., Un. S. Afr.*, XVIII, p. 281.

This species differs from *A. savignyi* in having the body covered with contiguous flat granulations which are smaller on the depressed areas, and the protarsi and tarsi of legs i, ii and iii are much shorter with the dorsal protuberances arranged closer together. Coarse setae present on body, especially numerous anteriorly.

Described by Neumann from a single female collected at Bethany, South-west Africa, and by Dönitz from numerous specimens collected by Schultze, also in Namaqualand. Schultze reported that they were common in places where travellers rest, attacking men when they lie upon the ground. Howard records receiving numerous specimens from South-west Africa, and states that the life history of the tick resembles that of *moubata* (= *caecus*) in the main.

Family IXODIDAE.

Key to the Genera.

1. Integument of body leathery, having a definite pattern and resembling that of Argasidae; scutum resembling the rest of body-integument, especially parts thereof; palpi short, the joints flexible, the third and fourth cylindrical, the latter being terminal; eyes absent; anal groove curving in front of anus *Nuttalliella* Bedford, p. 95
- Integument of body without a definite pattern; scutum not resembling rest of body-integument; palpi long or short, joints not flexible, the fourth situated ventrally at the distal end of the third segment 2
2. Anal grooves surrounding the anus in front or circular 3
- Anal grooves surrounding the anus behind (in *Boophilus* and *Margaropus* the anal groove is faint or obsolete) 4
3. Inornate, eyes and festoons absent; males with a pregenital, median, anal, two adanal and two epimeral plates on the venter. *Loödes* Latr.
4. Hypostome and palpi short 5
- Hypostome and palpi long 10
5. Eyes absent *Haemaphysalis* Koch.
- Eyes present 6
6. Festoons present 7
- Festoons absent 9
7. Males with coxae iv much larger than coxae i to iii, no plates or shields on ventral surface of male 8
- Males with coxae iv not larger than coxae i to iii, a pair of adanal shields and usually a pair of accessory adanal shields on ventral surface of male. Species usually inornate, basis capituli generally hexagonal dorsally. *Rhipicephalus* Koch.
8. Species ornate, basis capituli rectangular dorsally. *Dermacentor* Koch.
- Species inornate, basis capituli hexagonal dorsally with prominent lateral angles. Coxae iv of male with two long spines... .. *Rhipicentor* Nutt. and Warb.

- 9. Inornate; coxae i with a small spine. Male with median plate projecting backwards on either side of the anus, and with a caudal protrusion when engorged. Fourth pair of legs of male dilated *Margaropus* Karsch.
- Inornate; coxae i bifid. Male with a pair of adanal and accessory shields, and a caudal protrusion. Fourth pair of legs normal *Boophilus* Curtis.
- 10. Eyes present 11
- Eyes absent or rudimentary 12
- 11. Festoons absent or present. Males with a pair of adanal shields and two posterior abdominal protrusions, accessory adanal shields absent or present *Hyalomma* Koch.
- Species usually ornate; festoons present. Male without adanal shields, but small plaques may be present on the venter near the festoons *Amblyomma* Koch.
- 12. Species occurring almost exclusively on Reptilia.
Aponomma Neumann.

As the larvae do not always exhibit generic characters, the following key will serve to differentiate the known South African species:—

Key to the known South African Larvae.

- 1. Eyes absent 2
- Eyes present 8
- 2. Palpi long and slender 3
- Palpi short, salient laterally 6
- 3. Scapulae not projecting forwards; anal groove, if present, surrounding the anus in front 4
- Scapulae prominent, projecting forwards; anal groove contouring the anus behind; coxae i-iii each with a well-developed spur *Aponomma exornatum* Koch.
- 4. Basis capituli with lateral margins sub-parallel.
Ixodes simplex Neu., f. 36.
- Basis capituli with lateral margins otherwise 5
- 5. Hypostome with 10 outer teeth on each side, and 3 rows of 3/3; palpi very long *Ixodes ugandanus* Neu., f. 37.
- Hypostome with 8 outer teeth on each side, and 2 rows of 3/3; palpi shorter *Ixodes pilosus* Koch, f. 35.
- 6. First joint of palpi with a retrograde process on venter, basis capituli without cornua; coxae unarmed, rounded posteriorly *Haemaphysalis leachii* (Aud.) f. 38
- First joint of palpi without a retrograde process; coxae ii-iii unarmed 7
- 7. Basis capituli without cornua; coxa i with a pointed internal spur *Haemaphysalis parvata* Neu. (f. 39).
- Basis capituli with cornua; coxa i with a slight blunt spur.
Haemaphysalis hoodi Warb. and Nutt. (f. 41).
- 8. Palpi and hypostome short 9
- Palpi long and slender; hypostome long 16

9. Basis capituli pointed laterally; scapulae with prominence on inner margin 10
 Basis capituli with lateral margins rounded 12
10. Basis capituli with very acute lateral angles.
Rhipicephalus simus Koch (f. 44).
 Basis capituli with lateral angles less acute 11
11. Scutum more than twice as long as broad, with posterior margin only slightly convex.
Rhipicephalus sanguineus (Latr.) (f. 45).
 Scutum less than twice as long as broad, with posterior margin considerably more convex.
Rhipicephalus appendiculatus Neu. (f. 43).
12. Scutum almost as long as broad; scapulae with prominence on inner margin *Rhipicephalus cvertsii* Neu. (f. 42).
 Scutum considerably wider than long; scapulae without prominence on inner margin 13
13. Palpi very broad; scutum almost twice as wide as long, with posterior margin semicircular.
Margaropus winthemi Karsch (f. 46).
 Palpi narrower, especially at apex; scutum longer in proportion to width 14
14. Palpi shaped as in fig.
Rhipicentor nuttalli Cooper and Robins. (f. 40).
 Palpi shaped as in figs 15
15. Posterior margin of scutum semi-circular.
Boophilus microplus (Can.) f. 48).
 Posterior margin of scutum more sharply rounded.
Boophilus decoloratus (Koch) (f. 47).
16. Scutum 0.28 × 0.37 mm. with posterior margin rounded.
Hyalomma aegyptium impressum Neu. (f. 49).
 Scutum wider, 0.26 × 0.46 mm., with posterior margin more pointed *Amblyomma hebraeum* Koch (f. 50).
Amblyomma variegatum (Fabr.).
Amblyomma nuttalli Dönitz.

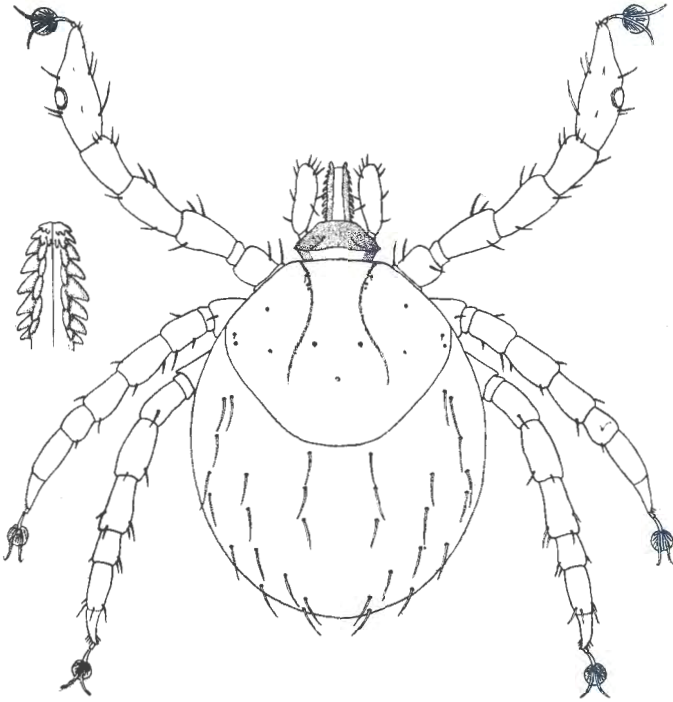


Fig. 35. *Ixodes pilosus* Koch, dorsum of unfed larva and hypostome.
G. A. H. B. del.

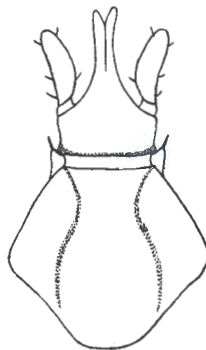


Fig. 36. *Ixodes simplex* Neu., capitulum and scutum of larva.
G. A. H. B. del.

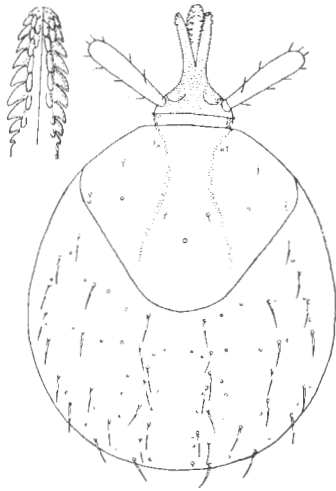


Fig. 37.

Fig. 37. *Ixodes ugandanus* Neu., dorsum of unfed larva and hypostome.
G. A. H. B. del.

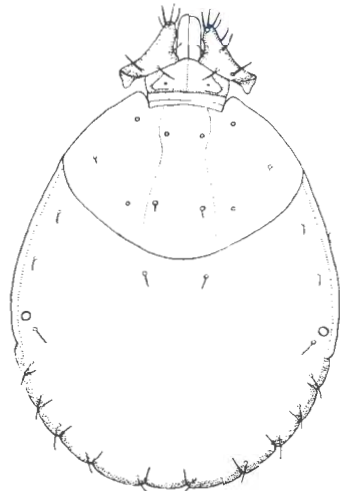


Fig. 38.

Fig. 38. *Haemaphysalis leachii* (Aud.), dorsum of unfed larva.
G. A. H. B. del.

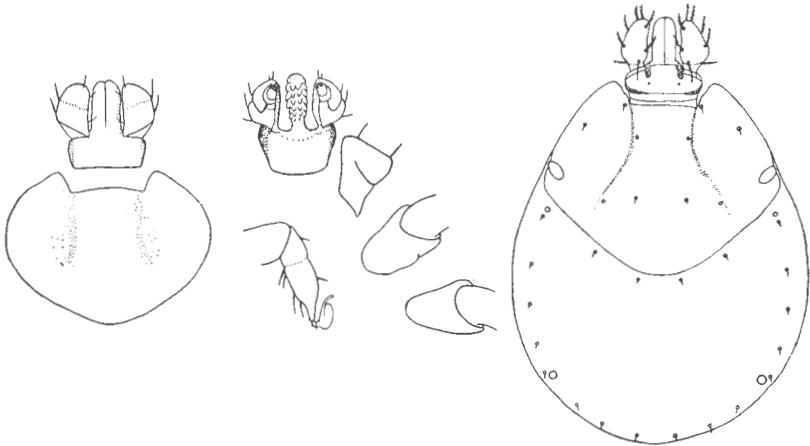


Fig. 39.

Fig. 39. *Haemaphysalis parvata* Neu., Larva. Scutum, capitulum in dorsal and ventral aspect, coxae and tarsus iii. (After Nuttall and Warburton.)

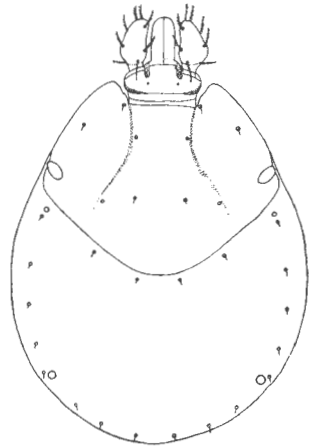


Fig. 40.

Fig. 40. *Rhipicentor nuttalli* Cooper and Robins, dorsum of unfed larva.
G. A. H. B. del.



Fig. 41.

Fig. 42.

Fig. 41. *Haemaphysalis hoodi* Warb. and Nutt., larva, scutum, capitulum in dorsal and ventral aspect, coxae and tarsus iii. (After Nuttall and Warburton.)

Fig. 42. *Rhipicephalus evertsi* Neu., dorsum of unfed larva.
G. A. H. B. del.

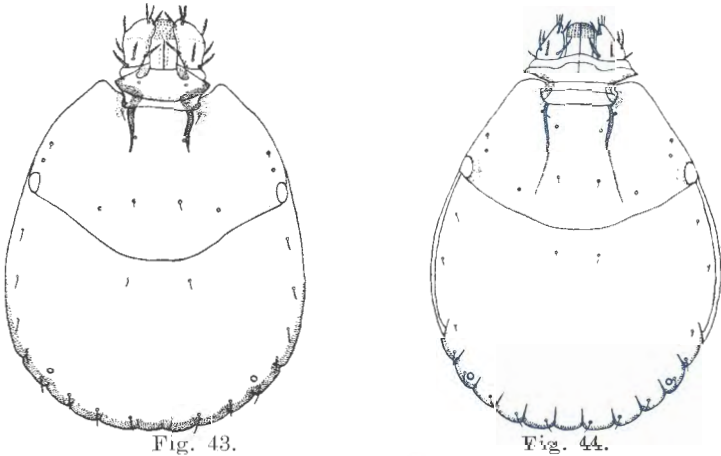


Fig. 43.

Fig. 44.

Fig. 43. *Rhipicephalus appendiculatus* Neu., dorsum of unfed larva.
G. A. H. B. del.

Fig. 44. *Rhipicephalus simus* Koch, dorsum of unfed larva.
G. A. H. B. del.

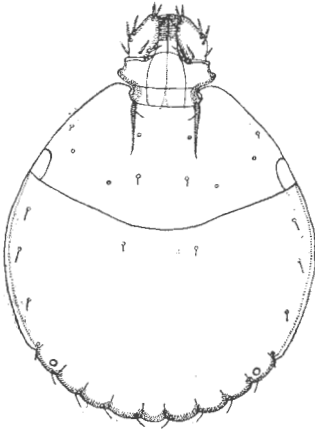


Fig. 45.

Fig. 45. *Rhipicephalus sanguineus* (Latr.), dorsum of unfed larva.
G. A. H. B. del.

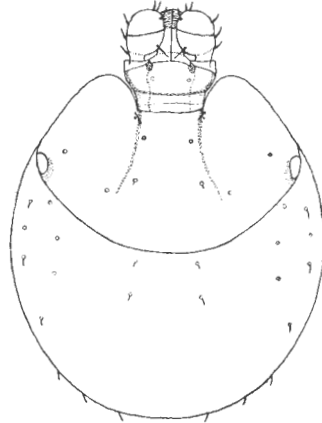


Fig. 46.

Fig. 46. *Margaropus winthemi* Karsch, dorsum of unfed larva.
G. A. H. B. del.

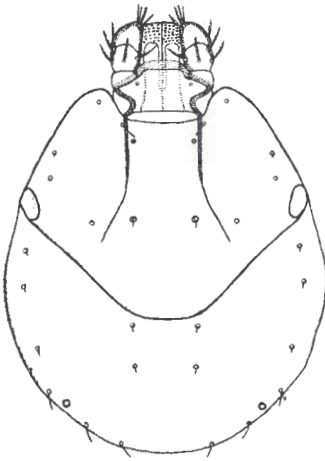


Fig. 47.

Fig. 47. *Boophilus decoloratus* (Koch), dorsum of unfed larva.
G. A. H. B. del.

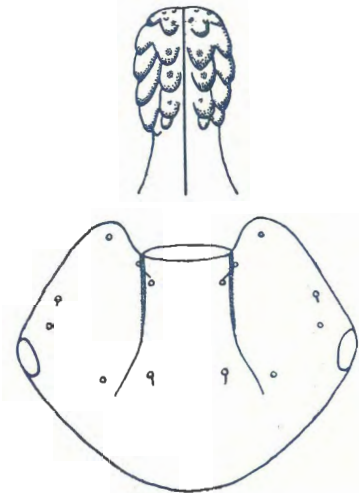


Fig. 48.

Fig. 48. *Boophilus microplus* (Can.), larva, scutum and hypostome.
G. A. H. B. del.

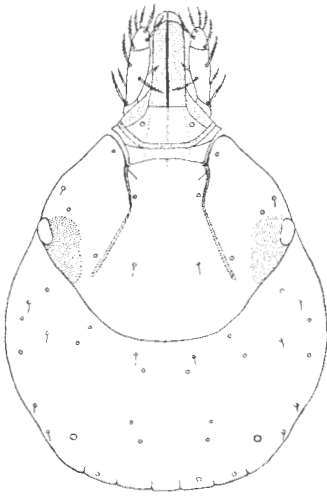


Fig. 49.

Fig. 49. *Hyalomma aegyptium impressum* Neu., dorsum of unfed larva.
G. A. H. B. del.

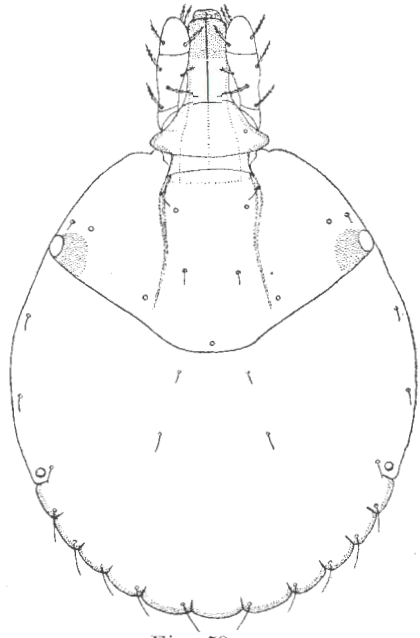


Fig. 50.

Fig. 50. *Amblyomma hebraeum* Koch, dorsum of unfed larva.
G. A. H. B. del.

Genus *NUTTALLIELLA* Bedford.

Nuttalliella Bedford, 1931, *Parasit.*, XXIII, ii, p. 231.

FEMALE CHARACTERS.—*Integument of body* leathery, having a definite pattern (see figs. 52, 53) and resembling that of Argasidae, more especially certain *Argas* spp. *Scutum* somewhat resembling the rest of the body-integument, especially parts thereof. *Eyes* absent. *Capitulum* situated on anterior margin; porose areas absent. *Hypostome* very short. *Chelicerae* present. *Palpi* short, the joints very flexible; basal segment very small, the second much the largest and grooved on inner surface; the third and fourth cylindrical, the latter terminal. *Anal groove* curving in front of anus. *Genital* and *dorsal grooves* absent. *Festoons* absent. *Legs* with most of the joints incised apically on the ventral side; coxae i and ii situated close together; coxae ii, iii and iv widely separated; tarsi without spurs. Haller's organ present on tarsus i.

This genus contains a single species, *Nuttalliella namaqua* Bedford.

***Nuttalliella namaqua* Bedford.**

Nuttalliella namaqua Bedford, 1931, *Parasit.*, XXIII, ii, p. 231, text fig. 1, pl. 10, f. 1, 2.

ENGORGED FEMALE (Figs. 51-53) (f. 50).—Body slate-coloured, slightly wider behind than in front, 4×3.5 mm., integument pitted (fig. 51), the pits being very shallow and more or less equidistant apart. *Capitulum* (fig 51 A.B.) orange-coloured with base very short dorsally, elongated ventrally (0.42×0.27 mm.), having the lateral margins parallel, the anterior margin straight and the posterior margin slightly convex. *Hypostome* with one or two very rudimentary teeth. *Scutum* (fig. 514) considerably wider than long (0.57×1.07 mm.), with two large very deep depressions behind, one

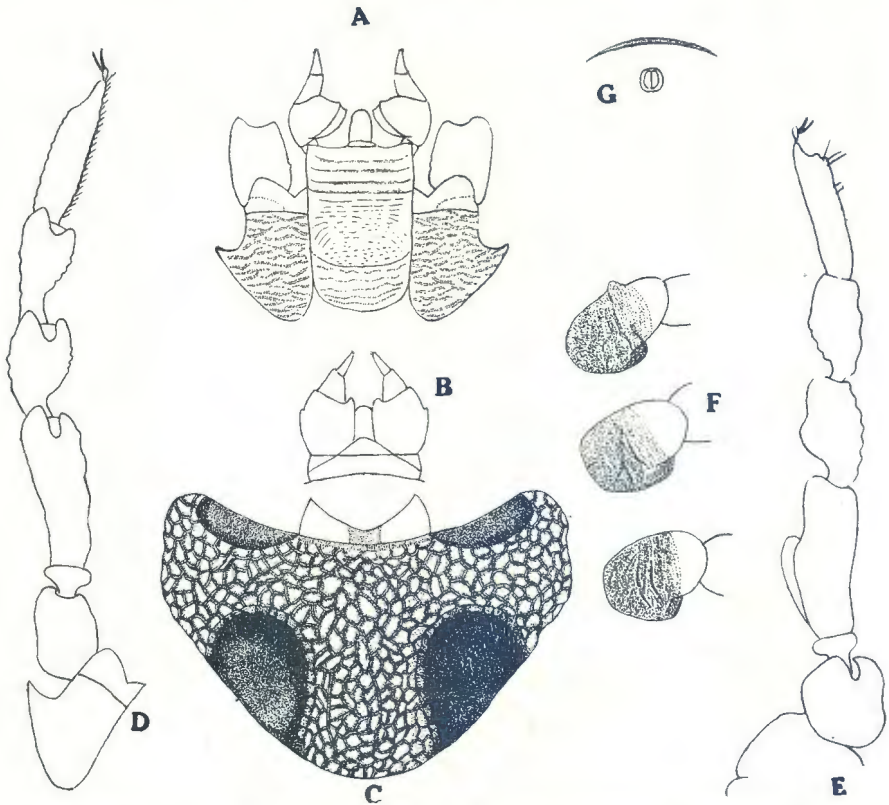


Fig. 51. *Nuttalliella namaqua* Bedford. A. Capitulum and coxae i in ventral aspect. B. Capitulum in dorsal aspect. C. Scutum. D. First leg, ventral aspect. E. First leg, lateral aspect. F. Coxae ii-iv, drawn separately. G. Anus with crescentic pre-anal groove.

G. A. H. B. del.

on each side on the posterior margin, and two smaller ones on the anterior margin; these depressions are dark and closely resemble the rest of the integument of the body, so much so that it is difficult to see the dividing line between them; the rest of the scutum is pale in colour and honeycombed with deep irregular pits. It is situated well forward on the anterior margin, lies almost at right angles to the capitulum, and can, therefore, hardly be seen when the tick is viewed from above. In an unengorged specimen it probably lies in the same or almost the same plane as the capitulum. *Legs* orange-



Fig. 52. *Nuttalliella namaqua* Bedford, dorsum of engorged female.

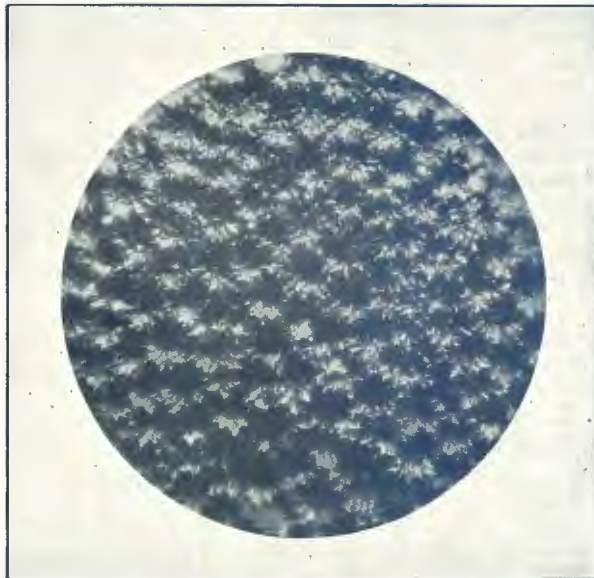


Fig. 53. *Nuttalliella namaqua* Bedford, portion of body integument highly magnified.

coloured, pale at the apices of the joints, except coxae ii-iv, which are dark basally and pale apically; coxa i with a large spur on its outer margin; coxa ii with a small spur on its anterior margin; coxae iii and iv unarmed, the remainder of the joints of legs ii to iv very similar to those of the forelegs, which are shown in figs. 51, D and E. *Genital opening* situated between coxae ii. Anus clothed with numerous minute setae, and situated a short distance in front of the posterior margin. *Anal groove* (fig. 51 G) rudimentary, pre-anal, and does not continue backwards towards the posterior margin.

The type is deposited in the South African Museum, Capetown. This species was described from an engorged female collected under a stone at Kamieskroon, Little Namaqualand, by Dr. R. F. Lawrence in October, 1930. Dr. Lawrence informs me that rock-rabbits were probably the commonest animals about the hill where he found it, but the host of the tick may be a bird.

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